Technical Appendix 2.1: Project Description Details

2.1.1 Turbine and Met Mast Locations

Table 2.1.1: Turbine and Met Mast Locations (British National Grid, OS GB 1936 Datum)

Reference (per Fig 1.2)	Easting	Northing
K42	439200	1159693
K43	439331	1159224
K44	439334	1158729
K45	439057	1158289
K46	438876	1158772
K47	438563	1158245
K48	438313	1157780
K49	438270	1158616
K50	438785	1157856
K51	439404	1158000
K52	439561	1157442
K53	439101	1157308
K54	438962	1156847
K55	438632	1157104
K56	438491	1156615
K57	439489	1156742
K58	438999	1156347
K59	439398	1156236
K60	438654	1155671
K61	438208	1155282
K62	438100	1154776
K63	437621	1154621
K64	437312	1154199
K66	436798	1154695
K67	436790	1155360
K68	436872	1156166
K69	437266	1155282
K70	437141	1155852
K71	437342	1156409
K72	437608	1156020
K73	438014	1154128
K74	437905	1153627
K75	437434	1153720
K76	437817	1152764
K77	437356	1152817
K78	440776	1160883
K79	440772	1160385
K80	440854	1159914
K81	440900	1159430
K82	440933	1158934
K83	440988	1158452
K84	441035	1157978
K85	441080	1157495
K86	441054	1156994
K87	441013	1156498
K88	440965	1155996
N89	441852	1160764
N90	441915	1161255
N91	442257	1161670

Table 2.1.1: Turbine and Met Mast Locations (British National Grid, OS GB 1936 Datum)

Reference (per Fig 1.2)	Easting	Northing
N92	442691	1161878
N93	442916	1162371
N94	443200	1161794
N95	443433	1162282
N96	443943	1162196
N97	443735	1161713
N98	443806	1161179
N99	444086	1161553
N100	442098	1160426
N101	442442	1160143
N102	442621	1160660
N103	442333	1160948
N104	442620	1161400
N105	443093	1160969
N106	441689	1160100
N107	442006	1159772
N108	442271	1159384
N109	442108	1158903
N110	442458	1156070
N111	442687.6	1155652
N112	442884	1155239
N113	443239	1156095
N114	443721	1155951
N115	443562	1155460
N116	443208	1156783
N117	443652	1156725

Table 2.1.1: Turbine and Met Mast Locations (British National Grid, OS GB 1936 Datum)

Reference (per Fig 1.2)	Easting	Northing
N118	444080	1157082
N119	444204	1157575
N120	443752	1157787
N121	443509	1157280
N122	443835	1158308
N123	444294	1158559
N124	444792	1158632
N125	444013	1158919
N126	444469	1159061
N127	444829	1159527
N128	444960	1159141
N129	444681	1157604
N130	444612	1157115
N131	444316	1156655
N132	444379.9	1156174
N137	444806.5	1156649
N138	445073	1158295
N139	444570	1158179
N140	445257	1158832
N141	445562	1158314
N142	446086	1158412
N143	445302	1157718
N144	445595	1157383
N145	445766	1156959
N147	446130	1157523
N148	445828	1157861

Table 2.1.1: Turbine and Met Mast Locations (British National Grid, OS GB 1936 Datum)		
Reference (per Fig 1.2)	**Easting**	**Northing**
N149	446380	1157963
N150	445315	1156780
MM1	444170	1161727
MM2	442087	1158797
MM3	446208	1158337
MM4	442586	1155513
MM5	440900	1155783
MM6	437272	1152640
MM7	437299	1156667

2.1.2 Land Use Areas

2.1.2.1 Table 2.1.2 sets out the area of land disturbed during construction operations. This land would be reinstated following the completion of construction and commissioning work.

Table 2.1.2: Land Use Areas Disturbed During Construction		
Wind Farm Element	**Area (sq m)**	**Assumptions**
Temporary Site Facilities Compound	40,000	(100m x 100m) x 4
Temporary Storage Area	4,900	(35m x 35m) x 4
Temporary turbine laydown areas at each turbine (hardstand for assist crane, blade and tower storage)	113,300	2,500m^2 (Chp2, para 2.3.9) – 1,400m^2 (Turbine crane hardstanding) * 103
Concrete batching plant	20,000	(100m x 100m) x 2
Site Entrance Office and Layby	0	Within Facilities Compound
Borrow pit search areas	136,238 (with NBP03) 138,206 (with NBP04) ***Either NBP03 or NBP04 would be used, not both.***	Borrow Pit 1 (KBP01) = 12,350 sq m Borrow Pit 2 (KBP02) = 14,140 sq m Borrow Pit 3 (KBP03) = 14,690 sq m Borrow Pit 4 (KBP04) = 13,410 sq m Borrow Pit 5 (KBP05) = 5,725 sq m Borrow Pit 6 (NBP01) = 25,360 sq m Borrow Pit 7 (NBP03) = 7,403 sq m Borrow Pit 8 (NBP04) = 9,371 sq m Borrow Pit 9 (NBP05) = 21,700 sq m Borrow Pit 10 (NBP06) = 21,460 sq m
Permanent substation/control building	25,754.4	Using Figure 2.7, assumed 2 rectangles: ((210.1m x 94.8m) + (153.2m x 38.1m))
Turbine crane hardstanding	144,200	1,400 sq m per turbine
Turbine foundation	50,560.022	Area = πr^2 radius = 12.5 m 490.874 sq m per turbine
Cut access track	404,433	44937 (length) x 9 (width)
Floating access track	156,714	26119 (length) x 6 (width)
Total	**959,861 sq m**	

2.1.2.2 Table 2.1.3 sets out the area of permanent land use change made a result of the proposed development.

Table 2.1.3: Permanent Land Use Areas During Operation		
Wind Farm Element	**Area (sq m)**	**Assumptions**
Permanent substation/control building	25,754.4	Using Figure 2.7, assumed 2 rectangles: ((210.1m x 94.8m) + (153.2m x 38.1m))
Turbine crane hardstanding	144,200	1,400 sq m per turbine
Turbine foundation	50,560.022	Area = πr^2 radius = 12.5 m 490.874 sq m per turbine
Cut access track	404,433	44937 (length) x 9 (width)
Floating access track	156,714	26119 (length) x 6 (width)
Total	**781,661 sq m**	

APPENDIX 2.2: SITE ENVIRONMENTAL MANAGEMENT PLAN

Information contained within the ES Addendum Site Environmental Management Plan (Appendix 14.6) remains valid for the purpose of supporting the 2018 EIA Report and thus has been included.

APPENDIX A14.6

SITE ENVIRONMENTAL MANAGEMENT PLAN

viking energy

Harnessing Shetland's natural resources

SITE ENVIRONMENTAL MANAGEMENT PLAN

VIKING WIND FARM

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

CONTENTS

DOCUMENT CONTROL SHEET

SECTIONS

VERSION			
Version No. :	**Description:**		**Date:**
1.0	**Viking Energy Partnership Addendum ES SEMP**		**Feb 2010**
	Name :	**Position :**	**Signature :**
Prepared by :	Jane MacDonald	Environmental Manager	
Checked by :	Oliver Moffat, BMT Cordah	Lead EIA Coordinator	
Reviewed by :	Viking Energy Partnership and all relevant consultants.	n/a	
Comments:	This version of the SEMP has been prepared as part of the Addendum ES and takes into account responses received from all statutory bodies in relation to the 2009 Environmental Statement.		
2.0	**Construction Phase SEMP**		
	Name :	**Position :**	**Signature :**
Prepared by :			
Checked by :			
Reviewed by :			
Comments:	Version 2.0 of the SEMP will be prepared following planning consent. Changes to the SEMP will be made to take into account requirements of relevant planning conditions. Version 2.0 will form part of the construction contract between Viking Energy Partnership and the appointed Contractor.		

1 INTRODUCTION

1.1 Site Environmental Management Plan (SEMP): Aims & Objectives

1.1.1 This Site Environmental Management Plan (SEMP) is provided as Appendix A14.6 to the Addendum Environmental Statement (ES) and has been developed in accordance with the Institute of Environmental Management and Assessment (IEMA) Practitioner "Environmental Management Plans", Best Practice Series, Volume 12, December 2008.

1.1.2 Viking Energy Partnership commit to safeguarding the environment through the identification, avoidance and mitigation of the potential negative environmental impacts associated with the development, construction, operation and decommissioning of the Viking wind farm.

1.1.3 The principle objective of the SEMP is to avoid, minimise and control adverse environmental impacts associated with the development of the wind farm.

1.1.4 This SEMP aims to define good practice as well as specific actions required to implement mitigation requirements as identified in the Environmental Statement (ES), the planning process and/or other licensing or consenting processes.

1.1.5 The SEMP is considered to be a live document which will be developed further and / or amended where necessary subsequent to planning consent to take account of planning condition requirements and any information which may be made available from additional consultations, site surveys etc.

1.1.6 The SEMP will form part of the main civils construction works Contract. The *Contractor* will take account of the structure, content, methods and requirements contained within the various sections of this SEMP when developing their detailed SEMP (including environmental plans and other related construction method statements) as required by the Contract.

1.1.7 While this version of the SEMP provides a benchmark for good practice, where avoidance or further minimisation of risks to the environment can be demonstrated through use of alternative methods or improvements to current practices the *Contractor* will implement these wherever possible.

1.2 SEMP Development & Implementation

1.2.1 There are two main stages in the development of the SEMP, each of which produces a revised version, as detailed below:

Version 1.0 Version 1.0: The SEMP, including all technical schedules, is prepared as part of the EIA for inclusion within the ES, or in this case the addendum ES. The documents are reviewed by all relevant consultants involved in preparation of the Addendum ES chapters to ensure consistency with required mitigation measures and input of site specific information. In this case, SEPA has been provided with draft versions of relevant SEMP documents for discussion as part on-going consultations during the ES / Addendum production. All comments and input received throughout this process are incorporated into Version 1.0.

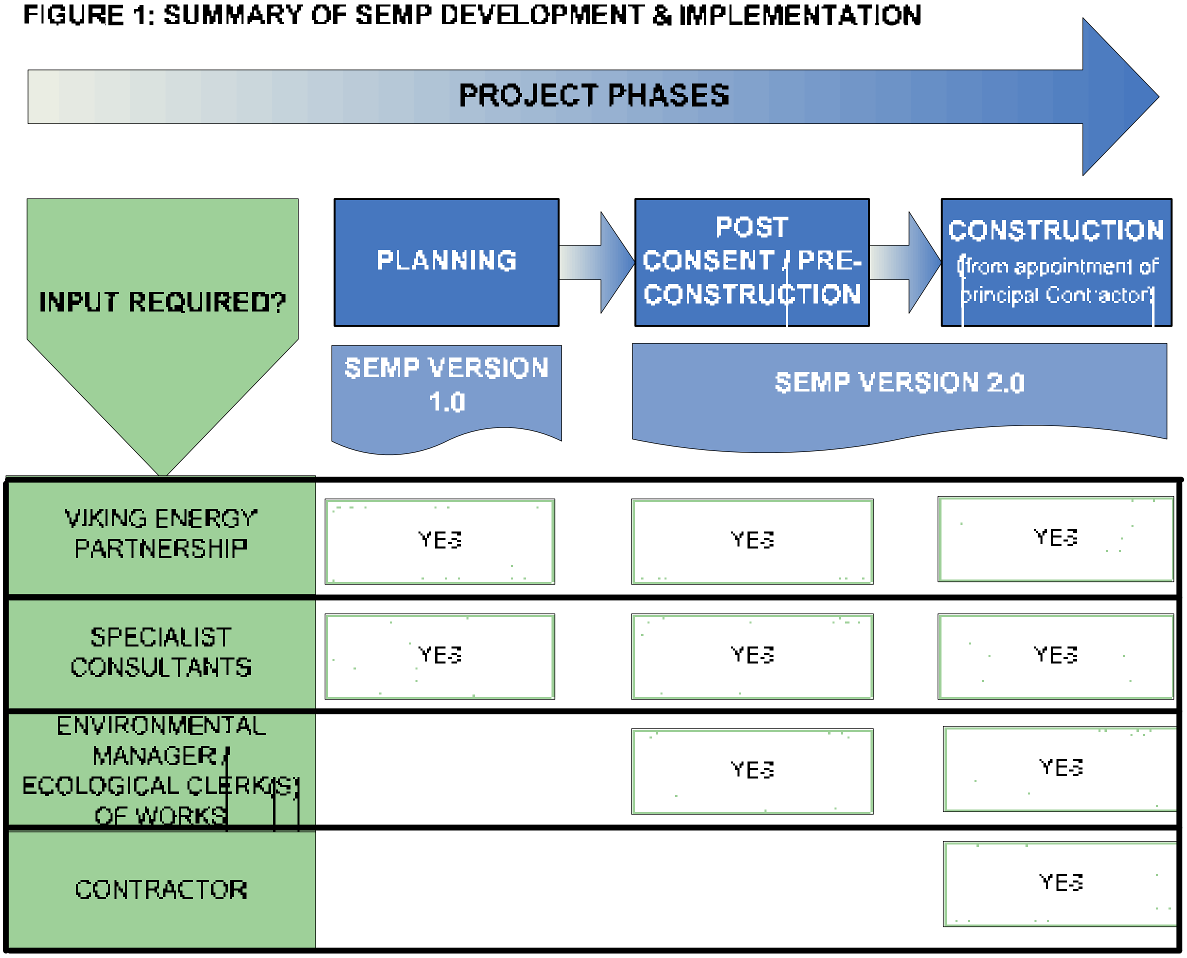
Version 2.0 Version 2.0 of the SEMP will be prepared following planning consent. Changes to the SEMP will be made to take into account requirements of relevant planning conditions. Version 2.0 will form part of the construction contract between Viking Energy Partnership and the appointed *Contractor*. Version 2.0 becomes a live document on site and will be developed further by the *Contractor* with site specific method statements and plans as required prior to each phase of the works. Version

2.0 is also effectively a document management system for recording information and data relating to environmental checks, reports, surveys, monitoring data and auditing. Upon completion of the construction works, the *Contractor* will submit a complete CD copy of the final SEMP to Viking Energy Partnership for their records

1.2.2 While version numbers will remain fixed depending on the stage of the project, it is acknowledged that the SEMP is a continually evolving document which can be updated in part or whole at any stage of the project. Hence, revision and document distribution records are included at the front of each SEMP document to enable individual documents to be updated at any time.

1.2.3 A summary of the SEMP development process and the required input from the main parties involved in the planning and construction of the wind farm is indicated in Figure 1.

FIGURE 1: SUMMARY OF SEMP DEVELOPMENT & IMPLEMENTATION



1.3 SEMP Roles & Responsibilities

1.3.1 Figure 2 illustrates the SEMP development process and outlines roles & responsibilities at each stage of the wind farm development and construction.

1.3.2 This SEMP (Version 1.0) has been prepared by Viking Energy Partnership. Viking Energy Partnership will be responsible for further development of the SEMP in line with planning condition requirements (Version 2.0). This will involve liaison with the planning authority, SEPA, SNH and other relevant bodies where appropriate.

1.3.3 Prior to commencement of construction works, Viking Energy Partnership will identify a core Environmental Management Group, comprising of specific project personnel and including an Environmental Manager and/or Ecological Clerk of Works (ECoW). The Environmental Management Group will meet monthly to discuss the monthly environmental report and will advise site personnel on areas where improvements may be made on site. The group will draw on technical expertise from relevant specialists where required and will liaise with other relevant external bodies, such as a proposed Shetland Wind Advisory Group (SWEAG).

1.3.4 Viking Energy Partnership will appoint an Environmental Manager who will be responsible for coordination and development of the SEMP and any other surveys, reports or method statements required for discharge of relevant pre-commencement planning conditions. In conjunction with the ECoW, the Environmental Manager will also review the Contractors method statements and environmental plans as required by the SEMP, carry out compliance auditing during the construction phase and coordinate the Environmental Management Group and required liaisons between Viking Energy Partnership, the *Contractor*, the planning monitoring officer (PMO) and other statutory authorities.

1.3.5 Viking Energy Partnership will appoint an independent Ecological Clerk of Works (ECoW). The main roles and responsibilities of the ECoW relate to compliance monitoring with the SEMP and planning conditions and advice provision in relation to ecological matters. The ECoW will also assist the Environmental Manager.

1.3.6 The *Contractor* will also appoint an appropriately qualified person(s) to undertake development, implementation and auditing of their detailed SEMP.

FIGURE 2.0:
SEMP DEVELOPMENT AND ROLES & RESPONSIBILITIES

Main Contractor (Civil Engineering Construction)	Specialist Environmental Consultants	Viking Energy Partnership	Planning Authority & Relevant Statutory Consultees
PLANNING STAGES – (surveys, data collation, liaison with 3rd parties, EIA, ES submission)			
	All consultants to **review and input into template SEMP Vers. 1.0** (revise to be site-specific and in line with ES and Addendum, including liaison with Authorities/clarification of issues). Lead consultant to coordinate collation of final **SEMP Vers 1.0**	**SEMP Vers. 1.0** Provide initial Template SEMP Vers 1.0 (including Technical Schedules). Consultation and liaison with Authorities/clarification of issues. Collation of **SEMP Vers 1.0** and all other EIA/ES documents for **submission to Authorities**	Early consultation with developer Review Planning Application Issue **(Conditional) Planning Consent**
POST – CONSENT / PRE – CONSTRUCTION			
Appoint **appropriately qualified person** (to undertake development, implementation and auditing of the SEMP prior to, during and upon completion of the construction works. Provide **Method Statements.** Provide **all relevant environmental plans** and incorporate into **SEMP Vers 2.0.** Submit to VEP **at least 4 weeks** prior to start of construction works for review.	Input / Preparation of documents to discharge Conditions as far as possible pre-construction. Undertake **Baseline monitoring and further surveys** if required. Ecological and/or Environmental Clerk of Works (EcoW) Review / comment on Contractor's submissions and relevant detailed SEMP sections. In liaison with SSE.	Address Consent Conditions in **SEMP Vers 2.0**. Discharge of all pre-commencement Conditions Appoint Ecological and/or Environmental Clerk of Works (EcoW) **Tender Works** (information provided to Tenderers to include **SEMP Vers 2.0**) Appoint **Contractor** **Review and comment on** Contractor's **SEMP Vers 2.0** and **method statements** in liaison with the ECoW and consultees as required. Initiate Environmental Management Group.	Review and approve of additional information provided in support of discharge of Planning Conditions. Generally this will include SEMP Vers. 2.0, although additional documents may also be submitted (outline construction method statements etc). Review and approval of relevant information, as applicable.
CONSTRUCTION			
Tasks in accordance with **ES and Addendum. SEMP Vers 2.0, Method Statements, Contract, and Planning Conditions.** Submission of complete CD copy of **Final SEMP Vers 2.0** upon completion of construction works.	Monitoring of compliance with detailed SEMP, including Technical Schedules and Planning Conditions. ECoW can suspend works at any time where potential risk from pollution is identified or where agreed methods and/or mitigation measures are adhered to.	Monitoring of compliance with **SEMP Vers 2.0**, Construction Contract and Planning Conditions. Employer can suspend works at any time where potential risk from pollution is identified or where agreed methods and/or mitigation measures are not being adhered to.	Planning Monitoring Officer (**PMO**) to inspect works as part of an overall construction works inspection programme on behalf of the planning authority. SEPA, SNH, HSE can suspend works at any time (if potential risk from pollution is identified or where agreed methods and/or mitigation measures are adhered to).

1.4 SEMP Structure

1.4.1 The SEMP is divided into discreet Sections which are designed to be filed as separate documents / folders if required. All versions of the SEMP, including the Contractors detailed SEMP, are required to follow a similar format / structure to this.

1.4.2 The *Contractor's* detailed SEMP will contain all the requested environmental plans and method statements as detailed within Technical Schedules 1 through 10 (as applicable) and as summarised within Tables 1.0 and 5.0 (contained within Sections 1 and 5 of the SEMP).

1.4.3 A copy of the SEMP documents / folder(s) will be kept in the site offices for the duration of the site works and will be made available for review at any time.

1.4.4 Upon completion of the construction works, the *Contractor* will submit a complete <u>CD</u> copy of the final SEMP to Viking Energy Partnership for their records. This final SEMP will include electronic scans of all hard copy reports, data, field records and correspondence which are gathered over the course of the construction works.

1.4.5 Where the *Contractor* has standard documents within his own company / corporate Environmental Management Plan which might cover a particular requirement of this SEMP, these will either be inserted or cross referenced within the relevant Section of the SEMP.

1.4.6 The SEMP Sections are listed in Table1.0 as follows:

TABLE 1.0

SITE ENVIRONMENTAL MANAGEMENT PLAN (SEMP): DOCUMENT STRUCTURE

Section	Title & Brief Description	Contractor Development Required?
1	**Introduction (this chapter)**	**No** (Information purposes only)
2	**Project Information** Provides details on site location, scheme description and a summary of the environmental sensitivities at the site in Table 2.0 (as derived from the Environmental Statement and other information where available). Provides details on relevant Planning Consent Conditions Any documents prepared by Viking Energy Partnership in response to Consent Conditions will be recorded in Table 2.1. Contains a record of all Scheme Amendments and a Register of Variations.	**Yes** Any documents prepared by the *Contractor* in response to Consent Conditions will be recorded by the *Contractor* in Table 2.1. Any Scheme Amendments and / or Variations to the SEMP required during the works will be recorded by the *Contractor* in Tables 2.2 and 2.3.
3	**Environmental Communication Plan** Contains details on specific requirements relating to: • Contact details for Viking Energy Partnership personnel, technical specialists, *Contractor* personnel, regulators, landowners, other stakeholders etc; • Meetings, reports and consultations; • Roles and responsibilities; and • General reporting procedures and tasks.	**Yes.** The *Contractor* will: i) Insert contact information for regulatory authorities and other stakeholders (where not already provided) into Table 3.0 and ii) Refer to Table 3.1 for details on requirements for meetings, reports and consultations; and iii) Insert information on *Contractor* appointments and responsibilities relating to environmental management and implementation of this SEMP into Table 3.2. iv) Refer to Figure 3.0 for a summary of the main communication lines.
4	**Correspondence, Records and Reports** This Section relates to document control and retention of records. The information at the start of Section 4 provides: • A list of all documents to be retained / filed within the SEMP. Table 4.0 provides a record of all Environmental Consents, Licenses and Permits issued for the project.	**Yes.** The *Contractor* will complete Table 4.0. Throughout the duration of the Contract, the *Contractor* will insert / file all communication records, data, field records and reports associated with Environmental Management and implementation of this SEMP into this Section 4. This Section may be sub-divided into

TABLE 1.0

SITE ENVIRONMENTAL MANAGEMENT PLAN (SEMP): DOCUMENT STRUCTURE

Section	Title & Brief Description	Contractor Development Required?
		sub-folders for specific information relating to discrete areas of Environmental Management (such as waste management, pollution prevention, water quality monitoring, ecology etc). Alternatively, this information may be filed within the individual Technical Schedules in Section 5. The filing method selected by the *Contractor* will be made explicit at the start of Section 4.
5	**Technical Schedules & Available Information** Technical Schedules include the following: 1. Site Induction Schedule 2. Pollution Prevention Plan (PPP) 3. Site Waste Management Plan (SWMP) 4. Drainage Management Plan (DMP) 5. Water Course Crossing Plan (WCCP) 6. Water Quality Monitoring Plan (WQMP) 7. Excavated Materials and Reinstatement Plan (EMRP) 8. Ecological Protection Plan (EPP) 9. Environmental (Emergency and Incident) Response Plan (ERP) Other relevant Available Information documents will also be included or cross referenced here.	**Yes** The *Contractor* is required to develop the Technical Schedules and/or include additional information or method statements as appropriate and where required by the Contract. The development of the Technical Schedules will generate more site-specific documents which address particular environmental management procedures applicable for works in specified areas of the site. These Technical Schedules form the *Contractor's* Environmental Plans (for example Pollution Prevention Plan, Site Waste Management Plan, Excavated Materials and Reinstatement Plan etc). Table 5.0 lists all Technical Schedules and provides information on *Contractor* responsibilities.

2 PROJECT INFORMATION

2.1 Site Location and Scheme Description

TABLE 2.0 General Project Information and Scheme Description	
Site Name:	Viking Wind Farm
Location:	The central part of mainland Shetland, stretching from near Scatsta in the north to Weisdale in the south. A site location and layout plan is included below.

Environmental Sensitivities

Statutory Protected Areas

There are no statutory conservation designations within the area where the proposed physical development will actually take place. However, there are two nature conservation designated sites within the wider Viking study area: The Burn of Lunklet SSSI (1.4ha designated for endemic hawkweed species) and the Kergord plantations SSSI (6.45ha designated for broadleaved, mixed and conifer woodlands). Neither of these designated sites lies directly within the area directly proposed for development and no impact is anticipated provided that all ecological (habitats and species), pollution prevention and other hydrological mitigation measures referred to within the ES and this SEMP are implemented.

Commenting on the 2009 ES, SNH objected due to potential impacts on the Sand Water SSSI. They acknowledged that "*although not directly affected by the windfarm itself or associated infrastructure within the development boundary, the Sand Water SSSI is likely to be adversely affected by other associated works outwith the development boundary*". The potential impacts relate to changes at the A970/B9075 junction, to upgrades to the B9075 and its bridge, and to the location of a construction compound. In particular, releases of sediment and polluting materials, nutrient enrichment and possible changes to the flow reaching the Sand Water SSSI were issues of concern. The following mitigation is required to address potential issues within the Sand Water catchment:

- (i) road alterations must take place on the north side of the existing B9075, so that the works do not encroach into the SSSI;
- (ii) construction methods, pollution prevention measures and details of water crossings and culverting to be fully agreed with SEPA, and ultimately implemented and controlled by the Ecological Clerk of Works;
- (iii) toilet, washroom and kitchen facilities for workers at the construction compound, near to Sand Water, to be in the form of sealed units which are regularly maintained and emptied to ensure no waste water spills from them.

Habitats

Blanket bog (mire) is the dominant vegetation type over the whole survey area. It occurs on peat over 50cm in depth and usually at least 2m deep, characterised by a range of species. In addition, wet and dry dwarf shrub heath, acid grassland and a small number of scattered woodland plantations are present within the development area. Blanket bog is a Priority habitat covered by EC and UK Biodiversity Action Plan legislation. Several trout and sea trout spawning burns are located in the area. Atlantic salmon was recorded in two watercourses (although these may be associated with fish farms).

TABLE 2.0
General Project Information and Scheme Description

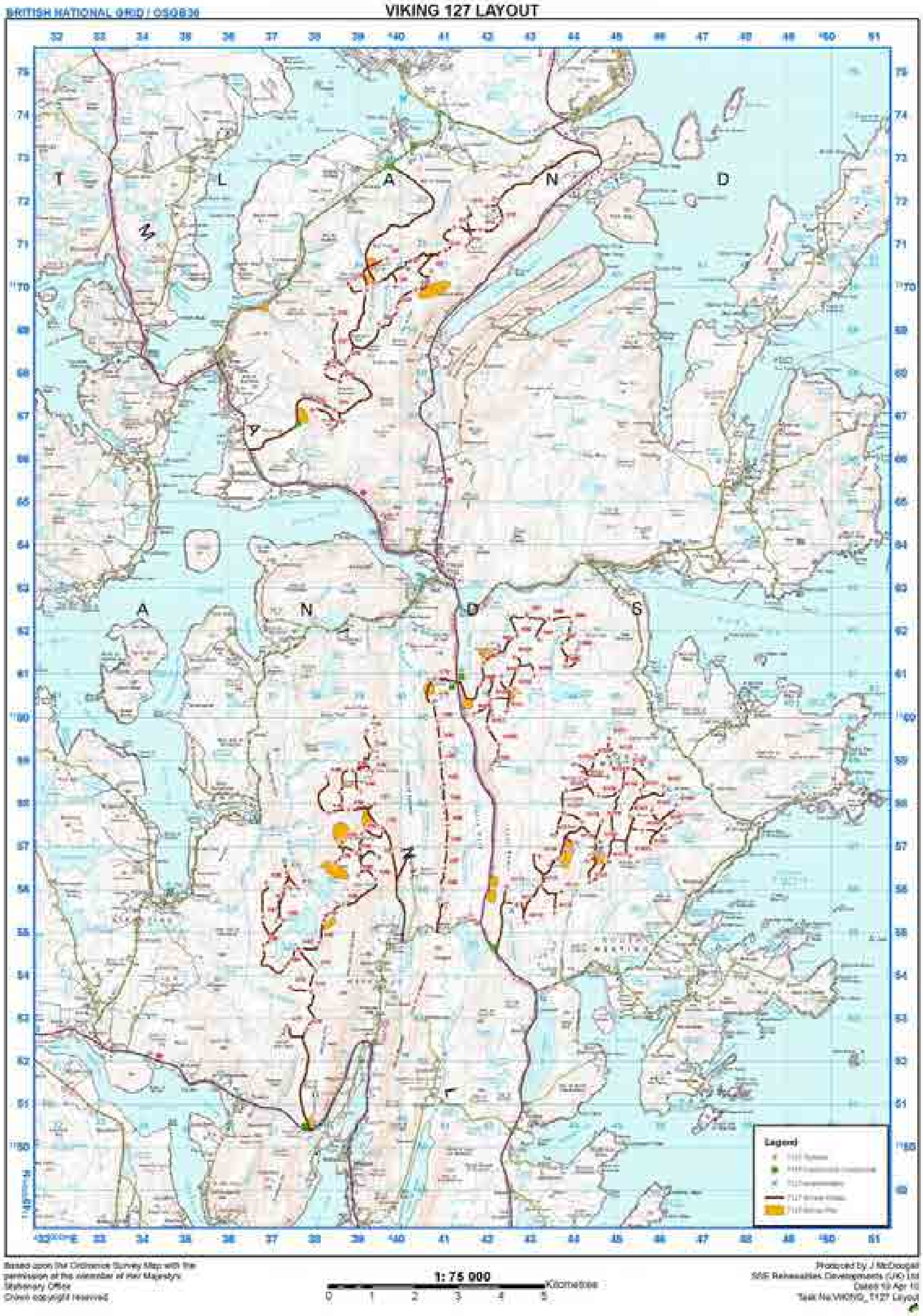
Birds

The Viking Site is of particular importance for breeding red-throated diver and merlin. Other breeding species of national importance within the Viking area include dunlin, whimbrel, arctic skua, golden plover, great skua, and in some years black-tailed godwit and whooper swan. In addition, greylag goose, wigeon, red grouse, golden plover, lapwing, snipe, curlew, common sandpiper, wood pigeon, goldcrest and fieldfare were noted. Some species, like the golden plover and merlin, are protected under the EC Birds Directive and UK law.

Mammals

Otter (protected under UK and EC legislation) are recorded as possibly present on site or likely to be affected by negative impacts on drainage.

Further information is provided on these sensitivities in:
TS8 Ecological (Habitats and Species) Protection Plan.



Based upon the Ordnance Survey Map with the permission of the controller of Her Majesty's Stationery Office
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Produced by J McDougal
SSE Renewables Developments (UK) Ltd
Dated 10 Apr 10

2.2 Planning Conditions and Outline Method Statements

2.2.1 This SEMP and its future versions/revisions will form part of the Contract for the Viking Wind Farm. It will therefore be updated and revised during the different stages of the wind farm development, including pre-construction subsequent to receipt of a conditioned planning consent. Where additional documents are prepared by Viking Energy Partnership or the *Contractor* in accordance with the requirements of Planning Conditions for this site, the documents will be listed in Table 2.1 below.

TABLE 2.1: RELEVANT PLANNING CONDITIONS AND RELATED DOCUMENTATION

Planning Condition	Document Title	Responsible Party

2.2.2 The *Contractor* will consider all of the mitigation measures and best practice construction methods detailed within the above plans in his design and in any detailed environmental plans as required by this SEMP or the Contract.

2.2.3 Where any mitigation measures or construction methods described in other documents deviate in any way from those contained within this SEMP, the *Contractor* will abide by whichever is the most onerous and stringent in terms of environmental protection.

2.3 Scheme Amendments

2.3.1 "Scheme Amendments" will be recorded in Table 2.2. These amendments do not include changes to the scheme design which are completed in accordance with the existing planning consent; instead, this refers to changes in the design of the wind farm for which additional approvals and / or consents may be required from the Planning Authority. For instance, amendments to track layouts or turbine locations out with approved micrositing boundaries.

2.3.2 The purpose of recording Scheme Amendments here is to provide a record of any changes in the design and siting of the wind farm infrastructure such that any associated environmental impacts and mitigation measures may be appropriately instigated through this SEMP.

TABLE 2.2
SCHEME AMENDMENTS

Ref.	Date	Scheme Amendment Description	Environmental Sensitivities Potentially Impacted by Scheme Amendment

DRAWINGS AND OTHER INFORMATION RELEVANT TO SCHEME AMENDMENTS AND VARIATIONS TO BE INSERTED IN SECTION 2.

2.4 Register of Variations

2.4.1 Where any amendments and variations to the Technical Schedules and SEMP are required (either as a result of Scheme Amendments or through corrective actions or improvements noted and undertaken on site) these will be recorded in Table 2.3, Register of Variations. Furthermore, all changes to construction methods, design, mitigation and the implications of these changes and authorising personnel will be recorded in the table below.

TABLE 2.3
REGISTER OF VARIATIONS

No.	Variation Description	Authorising Personnel	Completion Date

3 COMMUNICATION PLAN

3.1 Contacts Sheet

3.1.1 Table 3.0 provides a list of all Viking Energy Partnership, *Contractor* and relevant third party contact details. This table should be updated and kept current by the *Contractor* for the duration of the Contract.

3.2 Meetings, Reports and Consultations

3.2.1 Table 3.1 lists all meetings and consultations as required by the Contract. The table also provides details on the schedule/frequency, scope & objectives and attendees / responsibility for each meeting.

3.3 Roles and Responsibilities

3.3.1 Roles and responsibilities for environmental management, monitoring and reporting are detailed in Table 3.2.

3.4 Reporting Procedures

3.4.1 Figure 3.0 provides a diagrammatic outline of the general tasks and communication lines, based on the roles described in Tables 3.1 and 3.2 and tasks detailed in the Technical Schedules. The *Contractor* will update this information as part of the detailed SEMP.

3.4.2 Technical Schedule TS9, Environmental Incident and Emergency Response, includes a figure illustrating the communications plan for reporting procedures for all potential environmental risks, hazards or incidents which may relate to ecology, water quality, dust, noise or archaeology.

TABLE 3.0
CONTACTS SHEET

COMPANY	POSITION	NAME	TEL / MOBILE NO.	ADDRESS
Viking Energy Partnership	Development Project Manager			
Viking Energy Partnership	Civil Engineering Manager			
Viking Energy Partnership	Construction Project Manager			
Viking Energy Partnership	Construction Site Manager			
Viking Energy Partnership	Environmental Manager			
Viking Energy Partnership	Ecologist			
Viking Energy Partnership	Operational Phase Environmental Coordinator			
TBC – (Independent / External Appointment)	Environmental / Ecological Clerk of Works			
(TBC – Contractor)	Project Manager			
(TBC – Contractor)	Site Agent			
(TBC – Contractor)	Foreman			
(TBC – Contractor)	Environmental Manager			
(TBC – Contractor)	TBC – Other Site Responsibility for Environmental Management			

TABLE 3.0
CONTACTS SHEET

COMPANY	POSITION	NAME	TEL / MOBILE NO.	ADDRESS
(TBC – External Appointment)	Archaeological Clerk of Works			
(TBC – External Appointment)	Geotechnical Clerk of Works			
SEPA				
SNH				
Planning Authority				
Planning Monitoring Officer				
Fisheries Trusts				
Water Users				
Landowners / Land managers / Crofters				
[Sub-contractors to be listed]				
[Others to be listed as appropriate]				

TABLE 3.1
MEETINGS, REPORTS AND CONSULTATIONS

MEETING / REPORT	SCHEDULE / FREQUENCY	SCOPE & OBJECTIVE	ATTENDEES / RESPONSIBILITY
A record of all meetings, environmental checks, consultations, permissions, consents and licenses will be retained within Section 4 of this SEMP.			
Pre-construction Consultations	As required	To determine requirements for and to obtain all necessary consents and licenses.	*Contractor* and Viking Energy Partnership as required.
Start Up Meeting	Prior to construction commencement	Following submission of environmental plans and documents as required by the Contract (and as listed in Section 5 of this SEMP), an initial Start Up Meeting will be held. The objective of this meeting is to introduce all relevant personnel and to ensure awareness of all roles and responsibilities with respect to Environmental Protection and the implementation of this SEMP.	Meeting to be organised by *Contractor* and held on site, or at a location close to the site such that a site visit may be arranged to investigate any specific issues raised. Attendees should include: **Employer:** Project Environmental Manager Project Ecologist Construction Project Manager Construction Site Manager Ecological Clerk of Works (ECoW) Archaeological Clerk of Works (ACoW) Geotechnical Clerk of Works (GCoW) **Contractor** Project Manager Site Agent Site Foreman Contractors appointed Site Environmental Manager or otherwise responsible person(s).

TABLE 3.1
MEETINGS, REPORTS AND CONSULTATIONS

MEETING / REPORT	SCHEDULE / FREQUENCY	SCOPE & OBJECTIVE	ATTENDEES / RESPONSIBILITY
Site Inductions	All new site personnel and visitors.	Provide information on specific environmental issues relative to the site and to the activities to be undertaken by the personnel / visitors being inducted (Refer to Technical Schedule TS1: Site Inductions).	To be organised by the *Contractor.* A record must be kept of all inductions completed on site. A sign in register must be maintained on site. All employees, sub-contractors, suppliers and visitors.
Weekly Environmental Update Meeting	Weekly	To provide updates on environmental mitigation measures and performance and identify actions for improvement. As per the requirements of the Pollution Prevention Plan (Technical Schedule TS2), the ECoW is required to maintain a Pollution Prevention Measures Register (PPMR) in which all mitigation measures put into place will be listed, and checked weekly to assess the requirement for maintenance. The results of these checks will be discussed at the meeting and corrective actions agreed as required.	Attendance required: ECoW, Site Manager, *Contractor's* Site Agent and any other relevant personnel or statutory consultees where necessary. Meeting minutes to be documented by ECoW and forwarded to the Construction PM within two days of meeting. Construction PM to inform Site Environmental Manager and Project Manager in the event that any significant environmental issues are reported.

TABLE 3.1
MEETINGS, REPORTS AND CONSULTATIONS

MEETING / REPORT	SCHEDULE / FREQUENCY	SCOPE & OBJECTIVE	ATTENDEES / RESPONSIBILITY
Monthly Environmental Report & Monthly Environmental Management Group Meeting	Monthly	To provide a compiled record of weekly meeting minutes and environmental performance and monitoring results (e.g. air, noise or water quality monitoring as appropriate). To identify any areas / action for improvement.	To be prepared by ECoW. Report to be issued to the Environmental Management Group, *Contractor* and Construction PM and Environmental Manager before the end of each calendar month. Report to be discussed at the monthly meeting with recommendations for improvement passed to the Contractor in written format within 2 working days of the meeting.
Final Environmental Report	Upon completion of construction works.	The final report will document the environmental and ecological effects of the construction period. The evidence for effects will be based on findings included in the minutes of weekly meetings and monthly meetings, together with other recording information maintained by the ECoW. The report will relate results to residual effects predicted in the ES.	The Final Report will be prepared by the ECoW. The report will be made available to the C*ontractor*, planning authority, SNH and SEPA.
Environmental Checks and Monitoring of Mitigation Works	As required in advance of construction works Regular checks should also be made at least every 14 days.	Environmental Checks are to be carried out in advance of construction works. This will comprise an on site meeting / inspection to confirm the appropriate use of identified mitigation measures and highlight any further issues / measures which may be relevant prior to commencement of works in any area. As a minimum, Environmental Checks will be completed at each main piece of site infrastructure (turbine bases, construction compounds, sub-station, control room, borrow pits etc) prior to works commencing in that area. Advance checks will be undertaken no less than every 100m of constructed or upgraded access track. Environmental Checks will include:	Environmental checks will be undertaken by the *Contractor*, supervised by the ECoW where appropriate. The ECoW may also undertake regular checks, either independently or in conjunction with the *Contractor's* checks as required. The *Contractor* and ECoW will retain a record of all inspections / findings of Environmental Checks within Section 4 of this SEMP. All records will be made available for audit / review by the Employer, Planning Monitoring Officer (PMO) and any other interested parties. All records will also be made available for discussion during regular meetings as scheduled herein.

TABLE 3.1 MEETINGS, REPORTS AND CONSULTATIONS			
MEETING / REPORT	**SCHEDULE / FREQUENCY**	**SCOPE & OBJECTIVE**	**ATTENDEES / RESPONSIBILITY**
		• Inspection and maintenance of all passive bird discouraging measures put in place. • Checks for visual evidence of contamination / sediment alongside watercourses, near by working areas and in areas of surface water discharge. • Regular checks of all plant and equipment to identify any oil or fuel leaks to confirm the condition of the plant. • Inspection of drainage and erosion and sediment control measures. Additional checks should be made before, during (where safe to do so) and immediately following anticipated storm events or periods of continuous or heavy intermittent rainfall over one or more days. • Environmental checks will also encompass a review of: – Waste management procedures; – General site tidiness; – Temporary materials storage (extracted materials stockpiles) and restoration works; and – Peat stability (in conjunction with the GCoW).	
Environmental Audit	At least once every 12 months	Refer to Section 4	Environmental Audits may be carried out by the *Contractor*, Viking Energy Partnership or any other interested party at any time during the works.

TABLE 3.1
MEETINGS, REPORTS AND CONSULTATIONS

MEETING / REPORT	SCHEDULE / FREQUENCY	SCOPE & OBJECTIVE	ATTENDEES / RESPONSIBILITY
			Audit procedures and forms are included within Section 4. These will be followed / completed by the Employer when undertaking environmental audits and may also be adopted by the *Contractor*, unless alternative procedures and forms are submitted and approved as part of the Contractor's detailed SEMP.
Liaison with regulator / statutory consultees	As required	Provide regular updates to relevant authority on environmental performance and maintain good working relationships with the regulatory bodies.	*Contractor* and ECoW where required. Meetings will be initiated as required by Planning Condition, Technical Schedules or as agreed on a site by site basis. The *Contractor* is responsible for obtaining all relevant permissions, consents, licenses and permits. Some permits may require application and implementation by an appropriately qualified person. In these instances, the *Contractor* will consult with the ECoW, ACoW, or other specialist Environmental Consultant where required.

TABLE 3.2
ROLES & RESPONSIBILITIES

POSITION	ROLES & RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT
Construction Project Manager	The Construction Project Manager will: Ensure that the *Contractor* has obtained the relevant approvals and licenses and consents from regulatory bodies and statutory consultees where required. Ensure that the *Contractor* has submitted all relevant documentation to the ECoW and Project Environmental Manager Liaise with the Site Manager and the ECoW and ensure that the Project Environmental Manager is informed where corrective actions and

TABLE 3.2 ROLES & RESPONSIBILITIES	
POSITION	**ROLES & RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT**
	variations to the SEMP have been instigated.
Project Site Manager	The Site Manager will provide liaison between the ECoW and the *Contractor* where environmental sensitivities, instruction for environmental performance improvements or corrective actions are requested by the ECoW, Environmental Manager or other appropriate person(s) as a result of environmental checks or audits conducted by these person(s). The Site Manager will ensure that all notifications of environmental sensitivities and incidents as well as other general observations on environmental performance are reported back to the Project Manager.
Project Environmental Manager	The Project Environmental Manager is responsible for review and further development of the SEMP in the pre-commencement phase prior to appointment of a *Contractor*. The Project Environmental Manager will coordinate the Environmental Management Group. The Project Environmental Manager, or other nominated representative, will undertake regular visits to the site for the purposes of auditing and monitoring of compliance with SEMP. The Environmental Manager will maintain regular contact with the ECoW and Project and Site Management Team.
HMP Ecologist	The HMP Ecologist is responsible for coordination of the Habitat Management Plan (HMP) implementation and ensuring that all contractors, sub-contractors and consultants appointed to undertake works associated with the implementation of the Habitat Management Plan are provided with and also adhere to the general requirements of this SEMP.
ECoW: **Ecological Clerk of Works**	The Ecological CoW will work with Viking Energy Partnership and the *Contractor* to ensure compliance with best practice and with all environmental mitigation and monitoring requirements as detailed within the ES, relevant planning conditions and SEMP. Where a particular ecological concern exists at the site, or specific habitat management activities are to be undertaken in conjunction with the main civils construction works, a specialist Ecological CoW may also be required unless the ECoW is suitably qualified to undertake the particular ecological responsibilities. The main roles of the Ecological CoW are as follows: • Organise start-up meetings with Viking Energy Partnership and site contractors to agree working methods, specifically including communications; weekly schedules; monitoring of data storage; and preparation of plans indicating location of key features including mitigation measures, monitoring points and sensitive habitats. • Maintain a full time presence on site during the main construction works.

TABLE 3.2
ROLES & RESPONSIBILITIES

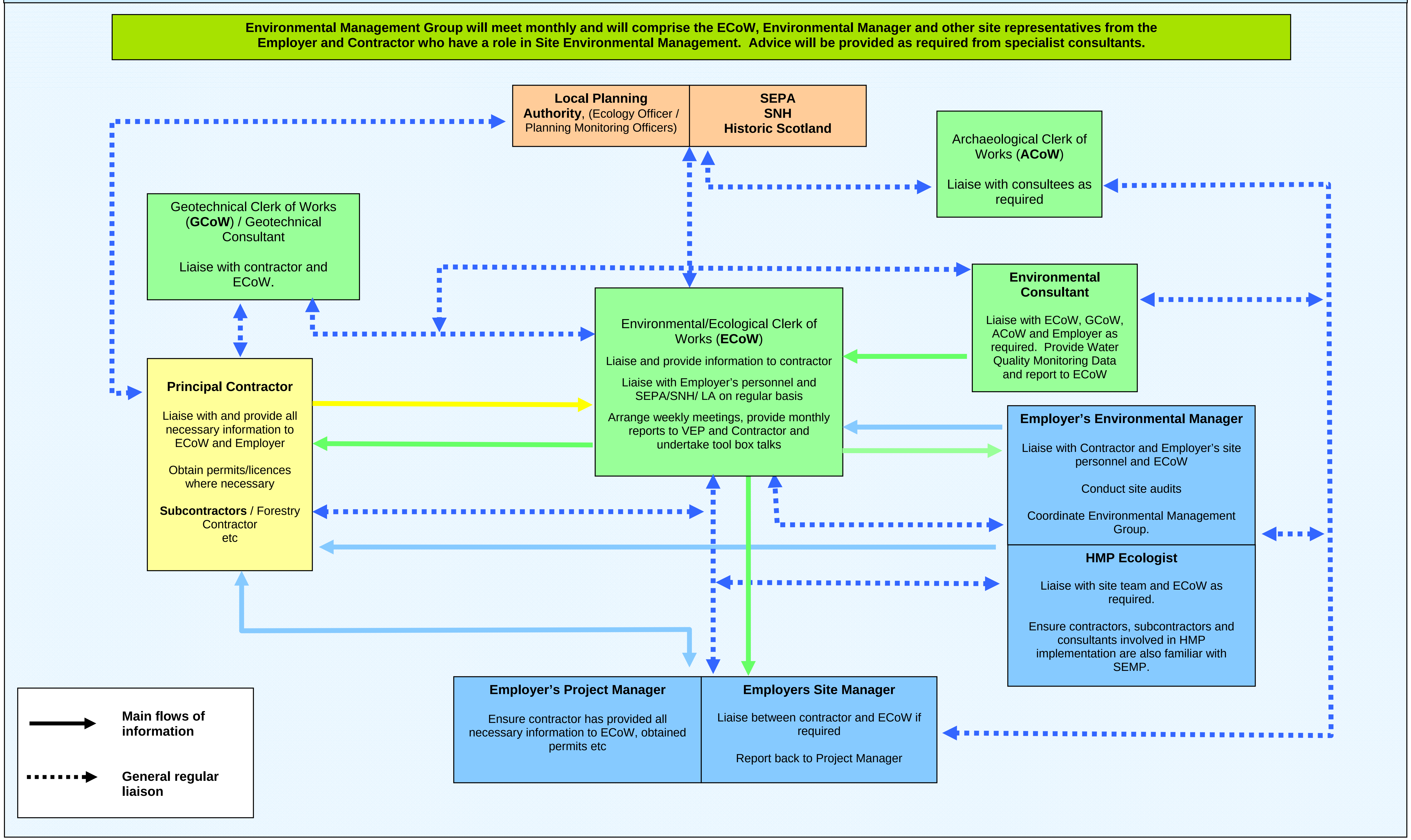
POSITION	ROLES & RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT
	• Organise regular liaison meetings and procedures with Viking Energy Partnership. • Organise a minimum of weekly meetings with the main *Contractor*, to allow briefing on the programme of works on site and to provide on-site guidance during construction. *Note*: It is essential that the *Contractor* supplies information on proposed works and scheduling to the ECoW in advance order to anticipate and address any issues, specifically including drainage, silt mitigation measures, cabling, roads, turbine bases, met masts, borrow pits, compounds, landscaping, topsoil removal, storage and replacement, vegetation reinstatement and restoration works, planting, felling and habitat management. • Maintain regular liaison with the Project Environmental Manager and HMP Ecologist. • Maintain liaison with officers of the Local Planning Authority, specifically the Planning Monitoring Officer. • Maintain liaison with SEPA/SNH personnel as appropriate. • Ensure compliance with planning conditions. ***Note*: If failures occur and actions are taken which contravene legislation then the ECoW has the power to stop works in the affected area with immediate effect and the appropriate statutory agency and planning officer will be informed. These actions will only be taken where appropriate. Notification to stop works will be by verbal means, followed up with written confirmation recording the time and date of the instruction, personnel involved and reasons for the instruction. Upon re-commencement of works, details of any corrective actions and / or remedial measures implemented will be recorded within Section 4.** • Give tool box talks as agreed with the site contractor to address key areas, including water pollution prevention, protected species management, and on-site biodiversity. • Organise ecological survey work and all proposed mitigation as detailed in the ES, Planning Conditions and Technical Schedules. • Monitor potential environmental impacts, including: – Dust emissions – Use of and storage of oils and toxic chemicals on site, e.g. cement – Dewatering of excavations (including borrow pits and turbine bases)

TABLE 3.2
ROLES & RESPONSIBILITIES

POSITION	ROLES & RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT
	– Silt control – Water management, including working in or close to watercourses – Protection of ecological interests, e.g. protected species and habitats • Demarcate environmentally-sensitive areas and ecological hazards. • Produce written reports to Viking Energy Partnership and the *Contractor* following site visits and meetings. This includes monthly reports and a final report.
Environmental Consultant	Where a specialist Environmental Consultant is employed on a project, this person(s) will: • Provide advice and maintain regular liaison with the Project Site Manager, Project Manager, Ecologist and Environmental Manager, *Contractor* and / or ECoW, GCoW and ACoW as and when required. • Undertake specific monitoring activities and reporting as defined in agreed documentation prepared as part of the planning process.
Archaeological Clerk of Works (ACoW)	• Maintain regular liaison with the Project Site Manager, Project Manager, Ecologist and Environmental Manager as appropriate. • Maintain liaison with officers of the Local Planning Authority, specifically the Council Archaeologist and Planning Officers, SNH and Historic Scotland as appropriate. • Ensure compliance with planning conditions as defined in agreed documentation prepared as part of the planning process. • Demarcate any archaeologically-sensitive areas and set up exclusion zones as required on site.
Geotechnical Clerk of Works (GCoW) or appointed Geotechnical Consultant	The GCoW will be responsible for preparation and monitoring of a geotechnical risk register as well as specific duties relating to geotechnical issues as they may arise during site construction works. Peat instability and the potential for peat slide events can have a significant impact on environmental receptors. In completing the geotechnical risk register, the GCoW will work with the Contractor to identify suitable mitigation and monitoring methods. Where possible, construction works will avoid causing change to local hydrological and hydrogeological flow patterns and water levels. Blanket bog habitat restoration works, including drain/ditch blocking, are proposed as part of the Habitat Management Plan. Should these works be undertaken simultaneously to the main construction works, the GCoW will liaise closely with the *Contractor* and the ECoW to ensure that any works do not impact on the main construction works (and vice versa) and that the either the construction works or the HMP

TABLE 3.2 ROLES & RESPONSIBILITIES	
POSITION	**ROLES & RESPONSIBILITIES FOR ENVIRONMENTAL MANAGEMENT**
	works do not result in peat instability.
CONTRACTOR APPOINTMENTS	
Construction Manager	[The *Contractor* is required to specify roles and responsibilities for each individual below]
Site Agent	
Foreman	
Environmental Manager	
Other Nominated Person(s)	

FIGURE 3.0: General Communication Plan



4 CORRESPONDENCE, RECORDS & REPORTS

4.1 Requirements

4.1.1 The *Contractor* will insert / file all communication records and reports associated with Environmental Management and implementation of this SEMP under this Section 4. As a guide, the following sub-sections of filed information are required:

4-A) Start up meeting minutes and attendance record

4-B) Weekly Environmental Reports

4-C) Monthly Environmental Reports

4-D) Environmental Checks

4-E) Audit Reports

4-F) Ecology

4-G) Pollution Prevention, including a Pollution Prevention Measures Register

4-H) Water Quality Monitoring

4-I) Archaeology

4-J) Ground Risk, including a Geotechnical Risk Register

4-K) Waste Management

4-L) Licensing and Consents: copies of all permissions, consents, licenses and permits and related correspondence. A summary record of all such documents shall also be provided as per **Table 4.0** of this SEMP.

4-M) General Correspondence: all other relevant internal and external communication records relating to environmental management issues and implementation of the SEMP.

4.2 Environmental Audits

4.2.1 A blank Environmental Audit Report form is included in TS9 Environmental Incident and Emergency Response.

4.2.2 The Contractor is required to complete an audit once in every 12 months.

4.2.3 Audits may be completed at any time by the Employer.

4.2.4 All completed audit report forms and records of corrective actions (and close outs) must be filed within this Section of the SEMP.

4.3 Environmental Consents, Licenses and Permits

4.3.1 The *Contractor's* Environmental Manager (or otherwise nominated responsible person(s)), in conjunction with the ECoW and ACoW, will complete the summary record below for all applicable permissions, consents, licenses and permits obtained for the site. This record will follow the format provided in Table 4.0 below.

TABLE 4.0
RECORD OF ENVIRONMENTAL CONSENTS, LICENSES AND PERMITS ISSUED

Consents, Licenses and Permits	Governing Legislation	Licensed Activity
Pollution Control & Hydrology		
Section 34 discharge consent (COPA)	COPA	
Abstraction license (CAR)	CAR	
CAR General Binding Rules	CAR	
CAR Registration	CAR	
CAR Licenses	CAR	
Biodiversity		
Operations Requiring Consent (ORCs) at Sites of Special Scientific Interest (SSSIs)	NCA	
Protected habitat or species licenses:	WCA HR PBA	
Felling License		
Tree Preservation Order		

TABLE 4.0
RECORD OF ENVIRONMENTAL CONSENTS, LICENSES AND PERMITS ISSUED

Consents, Licenses and Permits	Governing Legislation	Licensed Activity
Waste Management / Contaminated Land		
Waste Management Exemption The Contractor will utilise only registered waste carriers and will retain a record of all registration details. All hazardous waste will be dealt with as per Special Waste Regulations 1996 (and subsequent amendments).	WML	
Noise / Vibration		
Section 61 consent (COPA)	COPA	
Archaeology		
Scheduled Monument Consent	AMAAA	
Transport		
Permission, notification or consent for road closure, opening or diversion.	RSA	
Other		

Acronym	**Legislation**
COPA	Control of Pollution Act
CAR	The Water Environment (Controlled Activities) (Scotland) Regulations 2005
WML	Waste Management Licensing Regulations
WCA	Wildlife and Countryside Act 1981
HR	Habitats Regulations 1994
PBA	Protection of Badgers Act 1992
NCA	Nature Conservation (Scotland) Act 2004
AMAAA	Ancient Monuments and Archaeological Areas Act 1979
RSA	Roads (Scotland) Act 1984

5 TECHNICAL SCHEDULES & AVAILABLE INFORMATION

5.1 Technical Schedules

5.1.1 Various Technical Schedules have been prepared by Viking Energy Partnership as listed in Table 5.1 below. These are intended to provide a benchmark for best practice and to define Viking Energy Partnership's minimum requirements for environmental management and mitigation.

5.2 Contractor Requirements

5.2.1 The *Contractor* is required to further develop the Technical Schedules into detailed **site and works specific** environmental plans, method statements and procedural documents. Table 5.0 provides a summary of the content of the Technical Schedules and the *Contractor's* obligations for their further development.

TABLE 5.0
LIST OF TECHNICAL SCHEDULES (TS)

TS No.	Provided at ES / Tender Stage	*Contractor* Requirements
TS1	Site Induction Schedule	The *Contractor* is required to produce detailed Site Induction Procedures.
TS2	Pollution Prevention Plan (PPP).	The *Contractor* will provide a detailed PPP. The objective of a PPP is to identify potential risks to the environment from pollution and to document proposed mitigation measures in order to avoid or minimise these risks and ensure compliance with relevant legislation. A PPP is provided herein and provides a benchmark for best practice. The *Contractor* may make cross references to the generic measures contained herein; however, the detailed PPP will also provide specific details on the intended method of use and storage on site of chemicals, fuels and oils and stockpiled excavated materials, including specific locations intended for their storage noted on a plan and details on secondary containment measures and emergency response procedures. Details will also be provided on concrete batching and wash out areas and emergency response procedures associated with this potentially polluting activity. The Pollution Prevention Plan may overlap with the Drainage Management Plan (DMP) and therefore cross reference must be made to where specific drainage control measures detailed within the DMP are to be implemented to prevent pollution of water courses from silt run off or the containment of chemical contaminants potentially entering the drainage system.
TS3	Site Waste Management Plan (SWMP)	A SWMP is intended to implement reduction and effective management of resources and waste during the early design stages of the wind farm construction, through to completion, such that legal compliance is met; project build costs are minimised; a framework for continuous improvement and best practice is implemented and maintained; and carbon emissions and other negative environmental impacts associated with the production and management of waste materials are minimised. The SWMP contained within Technical Schedule TS3 provides an

TABLE 5.0
LIST OF TECHNICAL SCHEDULES (TS)

TS No.	Provided at ES / Tender Stage	*Contractor* Requirements
		outline of the minimum requirements to be contained within the *Contractor's* detailed SWMP. TS3 also provides an outline of the anticipated waste management procedures and routes that may apply during construction. In preparation of his detailed SWMP, the *Contractor* will liaise with SEPA to determine requirements for, and obtain, licenses and consents associated with waste management and foul water discharge from the site where appropriate.
TS4	Drainage Management Plan (DMP)	A detailed Drainage Management Plan (DMP) will be prepared by the *Contractor* prior to commencement of works. This will include a drainage impact assessment and procedures and methods for planning, design and management of appropriate sediment and silt control measures.
TS5	Water Course Crossing Plan (WCCP)	The *Contractor* will carry out a detailed survey of all water course crossings at the detailed design stage and prepare a detailed Water Course Crossing Plan. The *Contractor* is responsible for liaison with SEPA to determine all authorisations required under the Controlled Activities Regulations (CAR).
TS6	Water Quality Monitoring Plan (WQMP)	An independent consultant will be appointed by Viking Energy Partnership to undertake water quality monitoring pre-, during and post-construction works. Monitoring of water quality at Private Water Supplies and in the surface water courses within the catchment of the wind farm will be undertaken. The outline scope of the Water Quality Monitoring is presented in TS6. The results of the monitoring will be presented within the Monthly Reports and retained under Section 4 of this SEMP. The *Contractor* is not obliged to undertake water quality monitoring, however, where a decrease in water quality resulting from construction works is observed the *Contractor* will undertake remedial measures and will bear the costs of all associated sampling and investigation. The *Contractor* may wish to undertake confirmatory sampling and analysis at any point during the works at his own cost.
TS7	Excavated Materials and Reinstatement Plan (EMRP)	The *Contractor* will prepare a detailed Excavated Materials and Reinstatement Plan. This will include site-specific details on: intended programme of works; timing of reinstatement; estimated materials mass balance volumes (specifically peat, although other mineral soils and rock to be included); method statements for handling and storage of excavated materials, reinstatement methods and on-site soils classification and treatment methods if required.
TS8	Ecological (Habitats and Species) Protection Plan (EPP)	The *Contractor* will prepare a Construction Ecological (Habitats and Species) Protection Plan. This plan will include details of construction methods to be employed in areas where sensitive habitats or species are identified. The plan will also include a statement to the effect that all requirements of Technical Schedule TS8, Protected Habitats and Species Plan, will be adhered to.

TABLE 5.0
LIST OF TECHNICAL SCHEDULES (TS)

TS No.	Provided at ES / Tender Stage	*Contractor* Requirements
TS9	Environmental (Incident and Emergency) Response Plan (ERP)	The *Contractor* will prepare a detailed Environmental (Incident and Emergency) Response Plan. This will include procedures for dealing with containment of accidental chemical or fuel spills, potential overload of the drainage system by silt during unforeseen adverse weather conditions (this should be over and above the 1:200 year storm event that the drainage system is required to be designed for) and also procedures for dealing with potential mass movement of material from peat instability / slide events.

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 1

SITE INDUCTION SCHEDULE

SEMP Version:	**1.0**	
Rev No.	**Revision Description:**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	**Position :**	**Signature :**
Prepared by :	Jane MacDonald	SSE Renewables Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
Reviewed by :	Oliver Moffat	BMT Cordah	
Comment : Document was also reviewed by all consultants involved in preparation of the Addendum ES.			

CONTENTS

1 SITE INDUCTION

1.1.1 The Contractor will ensure that all contractor employees, sub-contractors, suppliers, and other visitors to the site are made aware of the Site Environmental Management Plan (SEMP) and are provided with an introduction to the contents and responsibilities contained therein.

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

- Identification of specific environmental risks associated with the work to be undertaken on site by the inductee.
- Summary of the main environmental aspects of concern at the site, in particular:
  i) Species and / or habitat protection
  ii) Pollution prevention (e.g. silt mitigation and protection of the water environment).
  iii) Ground stability and peat slide risk
  iv) Waste management.
- Environmental Incident and Emergency Response Procedures. Refer to TS9 for further information. This will include information on site areas with limited or no mobile phone reception, and means of alternative communication.

1.1.3 Fact sheets and posters will be displayed at prominent positions within the site offices / canteen areas relating to specific species or habitat information relevant to the site. The Contractor will liaise with the ECoW to determine the content of these fact sheets and posters.

1.1.4 Any areas of environmental sensitivity (ecological, archaeological, hydrological or geological) will be demarcated on site. These areas will be indicated on a map to be shown at all site inductions, with the exception of where specific areas are extremely sensitive and their location is required to be kept confidential for protection purposes (e.g. locations of breeding sites, freshwater pearl mussel sites etc). In instances of extreme sensitivity only a general buffer zone will be intimated at site inductions. The Contractor will liaise with the ECoW on the demarcation and advertising of sensitive areas.

2 TOOL BOX TRAINING TOPICS

2.1.1 During construction, in order to provide on-going reinforcement and awareness training, the above topics, along with any other environmental issues which arise on site, will be discussed at regular tool box talks.

2.1.2 Toolbox talks will generally be undertaken at the work face and be provided to *Contractor's* personnel who are engaged in the tool box talk activity. Tool box talks will also be provided to a wider range of site personnel, including managers, in order to raise general awareness of environmental issues and the SEMP procedures.

2.1.3 The Contractor will agree topics, frequency of tool box talks and proposed attendees with the ECoW and prepare a tool box talk programme

2.1.4 A record of all toolbox talks and attendees will be maintained and recorded within Section 4 of the SEMP.

SITE ENVIRONMENTAL MANAGEMENT PLAN

VIKING WIND FARM

TECHNICAL SCHEDULE 2

POLLUTION PREVENTION PLAN

SEMP Version:	**1.0**	
Rev No.	**Revision Description:**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	**Position :**	**Signature :**
Prepared by :	Jane MacDonald	SSE Renewables Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
Reviewed by :	Oliver Moffat	BMT Cordah	
Comment : Document was also reviewed by all consultants involved in preparation of the Addendum ES.			

CONTENTS

1 INTRODUCTION

1.1 Scope and Objectives

1.1.1 The information contained herein forms Technical Schedule 2 (TS2), Pollution Prevention Plan (PPP), of the Viking Wind Farm Site Environmental Management Plan (SEMP).

1.1.2 The SEMP, including the information and measures contained within this plan, form part of the Contract. The methods and principles contained herein, as well as within referenced legislative instruments and published guidance documents, will be adhered to by the appointed *Contractor* in developing the detailed design of the wind farm and in development of the construction method statements and other plans relating to environmental management as required by the Contract.

1.1.3 The objective of this pollution prevention plan is to ensure prevention of pollution to land, air or water and compliance with current environmental legislation, and to provide a benchmark for best practice such that all possible preventative measures will be taken to avoid pollution of land or the water environment during construction works and during the operational phase of the wind farm. Noise pollution mitigation may also be dealt with through the PPP, although it is recognised that this may also be covered by the Health and Safety File.

1.1.4 The *Contractor* will update/revise this Pollution Prevention Plan to reflect site-specific conditions/issues. The *Contractor* will submit the detailed Pollution Prevention Plan to the Employer for approval <u>at least</u> 4 weeks prior to any construction works commencing on site.

1.2 Reference Documentation

1.2.1 This pollution prevention plan will be read and implemented on site in conjunction with the requirements of SEPA's Prevention of Pollution from Civil Engineering Contracts: Special Requirements publication (SEPA, 2006) industry best practice, published guidance documents, and other documents as contained / specified within the SEMP and its associated Technical Schedules (TS). In particular:

- **SEPA Pollution Prevention Guidelines (PPGs):**
  - PPG01 General guide to the prevention of water pollution
  - PPG02 Above ground oil storage tanks
  - PPG03 Use and design of oil separators in surface water drainage systems
  - PPG04 Treatment and disposal of sewage where no foul sewer is available
  - PPG05 Works and maintenance in or near water
  - PPG06 Working at construction and demolition sites
  - PPG07 Refuelling facilities
  - PPG08 Safe storage and disposal of used oils

  - PPG18 Managing fire water and major spillages
  - PPG21 Pollution incident response planning
  - PPG26 Storage and handling of drums and intermediate bulk containers
- **SEPA:** The Water Environment (Controlled Activities) (Scotland) Regulations 2005, A Practical Guide, Version 5 June 2008.
- **Scottish Natural Heritage (SNH):**
  - Constructed tracks in the Scottish Uplands, March 2005.
  - Floating Roads on Peat, Forestry Civil Engineering and SNH, August 2010.
- **British Standards Institute (BSI):**
  - Code of Practice for Earth Works, BS6O31:1981
  - Code of practice for noise and vibration control on construction and open sites, BS5228-1: 2009.
- **Forestry Commission**: The Forests and Water Guidelines, 4th Edition, 2003
- **CIRIA Publications:**
  - Control of Water Pollution from Construction Sites – Guide to Good Practice (SP156)
  - Control of Water Pollution from Construction Sites – Guidance for Consultants and Contractors (C532)
  - Control of Water Pollution from Linear Construction Projects – Technical Guidance (C648)
  - Control of Water Pollution from Linear Construction Projects – Site Guide (C649)
  - Environmental Good Practice – Site Guide (C650)
  - The SUDS Manual (C697)
  - Site Handbook for the Construction of SUDS (C698)
- **SEMP Technical Schedules**

1.3 Responsibility

1.3.1 The company to whom the civil engineering construction contract is granted will be solely responsible for pollution prevention for the duration of the contract and until such time as permanent measures, such as permanent drainage and silt mitigation controls, are deemed to be adequate and appropriately constructed to the specifications stated within the Contract.

1.3.2 This responsibility will include the actions of any third party who is sub-contracted or otherwise involved in the project.

1.3.3 It is the responsibility of the *Contractor* to contact SEPA, SNH, other statutory and non-statutory bodies (e.g. RSPB, riparian owners, fishery and angling concerns etc) in the vicinity of and downstream of the proposed project so that the requirements and interests of these parties are adhered to and protected throughout the duration of the Contract.

1.3.4 The *Contractor* will be responsible for obtaining all necessary consents, licenses and permissions for his activities as required by current legislation governing the protection of the environment.

1.3.5 The ECoW will independently be maintaining a Pollution Prevention Measures Register (PPMR) in which all mitigation measures put into place will be listed and checked weekly to assess the requirement for maintenance.

1.4 Contractor Requirements

1.4.1 The *Contractor* is required to submit a detailed Pollution Prevention Plan prior to commencement of works within any area of the site. This plan should be viewed as an evolving document(s), tailored to suit specific activities or work areas, and be continually reviewed at weekly meetings for the duration of the works.

1.4.2 The detailed Pollution Prevention Plan will include, as a minimum, specific procedures relating to:

- Fuel handling and storage, including the locations of both periodic and regular fuelling points and emergency spill response;
- Concrete batching and / or concrete wash out areas, including locations of batching plants, pollution prevention measures, drainage controls;
- Responsibilities and details for monitoring and training in relation to pollution prevention and mitigation measures.
- Design, management and mitigation measures for noise, including monitoring of noise at the nearest sensitive receptors (unless covered elsewhere within the Health and Safety File).

1.4.3 In addition to the above minimum requirements for the Pollution Prevention Plan, the *Contractor* is also required to submit a number of other Environmental Plans which deal with specific aspects of pollution prevention. These include detailed:

- Drainage Management Plan (refer to TS4),
- Watercourse Crossing Plan (refer to TS5); and
- Site Waste Management Plan (refer to TS3).

1.4.4 Works may be suspended at the request of the Employer, the ECoW, Planning Monitoring Officer, SEPA, SNH or HSE at any time where a potential risk from pollution is identified and resulting harm may be caused to land, water or human health, or where construction methods and mitigation measures are not as specified within the construction method statements and relevant plans as submitted and agreed at the commencement of the works.

2 POLLUTION PREVENTION AND MITIGATION

2.1 Definitions & Potential Pollution Sources

2.1.1 Pollution may be defined as the introduction of a contaminant into air, land or water, resulting in an impact (generally negative) to the ecosystem into which the substance is released.

2.1.2 Pollution may arise as a result of poor planning and implementation of management procedures associated with traffic, plant and materials handling, waste management, surface water and drainage management, and concrete management.

2.1.3 Contaminants associated with the construction of a wind farm may be both chemical (e.g. released fuels, oils, lubricants, surfactants and other cleaning chemicals, flocculants etc) as well as physical (e.g. dust and other airborne particulates, siltation and sedimentation of watercourses). Noise may also constitute a form of pollution.

2.1.4 There are a number of potential sources of pollution from wind farm construction works which may adversely impact upon both terrestrial and aquatic ecosystems:

- Direct disturbance of the banks and bed of rivers and lochs during water course crossing construction, repair and/or upgrade works;
- Pumping of standing water required for de-watering of excavations such as turbine bases, or as required for drainage management purposes;
- Run-off from exposed ground, excavations and material stockpiles (aggregate and excavated / overburden peat and soil), tracks and haul routes;
- Run-off from tracks, bridges and culverts crossings at water course crossings;
- Run-off from recently reinstated areas (road verges, borrow pits etc);
- Peat landslides;
- Cement and cement wash from concrete batching plants, storage areas and other areas where cement grout or concrete is being applied;
- Plant washing and vehicle wheel wash areas;
- Fuel and chemical storage/refuelling areas;
- Leaking/vandalised plant and equipment; and
- Sewage and waste water from construction compound and permanent control building amenities.

2.1.5 Pollution from fuels, cement run off, other chemicals and silt or other particulate matter can pose a significant risk to both terrestrial and aquatic habitats, potentially resulting in direct mortality of fish, invertebrates and vegetation as well as longer term effects on fresh water ecology.

2.1.6 Of particular concern on wind farm sites is the control of particulates and suspended silt resulting from erosion and run off from exposed soils. Sedimentation and silt can have both short and longer term impacts to freshwater ecological systems. For example damage to fish stocks may occur via fine particulates coating fish gills or accumulation of sediment on river or stream beds can limit successful development of fish eggs and larval development may also be inhibited. In addition, suspended silt and increases in turbidity can affect nutrient levels and result in significant impact on the biological diversity of the water course.

2.1.7 All forms of pollution can also render receiving waters unsuitable for resource uses (such as private water supplies, agricultural or industrial abstraction etc), fish farming, angling and general recreation, amenity and tourism reasons.

2.1.8 Strict compliance with all pollution prevention measures contained within the SEMP is essential where construction works are occurring within the catchment of the Sand Water SSSI (refer to SEMP Section 2.0 for further details).

2.1.9 Noise and vibration from construction activities, in particular from the excavation of borrow pits, may lead to a temporary loss of amenity or health effects at nearby receptors.

2.1.10 **Good construction practice and appropriate mitigation and monitoring are therefore essential for prevention of potential pollution from any of the sources noted above.**

2.2 General Pollution Prevention Measures

2.2.1 The following points (not exhaustive) indicate general pollution prevention measures in accordance with those highlighted within the guidelines referenced above and the Environmental Statement:

i. Precautions will be taken to ensure the protection of watercourses and groundwater against pollution, silting and erosion during Watercourse Crossing construction operations.

ii. Any material or substance which could cause pollution, including silty water, will be prevented from entering surface water drains or water courses by the propitious use of and appropriate placement of straw bales, silt fences, cut-off drains, silt traps and drainage to vegetated areas where appropriate.

iii. Any silty water generated on site will ideally be settled out as much as possible through drainage mitigation measures (silt traps etc) and channelled into vegetated areas 20-50m from watercourses to allow the settlement of solids.

iv. All refuelling will be carried out in designated locations, 50 metres away from water courses. Where this buffer distance cannot be achieved a minimum of 20m may be agreed with the ECoW. Irrespective of the buffer distance and location of refuelling, drip trays and spill kits will be available in accordance with standard best practice across the construction industry.

v. Areas of waste, oil / fuel / chemical storage and permanent refuelling will be located 50m from watercourses or drainage paths. Where this is not possible no closer than 20m will be allowed without express permission from the ECoW. Such storage areas will be appropriately sited to prevent the downward percolation of contaminants to natural soils and groundwater.

vi. Fuel, oils and chemicals will be stored on an impervious base within a bund able to contain at least 110% of the volume stored. Rainwater will not be allowed to accumulate within the bund and in any way compromise the required 110% volume capacity.

vii. Site compounds, parking areas and turning areas and vehicle and equipment washing areas are to be sited at least 10m from water courses.

viii. All waste and stockpiled materials will be stored in designated areas and isolated from any surface drains and a minimum of 50 metres away from watercourses, although where this is not possible, a minimum of 20m buffer may be agreed with the ECoW.

ix. The use of cut-off ditches, silt fences, silt traps and drainage to vegetated areas will be employed as required / appropriate in areas of excavation, exposed soils, stockpiling, dewatering and plant and wheel washing.

x. A Personnel Site Induction will make specific reference to required pollution prevention measures as detailed in the guidance discussed above (refer to Technical Schedule TS1, Site Induction Material, of the SEMP).

xi. All works will be carried out in accordance with best practice and will aim to prevent deterioration in the ecological status of surface waters and to avoid compromising the restoration potential of such waters.

xii. In the event of a pollutant spillage on site, the material will be contained (using an absorbent material such as sand or soil or commercially available booms) and Scottish Environment Protection Agency (**SEPA**) notified immediately using the emergency **hotline number (0800 80 70 60).**

2.2.2 The buffer distances referred to in several of the items listed above are **minimum distances**. Each area of works will be assessed individually to determine whether there is sufficient buffering capacity to settle solids and suspended silt prior to entry of run-off into the water course. Buffering capacity will generally depend on the topography and vegetation type and sensitivity. This type of assessment will be implemented through the *Contractor's* detailed Drainage Management Plan.

2.3 Water Environment

2.3.1 The removal of established vegetative cover can lead to the loss of large quantities of soil particles and suspended silt to watercourses which can then cause significant pollution of water. Therefore, any earth moving works or other similar operations giving rise to contaminated drainage must be carried out in accordance with BSI Code of Practice for Earth Works, BS6O31:1981.

2.3.2 Site drainage and surface run off contaminated with silt will not be allowed to directly enter any watercourse; as such, appropriate sedimentation and silt mitigation measures will be implemented on site in order to treat contaminated waters.

2.3.3 Should formal discharge of contaminated site drainage be required (for example where sedimentation and silt mitigation measures are not possible or are of insufficient capacity to deal with site drainage), SEPA will be contacted in order to determine possible and appropriate licensing requirements as determined by the quality and quantity of effluent to be discharged, the location of the effluent discharge point and the receiving water.

2.3.4 As per the requirements of Technical Schedule TS4, Drainage Management Plan, the *Contractor* will undertake a detailed pollution risk assessment to inform preparation of a detailed drainage design. The outcome of this is a detailed Drainage Management Plan (DMP) which is required to be submitted for review by the Employer and the ECoW prior to commencement of construction works in a particular area of the site. This DMP will include a pollution risk assessment for the site and details on planning, design and management of appropriate sediment and silt control measures.

2.3.5 As per the requirements of Technical Schedule TS9, Environmental (Incident and Emergency) Response Plan, the *Contractor* will provide a plan detailing all contingency planning and emergency response procedures. This should include relevant telephone numbers (e.g. SEPA Emergency Hotline number, contact details for downstream landowners and water users etc.) and record the availability of equipment to carry out any emergency remedial work.

2.4 Watercourse Crossings

2.4.1 All Watercourse Crossing works are required to be carried out in accordance with the Water Environment and Water Services Act (WEWS) and Controlled Activities Regulations (CARs). Furthermore, works undertaken in or near watercourses will be completed in accordance with SEPA PPGs, and Technical Schedules 4 and 5 (Drainage Management Plan and Watercourse Crossing Plan) of the SEMP.

2.4.2 In line with the requirements of Technical Schedule TS5, Water Course Crossing Plan (WCCP), the *Contractor* will prepare a detailed Water Course Crossing Plan prior to commencement of works. The *Contractor* will submit this plan to the Employer and ECoW and SEPA for approval and will liaise with SEPA on appropriate CAR authorisations for each crossing.

2.4.3 The mitigation measures specified within the detailed WCCP will be monitored by the *Contractor* and ECoW during construction works.

2.4.4 As described in the body of this document, a number of mitigation measures are required to reduce environmental impact during the Watercourse Crossing works. These are summarised below:

- Following good practice and industry standard approaches, CARs, SEPA's PPGs, and other relevant industry best practice publications;
- On-site inspection and advice from the ECoW;

- Appropriate emergency response and oil spill response during construction works, including the use of drip trays / spill kits etc;
- Buffer zones and silt mitigation measures adjacent to water courses, including installation of adequate splash boards on bridge crossings to prevent mud and run-off from construction traffic;
- Stockpiling of any excavated materials away from watercourses; and
- Any additional ecological mitigation measures as required (such as electrofishing of watercourses prior to Watercourse Crossing works to remove potentially sensitive receptors for return to watercourse once works are completed).

2.5 Water Abstraction and Dewatering Activities

2.5.1 Suitable mitigation measures will be installed to minimise the volume of silt contained within pumped waters and to avoid or minimise the impact of the pumped water discharge on the water environment. These may include, but are not restricted to, the following techniques:

- In order to prevent disturbance from the base of excavations or from the bed of water courses during abstraction, any pump intakes will be protected from sediment by raising the intake using a floating rose and a 'Terram' filter;
- Prior to discharge, any silty water will be treated as per the mitigation measures detailed within this PPP and also Technical Schedule TS4, Drainage Management Plan.

2.5.2 The *Contractor* will discuss and agree all pumping and associated mitigation measures with the ECoW prior to commencement of works. SEPA will also be consulted where considered necessary.

2.6 Dust Suppression & Vehicle Wash

2.6.1 Water needed for dust suppression on the haul roads during periods of dry weather and the compound vehicle wash will be clean water. Clean water may be obtained from re-circulated clean or treated (silt removed) drainage waters.

2.6.2 Where required, water may be extracted from local watercourses or groundwater. In these instances, the *Contractor* will liaise with SEPA beforehand to agree abstraction locations, rates and CAR authorisation requirements.

2.7 Welfare facilities

2.7.1 Toilet, washroom and kitchen facilities for workers at the construction compound near to Sand Water SSSI will be in the form of sealed units which are regularly maintained and emptied to ensure no waste water spills from them.

Drinking Water

2.7.2 Drinking water for the site will be sourced from a registered supply and will be brought in by mains feed or mobile bowser and stored in a potable supply tank where no mains feed is available. Abstraction and treatment from an appropriate local watercourse or groundwater may be an alternative requirement.

2.7.3 The *Contractor* will ensure that appropriate training, signage and physical measures are in place to ensure that only potable water is supplied to the potable water tank and that no pollution of potable supplies occurs as a result of construction works.

Sewage

2.7.4 Disposal of sewage from the site will be carried out by methods recommended in PPG4.

2.7.5 Wind farm sites are generally remote and therefore connection to a main sewer may not be feasible during the construction stage; therefore, sustainable septic systems (waterless toilets or septic tanks) must be installed and maintained appropriately. Due to the sensitivity of upland environments and the nature of the underlying soil, conditions are unlikely to be suitable for the use of a soakaway.

2.7.6 All sewage collected from within septic systems will be tankered from site at an appropriate frequency and disposed of by an appropriately licensed contractor into the local foul water sewer system.

Toilets

2.7.7 Where water supply for toilet cisterns is proposed to be extracted from local watercourses or groundwater, abstraction locations and rates will be agreed with SEPA beforehand.

2.7.8 There will be training, signage and physical measures to ensure that abstracted river water is not supplied to the potable water tank and that measures are implemented to ensure that abstraction activities do not cause pollution of water courses of potable supplies.

2.8 Concrete Pollution Prevention Measures

2.8.1 Cement is alkaline and highly toxic to aquatic organisms. Measures will be implemented to prevent the direct release of any cement or cement contaminated run-off into water courses.

Base Pours

2.8.2 Accidental spillage and potential burst-out of concrete may occur during pouring of concrete for the turbine bases.

2.8.3 Foundation excavations are generally below the level of the surrounding ground, and therefore the risk of concrete spills exiting the base area is considered to be low. However, where the topography allows, foundation excavations are generally designed to be gravity draining in order to control ingress/egress of surface water from the excavation. It will therefore be stipulated that, prior to commencement of each base pour, the *Contractor* will assess the local gradient and the potential risk of concrete run-off exiting the base area and subsequently entering natural watercourses or otherwise impacting on sensitive habitats.

2.8.4 Where a potential risk is identified, cut off ditches and diversion dams will be installed in order to channel potential spillages and run-off water to a suitable collection area (pre-constructed pond or other area suitable for temporary containment of spillages). In the event of a major spill, treatment of the contained material would be agreed with the Environmental Manager and in accordance with CIRIA and SEPA guidance. Depending on the volume of effluent, treatment may involve settlement and evaporation and/or neutralisation of the collected effluent prior to ground soakaway, or pump-out and disposal off-site. Residual solidified concrete within the containment area would be broken up and disposed of off-site prior to reinstatement of the area.

Concrete Wash Out

2.8.5 Washout of concrete trucks will only be undertaken in designated areas. Designated wash out areas will be located at least 50m from any open watercourse, field drain or sensitive habitat area. No surface run-off from within the wash out area will be permitted to leave the area and directly enter any drain or water course. Each wash out area should be located away from main construction traffic area or access areas to prevent disturbance or tracking. A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilise only the designated washout areas.

2.8.6 The number of wash out areas should be kept to a minimum. The number and location of wash out areas will be specified within the *Contractor's* Construction Method Statement (CMS) prior to commencement of construction activities.

2.8.7 At the designated wash out areas, wash water will be contained within a specially constructed lined containment lagoon. Lagoons should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations. The supernatant from the wash pit may be reused for truck washing.

2.8.8 When temporary concrete washout facilities are no longer required for the work, any hardened concrete should be removed and disposed of. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and disposed of. Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

2.9 Emergency Response

2.9.1 An Environmental Incident and Emergency Response Plan will be developed for the site in line with the requirements of TS9. This will include details on incidents and emergencies relating to pollution.

2.9.2 Pollution control related environmental incidents may include: spillages (oils and chemicals); contaminated or silty run-off entering a watercourse or water supply; flooding; riverbed or other aquatic habitat / species disturbance; damage to underground services; damage to habitats; poor waste disposal and storage.

3 MONITORING AND CONTROLS

3.1 Monitoring

3.1.1 On site meetings / inspections will be carried out as necessary to confirm the appropriate use of mitigation measures identified within the *Contractor's* environmental plans relating to pollution control (as listed in Section 1.4). These meetings / inspections will highlight any further issues / measures which may be relevant either prior to commencement or during the works.

3.1.2 To ensure all mitigation measures put in place are maintained and continue to be effective, monitoring will be carried out. To ensure compliance of the works with this Pollution Prevention Plan, the ECoW will regularly inspect the Balance of Plant *Contractor's* works.

3.1.3 The Planning Monitoring Officer (PMO) will also inspect the works as part of an overall construction works inspection programme as required on behalf of the planning authority.

3.1.4 Regular checks of plant and equipment will be undertaken by the *Contractor* to identify any oil or fuel leaks will be carried out to confirm the condition of the plant. Records will be kept of all inspections / findings for review by the ECoW and the PMO and for discussion during regular meetings as discussed above. Regular checks for visual evidence of contamination / sediment will also be made alongside watercourses, near by working areas and in areas of surface water discharge

3.1.5 The ECoW will be maintaining a Pollution Prevention Measures Register (PPMR) in which all mitigation measures put into place will be listed, and audited weekly to assess the requirement for maintenance.

3.1.6 Water Quality Monitoring will also be undertaken (as per the requirements of TS6) for the purposes of monitoring water quality and ensuring quality is maintained at levels similar to baseline data throughout the construction phase. In addition to baseline water quality data, baseline data on fish and macro-invert populations from most of the main Viking Wind Farm catchments has been collected and reported upon in the ES. SEPA also requested that a survey of benthic diatoms in freshwater lochs is undertaken prior to commencement of construction and this data will also be used to inform baseline conditions and monitor impacts on lochs during the construction phase.

3.2 Records

3.2.1 Records will be kept for all initial, final and routine monitoring inspections of *Contractor's* mechanical plant and working construction areas, as well as ecological and environmental issues. These records will be stored in an agreed location on site and be available for internal and external monitoring as required.

3.2.2 Record sheets will detail the date, location of inspection, frequency, findings, appropriate person/s notified and identified actions as necessary by the PMO / ECoW.

3.3 Training

3.3.1 All employees, subcontractors, suppliers and visitors to the site will be notified via a site induction of the requirements on site for pollution prevention. Further details on the minimum requirements of the site induction are contained within Technical Schedule TS1.

3.3.2 Through tool box talks, site personnel and subcontractors will be educated on those aspects of environmental management as appropriate to the task assigned to them.

3.3.3 The ECoW will be consulted prior to commencement of works in any area of the site. Consultation meetings will include discussion on the works to be undertaken, review of applicable Environmental Plans and agreement on required mitigation and pollution prevention measures. Measures agreed at such consultation meetings will be disseminated to the relevant employees, subcontractors, suppliers and other appropriate persons via tool box talks and formal communications (email / memo), particularly where required for record purposes (e.g. variations, auditing and monitoring records).

3.3.4 The *Contractor* will ultimately be responsible for overseeing and enforcing pollution prevention procedures such that potential adverse impacts to human health or the environment from any activities involving handling of potential pollutants are avoided or mitigated. For the avoidance of doubt, pollution prevention procedures include, but are not necessarily limited to: all aspects of traffic, plant and materials management, waste management, surface water and drainage management and concrete management.

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 3

SITE WASTE MANAGEMENT PLAN

SEMP Version:	**1.0**	
Rev No.	**Revision Description:**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	Position :	Signature :
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Comment :

Document was also reviewed by all consultants involved in preparation of the Addendum ES. SEPA were also consulted and provided feedback which has been incorporated into this document.

CONTENTS

1 INTRODUCTION

1.1 Scope and Requirements

1.1.1 The information contained herein forms Technical Schedule (TS3), Site Waste Management Plan (SWMP) of the Viking Wind Farm Site Environmental Management Plan (SEMP). The SEMP is provided as Technical Appendix 14.6 to the Viking Wind Farm Addendum Environmental Statement (ES).

1.1.2 The SEMP replaces the original Technical Appendix 14.4 (Site Environmental Management Plan / Pollution Prevention Planning) submitted with the original ES.

1.1.3 The SEMP, including the information and measures contained within this SWMP along with any updates required as part of any relevant planning conditions, will form part of the main civil engineering construction *Contract* and will be made available to those tendering for construction works. All tendering *Contractors* will therefore be obligated to consider the requirements for waste management contained herein and allocate costs and resources accordingly.

1.1.4 Prior to commencement of works, the appointed *Contractor* will prepare a number of environmental plans to support and supplement the SEMP with detailed procedures and processes of his own design. This includes the requirement to prepare a detailed SWMP prior to commencement of construction works.

1.1.5 The *Contractor's* SWMP will be submitted to the planning officer at Shetland Islands Council, Scottish Environment Protection Agency (SEPA), Viking Energy Partnership Project Manager, Environmental Manager and the Environmental Clerk of Works (ECoW) for review, approval and comment where appropriate.

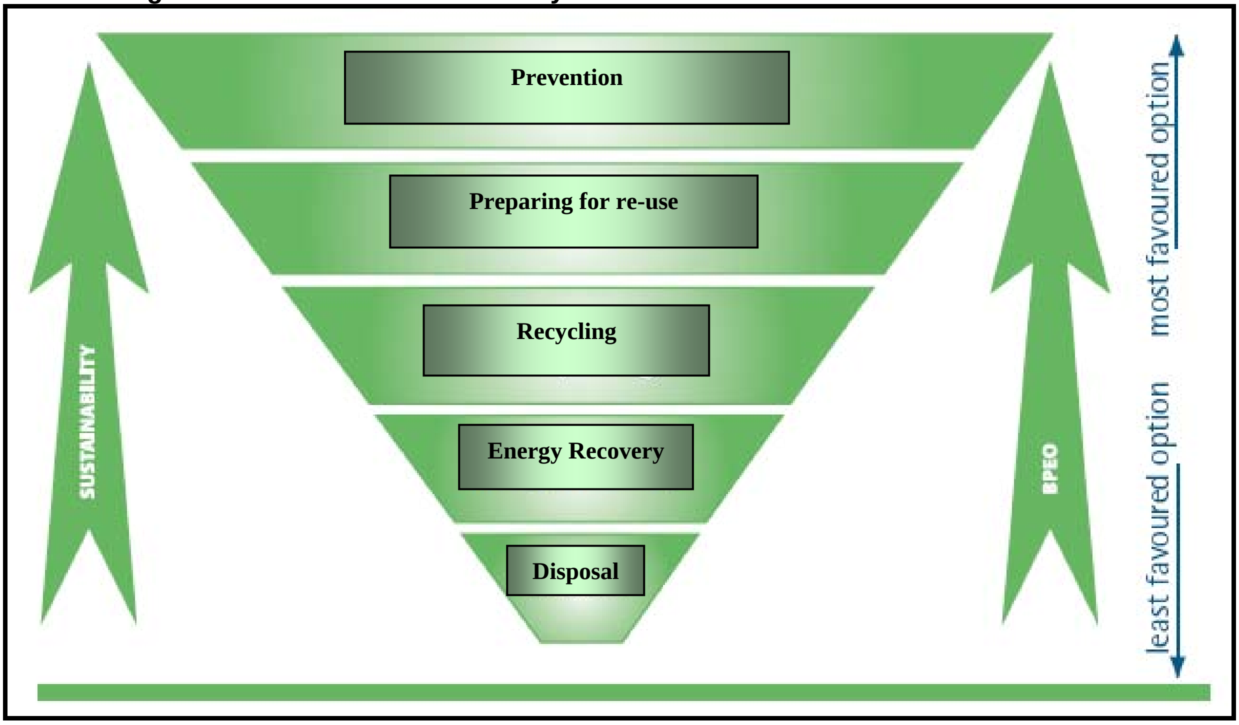
1.1.6 The general methods and principles contained herein, as well as within referenced legislative instruments and published guidance documents, will be adhered to by the *Contractor* in developing the SWMP as required by the Contract. The information contained herein provides an outline of the minimum requirements to be contained within the *Contractor's* detailed SWMP.

1.1.7 In preparation of the SWMP, the *Contractor* will liaise with SEPA to determine requirements for, and obtain, waste management license exemptions and consents associated with waste management and foul water discharge from the site where appropriate.

1.2 Objectives

1.2.1 Viking Energy Partnership is committed to managing activities to reduce the resources we use and, where possible, to re-use, recycle or recover resources, in accordance with best practice in waste management and SEPA's "The Waste Hierarchy (2006)". The Waste Hierarchy promotes selection of the Best Practical Environmental Option (BPEO) and preferred options for management of wastes as follows:

Figure TS3-1: The Waste Hierarchy



1.2.2 The principal objective of this SWMP is to provide details on the minimum requirements to be incorporated within the *Contractor's* detailed SWMP such that all possible preventative measures will be taken to adhere to the policies and commitments detailed above.

1.2.3 In achieving the principal objective noted above, the ultimate aim is to implement reduction and effective management of resources and waste during the early design stages of the wind farm construction, through to completion, such that:

- legal obligations are met;
- waste production is minimised and waste is recognised as a resource
- project build costs are minimised;
- a framework for continuous improvement and best practice is implemented and maintained; and
- carbon emissions and other negative environmental impacts associated with the production and management of waste materials are minimised.

1.3 Reference Documentation

1.3.1 In addition to legislative instruments, the information, methods and general principles contained within the following published guidance documents will be taken into consideration in the Contractor's detailed SWMP:

1.3.2 SEPA Pollution Prevention Guidelines (PPG):

- PPG02 Above ground oil storage tanks
- PPG04 Treatment and disposal of sewage where no foul sewer is available
- PPG08 Safe storage and disposal of used oils

1.3.3 SEPA Regulatory Position Statement, Developments on Peat, National Waste Policy Unit, 9 February 2010.

1.3.4 The Waste Hierarchy, National Waste Strategy: Scotland. SEPA, September 2006. (http://www.sepa.org.uk/waste/moving_towards_zero_waste/waste_hierarchy.aspx).

1.3.5 Institute of Environmental Management and Assessment (IEMA) Practitioner Series No.11: Waste Management: A Guide for Business in the UK, September 2008.

1.3.6 WRAP (Waste & Resources Action Programme): http://www.wrap.org.uk/construction/tools_and_guidance/site_waste_2.html

1.3.7 www.wasteonline.org.uk

1.3.8 www.wasteawarescotland.org.uk

1.3.9 www.defra.gov.uk/Environment/waste/

2 SWMP MINIMUM REQUIREMENTS

2.1 Implementation of a SWMP

2.1.1 In April 2008, the Site Waste Management Plan Regulations 2008 (The Regulations) came into force in England requiring a Site Waste Management Plan (SWMP) to be prepared and implemented on all construction projects with an estimated cost greater than £300,000 (exc. VAT).

2.1.2 Although these regulations currently only apply in England, in accordance with industry best practice and Viking Energy Partnership requirements, a SWMP is to be implemented by the *Contractor* on the Viking wind farm construction project.

2.1.3 A Site Waste Management Plan (SWMP) involves the following key stages:

- Planning;
- Implementation;
- Monitoring; and
- Review.

2.2 Planning

2.2.1 The SWMP must record any decision taken before the Plan was drafted on the nature of the project, its design, construction method or materials employed in order to minimise the quantity of waste produced on site.

2.2.2 The current layout of the wind farm has been subjected to rigorous assessment against numerous potential environmental constraints such that the optimum layout is selected and approved by the Planning Authority. This optimum layout takes into account aspects such as ecology, geology, hydrology, hydrogeology, landscape and visual impact, noise etc. The wind farm is therefore designed in order to avoid or minimise impact on these aspects, while taking into account practical and commercial considerations. Practical and commercial considerations include minimisation of construction material requirements and associated wastes at the initial design stage.

2.2.3 Following submission of the original ES, the wind farm layout has been amended in order to address initial objections from various statutory and non-statutory bodies relating to a range of environmental constraints. The resultant reduction in scale of the wind farm (reduction in turbines numbers and track lengths), along with adherence to current construction best practice methods for excavation and handling of the material, will significantly reduce the potential for generation of waste materials in the first place. Part of the review process for amending the wind farm layout included a re-assessment of the opportunities for minimising peat excavation, a review of the volumes of peat excavated and opportunities to re-use peat (refer to ES Appendix A14.4, Estimated Peat Extraction and Reuse Volumes). This report identified that all excavated peat is required for use in the works (as described in SEMP Technical Schedule TS7, Excavated Materials and Reinstatement Plan). Where excavated material is immediately suitable for reuse it is not considered to be waste. Where the material may prove to be unsuitable for the intended use it may be classified as waste and the appropriate regulatory controls will be imposed by SEPA[1]. This is discussed in more detail in Section 5.

2.2.4 The planning process can therefore be seen as the initial stage in the waste avoidance / minimisation process. This SWMP and the requirement for completion of a *Contractor's* detailed SWMP, presents the next stage in the process.

2.2.5 Designing out waste before it arises is one of the most efficient ways to reduce project waste arisings. When finalising the detailed design of wind farm infrastructure, including selecting construction methods and material requirements, the *Contractor* will consider all options for minimising peat excavation. This process will also focus on maximising opportunities to reuse peat on site where excavation cannot be avoided.

2.3 Implementation

2.3.1 The SWMP will identify: the Client; the *Contractor*; the person(s) who drafted the SWMP and the person(s) who will be responsible for its implementation, monitoring and review during and upon completion of construction works.

2.3.2 The SWMP must provide a waste inventory and procedures to address the following:

i. A description of each waste type expected to be produced in the course of the project;

ii. An estimate of the quantity (volume) of each different waste stream / type of waste expected to be produced;

iii. A written statement demonstrating what actions were taken to minimise the volume of each type of waste produced prior to commencement of the activity generating the waste.

iv. Procedures for identification of the waste management actions proposed for each different waste type, including re-using, recycling, recovery and disposal.

2.4 Checks & Records

2.4.1 Any waste fuel, oil or chemical storage area will be checked regularly (with additional checks in the event of extreme weather conditions) for evidence of leaks and spills. The required frequency for such "environmental checks" is detailed within Section 3 of the SEMP. Checks will include visual inspection for evidence of contamination / on the ground, in sediment or in surface water. These checks will also verify the integrity of storage facilities and the effectiveness of their storage and containment procedures.

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[1] Refer to SEPA Position Statement on Developments on Peat, February 2010. Which states that "*while there can be uses for peat within a development, peat is not always suitable for proposed uses. In such cases it may be regarded as waste in law*".

2.4.2 Records will be kept of all inspections / findings for review by the ECoW and external parties where requested. Waste management will be an agenda item on all regular meetings as required by the SEMP (again refer to Section 3 of the SEMP for required frequency of meetings).

2.4.3 The waste inventory will be maintained and kept up to date and will include a record of all waste materials arising from site works and all waste materials leaving the site for disposal.

2.5 SWMP Monitoring & Auditing

2.5.1 The SWMP will provide details on how waste reduction is to be implemented at the site and also how this is to be monitored throughout the construction phase. The *Contractor* will nominate an appropriate person to take responsibility for implementation and monitoring of the SWMP. This may be a Site Environmental Manager or otherwise appropriately qualified person(s).

2.5.2 As noted above (Section 2.3.2), the SWMP must provide an inventory and initial estimate of waste quantities for the various waste streams likely to be produced on the site. The ultimate aim will be to ensure the actual volumes of waste generated are managed below the estimate. Site progress will be monitored against the estimate set within the *Contractor's* detailed SWMP and changes will be implemented in order to revise site activities based on performance where necessary.

2.5.3 An element of waste auditing will be conducted with each SEMP audit conducted by the Employer, however additional waste specific audits will be carried out once every 6 months.

2.6 Completion Audit & Review

2.6.1 Following completion of construction works, and before the end of the defects correction period, a project Waste Management review will be undertaken. This will involve the *Contractor's* and Employer's Environmental Manager, Project Manager or other nominated person(s) as appropriate on both sides.

2.6.2 The purpose of this review is to identify project progress, areas for improvement with regards waste management and also measure compliance with any licensing conditions as required. Lessons learned from this process will be used to inform 'best practice' procedures on future projects.

2.7 Training

2.7.1 All employees, subcontractors and suppliers will be fully briefed regarding the general site waste management strategy as part of the site induction procedures and as appropriate to the task to be undertaken.

2.7.2 Littering on site will not be tolerated and all employees, suppliers and visitors will be briefed on the appropriate waste storage and disposal procedures on the site (including locations and appropriate use of recycling bins and skips).

3 GENERAL WASTE MANAGEMENT PRINCIPLES

3.1 Generation, Storage and Disposal of Waste Materials

3.1.1 As with any large scale construction project, the generation of waste from wind farm development is inevitable. However, the types and quantities of waste produced will be dependant on the local conditions and scale and type of development.

3.1.2 All possible actions will be taken by the *Contractor* to avoid or minimise the volume of waste generated.

3.1.3 Waste materials will not be stored within 50metres of a watercourse wherever possible. Where this may not be practically achievable, the Contractor will provide detailed justification for a reduction in this specified buffer distance, however, irrespective of the justification provided, on no account will this buffer distance be reduced to less than 20metres.

3.1.4 All areas used for storage of waste materials will comply with the SEPA Pollution Prevention Guidelines (PPG's). Waste storage and disposal will be carried out in such a manner as to prevent pollution and ensure compliance with current waste legislation.

3.1.5 Transport of waste will be carried out in accordance with legal and Duty of Care requirements. Transport of any waste requires completion of a Duty of Care Waste Transfer Note (WTN). WTNs can be in any format, but they must include a detailed record of the waste source and destination, description (including correct European Waste Catalogue (EWC) code), load volume and how it is contained.

3.1.6 Where hazardous waste is to be transported, SEPA must be notified and specific hazardous Waste Consignment Notes (WCNs) are required to be purchased.

3.1.7 Where hazardous waste is involved separate containers must be provided appropriate to the material being stored, used, transported or disposed of. Emergency procedures must also be clearly documented.

3.1.8 Material storage areas will be clearly located and signed. Space permitting, key waste streams should be segregated. The segregation scheme should include appropriate training, monitoring and enforcement with clear signage and using the National Colour Coding Scheme.

3.1.9 Where possible, the *Contractor* will arrange for just in time delivery and double handling will be avoided. Delivery vehicles should aim to remove waste materials on return trip.

3.1.10 All waste will be transported from site at an appropriate frequency by a registered waste carrier to prevent overfilling of waste containment facilities and will be reused/recycled where practical.

4 ANTICIPATED CONSTRUCTION WASTE STREAMS

4.1.1 A number of difference waste streams are likely to arise during construction of the wind farm. As per the requirements of Section 2 herein, the *Contractor* will identify all waste streams and provide an estimate of expected waste volumes for each waste type generated within the waste stream.

4.1.2 The *Contractor* will ensure that all relevant information obtained subsequent to the Addendum ES submission either by himself or other parties is taken into account in preparing his SWMP (for example intrusive ground investigation data, additional site investigation information, supply chain assessments, options appraisals etc).

4.1.3 The section below sets out further requirements in relation to those waste streams that typically arise during construction of an on-shore wind farm:

4.2 Waste from Welfare Facilities

4.2.1 This will primarily be food waste, paper, plastics, glass and other typically domestic refuse generated in the offices and canteen areas within the site compound, as well as on site. All waste of this type will be stored in an appropriate location, protected from wind, rain and wild animals. Facilities will be provided to segregate waste into appropriate waste streams (glass, paper etc) and minimise volumes of material stored (e.g. folding and baling of cardboard waste).

4.2.2 Sewage will also be generated at welfare facilities. Disposal of sewage from the site will be carried out by methods recommended in SEPA PPG4.

4.2.3 There is currently no anticipated requirement for a separate construction workers camp at the Viking Wind Farm. However, should such a facility be required at any stage, all waste streams from the welfare facilities and other general domestic refuse from such a facility will also be included within the *Contractor's* SWMP.

4.3 Concrete

4.3.1 Methods for dealing with concrete waste and wash out water are provided within Technical Schedule TS4, Drainage Management Plan. Where possible a settlement and re-circulation system for water reuse will be considered for water used in concrete batching and wash out areas.

4.3.2 Any waste water generated from concrete batching will be adequately treated to deal with suspended solids and high alkalinity before discharge under conditions and methods as agreed with SEPA.

4.4 Waste Chemicals, Fuel and Oils

4.4.1 Engine and hydraulic oil waste will be stored on site and disposed of in accordance with SEPA PPG2 and PPG8, as well as general mitigation measures described within Technical Schedule TS2, Pollution Prevention Plan.

4.4.2 **The *Contractor* will prepare and maintain a Chemical and Waste Inventory as part of the SWMP.** This inventory will include:

- List of all substances stored on-site (volume and description);
- Procedures and location details for storage of all materials listed; and
- Waste disposal records, including copies of all Waste Transfer Notes (WTN) detailing disposal routes and waste carriers used.

4.4.3 Fuels and other oils, including waste oils, will be stored and handled in accordance with procedures detailed in TS2, Pollution Prevention Plan.

4.5 Packaging

4.5.1 This includes waste materials arising from packaging of equipment or materials brought onto site, including paper, plastics and wood used for packaging turbine components, reinforcing rods, concrete formwork, cement and other raw materials.

4.5.2 In line with the Waste Hierarchy, wherever possible, packaging will be returned to originator for reuse ahead of recycling or disposal. Othey will be stored on site in a sealed skip within the construction compound and disposed of in accordance with PPG6 and general mitigation measures described within Technical Schedule TS2, Pollution Prevention Plan.

4.6 Waste Metals

4.6.1 Where there is residual metal such as from steel reinforcing rods for concrete and cabling, it is expected to have some commercial value and be suitable for re-use or recycling.

4.7 Cleaning Activities

4.7.1 Cleaning activities (e.g. for plant, vehicles, wheel washes, concrete truck wash out etc) can produce large volumes of polluted water. All cleaning activities must therefore be carried out in an appropriate enclosed area and waste water captured for treatment and appropriate discharge as per the requirements of Technical Schedules TS2 and TS4 (Pollution Prevention Plan and Drainage Management Plan).

4.8 Excavated Materials

4.8.1 Excavated materials, and in particular peat, may or may not be classed as waste in accordance with the legal definition of waste. This is discussed in more detail in Section 5.

5 EXCAVATED MATERIALS

5.1 Classification of Excavated Materials

5.1.1 The methods to be employed during excavation, storage and subsequent use of excavated materials are described within Technical Schedule TS7, Excavated Materials and Reinstatement Plan of the SEMP.

5.1.2 Excavated soils, peat and rock are required for reinstatement on site in landscaping and re-profiling works and in order to minimise visual impacts and facilitate habitat and ecological restoration, improvement and enhancement. However, in order to ensure compliance with relevant waste legislation, excavated materials will require to be classified on site and a use determined for those materials prior to excavation.

5.1.3 As indicated on Figure TS3-2, four initial classes of excavated materials may be identified during construction:

i) **Mineral Soil:** Highly variable composition which may depend on underlying geology, depositional environment or provenance if made ground. Refer to British Soil Classification System BS5930: 1999, Code of Practice for Site Investigations" (Table 13).

ii) **Turf:** surface layer of living vegetation and underlying fibrous subsoil.

iii) **Acrotelmic peat**: the upper layer of a peat bog in which organic matter decomposes aerobically. Material may be fibrous or pseudofibrous (plant remains recognisable), spongy, strength is lost but retains integral structure and can stand unsupported when stockpiled >1m. Acrotelmic material is generally found within the top 1m of peat, although may extend beyond this to depths of up to 2m depending on the degree of decomposition and fibrous nature of the peat.

iv) **Catotelmic peat:** the deeper layers of peat in which organic matter decomposes anaerobically. Material is amorphous (recognisable plant remains absent), plastic, has high water content and low tensile strength and is unable to stand unsupported >1m when stockpiled.

5.1.4 Figure TS3-2 outlines the general procedures that will be taken on site to classify excavated materials and determine whether they will be classed as waste, and, if so, what the anticipated regulatory controls are likely to be.

5.1.5 The first step in the process, and in advance of each main phase of works or 100m of constructed track (or as agreed on site), the *Contractor (*in conjunction with ECoW, GCoW or other specialists where required), will provide a method statement detailing expected volumes, material classification, storage and reuse procedures for the excavated materials anticipated from that particular work area. This will require a detailed walkover and data review (peat depth, habitat surveys etc) in order to determine likely characteristics of excavated materials and identify appropriate temporary storage or treatment areas.

5.1.6 All classification procedures and potential waste management routes referred to in this plan are provided as an outline guide only. The actual mechanisms employed on site during the construction works will be subject to revised volume estimates, detailed Method Statements as provided by the *Contractor* and actual site conditions encountered during the works.

5.1.7 The *Contractor* will liaise with SEPA on all aspects of waste management relating to excavated peat to ensure compliance with all appropriate regulatory controls prior to and during construction works.

5.2 Estimated Volumes of Peat

5.2.1 As the wind farm layout has altered significantly since the 2009 ES was submitted, Appendix A14.4 of the Addendum ES provides a revised preliminary estimate of the volumes of peat to be extracted and reused at the site. The design assumptions and engineering principles used to derive the volumes are discussed in detail in Appendix A14.4.

5.2.2 Based on a design scenario of constructing floating roads where peat depths generally exceed 1.0m, the total excavated volume of peat has been estimated to be around 742,000 m^3. Of this around 434,000m^3 will be required for reuse in reinstatement and restoration of infrastructure, while the remaining 308,000m^3 will be required for restoration of borrow pits. Assuming all remaining material is utilised, the restoration depth within the borrow pits may be within the region of 1.7m.

5.2.3 While there is a significant volume of peat to be excavated during the course of the construction works, Appendix A14.4 has demonstrated that there is a legitimate requirement to reuse all of the estimated excavated volumes in essential reinstatement and restoration works. This is in line with SEPA's guidance in their Position Statement on peat, which states: "*Developers should attempt to re-use as much of the peat produced on site as is possible*."

5.2.4 Of the total volume of peat excavated, it has been estimated that approximately 217,000m^3 may be catotelmic peat. Due to its physical characteristics (low tensile strength etc) this material may be unsuitable for reuse without prior treatment. If this is the case then this material may be classed as waste. However, as the volume of material is still required for completion of restoration activities, including borrow pit restoration, the waste will require to be reused or treated such that is recovered prior to reuse. Reuse or treatment of this material will require to be agreed with SEPA and will be undertaken in compliance will all relevant waste legislation.

5.2.5 It should be noted that these excavation volumes are an estimate. In preparing his detailed SWMP, the *Contractor* will undertake a review of these preliminary volume estimates and will take into account all relevant information obtained subsequent to the Addendum ES either by himself or other parties (e.g. further ground investigations and peat depth surveys etc).

5.2.6 It is imperative that, prior to excavations, the *Contractor* identifies in his detailed Method Statement where and how excavated peat will be used in reinstatement or landscaping works. Furthermore, throughout the construction process, the *Contractor* (and / or *Designer*) will demonstrate that all possible methods have been employed to prevent or minimise the volumes of excavated peat; this will include, but is not necessarily limited to:

- Assessment and consideration of all potential alternative engineering methods which would minimise the excavation of peat (e.g. piling as opposed to excavating turbine bases and hard standing areas);
- Micro-siting of access tracks to avoid deep peat;
- Minimisation of excavation extents and land disturbance during the works; and
- Appropriate handling and storage of excavated materials such that their integrity and subsequent reuse is not jeopardised prior to their reuse.

5.3 Waste or Not Waste?

5.3.1 The wind farm design, revised layout and Environmental Impact Assessment has taken into account all measures to avoid or reduce the potential for generation of waste excavated material and, in particular, peat. Prevention of the generation of waste is the first step in the waste hierarchy followed by minimisation and reuse.

5.3.2 In line with the SEPA Position Statement on Developments on Peat, and the SEPA "Land Remediation and Waste Management Guidelines", any excavated material (whether peat, mineral soil or rock) which is not intended to be disposed of or discarded will not be considered as waste will not be regulated under waste management controls provided the following six criteria are met:

i) The use is a necessary part of the planned works.
ii) The material is suitable for that use.
iii) The material does not require any processing or treatment before it is reused.
iv) No more than the quantity necessary is used.
v) The use of the material is not a mere possibility but a certainty.
vi) The use of the soil will not result in pollution of the environment or harm to human health.

5.3.3 Excavated material that does not meet any one of the above six criteria, but undergoes some form of treatment to 'recover' the waste, such that it does become suitable for use, will be classed as waste initially; however, following treatment and reuse on site it will no longer be a waste. Anticipated regulatory license requirements for this site are discussed further below.

5.3.4 All excavated peat can justifiably reused on site as part of the construction works, hence criteria (i) and (iv) in the list above are likely to be met in all instances. However, dependant on the material description (refer above to classification) and intended reuse, other criteria may not be met in all instances as described in Table TS3-1 below.

Table TS3-1: Is it Waste?	
"Not Waste" Criteria	**"Not Waste" Criteria met?**
i) The use is a necessary part of the planned works.	**Yes.** Appendix A14.4 demonstrates that all excavated peat can be reused on site (more peat is estimated to be required for re-use than is to be excavated).
ii) The material is suitable for that use.	**Not always.** Where peat loses integrity and structure upon excavation and handling, subsequent reuse may be limited without further treatment (dewatering or mixing) or other specific engineering controls at the site of reuse. If treatment or engineering controls are required this may be classed as waste.
iii) The material does not require any processing or treatment before it is reused.	**Not always.** Refer ii) above.
iv) No more than the quantity necessary is used.	**Yes.** Appendix A14.4 demonstrates that all excavated peat can be reused on site and it is unlikely that surplus quantity will be generated that does not have a required use.
v) The use of the material is not a mere possibility but a certainty.	**Yes.** All reinstatement works are certain to be required as detailed within TS7.
vi) Use of the material will not result in pollution of the environment or harm to human health.	**Not always.** Material that is unsuitable for use without treatment due to its low structural integrity could result in peat slide or excessive run off that may cause pollution of water courses. Similarly, the liquefied nature of this material may pose a hazard to humans or livestock walking over the area if deposited at significant depth without mitigating measures put in place.

5.3.5 For the purposes of waste description, excavated peat that does not meet all of the above criteria would fall under Chapter 17 of the European Waste Catalogue (EWC), 'Construction and demolition wastes', and the EWC Code '17 05 04, soil and stones' (non-hazardous) would apply.

5.3.6 At all stages in the development and construction process, the principles of the waste hierarchy will be strictly adhered to in order to avoid and/or minimise production of excavated peat, and ensure that all materials are recovered and reused on site. Waste peat will not be sent for disposal, recovery and / or reuse off site[2]. This reflects the requirements of EC Directive 2006/12/ED, which states:

> "*Movements of waste should be reduced".*

5.4 Waste Management License Exemptions

5.4.1 Activities exempt from waste management licensing are detailed within the Waste Management Licensing Regulations 1994 (WML) (as amended). It is noted that there is currently a Scottish Government consultation out on consolidation of the Waste Management Licensing Regulations in Scotland which will allow for the transposition of the provisions of the revised Waste Framework Directive (2008/98/EC). These provisions must be transposed into Scots law before 12 December 2010. The draft Waste Management Licensing (Scotland) Regulations 2010 are available to review as part of this consultation. Relevant to the use of peat on wind farm developments, the consultation document proposes removal of the essentially arbitrary 2 metre depth restriction on a Paragraph 9 Exemption.

5.4.2 Activities exempt from waste management licensing are set out in Schedule 1, Regulations 2(1) and 17) of the WML Regulations. Of these, Paragraph 9 may be relevant to the use of peat in borrow pits under certain circumstances only.

5.4.3 In applying this exemption, it is assumed that the excavated catotelmic peat will be only be used in restoration works where the topography allows straight forward deposition with no pre-treatment or containment measures and without risk to the environment. Suitable scenarios may present in those disturbed areas where natural topography or borrow pit pre-restoration profile allows such use.

5.4.4 Table TS3-2 describes the conditions that apply to the use of a Paragraph 9 exemption and the implications on the use of untreated catotelmic peat in restoration works.

Table TS3-2: Paragraph 9 WML Exemption Conditions

Conditions	Does this condition restrict the use of peat in restoration?
Paragraph 9-	
(1) Subject to the following provisions of this paragraph—	
(a) the treatment of land with any of the wastes listed in Part I of Table 3;	**No** Part II of Table 3 includes 17 05 04 (soil and stones) (non-hazardous).
(b) the treatment of land with any of the wastes listed in Part II of that Table where such treatment results in benefit to agriculture or ecological improvement;	

[2] Various alternative off-site options were previously considered in the original ES (Appendix 14.4) and it was concluded that, for reasons relating to practicality and environmental sustainability, export of peat for either disposal or recovery/alternative reuse is not feasible.

Table TS3-2: Paragraph 9 WML Exemption Conditions	
Conditions	**Does this condition restrict the use of peat in restoration?**
(c) the secure storage, at the place where it is to be used and for a period not exceeding 6 months, of waste intended to be used in reliance upon the exemption conferred by paragraph (a) or (b).	**No** Material will not be stored for more than 6 months prior to final use in restoration works.
(2) Sub paragraph (1) does not apply to the use of waste at a site designed or adapted for the final disposal of waste by landfill at any time when such disposal is the subject of a waste management licence or a permit granted under regulation 7 of the 2000 Regulations[3].	**No** Borrow pits (or any other area) are not being used for final disposal of peat or any other material and will not be designed or adapted in any way. Only areas with suitable topographical, geological, hydrological and ecological conditions will be selected for reinstatement or restoration and fill-in work using peat or other suitable materials. On this basis the reuse site will not be the subject of a site license or landfill permit. Article e 3(2) of the Landfill Directive specifically excludes the "*use of inert waste which is suitable, in redevelopment/restoration and filling-in work, or for construction purposes, in landfills*" from the scope of the Directive. Restoration of the borrow pit would be classed as a recovery operation as the borrow pit has not been designed for the final disposal of waste. The Waste Framework Directive includes a recovery category of "*land treatment resulting in benefit to agriculture or ecological improvement*". This is supported by Recitals 15 and 3 of the Landfill Directive which state respectively: "*the recovery of inert or non hazardous waste which is suitable, through their use in redevelopment/restoration and filling-in work, or for construction purposes may not constitute a landfilling activity*." And *"the prevention, recycling and recovery of waste should be encouraged as should the use of recovered materials and energy so as to safeguard natural resources and obviate wasteful use of land".*
(3) Sub paragraph (1) applies only where—	
(a) the waste is used for the purpose of reclamation, restoration or improvement of land which has been subject to industrial or other man made development;	**No** Borrow pit restoration with peat contributes to achieving biodiversity benefits, reducing landscape and visual impacts and is the most sustainable option in terms of carbon emissions and environmental impacts associated with alternative treatment options and / or off-site disposal or

[3] Refers to: Pollution Prevention and Control (Scotland) Regulations 2000 (PPC)

Table TS3-2: Paragraph 9 WML Exemption Conditions

Conditions	Does this condition restrict the use of peat in restoration?
	reuses.
(b) the waste is suitable for use for the purposes mentioned in sub paragraph (a);	**No** (refer paragraph (a) above), plus provisional on: Compliance with Waste Framework Directive which states waste must be "*recovered or disposed of without endangering human health and without using processes or methods which could harm the environment, and in particular:* *i) without risk to water, air or soil, or to plants or animals;* *ii) without causing a nuisance through noise or odours; and* *iii) without adversely affecting the countryside or places of special interest*." To meet the above provisions, only areas with suitable topographical, geological, hydrological and ecological conditions will be selected for use. Depths of liquefied peat will not exceed a maximum safe depth for either humans or animals who may be at risk, and will pose no risk of residual instability or pollution of the surrounding environment (either from mass movement, creep or leaching of deposited material).
(c) the waste is used in accordance with the requisite planning permission (if any);	**No** Within the ES it is stated that borrow pit restoration is required to minimise visual impacts and facilitate habitat and ecological restoration, improvement and enhancement. Should planning consent be granted on this basis then this would become a planning requisite.
(d) the waste is used to a depth not exceeding the final cross sections shown on the plan submitted under regulation 25(2) or 26(2) of these Regulations; and	**No** (refer to Table 3 below).
(e) the waste used does not exceed 20,000 cubic metres per hectare.	**No** Appendix 14.4A indicates that if all material excavated were to be used on site, the total depth required for reinstatement within borrow pits would not exceed 2m (20,000m3/ha equivalent). Furthermore, as with sub-paragraph (b) response above, the depth of (untreated) waste will not exceed 2m as this would pose an unacceptable risk.

5.4.5 As detailed within Schedule 3, Regulation 25(2) of the WML Regulations, registration for a paragraph 9 exemption requires preparation and submission to SEPA of a number of plans and documents as detailed within Table TS3-3. These plans and documents will be prepared by the *Contractor* prior to the reuse of any untreated catoltelmic peat on site.

Table TS3-3: Registration Requirements for Paragraph 9 Exemption (as per Schedule 3, Regulation 25(2) of WML Regulations)
A plan of each place at which the exempt activity is to be carried on showing— (a) the boundaries of that place; and (b) the locations within that place at which the exempt activity is to be carried on.
1. The notice shall include the following particulars— (a) the establishment or undertaking's name, address and telephone number and, if applicable, its fax number and email address. (b) where less than 2,500 cubic metres of waste are to be used, a description of the treatment, the type and quantity of waste to be used and the location of the treatment; (c) where 2,500 or more cubic metres of waste are to be used— (i) the total quantity of waste to be used; (ii) the type of waste to be used, identified by reference to the descriptions in the second column of Table 3; (iii) the location of the land where the waste is to be used or stored, identified by reference to a map and a six figure Ordnance Survey grid reference, including the name, address, telephone number and, if applicable, the fax number and email address of the landowner (iv) a plan of the use with cross-sections showing the proposed levels of the land affected by the treatment; (v) the intended start and completion date of the use or storage.
2. Where any of the wastes listed in Part II of Table 3 is to be used, the notice shall be accompanied by a certificate describing how the activity will result in benefit to agriculture or ecological improvement, which shall be prepared by or based on advice from a person who, in the opinion of the appropriate registration authority, has appropriate technical or professional expertise.

5.5 Mobile Plant License and Recovery of Waste

5.5.1 Management of waste under a Paragraph 9 exemption must be investigated as a preferred route over a MPL as treatment of peat waste will require more handling and disturbance of the material and therefore increase in C emissions from atmospheric and aqueous losses from the peat itself (from dewatering and drying out of the excavated material required to render it suitable for use) as well as additional carbon emissions from additional mechanical plant required on site to undertake the treatment.

5.5.2 Where a Paragraph 9 waste management license exemption is not applicable (for example where the site of reuse requires modification or the waste requires treatment in order to be reused without posing a risk to the environment etc), waste catotelmic peat will be treated prior to reuse under a Mobile Plant License until the waste is fully 'recovered' and suitable for reuse in restoration and landscaping works.

5.5.3 The *Contractor* will prepare, submit and obtain approval from SEPA of his site specific 'Working Plan' for treatment of waste catotelmic peat. Treatment may comprise mixing with suitable non-waste material or dewatering to produce a fill material that is suitable for reuse in restoration works without any further specific engineering measures required at the site of reuse.

5.5.4 As a minimum the Working Plan will include all details as referred to in Section 3) of Tables TS3-4 below.

Table TS3-4: Mobile Plant License Guidance (*SEPA Interim Guidance on Mobile Plant, issued 19 June 2006, quoted in italics*)
1) A mobile plant licence applies to: *"Under Regulation 12 of the Waste Management Licensing Regulations 1994, as amended, it is possible to apply for a mobile plant licence for, amongst other things,* ***the treatment of waste soil****.* *A mobile plant licence specifies the mobile plant that can be used for the treatment and disposal of specified controlled waste. Licence conditions cover the treatment and/or disposal activities.* *"A single mobile plant licence can cover several pieces of mobile plant and types of treatment on a number of different sites at the same time".*
2) A mobile plant licence will not apply where: • *"the waste soil needs to be encapsulated eg. in a bund;* • *where technical precautions must be employed to make the waste soil fit for use eg. capping it to avoid water ingress or to prevent direct contact, or* • *where residual contaminants are likely to be mobilised".*
3) A site specific working plan must include: • *"The operation of the site. e.g. the specific plant and equipment necessary to facilitate the operation of the plant, the treatment process, the types and quantities of wastes to be treated including any wastes necessary for use in the*

Table TS3-4: Mobile Plant License Guidance

(*SEPA Interim Guidance on Mobile Plant, issued 19 June 2006, quoted in italics*)

treatment of the wastes

- *Site infrastructure. e.g. Security provisions, location of waste storage and treatment*
- *Pollution control. e.g. procedures for dealing with pollution incidents and other emergencies, a groundwater risk assessment or justification that there is no potential for the mobilisation and/or discharge of list I or List II substances to groundwater, dust minimisation, litter control,*
- *Site completion e.g. procedures to be used to clean the Mobile Plant of all wastes and treatment chemicals before it is moved to another location.*
- *Monitoring. e.g. monitoring and pollution control methods to be utilised on Site.*
- *Site Location Plan. e.g. a location plan of the area where treatment is to be carried out* ".

The Working Plan will also include suitable material specification / reuse criteria and details of required materials inspection / compliance testing procedures.

Figure TS3-2: Excavated Materials - Outline Waste Classification and Procedures for Reuse

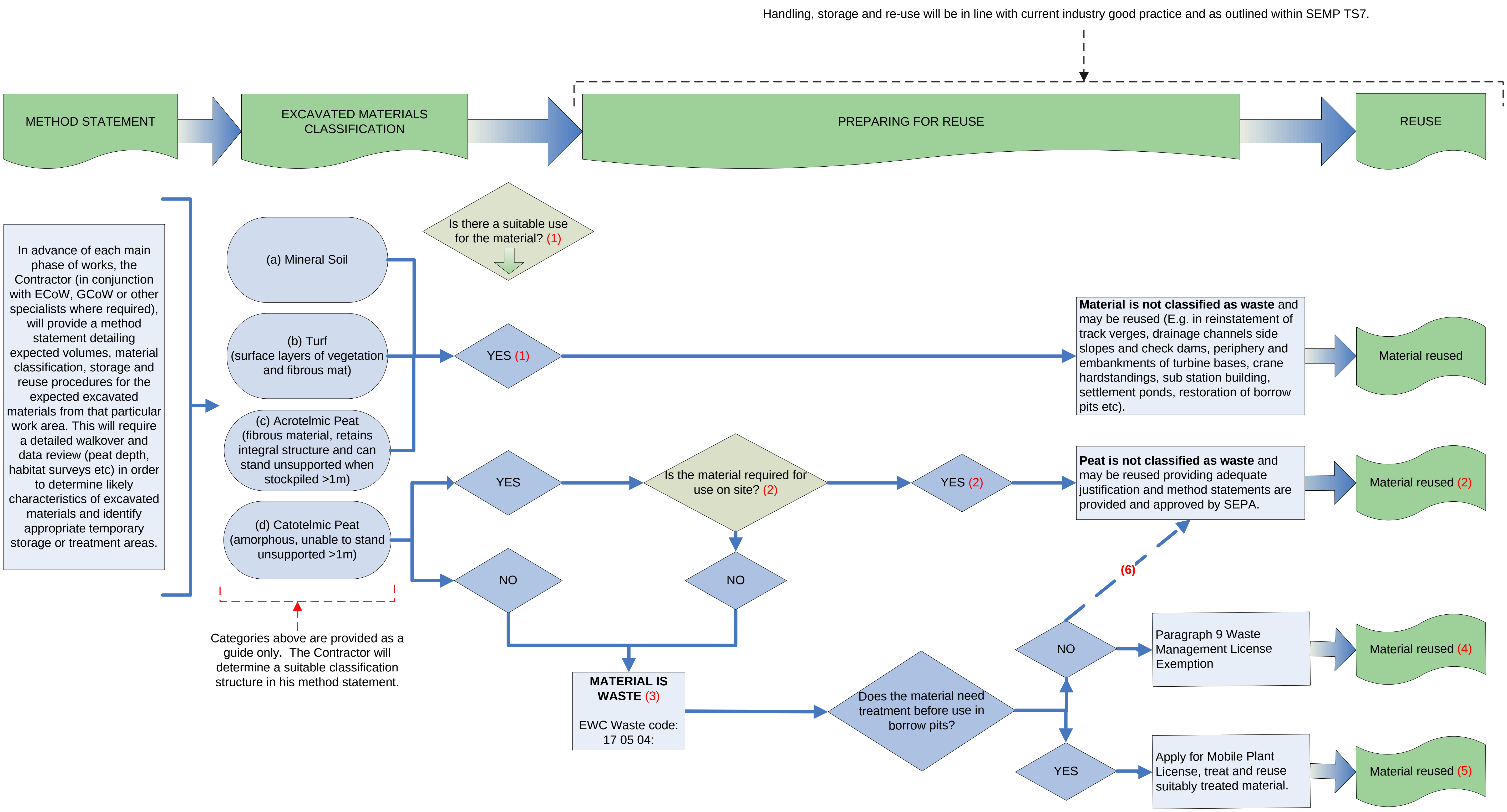

Figure TS3-2: Excavated Peat - Outline Waste Classification and Procedures for Reuse

NOTES:

(1)
Is there a suitable use for the material without need for treatment and without risk to the environment or human health?
For categories (a), (b) and (c), based on the information provided in TS7, Excavated Materials and Reinstatement Plan and Appendix A14.4 (and summarised in Section 5.2 of this TS3. Site Waste Management Plan (SWMP)), the answer is expected to be "Yes" as these materials are required in reinstatement works. For category (d) preliminary volume estimates provided in Appendix 14.4 indicate that there will be a need to reuse catotelmic material to provide sufficient quantities of material to complete borrow pit and other restoration works as required as part of the works. However, due to the physical characteristics of this material, required treatment and reuse options must be carefully considered.

(2)
To answer "yes": the material must be required in its excavated state and the six criteria referred to in Table TS3-1 of the SWMP must be met. The use must not entail any form of treatment, specialist containment or engineering at the site of use.

Such uses for this type of material are limited, however there may be justification for use in some habitat management works such as gully or ditch blocking where saturated peat is required to mimic mire type habitats and encourage establishment of sphagnum. While containment may be required for ditch blocking this is not considered to be treatment or engineering required for the final disposal of waste, rather it is the objective of the raising water table.

Material such as this may also be required at the base of borrow pits for fill material, again to mimic wetland habitat; however the use must be fully justified and the borrow pit base profile must be such that the material will not be released or be of sufficient depth to pose a risk to humans, livestock or the environment.

(3)
Waste excavated materials must not leave site and must be reused in site reinstatement and restoration activities, including the restoration of borrow pits. Restoration is required for:

i) Enhanced amenity value and reduction in landscape and visual impacts.
iii) Bio-diversity enhancement through habitat restoration.
iii) Removal and reduction in environmental (pollution from run off and erosion) and health & safety (high walls, pollution of water supplies etc) risks associated with exposed soil and rock faces.

Waste may either be reused under an exemption, or if treatment is required prior to use then treatment will be undertaken under a Mobile Plant license such that the material is 'recovered' and is no longer classified as waste prior to use. The essential characteristic of a waste recovery operation is that the waste must serve a useful purpose in replacing other materials which would have had to be used for that purpose, thereby conserving natural resources.

(4)
In order to reuse material under a Paragraph 9 exemption, ecological benefit must be fully justified for each site of reuse, the material must be reused in accordance with all exemption conditions and reuse must not pose any risks to environmental receptors, including humans and livestock.

(5)
It must be demonstrated that there is a requirement for the treated material. In this case, the preliminary volume estimates indicate a neutral or even potential deficit materials mass balance and therefore there is a need to create a suitable product (fill material) from the waste in order to complete site reinstatement activities, including borrow pit restoration.

(6)
In some site-specific situations, although material may be classed as a waste according to the legal definition, if it does not require treatment before disposal within borrow pits, SEPA may not require an exemption provided that it may be demonstrated that no harm will be caused by the deposit. This was discussed with SEPA during consultations held prior to submission of the ES Addendum and it is recognised by both parties that while this may be an option, this will require very detailed consideration and specific consultation on a site by site basis (i.e. localised areas within the Viking Wind Farm site).

SITE ENVIRONMENTAL MANAGEMENT PLAN

VIKING WIND FARM

TECHNICAL SCHEDULE 4

DRAINAGE MANAGEMENT PLAN

SEMP Version:	**1.0**	
Rev No. :	**Revision Description:**	**Date :**
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Comment:

Document was also reviewed by all consultants involved in preparation of the Addendum ES.

CONTENTS

DRAWINGS

1 INTRODUCTION

1.1 Objectives

1.1.1 The information contained herein forms Technical Schedule (TS4) of the Viking Wind Farm Wind Farm Site Environmental Management Plan (SEMP). This document provides a Drainage Management Plan which will be used by the Balance of Plant Contractor (the *Contractor*) to develop a detailed Drainage Management Plan (DMP) and associated construction method statements for both temporary drainage controls required during construction works and permanent drainage works to be incorporated into the detailed design of the wind farm.

1.1.2 The objective of this DMP is to provide a benchmark for best practice such that all possible preventative measures will be taken to avoid pollution of the water environment via the drainage network during construction works and during the operational phase of the wind farm.

1.1.3 The *Contractor* will submit the detailed DMP to the Employer and the Ecological Clerk of Works (ECoW) for approval prior to any construction works commencing in any area of the site.

1.2 Sensitive Areas

1.2.1 The following areas are considered to be particularly sensitive with respect to potential impacts from pollution which may result from inadequate drainage control:

- All water course crossings. The *Contractor* is required to identify all crossings shown on the OS 1:50,000 map, the OS 1:10,000 map and crossings identified during a walk over. The *Contractor* will be required to produce a water course crossing plan for these in line with the requirements of TS5.

- Access tracks / infrastructure and borrow pits within 50m of a water course. The *Contractor* is required to identify all areas in proximity to water courses in his detailed DMP.

- Any historical peatland drains and ditches within the main wind farm area.

1.3 Contractor's detailed DMP: Scope and Minimum Requirements

1.3.1 The detailed DMP will be built on information contained within this DMP, current industry best practice, and any information obtained during the detailed design works. The *Contractor*'s detailed DMP will be an evolving document(s) as the wind farm is constructed, and will be fully integrated with the Site Environmental Management Plan (SEMP).

1.3.2 The DMP may comprise a number of separate drainage plans (e.g. drawings and method statements) for each of the main phases of works, works areas, or works in proximity to sensitive receptors. The purpose of these plans is to identify potential risk areas and design bespoke drainage and mitigation measures specific to that particular locality or works activity.

1.3.3 The DMP will incorporate the following minimum requirements:

i. Procedures and methods for planning, design and management of appropriate sediment and silt control measures. The control measures will be designed appropriately to comply with the Contract for a minimum of a 1 in 200 year rainfall event. This should allow for sufficient drainage channel dimensions, and capacity for siltation management solutions;

ii. There will be no direct discharge from constructed drainage measures into watercourses. As such, sedimentation and silt mitigation measures will be adequately designed and positioned such that no silty water or pollution of any kind is permitted to enter watercourses directly from constructed drainage measures;

iii. There will be no stockpiling of materials within 50m of a watercourse or a private water supply. Where this is not possible, no less than 20m may be permitted with the express permission of the ECoW; and

iv. Reinstatement of temporary drainage and silt mitigation measures will be undertaken as required as soon as possible after the completion of excavations.

1.3.4 The *Contractor* will also take into account the requirements of Technical Schedules TS2: Pollution Prevention Plan, TS5: Watercourse Crossing Plan, and TS9: Environmental Incident and Emergency Response Plan in preparing his detailed DMP. Reference documentation referred to in all of these Technical Schedules is relevant to drainage control.

2 GENERAL DRAINAGE CONTROL REQUIREMENTS

2.1 Monitoring & Records

2.1.1 To ensure all drainage measures put in place for the construction phase of the works are maintained and continue to be effective, monitoring will be carried out. To ensure compliance of the construction works with this DMP and the *Contractor*'s detailed DMP, drainage management works will be supervised by the ECoW. The Planning Monitoring Officer (PMO) may also inspect the construction works as required on behalf of the local authority. The *Contractor*'s Environmental Manager / Engineer or other suitably qualified person(s) will be tasked with undertaking monitoring duties.

2.1.2 All monitoring and environmental checks will be undertaken in accordance with the requirements detailed within Section 3 of the SEMP. Records of all monitoring undertaken on drainage mitigation measures will be kept as per the requirements of Section 4 of the SEMP.

2.1.3 Independent water quality monitoring of surface water catchments and private water supplies in the vicinity of construction works will be undertaken as per the requirements of TS6. This monitoring will serve to identify impacts to water courses and supplies which may occur as a result of insufficient silt mitigation or poor drainage design.

2.1.4 Prior to commencement of the construction works in an area, an on site meeting / inspection will be carried out by the *Contractor* and the ECoW to confirm the final drainage design (temporary or permanent) and appropriate use of identified silt mitigation measures. Particular attention will be paid to drainage and silt mitigation designs in the vicinity of the sensitive areas noted in Section 1.21.2.

2.1.5 Inspection of drains and any erosion, silt or sediment control measures should be made before, during (where safe to do so) and immediately following anticipated storm events or periods of continuous or heavy intermittent rainfall over one or more days. Regular checks will be made at least every 14 days.

2.2 Emergency Spill Response

2.2.1 Drainage networks provide a conduit for rapid transport of silty water and potentially contamination from surface spills of fuels / oils, concrete or chemicals.

2.2.2 For the purposes of emergency response planning, the detailed DMP will identify:

- drainage flow paths (including links to existing drainage networks at the site) and potential direct connections with any surface water course or natural spring / flush area; and

- areas where spill kits and drainage stops and diversions may be implemented in an emergency to prevent release of contaminated drainage waters.

3 DRAINAGE MITIGATION: GENERAL PRINCIPLES AND STRUCTURES

3.1 Clean Water Diversion

3.1.1 Where possible at all construction works areas, clean water (i.e. non-silty surface water flow that has not yet passed over any disturbed construction areas) will be kept separate from silty water or other potentially contaminated water. Where appropriate, up-gradient cut off ditches and other drainage diversion measures should be installed in order to collect and divert up-gradient surface water runoff from construction disturbed areas. These measures should be installed ahead of actual construction and excavation works wherever practical. This will reduce the flow of water onto any exposed areas of rock and soil, thereby reducing the amount of potential silt laden run off requiring treatment.

3.1.2 Clean runoff water should be discharged into an area of vegetation for dispersion or infiltration. Silt traps, gravel, sand bags, silt fencing and anchored straw bales may be required at the discharge point in order to prevent erosion at the outlet, alleviate flow and aid in flow dispersion across a wider area of vegetation to prevent potential scour and remobilisation of deposited silt.

3.1.3 Discharge points will be located sufficient distance from any water courses to allow adequate infiltration or settlement of suspended solids prior to any discharged surface run-off potentially entering the water course.

3.2 Silt Mitigation and Settlement Ponds

3.2.1 Silt laden run off should be expected from any areas of recently exposed soil or rock. This silt laden run off will be captured and directed via berms or ditches towards specially constructed sediment control structures.

3.2.2 Sediment control structures may comprise a series of settlement ponds with additional incorporated filtration measures where required. Typical details of a settlement pond are indicated on Figure TS4-1. Additional filtration measures may include flow attenuation measures such as weirs, rock bars and / or anchored and embedded straw bales within ponds or between series of ponds.

3.2.3 The number, location and dimensions of settlement ponds, plus requirements for flow attenuation measures will depend on the volume of water requiring treatment, silt load characteristics, topography and access constraints.

3.2.4 The use of synthetic liners within settlement ponds will be avoided in order to reduce the impacts from disturbance of silt during liner removal and reinstatement of ponds on completion of construction works. The exception to this may be where the pond is dug into very silty or clayey mineral soil substrate which may adversely contribute a significant silt load to the settlement pond, or where impermeable liners are required to prevent risks to underlying groundwater from infiltration of contaminated water from the pond (e.g at settlement ponds associated with concrete wash out pits).

3.2.5 Native materials (peat turves, soil bunds, clean rock aggregate etc) will be used in preference to artificial or 'foreign' materials in construction of any silt mitigation measures. Any introduced or artificial materials required for temporary erosion or silt mitigation controls, such as silt fencing, straw bales, sand bags etc are required to be removed upon completion of construction works. Silt mitigation measures will be implemented during removal of these materials as disturbance may be caused in drains and ponds which have since bedded in.

3.2.6 Final discharge from any settlement pond will be over vegetated ground (with exceptions, e.g. blanket bogs). Silt fences or other flow attenuation measures may be required at the discharge point in order to disperse the discharge and prevent build up of settled solids which could be subject to remobilisation.

3.2.7 Settlement ponds will be designed and constructed with sufficient capacity to allow settlement and allow contingency for unexpected increased rainfall events. Contingency measures may include additional capacity within an existing pond, or identification of additional areas within the vicinity which may be suitable for creation of additional ponds.

3.2.8 In the event that the natural or excavated ground profile in any area of the site does not lend itself easily to construction of an adequate settlement pond(s), water should be directed towards a sump area prior to being pumped away to a suitable settlement pond(s) or vegetated area with adequate silt mitigation measures well away from sensitive habitats or water courses.

3.2.9 Siting of settlement ponds will take into consideration access requirements for reinstatement and maintenance (for example: periodic silt removal, expansion of ponds or incorporation of additional silt mitigation measures etc). Additional temporary silt mitigation measures may be required during maintenance and reinstatement activities.

3.2.10 Where water depth within settlement ponds has the potential to exceed 0.5m, the perimeter of the ponds will be demarcated by safety fencing and appropriate warning signs.

3.3 Drains and Check Dams

3.3.1 Where possible, drains should be constructed so that the gradient does not exceed 2º in order to slow flows, prevent erosion of the drain base and sides, and encourage establishment of terrestrial and aquatic vegetation where possible. Where this is not possible, sufficient flow attenuation measures will be installed.

3.3.2 The width and depth of constructed drainage channels will be minimised as far as practical in order to reduce ground disturbance, excavation footprint (and hence volume of excavated materials) and also disruption of local hydrology as far as possible. In peat, drainage channels should avoid penetration into the catotelmic layers where ever possible. However, drainage channels and associated pipes will require to be as wide as practical to allow wildlife to safely enter/exit the channel/pipe. SNH in their formal response to the original Viking Wind Farm application (letter of 24 July 2009) noted the following recommendations for ecological provision in relation to drainage (refer to TS8, Ecological Protection Plan for further information):

- "*As otter pass through some of the proposed development site, SNH recommends a condition of planning that at the end of each day, pipe ends should be covered to prevent otters from entering pipes and becoming trapped and planks should be placed* *in excavations and other construction holes to allow otters to climb out so they do not become trapped*".

3.3.3 Temporary or permanent check dams (flow barriers or dams constructed across the drainage channel) will be installed at regular intervals within any clean water or dirty water cut off ditches. Typical details of check dams are provided on Figure TS4-1. Check dams are required in order to reduce the velocity of water and therefore allow settlement of coarser sediment particles as well as silt at low flow conditions. Reduction in flow velocity will also prevent scouring of the drainage channel itself.

3.3.4 Check dams are ideally constructed of clean hard rock aggregate (ideally gravel or cobble sized depending on the volume and velocity of flow and size of the channel), although sand bags and anchored and embedded straw bales may also be deployed in the short term. The number and location of check dams will be dependent on the slope, flow and volume of water, although the following general rules will be applied:

- The maximum spacing between check dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam;
- The centre of the check dam should be at least 0.2m lower than the outside edges;
- Side slopes should be 2:1 or less;
- Check dams should be keyed at least 0.1m into the drainage channel bottom in order to prevent the dam washing out; and
- Temporary sand bag or straw bale check dams should also be keyed / embedded into the base and sides of the drainage channel, staked and tied together, and provide an overflow weir in the centre to concentrate flow away from the sides of the drainage channel.
- Straw bales and sand bags may only be used as a temporary flow attenuation measure and all bales and bags will be removed and replaced with permanent measures upon completion of construction works. Straw bales will be monitored regularly for effectiveness in flow attenuation and decomposition. Decomposing or fragmenting straw bales will be removed and disposed of appropriately and alternative flow attenuation measures replaced as required.

3.3.5 Silt traps will be installed where required (and where practical for maintenance purposes) at intervals along drainage channels. Silt traps will also be constructed at the inlet and outlet of any pipe culverts to prevent the pipes becoming blocked and prevent erosion at the inlet and outlet points.

3.3.6 Check dams and silt traps should be maintained and monitored on a regular basis. Sediment should be removed before it reaches one half the original dam height or silt trap depth.

4 TRACKS AND WATERCOURSE CROSSINGS

4.1 General

4.1.1 As noted previously, clean water and dirty water should be kept separate where possible on site and in particular during construction activities. A schematic representation of how this may be achieved adjacent to tracks and at water course crossings is provided on Figure TS4-2. Additional details on typical trackside drainage arrangements are provided on Figure TS4-3.

4.1.2 Ecological design requirements noted in Section 2.3 will be considered in all trackside drainage.

4.2 Cut tracks

4.2.1 Where practical, up gradient ‘clean’ surface run off will be separated and diverted from any surface run off which is in contact with road surfaces or any other areas with exposed soil. Any silty water generated will ideally be channelled into separate down slope drains.

4.2.2 Silty and clean water drainage will be channelled separately to vegetated areas at least 50 metres from watercourses to allow the settlement of solids. Where settlement over vegetation is not ecologically sound (e.g. involving intact blanket bog, requiring only rain-fed nutrients), or is not practical or adequate to deal with the volume of silt generated, silt traps or settlement lagoons will be utilised and monitored to ensure stored surface water is kept to a minimum.

4.2.3 Particular care will be taken to control silt laden drainage within the vicinity of any water courses or existing drainage ditches. As per the requirements of TS5, splash boards and run-off diversion measures, including silt fencing adjacent and parallel to water courses beneath bridges and at culvert crossings, will be used at all crossings to prevent direct siltation of watercourses. Silt mitigation measures will be installed manually where possible to minimise disturbance.

4.2.4 Cross drains will be installed at regular intervals for up slope drainage in order to reduce flow volume within the main upslope drain and reduce loading on any particular discharge point. Cross drains will be installed as pipe culverts under the track surface. The frequency of cross drains should increase in areas where higher flows are anticipated such as: steeper gradients; in areas of high surface flow (e.g. flushes in bog areas); where bank seepages are noted; and where historical land drains are intercepted. Each cross drain will require a silt trap at each end, large enough on the lower side to hold pollution prevention absorbent booms.

4.2.5 Pipe culverts used for cross drainage will be long enough so that road fill does not extend beyond the end of a culvert. Cross drain culverted pipes will be constructed at grades at least 2% more than the ditch grade and angled 30 to 45 degrees cross-track to improve inlet efficiency. Check dams will be installed immediately above a cross drain inlet and silt traps are required at the inlet and outlet points to prevent blockage of the pipe due to silt build up as well as erosion and undercutting at the ends of the culverted pipes.

4.3 Floating tracks

4.3.1 The recently published guidance "Floating Roads on Peat" (Scottish Natural Heritage & Forestry Civil Engineering, August 2010) provides detailed information relating to drainage associated with floating roads.

4.3.2 The aggregate size at the base of the track foundation should be such that it is permeable to at least the extent of the underlying organic soil / peat to allow flow through of water and, if necessary, there should be a geotextile layer to prevent fines from blinding the foundation layer. Thus, although there may be some compaction there will be no impediment to lateral seepage below the full length of the road.

4.3.3 Where springs or flushes flow diffusely across the peat surface. In these instances, drainage ducts beneath the tracks may be required to maintain hydrological equilibrium of the underlying peat. Where hydraulic continuity is severed, erosion of the upslope road edge may occur and changes in water tables either up slope or down slope can have a negative effect on peat stability. Drainage ducts (pipes) will therefore be installed beneath floating track sections at a minimum of 100m centres, or more frequently as required, where mire or flush areas are crossed or the track passes through an area of potential peat instability.

4.3.4 If ditches are required to be installed post-construction of the road, to minimize any drawdown of the water table below the road and any consequential settlement ditches should be installed sufficiently far away from the road and will be shallow enough to limit the local lowering of the groundwater in the peat as much as possible. Ditches should avoid penetration of the catotelmic peat where ever possible.

4.3.5 Where drainage paths or peat pipes are detected at or near the surface of the peat they should be taken through or under the floating road in a permanent drainage pipe. The size of the pipe should be sufficient to accommodate the expected flow through the drain / peat pipe and hung in a geogrid below the floating road.

4.3.6 The final design of drainage associated with floating roads will be determined prior to commencement of works in any area of the site in agreement with the ECoW and Geotechnical Consultant / Clerk of Works.

4.3.7 The following negative environmental effects must be minimised: erosion of the road surface; silt dispersion across a wide area of peat; and silt entry into peat gullies and natural hydrological channels. These effects can be avoided by constructing road camber and raised verges such that surface flow is directed towards constructed silt traps and other silt mitigation measures as required.

5 BORROW PITS

5.1.1 Schematic representation of a typical borrow pit drainage arrangement is provided on Figure TS4-4.

5.1.2 Overburden will be stripped and stored on the up-gradient side of the borrow pit, sealing in all mineral material with a covering of peat to minimise wash out of silt. The height of the storage bund will be dependant on the stability of the stored material and the ground beneath. Proposals for storage of overburden material must be checked and approved in advance by the site Geotechnical Clerk of Works.

5.1.3 Consideration should be given to minimising erosion and run off from the overburden stock piles. A silt fence should be installed on the down-gradient side of the stockpile.

5.1.4 An up-gradient cut off ditch should be installed around the edge of the storage bund above the borrow pit in order to collect up-gradient surface water runoff and divert water runoff from eroding the bund foot. This will eliminate or reduce the flow of water onto the exposed rock and soil faces and into the worked quarry floor, thereby reducing the amount of potential silt laden run off to be treated. For health and safety reasons, and to avoid significant erosion of ditches on steep gradients, where the up-gradient perimeter and sides of borrow pits are on steeply sloping ground the cut off ditch may only be installed where safe and practicable.

5.1.5 Clean runoff water from cut off ditches should be discharged into an area of vegetation for dispersion or infiltration. Silt fencing and anchored straw bales may be required at the discharge point in order to alleviate flow and aid in flow dispersion across a wider area of vegetation to prevent potential scour.

5.1.6 Due to the exposed soil and rock faces and worked quarry floor, silt laden run off should be expected from within the confines of the borrow pit and also from the access track leading down to the borrow pit.

5.1.7 Silt laden run off will be captured and directed via berms or ditches towards specially constructed sediment control structures. Sediment control structures may comprise a series of settlement ponds with additional incorporated filtration measures where required.

5.1.8 In the event that the natural or excavated ground profile does not lend itself easily to capture and diversion of run-off towards the settlement pond area, water within the borrow pit should be directed towards a sump area prior to being pumped into the ponds.

5.1.9 Consideration should be given to the location of any aggregate or overburden stock piles such that erosion and run off from the stockpiles is limited. A silt fence should be installed on the down-gradient side of the stockpile and an up-gradient ditch to divert water runoff from eroding the base of the stockpile and collecting further sediment.

6 OTHER INFRASTRUCTURE

6.1 Turbine Foundations and Crane Hardstandings

6.1.1 Schematic representation of a typical turbine base and crane hardstanding drainage arrangement is provided on Figure TS4-5.

6.1.2 Foundation excavations for turbines are generally below the level of the surrounding ground and hence surface water ingress from up slope or groundwater seepage may occur, leading to standing water within the base of the excavation.

6.1.3 Prior to commencement of each foundation excavation, the *Contractor* will assess the local gradient and the potential risk of silty run-off exiting the base area and design appropriate sediment control and silt mitigation measures accordingly. The site investigation details for all recorded soils should be considered, especially the potential presence of clay, silt and mixed unconsolidated sediments as these are most likely to generate significant volumes of suspended solids within run off once excavated.

6.1.4 Overburden will be stripped and stored on the up-gradient side of the turbine base and crane hardstanding, sealing in all mineral material with a covering of peat to minimise erosion, run off and wash out of silt. If necessary, a silt fence should be installed on the down-gradient side of the bund.

6.1.5 An up-gradient cut off ditch should be installed around the edge of the storage bund above the deep excavation in order to collect up-gradient surface water runoff and divert water runoff from eroding the bund foot. This will eliminate or reduce the flow of water into the deep excavation, thereby reducing the amount of potential silt laden run off to be treated.

6.1.6 Where the topography allows, foundation excavations will be designed to be gravity draining in order to facilitate egress of surface water from the excavation. Where this is not possible, a sump should be created from which water can be pumped into an appropriate sediment control structure.

6.1.7 Up slope cut off ditches will be constructed to minimise surface water ingress into the excavation area.

6.1.8 Diversion dams / berms will be constructed accordingly in order to channel silty run-off water into the 'dirty' water drainage system for discharge into a suitable sediment control structure.

6.2 Construction Compounds, Substation and Control Buildings

6.2.1 Schematic representation of a typical drainage arrangements around construction compounds and substation control building excavations are provided on Figure TS4-6.

6.2.2 During construction works large areas of soil may be exposed at the site of the construction compounds and substation / control building construction footprints. As with tracks and borrow pits, clean up-slope run off and run off from the exposed construction area will be kept separate and appropriate silt mitigation measures will be deployed.

6.3 Peat Storage and Reinstatement Works

6.3.1 Consideration should be given to the location of any peat storage areas such that no significant risks are presented to humans or the environment (including livestock or wild animals). In particular, erosion and run off will be limited and leachate from the peat material will be controlled and the stability of the existing peatland in the vicinity will not be affected.

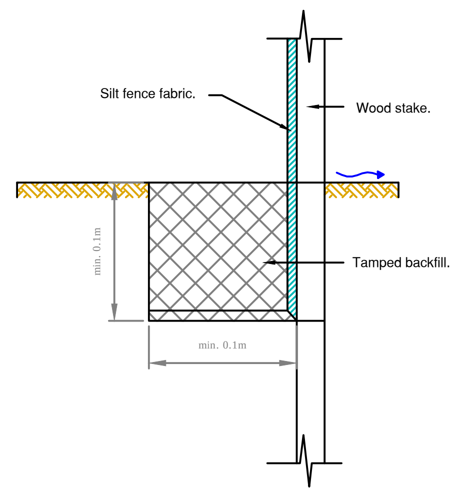
6.3.2 Similarly, consideration should be given to the impacts of poor drainage control in any areas where peat is used in reinstatement, for instance track verges, reinstatement of construction compounds, restoration of borrow pits etc.

6.3.3 Up slope cut off ditches, down slope drainage collection systems, containment berms (keyed-in where appropriate), and appropriate drainage mitigation measures will be required as with other infrastructure described above.

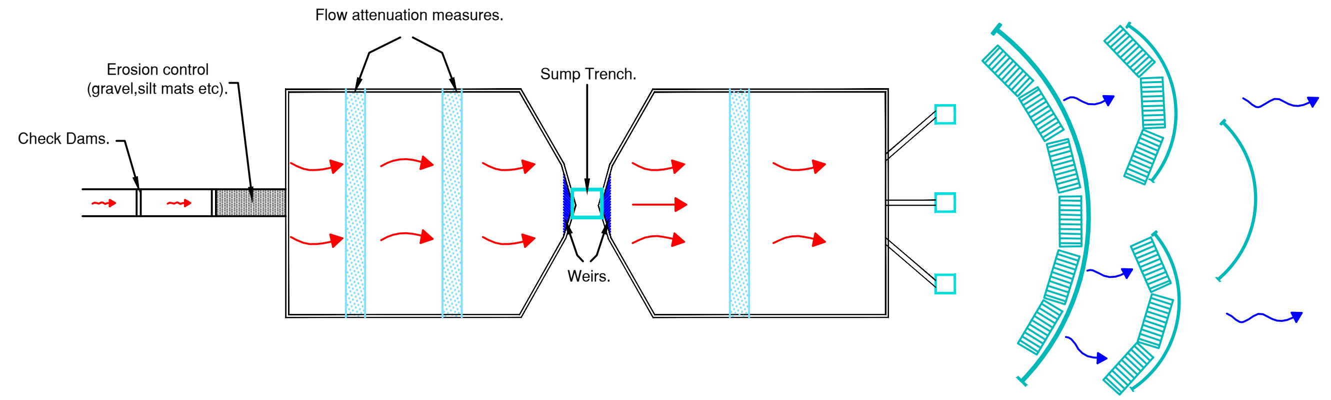
6.3.4 The design of any peat storage and reinstatement works, including incorporated drainage elements, will be agreed with the ECoW and Geotechnical Consultant / Geotechnical Clerk of Works prior to works commencing.

6.3.5 If any longer term storage is proposed (e.g. associated with material required for decommissioning of the wind farm) the detailed proposals will be agreed with the ECoW and Geotechnical Consultant / Geotechnical Clerk of Works and SEPA.

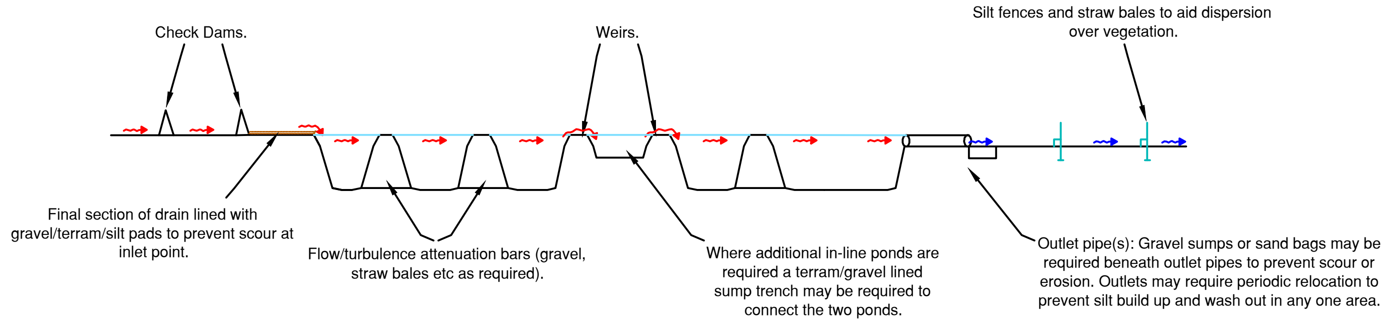
Silt Fence Detail.



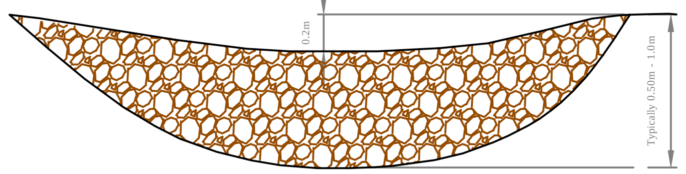
Plan View: In-line Settlement Ponds (typical for higher flow, higher silt load conditions).



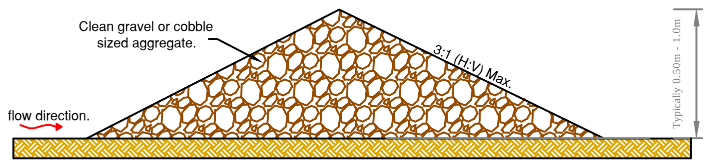
Schematic Section: In-line Settlement Ponds.



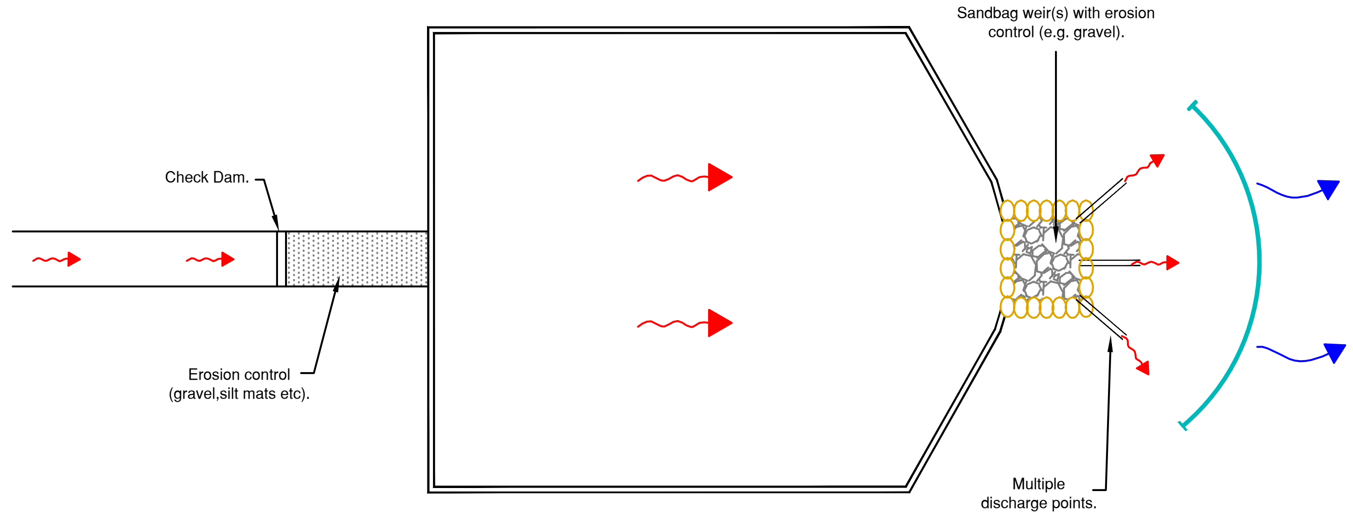
Rock Check Dam Elevation.



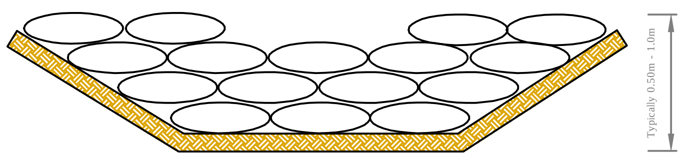
Rock Check Dam Section.



Plan View: Single Settlement Pond. (Typical for low flow, low silt, load conditions).



Sand Bag Check Dam Elevation.



NOTES

Silty water

Clean water

Notes

1. Dimensions and number of settlement ponds or requirements for flow attenuation measures will depend on volume and velocity of water and silt load chracteristics.

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

DRAWING TITLE

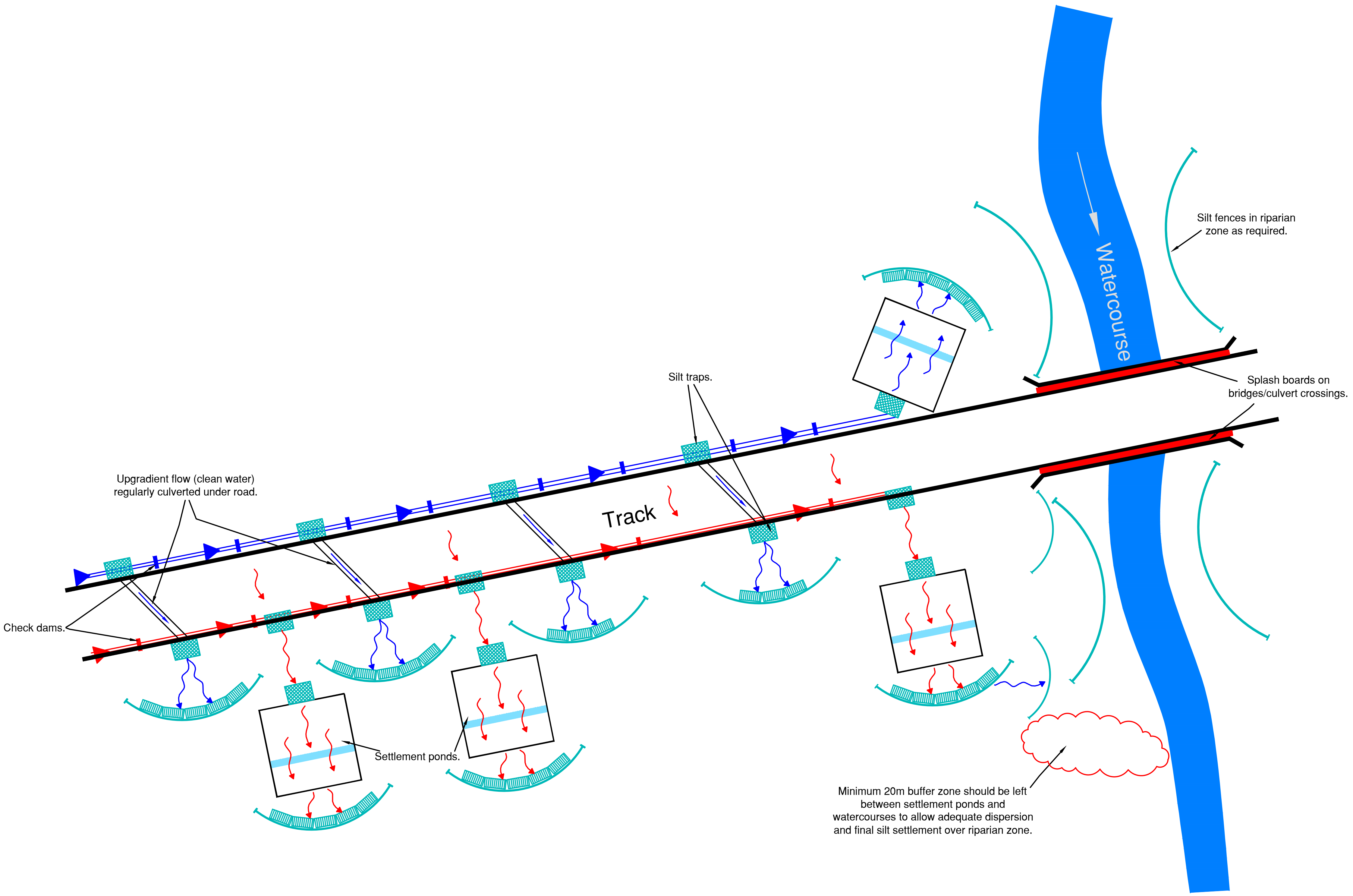
TYPICAL DETAILS OF SETTLEMENT PONDS AND SILT MITIGATION MEASURES

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			14/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
	FIGURE 1	

viking energy

Harnessing Shetland's natural resources



NOTES

- Silty water
- Clean water
- Silt trap
- Silt fence and straw bales

Notes

1. In order to reduce volumes of potentially silty laden run-off, 'clean' (upgradient) surface run-off to be kept away from exposed soil areas and seperated from construction works run-off where possible.

2. Typical details for settlement ponds, check dams and silt fences are shown in Figure 01.

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

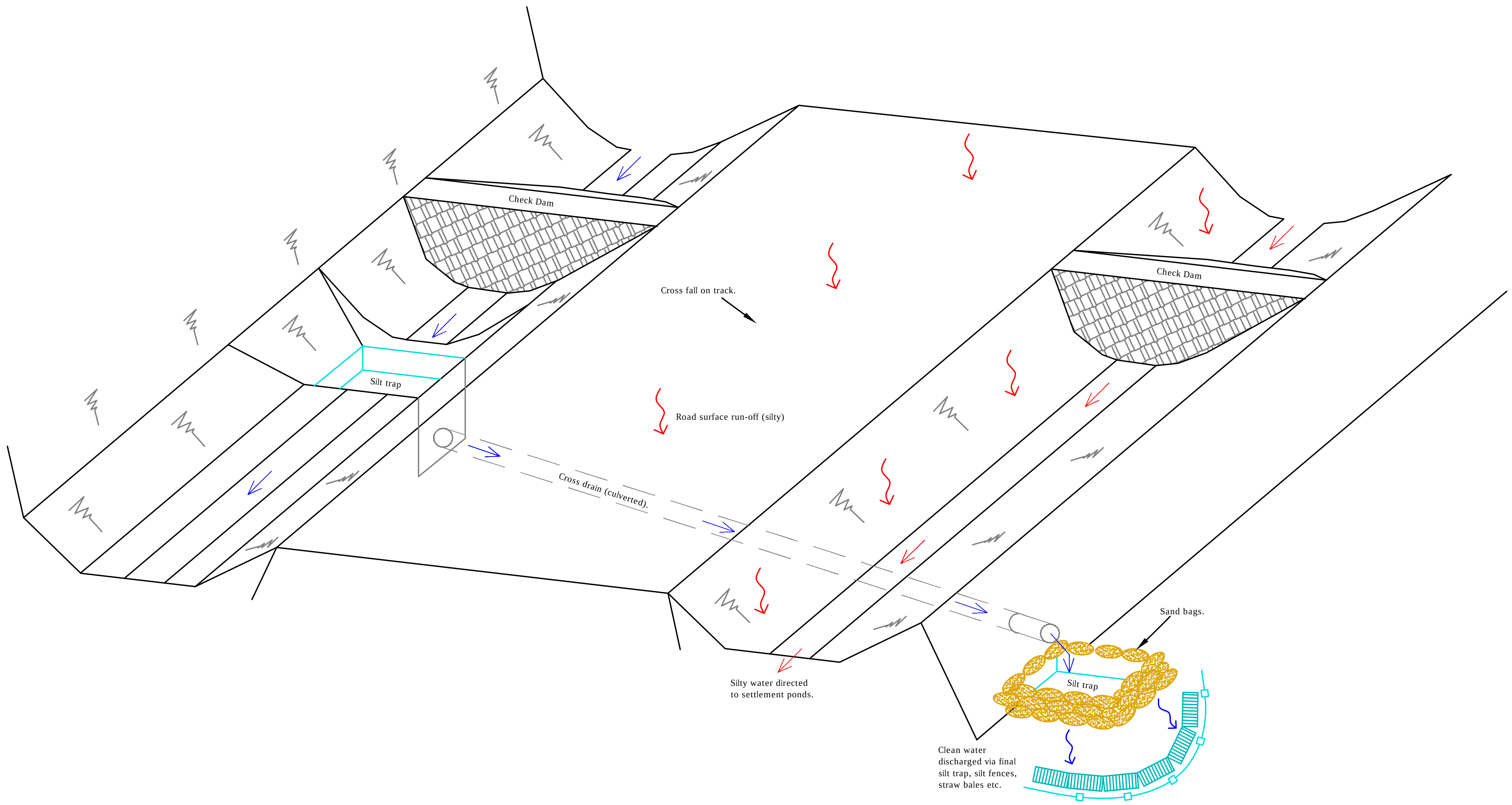
DRAWING TITLE

SCHEMATIC DRAINAGE ARRANGEMENTS FOR TRACKS AND WATERCOURSE CROSSING

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			13/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
	FIGURE 2	

viking energy
Harnessing Shetland's natural resources



NOTES

Notes

1. Refer to Figure 01 for typical details of settlement ponds, check dams and silt fences.

2. Refer to Figure 02 for further details on track drainage arrangements.

3. Where topography or other constraints preclude the segregation of clean / dirty water drainage (as illustrated on this drawing), the road surface cross fall shall be towards the upslope drainage ditch. Flow rates and volumes within such a combined drainage system may be higher and therefore sediment and silt attenuation measures shall be implemented accordingly to control expected increase in flow, erosion and sediment / silt load.

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

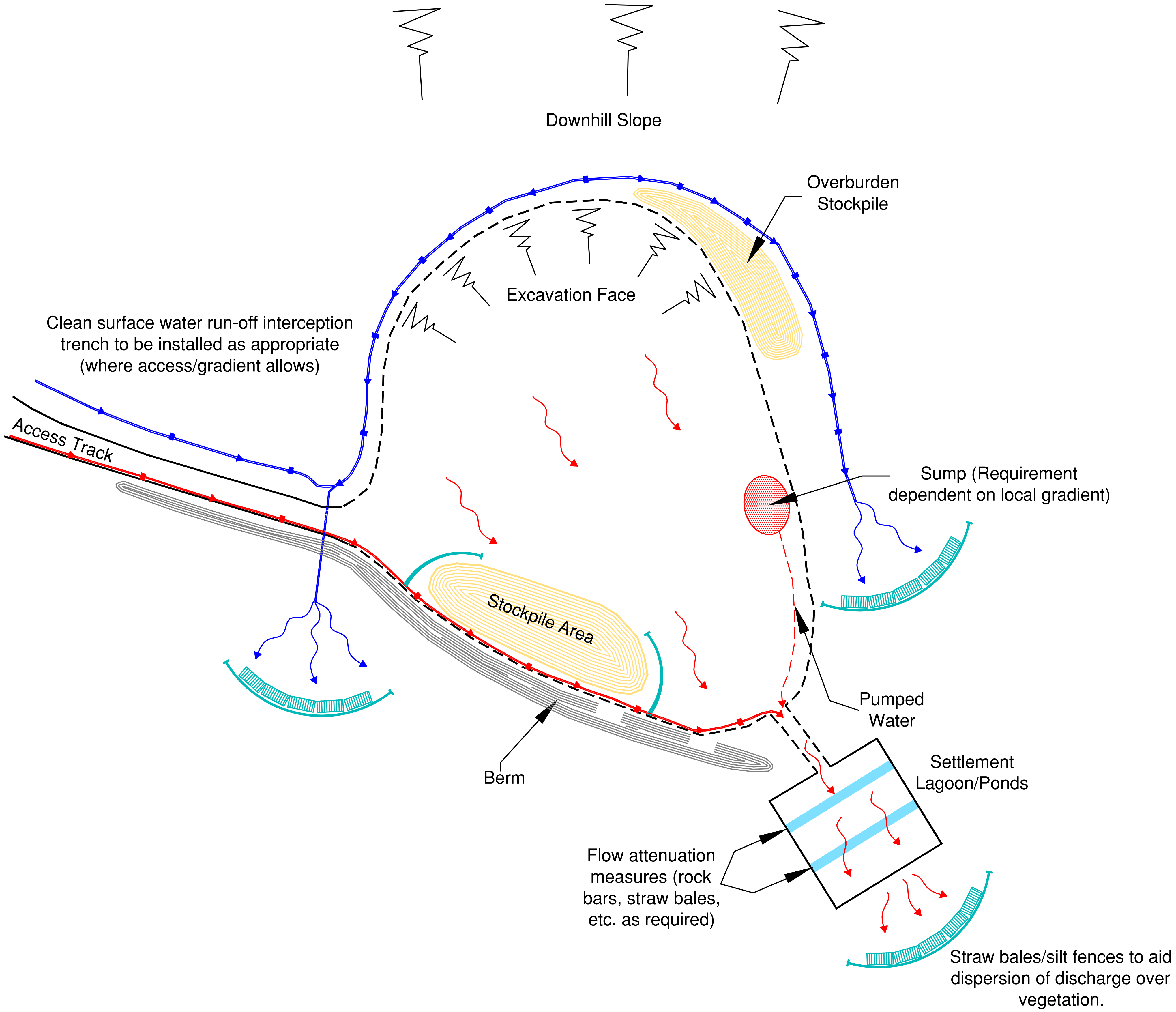
DRAWING TITLE

SCHEMATIC SECTION OF TYPICAL CUT AND FILL TRACK DRAINAGE ARRANGEMENTS

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			13/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
	FIGURE 3	

viking energy
Harnessing Shetland's natural resources



NOTES

- Borrow pit boundary
- Potentially silty run-off/drainage
- Check dams
- Clean water run-off/drainage
- Silt fence and/or straw bales to aid dispersion (and protect stockpile)

1. Borrow pit configurations will vary from that indicated on this drawing (for instance borrow pits are likely to be off-line of continuing access tracks); However, the general principles of clean / dirty water drainage segregation, stockpile erosion and run off control, and general sediment and silt control shall apply irrespective of the final borrow pit configuration.

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

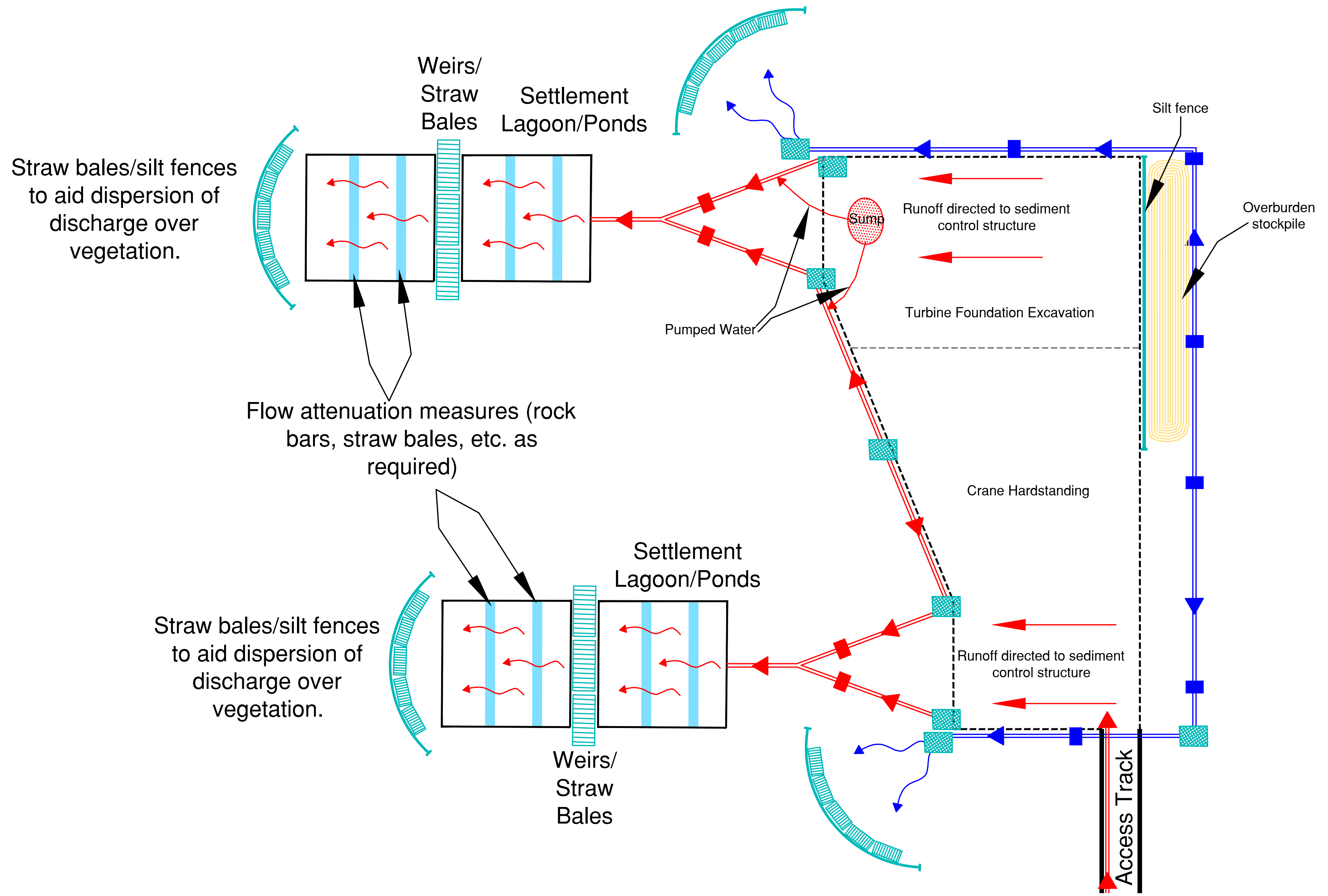
DRAWING TITLE

SCHEMATIC BORROW PIT DRAINAGE ARRANGEMENTS

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			14/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
G2009/230	FIGURE 04	

viking energy
Harnessing Shetland's natural resources



NOTES

Potentially silty run-off/drainage

Clean water run-off/drainage

Silt fence and/or straw bales to aid dispersion (and protect stockpile)

Check dams

Silt traps

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

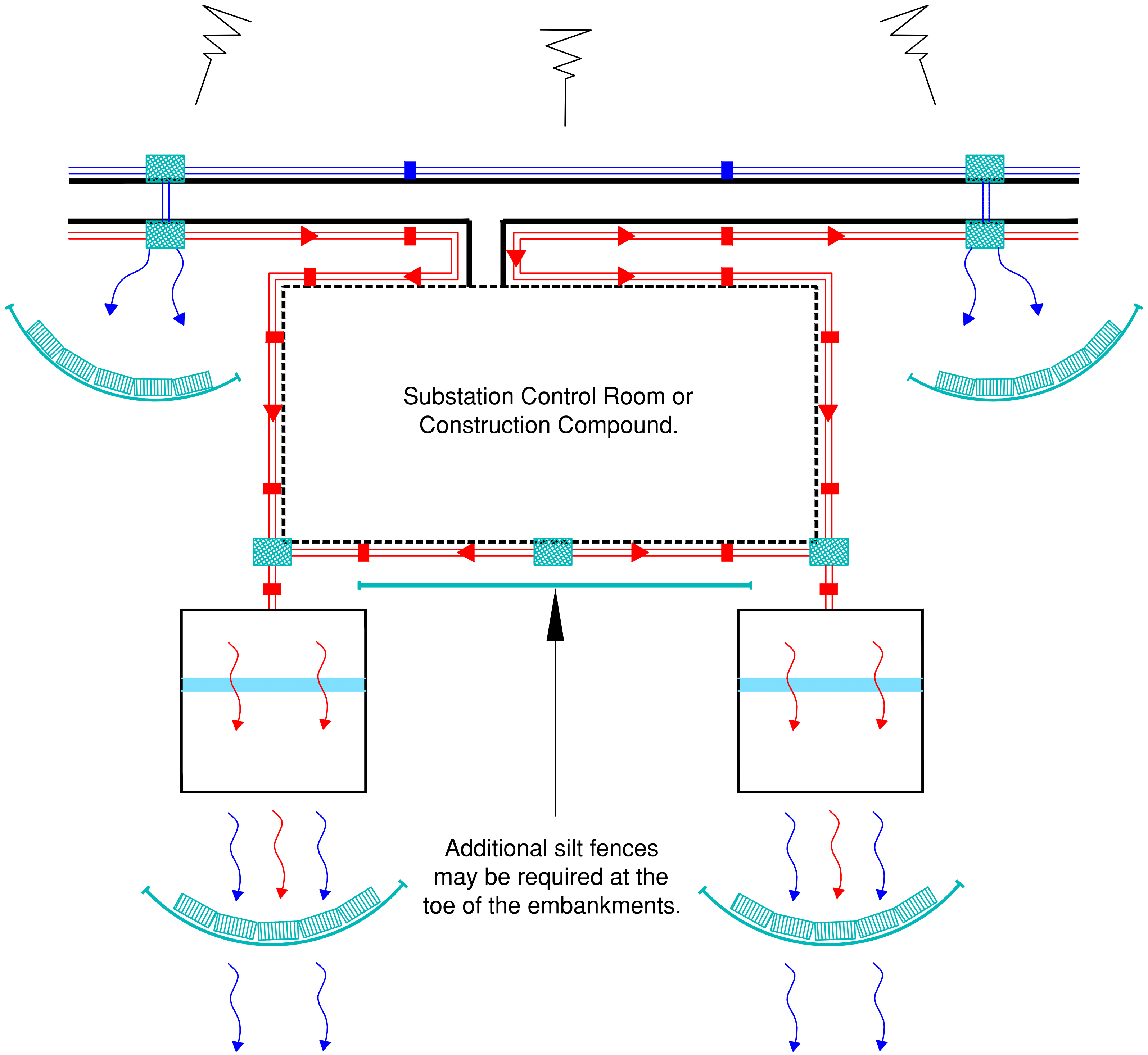
DRAWING TITLE

SCHEMATIC DRAINAGE ARRANGEMENTS FOR TURBINE BASES AND CRANE PADS HARDSTANDINGS

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			15/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
	FIGURE 5	

viking energy
Harnessing Shetland's natural resources



NOTES

Potentially silty run-off/drainage

Clean water run-off/drainage

Silt fence and/or straw bales to aid dispersion (and protect stockpile)

Check dams

Silt traps

REV	DATE	DETAILS

PROJECT TITLE

FRAMEWORK DRAINAGE MANAGEMENT PLAN

DRAWING TITLE

SCHEMATIC DRAINAGE ARRANGEMENTS FOR SUBSTATION CONTROL ROOM

DRAWN BY	CHK'D BY	APP'D BY	DATE	SCALES
DB			15/10/09	N.T.S.

PROJECT No.	DRAWING No.	REVISION
	FIGURE 6	

viking energy
Harnessing Shetland's natural resources

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 5

WATER COURSE CROSSING PLAN

SEMP Version:	**1.0**	
Rev No. :	**Revision Description**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	Position :	Signature :
Prepared by :	Jane MacDonald	Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
Reviewed by :	Oliver Moffat	BMT Cordah	

Comment :

Document was also reviewed by all consultants involved in preparation of the Addendum ES.

CONTENTS

1 INTRODUCTION

1.1.1 This document concerns the proposed operations required for watercourse crossings works in areas of the consented wind farm site (the Site). The information contained herein will be used by the *Contractor* in developing his detailed design of all water course crossings at the Site and also compliance with the Controlled Activities (Scotland) Regulations 2005 (CAR).

1.1.2 The CARs require that all new river, loch and wetland engineering activities, including river crossings and culverts, will require authorisation by SEPA, which may include (depending on the nature of the works) Registration with, or a Licence from, the Scottish Environment Protection Agency (SEPA). Even if a proposed crossing does not require a Registration or Licence, due to it's compliance with a General Binding Rule (GBR), as defined in the CARs, SEPA are still required to be notified.

1.1.3 **Appendix 14.3 of the Environmental Statement (Mouchel, February 2009)** provides a comprehensive survey and assessment of CAR-regulated and non-regulated water crossings. This includes an evaluation of stream size, morphology and different type of crossing required across the site, including ecological provisions where required.

1.1.4 SEPA responded positively to this assessment as noted in their response to the Environmental Statement (letter of 28 July 2009, Section 4.5: Design of watercourse crossings):

> *"The assessment provided in Appendix 14.3 is clearly presented and provides a good level of information to assess whether the types of crossing proposed are likely to be acceptable. We particularly welcome the inclusion of photographs. We are satisfied with the methods of crossing proposed in relation to the watercourse parameters".*

1.1.5 Similarly, Scottish Natural Heritage (SNH) also responded positively, as stated in their response (letter of 24 July 2009. Section 8.4):

> *"In relation to the proposed water crossings within the development boundary, SNH welcome the thorough approach taken by the applicant in seeking to minimise water crossings and the impacts on the water environment."*

1.1.6 Following the reductions in infrastructure (now 127 turbine layout), the number of stream crossings has reduced from 97 proposed in 2009 to 79. **Chapter A14 of the Environmental Statement Addendum (prepared by Mouchel, 2010)** provides updated information on the catchments where crossings have been reduced and details of expected CAR-regulated crossings for the revised scheme layout.

2 REFERENCE DOCUMENTS

2.1.1 All construction works on the Site, and specifically design and construction works to be undertaken within and in the vicinity of any water courses, will be completed in compliance with current legislation and best practice as detailed within the Environmental Statement and Addendum, SEMP Technical Schedules (TS), current legislation and published guidance, including (non-exhaustive list):

- Appendix 14.3 of the Viking Wind Farm Environmental Statement (Mouchel, 2009) and Chapter A14 of the Viking Wind Farm Environmental Statement Addendum (Mouchel, 2010). These documents provide a detailed water course crossing assessment for the Viking Wind Farm site, including individual stream crossing descriptions and detailed Watercourse Crossing Selection Guidelines.

- SEMP TS2 Pollution Prevention Plan. This provides information on best practice to be implemented to mitigate risks from pollution of the water environment in general.

- SEMP TS3 Site Waste Management Plan. This provides information on best practice for mitigation of risks to water courses from storage and handling of waste materials.

- SEMP TS4: Drainage Management Plan. This provides more specific information on best practice for silt mitigation and avoidance of pollution of water courses from site run off and drainage pathways. This includes details on specific drainage and silt mitigation requirements in the vicinity of water course crossings.

- The Water Environment (Controlled Activities) (Scotland) Regulations 2005 ("CARs").

- The Water Environment (Controlled Activities) (Scotland) Regulations 2005, A Practical Guide, SEPA, Version 5, June 2008.

- Engineering in the Water Environment, Good Practice Guide, Construction of River Crossings, First edition, SEPA, April 2008.

- River Crossings and Migratory Fish: Design Guidance, Scottish Government, April 2000;

- Culvert Design Guide, Report 168, CIRIA, 1997;

- SEPA Pollution Prevention Guidelines, in particular:

  – PPG 01 – General Guide to the Prevention of Pollution

  – PPG 05 – Works in, near or liable to affect watercourses

3 CONSTRUCTION REQUIREMENTS

3.1.1 The *Contractor* is required to produce a detailed Water Course Crossing Plan prior to commencement of the works. This plan will take into account the stream crossing information prepared by Mouchel (and referred to in bold above) as well as any further information that may be obtained during subsequent surveys that may be undertaken post-consent and prior to construction works commencing (for example further ground investigations, ecological baseline studies etc).

3.1.2 The *Contractor's* Water Course Crossing Plan will be submitted to the Employer, ECoW and SEPA for review and approval where appropriate. The *Contractor* is responsible for liaising with and obtaining from SEPA all relevant consents, licenses and authorisations relating to construction of water course crossings at the Site.

3.1.3 The Ecological Clerk of Works (ECoW) will be consulted with regard to all water course crossing works. Surveys by the ECoW will be carried out immediately prior to construction to ensure that adequate species mitigation is built into the design and that the following issues are addressed:

i) All watercourses, over which the access roads cross, will be routed through culverts or under bridges appropriately sized and designed not to impede the flow of water and will allow safe passage for wildlife, particularly fish and otters (i.e. capacity will be well in excess of the design flow);

ii) The Viking fish study (Viking Baseline Assessment of Fish Populations, Appendix 10.6 to non-avian ES chapter, 2009) has shown that trout are present in the upper reaches of many of the survey streams, indeed some of the highest trout densities recorded during the present survey were in small, headwater areas and these habitats are important to the maintenance of healthy trout populations. Both migratory and non-migratory trout undergo spawning migrations and access to spawning areas must not be restricted. Although their movements may be of lesser magnitude than those of sea trout, artificial barriers that restrict movements can damage brown trout through population fragmentation leading to loss of genetic diversity and reduction in fitness. All watercourse crossing will also be suitable for eels. To minimise impacts on breeding fish and eels, where encountered, it is preferred that any in-stream works be conducted during the months of June, July and August, where possible;

iii) SNH in their formal response to the original Viking wind farm application (letter of 24 July 2009) highlighted the following points which will be accounted for in relation to otters (points 6.4 & 6.5).

6.4 "As otter pass through some of the proposed development site, SNH recommends a condition of planning that at the end of each day, pipe ends should be covered to prevent otters from entering pipes and becoming trapped and planks should be placed in excavations and other construction holes to allow otters to climb out so they do not become trapped".

6.5 SNH also advise that "all contractors are made aware of possible presence of otter passing through the site and the law for European Protected Species, and that should a holt be found then all works within 250m of the holt should stop immediately and local SNH office contacted for advice".

3.1.4 Groundworks, including Watercourse Crossings, in all areas that may be affected by nesting birds will follow established best practice guidance. In line with these requirements (i.e. best practice guidance) a pre-clearance inspection by the ECoW or other suitably qualified person (ornithologist / ecologist) will be carried out.

3.1.5 Any Watercourse Crossing operations taking place during the period March to August ("Bird Breeding Season") will be in strict accordance with best practice with regard to identifying and protecting bird nests as appropriate, including the creation of a suitable "buffer zone". Ornithological surveys will be undertaken prior to the on-set of any works and the ECoW will be present on site so that if any early (e.g. raven) or late breeding species (e.g. red-throated diver) are still present, then mitigation measures will be extended into these periods accordingly. Any micro-siting required to avoid a nest will be advised by the ECoW, working with those parties undertaking the ornithological surveys.

3.1.6 The Archaeological Clerk of Works (ACoW) will also be consulted with regard to all Watercourse

Crossing works. All known sites of Cultural Heritage will be fenced to avoid accidental damage during the construction phase. All groundworks to be undertaken within identified archaeologically sensitive areas will be monitored by the ACoW. All works associated with cultural heritage will be overseen and coordinated by the ACoW.

3.1.7 Prior to the commencement of water course crossing works an on-site meeting will be held where deemed necessary. This meeting will be between the *Contractor*, ECoW, ACoW, and Consultees where appropriate, including SEPA and SNH. The purpose of this meeting is to agree specific requirements and working practices at key locations, or for particular structures (bridges or culverts). All wildlife mitigation associated with water course crossings will be carefully planned, robust and implemented for the species present.

3.1.8 During the water course crossing construction operations, both regular and periodic consultation may be made with the Consultees as required / agreed at this commencement meeting.

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 6

WATER QUALITY MONITORING PLAN

Rev No. :	**Revision Description**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	Position :	Signature :
Prepared by :	Jane MacDonald	Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
Reviewed by :	Oliver Moffat	BMT Cordah	

Comment :

Document was also reviewed by all consultants involved in preparation of the Addendum ES.

CONTENTS

1 INTRODUCTION

1.1 Scope and Requirements

1.1.1 The *Contractor* is solely responsible for pollution prevention for the duration of the contract and until such time as permanent measures, such as permanent drainage and silt mitigation controls, are deemed to be adequate and appropriately constructed.

1.1.2 In order to verify the efficacy of pollution prevention and mitigation works during construction, Water Quality Monitoring is required to be undertaken by a suitably qualified Environmental Consultant(s), prior to, during and post completion of construction works. This will extend to all watercourses within the catchment of the construction area as well as both the source and point of supply at Private Water Supply (PWS) properties as required. The monitoring will also comprise both hydrochemistry as well as aquatic ecology monitoring.

1.1.3 The details of the monitoring will be contained within a detailed Water Quality Monitoring Plan (i.e. Version 2 of this plan) to be prepared by Viking Energy Partnership and submitted to SEPA for approval prior to commencement of construction. The approved plan will be coordinated and implemented on site by the Environmental Consultant.

1.2 Reference Documentation

1.2.1 Construction works have the potential to cause pollution of the water environment. All construction works on site, and specifically construction works to be undertaken within and in the vicinity of any water courses, will be completed in compliance with current legislation and best practice as detailed within the SEMP and Technical Schedules, in particular:

- TS2: Pollution Prevention Plan
- TS3 Site Waste Management Plan
- TS4: Drainage Management Plan
- TS5: Water Course Crossings Plan

1.2.2 The following reports (along with any further surveys conducted post-consent) will be used to inform the scope of the construction phase Water Quality Monitoring Plan.

- Hydrochemistry Survey, Technical Appendix 14.5, Viking Wind Farm 2009 Environmental Statement (ES), Mouchel, 2009.
- Baseline Assessment of Fish Populations, Technical Appendix 10.6, Viking Wind Farm 2009 ES, Waterside Ecology, October 2008.
- Freshwater Invertebrates, Technical Appendix 10.7, Viking Wind Farm ES 2009, Report to Envirocentre, Aquaterra Ecology, September 2008.

2 RESPONSIBILITIES

2.1 General

2.1.1 Responsibility for the water quality monitoring programme, and coordination thereof, will lie with the independent Environmental Consultant(s) appointed at the start of the programme.

2.2 Hydrochemistry Monitoring

2.2.1 Field Monitoring

2.2.2 Field monitoring of water quality parameters and collection of samples may be undertaken by the Environmental / Ecological Clerk of Works (ECoW) or other nominated person(s) based at the site. The ECoW or nominated site person(s) will be appropriately trained on the required monitoring methods and the use, calibration and maintenance of all monitoring equipment used. Training will be provided by the Environmental Consultant appointed to undertake the hydrochemistry element of the Water Quality Monitoring programme.

2.2.3 If the ECoW is to undertake duties relating to the Water Quality Monitoring programme, these will be in addition to the ECoW responsibilities for species and habitat monitoring, advance environmental checks and monitoring of mitigation works as detailed within Section 3 of the SEMP and Technical Schedules TS2 (Pollution Prevention Plan) and TS8 (Ecological Protection Plan).

2.2.4 Laboratory Analysis

2.2.5 Laboratory analysis of water samples will also be undertaken as part of the monitoring programme by an independent and appropriately certified laboratory to be appointed by the Environmental Consultant.

2.2.6 Coordination of the laboratory sampling and analytical programme will be undertaken by the Environmental Consultant. Under the direction of the Environmental Consultant, the ECoW or other nominated site person(s) may be responsible for field collection of the samples required for laboratory analysis. Samples will be despatched for analysis under chain of custody procedures. Laboratory analytical results will be sent directly to the Environmental Consultant.

2.2.7 Interpretation and reporting of both the field and laboratory data will be the responsibility of the Environmental Consultant. Further detail on reporting requirements is provided in Section 2.4.

2.3 Aquatic Ecology Monitoring

2.3.1 Aquatic ecological receptors (fish, invertebrates, benthic diatoms etc) can provide useful indicators of impacts on water quality. Therefore, along with hydrochemistry monitoring, the results of any surveys on these receptors will be incorporated into the interpretation and assessment of impacts on water quality whenever new survey data becomes available.

2.3.2 Ecological surveys will be undertaken by appropriately qualified specialists.

2.3.3 Ecological survey results and reports will be provided to the Environmental Consultant for inclusion into the ECoW's Monthly Report where completed that month. The results will also be incorporated into the final report on water quality.

2.4 Reporting

2.4.1 Monthly water quality reporting

2.4.2 Results of water quality monitoring shall assist in determining requirements for improvements in drainage and pollution prevention measures implemented on site. A monthly report on water quality will be prepared by the Environmental Consultant and provided to the ECoW.

2.4.3 It will be the responsibility of the ECoW to present the ongoing results of water quality and weather monitoring at site meetings and with outside bodies. This shall be done at weekly meetings and reported within the overall Monthly Environmental Report to be prepared by the ECoW.

2.4.4 The monthly reports on water quality will consider all field monitoring and results of laboratory analysis completed that month. Reports will describe how the results compare with baseline data as well as previous monthly reports on water quality. The reports will also describe whether any deterioration or improvement in water quality has been observed and whether any effects are attributable to construction activities and what remedial measures or corrective actions have been implemented.

2.4.5 Monthly reports on water quality will be provided to SEPA and the Local Authority.

2.4.6 Final report on water quality

2.4.7 Upon completion of all post-construction monitoring (including both hydrochemistry monitoring and aquatic ecology surveys), the Environmental Consultant will prepare a final report on water quality. This final report will cover the overall performance against baseline data, details on any impacts attributed to construction works and recommendations for remedial works if required.

2.4.8 The final report will be provided to SEPA and the Local Authority.

2.5 Contingency Sampling & Emergency Response

2.5.1 Where pollution arising from the construction works, such as that resulting from a spill or accidental release of chemicals, oils and fuels or concrete effluent, threatens to enter, or has entered a water course, additional sampling and analysis of surface water samples will be undertaken to determine the level of impact to the surface water receptor and remedial requirements where necessary.

2.5.2 Where a pollution incident has occurred as a result of construction works, the

ECoW, Environmental Consultant and SEPA shall be consulted to determine sampling requirements and any additional ecological survey requirements where potentially significant impacts are identified. Where it is demonstrated that the pollution occurred as a result of non-compliance with this SEMP, the costs of any additional sampling or survey requirements shall be borne by the *Contractor*.

2.5.3 The results of any monitoring or survey work undertaken by the *Contractor* shall be made available to the ECoW, the Environmental Consultant and SEPA and copies of all correspondence and test certificates shall be retained on site.

2.6 Ancillary works

2.6.1 A room within the site cabins will be dedicated for use by the ECoW as an on-site 'laboratory'. This facility will have space for a work bench, fridge for storing samples, sink, and adequate storage for a full set of sample bottles, sampling equipment (including calibration fluids etc), PPE, records and documentation.

2.6.2 A rain gauge will be established in the site compound to help inform on weather conditions affecting site water quality. Advance weather forecasts will also be consulted to predict storm events and ensure preparation of additional flood and siltation mitigation requirements as appropriate.

3 WATER QUALITY MONITORING: OUTLINE SCOPE

3.1 General

3.1.1 The full scope of monitoring will be determined at the detailed design stages (prior to commencement) and will be tailored to take into account intended construction programme and phasing of works within each catchment. The full scope of monitoring will be agreed with SEPA prior to commencement of construction works.

3.1.2 Key trigger levels at which action will be required to prevent an impact occurring to either a water feature or Private Water Supply (PWS) will be determined through consultation with SEPA and analysis of the results of any baseline monitoring data.

3.1.3 Water Quality Monitoring locations (including any aquatic ecological baseline survey locations) will be identified through grid reference, photographic record and indicated on a plan. For repeat sampling locations, each location will also be marked on the ground (stake/post) to ensure that the correct location is sampled each time.

3.1.4 Sample locations shall be labelled consistently for the duration of the monitoring period. Where any additional locations are sampled during the works, the location (grid reference) of the sampling point will be recorded and a photograph will be taken at the time of sampling.

3.1.5 'Control' sample locations will also be included in the scope of any monitoring.

3.2 Hydrochemistry Monitoring

3.2.1 Baseline data contained within the 2009 Hydrochemistry Survey (Technical Appendix 14.5 of ES 2009) will be used to inform the scope of future monitoring. The detailed scope will be determined and agreed with SEPA prior to commencement of construction.

3.2.2 Sample locations and monitoring frequency will be specified and agreed with SEPA.

3.2.3 As a minimum, the monitoring programme will include:

- At least three additional baseline monitoring visits.
- A combination of daily and weekly monitoring on catchments where construction is on-going.
- Post construction monitoring on a weekly basis for a period of three months. Post construction will be defined as when the reinstatement phase is completed.

3.2.4 Analytical determinands (including limits of detection and frequency of analysis) will be specified and agreed with SEPA for each sample location. The expected suite of determinands will include:

Parameters for hydrochemistry analysis
pH
Conductivity
Alkalinity (CaCO3)
Sodium
Potassium
Magnesium
Calcium
Chloride
Nitrate
Sulphate
Phosphate
Total Organic Carbon
Biological Oxygen Demand (5 day)
Soluble Iron
Soluble Manganese
Ammoniacal Nitrogen
Total Petroleum Hydrocarbons (TPH)
Chemical Oxygen Demand
Total Suspended Solids
Soluble Aluminium
Colour
Metals: Cadmium, Lead, Zinc, Nickel, Mercury, Arsenic, Chromium and Copper

3.3 Ecological Monitoring

3.3.1 As with the hydrochemistry monitoring programme, the detailed scope of aquatic ecological monitoring will be determined and agreed with SEPA prior to commencement of construction.

3.3.2 Ecological monitoring requirements will be informed by the existing baseline data contained within the Freshwater Invertebrate Study, the Baseline Assessment of Fish Populations and also specific requests made by SEPA in response to the 2009 ES (letter of 28th July 2009). Based on these sources of information, as a minimum, the monitoring programme will include:

3.3.3 Freshwater Invertebrates

- One pre-construction year baseline followed by post construction monitoring immediately after completion of works and again three years later.
- Monitoring locations to include upper watercourses where suitable habitat may be found. This will improve geographical coverage and should include sites closer to turbines/batching plants in order to improve the baseline from which to monitor impacts.
- SEPA also hold invertebrate data for a number of watercourses in the area and this information should also be considered as additional baseline information.
- Monitoring will include three control burns, one in each area of Delting, Nesting and Kergord.

3.3.4 Fish

- Additional baseline survey (to include assessment of temporal variation in fish abundance to allow adequate assessment of post construction monitoring data).
- Post construction monitoring.

3.3.5 Benthic Diatoms

- Benthic diatom surveys in Spring (April/May) and Autumn (Sept-Nov) to provide baseline information to assess impact of potential siltation on freshwater lochs.
- Surveys to include Truggle Water, Maa Water, Lamba Water, Petta Water, Loch of Skellister, Gossa Water, Laxobiggin and south burn of Burrafirth.

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 7

EXCAVATED MATERIALS & REINSTATEMENT PLAN

SEMP Version:	**1.0**	
Rev No. :	**Revision Description**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	Position :	Signature :
Prepared by :	Jane MacDonald	Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
Reviewed by :	Oliver Moffat	BMT Cordah	

Comment :

Document was also reviewed by all consultants involved in preparation of the Addendum ES. SEPA were also consulted and provided feedback which has been incorporated into this document.

CONTENTS

1 INTRODUCTION

1.1 Scope and Objectives

1.1.1 The information contained herein forms Technical Schedule (TS7), Excavated Materials & Reinstatement Plan (EMRP), of the Viking Wind Farm Site Environmental Management Plan (SEMP).

1.1.2 During construction works, the *Contractor* will reinstate and re-profile the site in line with current best practice in wind farm construction and in accordance with current legislation, published guidance documents and the methods detailed in this Technical Schedule.

1.1.3 This EMRP provides outline proposals for the environmental management aspects related to the excavation and reinstatement of materials on site, including outline proposals for decommissioning of the wind farm.

1.1.4 The principal objective of this EMRP document is to provide a benchmark for best practice such that excavation, handling, storage and reinstatement of excavated materials is undertaken in such a manner as to avoid or minimise environmental impacts, including disturbance and excavation of peat and generation of waste.

1.1.5 This Technical Schedule TS7 should be read in conjunction with Technical Schedules: TS2, Pollution Prevention Plan; TS3, Site Waste Management Plan; and TS4, Drainage Management Plan.

1.2 Environmental Statement Context

1.2.1 This document provides clarification on issues raised by both SEPA and SNH in their formal consultation responses. Specifically, SEPA raised several points of clarification in relation to storage and use of peat in their letter of 16 July 2009, and SNH raised similar points in paragraph 8.2 of their letter of 24 July 2009.

1.2.2 This document should be read in conjunction with **Technical Appendix A14.4** of the Viking Wind Farm Addendum ES, which provides a supplementary and updated review of the preliminary peat excavation and reuse volume estimates provided in the original ES Appendix 14.4, "Estimated Peat Extraction Volume and Potential Reuse Options".

1.2.3 The updated peat volume estimates provided in Technical Appendix A14.4 have been revised to take into account the amendments to the wind farm layout made following submission of the original ES. Technical Appendix A14.4 also provides further clarification (as requested by SEPA) on the reuse options (on-site uses), dimensions and other assumptions used to generate these conservative and preliminary volume estimates.

1.3 Glossary of Terminology

1.3.1 For clarification the following term definitions apply to their use within this report:

1.3.2 Reinstatement involves placement of subsoil, topsoil and turves as required:

i) On any areas of disturbed ground or any areas of soil or rock exposed during the construction works;

ii) In borrow pits;

iii) Alongside tracks (including embankments and batters of cut and fill and floating tracks;

iv) Around turbine bases and hard standings; and

v) Upon completion of use of construction compounds and other temporary works areas and redundant features (settlement ponds etc) which may not be required as part of the permanent works.

1.3.3 Re-profiling describes the placement of reinstated materials such that the required final landform (slope angle etc) is achieved.

1.3.4 Landscaping describes the final placement of surface materials and replacement and regeneration of vegetation.

1.3.5 Side casting describes the operation of immediate placement of excavated materials within one arms reach of the excavator (as a temporary stockpile).

1.3.6 Backfilling describes the replacement of materials excavated from a temporary excavation (e.g. cable trenches, temporary diversion ditches, settlement ponds etc).

1.4 Contractor Requirements

1.4.1 The SEMP, incorporating any subsequent revisions required under planning conditions, will form part of the main civil engineering construction Contract and will be made available to those tendering for construction works.

1.4.2 Prior to commencement of works, the appointed *Contractor* will prepare environmental plans and method statements, including a detailed EMRP, to support and supplement the SEMP.

1.4.3 No on site construction will be allowed to proceed without agreement and acceptance of the *Contractor's* EMRP by the Employer and the Ecological / Environmental Clerk of Works (ECoW).

1.4.4 As a minimum, the *Contractor's* detailed EMRP will include:

i) A Programme of Excavation and Reinstatement Works

Separate programmes may require to be produced for discrete phases of works or for particular construction areas of the site. Each programme will indicate the intended timescales for excavation, temporary storage and reinstatement works for that particular phase or area of the site.

ii) Method Statement for Excavation and Reinstatement Works

For each programme of works provided, a Method Statement will be provided with details on the following:

- Expected excavated material type(s), their physical description and method of on-site classification;
- Estimated volumes of each type of anticipated excavated material;
- Intended end-use(s) for each type of excavated material;
- Proposed excavation methods for all temporary and permanent features;
- Proposed temporary storage solutions. Where a specific storage location is identified, details will be provided on the intended haulage and deposition method, volume to be stored at any location, intended pollution mitigation, engineering and drainage control measures required at the storage location; and
- Proposed methods for reinstatement of materials in landscaping and re-profiling of: track verges; turbine bases; construction compounds; borrow pits; cable trenches; other disturbed areas and redundant construction features (such as drainage ditches, settlement ponds or other sediment control measures, concrete wash out pits and other features which may not be required as part of the permanent works). Reinstatement proposals will provide details on methods proposed for replacement of turves and re-seeding where appropriate.

iii) Plans and Drawings to Support Excavation and Reinstatement Works

The following plans and drawings will be provided to support the Programmes and Method Statements for Excavation and Reinstatement Works. All plans and method statements will be supported where necessary by detailed scale drawings and maps cross-referenced to national grid reference.

- **Indicative Track Construction Drawing,** illustrating:
  - Proposed sections of upgrades to existing tracks, cut and fill construction and floating road;
  - maximum working widths for specific sections of track including sections to be widened, locations of double and single tracks and position of indicative passing places; and
  - Details on the anticipated track footprint and ground disturbance,

including specification and dimensions of supporting geotextile materials and cabling at the edges of the track.

- **Infrastructure Construction Drawings**, to include:
  - – Plans and details relating to design and maximum working areas for construction of turbine bases, hardstandings, construction compounds and all other infrastructure as required by the Contract.
- **Temporary storage details,** including plans showing:
  - – Location, dimensions and pollution prevention control measures required for any temporary storage sites or side cast stockpiles of excavated materials adjacent to tracks or other excavation areas.

1.4.5 All plans and method statements will consider the characteristics and specific handling requirements for the anticipated excavated materials, taking into account all available site investigation information, including detailed ground investigation data obtained as part of the Environmental Impact Assessment process and any subsequent surveys undertaken during the pre-construction planning phase.

1.4.6 The *Contractor* will consider all potential options for minimising excavation volumes and also specific requirements for handling, storage and reinstatement of peat and mineral soils with a high propensity for generation of silt and potential instability issues. Consideration will also be given to the methods required for excavation, storage, maintenance and reinstatement of all forms of turf (including peat and all other turves and vegetation covers likely to be encountered at the site).

1.4.7 All plans and method statements will be accompanied by justification of the final design and / or construction methods identified by the *Contractor*, including reasons for discounting alternative methods. This is required in order to demonstrate that all avenues for avoiding hydrological disruption and reducing the disturbance and excavation of peat have been considered.

2 EXCAVATION

2.1 General Requirements for Excavations

2.1.1 All reasonably practicable measures will be taken to avoid or minimise excavations as far as is practical and feasible within the engineering and environmental constraints of a particular location.

2.1.2 The aim to be considered prior to any excavations is to minimise disturbance to peat, peatland habitats and hydrology. In order to achieve this, the following objectives will be considered during the detailed engineering design for all elements of wind farm infrastructure:

- Minimising the construction footprint and ground / habitat disturbance wherever possible;
- Minimising waste production;
- Restoring vegetation and habitats as early as possible;
- Minimise disruption to major hydrological flow paths;
- Avoidance of any adverse impact on peat stability;
- Reducing run off from exposed areas; and
- Minimising the visual impacts of the construction works.

2.1.3 The *Contractor* will take all measures possible to ensure that the depth, extent and duration of excavations are minimised as far as is reasonably practical during the construction works.

2.1.4 All construction works involving excavation of rock, mineral soil, peat or topsoil will be flexible and adaptable to take account of changing conditions, particularly in relation to weather and ground conditions that may be encountered during the works.

2.1.5 Adequate drainage control and pollution prevention control measures will be implemented prior to excavation in any area of the site such that potential impacts on the water environment or sensitive habitats and species are not significant.

2.2 Engineering Design and Construction Methods

2.2.1 Where practical, the excavation footprint, extent of ground disturbance and volume of excavated material will be minimised. Examples include: the use of micrositing to avoid deeper peat; maximising batter angles in cuttings (without adversely affecting the stability of the exposed face); and the use of floating track or piled solutions where practical.

2.2.2 In general, floating track construction is preferred in areas where peat depth is greater than 1m deep and gradients are 1:10 or less. Cut and fill track construction is preferred in areas where peat depth is less than 1m deep or gradients are greater than 1:10, or ground conditions are otherwise unsuitable for floating track construction (e.g. on cross slopes).

2.2.3 The *Contractor* will provide a rationale for the foundation design proposed for each turbine. Piled foundation engineering may be preferred in areas where peat depth is greater than 3m and micrositing is not practical.

2.2.4 All infrastructure and associated surface drainage requirements will be designed to minimise disruption to the local hydrological regime through use of appropriate drainage controls and mitigation and prevention of preferential subsurface flow pathways (refer to Technical Schedule TS4, Drainage Management Plan).

2.3 Micrositing

2.3.1 Micrositing will be carried out where reasonably practical to:

- Avoid areas of potential ground instability and unsuitable founding materials;
- Minimise ground disturbance and excavation volumes; and
- Mitigate adverse impacts to water courses and groundwater, sensitive habitats or species and cultural heritage sensitivities.

2.3.2 Micrositing up to 50m will be undertaken with the approval of the Employer, ECoW, Geotechnical Clerk of Works (GCoW) and Archaeological Clerk of Works (ACoW) as appropriate. Approval from the relevant authority for micrositing between 50 and 100m is required. No micrositing will be undertaken any greater than 100m from the consented infrastructure position.

2.3.3 Additional peat probing and / or other ground investigation techniques will be employed as necessary prior to and during the works in order to inform micrositing requirements.

2.3.4 Once micrositing, engineering design and final layouts have been agreed on site, track routes and other infrastructure will be pegged out a minimum of 100 m in advance of construction operations to the satisfaction of the ECoW.

2.3.5 Should unexpected risks associated with ground conditions or other environmental sensitivities arise during construction in any area of the site, either the ECoW, GCoW or ACoW may instruct work to cease until an agreed alternative solution is identified and the risks are avoided or minimised to an acceptable level.

2.3.6 Where unstable ground is encountered, construction in the immediate area will cease with immediate effect. If micro-siting within agreed limits is possible and acceptable then construction may recommence along the newly agreed alignment

2.4 Working Areas

2.4.1 Ground disturbance around excavation will be kept to the minimum practical area. Working areas will be carefully planned to encompass the minimum area necessary to facilitate good working practices and to achieve suitable gradients for reinstatement, landscaping and restoration purposes.

2.4.2 The working areas must be clearly defined on site using marker posts or other agreed method. Working areas are to be defined in agreement with the Employer, ECoW, GCoW and ACoW (as appropriate and depending on pre-identified environmental sensitivities in the vicinity of the proposed working area).

2.4.3 Access routes should be clearly marked / identified. Access during construction to any working areas will be restricted to specified routes. These will comprise existing roads, established made-up tracks, or a variable working corridor of an appropriate width (as agreed by the Employer, ECoW, ACoW or GCoW as required) to avoid any particularly sensitive areas.

2.4.4 The *Contractor* is required to provide appropriate plant for undertaking all reinstatement works such that no unnecessary disturbance of the ground surface occurs. In order to minimise disturbance and damage to the ground surface, any mobile plant required for reinstatement and landscaping works will be positioned on constructed access tracks, hard standing areas or existing disturbed areas wherever possible. The use of a long reach excavator for excavations and reinstatement works is preferable as it enables sufficient room to allow initial side casting and subsequent pulling back of turves over reinstated peat or soil.

2.4.5 Some occasional work off access tracks, hard standing or disturbed areas will be needed (e.g. excavation of drainage diversion channels). This will include work on peat and wet heath habitats. The *Contractor* will utilise appropriate temporary surface protection or supply suitable low ground pressure mobile plant to do such work. The mobile plant, location of access on to and from sensitive habitats, together with working procedures, must be approved in advance by the ECoW, ACoW and GCoW.

2.5 Handling and Classification of Excavated Material

2.5.1 At this site it is anticipated that the material to be excavated will comprise predominantly peat (which may be sub-divided into catotelmic, acrotelmic and turf) with some mineral soils (subsoil and topsoil). Classification of excavated materials will depend on their identified re-use in reinstatement works. All excavated material will be reused on site.

2.5.2 Preliminary volume estimates for peat to be excavated and reused at the site are provided within Appendix A14.4 of the Addendum ES. This report estimates that, based on a design scenario of constructing floating roads where peat depths generally exceed 1.0m, the total excavated volume of peat has been estimated to be around 742,000m^3. Of this around 434,000m^3 will be required for reuse in reinstatement and restoration of infrastructure, while the remaining 308,000m^3 will be required for restoration of borrow pits. Assuming all remaining material is utilised, the restoration depth within the borrow pits may be within the region of 1.7m.

2.5.3 Any material that is not immediately suitable for a predetermined use without the requirement for treatment may be classed as waste and requires to be dealt with in accordance with the *Contractor's* developed Site Waste Management Plan (refer to TS3, Site Waste Management Plan for further information).

2.5.4 Geographical locations and timescales for both temporary and potentially longer term (decommissioning) storage areas have not been identified to date. These will be considered post-consent when methods, programme and phasing of construction works will be defined.

2.5.5 Specific means of treatment (whether mechanical, physical or other) for catotelmic material have not been specified to date as this will depend on a number of factors as well as final volumes and in some cases variability in the physical behaviour of the material once it is excavated. Treatment processes will be defined by the *Contractor* and agreed with SEPA.

2.5.6 Appendix A14.4 estimates that potentially 217,000m^3 of excavated material may be catotelmic peat. This material may be unsuitable for reuse without prior treatment and therefore may be classed as waste. Treatment and subsequent reuse will be undertaken in compliance with relevant waste management legislation.

2.5.7 In order to complete his required Programme and Method Statement for Excavation and Reinstatement Works, prior to commencement of a particular phase of works or in a particular area of the site, the *Contractor* will undertake an assessment of:

- The likely excavated material types and method of on-site classification (refer to TS3 (Site Waste Management Plan) for further information on classification of materials and list of the anticipated types of excavated material at this site);
- Estimated volumes of each type of anticipated excavated material; and
- Intended end-use(s) for each type of excavated material.

2.5.8 The above assessment will involve a review of existing ground investigation data and potential further survey of the principal habitat types and existing depth of soil / peat horizons. The area to be encompassed by such an assessment will be determined by the construction works programme, phasing of the works and available ground investigation data for any particular area.

2.5.9 Where possible, excavation of soils will be undertaken in such a manner as to avoid cross contamination between distinct horizons.

2.5.10 During and after excavation, storage, haulage and reuse of excavated material will be planned to minimise material movement around the site.

2.5.11 Turves will be stripped and handled with care such that damage to the living vegetation mat is prevented or minimised as far as possible.

3 STORAGE

3.1 General

3.1.1 The design of any excavated materials storage areas will be agreed with the ECoW and Geotechnical Consultant / Geotechnical Clerk of Works prior to works commencing.

3.1.2 If any longer term storage is proposed (e.g. associated with material required for decommissioning of the wind farm) the detailed proposals will be agreed with the ECoW and Geotechnical Consultant / Geotechnical Clerk of Works (GCoW) and SEPA. Potential waste management licensing controls may apply.

3.1.3 Geographical locations and timescales for both temporary and potentially longer term (decommissioning) storage areas have not been identified to date. These will be considered post-consent when methods, programme and phasing of construction works will be defined.

3.2 Temporary Storage

3.2.1 Stripped materials will be stored in appropriately designed and clearly defined separate piles.

3.2.2 In order to reduce the need for temporary storage, reinstatement of soils and turves around infrastructure, and in restoration and landscaping works on areas of excavated / disturbed ground, will be carried out during the construction phase or as soon as is practical after the completion of the works in any one area of the site.

3.2.3 Where possible, reinstatement and re-profiling of track side verges will commence upon completion of each 400m of constructed track or otherwise as agreed with the ECoW.

3.2.4 Where material is not required for immediate reinstatement, temporary storage may be required. To minimise handling and haulage distances, where possible excavated material will be stored local to the site of excavation and/or local to the end–use site where it is required for re-profiling and landscaping purposes.

3.2.5 All environmental risks (including stockpile instability and increased risk of peatslide from storage on peatland) will be considered prior to excavation works commencing.

3.2.6 Temporary storage locations will be appropriately located and designed to minimise impact to sensitive habitats and species, prevent risks from material instability (particularly in peatland areas) and run off into watercourses. Specific locations for temporary storage will be determined and agreed with the ECoW and GCoW following detailed walkovers and localised ground surveys (topography, peat depth and stability etc).

3.2.7 Distinct horizons of soil (subsoil and topsoil) or peat (catotelmic, acrotelmic and turves) will be stored in separate stockpiles. A record will be kept for each stockpile based on origin, soil depth and habitat type. Stockpiles will be formed avoiding excess consolidation during placing and with naturally stable side slopes. Stockpiles will be isolated from any surface drains and a minimum of 50 m away from watercourses, unless otherwise agreed with the ECoW.

3.2.8 Turves must be stored turf side up and must not be allowed to dry out. During periods of dry weather a mobile water bowser may require to be mobilised for watering of stored turves. The condition of stored turves will be monitored by the *Contractor* and the ECoW.

3.3 Temporary Borrow Pit Storage

3.3.1 Where the excavated material is identified to be required elsewhere in restoration works, although re-use is not imminent, specified areas within working borrow pits may provide suitable temporary storage locations. However, the handling of the stored material must be kept to a minimum and appropriate drainage, pollution prevention and material stability measures must be designed prior to the temporary deposition of the material to ensure material is maintained in a suitable condition for future use.

3.3.2 The *Contractor* will ensure that any temporary control measures (bunds, drainage etc) required in order to use borrow pits as temporary storage areas will also be compatible with the final re-profiling proposals for the borrow pits.

4 REINSTATEMENT & RE-PROFILING

4.1 General Reinstatement Requirements

4.1.1 Reinstatement will incorporate re-profiling and landscaping of track verges, cable runs (where plough methods are not employed), turbine bases, temporary construction compounds, temporary hard standings (as required), borrow pits, temporary drainage control measures (e.g. settlement ponds and extra ditches, which may only be required for construction run-off control), concrete wash out pits and any other features which are not required as part of the permanent works.

4.1.2 All excavated material will be re-used (reinstated, landscaped and re-profiled) as part of the site works in a timely manner. Only materials won during the construction works will be reinstated on site and utilised in re-profiling or landscaping works.

4.1.3 Any reinstatement and re-profiling proposals will consider, and mitigate against all identified significant risks to environmental receptors. In particular, in areas of replaced peat, water management will be considered in the *Contractor's* plans and method statements to ensure that as far as possible an appropriate hydrological regime is re-established within areas of disturbance. Particular attention will be paid to maintaining hydrological continuity and preventing creation of preferential subsurface flow paths (for instance within backfilled cable trenches).

4.2 Locality & Timing

4.2.1 Reinstatement of all excavated materials will occur as close to the site of excavation as possible. As far as is reasonably practical and achievable, excavated material horizons will be replaced in sequence and depths similar to those recorded prior to excavation or similar to the surrounding undisturbed ground at the point of reinstatement.

4.2.2 Excavated peat from cut and fill sections of access tracks will be used for dressing the side slopes of floating track sections. No mineral soil should be used for dressing the side slopes of floating road sections to prevent silt run off onto adjacent peatland.

4.2.3 Where practical, reinstatement and re-profiling of, and around, infrastructure and borrow pits will be carried out during the construction phase, or as soon as is practical after the completion of the works themselves. Early reinstatement and re-profiling is required to minimise visual impact and temporary storage / stockpiling of soils and to promote vegetation and habitat reinstatement as early as possible.

4.3 Vegetation

4.3.1 Re-profiling and landscaping will allow for sympathetic restoration of the ground surface and ground profile to reduce the visual impact of new infrastructure, facilitate turf establishment and vegetation re-growth and reduce scour and erosion of bare surfaces prior to vegetation establishment.

4.3.2 The preferred method for restoration of excavated or disturbed areas is to replicate, where practical, the principal grassland, heath and bog communities found within the project area. In order to achieve this, as far as is reasonably practical, excavated material horizons (e.g. mineral subsoil, topsoil, peat and turves etc) will be replaced in sequence and depths similar to those recorded prior to excavation or similar to the surrounding undisturbed ground at the point of reinstatement.

4.3.3 Reinstatement of vegetation will be focused on natural regeneration utilising peat or other vegetated turves or soils stripped and stored with their intrinsic seed bank. To encourage stabilisation and early establishment of vegetation cover, where available, peat turves (acrotelmic material) or other topsoil and vegetation turves in keeping with the surrounding vegetation type will be used to provide a dressing for the final surface.

4.3.4 Peat turves should be replaced on all disturbed areas, including constructed roadside drainage channel embankments where possible. In low flow drains, anchored peat turves may be utilised to trap fine silt and reduce flow velocity, and hence scour / erosion of the channel. In the long term, once the drainage system is well bedded in, this may also encourage establishment of aquatic / bog vegetation in lower flow sections of the drainage network.

4.3.5 Where there are insufficient turves for top dressing, hydro-seeding may be an acceptable method of vegetation reinstatement. Proposals for hydro-seeding, including specification for seed mixes and application methods, will be agreed with the ECoW and relevant external consultees and stakeholders (e.g. Scottish Natural Heritage, the planning authority, land owners, estate managers etc) where appropriate.

4.4 Tracks and Other Constructed Infrastructure

4.4.1 Platforms and turbine base areas may include raised banking of up to 1m to create a visual screen, depending on local requirements. This is likely to be required on the down-slope side in order to provide a screen when viewed upslope.

4.4.2 To prevent scour and run off and facilitate vegetation re-establishment, any down-slope embankments will be graded such that the slope angles are not too steep and that embankments blend with the surrounding ground profile.

4.4.3 Double tracks will be restored to single track width upon completion of construction works where material to further reduce the visual impact and reinstate some ecologically beneficial habitat. This will be undertaken providing that sufficient excavated material is available for this purpose and that the ecological benefits and intended reinstatement method is agreed by the ECoW.

4.4.4 Provided ecological or other landscape benefits can be demonstrated, excavated peat may be utilised for restoration of spur tracks out to borrow pits where these are not required post-construction. This will be considered at the detailed design stage.

4.5 Borrow Pits

4.5.1 Unless otherwise required by planning conditions, or in agreement with landowners and relevant consultees, borrow pit restoration and re-profiling will be undertaken such that the final landform is sympathetic to the adjacent / existing landform type. Re-profiling will be undertaken using material won from the excavation area (e.g. borrow pit overburden) or excavated elsewhere on the site during the works.

4.5.2 Restoration and re-profiling of borrow pits will be necessary following completion of aggregate extraction and any required use of the borrow pits as temporary storage areas. This is required to reduce the visual impact, mitigate against residual health and safety risks arising from deep excavations and exposed rock faces, and restore habitats as far as is practical and achievable.

4.5.3 The broadly indicative worked profiles and restoration profiles of each borrow pit are illustrated on Figures A14.16a to A14.16m. The actual depth and restoration profile for each borrow pit will be dependant on the final worked profile which is not possible to determine with any degree of accuracy without detailed ground investigations.

4.5.4 Outline design proposals for borrow pit re-profiling, including details on reinstatement material origin and classification, placement method, final ground profiles and surface dressing will be submitted by the *Contractor* and approved by the ECoW prior to commencement of construction.

4.5.5 Re-profiling of the borrow pits will be achieved using excavated material won as part of the construction works. This material may comprise the original borrow pit overburden, locally excavated material, extracted rock which is not utilised for construction of roads or other infrastructure on site, and excavated material not required for reinstatement activities elsewhere at the original site of excavation.

4.5.6 The final profile will be designed to minimise any residual risks to environmental receptors or end users of the site. The restored surface should be designed to be safe for animals, livestock and humans to walkover. In this regard, where peat is being used for borrow pit restoration particular consideration will be given to the suitability of this material.

4.5.7 Where material is unsuitable for use in its extracted form without pre-treatment, this material will be classed as waste and treatment of the material prior to reuse may be required; in this case appropriate waste management licensing requirements will apply (refer to Technical Schedule TS3, Site Waste Management Plan).

4.5.8 Comprehensive records must be maintained of the location, depth and volumes of all materials used in restoration of the borrow pits.

4.5.9 As noted earlier, provided ecological or other landscape benefits can be demonstrated, excavated peat may be utilised for restoration of spur tracks out to borrow pits.

5 DECOMMISIONING

5.1.1 Detailed decommissioning proposals will be established and agreed with relevant authorities prior to commencement of decommissioning activities.

5.1.2 It is anticipated that upon decommissioning it will be preferable to leave buried structures and equipment such as foundations and cables in situ. Furthermore, it is anticipated that the majority of access tracks and constructed water course crossings would be left in-situ for amenity or landowner access requirements. Attempting to remove and reinstate the tracks is likely to result in minimal benefit which will be outweighed by the ground disturbance involved in removing the tracks.

5.1.3 Where infrastructure is to be retained, ownership and responsibility for upkeep of the tracks and water course crossings etc will pass to the landowner. Agreement on maintenance requirements would be essential to prevent detrimental effects such as flooding caused by the blockage of crossings not being maintained, or blocked cross drains or subsidence on floating road sections causing disruption of hydrological flows etc.

5.1.4 During the decommissioning works the activities on site and the subsequent potential impacts will be similar to those during construction, therefore similar mitigation measures would be implemented. Mitigation measures would also take into consideration any future improvements and developments in “good practice”.

5.1.5 On decommissioning, reinstatement of some infrastructure is likely to be required (e.g. control room and substations, turbine bases and hard standings), and therefore in order to restore ground and habitats to as near to natural conditions as is possible reinstatement of surface cover material will be required. This reinstatement will mirror surrounding ground depth and material profiles as near as possible. Hydrological conditions will be maintained where possible.

5.1.6 It is preferable that previously ‘disturbed’ soil and peat is used for reinstatement and landscaping required at decommissioning stage, as opposed to disturbing virgin peatland. Disturbed peat will be retrieved from previously reinstated infrastructure borders and verges. Where additional material is required, this will be obtained from restored borrow pits or other restored areas providing that: no ecologically sensitive receptors have since established in these areas; the extraction of the material is done in a sensitive manner with minimal visual impacts; and there are no significant risks to environmental receptors.

5.1.7 Any aggregate removed from decommissioned infrastructure will be put back into borrow pits and covered with an appropriate layer of peat. This is likely to be a volume neutral exercise as the aggregate removed would be replaced by peat used to reinstate the residual surface and vice versa.

5.1.8 Turbine bases and their adjacent hard standing areas represent the largest potential area for reinstatement, requiring a significant volume of soil/peat for their restoration.

During construction, appropriate storage of material for decommissioning reinstatement will be identified and a rationale for the storage method chosen provided by the *Contractor.* In determining the preferred storage option for reinstatement material, the Contractor must consider the impacts of double handling and the availability of suitable storage locations. All proposals for storage of material for use at decommissioning will be agreed with SEPA.

SITE ENVIRONMENTAL MANAGEMENT PLAN

VIKING WIND FARM

TECHNICAL SCHEDULE 8

ECOLOGICAL (HABITAT AND SPECIES) PROTECTION PLAN

SEMP VERSION:	**1.0**	
Rev No. :	**Revision Description:**	**Date :**
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CONTENTS

1 INTRODUCTION

1.1 Scope and Objectives

1.1.1 The information here forms Technical Schedule 8 (TS8) Ecological (Habitat and Species) Protection Plan (EPP), of the Viking Wind Farm Site Environmental Management Plan (SEMP). The SEMP, including the information and measures contained within this plan, form part of the Contract and will be made available to those tendering for construction works. The methods and principles contained herein, as well as within referenced legislative instruments and published guidance documents, shall be adhered to by the appointed *Contractor* in developing the detailed design of the wind farm and in development of the construction method statements and other plans relating to environmental management as required by the Contract.

1.1.2 The objective of this Ecological (Habitat and Species) Protection Plan is to ensure compliance with these policy objectives, as well as current environmental legislation, and to provide a benchmark for best practice such that all possible preventative measures will be taken to avoid harm to the terrestrial and aquatic habitats of the Viking site area and the species they support, together with downstream ecosystems, both during construction works and during the operational phase of the wind farm.

1.1.3 Implementation and monitoring of this Habitat and Species Protection Plan will be the responsibility of the Viking's Environmental/Ecological Clerk of Works (ECoW), appointed by Viking Energy Partnership. The ECoW will be a qualified ecologist and environmental scientist, a Member of the Institute of Ecology and Environmental Management, and be approved by Shetland Islands Council and Scottish Natural Heritage after submission of details of qualifications and experience. The role and duties of the ECoW are given in detail in Section 3 of the SEMP, and further details are also provided in Section 2 of this document.

1.1.4 This Ecological (Habitat and Species) Protection Plan should be read and implemented on site in conjunction with the requirements of other documents as contained / specified within the SEMP and its associated Technical Schedules (TS), plus site documentation on species and habitats within environmental statements and mitigation proposals for habitat management (including the Viking Wind Farm Environmental Statement, Addendum and Planning Statement).

1.2 Definitions, coverage and scope

1.2.1 Species protection may be defined as the set of measures used to minimise the risk of disturbance, injury or death to species of nature conservation interest. Particular attention is paid to species protected under EC and/or UK legislation.

1.2.2 Habitat protection may be defined as the set of measures used to minimise the risk of damage or destruction to the terrestrial and aquatic habitats of the site and downstream ecosystems.

1.2.3 A two-tier approach is to be applied to species protection:

1. Formal species protection plans will be applied to species present on site which are protected by EC and/or UK legislation and which are considered at risk from development: e.g. Otter.
2. Other species which are known to be present, or are possibly present, but which have not been found within or close to the ground to be developed, or close to watercourses, will not have a species protection plan. Instead, mitigation measures used for Otter, plus other environmental protection measures will be used to ensure other species are not affected. These measures include surveys of the development corridor and water courses in advance of construction and during construction. If evidence is found that other species are at risk, a species protection plan will be implemented.

1.2.4 Note that the evidence for Otter relates only to fresh spraint, evidence of recent use. No holts were found. Only two sites, both containing only ‘remains’ (in the quadrant area of Nesting), were found within the area potentially ‘disturbed’ by the proposed physical development. The lack of evidence of otter presence recorded during the survey suggests the population is not widely dispersed throughout the Viking study area, and, therefore, it is assumed to be at a relatively low density.

1.2.5 Other species such as breeding birds will also require protection.

Habitats to be protected and enhanced

1.2.6 Healthy species populations require appropriate habitats. Impacts upon habitats have direct and indirect effects upon species. The key habitat types present at the Viking site are therefore identified in this document, on the basis of information in the Environmental Statement and Addendum thereof, the Planning Statement and Habitat Management Plan (HMP) documents.

1.2.7 Habitat enhancement may be defined as the measures to modify the distribution and improve the condition of habitats, as set out in the HMP.

1.2.8 The following important habitats have been identified within the development area, and will be the subject of formal protection measures during the construction phase of the wind farm and improved management under the HMP:

- *Sphagnum* blanket bog
- Lochans
- Rivers and streams
- Wet grassland communities

1.2.9 The aquatic habitats and aquatic life within the development area watercourses will be protected using measures in detailed site-specific Construction Method Statements and other components of the Site Environmental Management Plan. Protection will include fish within those watercourses and further downstream.

1.2.10 The habitat protection measures covering terrestrial and aquatic habitats are given in Section 4 herein.

Species: Birds to be protected

1.2.11 All bird species (apart from a few “pest” and game species) are protected by law, under the Wildlife and Countryside Act 1981 (Appendix 1), so that it is an offence to kill them or damage their nests and eggs. Species listed in Schedule 1 of the Act are specially protected, so that it is an offence merely to disturb them while nesting. Other specially protected species are listed on Annex 1 of the EC Birds Directive, which also prohibits willful disturbance at the nest. However, if disturbance to the nest of any other bird species without special protection were sufficient to prevent parent birds from incubating their eggs or feeding their nestlings, so that the brood died, this could be regarded as an offence under the 1981 Act.

1.2.12 Accordingly, all breeding birds likely to use the development area will be protected.

1.2.13 The bird protection measures are given in Section 3 herein.

1.2.14 Habitat enhancement measures and mitigation management for several species of bird are included under the HMP. These measures are unlikely to affect wind farm work in the construction and operation phases of the wind farm and are not considered further in this document.

Species: Mammals to be protected

1.2.15 The following mammal species protected under UK and/or EC legislation are recorded as present within the wind farm development area and as using the watercourses downstream of the development:

- Otter

1.2.16 **Otter** The Otter is a species of European importance, protected under Regulation 39 of the Conservation (Natural Habitats, & etc.) Regulations 1994 (as amended). Under these regulations it is an offence to; deliberately or recklessly kill, injure or capture an Otter; deliberately or recklessly disturb or harass an Otter; and to, damage, destroy or obstruct access to a breeding site or resting place of an Otter (i.e. an Otter shelter). A licence is required for all developments which will affect areas known to contain Otter shelters. This licence is issued by the Scottish Government, in consultation with SNH. The Otter is also fully protected by the Wildlife and Countryside Act (1981, as amended) and the Nature Conservation (Scotland) Act (2004). Note, SNH (letter 24 June 2009) advised against applying for an Otter EPS licence as a precautionary measure as they noted the survey results showed that the proposal was not likely to result in actions contrary to the species protection elements of the Conservation (Natural Habitats &c) Regulations 1994, as amended.

1.2.17 The mammal protection measures are given in Section 3 herein.

Potential sources of harm to habitats and species

1.2.18 A very wide range of activities have the potential to cause harm to habitats and species. An outline of activities is given in Table 1 below.

1.2.19 Potentially harmful activities which will occur during the pre-construction, construction, operation, decommissioning and restoration phases of wind farm development are highlighted in grey in Table 1. As a simple example, disturbance, injury or death can arise from the introduction of a contaminant into air, land or water, resulting in an impact (generally negative) to the ecosystem into which the substance is released. Silt-laden waters can destroy or harm most aquatic life if the receiving watercourse was high quality before development. Loss of fish and fish spawning grounds reduces food for Otter and recreational use for fishing.

1.2.20 Careful planning of activities, followed by implementing best practice methods which include appropriate mitigation and monitoring at all stages of an operation, together will avoid or minimise negative effects.

1.2.21 The ES and PS documents have estimated the levels of negative impact which will occur and concluded these will be small and of low significance as residual effects. The ES and PS documents have assumed, as part of calculating residual effects, that best practice methods will be used at all times.

1.2.22 **Good construction practice and appropriate mitigation and monitoring are therefore essential for the protection of habitats and species during construction and operation of the wind farm.**

1.2.23 An additional aim of this Ecological (Habitat and Species) Protection Plan is to keep effects within the predictions of those documents, or to make them smaller. Measures within the HMP aim to improve the habitats and key species on the Viking site, offsetting the effects of the development.

Table 1 - Activities with the potential to damage habitats and disturb, injure or kill plant or animal species

Source: Adapted from IEEM (2006) Guidelines for Ecological Impact Assessment in the United Kingdom. Institute of Ecology and Environmental Management, Winchester.

Preliminary activities prior to the main construction contract
(e.g. ground investigations)

Construction phase

- Access and travel on/off-site.
- Assembly areas for components of construction.
- Blasting, e.g. for minerals operations.
- Construction of structures and hard surfaces.
- Demolition operations.
- Environmental incidents and accidents (e.g. spillages, noise and emissions).
- Fires.
- Ground and excavation works.
- Lighting.
- Provision of services and utilities (e.g. underground power lines, water supply and drainage).
- Removal or disruption of top-soil/sub-soil etc.
- Siting and subsequent removal of site offices/compounds and final site clear away after construction.
- Storage areas for construction materials.
- Structural works for building and engineering.
- Structural works to existing buildings, including conversions.
- Temporary access routes for construction vehicles - both on and offsite.
- Vegetation clearance.

Occupation/Operational phase

- Access (both route and means).
- Drainage.
- Damage to mitigation work through accident or vandalism.
- Implementation of landscape design and habitat management (type and location).
- Presence of people, vehicles and typical uses and activities (including factors likely to cause disturbance, e.g. on-site monitoring, increased public access and recreational pressure, risk of fires, lighting, noise, regular emissions).
- Presence of pets and working dogs.
- Site operation and management (e.g. maintenance operations, industrial processes generating emissions, etc.).

Decommissioning phase

- Removal of contaminated water or soil.
- Removal or demolition of disused structures that may have been colonised by, e.g. roosting bats, barn owls.
- Removal of ancillary developments including culverts.
- Removal or neglect of structures which might cause pollution if they fail.

Restoration phase
(where operations/phases have finished, e.g. for mineral extractions).

Potential unexpected events
(e.g. other one-off incidents and accidents such as peat instability).

1.2.24 Works may be suspended at the request of the Employer, ECoW, SEPA, SNH or HSE at any time when a potential risk to habitats and species is identified (and resulting harm may be caused to land, water, protected species or human health) or where construction methods and mitigation measures relating to site ecology (habitats and species) are not as specified within the construction method statements and relevant plans as submitted and agreed at the commencement of the works.

2 THE ENVIRONMENTAL/ECOLOGICAL CLERK OF WORKS

2.1 Background

2.1.1 The Employer will appoint an appropriately qualified Environmental/Ecological Clerk of Works (ECoW), who will be named to and approved by the planning authority and SNH. This person(s) will be known as the Viking Wind Farm ECoW. The ECoW must be a member of the Institute of Ecology and Environmental Management (IEEM).

2.1.2 As the delivery of this Ecological Protection Plan is highly dependent on the roles and responsibilities of the ECoW, at least during the construction phase of the development, some detail is provided here regarding this position.

2.2 Term of appointment

2.2.1 The ECoW will be a full time post, and will be on site for 4.5-5 days per week during the main construction period. Some office time is required for reporting.

2.3 ECoW tasks

Overview

2.3.1 There are no statutory conservation designations within the area where the proposed physical development will actually take place. However, there are two nature conservation designated sites within the wider Viking study area: The Burn of Lunklet SSSI (1.4ha designated for endemic hawkweed species) and the Kergord plantations SSSI (6.45ha designated for broadleaved, mixed and conifer woodlands).

2.3.2 Although not directly affected by the wind farm itself or associated infrastructure within the development boundary, the Sand Water SSSI is likely to be adversely affected by other associated works out with the development boundary.

2.3.3 All works within 500m of any designated site, or within 500m of any tributary water courses or other direct pathways to a designated site, will be undertaken in strict accordance with the pollution prevention principles contained within this SEMP.

2.3.4 In particular, the following mitigation is required to address potential issues that may be associated with the construction compound and road upgrades within the Sand Water SSSI catchment:

- road alterations must take place on the north side of the existing B9075, so that the works do not encroach into the SSSI;
- construction methods, pollution prevention measures and details of water crossings and culverting to be fully agreed with SEPA, and ultimately implemented and controlled by the Ecological Clerk of Works;
- toilet, washroom and kitchen facilities for workers at the construction compound, near to Sand Water, to be in the form of sealed units which are regularly maintained and emptied to ensure no waste water spills from them.

2.3.5 The Viking Wind Farm development is located in an area of sensitive habitats which support known protected species. The wind farm area is likely to experience a range of environmental and ecological issues associated with its construction. The ECoW will advise and assist in avoiding, minimising and mitigating adverse effects. The ECoW will document effects and relate them to predicted residual effects specified in ES documents at the end of the construction period.

2.3.6 The following are anticipated to represent the main tasks which translate these aspects of the role into action. This list is not intended to be exhaustive, and will require modification during the construction period as and when circumstances dictate.

Micrositing

2.3.7 Movement of turbines and associated tracks within micrositing allowances, to take account of environmental considerations, in consultation with the Geotechnical Clerk of Works (GCoW) and Archaeological Clerk of Works (ACoW) as necessary.

Pollution Prevention Plan

2.3.8 Review, agreement and approval of contractor's Pollution Prevention Plan prior to commencement of work.

2.3.9 Conduct weekly inspection of site pollution prevention measures (straw bales, silt traps etc.) and visually assess their effectiveness. This will include inspection of water management measures installed by contractors such as excavation pumping and diversion channels, as well as the containment of silt away from watercourses and advice on micro-siting of mitigation measures.

2.3.10 Maintain a Pollution Prevention Measures Register of the weekly inspections, to include an inventory of all measures on the site, their effectiveness, as well as any advice provided.

2.3.11 Collation of water sampling results (collected and analysed by third parties) for presentation in monthly reports (see below).

2.3.12 Suspension of work where potential risk from pollution is identified, or where construction methods and mitigation measures are not as specified in construction method statements and/or plans as agreed at commencement of works.

2.3.13 Provide advice and recommendations to Viking Energy Partnership and its contractors regarding the above.

Waste management

2.3.14 Review, agreement and approval of the *Contractor's* Site Waste Management Plan

2.3.15 Review of the *Contractor's* records for all inspections of fuel, oil or chemical storage areas, including the integrity of storage facilities.

Drainage Management

2.3.16 Review, agreement and approval of the *Contractor's* Site Drainage Management Plan.

2.3.17 Inspection of drainage management works.

2.3.18 Liaison with Planning Monitoring Officer inspecting works on behalf of the local authority.

2.3.19 Agreement of monitoring standards to be applied by contractor's personnel.

2.3.20 Assessment in advance of habitats and species for ground to be affected by drainage management.

2.3.21 Review of the *Contractor's* records for plant inspections, evidence of contamination and checks made after extreme weather conditions.

2.3.22 Liaison, field discussion and agreement of drainage management works with SEPA and/or SNH, when required by consultees and when considered necessary by ECoW.

2.3.23 Agreement of frequency and location of drainage ducts installed beneath floating roads.

2.3.24 Agreement of drainage management associated with temporary peat storage and reinstatement works in advance of such works commencing.

Watercourse Crossings

2.3.25 Review, agreement and approval of the *Contractor's* Site Watercourse Crossing Plan.

2.3.26 Survey in advance of watercourse condition and protected mammals for all ditch and stream crossings, using an established specialist if necessary.

2.3.27 Review of the *Contractor's* records for plant inspections, evidence of contamination and checks made after extreme weather conditions.

Water Quality Monitoring

2.3.28 Review, agreement and approval of the *Contractor's* and independent Site Water Quality Monitoring Plans where undertaken.

2.3.29 Inspection of contractor's records for water environment monitoring and comparison of those records with independent records.

2.3.30 Presentation of independent water environment monitoring results at weekly and monthly site meetings.

Excavated materials and reinstatement

2.3.31 Review, agreement and approval of the *Contractor's* Site Excavated Materials and Reinstatement Plan.

2.3.32 Marking working areas and route corridors, in consultation with GCoW and/or ACoW as necessary.

2.3.33 Granting permission to work off hard ground using low ground pressure machines, including specification of the points of entry and return, and the route to be taken.

2.3.34 Micrositing of wind farm infrastructure to avoid unstable ground, avoid unsuitable foundations, minimise ground disturbance and excavation volumes (especially of peat), adverse impacts on watercourses, sensitive habitats, species or cultural heritage, in consultation with GCoW and/or ACoW as necessary.

2.3.35 Agreeing proposals for side casting and temporary storage areas as development proceeds.

2.3.36 Agreeing timing of restoration and reinstatement of track sides.

2.3.37 Monitoring the condition of stored turf.

2.3.38 Agreeing any required hydroseeding specification, including seed mix and fertiliser quantities.

2.3.39 Agreeing specification for borrow pit restoration.

2.3.40 Agreeing specification for survey and 'as built' information of each borrow pit after completion of initial restoration.

2.3.41 Issuing instruction to cease work if unexpected risks arise, until an agreed alternative solution is identified and risks are avoided or minimised.

Ecological Protection Tasks

2.3.42 Review, agreement and approval of the *Contractor's* Ecological (Habitat and Species) Protection Plan.

2.3.43 Erection and maintenance of markers and notices for limits around watercourses and other areas with protected species or habitats.

2.3.44 Consideration of requests and granting of permission to enter within habitat and protected species exclusion zones.

2.3.45 Conduct weekly checks for protected species within and adjacent to construction areas, particularly covering Otter.

2.3.46 Check ground ahead of the likely construction and felling front for species (Otter).

2.3.47 Recommend implementation of the terms of specific protection plans (e.g. Otter) as and when required.

2.3.48 Implementation of species protection plans if ground checks suggest this is necessary for the following: Otter, breeding birds.

2.3.49 Execution of the terms of any Licence to Disturb Otters which might be required as a result of future surveys and searches.

2.3.50 Maintain a register of faunal sightings/signs for the site, within a GIS.

2.3.51 Conduct weekly checks of sensitive habitat (peatland, watercourses) within the proposed areas of felling and construction.

2.3.52 Implement the Terrestrial Habitat Protection Plan and Freshwater Habitat Protection Plan, including surveys and checks specific to those plans.

2.3.53 Maintain a register of all habitat inspections carried out.

2.3.54 Provide advice and recommendations to Viking Energy Partnership and its contractors regarding the above and where appropriate provide advice on aspects of implementation of the Habitat Management Plan for the site.

Recording

2.3.55 The ECoW will keep a record of the following:

- notable animal sightings and signs (including birds, in addition to other site ornithological monitoring), particularly those noted in searches one or two days in advance of construction;
- the Pollution Prevention Measures Register (as detailed above);
- the habitats and soil (including peat depth) of ground to be developed via survey at least a week in advance of construction work;
- record of tasks carried out;

- written record of all oral advice given.

2.3.56 The ECoW will maintain a GIS database of key recordings made during the construction period. Field records will use, if necessary, differential GPS technology captured into a field GIS system.

2.3.57 The hard copy registers will be made available for all personnel on site to consult. Access to GIS records will also be made available, but under the supervision of the ECoW.

Environmental Management Group

2.3.58 Attend and minute weekly and monthly meeting of an Environmental Management Group (or equivalent) which will include representatives from Viking Energy Partnership and its main Contractor. The purpose of the group will be to:

- review the construction progress on site in the context of ecological and environmental mitigation;
- review the effectiveness of the ecological and environmental mitigation;
- discuss construction programme for the following week, and fortnight look-ahead;
- agree actions on these matters;
- agree items for discussion at monthly Project Meetings.
- Liaise with any wider external environmental advisory groups (e.g. Shetland Windfarm Environmental Advisory Group (SWEAG)).

On-site communication

2.3.59 The success of ECoW appointments is largely dependent on well-defined lines of communication. In theory, robust construction method statements will incorporate many of the areas of ECoW concern into the daily activities of construction personnel. However, the ECoW will always inform the Viking Energy Partnership Project Manager of areas of particular concern, who will then make a decision as to the subsequent action.

2.3.60 The ECoW will be involved in the delivery of biodiversity-related Toolbox Talks as part of the site induction process. All staff will know of the circumstances when the ECoW should be contacted, and the relevant phone numbers.

Liaison with consultees

2.3.61 The ECoW will provide a liaison between SNH, Shetland Islands Council and SEPA if this is required. In addition, the ECoW will liaise with wider external advisory groups such as SWEAG where required.

Monthly reports

2.3.62 The ECoW will produce a monthly report detailing the above activities.

2.3.63 The report will also contain water sampling analysis results, if these are available.

2.3.64 The ECoW will also assist Viking Energy Partnership with the supply of relevant information for compliance assessment.

Final Report

2.3.65 The ECoW will produce a final report to Viking Energy Partnership documenting the environmental and ecological effects of the construction period. The evidence for effects will be based on findings included in the minutes of weekly meetings and monthly meetings, together with other recording information maintained by the ECoW. The report will relate results to residual effects predicted in Viking ES documents. The report will be made available to the Contractor, Shetland Island Council, SNH, SEPA and other external agencies where appropriate (e.g SWEAG).

3 SPECIES PROTECTION PLANS

3.1 Deciding species requiring protection

3.1.1 Surveys for environmental statements and confirmatory work for ES findings show the following species of interest in the Viking area.

3.1.2 **Otter:** Otter is protected under the EC Habitats and Species Directive, which is transposed into UK law by the Conservation (Natural Habitats &c) Regulations (as amended in Scotland 2007) 1994. The evidence for Otter relates only to fresh spraint, evidence of recent use. No holts were found, although this may be attributed to seasonal breeding. Only two sites, both containing only 'remains' (in the quadrant area of Nesting), were found within the area potentially 'disturbed' by the proposed physical development. However, the implementation of an otter protection plan should be considered for the development.

3.1.3 **Birds**: Breeding bird surveys have shown the area of development contains nesting birds in the breeding season.

3.2 Otter Protection Plan

3.2.1 The Otter protection plan is required to safeguard the Otter interest during the construction period of the Viking Wind Farm. This plan should be used for the induction of relevant site personnel and as a management tool for on-going Otter protection.

3.2.2 The plan is divided into five sections, covering both pro-active and reactive measures as follows:

- General protection measures;
- Personnel induction;
- Pre-construction checks and monitoring;
- Procedures in the event of discovering an Otter shelter;
- Licensing (if and when required).

3.2.3 General Protection Measures

3.2.3.1 Water Quality Protection Measures:

- The TS2 Pollution Prevention Plan, TS4 Drainage Management Plan, TS5 Watercourse Crossing Plan, TS7 Excavated Materials and Reinstatement Plan and TS9 Environmental Incident and Emergency Response Plan will together put in place water quality measures to ensure the protection of Otters. These plans will prevent contamination of watercourses and will protect Otter, other species, aquatic habitats and habitats close to watercourses. There will be daily visual inspections of watercourses for pollution, and independent monitoring of water quality at agreed locations (TS6 Water Quality Monitoring Plan);
- The above measures include mitigation to reduce the risk of pollution of water courses from fuel and silt contamination, effects which can result directly in death, impaired

reproduction, impaired immunity and seriously damaged habitat which may not recover for months or years. The main mitigation in the above measures are as follows:

- o Strict adherence to water pollution prevention guidelines throughout the development;
- o Chemicals, oils and hazardous materials will be stored securely away from the watercourses. Fuel spilled up-gradient of watercourses will be washed down tracks and into watercourses during periods of rainfall or snow melt. Fuel storage locations and fuelling points will be situated to avoid this, positioned down-gradient if possible and located within bunds. The bunds should exceed fuel drum capacity by a substantial proportion, to allow for the effects of heavy rainfall. Bunds should be cleaned and then drained regularly. Spill kits and drip trays should be compulsory at all fuel or vehicle maintenance locations on site. Oil booms should be situated in all site drainage ditches and silt lagoons where there is a risk of fuel contamination.
- o Silt mitigation measures should also be a priority during the construction and post-construction phases of development.

- Pollution prevention measures involving silt will be installed and maintained as appropriate, including silt interception traps, settling lagoons or mobile silt-trapping units (such as Siltbusters or equivalent device), as well as installation of splash boards at watercourse crossing points to prevent contamination from track run-off;
- Spillage contingency kits will be provided in all site vehicles and there will be daily checks for oil and fuel leaks.

3.2.3.2 Measures to Minimise Disturbance and Risk to Otters During Construction Activities:

- All relevant construction drawings and plans should have an indication of Otter shelter presence if it is in the locality (within 100 m). Exact location should not be marked, to maintain confidentiality.
- All open excavations will be ramped to enable easy exit by Otter and other species;
- Culvert pipes stored on site will be capped or if caps are not available, stored vertically, to prevent Otter entrapment;
- Design of any permanent or temporary lighting will be such that it will be directed away from watercourses and will maintain an unlit corridor of 50m either side of watercourses;
- Prohibition of all fires on site which should take account of known Otter interest. Upland habitats are particularly susceptible to fire and, as such, a no smoking policy should be implemented except in designated areas of the site.
- All construction personnel will be provided with an emergency telephone contact for the ECoW.

3.2.3.3 Design of Safe Watercourse Crossings

- All watercourse crossings highlighted will be designed to ensure dry passage of Otter during high flows either by:

a) providing a bridge which is large enough to give dry passage along the bank;

b) installing a dry mammal culvert adjacent to the normal culvert; or

c) incorporating a ledge into the bridge or culvert design to allow passage by Otters.

- Watercourse crossings in areas of high Otter activity will incorporate reflectors designed to reflect vehicle headlight beams and provide warning of the vehicle's approach to Otters.
- A site speed limit of 15 mph for all construction traffic will be imposed across the site.

3.2.4 Personnel Induction

3.2.4.1 All relevant site personnel will be given an induction by the ECoW. The induction will be in a format of a toolbox talk with the aim of:

- Making personnel aware of legal obligations placed on them in relation to Otter by national and international legislation and by the conditions of any Scottish Government Otter licence or any other licences which may be obtained;
- Making personnel aware of their personal responsibility for ensuring that no infringement of legislation or breach of any licence condition occurs;
- Ensuring personnel are aware of the current status of Otter on site and the locations in which they are likely to be encountered. Emphasise the importance of amphibians (frogs, toads, newts) as the main prey for upland Otter for most of the year and the need to protect the breeding habitats of amphibians (e.g. bog pools) as well as terrestrial habitats (e.g. damp rushy flushes);
- Ensuring personnel have an understanding of key mitigation methods in place for Otter and their responsibility to implement these measures;
- Ensuring personnel understand the procedure to be followed in the event of finding an Otter shelter, a structure suspected to be an Otter shelter, or an Otter;
- Ensuring personnel understand that no person or work is allowed within exclusion zones without prior agreement and/or supervision with an Otter consultant or ECoW and in consultation with SNH and/or under a disturbance licence;
- Ensuring personnel understand the procedure for encountering a dead or injured Otter within site works, away from any known Otter shelter. An injured Otter must be observed from a distance and followed discreetly at a distance if it is moving. A dead Otter must be left undisturbed. The ECoW is to be called to the location immediately. The ECoW will collect the injured or dead Otter. The ECoW will be responsible for ensuring that any injured or dead Otters are handed over to the proper authorities for care, as well as reporting the circumstances to the appropriate authorities.

3.2.5 Pre-Construction Survey, Checks and Monitoring

3.2.5.1 Within 4 months prior to commencement of the development on site, a pre-construction Otter survey for Otter holts or resting places within 500m of wind farm infrastructure will be carried out. This will be conducted by a suitably qualified and experienced ecologist. These checks will take place 14 days or less before commencement of construction and will be carried out under conditions of normal water flow. Surveys will not be undertaken during, or after heavy rain or periods of flood.

3.2.5.2 If new Otter holts and/or resting places are found, this information will be added to existing Otter information for the site and the ECoW will evaluate all information in relation to construction.

3.2.5.3 The ECoW will carry out further checks during the construction period, including checks ahead of the construction front. These checks will involve at least the following:

- Checks 500m upstream and downstream of all new and upgraded watercourse crossings.

3.2.5.4 Suspected natal dens should have a minimum exclusion zone of 200m. If site works are likely to come within 100m of a suspected natal den, advice should be taken from an Otter consultant and the exclusion zone should be extended if required. A cessation of works within the exclusion zone may be necessary until the cubs are mobile and this might be up to 6-8 weeks.

3.2.5.5 While all pre-construction checks are the responsibility of the ECoW, it is not physically possible or necessary for the ECoW to check all watercourses on site.

3.2.5.6 All site personnel will be obliged to report any sightings of Otters and any potential Otter shelters found on site to the ECoW as soon as practicably possible.

3.2.6 Procedures in the event of discovering an Otter shelter

Overview

3.2.6.1 Procedure A describes the steps in the event of disturbance of a known Otter shelter. If disturbance to a known Otter shelter occurs, an offence will have been committed under The Conservation (Natural Habitats, & etc.) Regulations 1994 (as amended). Disturbance to a known Otter shelter is extremely unlikely as toolbox talks will focus on protection of known shelters, and the ECoW will monitor these areas. However, this procedure has been included for comprehensiveness.

3.2.6.2 Procedures B, C and D describe the procedure in the event of the discovery of the following three types of evidence, formerly unknown on site: a suspected Otter shelter (B), a non-breeding shelter (C) and a breeding shelter (D)

A) Procedure in the event of disturbance to a known Otter shelter

3.2.6.3 Any accidental damage or disturbance to a known holt will be reported to the ECoW and work will be stopped immediately. In some circumstances, particularly where high disturbance activities are taking place (blasting, piling) or where the shelter is suspected or known to support breeding Otter, the buffer zone may required to be larger, based on the judgement of the ECoW or an Otter consultant.

3.2.6.4 The ECoW will investigate the nature of the damage or disturbance and report immediately to Viking Energy Partnership.

3.2.6.5 Viking Energy Partnership in consultation with the ECoW will inform SNH of the incident and the actions taken and proposed subsequent actions, as soon as practicable after the incident. Work in the vicinity of the shelter will not commence until SNH advice has been complied with and any necessary licences have been obtained or amended.

3.2.6.6 The ECoW will be responsible for ensuring that any injured Otters are handed over to the proper authorities for care.

B) Procedure in the event of discovering a suspected and formerly unknown Otter shelter

3.2.6.7 All construction activity within 200m of the suspected shelter will stop immediately and no personnel will approach the area of the suspected shelter. The ECoW will be informed immediately of the location.

3.2.6.8 The ECoW will inform site foreman/manager of the situation in the first instance.

3.2.6.9 The ECoW will attend to the location as a matter of urgency to ensure that activity has stopped in the area and no personnel are within 200m of the suspected site, and then investigate any damage to the structure and the location and behaviour of any animals still in the vicinity.

3.2.6.10 If at this point the ECoW is able to confirm whether the suspected shelter is that of an Otter he/she will follow Procedure C for a non-breeding shelter or Procedure D for a breeding shelter. If the shelter is still not confirmed as being that of an Otter, the ECoW will proceed to the next step of this procedure and construction will be delayed until the status of the shelter has been confirmed.

3.2.6.11 The ECoW will monitor any potential shelter site daily as necessary to confirm its status (and if a breeding female is present the number and approximate age of young). If it is confirmed that the shelter is not that of an Otter, then works may continue.

3.2.6.12 The ECoW will check suspected couch sites (above ground shelters, normally in a nest of rushes or grass) for any signs of occupancy. This will require a Licence to Disturb the species issued by the Scottish Government, although it is highly likely that no Otter will be present at that time as a result of disturbance. If it is confirmed that the shelter is that of non-breeding Otter, Procedure C will be adopted and for that of a breeding Otter, Procedure D.

3.2.6.13 The ECoW will authorise continued works in the area of the couch once it is confirmed that no Otter is present.

C) Procedure in the event of discovering a non-breeding shelter

3.2.6.14 All construction works will cease immediately and a buffer zone of a minimum of 50m from the shelter will be erected using appropriate, temporary fencing with notices indicating an ecological buffer zone. No personnel will enter the buffer zone except when accompanied by the ECoW. In some circumstances, particularly where high disturbance activities are taking place (e.g. blasting or piling) the buffer zone may need to be larger, based on the judgement of the ECoW.

3.2.6.15 The ECoW will inform Viking Energy Partnership of the status of the shelter.

3.2.6.16 The ECoW will consult SNH and the Scottish Government if a licence or amendments to an existing licence will be required and will seek an approval of proposed suitable actions and mitigation proposals. These will only be pursued where there are no alternative solutions:

3.2.6.17 If the shelter can be avoided, the buffer zone will remain in place until construction is finished.

3.2.6.18 Procedure B will have already confirmed whether the shelter supports breeding or non-breeding Otter.

3.2.6.19 If work is required within the buffer zone but will not directly impact the shelter, the shelter will be temporarily excluded or other appropriate mitigation/supervision will be put in place.

3.2.6.20 If work will directly impact the shelter, the shelter will be excluded and destroyed under license, but only if there are no alternative solutions and after full consultation with SNH and the Scottish Government.

3.2.6.21 Viking Energy Partnership in consultation with the ECoW, will apply for any relevant licence or licence amendments which may be required before work can proceed.

3.2.6.22 In the event that temporary exclusion is required, the following procedure will be followed:

- The ECoW will apply suitable one-way gates on the shelter entrances and monitor these until it is certain that no animal is within the shelter;
- The ECoW will monitor all activities within the exclusion zone until completion;
- Upon completion of work activities the shelter will be re-opened for use by Otters;
- The exclusion zone will remain in place until completion of works within the general area.

3.2.6.23 In the event of destruction of a shelter, the following procedures will be followed and may need to be implemented by an Otter specialist:

- The Otter specialist will select a suitable site near to the natural shelter site but no less than 50m from the construction zone, and will construct an artificial shelter and a buffer zone of 50m around the new shelter. The artificial shelter will be left in place for as long as possible before exclusion of the natural shelter begins;
- At an appropriate time, the ECoW will apply suitable one-way gates on the holt entrances and monitor these until it is certain that no animal is within the holt;
- The ECoW will supervise the destruction of the shelter. Destruction will take place with extreme care to ensure that any animal that may have remained within the shelter is not injured. Although it is rare, animals can be extremely gate shy, and if water is available

below ground they can survive for a considerable period, past the point where all indications from monitoring suggest that the shelter is empty.

- Destruction will be by hand tools if possible;
- Upon completion of shelter destruction, the ECoW will advise Viking Energy Partnership, SNH and the Scottish Government that destruction is complete, and authorise construction within the area:
- The buffer zone will remain in place around the artificial shelter until site completion;
- The ECoW will monitor the artificial shelter on a monthly basis for signs of use.

3.2.6.24 All of the above exclusion activities may be carried out by another Otter specialist in addition to the ECoW in the case that specialist knowledge or licensing is required. All exclusion activities described in paragraphs 3.2.6.22 and 3.2.6.23 can only be legally undertaken under the terms of an appropriate licence from the Scottish Government.

D) Procedure in the Event of Discovering a Breeding Shelter

3.2.6.25 All construction works will stop immediately a buffer zone of at least 200m will be erected, consisting of appropriate fencing with notices indicating an ecological buffer zone. In some circumstances, particularly where high disturbance activities are taking place (blasting, piling) the buffer zone may require to be larger, based on the judgement of the ECoW.

3.2.6.26 No personnel will enter the buffer zone except when accompanied by the ECoW.

3.2.6.27 The ECoW will inform Viking Energy Partnership of the status of the shelter.

3.2.6.28 Relevant licences or licence amendments will be sought from the Scottish Government by Viking Energy Partnership in consultation with ECoW.

3.2.6.29 The shelter site will be avoided until young are mobile. The ECoW will determine when this occurs. No work will take place within the buffer zone while the female is present with young.

3.2.6.30 If disturbance to the shelter is unavoidable and there are no alternative solutions, SNH and the Scottish Government will be consulted and advice sought on appropriate actions and mitigation measures. Actions to deal with the holt will reflect the mitigation measures described in paragraphs 3.2.6.22 and 3.2.6.23 of Procedure C.

3.2.6.31 While the female is present, the ECoW will select a suitable site near to the natural shelter site but no less than 200m from the construction zone, and will construct an artificial shelter and a buffer zone of 200m. The shelter will be left in place for as long as possible before exclusion of the natural shelter begins. This will only be done after full consultation with SNH and the Scottish Government.

3.2.6.32 When the ECoW determines that young are mobile an exclusion can take place. Viking Energy Partnership in conjunction with the ECoW will obtain the necessary licence and destruction of the shelter would be carried out as described at paragraph 3.2.6.23 of Procedure C.

3.2.6.33 All of the above exclusion activities may be carried out by another Otter specialist in addition to the ECoW in the case that specialist assistance is required. All exclusion activities described can only be legally undertaken under the terms of an appropriate licence from the Scottish Government.

3.2.7 Licensing

3.2.7.1 No known Otter shelters will be directly affected by construction activities and therefore no application has been made for a Licence to Disturb Otters as per SNH's recommendation.

3.2.7.2 The pre-construction Otter survey might reveal an Otter shelter within 100 metres of future works. If this occurs, no works will take place until a Licence to Disturb Otters has been obtained from the Scottish Government under the Conservation (Natural Habitats &c) Amendment (Scotland) regulations 2004.

3.2.7.3 In addition, there is potential for indirect effects on the species across the site as a result of disturbance due to construction light, noise and vibration, disrupted movement corridors and pollution. If ECoW checks during the construction phase show that Otter distribution is changing, with new shelters occurring within 100 metres of future works, no works will take place in the vicinity of the new shelter until a Licence to Disturb Otters has been obtained from the Scottish Government under the Conservation (Natural Habitats &c) Amendment (Scotland) regulations 2004.

3.2.8 Compliance with best practice and legislation

3.2.8.1 The above components of the Otter Protection Plan have been produced after following advice on mitigation and legislation in the following document: SNH: Otters and Development - www.snh.org.uk/publication/on-line/wildlife/otters/mitigation.asp

3.3 Bird Protection Plan

3.3.1 Summary of the Wildlife & Countryside Act 1981

3.3.1.1 The Wildlife and Countryside Act 1981 is the primary legislation which protects animals, plants, and certain habitats in the UK. The legal protection afforded to wild birds in Scotland, England and Wales in Part 1 of the Act is summarised below. For detailed information, it is advisable to consult the Act itself, which is available from HMSO. Note that following devolution there are some significant differences in the law between the constituent countries of the UK.

3.3.1.2 Definition of a wild bird

3.3.1.3 Under the Wildlife and Countryside Act, a wild bird is defined as any bird of a species that is resident in or is a visitor to the European Territory of any member state in a wild state. Game birds however are not included in this definition (except for limited parts of the Act). They are covered by the Game Acts, which fully protect them during the close season.

3.3.1.4 Basic protection

3.3.1.5 All birds, their nests and eggs are protected by law and it is thus an offence, with certain exceptions (see below), to:

- intentionally kill, injure or take any wild bird;
- intentionally take, damage or destroy the nest of any wild bird whilst it is in use or being built;
- intentionally take or destroy the egg of any wild bird;
- have in one's possession or control any wild bird, dead or alive, or any part of a wild bird, which has been taken in contravention of the Act or the Protection of Birds Act 1954;
- have in one's possession or control any egg or part of an egg which has been taken in contravention of the Act or the Protection of Birds Act 1954;
- use traps or similar items to kill, injure or take wild birds;
- have in one's possession or control any bird of a species occurring on Schedule 4 of the Act unless registered, and in most cases ringed, in accordance with the Secretary of State's regulations; and
- intentionally or recklessly disturb any wild bird listed on Schedule 1 while it is nest building, or at a nest containing eggs or young, or disturb the dependent young of such a bird.

3.3.1.6 Penalties

3.3.1.7 The maximum penalty that can be imposed for an offence under the Wildlife and Countryside Act - in respect of a single bird, nest or egg - is a fine of up to £5,000, and/or six months' imprisonment.

3.3.2 General

3.3.2.1 The bird protection measures contained herein will be agreed with Scottish Natural Heritage prior to commencement of works.

3.3.2.2 All bird species (apart from a few “pest” species) are protected by law, under the Wildlife and Countryside Act 1981 (Appendix 1), so that it is an offence to kill them or damage their nests and eggs. Species listed in Schedule 1 of the Act are specially protected, so that is an offence merely to disturb them while nesting. Other specially protected species are listed on Annex 1 of the EU Birds Directive, which also prohibits willful disturbance at the nest. However, if disturbance to the nest of any other bird species without special protection were sufficient to prevent parent birds from incubating their eggs or feeding their nestlings, so that the brood died, this could be regarded as an offence under the 1981 Act. The aim of these guidelines is to avoid this situation.

3.3.2.3 A General Licence will be required to deal with ‘Pest’ species and consultation with SNH is recommended. Strict terms and conditions may apply. The licence also details which species are considered to be ‘pest’ species.

3.3.2.4 The aim of the bird protection scheme will be to prevent disturbance to breeding birds during the construction period, which includes tree felling. Priority will be given to Annex 1 and Schedule 1 birds and other species of conservation concern, although the nests of common widespread species will also be protected. For most bird species (i.e. excluding specially-protected Annex 1/Schedule 1 species) the principal approach will be deterrence of settlement close to construction sites, so that birds are encouraged to nest away from areas where they would be disturbed. In addition, however, explicit guidance on the actions to be taken if a nest should be found close to a construction site will be issued to all personnel.

3.3.2.5 Site inductions and toolbox talks will highlight working procedures near bird nesting areas as well as all other ecologically based site procedures and requirements. The guidance issued to all personnel on site will include information on:

i) the law regarding wild birds
ii) bird species likely to be encountered
iii) bird behaviour that may indicate the presence of a nest
iv) procedure to follow if a nest or suspected nest site is discovered*
v) marking protocol for nest sites
vi) any other aspects of general good practice

*This will include the immediate cessation of all construction activity and withdrawal of personnel from areas within 50m of the nest (up to 750m for some Schedule 1/Annex 1 species). This exclusion zone will remain in place until the Ecological Clerk of Works has assessed the situation and, in consultation with the Ornithological Consultant, and SNH if necessary, decided on appropriate protection measures to be put in place (see deterrence/mitigation below).

3.3.2.6 Breeding birds of conservation concern will be protected by appropriate mitigation measures, which could include restriction of construction activity to times when the birds were unlikely to be present; screening of construction activity by green netting; or if necessary, the delay of construction at a particular site until it is confirmed by the Ecological Clerk of Works, in consultation with the Ornithological Consultant, that the young have fledged and left the area or that the breeding attempt has failed.

3.3.2.7 Proposed mitigation measures will be discussed with SNH, the Ornithological Consultant and the appropriate representatives of the construction company, and will be initiated immediately birds of conservation concern are detected attempting to settle to breed near construction sites. As with the deterrence measures, the site will then be monitored daily, to ensure that the mitigation has been effective. Specific measures for golden plover and merlin are given below.

3.3.2.8 The protection of common, widespread species will concentrate on the prevention of disturbance to their nests. Consultation with SNH and RSPB at other wind farm sites suggested that deterrence was an acceptable means to avoid disturbance to nesting, provided that it was carried out very early in the breeding cycle, before nests were established and provided that the birds were merely moved the minimum distance away from the potential source of disturbance and not displaced entirely from the site. It was suggested that in the event that deterrence was not feasible or was unsuccessful, mitigation measures would be implemented. This method has also now been approved by SNH for the Griffin wind farm site.

3.3.3 Deterrence methods

3.3.3.1 Where deterrence is considered to be a viable option at a particular construction site, measures will be put in place as required, to deter target species from settling so close to the site that they would be disturbed by activities there (generally, within 300m). The most cost-effective technique to move birds further away from sites would be the installation of iridescent reflective tapes, a method which has been applied successfully elsewhere. Tape will be stretched between posts, across the area of the relevant construction site. This area will then be monitored daily, to ensure that deterrence has been effective. If birds continue to visit the exclusion zone, additional tape or more conspicuous items such as revolving reflective discs will be installed.

3.3.3.2 If deterrence is not considered to be a viable option, for example due to strong winds regularly destroying tape , mitigation as outlined below will be implemented.

3.3.4 Nest protection procedures

3.3.4.1 Breeding bird surveys will be carried out in advance of all construction activities. Time scales between surveys and works will depend upon initial results and work progress but will generally range between daily and weekly. Nesting evidence will include the following:

- territory singing / flight display,
- alarm calling,

- birds seen carrying food and/or nesting materials,
- calling young,
- birds seen carrying faecal sacs or egg shells,
- visual checks for nest

3.3.4.2 Following pre-works surveys, any nests found will be assessed on a species specific level to determine the most appropriate action to be taken regarding protection zone distances and timescales. As a minimum, protection measures will include:

- A buffer zone around nest sites being demarcated with marker canes and bunting tape. The tape will not be placed in a manner as to cause disturbance in itself.

- Buffer zones will allow for safe areas for fledglings until they are fully mobile.

- Works within the buffer zone will be resumed only after consultation with the ECoW and/or SNH.

- Working procedures in the immediate area outside the buffer zone may entail contractors remaining in their vehicles within a specified distance as agreed with the ECoW.

- If an active nest is suspected by machine operators / site staff, work should cease in the immediate area within 50m of the suspected nest site (up to 750m for some Schedule 1 / Annexe 1 species) and the ECoW contacted immediately for assessment. Works will then proceed only after consultation with the ECoW and/or SNH.

3.3.5 Protection measures for golden plover and merlin

3.3.5.1 As these specially-protected species have previously been recorded breeding within or close to the development site, the following guidelines are to be followed to ensure no accidental disturbance to active nest sites. It should be noted that breeding bird surveys will be carried out as a matter of course in relation to all proposed and current works.

- Should a merlin nest be confirmed, an initial buffer zone of at least 500m should be set up between the nest site and works. This may be reduced depending upon topography and nesting stage in conjunction with the behavioural response of the birds. No persons should be permitted within this buffer zone without supervision from the ECoW. It should be noted that the behavioural response of the birds will strongly dictate the effective distance to which works and working methods can proceed.

- If nesting activity is suspected by machine operators / site staff, work should cease in the immediate area to within 500m and the ECoW contacted immediately for assessment. Works will then proceed only after consultation with the ECoW and/or the ornithological consultant and SNH.

3.3.6 Bird monitoring

3.3.6.1 Bird monitoring protocols and methodologies will be developed and agreed with SNH following wind farm consent.

3.3.7 References

Pearce-Higgins, J.W., Stephen, L., Langston, R.H.W., Bainbridge, I.P. and Bullman, R. 2009. The distribution of breeding birds around upland wind farms J. appl. Ecol. 46: 1323 – 1331.

Ruddock, M. and Whitfield, D.P. 2007. A review of disturbance distances in selected bird species. Report by Natural Research (Projects) Ltd, for SNH

4 HABITAT PROTECTION PLAN

4.1 Habitat Protection Plans

4.1.1 Two habitat protection plans are proposed:

1. Terrestrial Habitats Protection Plan (section 4.2);
2. Aquatic Habitats Protection Plan (section 4.3).

4.2 Terrestrial Habitats Protection Plan

4.2.1 The following important habitats have been identified within the development area:

- Sphagnum blanket bog
- Lochans
- Rivers and streams
- Wet grassland communities

4.2.2 Protection of these habitats (through avoidance and minimisation of damage and loss) is necessary for the following reasons:

- Blanket bog (mire) is the dominant vegetation type over the whole survey area. It occurs on peat over 50cm in depth and usually at least 2m deep. The vegetation is characterised by a range of species. Active blanket bog (i.e. bog supporting a significant area of peat-forming vegetation) is listed as a Priority habitat on Annex 1 of the EC Habitats Directive and therefore the habitat is of international importance. Blanket bog is also a Priority habitat in the UK BAP and the component communities are Priority habitats on the Scottish Biodiversity List. Some of the Sphagnum rich vegetation communities found on peat within the Viking study area fall within these definitions, but many areas are severely degraded and do not qualify as 'active blanket bog' under standard definitions.
- All of the above habitats are located on peat soils which are a vital store of organic carbon. Deep peat stores carbon accumulated following plant photosynthesis over thousands of years. Organic soils in Scotland were estimated in 2007 to hold 2735 Mt C, 1778 Mt C in deep peat (dominated by blanket bog) and 957 Mt C in shallower organo-mineral soils which include wet heath conditions. Exposure of peat leads to drying and ultimately to oxidation of the peat as carbon dioxide and water, increasing carbon emissions to the atmosphere. Damage to peatlands can also lead to release of dissolved organic carbon in drainage waters, as well as erosion as particulate organic carbon. Both of these sources can then lead to emission of carbon dioxide to atmosphere at a later stage within ecosystems downstream of the original carbon store. The Viking development is being undertaken to reduce UK fossil fuel emissions, particularly carbon dioxide. It would be counterproductive to undertake such development without ensuring that important natural stores of carbon on site are left as intact and little affected as possible.

- The above habitats and soils are fragile and easily damaged. All site working practices need to consider their possible effects on these habitats and soils and mitigate significant negative effects as far as is reasonably possible.
- The surface waters represent a habitat set which provides the refuges and resting areas for Otter, birds and fish population.

4.2.3 The following protection measures are proposed under the Terrestrial Habitats Protection Plan:

- Inclusion of habitat sensitivity material in site induction procedures and the procedures to be implemented to minimise impacts outside the development footprint.
- Micrositing of development infrastructure to reduce the volume of excavated peat, to be done by the ECoW in consultation with the Geotechnical Clerk of Works and Archaeological Clerk of Works, as necessary;
- Making best use of excavated live turf and deeper peat as part of reinstatement procedures (see TS7 Site Excavated Materials and Reinstatement Plan);
- ECoW authorisation of work off hard ground using low ground pressure machines, to minimise damage to e.g. blanket bog (see TS7 Site Excavated Materials and Reinstatement Plan);
- Ongoing ECoW comparison of pre-construction and post-construction checks of development ground to ensure that the areas of habitat loss and damage are as expected;
- Strict ECoW control of discharges of water on to blanket bog surfaces. Blanket bog habitat gains most of its nutrition from rainfall and it is adapted to low nutrient inputs via rain and snow. Discharge of silty water could partly bury vegetation and greatly increase nutrients, creating negative effects on blanket bog. Discharge on to other habitats, as a mitigation measure for pollution prevention and drainage management, will be preferred (see TS2 Pollution Prevention Plan and TS4 Drainage Management Plan);
- ECoW control over the use of a 50 metre unmarked buffer around watercourses with detailed consideration of mitigation measures for all site working practices to minimise effects on habitats within that buffer zone.

4.3 Aquatic Habitats Protection Plan

4.3.1 Aims

4.3.1.1 There are two aims to this protection plan:

- Maintenance of a high water quality to support aquatic habitats possibly used by Otter populations during and after windfarm construction;
- Maintenance of a high water quality sufficient to support existing aquatic life and aquatic ecosystems.

4.3.2 The importance of maintained high water quality

4.3.2.1 These two aims of this plan are complementary and the required water quality needs to be considered in the context of ecological receptors.

4.3.2.2 During the preparation of environmental statements, consultees (Shetland Anglers Association, SAA) identified several lochs in the proposed development site that are regularly fished, of which some are owned and some are leased by SAA. In addition, a number of burns are used by SAA members. Several important trout and sea trout spawning burns are located in the area. Atlantic salmon was recorded in two watercourses (although these may be associated with fish farms).

4.3.2.3 The most sensitive ecological receptors in likely affected watercourses are spawning grounds for Salmon and Sea/Brown Trout (salmonids). These are termed redds and are local areas of gravel used for salmonid egg laying in early winter. If silt is deposited over the gravels, oxygen diffusion to eggs is reduced or eliminated and developing eggs die. Silt-laden runoff during construction could therefore have negative effects on recruitment into local salmonid populations.

4.3.2.4 Increased acidity can also kill salmonid eggs but is unlikely to occur as an effect of windfarm construction. Instead, it can arise in winter after a period of atmospheric acid deposition upon snow lying for a considerable time, with the increased acidity of stream waters occurring during snow melt. These events are generally rare in Scotland but need to be considered as part of monitoring during construction.

4.3.2.5 Water quality protection measures, including mitigation for silt-laden waters, are included in TS2 Pollution Prevention Plan, TS4 Drainage Management Plan, TS5 Watercourse Crossing Plan and TS7 Excavated Materials and Reinstatement Plan, TS9 Environmental Incident and Emergency Response Plan.

4.3.2.6 Water quality monitoring is proposed, to be undertaken by an independent consultant. The ECoW will be responsible for reporting the results of independent monitoring during the construction period. Further details are provided within TS6, Water Quality Monitoring Plan.

4.3.3 The Aquatic Habitats Protection Plan is divided into four sections, covering both pro-active and reactive measures as follows:

- General protection measures;
- Design of safe watercourse crossings;

- Personnel induction; and
- Pre-construction checks and monitoring.

4.3.4 General Protection Measures:

- The TS2 Pollution Prevention Plan, TS4 Drainage Management Plan, TS5 Watercourse Monitoring Plan and Excavated Materials and Reinstatement Plan, TS9 Environmental Incident and Emergency Response Plan will together prevent contamination of watercourses and will protect Otter, other species, aquatic habitats and habitats close to watercourses. There will be daily visual inspections of watercourses for pollution, and independent monitoring of water quality at agreed locations (TS6 Water Quality Monitoring Plan) when operations are carried out within an area;
- A minimum 10m buffer (and probably up to 50m) will be maintained between working areas, machinery and watercourses in all areas except at watercourse crossing points;
- Pollution prevention measures will be installed and maintained as appropriate, including silt interception traps, settling lagoons or mobile silt-trapping units (such as Siltbusters or equivalent device), as well as installation of splash boards at watercourse crossing points to prevent contamination from track run-off;
- Chemicals, oils and hazardous materials will be stored securely away from the watercourses;
- Spillage contingency kits will be provided in all site vehicles and there will be daily checks for oil and fuel leaks.
- Felling and construction personnel shall be provided with an emergency telephone number for the ECoW.

4.3.5 Design of Watercourse Crossings

4.3.5.1 All watercourse crossings will be designed to cope with extreme rainfall events. This will minimise the risk of bank erosion and flooding, with possible consequent loss of habitat.

4.3.5.2 Any drainage diversion required in forming a watercourse crossing will be purely temporary and will last only a few hours. Such diversions will only affect minor tributaries and will not occur on the main watercourses.

4.3.5.3 Watercourse crossings using culverts will sever aquatic habitats. This effect will be minimised by ensuring that culvert floor levels are below the watercourse floor, with mineral material inserted to create a mineral floor.

4.3.6 Personnel Induction

4.3.6.1 All relevant site personnel will be given an induction by the Ecological Clerk of Works (ECoW). The induction will be in a format of a toolbox talk with the aim of:

- Making personnel aware of legal obligations placed on them in relation to the Controlled Activities Regulations 2005, together with protected species using watercourses (e.g. Otter) and the responsibilities of personnel for ensuring they do not breach that legislation;

- Discussing the quality of pre-construction aquatic habitats within the site and downstream, together with its importance for fishing;
- Making personnel aware of the requirement for pre-construction checks by the ECoW at proposed new and upgraded watercourse crossings;
- Outline the key mitigation methods in place for maintaining the water quality of aquatic habitats.
- Ensuring that personnel are aware of the emergency response procedures to be followed in the event of a pollution incident.

4.3.7 Pre-Construction Survey, Checks, Monitoring and Incidents

4.3.7.1 Qualitative and semi-quantitative inspections of aquatic habitats will be included as part of pre-construction surveys. These will include hydrochemical as well as ecological (benthic diatoms invertebrate and fish population surveys) baseline surveys. The scope of such surveys will be agreed within the detailed Water Quality Monitoring Plan (refer to TS6) prior to commencement of construction. A photographic record will also be made of sample locations and locations will be recorded using GPS.

4.3.7.2 Quantitative measurements of water quality will be undertaken at a series of fixed locations pre-, during and post-construction as described in TS6 Water Environment Monitoring Plan.

4.3.7.3 The ECoW will carry out further checks of aquatic habitats at the baseline sample locations at set intervals during the construction period, or following the triggering of an incident response. Each set of checks will use the same sampling methods, supplemented by visual and olfactory sampling for oil and fuel traces after construction begins.

4.3.7.4 Results from regular specified physical sampling will be used to assess any evidence of siltation, bank erosion and flooding. Additional sampling locations will be added at proposed water crossing locations, before and after construction, to assess the effects of construction on aquatic conditions.

4.3.7.5 Results from sampling after a pollution incident response will be used to seek and stop the cause of the incident. Further sampling will be undertaken after implementing pollution control measures to be sure that measures have been effective.

4.3.7.6 The ECoW will be responsible for maintaining a mapped record of checked areas and the results of all sampling. Results will be included in ECoW reports covering water quality.

SITE ENVIRONMENTAL MANAGEMENT PLAN
VIKING WIND FARM

TECHNICAL SCHEDULE 9

ENVIRONMENTAL (INCIDENT AND EMERGENCY) RESPONSE PLAN

SEMP Version:	**1.0**	
Rev No. :	**Revision Description**	**Date :**
0.0	Addendum ES, Appendix A14.6	Sept 2010

	Name :	Position :	Signature :
Prepared by :	Jane MacDonald	Environmental Manager	
Checked by :	Andrew Sloan	SSE Renewables / Viking Energy PM	
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Comment :

Document was also reviewed by all consultants involved in preparation of the Addendum ES.

CONTENTS

1 INTRODUCTION

1.1 Scope and Objectives

1.1.1 The information contained herein forms Technical Schedule 9 (TS9), Environmental (Incident and Emergency) Response Plan, of the Viking Wind Farm Site Environmental Management Plan (SEMP). The SEMP, including the information and measures contained within this Technical Schedule, form part of the Contract and will be made available to those tendering for construction works.

1.1.2 The Contractor is required to prepare a detailed Environmental (Incident and Emergency) Response Plan in line with the requirements of the SEMP and in particular the information contained within this Technical Schedule. Within this plan, the Contractor's will provide emergency response contacts, reporting procedures, and procedures for dealing with all potential pollution incidents during the construction of the wind farm. A pollution incident is any discharge to land, air or water that could cause environmental damage. Examples of pollution incidents include:

- fuel drips or spills during refuelling;
- leaking plant or equipment;
- leaks from fuel or chemical containers;
- contaminated water or sediment / silt entering a watercourse or drain;
- wind blown dust and waste;
- operational failures of pumps and pipelines; and
- failures of treatment plant.

1.2 Reference Documentation

1.2.1 The Contractor's detailed Environmental Response Plan will take into account the requirements of current legislation as well as published guidance documents such as:

- **SEPA PPG21, Pollution Incident Response Planning.**

1.2.2 In developing the detailed plan, reference will be made to Technical Schedules TS2 (Pollution Prevention Plan), TS3 (Site Waste Management Plan) and TS4 (Drainage Management Plan).

2 GENERAL REQUIREMENTS

2.1.1 Environmental incidents may include: spillages (oils and chemicals); contaminated run-off; flooding; riverbed disturbance; damage to underground services; damage to habitats; poor waste disposal and storage.

2.1.2 The Environmental Response Plan will:

- Provide an outline of the construction works and appropriate references to other developed environmental plans (Pollution Prevention Plan, Drainage Management Plan and Site Waste Management Plan) and construction method statements.
- Summary of local environmental sensitivities, e.g. private water supplies or other abstractions, protected species or habitats and high amenity areas;
- Identify key staff and contact details for environmental management and emergency response, including contact details for staff trained in the use of spill kits, booms etc.
- Provide contact telephone numbers for the emergency services and SEPA Pollution Hotline (0800 80 70 60).
- Inventory of stored materials and emergency response spill kits (e.g. oil absorbent materials, silt fencing, sand bags etc);
- Provide detailed procedures to be taken in the event of an incident or emergency (including procedures for positioning and movement of plant) and identify relevant personnel who will be responsible for implementing such procedures.
- Provide details and evidence of training of site staff/plant operators in emergency response procedures, including the correct use of spill kits and booms etc.
- Procedures contained within the plan should consider preventative measures, containment, clean up, waste disposal of recovered spilled materials or contaminated soils and clean up kits, and reporting requirements.
- Provide details on training requirements, including inclusion of Environmental Incident and Response training in site inductions and tool box talks.
- Provide a 1-2 page Summary Sheet as outlined in Section 4 containing the key information for incidents response. This sheet, once finalised as part of the detailed SEMP, will be provided as a laminate copy to all plant operators (i.e. one copy to be located in all machinery and on-site vehicles) and displayed at prominent locations (to be agreed with EcoW and the Employer).

2.1.3 The *Contractor* will provide a site layout plan that shows:

- all areas that potential pollution sources including the locations of car parks, delivery and fuel / chemical storage areas, oil separator equipment, excavations, and any other high risk areas (oil/chemical storage areas, refuelling areas, concrete batching and wash out areas etc) that could give rise to pollution;

- The location of potential sensitive environmental receptors, including locations of private water supply, sensitive habitats or species, surface watercourses, drains or culverts where pollution may travel to; and

- The location of spill kits and other pollution control or emergency response equipment; and

- Those areas on site which have limited or no mobile phone reception (or reception for certain providers only).

2.1.4 To ensure than the incident response plan works, and that all involved know their role in it, the procedures for responding to a major pollution incident will be a regular topic at tool box talks and management meetings on site. Any lessons learnt from any response to real incidents will be fed back into the plan to ensure that best practice is followed.

3 ENVIRONMENTAL INCIDENT AND HAZARD REPORTING

3.1.1 A system for reporting environmental incidents or potential hazards will be developed for the site. All reported incidents or hazards will be logged in a database to allow review, auditing and lessons learned.

3.1.2 A blank Environmental Audit Form is appended to this document. Non-compliance with this SEMP may result in a potentially damaging environmental incident. Non-compliances and corrective actions will be logged as part of the reporting system referred to above.

4 SUMMARY SHEET FOR MACHINERY / PLANT OPERATORS

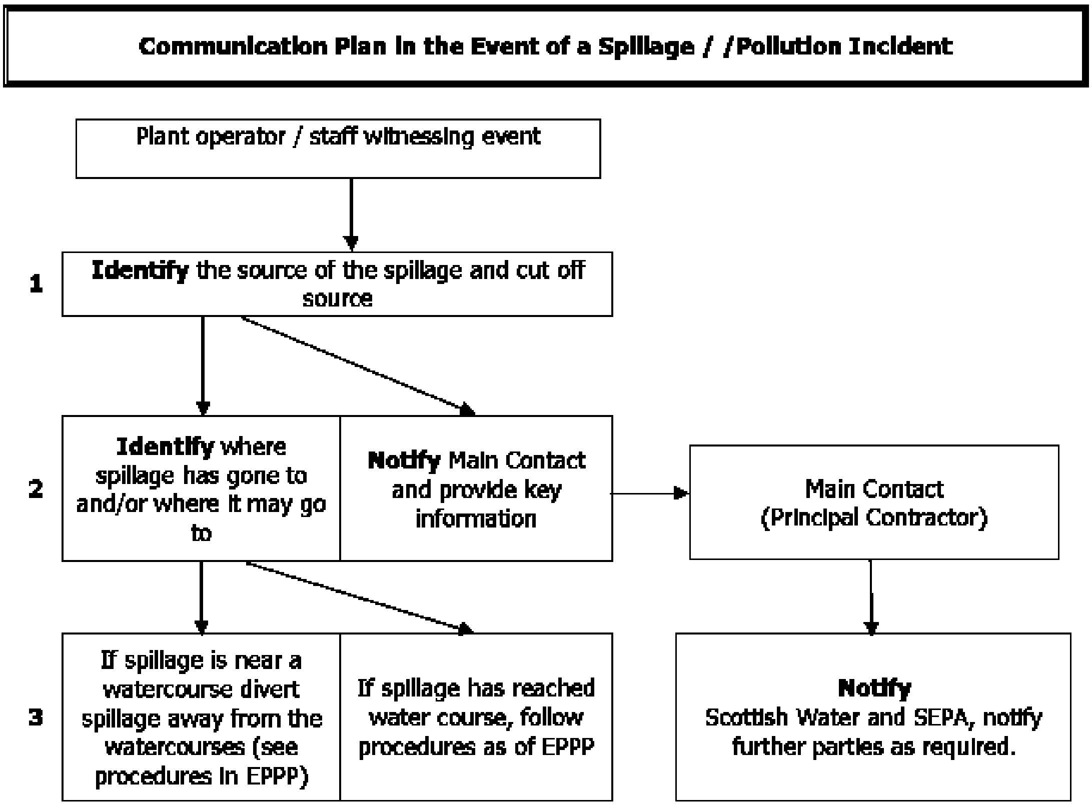
4.1.1 As outlined in Section 2 above, the *Contractor* will provide a 1-2 page Summary Sheet containing the key information for incidents response to be used as a quick reference for any on-site personnel witnessing an incident. A laminate copy of this Summary Sheet will be located with all plant / machinery / on-site vehicles. Suggested content of this sheet is provided as follows:

PROCEDURES TO BE FOLLOWED IN THE EVENT OF A SPILLAGE/ INCIDENT:

The following procedures are intended as a guide to dealing with incidents. Staff shall act in accordance with these procedures whilst applying common sense and ensuring their own health & safety and those of others.

1. If possible, identify the source of the spillage and cut off source, e.g. by closing valve, righting container etc;
2. Identify where spillage has gone to and/or where it may go to. If spillage is near a watercourse (drainage ditch, burn, river) divert spillage away from the watercourses by digging interception trenches or by using absorbent material (spill kit);
3. Notify all parties in an appropriate order as stated below. Notification should be made by one person only whilst the remainder of staff present attend to the spill itself;
4. If a spill has reached a watercourse the following measures should be applied-
   - Place flexible absorbent booms ahead of the contamination within a quiet stretch of water;
   - Place absorbent cushions in the water immediately upstream of these booms; and
   - Repeat this process further downstream and remove and replace saturated absorbent material as required.
5. Dig up all contaminated ground as soon as possible / immediately. All contaminated materials should be placed in sealed polythene bags/containers and disposed of appropriately by the Principal Contractor; and
6. Complete required record of incident and response into reporting system / database.

4.1.2 A Communication Plan (to be followed in the event of a spillage) will be provided by the *Contactor*, in liaison with relevant stakeholders and will be included in the updated TS9 prior to commencement of site development works. An outline Communication Plan is proposed below:



The final plan should also provide relevant key telephone/mobile numbers.

Key Information to be provided in a clear and concise manner:

- What substance was spilled;
- Approximate volume and time of spillage;
- Accurate Location of spill (GPS or grid reference if possible, or bridge ID/number referenced on map etc);
- All measures taken;
- Help required i.e. manpower, machinery, expert advice, disposal, etc; and,
- Whether the spill has reached a watercourse.

SITE ENVIRONMENTAL AUDIT REPORT
VIKING WIND FARM

viking energy
Harnessing Shetland's natural resources

Site:		**Date:**	
Time:		**Weather conditions:**	

Report by:		**Position:**	
Viking Energy Partnership personnel present:		**Position:**	
Contractor personnel present:		**Position:**	

Item	Questions	Yes	No	Corrective Action Required	
				Action	**By**
1. Miscellaneous					
1.01	Does the contractor carry out regular internal environmental audits on the site? Are recommendations recorded and is corrective action monitored?				
1.02	Have any environmental incidents occurred and have these been reported as per on site procedure?				
1.03	Does the site induction contain a section on environmental requirements, including spill procedures, and is this communicated effectively?				
2. Land					
2.01	Are areas of hard standing (excluding bunded and refuelling areas) appropriately drained?				
2.02	Have local roads been inspected and cleaned where necessary?				
2.03	Has all test pitting and soil stripping been monitored by an archaeologist?				
2.04	Have all site clearance works been checked by an ecologist prior to works?				

SITE ENVIRONMENTAL AUDIT REPORT
VIKING WIND FARM

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
3. Materials and equipment					
3.01	Is there knowledge of the Water Environment (Oil Storage) Regulations 2006(Scotland)?				
3.02	Are transformers/generators located in secondary containment bunds?				
3.03	Are all bunds capable of containing 110% of the volume of the largest container?				
3.04	Is refuelling carried out in a designated refuelling bay?				
3.05	Does all site drainage on hard standing drain to an oil interceptor?				
3.06	Is the designated area for oil, fuel and chemical storage appropriately sited (i.e. on hard standing at least 10m from a watercourse)?				
3.07	Are there procedures in place to monitor bund integrity and manage bund rainwater levels? Are these followed and recorded?				
3.08	Is there awareness that oil or residue from contaminated water removed from bunds should be disposed of as special waste and not discharged to land or the water environment? (oil absorbent materials (pads etc) should be used first)				
3.09	Are all drums and mobile plant (e.g. generators) placed on drip trays more than 10m from any watercourse?				
3.10	Is all plant maintained in a good state of repair and checked for evidence of leaks? Are there records of this?				
3.11	Are there adequate spill kits available and stored in close proximity to potential risks?				
3.12	Are all refuelling bowsers double skinned, locked when not in use, and in				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
	a good state of repair?				
3.13	Is there evidence of unmanaged / unrecorded fuel / oil spillages on site?				
3.14	Are dry or wet wheel washing facilities fully operational and effective?				
3.15	If wet wheel washing facilities are required, are these closed systems with no discharge to the water environment?				
3.16	Are there laboratory certificates (accredited by the UK Accreditation Service (UKAS)) to confirm that imported material stone aggregate brought onto site is free from any contamination?				
4. Noise, Dust and Light					
4.01	Are there facilities to dampen stockpiles and site working areas/roads to suppress dust?				
4.02	Are vehicles carrying loose material sheeted at all times?				
4.03	Are construction works, or deliveries of materials to and from the development, audible at noise sensitive premises? To avoid noise nuisance, do deliveries take place within the hours of 07.30-19.00 Monday to Friday and 07.30-13.00 on Saturdays?				
4.04	Has all external construction lighting received the approval of the planning authority?				
5. Waste					
5.01	Is the site tidy and free from litter?				
5.02	Is there evidence of waste beyond the site boundary?				
5.03	Is waste segregated and kept securely in containers in clearly designated areas?				
5.06	Does all waste leaving the site have the appropriate duty of care paperwork?				

SITE ENVIRONMENTAL AUDIT REPORT

VIKING WIND FARM

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
5.07	Is all waste leaving the site being taken to an appropriately licensed site?				
5.08	Does all special/hazardous waste (e.g. oil contaminated soils, waste oil) have the appropriate Special Waste Consignment Note?				
5.09	Is material re-used/recycled on site where possible?				
5.10	Are waste management practices in line with the site waste management plan?				
5.11	Are relevant Waste Management Exemptions in place for use of waste on site (e.g. use of waste concrete to create foundation sub-base)?				
5.12	Is there any evidence of burning on site?				
5.13	Is there any evidence of unlicensed burial of waste?				
6. Water					
6.01	Do all discharges to land or watercourses have appropriate authorisation from SEPA?				
6.02	Does all watercourse engineering (bank protection, crossings etc.) have the appropriate authorisation from SEPA?				
6.03	Do any abstractions from a watercourse or groundwater body have the appropriate authorisation from SEPA?				
6.04	Has confirmation for the SUDS design for access roads been gained from SEPA?				
6.05	Are cut-off ditches installed on the uphill side of the working area to avoid contaminating surface water run-off?				
6.06	Have field drains been diverted where necessary?				
6.07	Is adequate treatment (e.g. settlement tanks/lagoons/ discharge to land) provided to prevent silt contaminated water entering watercourses and				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
	groundwater?				
6.08	Has vegetation removal/ clearance of the site been minimised to avoid unnecessary areas of bare ground?				
6.09	Have buffer-strips been left between working areas and watercourses?				
6.10	Is plant operating in the watercourse?				
6.11	Have all culverts been approved in writing by the planning authority / local council in conjunction with SEPA and SNH?				
6.12	Have silt fences been installed at the base of stockpiles situated within close proximity to watercourses?				
6.13	Are there adequate controls on site construction roads to minimise sediment runoff into watercourses (in particular, are there adequate flow attenuation measures within surface drains)?				
6.14	Are there any signs of decaying straw bales in water courses? (this could lead to organic pollution of the water course)				
6.15	Are silt traps regularly maintained?				
6.16	Has ease of maintenance been considered in the design of permanent drainage features?				
6.17	Is there evidence of contamination of any watercourse (e.g. with oil, sediment, concrete, waste) in the vicinity of the works?				
6.18	Is monitoring of potential impacts on watercourses carried out on a regular basis and fully recorded?				
6.19	Are dewatering operations being carried out in such a way to minimise sediment contamination?				
6.20	Is drainage and run off in concrete batching areas adequate?				
6.21	Are adequate pollution prevention				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
	measures considered and put in place during concrete pours?				
7. Landscape					
7.01	Have earthworks been designed to promote successful re-instatement of vegetation?				
7.02	Are reinstatement and restoration works being implemented in a timely manner as per the requirements of the Contract?				
8. Ecology					
8.01	Have storage sites (soil, plant etc.) been sited on areas of lower quality habitat where possible?				
8.02	Is the ECoW a member of the Institute of Ecology and/or Environmental management as required by planning conditions?				
8.03	Has the ECoW inspected areas of forest prior to felling?				
8.04	Have buffer zones been constructed and maintained around designated protected species exclusion areas (e.g. red squirrel dreys, water vole habitats, otter holts etc)?				
8.05	Have bat emergence/ dawn surveys been carried out prior to tree felling to ensure bats are not present in forested areas?				
8.06	Have toolbox talks on the subject of ecology and environmental responsibilities on site been delivered? Have attendance records been maintained for these?				
9. Documentation Check					
9.01	Start up meeting record				
9.02	Full contacts list in Section 3, Table 3.0 of SEMP				
9.03	Induction records				

Item	Questions	Yes	No	Corrective Action Required	
				Action	By
9.04	Pollution Prevention Measures Register				
9.05	Geotechnical Risk Register				
9.06	Weekly meeting minutes				
9.07	Records of environmental checks and routine monitoring of mitigation measures				
9.08	Monthly ECoW reports				
9.09	Final report				
9.10	Water Quality Monitoring Results				
9.11	Safety and Environmental Awareness Reports (SEARs). Filed and entered on database?				
9.12	Previous Environmental Audit Reports for the site. (If yes, insert date of last audit_____________)				
9.13	Contractor's Environmental Plans (Technical Schedules or Construction Method Statements): • TS1-Site Induction Schedule • TS2-Pollution Prevention Plan • TS3-Site Waste Management Plan • TS4-Drainage Management Plan • TS5-Water Course Crossing Plan • TS6-Water Quality Monitoring Plan • TS7-Excavated Material and Reinstatement Plan • TS8-Ecological (Species and Habitat) Protection Plan • TS9-Environmental Incident and Emergency Response Plan				

APPENDIX 2.3: PEAT STABILITY ASSESSMENT

Information contained within the 2009 Peat Stability Assessment was seen as relevant to support the 2018 EIA, thus has been included.

Viking Energy Partnership

Viking Wind Farm

Technical Appendix 14.1
Peat Stability Assessment

March 2009

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CONTENTS

PLEASE NOTE: Section 8 DETAILED ASSESSMENT of this report is contained with the A3 figures and technical drawings in Volume 4b as Figure 14.1.PS.

APPENDICES

See Environmental Statement Volume 3 and Volume 4b for all A3 Figures

This report is presented to Viking Energy Partnership in respect of Viking Wind Farm and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this report.

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1 INTRODUCTION

This report forms a Technical Appendix to Chapter 14 (Soil and Water) of the Environmental Statement for Viking Wind Farm (Mouchel, 2009) and should be read with reference to this chapter.

Viking Energy Partnership is currently progressing proposals for a wind farm on North Mainland in the Shetland Islands. The proposed wind farm site is located in an area of extensive and highly variable peat cover and it was considered important that the risk of peat instability as a consequence of the wind farm construction is assessed.

Mouchel was commissioned in 2006 to undertake the peat stability assessment for the Viking Wind Farm site, in conjunction with the soil and water element of the Environmental Impact Assessment.

This document presents Mouchel's methodology for peat stability risk assessment, the analysis performed and results obtained.

1.1 Aims

The aims of this Peat Stability Assessment are to:

- Undertake a review of available relevant site information;
- Undertake site survey work to characterise the prevailing ground conditions and identify existing or potential peat instability;
- Detail the findings of the above, reporting on any existing or potential instability, the likely causes and contributory factors;
- Assess the risk of instability, including estimating impacts of potential peatslides;
- Provide recommendations on further work, mitigation measures and specific construction methodologies that should be implemented pre-construction to minimise the risk of peat instability at the development site.

1.2 Methodology

The methodology adopted by Mouchel for the peat stability assessment of the Viking Wind Farm site has involved the following stages:

- Desk study;
- Site reconnaissance;
- Peat depth survey;
- Preliminary stability analysis;
- Preliminary hazard ranking;
- Ground investigation;
- Detailed assessment;
- Mitigation.

Further detail on each of these stages is provided in the following sections.

A phased approach has been taken to the peat stability assessment, which has been undertaken concurrently with the layout design of the wind farm and the Environmental Impact Assessment. The process is necessarily iterative; in consequence, the peat depth survey and stability analysis work have been revisited and refined as the project has progressed.

The desk study, site reconnaissance and preliminary peat depth survey were carried out prior to the design of the wind farm layout. The resulting data were used to inform the layout design, providing guidance on areas of potentially deep or unstable peat that should be avoided wherever practical.

Following the design of the layout, further peat depth probing was carried out at the infrastructure locations. These data were used to carry out preliminary slope stability analysis and to identify areas at potentially higher risk of instability. Using all the collated data, a preliminary assessment of hazard ranking was made and areas of concern identified.

Owing to the large site area it was not possible to undertake ground investigation work at all areas identified as being of concern after the preliminary hazard ranking assessment. In place of this, representative areas from across the whole site were selected on the basis of their hazard rank. These cover areas with different levels of hazard rank, including some identified as having no significant risk of peat slide to act as control sites.

Further stability analysis was carried out using the ground investigation data and a semi-quantitative evaluation of peat landslide risk at each location was made, considering both hazard and exposure. Following the evaluation, recommendations on further work and mitigation measures were provided as necessary.

2 DESK STUDY

2.1 Information Sources

A desk study was undertaken, reviewing available information on the ground conditions at the Viking Wind Farm site. Information sources included:

- Ordnance Survey Landranger Map 3: Shetland North Mainland;
- Ordnance Survey 1:10,000 and 1:50,000 digital raster mapping;
- Ordnance Survey 1:10,000 digital elevation model (DEM) data;
- XYZ Mapping (May 2008) orthorectified aerial photography, 0.25m resolution;
- British Geological Survey DiGMap GB 1:50,000 digital geological mapping, bedrock and superficial;
- British Geological Survey Hydrogeological Map of Scotland;
- Groundwater Vulnerability Map of Scotland;
- Soil Survey of Scotland 1:250,000 Sheet 1 Orkney & Shetland;
- Flood Estimation Handbook CD-ROM (v2);
- LowFlows2000 software.

2.2 Context

The development site, known as Viking Wind Farm, is located on North Mainland in the Shetland Islands, approximately 27km north of the main town, Lerwick. The site is roughly centred on the settlement of Voe (grid reference HU 4077 6320). The area of interest is divided into four quadrants, with two quadrants to either side of the main A970/A968 route which runs north–south across the island. The quadrants are known as Delting, Collafirth, Kergord and Nesting.

All four quadrants of the proposed 150-turbine wind farm comprise areas of open peat moorland used mainly for rough grazing. Kergord and Nesting include large freshwater lochs whereas Delting and Collafirth have only very small amounts of standing freshwater. At the margins of the site, in particular near the settlements, there is some semi-improved grassland. Some areas have evidence of historic peat cutting, although this tends to be fairly limited. Many of the waterbodies have fisheries interests, especially for trout.

2.3 Historical Information

There is documented evidence of peat slides across the Shetland Islands for nearly a century (Halcrow, 2004). Three peat slide events in particular are reported: an event in 1935 in the Weisdale area, one in 1950 and the recent series of peat slides at Channerwick in 2003.

On 19 September 2003 a series of peat slides occurred at Channerwick on South Mainland, resulting in temporary closure of the main A970 between Levenwick and Cunningsburgh. The peat slides caused the mobilisation of large volumes of peat across a large area, with consequent direct and indirect impacts on the natural environment and local infrastructure.

Halcrow Group Ltd was appointed by the Shetland Islands Council to undertake an investigation of the area in order to determine failure mechanisms and causes of the event. The following information is summarised from the Halcrow report (Halcrow, 2004) with supporting information from the Shetland Times (2008).

The peat slides at Channerwick occurred during a period of very intense rainfall, although records of duration and intensity are not available for the event. The preceding winter and summer had been unusually dry, causing drying and cracking of the peat mass. The sudden, high intensity rainstorm is believed to have caused build-up of water pressure within the peat cracks, the underlying network of peat pipes and along the peat-bedrock interface. The site investigation indicated that slopes in the area are convex, leading from broad summits to steeper valley sides.

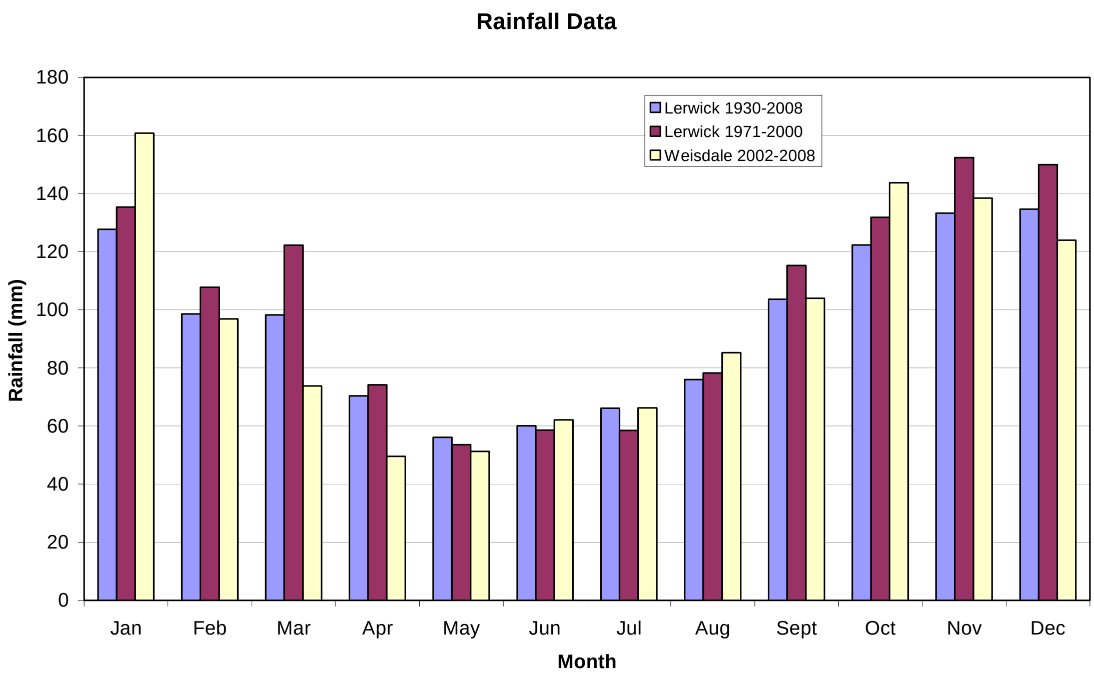
Halcrow conclude that slopes such as those found at Channerwick are likely to be stable under normal climatic conditions. It is suggested that the interface between the peat and the underlying weathered schist bedrock represents the weakest plane and that failure at this interface can be initiated through excessive build-up of water along the interface. Convexity of slope is considered to be an important control on peat failure.

2.4 Climate

The Shetland Islands have a temperate maritime climate, characterised by cool, short summers and mild, wet winters.

Two monitoring stations have rainfall data relevant to the Viking Wind Farm site. The closer of these, at Weisdale near the southern boundary of the site, began operation in 2002. Monthly average rainfall has been calculated from daily rainfall data collected between April 2002 and November 2008. The Lerwick rain gauge currently has monthly average rainfall data records from December 1930 through to December 2008. These data are represented graphically in Figure 1. The 30-year long-term average monthly rainfall for Lerwick has also been included as this is the standard reporting period for long-term rainfall data.

Figure 1 Average monthly rainfall data for Lerwick and Weisdale monitoring stations



Based on data collected from 1931 to the present day, the annual average rainfall for Lerwick is 1147mm. Average annual rainfall from the Weisdale monitoring station for the years with a complete dataset (2003-2007) is 1180mm. To put these data into a national context, rainfall in Scotland varies from over 3000mm per year in the Western Highlands to less than 800mm per year in eastern Scottish mainland areas.

For comparison, the average annual rainfall at Lerwick over the 1971-2000 reporting period is 1238mm, indicating a trend of increasing rainfall over recent decades. Changes in rainfall patterns between the different datasets suggest a slight decrease in rainfall in the summer months and an increase in the winter months, in addition to the increase in total annual rainfall.

2.5 Topography & Slope

The topography of the site is dominated by a series of steep-sided north–south trending ridges and valleys, becoming north-east trending in the northern part of the site. The ridges tend to have narrow, nearly flat summit areas defined by distinct breaks in slope. East and west from the central part of the site the ridges become less well defined although the north–south trend remains distinct throughout.

Elevations across the development site vary from sea level to 281m AOD, the highest point being Scalla Field in the Kergord quadrant. The study area is divided into four sections by prominent breaks in the landscape. The topographic cross-sections included below give examples of the terrain in each quadrant.

The site centres on the settlement of Voe, HU 4086 6359, with two quadrants lying on either side of the A970-A968 route. The two quadrants west of this line, Delting to the north and Kergord to the south, typically show steeper slopes and higher elevations than the eastern quadrants. The eastern quadrants, Collafirth to the north and Nesting to the south, are characterised by more broken ridge lines with rounded hills and less pronounced valley sections.

Slope angles across the site are very variable. Owing to the prevailing topography of long, flat topped ridges and wide valleys, much of the area is made up of flat or nearly flat ground (0-3°). Analysis of the slope angle map, derived from the DEM data, shows that just over 60% of the site has a slope angle of less than 6° and 86% of the site has a slope angle of 12° or less. The steepest areas are typically confined to the long ridge sides, as shown on Figure 14.1.PS03 (in Volume 4b).

Cross sections across the quadrants have been generated from the DEM and are presented in Figure 2 to Figure 5 below, to give a clearer illustration of the site topography. Locations of the cross section lines are shown in Figure 14.1.PS06 (in Volume 4b).

Figure 2 Cross section through Delting quadrant, from Scatsta (NW) to Dales Voe (SE)

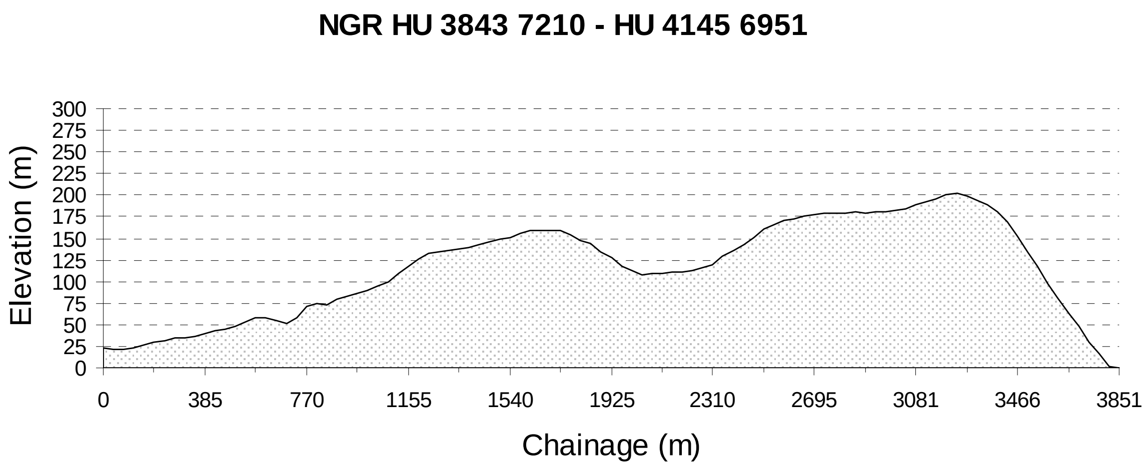


Figure 3 Cross section through Kergord quadrant, from the South Burn of Burrafirth (W) to East Kame (E)

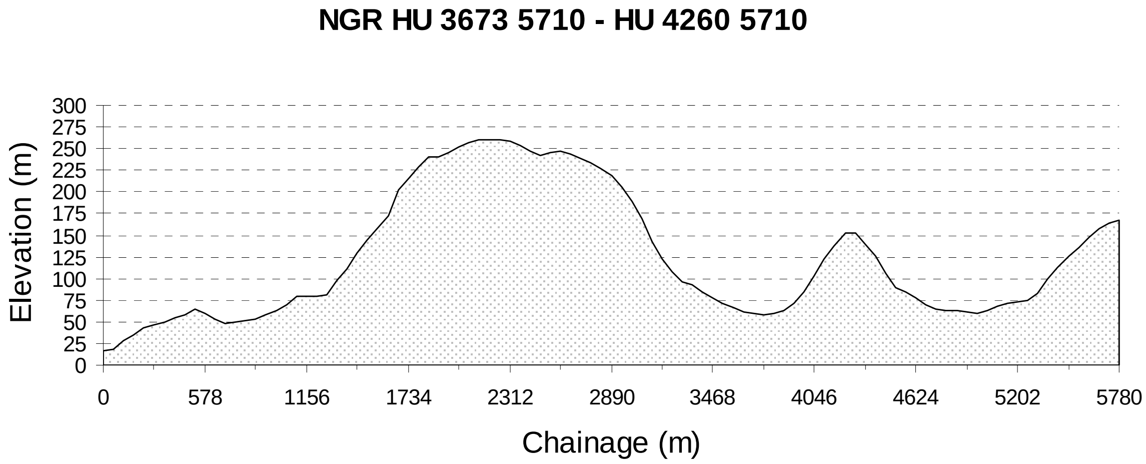


Figure 4 Cross section through Collafirth quadrant, from Susetter (W) to Laxo Water (E)

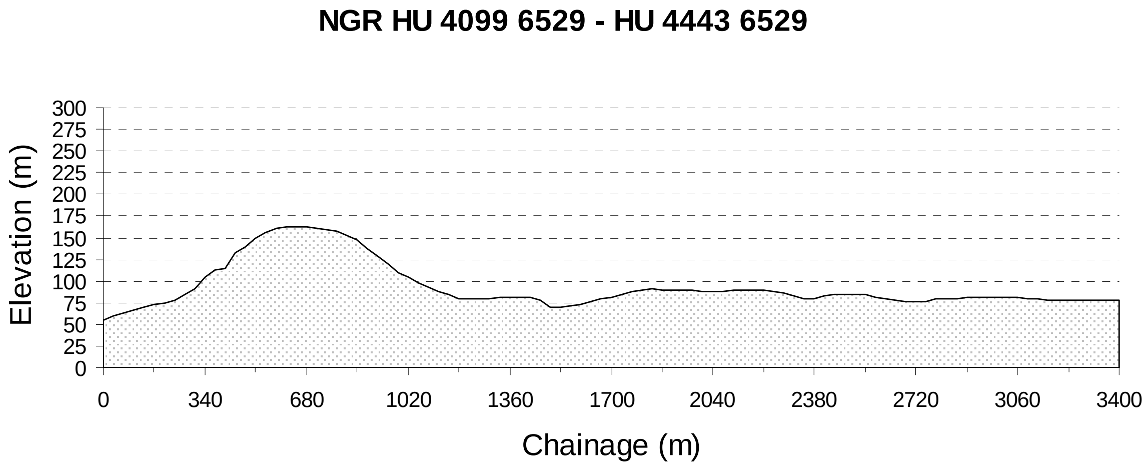
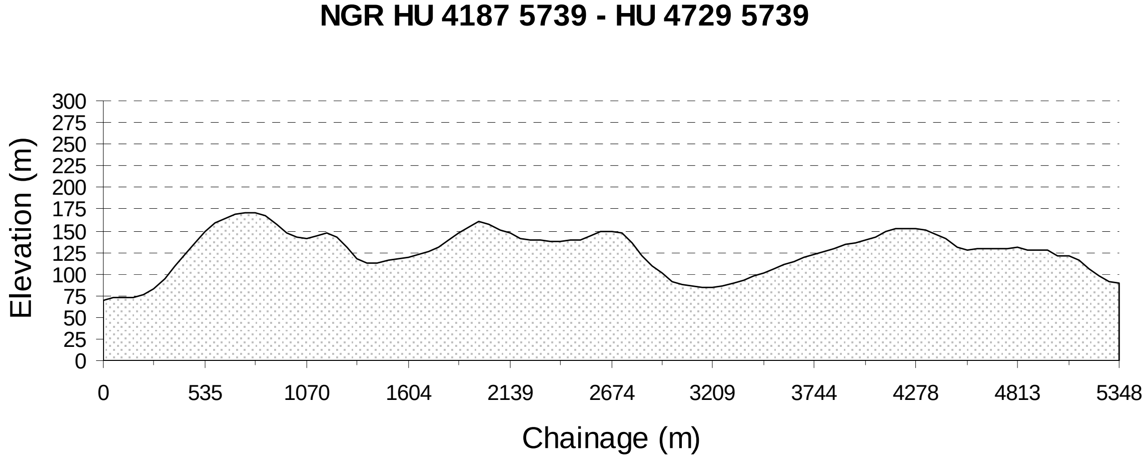


Figure 5 Cross section through Nesting quadrant, from Petta Dale (W) to Brettabister (E)



2.6 Geology

The geology of Shetland consists partly of metamorphosed sedimentary rocks of Moinian and Dalradian age, and partly of sedimentary and igneous rocks of Devonian age. The Shetland Islands are elongate and dominated by north–south trending geological units cut by a series of similar trending faults. The site exhibits variable amounts of outcrop, some drift deposits and very extensive peat cover.

North Mainland is cut by several major strike-slip faults trending north–south, in particular the Walls Boundary Fault (WBF), the Nesting Fault and the Melby Fault. The WBF is thought to be the northward extension of the Great Glen Fault and has undergone several phases of movement during its geological history. These fault planes have a vertical or near-vertical dip. The rocks within the proposed development area lie predominantly between the Walls Boundary Fault to the west and the Nesting Fault to the east, with a small section of the Nesting quadrant lying to the east of the Nesting Fault.

Shetland is divided into two geologically distinct sections, typically called East and West Shetland and separated by the WBF. The East Shetland succession, east of the WBF, consists of a thick sequence of north–south trending metasediments with a vertical or steep dip, younging to the east. The rock types vary from schist and gneiss to quartzite and metalimestone. The sequence has been intruded by plutonic igneous complexes of variable composition, and is cut by a sequence of sills and dykes. The development area lies entirely within the East Shetland succession.

This combination of major faulting and near-vertically dipping strata form the principal controls on the landscape and drainage systems, which are dominated by a series of parallel north-south trending ridges and valleys.

The bedrock geology is extensively covered by superficial deposits, mostly composed of blanket peat and glacial drift material. Blanket peat is fairly extensive across the development area, forming a nearly unbroken cover over much of the site. There has been significant erosion on some hill and ridge tops, in places exposing the mineral soil. The peat is slightly more broken further south, giving more bedrock exposure especially in the Kergord quadrant and the area to the east of the Nesting Fault in the Nesting quadrant.

The peat is often underlain by a thin irregular layer of glacial till; the till is sometimes exposed in stream and road sections, especially in areas where peat is absent. Hummocky till or moraine deposits are noted in some localised areas with thin peat. Alluvium is present in small amounts in some river valleys but is very minor in extent, as are the occasional lacustrine deposits. Marine beach deposits are present along much of the coastline with minor blown sand in places. Glaciofluvial material is confined to a small area south of the Kergord quadrant. Rock falls have been noted in places, although these are usually small and infrequent.

Overview maps of the bedrock and superficial geology are presented in Figures 14.1 and 14.2 (in Volume 3).

2.7 Soils and Peat

The distribution of soils is dependent on the geology, topography and drainage regime of the local area. Regional soils consist predominantly of blanket peat and peaty units of the Arkaig Association. Some further information on the main soil types identified is provided below:

- *Blanket peat*: organic material generated from the remains of bog and/or fen vegetation. The wetness of the substrate leads to anaerobic acid conditions inhibiting the decay process.
- *Deep and eroded blanket peat*: deep blanket peat which may display extensive erosion features such as gullies and haggs.
- *Peaty gleys*: slowly permeable, seasonally waterlogged clay-like soils with a peaty surface horizon. Saturation of the soil results in a lack of oxygen and reducing conditions, the subsequent reduced iron within the soil takes on a bluish colour. In the upper soil horizons, where the water table fluctuates, the soil has a mottled appearance.
- *Peaty podzols*: leached soils with a peaty surface layer. The drainage of these soils is dependent on the level of leaching. Peaty podzols are normally free-draining; however, where strong leaching has occurred sufficient deposition of iron and aluminium in the lower soil horizons may cement the material into a hard impermeable layer, or ironpan, resulting in waterlogging of the profile above. The product of this is a soil intermediate between podzol and gley.
- *Peaty rankers*: very shallow soils over rocks with a peat surface layer but no subsoil.

There are ten main soil units found on the Viking Wind Farm site, based on the Soil Survey of Scotland digital mapping. Each soil unit consists of varying proportions of the soils described above. The proportion of each soil type within a soil unit is dictated by the local topography and drainage conditions, so each soil unit is associated with a particular geographical situation. The soil units found at Viking and the percentage of the wind farm footprint underlain by each are displayed in Figure 14.8 (in Volume 3) and summarised in Table 1. The information on the soil mapping correlates closely with the superficial deposits map (Figure 14.2, Volume 3).

Table 1 Summary of regional soil types

Component Soils	Soil Unit	Associated Landform	% Regional Coverage
Deep and eroded blanket peat	605	Uplands and northern lowlands with gentle and strong slopes	68.1
Deep blanket peat	604	Uplands and northern lowlands with gentle and strong slopes	11.4
Peat with peaty gleys with peaty podzols	24	Hills and valley sides with steep and very steep slopes: non-rocky	5.6
Peaty gleys with peat: peaty podzols with peaty rankers	29	Undulating hills with gentle and strong slopes: moderately rocky	5.4
Basin with valley peats	3	Basins and valleys	5.2
Peaty gleys with peaty podzols with peaty rankers	31	Hill sides with steep and very steep slopes: moderately and very rocky	1.8
Brown forest soils: brown rankers with noncalcareous gleys	165	Undulating lowlands and hills with gentle and strong slopes: slightly rocky to rocky	1.2
Noncalcareous gleys with peaty gleys: humic gleys with peat	19	Hills and valley sides with gentle to strong slopes: non-rocky	0.6
Peaty podzols with peat: peaty gleys with humus-iron podzols	320	Hills and lowlands with gentle to steep slopes: non-rocky	0.4

Component Soils	Soil Unit	Associated Landform	% Regional Coverage
Peat with subalpine soils: alpine soils	193	Hill and mountain summits with gentle and strong slopes: slightly and moderately rocky	0.2

2.8 Hydrogeology

Groundwater at the site is largely restricted to the superficial peat deposits, as the Viking Wind Farm site is mostly underlain by impermeable Pre-Cambrian basement rocks.

These basement rocks are crystalline metamorphic and igneous strata which have extremely restricted groundwater flow and storage potential. What storage and flow capacity they exhibit is limited to near-surface fracture systems, joints and fault lines. In some areas the presence of a thin weathered horizon provides some limited groundwater storage capacity although the quartz-rich nature of most of the rocks restricts weathering to the very top layer. Notable exceptions are the meta-granite exposed at NBP04, which is quite deeply weathered in places, and the bands of metalimestone which are subject to chemical weathering and dissolution by acidic waters.

There is likely to be some groundwater present within the glacial till deposits that are present across the site. However, these are mainly discontinuous within the wind farm site and are generally confined to steeper slopes or lower-lying areas around the site margins.

Groundwater within site peat aquifers is generally perched on the less permeable basement strata which they overlie. These aquifers may be thick where they are located in areas of low relief, such as valley floors and cols in elevated areas. In these situations they will provide baseflow to local streams. While peat aquifers in some areas have sufficient storage to ensure perennial flow, in the majority of peat aquifer-fed watercourses flow appears to be more intermittent.

The occurrence and behaviour of the water table within the peat is also of significance. In lower-lying areas of lesser relief and where peat is relatively thick, the water table generally occurs at or near the surface. In areas of higher relief groundwater occurs at greater depth and in some instances may only be present for short periods on a seasonal basis.

2.9 Hydrology

There is a considerable number of small streams, rivers, lochs and lochans throughout the site, although these water features are not uniformly distributed. In particular, when considering lochs, the majority of waterbodies visible on the 1:50,000 scale map lie within Kergord quadrant, whereas Delting quadrant has the fewest lochs. In addition to lochs shown at 1:50,000 scale, there are numerous lochans found particularly in the southern sector of the study area. Many of these are ‘perched’ in depressions within the predominantly peat-covered terrain. There are also numerous peat bodies, flush zones and other areas of diffuse surface runoff.

All site catchments display upland moor characteristics, with the main hydrological control across the site being the impermeable bedrock geology and the resulting extensive peat deposits. As peat deposits are generally fully saturated but have a low permeability, the water is effectively ‘locked’ into the peat, restricting direct rainfall infiltration to groundwater. As a result there is little storage capacity and a large proportion of rainfall would become surface runoff, giving catchments a very ‘flashy’ response to rainfall events. This response is characterised by rapid response times and high peak flows. Catchments with larger lochs, such as those within Kergord quadrant, may have a dampened response owing to the additional storage capacity provided by the lochs. During extended periods of dry weather there are very low flows in the streams in consequence of the small seepage rates from the peat deposits.

Hydrological catchment boundaries relating to the site were mapped, with catchments shown in Figure 14.13 (in Volume 3). Numerical identifiers for the catchments are based on unit area, where Catchment 1 the largest and Catchment 30 the smallest. Examples from each quadrant are presented below, with additional hydrological information provided in Chapter 14 of the Environmental Statement (Mouchel, 2009).

Catchment 1: Laxo Burn/Gossawater Burn (Collafirth & Nesting quadrants)

The largest of the study area catchments, the Laxo Burn/Gossawater Burn catchment covers an extent of approximately 20.86km^2 (2086 hectares). This catchment is characterised by rounded hills and dendritic stream channels with peat haggs and gullies. There is also a number of lochs of varied size within the catchment. Within this large area there are two distinct subcatchments, situated north and south of the settlement of Laxo.

Based on surface area, the largest of the lochs are Gossa Water (0.23km^2) in the southern subcatchment and Laxo Water (0.17km^2) in the northern subcatchment. Both of these lochs are fed via direct stream flow and outflows from smaller lochs upstream.

In addition to the outflows from the lochs identified above, the main watercourses in the catchment are the Seggie Burn, the Gossawater Burn and Easter Filla Burn. These form the principal tributaries to the Laxo Burn, which reaches the sea at the settlement of Laxo on the east coast. Examples of watercourses from this catchment are shown in Figure 6 and Figure 7 below.

Figure 6 View west (upstream) along the Seggie Burn from Kingshouse (HU 4360 6484)

Figure 7 View north (downstream) along the Gossawater Burn (HU 4352 6175)

Catchment 2: Burn of Lunklet/South Burn of Burrafirth (Kergord quadrant)

This large catchment covers an area of approximately 18.47km^2 (1847 hectares) and includes a number of large freshwater lochs, including Maa Water which is the largest in the study area. The watercourses in this catchment drain the western slopes of West Kame, Scalla Field and West Hill of Weisdale. The main streams in the catchment are the South Burn of Burrafirth, Burn of Lambawater, Burn of Lunklet (Figure 8) and Burn of Marrofield, which converge to form the Burn of Burrafirth within 500m of the coast. The Burn of Burrafirth flows into the sea at East Burrafirth.

Figure 8 View upstream (east) along the Burn of Lunklet (HU 3699 5735)

Figure 9 View north-west across Lamba Water (HU 3828 5521)

This catchment contains most of the major lochs within the Kergord quadrant, Maa Water (0.25km^2), Lamba Water (0.15km^2, Figure 9), Truggles Water (0.07km^2), Marrofield Water (0.06km^2) and Loch of Lunklet (0.03km^2). This dominant presence of standing waterbodies is expected to regulate the flow into the outflowing streams, which will have a steadying influence on the overall catchment flow characteristics.

Catchment 3: Burn of Sandwater/Burn of Pettawater (Kergord & Nesting quadrants)

This catchment covers an area of approximately 14.69km^2 (1469 hectares) within the fjord-like valley of Petta Dale. Petta Dale forms the major north–south boundary between Kergord and Nesting quadrants and drains the eastern side of Mid Kame and the western side of East Kame. The main streams within the catchment are the Burn of Pettawater and the Burn of Sandwater, with two notable waterbodies, Petta Water (0.11km^2) and Sand Water (0.37km^2). The Burn of Pettawater provides the main inflow to Sand Water (Figure 10), which then feeds the Burn of Sandwater which flows south to meet the sea at Stromfirth.

The catchment topography is dominated by the wide, flat floor and steep bounding slopes. Owing to the gentle slope on the valley floor, the catchment is dominated by boggy ground with an intricate network of small channels. Sand Water is a shallow loch and its size will provide a moderating influence on the catchment flow characteristics.

Figure 10 View south-west across Petta Dale to Sand Water (HU 4099 5624)

Catchment 5: Burn of Laxobigging (Delting quadrant)

The upper reaches of this catchment are drained by the Burns of Easterbutton and Westerbutton (Figure 11), which form a confluence at the Meadow of Fitchen. The topography in this area is gently sloping to the north-east and these watercourses follow this, meeting with other drainage features to become the Burn of Laxobigging. The catchment covers an area of approximately 11.33km^2 (1133 hectares).

The catchment drains the western slopes of the Hill of Dale, Hill of Oxnabool and Hill of Neegarth. The Burn of Laxobigging enters the sea at Garths Voe, adjacent to the settlement of Laxobigging on the west coast.

Figure 11 View down the Burn of Westerbutton towards the Burn of Laxobigging (HU 3965 7018)

The Burn of Laxobigging has a redundant dam in its lower reaches, situated near the village of Graven (HU 4166 7261). This artificial feature forms pool habitats upstream which may be considered of value and may contribute to water flow moderation at higher water levels. There are no significant standing waterbodies in the catchment.

Figure 12 Dam on the Burn of Laxobigging (HU 4166 7261)

Flow statistics for the all the site catchments are provided in Table 2. The mean daily flow and low flow figures have been calculated using LowFlows 2000 software (Wallingford

HydroSolutions, 2007) and the peak runoff figures have been calculated using the Flood Estimation Handbook (FEH). The low flow estimate is given as $Q_{95}(10)$ and represents the flow exceeded 95% of the time as observed over a 10-day period. For very small catchments, less than $0.5km^2$ in area, where the FEH software is not able to provide information a pro-rata interpolation on unit runoff was made and results extrapolated from other watercourses.

Table 2 Estimated mean daily flow, low flow (Q_{95}) and peak runoff rates (m^3/s) for site catchments

Catchment ID	Area (km^2)	Mean Daily Flow (m^3/s)	Q_{95} (10)	Estimated Peak Runoff (m^3/s) for each Return Period (years)						
			(m^3/s)	2	5	10	25	50	100	200
1	20.86	0.578	0.115	10.32	14.04	16.31	19.46	22.11	24.70	28.59
2	18.47	0.489	0.108	9.60	13.16	15.33	18.36	20.92	23.32	26.69
3	14.69	0.399	0.0792	6.42	8.74	10.16	12.13	13.78	15.55	18.01
4	13.17	0.385	0.0514	5.66	7.70	8.95	10.68	12.15	13.52	16.06
5	11.33	0.302	0.0493	5.39	7.34	8.53	10.18	11.57	12.87	14.79
6	10.60	0.265	0.0423	5.11	6.98	8.12	9.72	11.06	12.31	14.22
7	6.79	0.181	0.0249	3.64	4.99	5.82	6.98	7.95	8.87	10.12
8	5.88	0.164	0.0218	2.68	3.67	4.27	5.11	5.82	6.48	7.36
9	4.82	0.145	0.018	2.62	3.60	4.19	5.03	5.73	6.39	7.26
10	4.72	0.127	0.0202	2.75	3.78	4.42	5.31	6.06	6.76	7.69
11	4.46	0.126	0.0273	2.586	3.556	4.150	4.979	5.678	6.335	7.20
12	4.27	0.111	0.0167	2.59	3.57	4.18	5.02	5.73	6.40	7.29
13	4.04	0.125	0.015	1.82	2.49	2.91	3.49	3.98	4.44	5.05
14	3.95	0.12	0.0183	1.76	2.41	2.81	3.37	3.84	4.28	4.86
15	3.26	0.0843	0.0214	2.16	2.99	3.50	4.20	4.80	5.36	6.11
16	2.90	0.079	0.0171	1.84	2.53	2.95	3.55	4.05	4.51	5.13
17	2.91	0.0744	0.00879	1.65	2.28	2.66	3.19	3.64	4.07	4.63
18	2.69	0.0665	0.0123	1.43	1.97	2.30	2.76	3.15	3.52	4.01
19	2.61	0.062	0.0121	1.51	2.09	2.44	2.93	3.35	3.74	4.23
20	2.69	0.0689	0.0088	1.65	2.28	2.66	3.30	3.77	4.21	4.52
21	2.13	0.0493	0.00980	1.35	1.87	2.19	2.64	3.02	3.37	3.88
22	2.01	0.0569	0.00856	1.25	1.72	2.01	2.41	2.75	3.07	3.50
23	1.66	0.0561	0.0108	1.14	1.57	1.84	2.21	2.52	2.82	3.21
24	1.69	0.0446	0.00598	1.08	1.49	1.75	2.11	2.41	2.69	3.07
25	1.73	0.0438	0.0066	1.20	1.66	1.94	2.34	2.67	2.99	3.41
26	1.34	0.0385	0.00276	0.82	1.14	1.33	1.60	1.83	2.04	2.33
27	0.93	0.0238	0.0028	0.41	0.56	0.66	0.79	0.91	1.02	1.16
28	0.51	0.0123	0.00165	0.38	0.53	0.63	0.76	0.87	0.97	1.11
29	0.43	0.0111	0.00167	0.40	0.53	0.67	0.85	1.03	1.11	1.34
30	0.36	0.0096	*	0.37	0.49	0.57	0.74	0.90	1.02	1.23

*Too small a catchment for LowFlows software to generate a value

The rural location of the site and the number of small lochs and burns in the region means it is not possible to monitor all watercourses in the area. Within the area of interest, several watercourses have been classified as having A2 (good) water quality status and the Burn of Laxobigging has been assigned A1 (excellent) status.

A suite of water samples has been collected for quality monitoring purposes and preliminary results indicate that 22 out of 30 samples have A1 (excellent) quality, four sites have A2 (good) quality and four have B (moderate) quality. Further details are provided in Chapter 14 of the Environmental Statement (Mouchel, 2009).

Taking this information into consideration, and using a precautionary approach, it has been assumed that all unclassified watercourses have at least A2 (good) water quality status.

2.10 Aerial Photography

High resolution orthorectified colour aerial photography was made available in late summer 2008, having been flown in May 2008 by XYZ Mapping. The photography is at a resolution of 25cm. Analysis of the aerial photography of the site (Figure 14.1.PS04, in Volume 4b) reveals that the site has a remarkably uniform character. The site is for the most part mid- to dark grey-brown in colour, indicative of the extensive blanket peat.

Very pale green or straw-coloured areas tend to mark river channels, usually indicative of deeper peat. These areas show that watercourses almost invariably start upstream of the 'source' marked on OS 1:10,000 base mapping and typically have a dendritic network that converges to form the main stream. Burns across the site have variable character, with some forming narrow channels within the peat and others cutting through into the bedrock to form narrow almost gorge-like valleys. The larger burns and lochs are well-defined

Better-drained areas following river valleys and along ridgelines appear as greener sections, broken in places by pale grey or white indicating mineral soils or bedrock exposure. In places, these pale sections are extensive, typically marking hill or ridge tops where the peat is heavily eroded. Remnant peat in these sections shows a dark red-brown to nearly black in places, indicating the extensive peat hagging in these areas. Peat dissected by networks of drainage channels has the standard grey-brown colouration with the channels indicated by irregular dark lines.

Brighter green areas around the flanks of the site indicate improved or semi-improved grassland for livestock grazing. Straight line traces across the photographs typically show the positions of fences, across which vegetation patterns can be distinct as representing a change in grazing patterns or other land use.

A small peatslide was identified south of Aith, on the flank of Whitelaw Hill, and a recent landslide is visible below the main road A971 above Weisdale Voe.

2.11 Vegetation

Vegetation mapping of the site has been carried out as part of the Environmental Impact Assessment. The site vegetation is dominated by blanket mire interspersed with smaller areas of wet and dry heath, grassland and bog pool habitats. Blanket mire vegetation covers the vast majority of the site.

Areas of grassland tend to be found on the steeper slopes along ridge sides, such as Mid Kame ridge and around Scalla Field in Kergord quadrant. In these areas the slope angles are generally too steep to allow waterlogging and development of peat. Grassland communities are also found around the site margins in areas of semi-improved grassland with artificial drainage. Other steep slope areas have wet or dry heath vegetation, with the wet heath tending to occur on shallower or more broken slopes.

Bog pool communities are more frequent in Nesting and Kergord quadrants, tending to occur along ridge tops in the gaps and hollows of the eroded peat. These quadrants also have small areas of limestone grassland corresponding with the bedrock outcrops of marble across the southern half of the site; particular examples occur around NBP01 in Nesting quadrant.

3 SITE RECONNAISSANCE

Subsequent to the desk study a walkover survey was carried out in March 2006, prior to the initial wind farm layout being produced. The walkover survey consisted of traverses across the original study area with the intention to gather representative regional data from areas across the site. The scope of the site visit included reconnaissance survey and mapping of the geology, geomorphology and hydrology of the site area. Following the walkover, a preliminary peat probing survey was undertaken in April 2006. The routes probed were designed to provide good representation of regional features in North Mainland, including ridge lines, rounded hills and various valleys. Owing to the extent of the site it was not possible to visit the whole site. Traverses and walkover routes were carefully planned to ensure a good coverage and that a range of representative areas were visited directly. Weather conditions during the initial field surveys were varied, including clear sunny days, heavy rain, low cloud and snow.

Following the production of the initial 171 turbine layout, further site investigations were carried out in November 2007, and January and February 2008. These visits were primarily to undertake further peat probing, discussed below, and to assess potential borrow pit and stream crossing locations. Additional features of relevance to the peat stability assessment were also recorded during this stage of the field investigation.

Despite this work being undertaken during the winter months, the weather was generally fair although strong winds impeded progress at times. Some days were wet with poor visibility and hail showers were common at times. A short thunderstorm occurred during the February fieldwork.

A final layout was produced in October 2008, necessitating additional fieldwork to provide information on areas where the infrastructure layout had been modified. This fieldwork was undertaken between 17 and 28 November 2008. In addition to peat probing, further information was collected for potential borrow pit and stream crossing locations to supplement that obtained previously. Concurrent with this work, peat coring was undertaken at 15 locations across the site which had been identified for ground investigation work; the remainder of the ground investigation work was undertaken during December 2008 and January 2009.

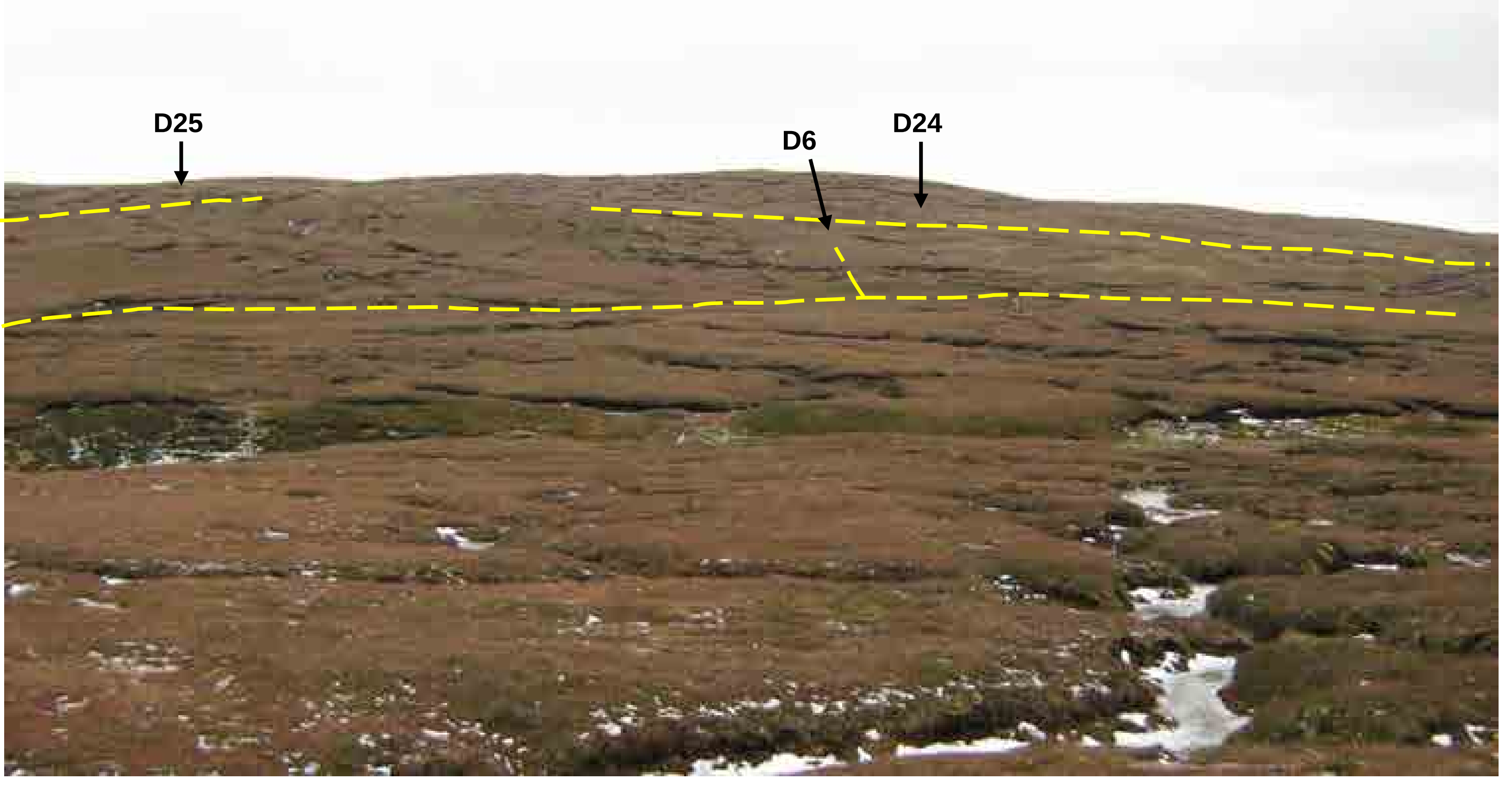
As has proved typical for this site, weather conditions were very variable during the field survey. Strong winds were common and fieldwork was restricted during the mid and later section of the visit owing to significant snowfall and icy conditions, resulting in dangerous and very slippery underfoot conditions. Low cloud and periodic blizzard conditions necessitated leaving the field early on three occasions. Low air temperatures combined with substantial wind chill provided an extra concern.

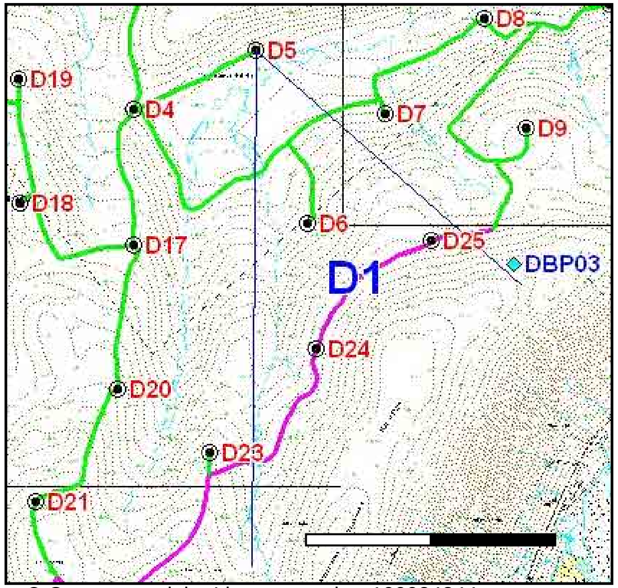
The areas described below provide a representative sample of the wind farm site, detailing the range of landforms, vegetation and erosion patterns encountered. Each detailed description is accompanied by a photograph giving an indication of the infrastructure proposed for the area, plus a location map and notes pertaining to the area. The locations of the areas and the boundaries are shown in Figure 14.1.PS06, in Volume 4b.

3.1 Area D1

Area D1 is situated in the central part of Delting quadrant, on the south-east flank of the Burn of Laxobigging valley. The area provides a typical overview of central Delting showing variation from the nearly flat river valley rising to steep slopes along the ridge lines. Slopes are generally smooth in character although prominent breaks in slope are present along the valley and ridge sides. Figure 13 shows a view across the area from Turbine D5.

Figure 13 View south-east over Area D1 from Turbine D5 (HU 3967 7067). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation: Blanket mire; sedge/grass, moss, heather

Peat depths (m): Maximum: 4.0; minimum: 0.0; average: 1.9

Erosion patterns: Dissected by drainage channels; more extensive gullying at higher levels

Instability: No signs of instability in the area

Notes:

The Burn of Laxobigging channel is visible in the foreground. The near track route runs approximately parallel to the stream channel in the middle distance. A second, higher level track runs along the valley side below the Hill of Dale in the distance.

Figure 13 indicates that this area has a fairly uniform cover of blanket peat. Peat probing indicates that peat in the valley floor is generally in excess of 1.5m deep with areas deeper than 2.5m.

The peat is dissected to varying degrees by drainage channels at the lower levels; at higher elevations has it has been subjected to considerable erosion and hagging. This is visible in the area near Turbine D24 in Figure 13.

Small, ice-smoothed knolls and spurs are present in places; an example can be seen immediately right of Turbine D25 in Figure 13. These sometimes expose small areas of bedrock in the steeper sides.

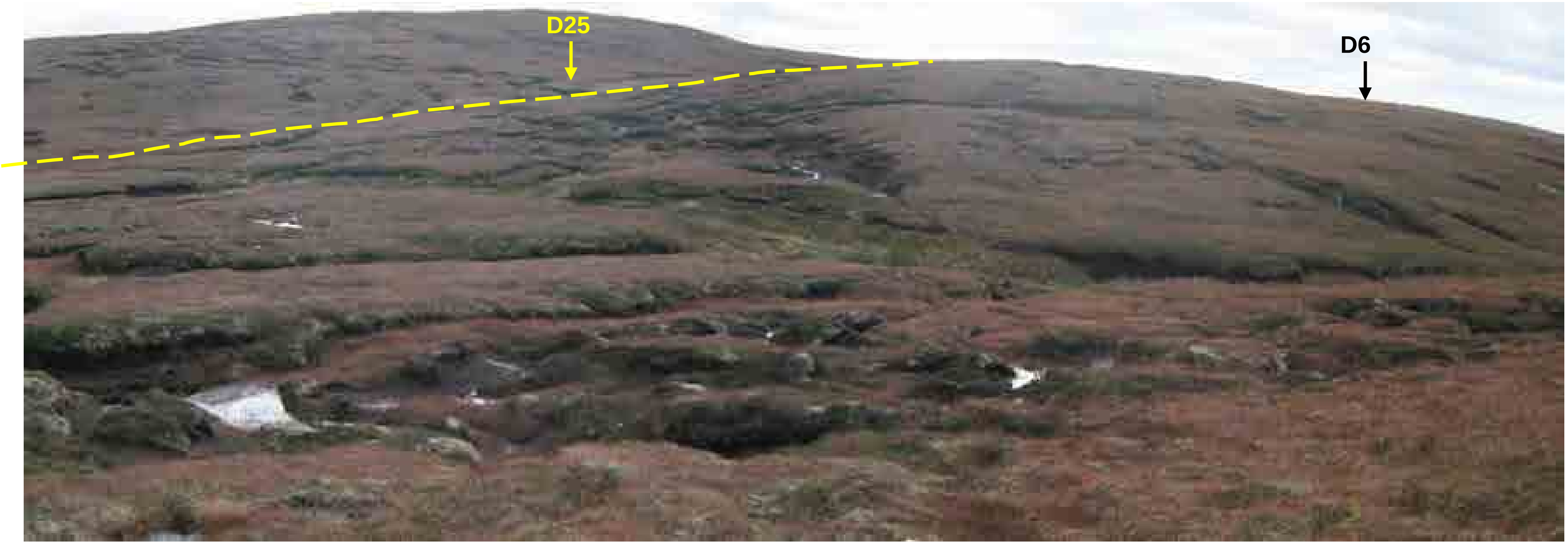
Areas of lighter green vegetation, for example between the two track lines towards the right hand side of Figure 13, indicate dryer areas where the peat is shallower and vegetation is more grass-dominated. For the most part the vegetation cover is a typical blanket mire mix of heather, sedges, grass and moss.

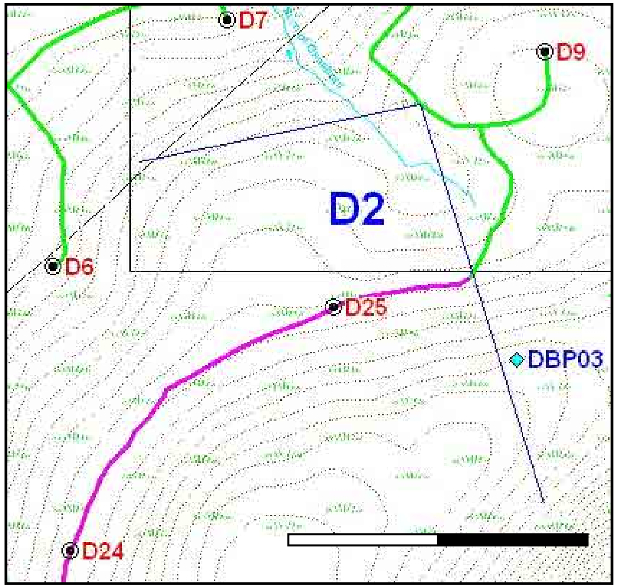
Track lines have been routed where possible to avoid steeper slopes and to minimise damage to intact blanket bog. Given the prevalence of deep peat it has not been possible to site turbines on shallow peat, although their locations avoid the deeper peat areas as far as this is practicable.

3.2 Area D2

Area D2 is also in the central part of Delting. This area includes the headwaters and upper part of the Burn of Oxnabool, the channel of which is visible in the right half of Figure 14. The topography is dominated by a shallow bowl, which is crossed by the track alignment, rising quite steeply to the Hill of Dale in the south-east and confined to the north-west by a broad spur and hill. The spur and hill are separated by the Burn of Oxnabool.

Figure 14 View south-west over Area D2 from north-eastern side of the Burn of Oxnabool (HU 4050 7028). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 500m).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather
Peat depths (m):	Maximum: 3.3; minimum: 0.0; average: 2.0
Erosion patterns:	Widespread gullying with exposed bare peat
Instability:	No signs of instability in the area

Notes:

The Burn of Oxnabool channel is visible in the centre of Figure 14, draining to the right hand side. The track route crosses a shallow bowl that forms the source region for the burn.

Peat probing in this area indicates that peat within the bowl area is mainly deeper than 1.5m. The top of the Hill of Dale, behind the track, has mostly shallow peat. Pockets of shallow peat are present across the area.

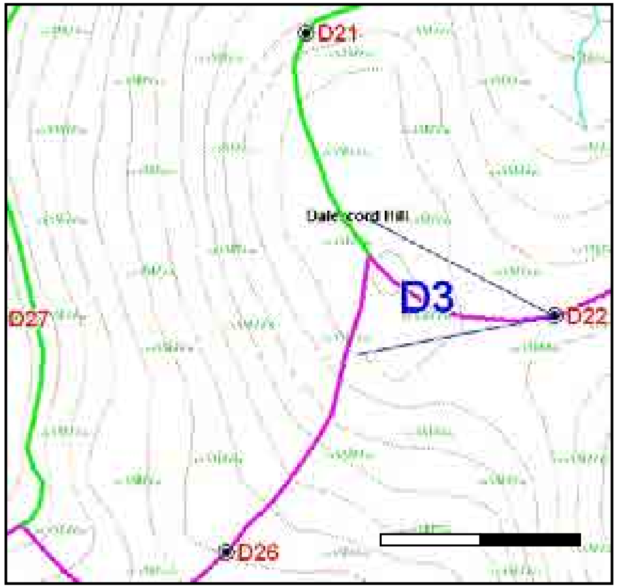
The blanket peat cover in this area has been subjected to extensive erosion, resulting in widespread gullying. The spur between Turbines D25 and D6 has a wide, nearly flat summit with steepening slopes towards the Burn of Oxnabool and down towards the west. The peat in this area is less eroded than in the main bowl, with only a few drainage channels running down-slope.

There is a fair amount of exposed bare peat, some of which is being recolonised by lichens, visible in the left foreground of Figure 14. Vegetation is otherwise dominated by the heather, sedges, grass and moss characteristic of blanket mire. Drier areas, such as the burn valley, are indicated by greener colouration.

3.3 Area D3

Many of the hill and ridge tops are characterised by extreme peat erosion where peat has mostly been removed to expose mineral soil and, in places, bedrock and leaving only isolated peat haggs and banks. Area D3 provides a good example of this terrain (Figure 15).

Figure 15 View west over Area D3 from Turbine D22 (HU 3913 6858). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 250m).



Habitat type/vegetation:	Blanket mire & wet heath; heather, sedge/grass, moss
Peat depths (m):	Maximum: 1.5; minimum: 0.2; average: 0.7
Erosion patterns:	Isolated haggs with bare peat and mineral soil
Instability:	No signs of instability in the area

Notes:

Area D3 includes a col leading up to Dalescord Hill, immediately west of Turbine D22. The track route follows the top of the col and runs along the summit of Dalescord Hill.

Peat probing indicates that peat depths across the col are shallow, mainly less than 0.5m, as are the peat depths across the summit of Dalescord Hill. Remaining peat banks stand to around 1.5m above the erosion surface.

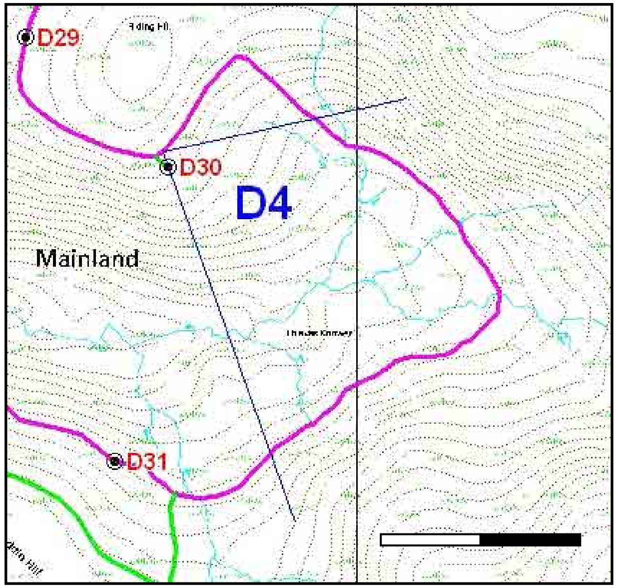
The col itself has fairly intact peat with occasional eroded channels and peat banks; an example can be seen in the foreground of Figure 15. The summit area of Dalescord Hill has largely been eroded to mineral soil or bare peat with a few remnant peat haggs particularly around the edges. These show clearly along the skyline in Figure 15.

Vegetation in the area is mainly sedges and grass with subordinate moss and heather, clearly visible in the foreground of Figure 15. Bare peat surfaces have in places become recolonised by lichens. Heavily eroded sections mostly remain unvegetated although some areas are showing signs of early regrowth of grasses & sedges.

3.4 Area D4

Situated in the southern part of Delting quadrant, Area D4 includes the headwaters of the Burn of Skelladale and across to Button Hills to the north-east and Souther Hill to the south-east (Figure 16). The head of the valley forms a shallow bowl surrounded on three sides by higher ground, similar in form to Area D2 but on a larger scale. A narrow terrace runs around the head of the valley at the base of the main slope up to Button Hills. This slope is cut by several streams which form tributaries to the Burn of Skelladale.

Figure 16 View east over Area D4 from the eastern slope of Riding Hill (HU 3855 6783). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 500m).



Habitat type/vegetation: Blanket mire; heather, sedge/grass, moss

Peat depths (m): Maximum: 3.3; minimum: 0.1; average: 1.4

Erosion patterns: Smooth vegetated slopes with drainage channels & gullying

Instability: No signs of instability in the area

Notes:

The Burn of Skelladale valley can be seen in the middle distance at the right hand side of Figure 16. The track line follows a narrow but distinct terrace around the head of the valley.

Measured peat depths on the south-east slope of Riding Hill indicate that the peat here is deeper than along the other slopes in the area. The site of Turbine D30, on the right-hand edge of Figure 16, gives depths ranging from 1.1m to 3.2m. Peat probing along the track line indicates that peat depths are mostly moderate to shallow (less than 2m) whereas across the valley floor peat depths are in places in excess of 4m.

The blanket peat is variably dissected by drainage channels and small watercourses. Below the track line these drainage channels and gullies become more frequent and the peat is more dissected in this area. A similar network of small interconnected channels in the peat is visible in the foreground and also on the slopes of Souther Hill, towards the right-hand side of Figure 16.

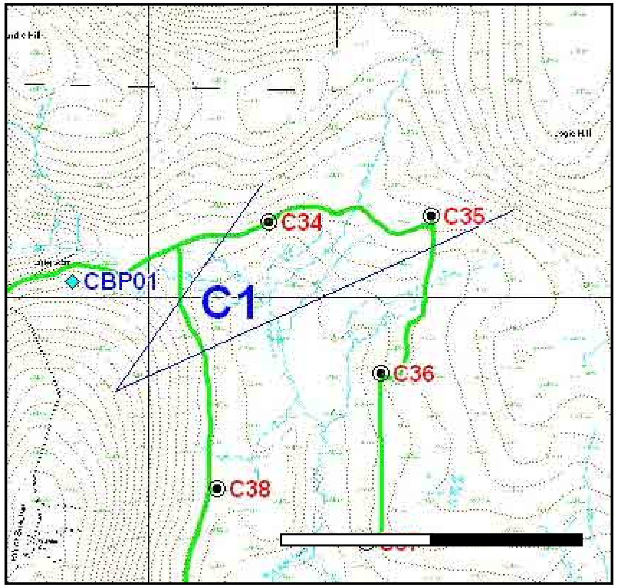
Positions of streams and other well-drained areas are marked by areas of paler vegetation in Figure 16, showing that they have a wide distribution across the steeper slopes of Button Hills and Souther Hill. The lower slopes of Riding Hill in the foreground generally slope at shallower angles and have vegetation characteristic of blanket peat, dominated by sedges, grasses, heather and moss, with bare peat exposed in some of the drainage channels and peat banks.

The track line has been routed to avoid the deeper peat present in the main valley floor and to avoid steeper slope angles.

3.5 Area C1

Area C1 covers the northern part of Collafirth quadrant. This area includes the upper part of the wide valley of the Seggie Burn, which is characterised by smooth slopes, a flat valley floor and a network of streams. A view across the area is shown in Figure 17.

Figure 17 View north-east across Area C1 from the flank of Hill of Susetter (HU 4189 6570). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).



Habitat type/vegetation:	Blanket mire; heather, sedge/grass, moss; subordinate acid grassland
Peat depths (m):	Maximum: 3.0; minimum: 0.2; average: 2.0
Erosion patterns:	Smooth vegetated slopes with drainage channels; more prominent gullying at higher levels
Instability:	Large partially collapsed peat pipe; no other signs of instability

Notes:

The Collafirth infrastructure is situated predominantly within the wide valley of the Seggie Burn, which runs left to right across Figure 17. Significant tributaries are also visible.

This area has a fairly uniform cover of blanket peat, especially at lower levels (Figure 17). Peat probing in the area indicates that peat is mainly deeper than 1.5m, and in places in excess of 4m. The prominent stream in the middle distance of Figure 17, crossed by the track route, is incised to bedrock so consequently peat depths within this valley are shallow.

The mainly smooth lower surfaces give way to more dissected peat visible above the track line, on the side of Logie Hill, where a more extensive network of drainage channels has developed.

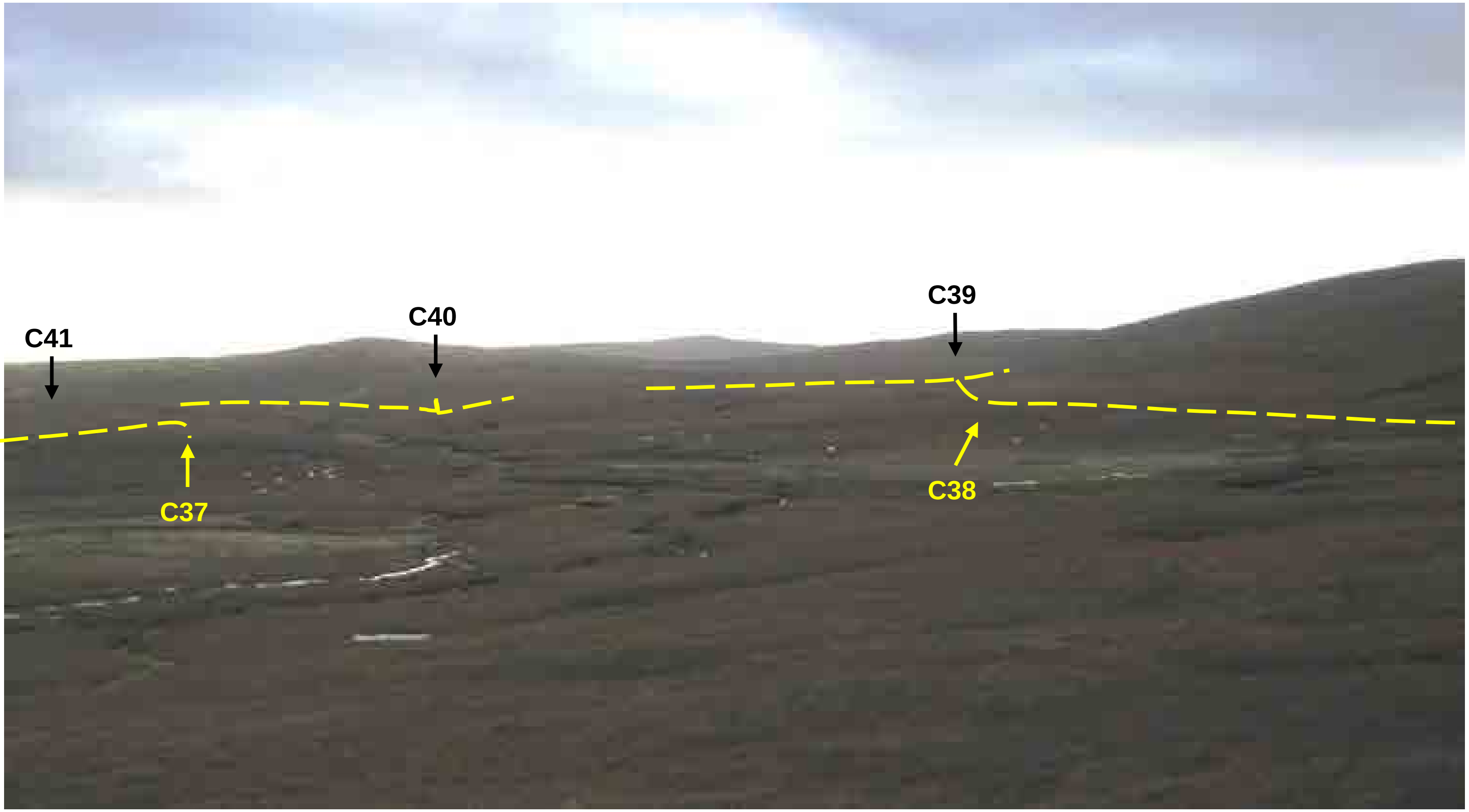
A large, partially collapsed peat pipe is present within this area and crosses the proposed track line. Its position is indicated in Figure 17. The first sink hole, just to the right of Turbine C34, marks the first entry of the stream into the peat. The sink hole here is nearly 3m deep by 2.5m wide and reaches to the peat-substrate interface. Further downhill the watercourse emerges before going underground again for a short section.

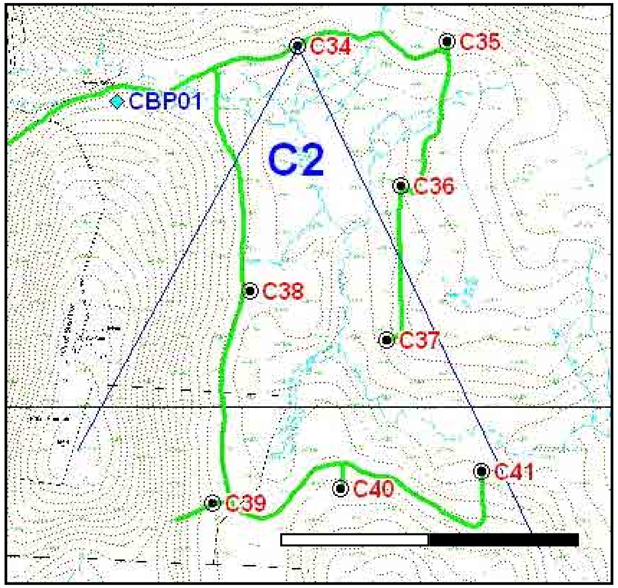
Vegetation on the lower hill slopes is dominantly typical blanket mire vegetation, with the darker areas representing dryer ground and a higher proportion of heather. The very light area in the middle distance corresponds with an area of acid grassland, crossed by dark green acidic flushes where inflowing watercourses cross the area.

3.6 Area C2

The southern part of Collafirth quadrant is covered by Area C2 and is shown in Figure 18. The area provides a typical overview of the Collafirth quadrant, with the contrast between the nearly flat-lying ground on the valley floor and the steep hill slopes around the sides.

Figure 18 View south across Area C2 from Turbine C34 (HU 4237 6623). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather; subordinate acid grassland
Peat depths (m):	Maximum: 4.0; minimum: 0.5; average: 2.3
Erosion patterns:	Smooth vegetated slopes with drainage channels
Instability:	Several partially collapsed peat pipes; old crack parallel to hillside above Turbine C39

Notes:

The Seggie Burn is visible in Figure 18 crossing the area from just below the track line at the right-hand margin, with its principal tributary joining from the middle distance on the left. Additional small waterbodies are visible in Figure 18.

Peat probing across the area indicates that peat is predominantly deep, especially below the Hill of Susetter (right hand side of Figure 18) where depths are mostly over 2m and in places in excess of 4m. Slightly shallower peat was encountered along Laxo Knowe between Turbines C40 and C41 where depths were typically less than 2m.

As with the northern part of the quadrant, this area is characterised by flat or shallow slopes with a fairly uniform coverage of blanket bog broken in places by drainage channels. Unlike the northern end, the higher slopes remain fairly smooth and unbroken, in particular on the Hill of Susetter to the west. The area between Turbines C40 and C41 on the lower slopes of Laxo Knowe is more dissected with a more interconnected network of gullies through the peat.

Some of the drainage channels down the Hill of Susetter form collapsed or partially collapsed peat pipes where the slope angle changes, just above the track line. One particular pipe is adjacent to Turbine C38. There may be other intact pipes that have no visible surface expression in this area.

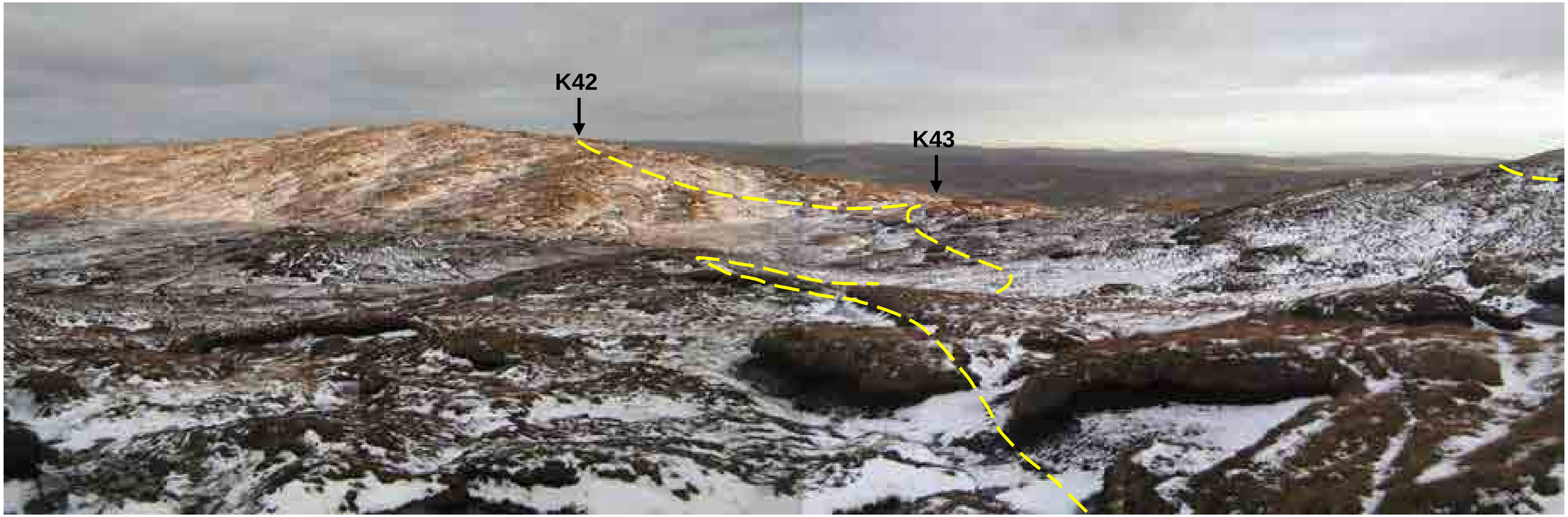
The flat-lying ground immediately adjacent to both watercourses is demarcated by pale vegetation. The area in the left foreground is the acid grassland mentioned in Area C1. Otherwise, vegetation is characterised by typical blanket mire species.

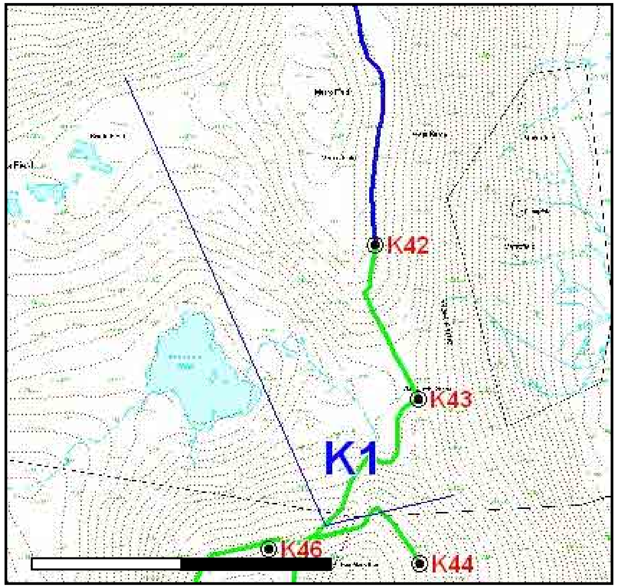
The track lines have been routed to take advantage of the nearly flat ground around the margins of the valley, even though the area is dominated by deep peat. It is likely that most of the track within this quadrant will be of floating construction because of the combination of deep peat and frequent large peat pipes.

3.7 Area K1

Area K1 is in the northern part of Kergord quadrant and encompasses the col of Marrofield Scord and part of West Kame ridge (Figure 19). This col includes a mixture of deep and eroded peat and exposed bedrock. Good examples of peat banks can be seen in the foreground of Figure 19. The small knoll in the central foreground, along the track line, has excellent bedrock exposure as rocksteps on the northern face and slabs across the summit. The area around Turbine K43 also exposes bedrock as a series of smoothed slabs within the col itself and on the south side.

Figure 19 View north-east across Area K1 from the flanks of Gruti Field (HU 3904 5884). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; heather, sedge/grass, moss
Peat depths (m):	Maximum: 4.0; minimum: 0.0; average: 1.0
Erosion patterns:	Irregular peat banks & gullies
Instability:	Small collapsed peat pipe; no other instability observed

Notes:

Marrofield Water is just off-picture to the left; tributaries to the loch follow the lower ground down from the col by Turbine K43.

Figure 19 shows clearly that the peat has been subjected to considerable erosion. Measured peat depths across the area are variable but mainly fairly shallow (<1.5m), although occasional points have depths up to 4m. The extent of rock outcrop and variability of peat depth within a short distance indicate that peat has mainly developed in pockets in the land surface and deep peat consequently has limited extent.

Drainage channels are clearly visible on the lower slopes of Marro Field, below Turbine K42. Exposed peat banks are visible in the foreground. A small collapsed peat pipe is present in the left foreground, although not clearly visible.

Small ice-smoothed knolls are present in some areas; an example can be seen in the middle distance down to the left from Turbine K42.

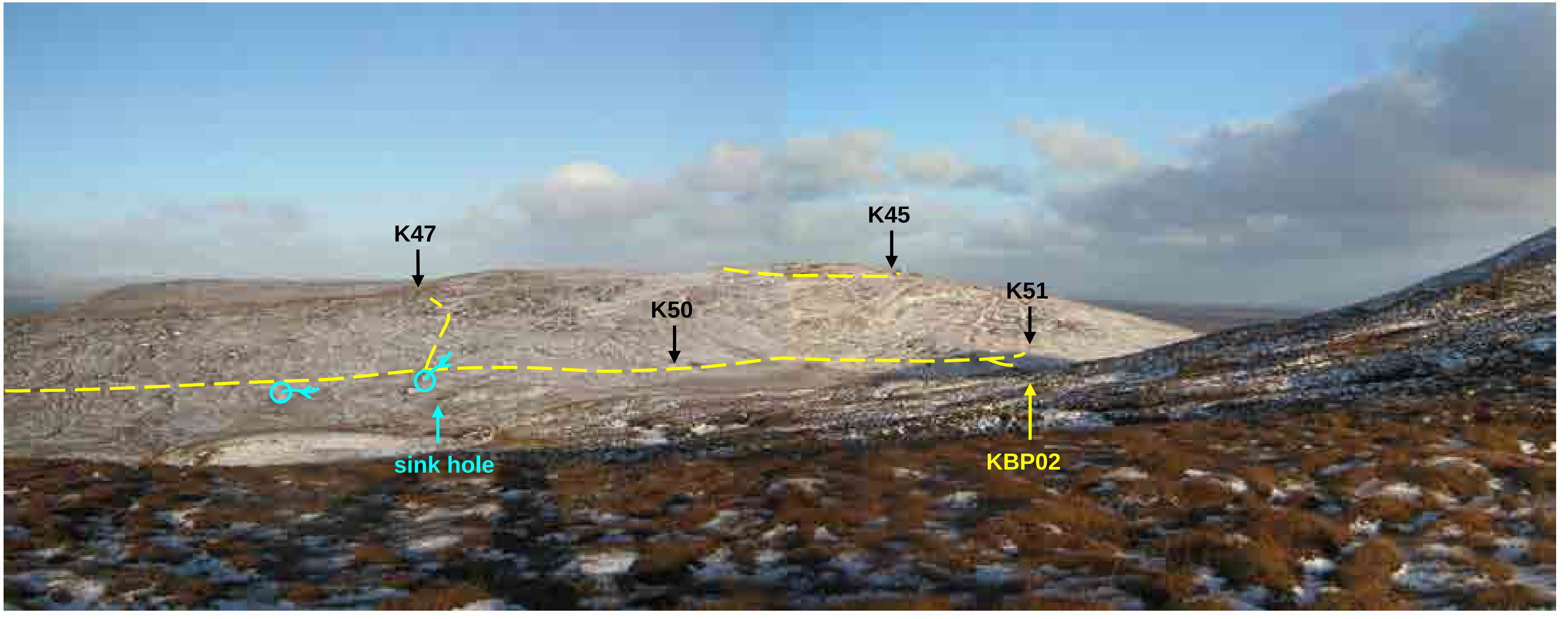
Areas of paler vegetation in the left foreground mark places with mixed vegetation cover and rock exposure, as does the section between the two track lines in the right middle distance. Vegetation is dominated by blanket mire species of grass, sedges, moss and some heather.

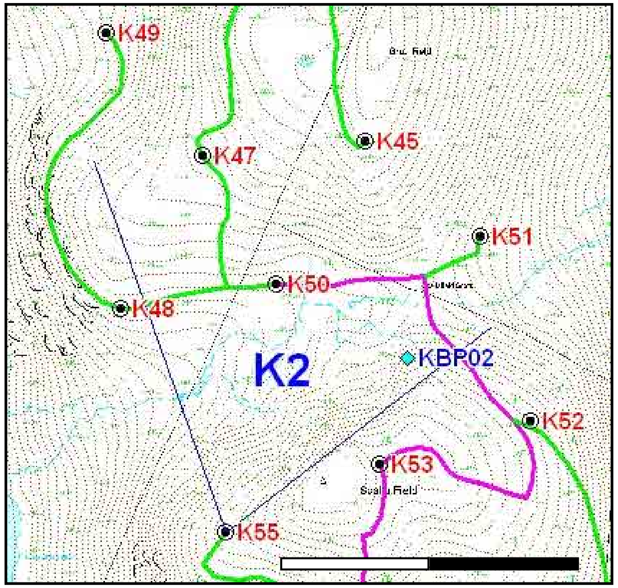
The track line has been planned to take advantage of the rocky ground and shallower peat where this is possible.

3.8 Area K2

Area K2 has a similar topographical setting to Area K1, encompassing Scallafield Scord col with Turbine K51 and Gruti Field with Turbine K45. The northern slopes of Scalla Field, visible in the right middle distance of Figure 20, are steep with angles up to 40° and have fairly substantial exposures of bedrock. These continue northwards to the site of proposed borrow pit KBP02, just south of Scallafield Scord, which has excellent bedrock exposed as rocksteps and slabs.

Figure 20 View north-east across Area K2 from the west ridge of Scalla Field, at Turbine K55 (HU 3863 5710). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; heather, sedge/grass, moss
Peat depths (m):	Maximum: 4.0; minimum: 0.0; average: 1.6
Erosion patterns:	Smooth vegetated slopes with drainage channels
Instability:	Partially collapsed peat pipe; no other instability observed

Notes:

The main watercourse, the Red Burn, follows the prominent valley down west from Scallafield Scord, near Turbine K51 (Figure 20). The track route runs along the valley side approximately parallel to the burn.

Figure 20 indicates that the area has extensive peat cover. Peat probing indicates that the main valley has fairly deep peat, especially within the valley floor where peat is largely in excess of 1.5m deep. Across the top of Gruti Field, around Turbine K45, peat depths are all <1m although these show a slight increase in the area around Turbine K47 with depths up to 1.7m at the turbine itself.

The peat cover is mostly fairly smooth although it is dissected in places by drainage channels. These are clearly visible around the track line towards the left hand side of Figure 20. A partially collapsed peat pipe has been identified in the area west of Turbine K50, marked by sink holes (Figure 20).

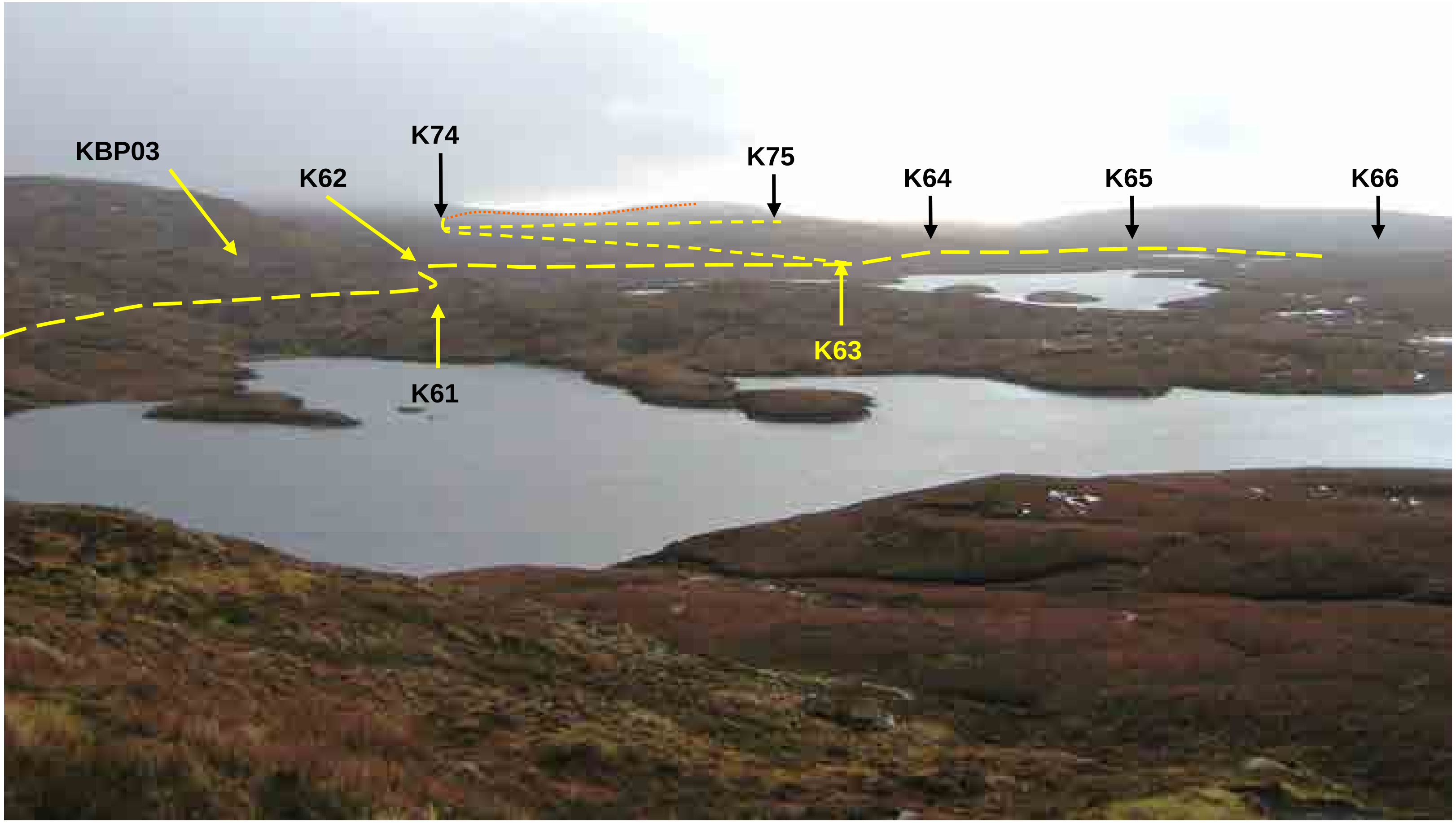
Pale vegetation visible on the hilltops and steeper slopes is indicative of dryer conditions where the peat is thinner. Most vegetation in the area consists of a typical blanket bog mix of grass, sedges, heather and moss.

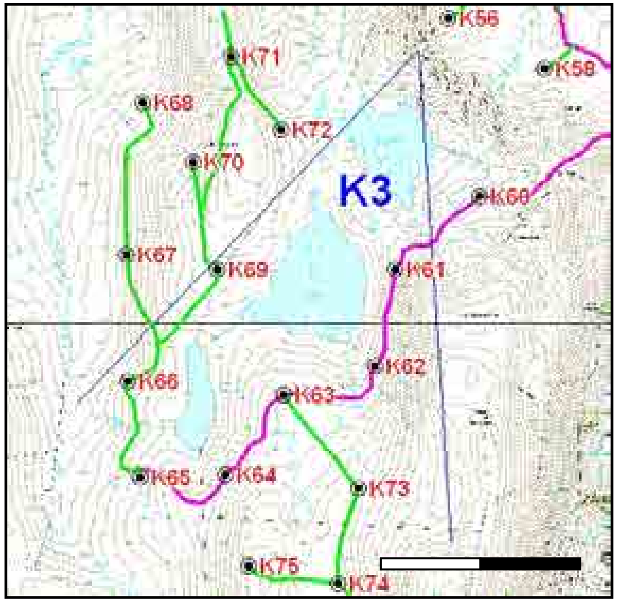
The track has been routed to skirt the main valley, taking advantage of shallowing peat along the valley sides but also modest slope angles along the hillside.

3.9 Area K3

The central part of Kergord quadrant includes several lochs of varying sizes and the wind farm infrastructure has been positioned carefully with respect to these important hydrological features. Area K3 covers part of central Kergord and is shown in Figure 21.

Figure 21 View south-west across Area K3 from the flanks of Scalla Field (HU 3833 5644) over Lamba Water and Maa Water. Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation: Blanket mire; sedge/grass, moss, heather

Peat depths (m): Maximum: 4.0; minimum: 0.4; average: 1.9

Erosion patterns: Smooth vegetated slopes with drainage channels and exposed bedrock

Instability: Minor cracking on steep slopes of Scalla Field; no other instability observed

Notes:

Lamba Water is clearly visible in the middle distance of Figure 21, with Maa Water behind. An area of low-lying boggy ground links the two lochs at the western side

Area K3 has extensive but variable peat cover and areas with good rock exposure. Rock outcrop is visible in the foreground of Figure 21 and proposed borrow pit KBP03 is indicated in the photograph; this site exposes extensive slabs of bedrock which continue along the slopes of the hill both north-east and south of the borrow pit site. The ridge of higher land between the two lochs has good exposure of bedrock.

Peat probing along the tracks indicates that peat is mainly between 1 and 2.5m deep with areas of both deeper and shallower peat. The area behind Maa Water, around Turbine K63, is mainly deeper as this is fairly flat and provides most of the headwaters for the loch. The track between Turbines K63 and K74 crosses an area of more uniform blanket peat and has measured depths to 3.2m.

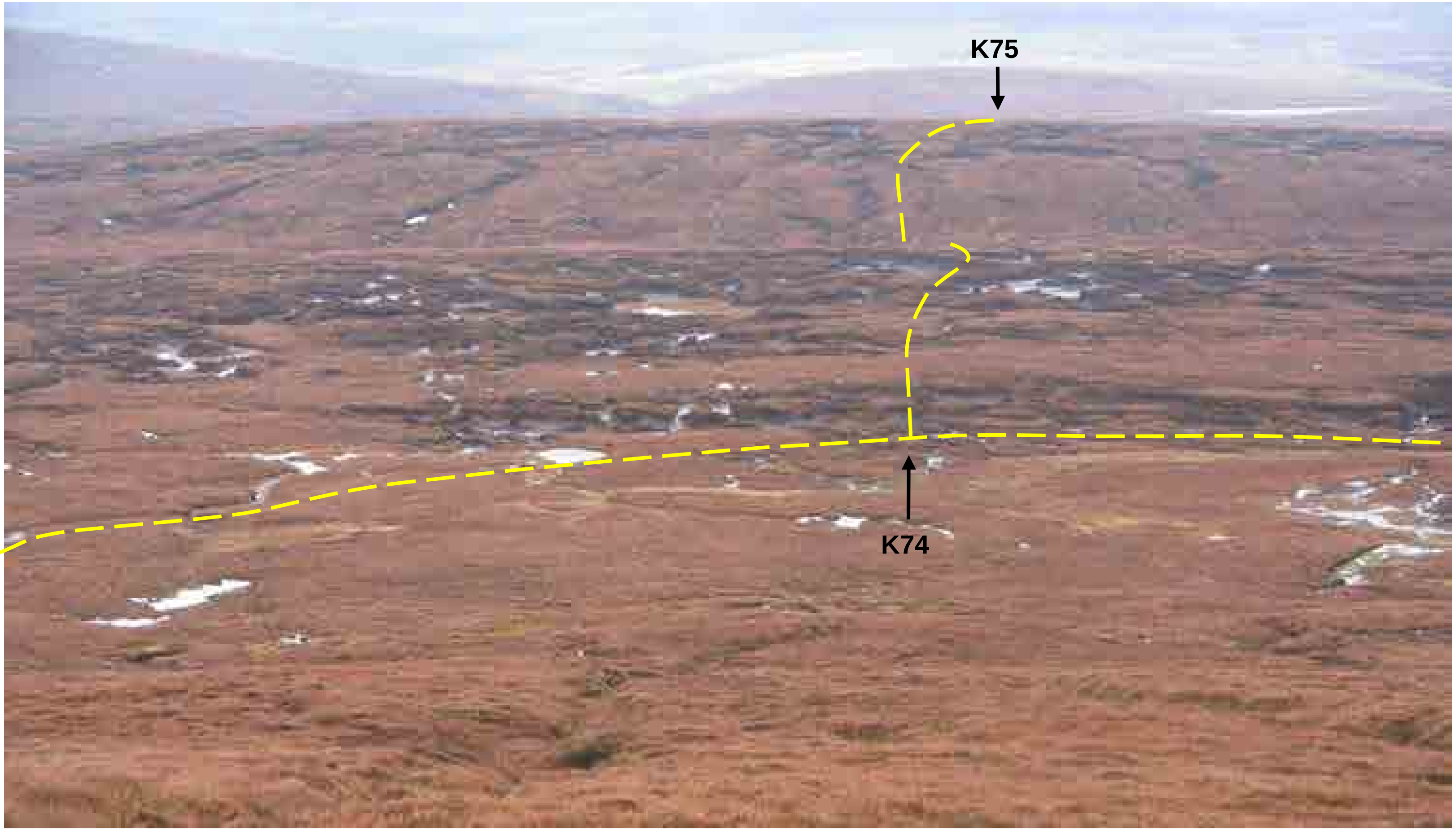
The mixed vegetation visible in the foreground indicates that peat cover is generally thinner and the drainage better in this part of the area. Similar vegetation patterns can be seen on other rocky parts of the area, for example around KBP03. Most of the area vegetation is dominated by the typical blanket mire mix of grass, sedges, moss and heather.

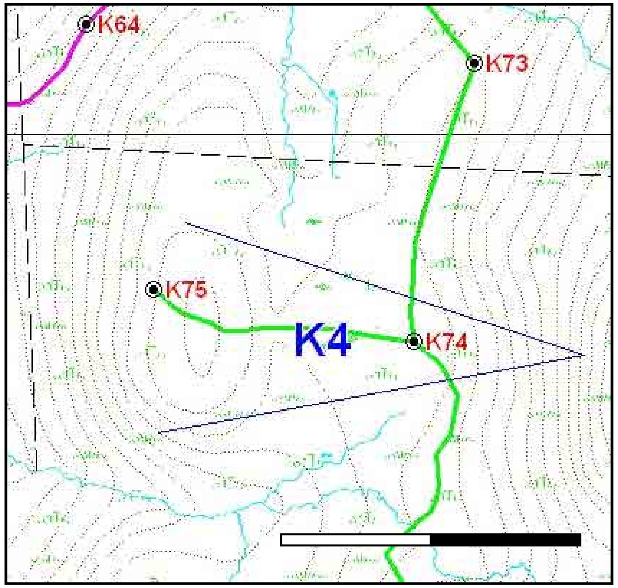
For the most part, the track has been routed to take advantage of the break in slope between the steeper hills and the flatter area immediately around the lochs, whilst maintaining a buffer zone between the lochs and the track line.

3.10 Area K4

Towards the southern part of Kergord, blanket peat becomes dominant again. This is clearly shown in Figure 22 with a view across Area K4.

Figure 22 View west across Area K4 from the flank of West Hill of Weisdale (HU 3821 5360). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 500m).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather
Peat depths (m):	Maximum: >4.0; minimum: 0.8; average: 2.4
Erosion patterns:	Extensive gullying and erosion with exposed bare peat
Instability:	No signs of instability in the area

Notes:

Area K4 is situated on a shallow col with watercourses draining to north and south. The track line crosses the col and continues on over a low hill to the west, with Turbine K75 just over the summit. A distinct break in slope is visible in the foreground of Figure 22 before Turbine K74.

This area has extensive peat coverage with widespread erosion and gullying across the col area and distinctive drainage channels visible on the sides and summit of the hill to the west (Figure 22). In contrast, the lower slopes in the foreground are fairly smooth and continuous.

Peat depths in this area are generally deep, mainly in excess of 2m and in places more than 4m. Track construction is consequently most likely to be floating.

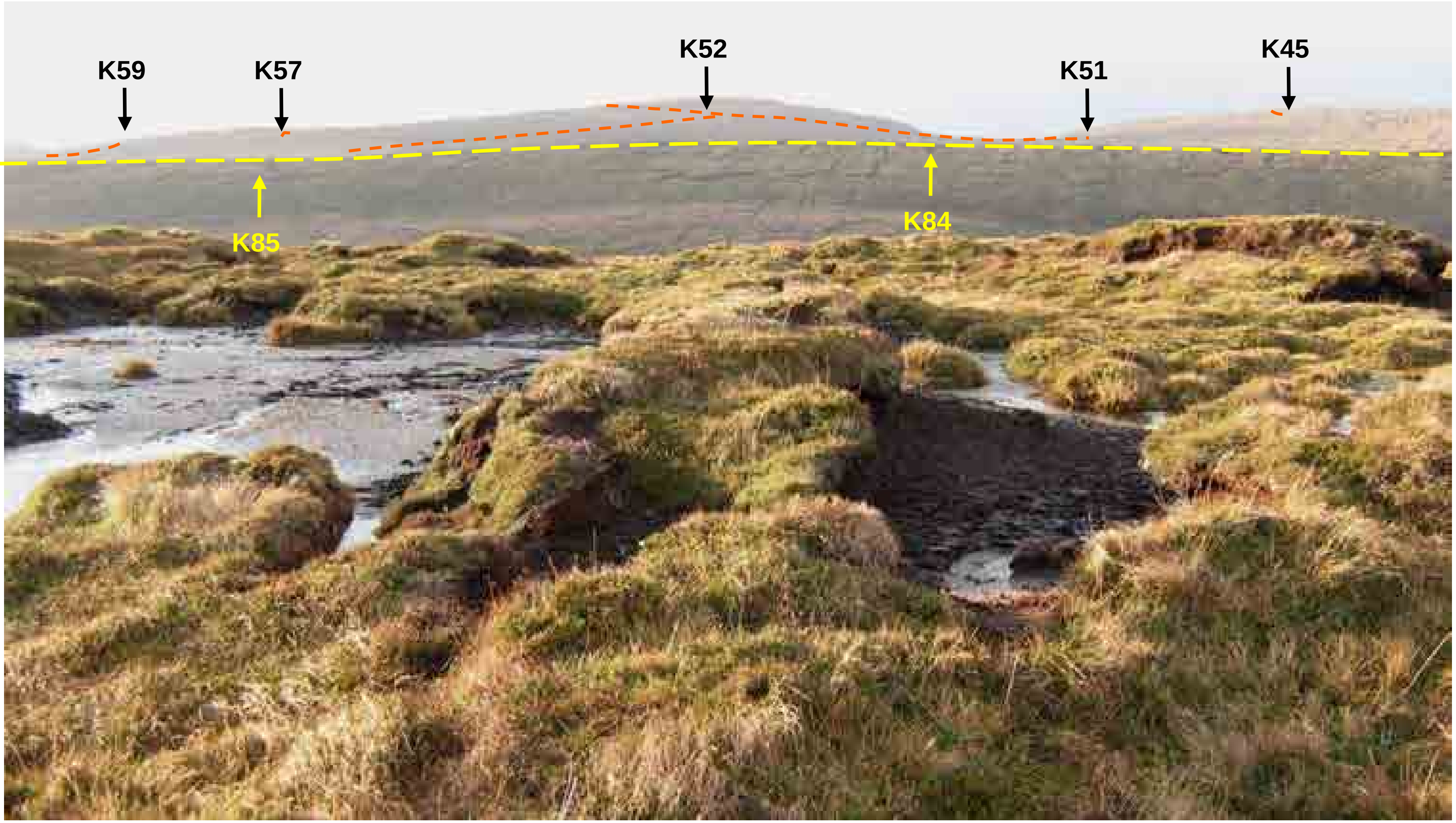
Vegetation in the area is dominated by typical blanket mire vegetation consisting of grass, sedges and moss. Subordinate heather is present in places. Paler green areas demark deep bog channels, characterised by floating mats of *Sphagnum* moss, and eroded areas expose large amounts of bare peat. In general, the bare peat is not showing signs of significant revegetation in this area.

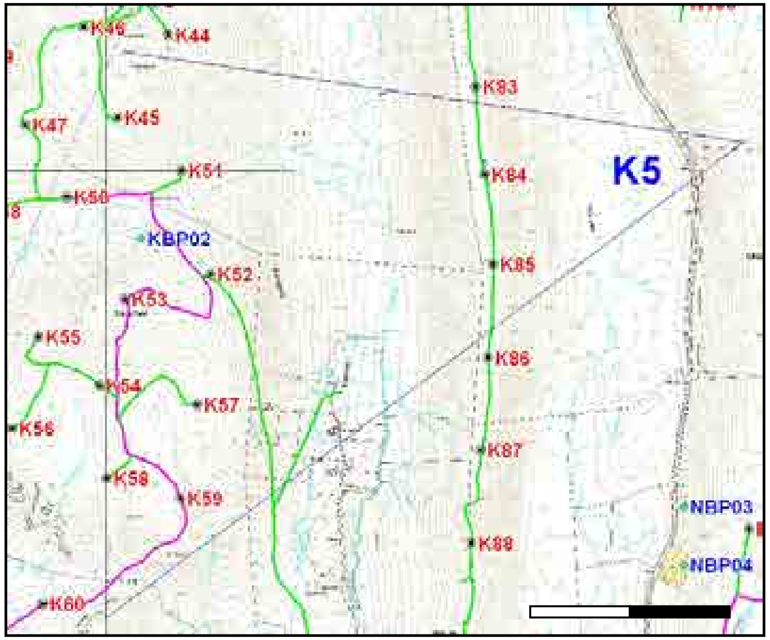
Owing to the prevalence of deep peat in this area it is not possible to route the track so as to avoid it. The track line follows areas with shallow slope angles as far as possible and is confined to the crest of the col between Turbines K74 and K75.

3.11 Area K5

Mid Kame dominates the eastern side of Kergord quadrant and forms a long, straight and steep-sided ridge with prominent breaks in slope at the top and bottom of each side. Figure 23 shows a view across Mid Kame to Scalla Field from the western side of Nesting quadrant.

Figure 23 View west across Area K5 from East Kame (HU 4242 5815) to Mid Kame and Scalla Field. Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather; subsidiary grassland
Peat depths (m):	Maximum: >4.0; minimum: 0.0; average: 1.4
Erosion patterns:	Dissected by drainage channels; extensive hagging along ridge and hill tops
Instability:	No signs of instability in the area

Notes:

Area K5 includes parts of East Kame (foreground), Mid Kame (centre) and West Kame (including Scalla Field) ridges, separated by Petta Dale and the Valley of Kergord respectively. Proposed infrastructure is mostly restricted to the higher ground.

Peat depths are very variable across this area, owing to the variable topography. The steeper slopes have peat depths up to 1m; in the valley floors peat is in places in excess of 4m and mostly more than 2m deep.

The summit of Mid Kame has been extensively eroded for most of its length, down to bare mineral soil, with remnant peat haggs up to 2m in height in places. The ridge sides show distinct drainage channels, although the steepness of the slopes precludes build-up of substantial peat deposits. The steep sides of Gruti Field, around Turbine K45, show similar drainage channel patterns to Mid Kame.

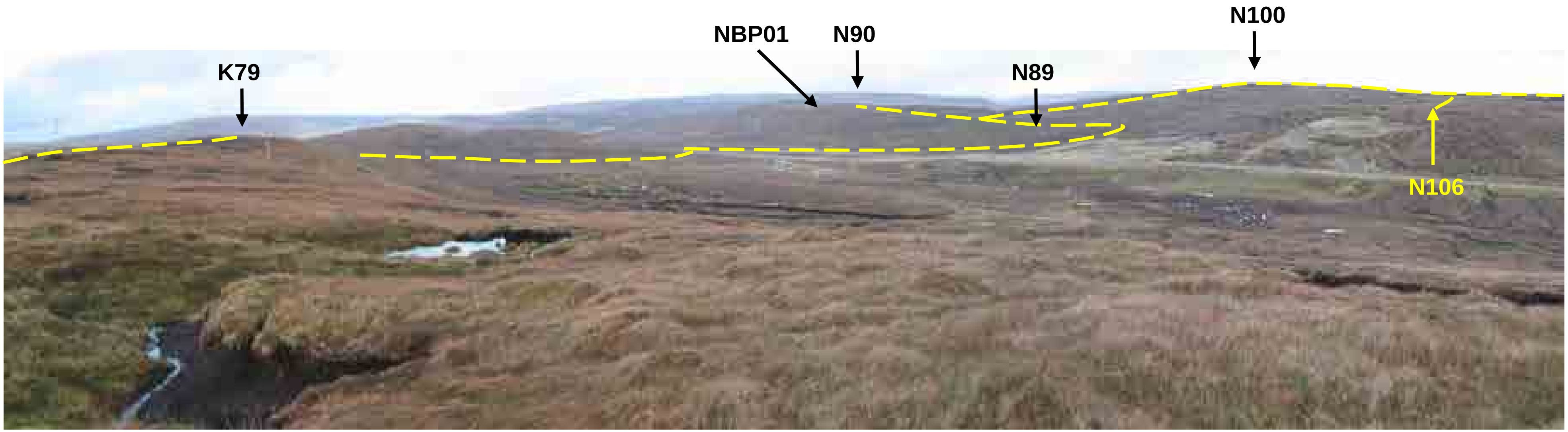
Vegetation along the side of Mid Kame appears greener than the typical tawny blanket mire vegetation. This reflects the thinner peat and better drainage of this area, giving rise to a dominant grassland vegetation. The foreground is characterised by eroded peat with mossy vegetation.

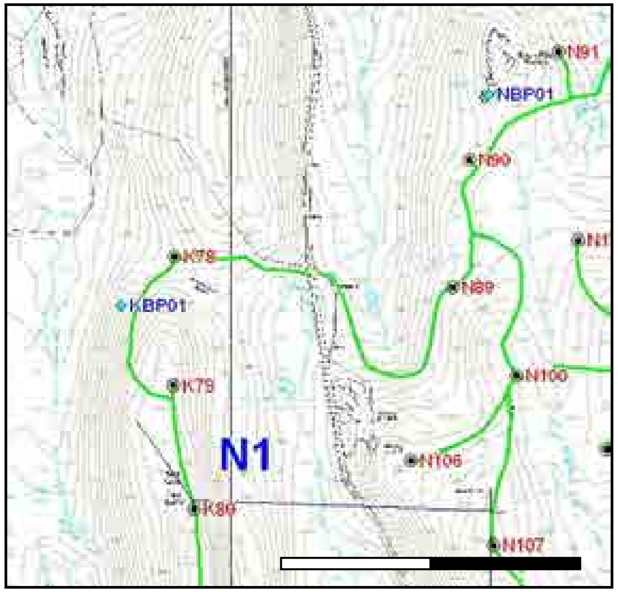
Track lines have been routed to take advantage of ridge lines where possible, in particular along Mid Kame ridge. West Kame is less continuous, although the track follows the high ground as far as is practicable.

3.12 Area N1

Area N1 encompasses the northern end of Mid Kame ridge and the north-western section of Nesting quadrant. The main road A970 can be seen crossing Figure 24 and dividing Kergord and Nesting quadrants. The break in slope that defines the summit line of Mid Kame is clearly visible running from the right of Turbine K79 across the foreground of Figure 24.

Figure 24 View north-east across Area N1 from Mid Kame ridge (HU 4084 5994). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather; subsidiary grassland
Peat depths (m):	Maximum: >4.0; minimum: 0.2; average: 1.8
Erosion patterns:	Dissected by drainage channels; eroded to mineral soil & bare peat in places
Instability:	No signs of instability in the area

Notes:

The headwaters of the Burn of Pettawater and the Wester Filla Burn are visible in the middle distance, just below the A970. An overhead power line can be seen crossing Mid Kame in front of Turbine K79.

Figure 24 indicates that the blanket peat cover in this area has been subject to considerable erosion. Measured peat depths across this area are variable, with deeper peat (in excess of 2m) occurring mainly on the valley floors. Shallower peat, mainly less than 1.5m, is found on the steep sides of Mid Kame.

Along Mid Kame, towards Turbine K79, bare peat is exposed and a peat bank is visible in the foreground. In places peat has been eroded to mineral soil. Similar erosion patterns are apparent on hill tops in north Nesting. Extensive erosion to form drainage channels can be seen around Turbine N106, at the right-hand side of Figure 24.

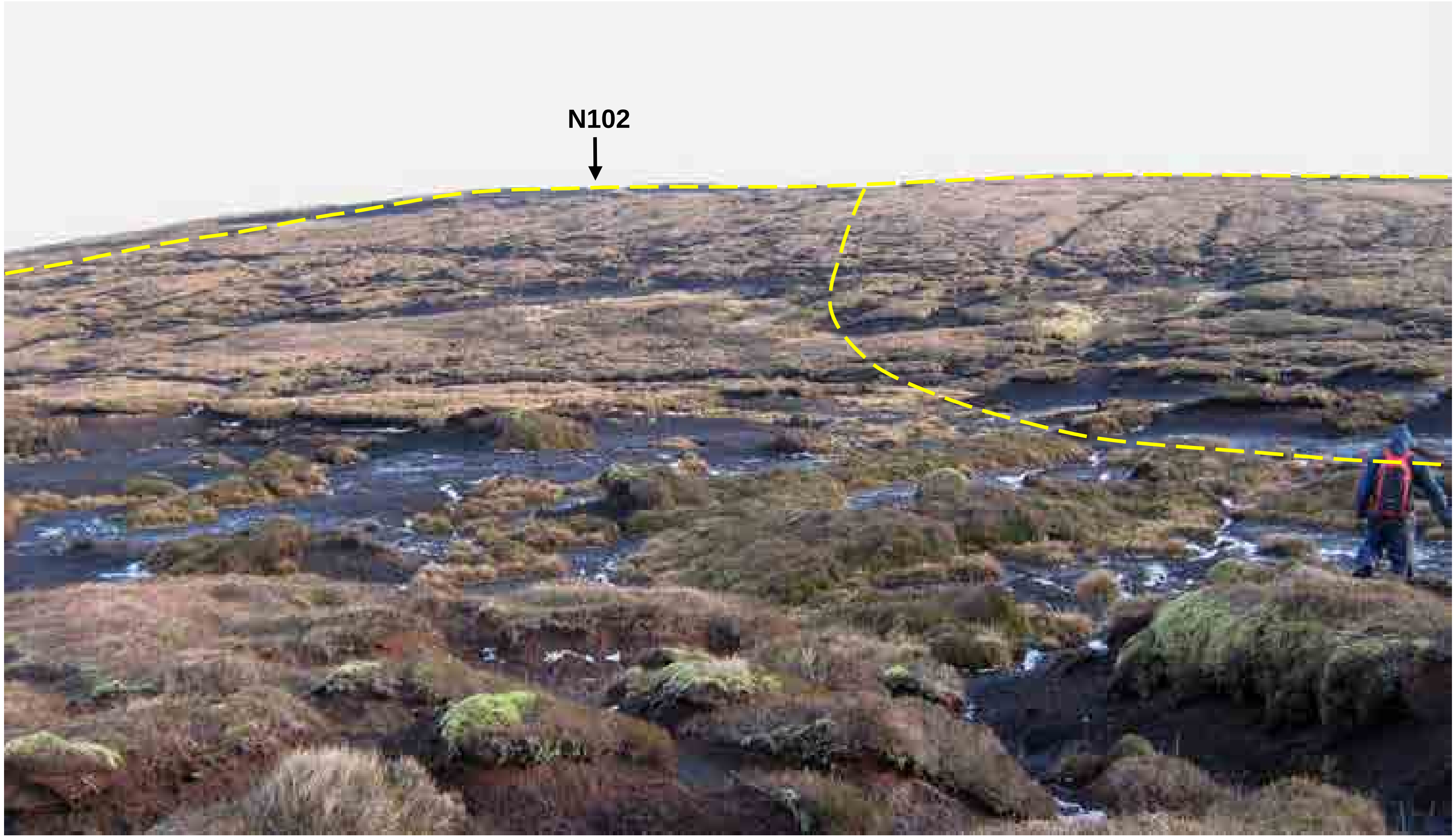
Vegetation is dominated across the area by tawny-coloured blanket mire vegetation. Paler green to straw-coloured areas are dryer, such as the quarry and track area immediately below Turbine N100, where grassland species are prevalent. An area of greener vegetation around borrow pit NBP01 marks the presence of marble bedrock which has a distinct natural flora.

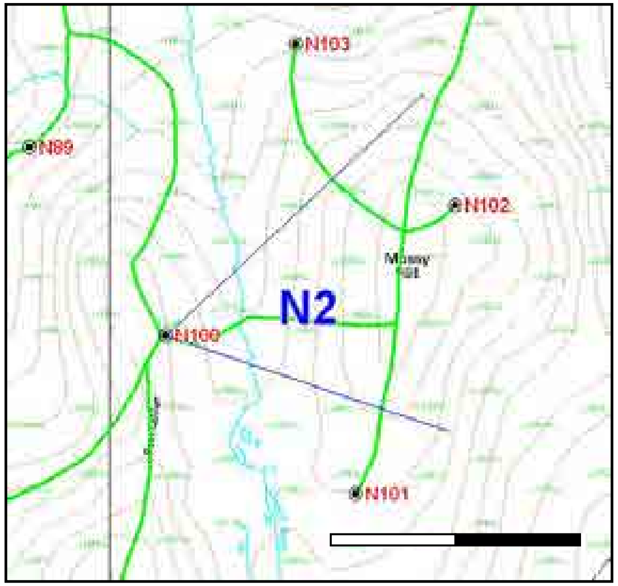
Track lines have been routed to avoid the wetter areas and deeper peat where possible.

3.13 Area N2

Many of the cols and valleys in Nesting quadrant are characterised by extensive peat erosion and gullying. Area N2, shown in Figure 25, provides a good example of this. Slopes in this area are fairly smooth with moderate slope angles and no clearly defined breaks in slope.

Figure 25 View east across area N2 from Turbine N100 (HU 4209 6042). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 500m).





Habitat type/vegetation: Blanket mire; sedge/grass, moss, heather

Peat depths (m): Maximum: 3.7; minimum: 0.6; average: 1.9

Erosion patterns: Extensive erosion and gullying to mineral soil & bare peat; drainage channels in places

Instability: No signs of instability in the area

Notes:

The headwaters of the Easter Filla Burn cross the col although, as the watercourse is not well-developed in this section, this is not clear in Figure 25.

This area has undergone extensive erosion, particularly within the valley floor. Measured peat depths within the valley are mostly in excess of 2m. Some peat on Mossy Hill, around Turbine N102, and in the left foreground of Figure 25 is shallower than 1m.

The peatland in this area has been heavily eroded, with expanses of bare peat and mineral soil visible in places especially in the valley floor and on hill tops. Along the slopes of Mossy Hill distinct drainage channels are clear.

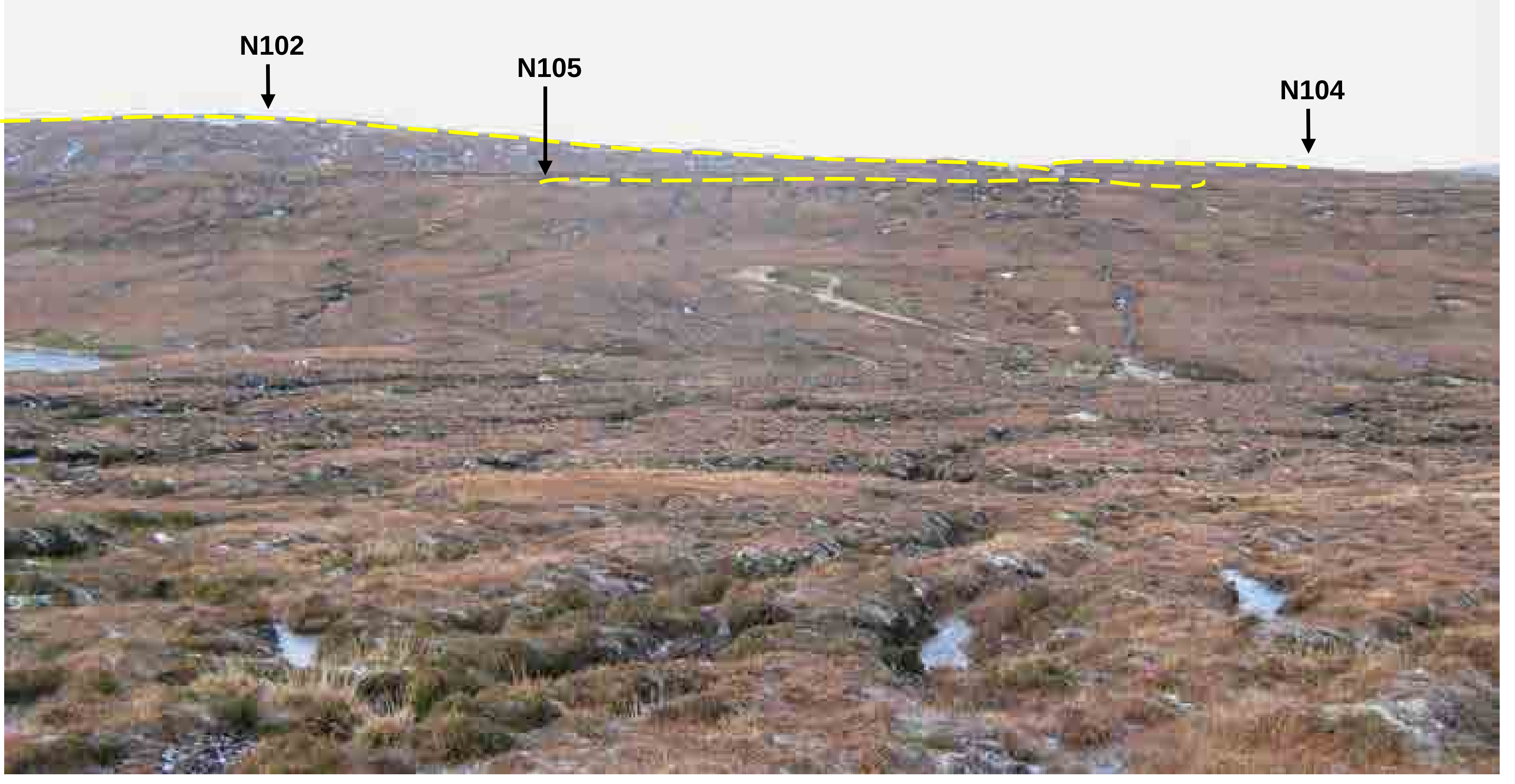
Areas of bare peat are showing little sign of revegetation although some peat banks in the foreground have lichen and new moss growth. Most of the area has typical blanket mire vegetation dominated by grass, sedges, moss and heather.

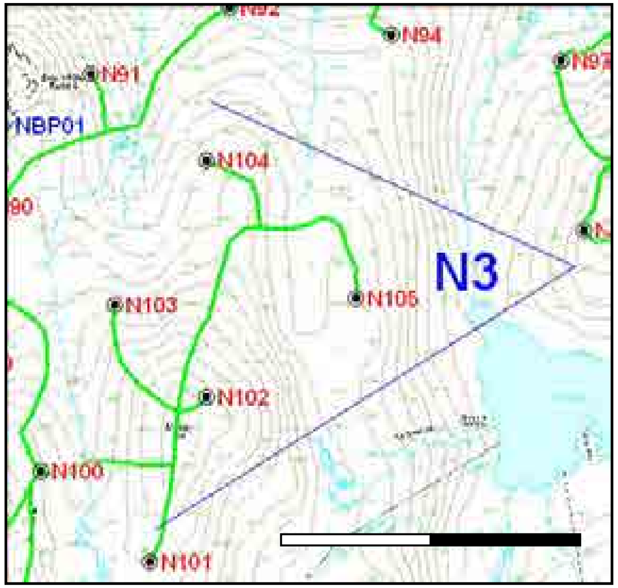
The track route crosses just below the summit of the col, to avoid the deep and extensive hagging and boggy ground in this area. An additional track follows the eroded ground along the summit of Mossy Hill between Turbines N101 and N102.

3.14 Area N3

Area N3 covers part of northern Nesting showing a typical example of the peatland present. This area includes the upper part of the Burn of Gossawater valley, with Gossa Water itself visible at the left-hand side of Figure 26.

Figure 26 View west across Area N3 from the south-west slopes of Strani Field (HU 4377 6107). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather
Peat depths (m):	Maximum: 2.7; minimum: 0.2; average: 1.5
Erosion patterns:	Dissected by drainage channels & gullies
Instability:	No signs of instability in the area

Notes:

The Burn of Gossawater valley runs from Gossa Water, to the left-hand side of Figure 26, across to the right. Minor tributaries are visible on the slope below Turbine N105, one of which is marked by a distinct pale green channel.

The peat in this area is heavily dissected by drainage channels, mostly running directly down-slope. Peat probing indicates that peat depths are quite variable and mostly within the range of 1-2m. Pockets of deeper peat and areas of shallow peat are present in some places but are generally small.

More extensive hagging can be found along ridge tops, in particular around Turbine N102. Areas with more gentle slopes tend to have more intact blanket peat; this is clear from the mid-section of Figure 26 where slope angles become slightly shallower.

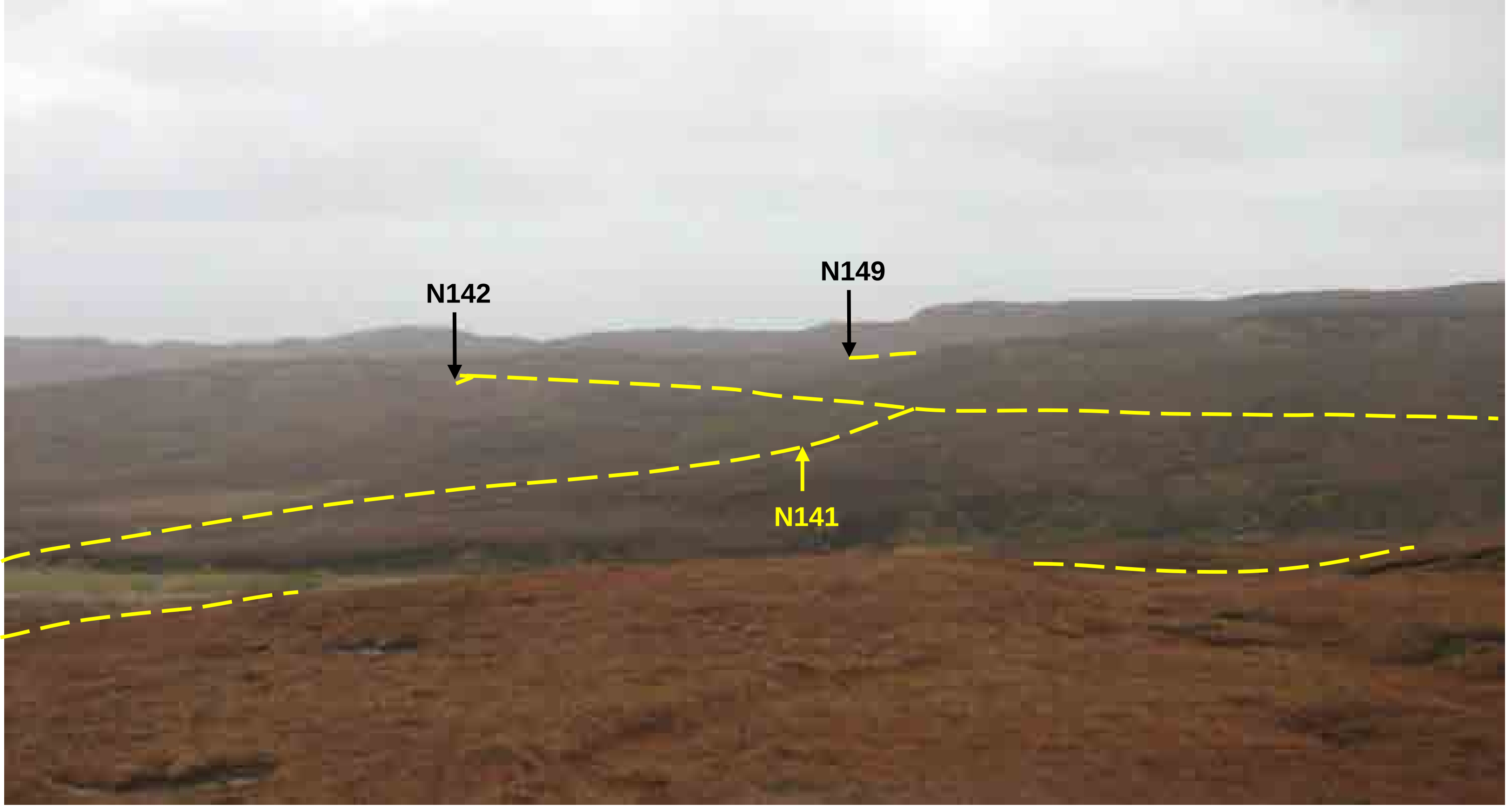
In addition to the distinct pale green watercourse channel mentioned above, areas of brighter green mark wet and boggy sites. Dryer areas are marked by an increase in heather; an example is visible in the foreground of Figure 26.

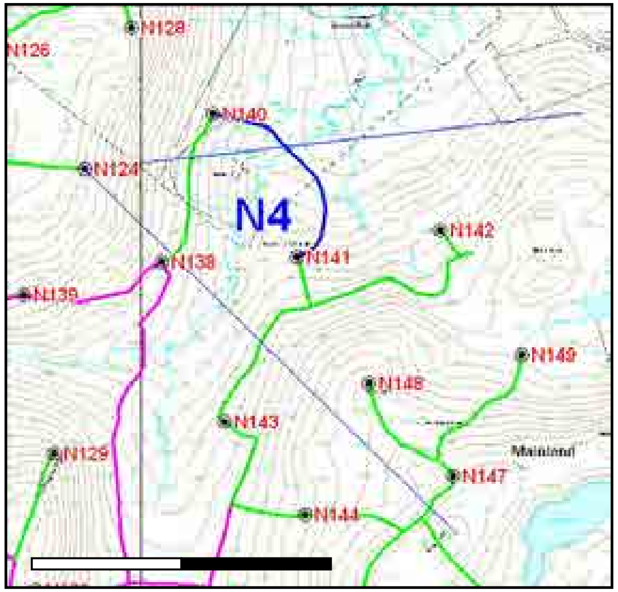
Track lines mainly follow ridge and hill crests as the peat tends to be thinner and more eroded in these areas.

3.15 Area N4

Area N4 provides a representative view across the eastern part of Nesting quadrant (Figure 27). In the middle distance, the incised valley contains the Burn of Grunnafirth which is one of the larger watercourses in this quadrant.

Figure 27 View east across Area N4 from Turbine N124 (HU 4480 5864). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation: Blanket mire; sedge/grass, moss, heather

Peat depths (m): Maximum: >4.0; minimum: 0.0; average: 1.8

Erosion patterns: Smooth vegetated slopes with some drainage channels

Instability: Small slumps along incised river valleys; no other instability observed

Notes:

The Burn of Grunnafirth valley crosses the area flowing roughly south–north. The valley is quite incised with steep sides. The burn itself, with its tributaries, drains much of the central and eastern part of Nesting quadrant. The track crosses the burn at the northern margin of the area.

As indicated in Figure 27, this area has a fairly uniform cover of blanket peat. Measured peat depths are quite variable, with pockets of deep peat (in excess of 2.5m) and areas of shallow peat (less than 1m). Most of the area has peat probing depths between 1 and 2m.

Although the slopes are mostly smooth and well-vegetated, there are some drainage channels in addition to the main burn valley. Minor slumping scars are visible on the east bank of the Burn of Grunnafirth, below and right of Turbine N141; these are a result of bank undercutting on the stream bend.

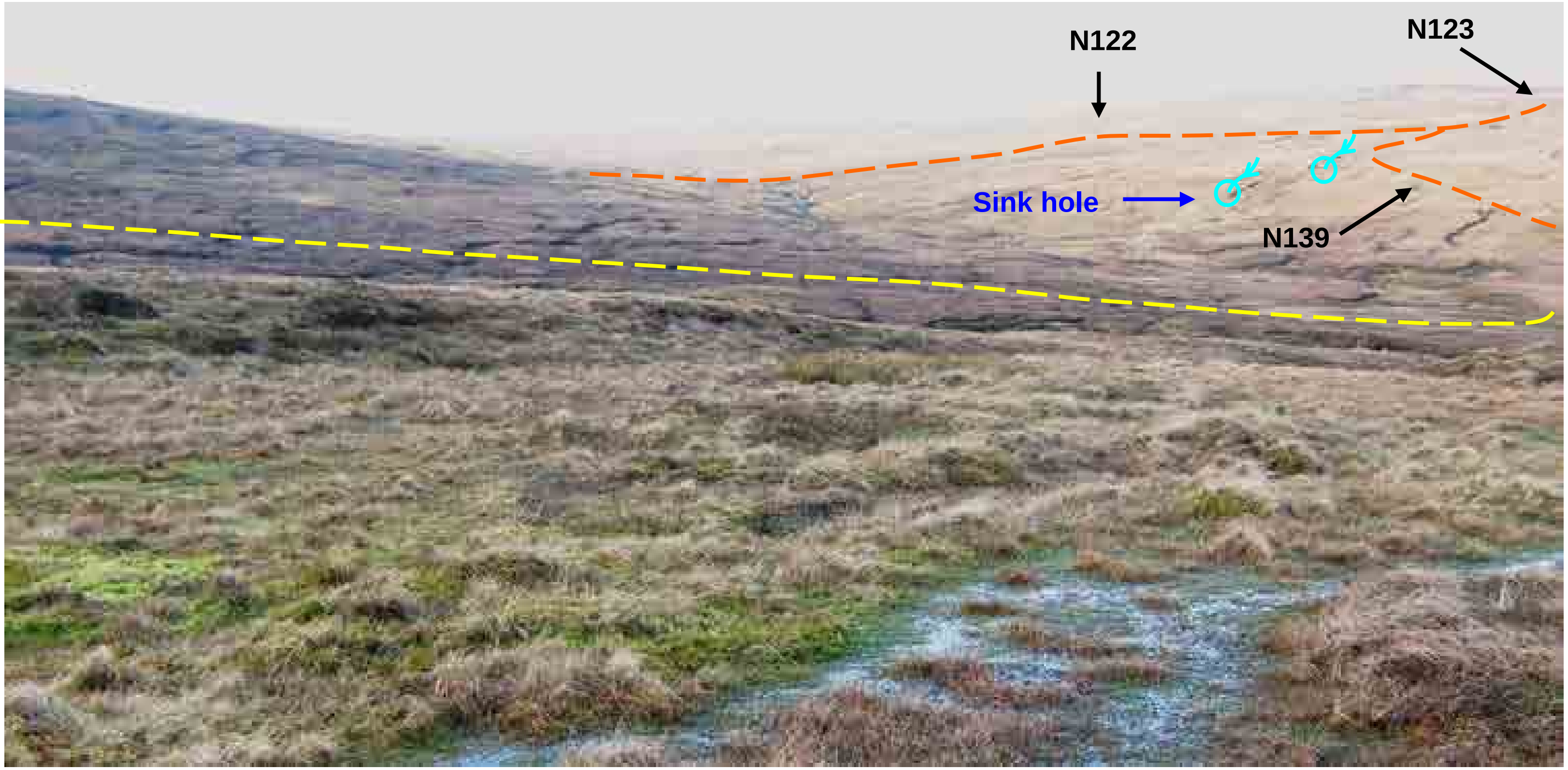
Areas of greener vegetation indicate better drainage and development of grassland habitat; an example of this can be seen towards the left-hand side of Figure 27 in the Burn of Grunnafirth valley. The area is dominated by typical blanket mire vegetation of grass, sedges, moss and heather.

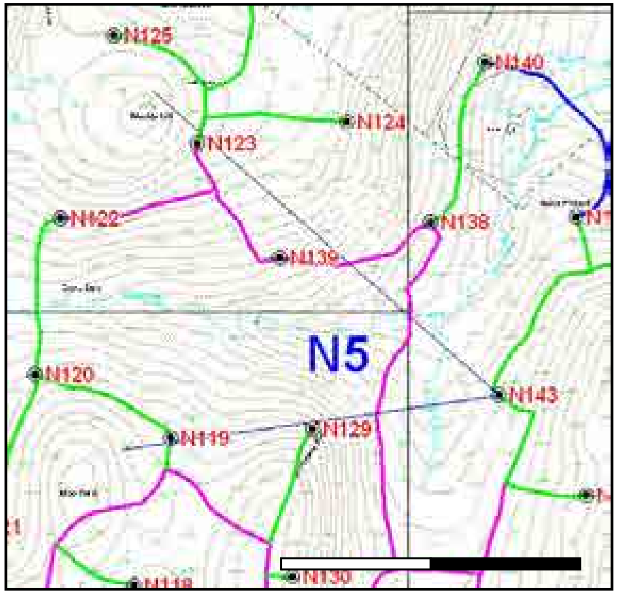
The track lines have been routed to follow the stream valley whilst maintaining a buffer zone around the stream. Tracks have been routed to avoid deep peat and steeper slopes where possible.

3.16 Area N5

Area N5 covers the Burn of Forse valley, which is one of the principal tributaries to the Burn of Grunnafirth. This area includes part of the central Nesting infrastructure, as shown in Figure 28.

Figure 28 View west across Area N5 from Turbine N143 (HU 4530 5772). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation: Blanket mire; sedge/grass, moss, heather

Peat depths (m): Maximum: 3.9; minimum: 0.1; average: 1.5

Erosion patterns: Dissected by drainage channels and streams

Instability: Collapsed peat pipes; no other instability observed

Notes:

The Burn of Forse valley runs through the centre of Area N5, with a small tributary stream channel visible in the foreground of Figure 28. The Burn of Forse is fairly incised with waterfalls in places.

Area N5 has extensive blanket peat cover. Peat probing indicates that peat within the main valley is generally deeper than 1.5m although shallower areas are present in places. On the side slopes peat depths are variable with pockets of deep peat and areas of shallow peat widely distributed across the area.

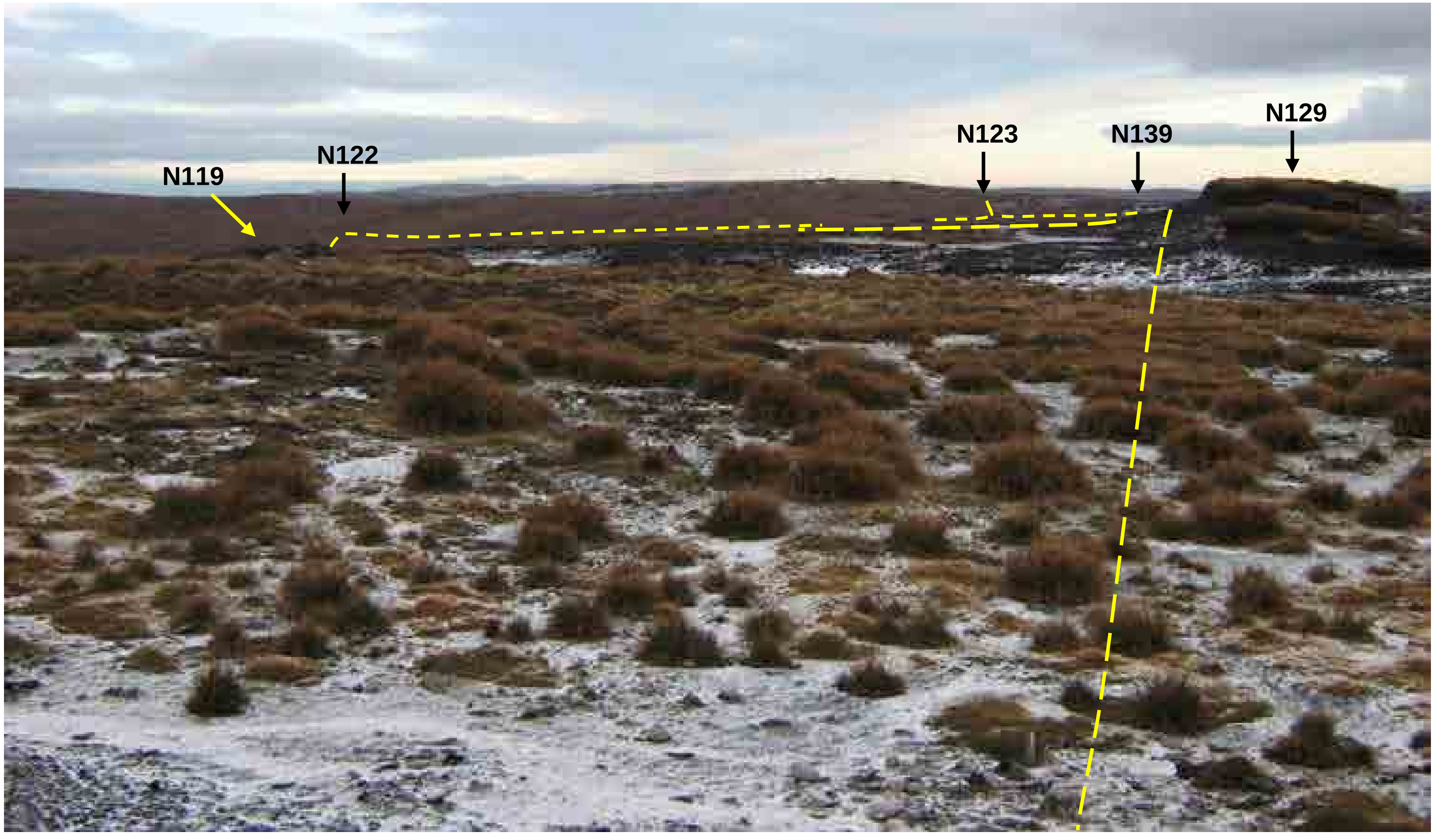
The peat is dissected by drainage channels and streams, some of which take the form of collapsed or partially collapsed peat pipes. Additional unidentified peat pipes may exist in the area. Boggy areas, such as the one visible in the foreground of Figure 28, occur in places.

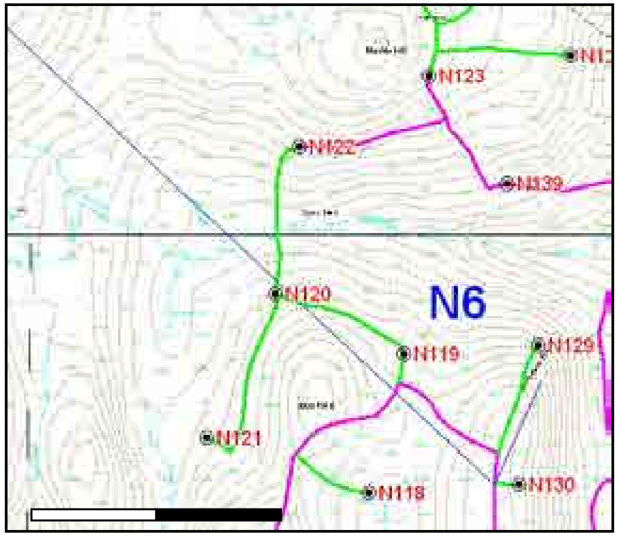
Most of the area has typical blanket mire vegetation of grasses and mosses with heather in places. Boggy areas are indicated by brighter green vegetation, mostly *Sphagnum* mosses; a good example is visible in the foreground of Figure 28.

3.17 Area N6

Many if the ridge and hill tops within Nesting quadrant have been subject to extensive erosion. Area N6 provides a good example of this terrain with isolated haggs, exposed bare peat and some revegetation surfaces (Figure 29).

Figure 29 View north across Area N6 from Turbine N130 (HU 4452 5711). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; sedge/grass, moss, heather
Peat depths (m):	Maximum: 3.9; minimum: 0.0; average: 1.6
Erosion patterns:	Extensive bare peat & isolated haggs; some revegetation
Instability:	No signs of instability in the area

Notes:

The Burn of Forse valley runs through Area N6, although it is not clearly visible in Figure 29. The area includes the northern half of the Hill of Flamister, and across to Muckle Hill on the north side of the Burn of Forse.

Peat probing indicates that peat depths across the Hill of Flamister are generally shallow, mainly less than 1m. Remaining peat banks stand to around 1.5 to 2m above the erosion surface. Peat depths along the side of Muckle Hill, in the distance of Figure 29, are mostly within the range 1-2.5m deep.

The summit areas of both the Hill of Flamister and Muckle Hill have undergone severe peat erosion, leaving expanses of bare peat with isolated peat haggs in places; an example is visible to the right-hand side of Figure 29. The peat has been eroded to mineral soil in places.

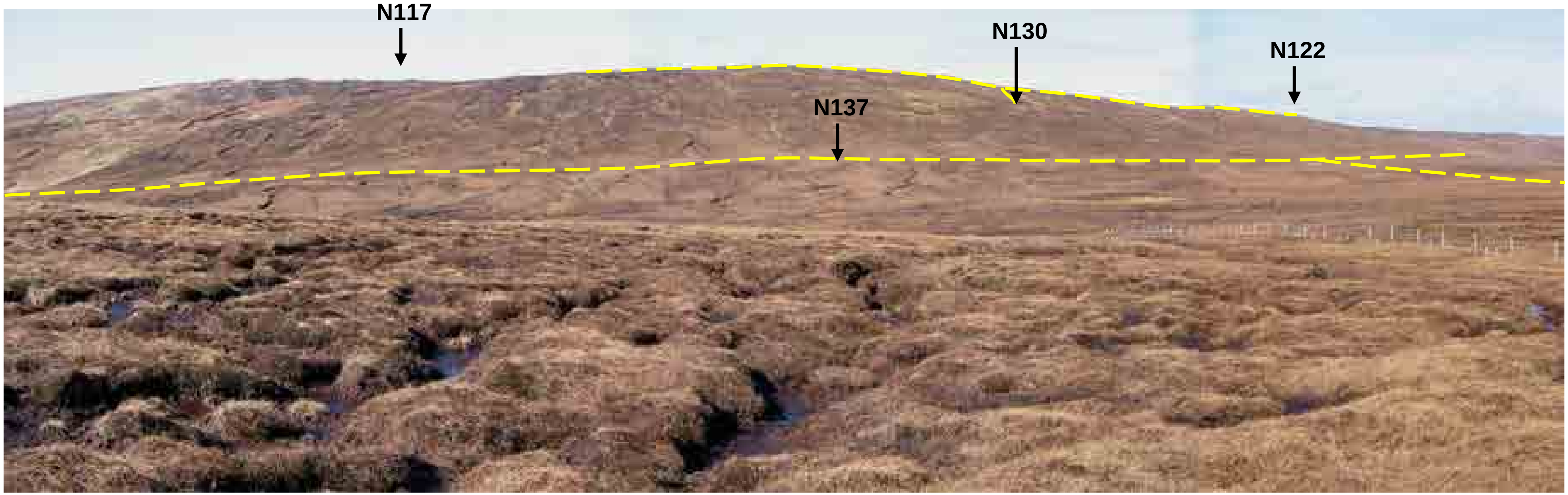
Some erosion surfaces are showing signs of revegetation; this is clear in the foreground of Figure 29 where moss and tufts of sedge and grass cover some of the exposed peat. Remnants of blanket mire vegetation can be seen on top of the isolated haggs.

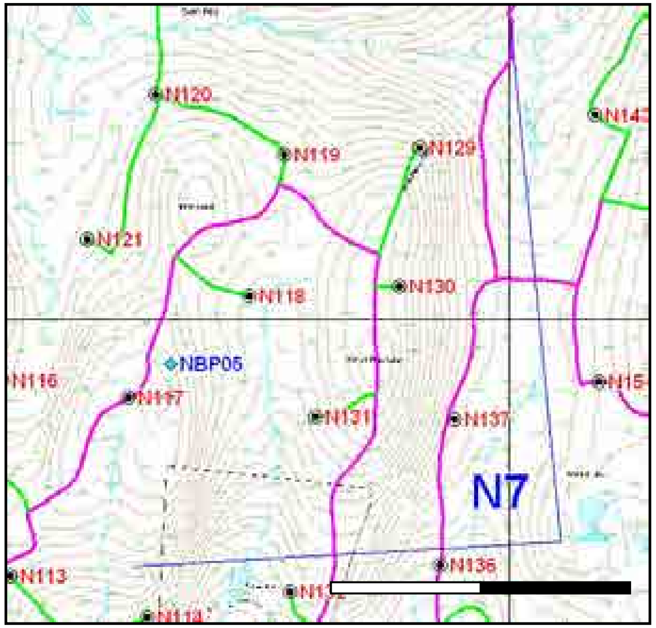
Tracks have been routed to take advantage of the thin and eroded peat along ridge and hill tops to minimise impacts on intact and active blanket mire.

3.18 Area N7

Area N7 covers a wide section in the southern part of Nesting quadrant, including the Hill of Flamister and part of the Dud of Flamister. Figure 30 shows a view across the area. Both of the main hills are defined by distinct breaks in slope at the top and bottom. The lower, concave, break in slope lies above and behind the proposed track line.

Figure 30 View north-west across Area N7 from South Black Water (HU 4517 5622). Approximate positions of tracks and turbines are shown for reference; lines of sight are indicated in the accompanying map (scale bar 1km).





Habitat type/vegetation:	Blanket mire; heather, sedge/grass, moss
Peat depths (m):	Maximum: >4.0; minimum: 0.0; average: 1.2
Erosion patterns:	Dissected by drainage channels; extensive hagging at high levels
Instability:	No signs of instability in the area

Notes:

Area N7 includes a col between Bow Field and the Hill of Flamister, visible to the right-hand side of Figure 30. Down to the left from the col are the headwaters to the Burn of Quoys.

Figure 30 indicates that the area has fairly uniform coverage of blanket peat. Measure peat depths along the lower track section are mostly within the range 1-2.5m with occasional deep and shallow measurements. Along the summit of the Hill of Flamister peat depths are generally less than 1m owing to the extensive erosion that has occurred here.

Although the hill and ridge tops have undergone extensive erosion, visible along the skyline around Turbine N117, the lower slopes are characterised by drainage channels and gullies. These cause dissection of the peatland and expose bare peat in the banks and gully bases, as shown in the foreground of Figure 30.

Larger watercourses on the Hill of Flamister are indicated by lines of pale green vegetation. Otherwise, the area is dominated by the typical blanket mire vegetation of grass, sedges, moss and heather. These are clearly visible in the foreground of Figure 30.

The track lines follow the eroded hill crests where possible, to take advantage of the less active peat in these areas. The lower track line follows the side of the valley, where the slope angles remain moderate but to avoid the deeper peat present in the main valley floor.

4 PEAT DEPTH SURVEY

The peat depth survey for the Viking Wind Farm was carried out using a two-phase approach. During March 2006 a team visited the wind farm site prior to the production of an infrastructure layout and undertook peat probing at 1762 locations across the site. The peat probing data were collected along selected transects across the proposed site at a mixture of 20m and 50m spacings. This sampling allowed the characterisation of peat depths in different topographical settings, such as on ridge lines and summits, in valleys and on cols, and on slopes of varying angles. The position of each probing location was identified using a handheld GPS with a typical accuracy or +/-7m and peat depths were measured to an accuracy of +/-5cm to a maximum of 4m depth. Where peat deeper than 4m was encountered, the depth was recorded as >4m.

The peat depths were measured using 2m long, 10mm diameter steel rods, connected together into a 4m length where necessary, and marked in 10cm intervals. The rods were pushed into the ground until they could be pushed no further, when the depth was recorded. The underlying substrate can be estimated from the feel of the rod reaching total depth; for example, the rod suddenly hitting a solid surface with a ringing sensation would suggest bedrock, a 'gritty' feel at total depth suggests sandy or gravelly material, and a gradually increasing difficulty in pushing in the rod suggests clayey material underlying the peat.

The collected data from the Phase 1 survey are summarised in Table 3. Locations with deep peat tend to coincide with flat valley floors and cols. Deep peat deposits in higher areas have often been subject to substantial erosion, resulting in extensive exposure of mineral soil and areas of bare peat with isolated haggs and peat banks. The areas with steeper slopes and frequent outcrop were confirmed as having generally shallow peat. The probing results also serve to demonstrate that peat depths can vary substantially over very short distances.

Table 3 Results of Phase 1 peat probing

Peat Depth Range (m)	No. of Points	Percentage of Points
0 – <0.5	299 (194)	17 (11)
0.5 – <1.0	334 (281)	19 (16)
1.0 – <1.5	383 (334)	22 (19)
1.5 – <2.0	317 (364)	18 (21)
2.0 – <2.5	245 (311)	14 (18)
2.5 – <3.0	98 (135)	6 (8)
3.0 – <3.5	32 (60)	2 (3)
3.5 – <4.0	19 (33)	1 (2)
4.0 +	34 (49)	2 (2)
Totals	**1761**	**100**

With reference to Table 3, the results given in parentheses represent a 'processed peat depth' which takes into account the local micro-topography of the peat at the probing point. This information was gathered to allow for the highly eroded nature of the blanket peat in many areas across the wind farm site, to assist with describing the peat depth to a nominal 'surface level'. Processing of the peat depths followed the rules below:

- For a probing point on a uniform, uneroded surface: no adjustment is made;
- For a probing point in a gully: the processed result adds the gully depth to the peat depth result;

- For a probing point on an isolated hagg: the height of hagg is subtracted.

Examples of gully and hagg environments are given in Figure 31 and Figure 32 repectively. The use of processed probing data tends to increase the numbers of deeper peat points and is consequently considered a more conservative approach for peat depth assessment.

Figure 31 Example of a peat gully, Turbine C41 (HU 4300 6478). At this point, the measured peat depth was 0.2m and the gully depth was 2m, giving a processed peat depth of 2.2m.

Figure 32 Example of isolated haggs, near Turbine N117 (HU 4365 5672). The measured peat depth was 1.8m, and the peat hagg height was 1.5m, giving a processed peat depth of 0.3m.

To provide feedback to the client, to aid in the design of the wind farm layout, the results of the first phase of peat depth probing were used to produce an extrapolated indicative peat depth map for the entire study area. A grid of 100m x 100m cells was overlaid across the site and a peat depth range assigned to each cell. The peat depth ranges used are given in Table 4 below.

Table 4 Indicative peat depth categories

Peat Depth Category Number	Peat Depth Category	Peat Depth Range
1	Very Shallow	<0.5m
2	Shallow	0.5 – <1.0m
3	Moderate	1.0 – <1.5m
4	Deep	1.5 – <2.5m
5	Very Deep	2.5m +

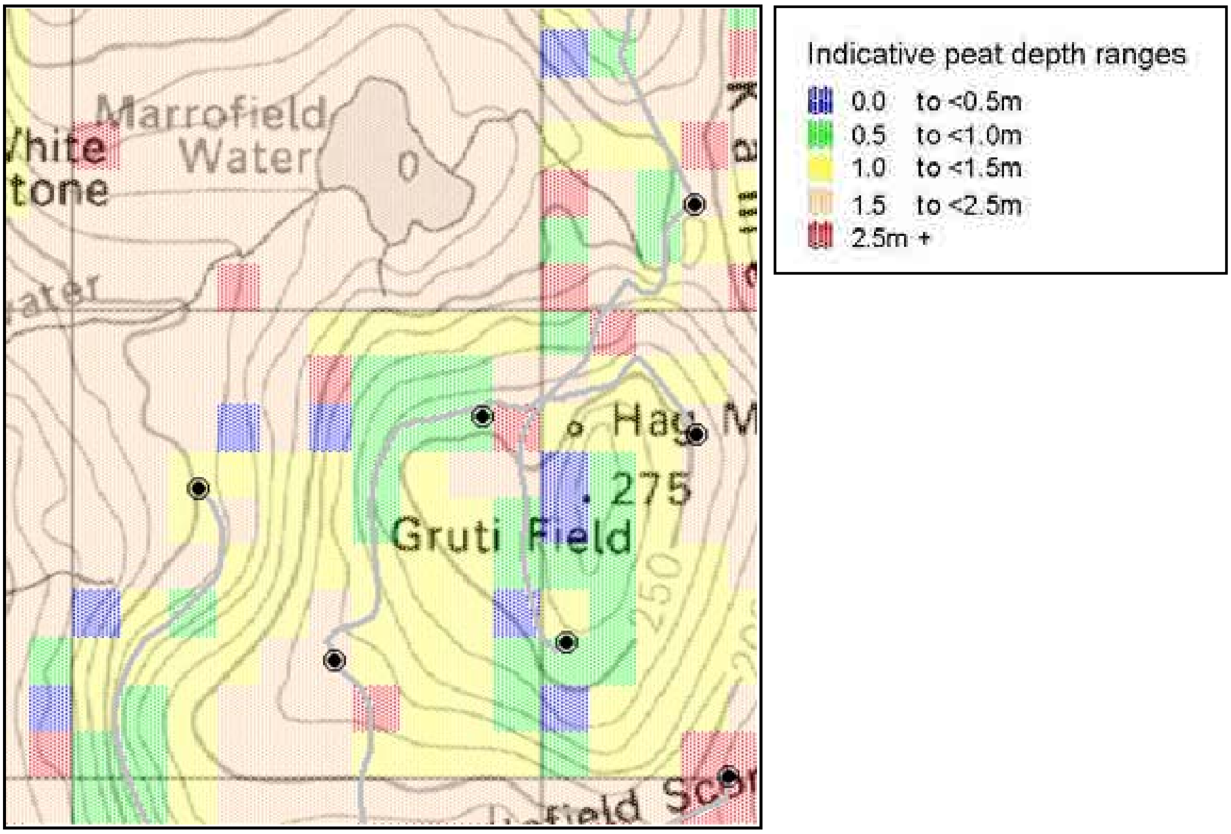
The use of a regular grid for terrain analyses of this type is a standard recognised GIS technique and is widely applied in a range of situations. A grid system allows the application of a systematic process across the landscape, where a set of relevant properties need to be assigned to each particular location. In this analysis, these properties include slope angle and peat depth.

Selection of grid resolution is necessarily a balance between granularity of the underlying data and the volume of information returned in the analysis. The resolution of DEM and base mapping must be taken into account, as using a very fine grid with a resolution identical to or finer than the DEM will return spurious results with a false indication of accuracy. For Viking Wind Farm, a 100m x 100m grid was selected as this allows a reasonable degree of accuracy whilst also producing a manageable volume of data to be used within the analyses.

Blanket peat, as found on Shetland, tends to form in areas with high rainfall and low temperatures. Peat deposits in the Shetland Islands have been recorded to depths of 6m (Mykura, 1976) in hollows and valleys but are generally not much more than 2-3m deep and often much less. Peat depth category names and ranges were chosen in the context of wind farm construction; for example a peat depth of 1m represents approximately the cut-off between cut-and-fill and floating track construction. Equally, the practicalities of constructing turbine foundations in peat more than 2.5m deep make this a less attractive option. The cut-off for very shallow peat of 0.5m is based on the Soil Survey of Scotland definition of peat, as used in the Scottish Executive guidelines (Scottish Executive, 2006).

Figure 33 shows an enlarged portion of the indicative peat depth mapping. Each square is 100m x 100m with very shallow peat coloured blue, shallow peat coloured green, moderate peat coloured yellow, deep peat shown in orange and very deep peat in red. It should be emphasised that processed peat depth values have been used throughout.

Figure 33 Sample of indicative peat depth map



The full indicative peat depth map is included as Figure 14.1PS08 (in Volume 4b). Measured peat depth data are not included on this figure for purposes of clarity. From observation it is clear that both slope and elevation have an influence on the development of peat, although the exact mechanism is not well understood and there is no mathematical growth/decay model for the development and depth of peat. However, slope and elevation factors may be used intuitively when extrapolating from peat sampling data in the creation of an indicative peat depth map. It can be seen that the deeper peat is to be found in flatter areas, such as cols, plateaux and valley floors. Flat areas on hill summits have often been subject to extensive erosion, with little remaining peat except as isolated haggs (Figure 32). In other areas peat formation on the summits has been very limited, possibly owing to a combination of exposure, slow growth rate and better drainage (Figure 34). Steep slopes tend also to have less peat, owing for the most part to their better drainage and more rapid runoff.

Figure 34 Example of a hill top area with very limited peat development, Delting quadrant (HU 4114 6998)

As can be seen from the map, where a cluster of peat probing points is all within the same peat depth category this has been taken to be a good indication of the general peat depth in the surrounding area and the indicative peat depth map has been coloured accordingly. Where clusters of peat probing points have returned depths across a range of peat depth categories a cautious approach has been taken, with the indicative peat depth map being classified with the deeper category of peat found in the area. This has led to a conservative indicative peat depth map, as demonstrated clearly by the peat depth category breakdown for both the actual probing data and for the extrapolated grid. These data are compared in Table 5. The conservative nature of the extrapolated map is apparent from the underestimation of very shallow peat and the overestimation of moderate and deeper peat, compared with the breakdown of the actual probing data.

Viking Energy used the indicative peat depth map to inform the design of the wind farm layout. Areas identified as having deep peat were identified where possible; however, the dominance of deep blanket peat in some parts of the site has meant this was not possible in all places. In addition, other constraints such as areas of ornithological importance or archaeological features have necessitated compromise in the siting of infrastructure.

Table 5 Peat depth category breakdown

Peat Depth Category (m)		<0.5	0.5 - <1.0	1.0 - <1.5	1.5 - <2.5	2.5 +	Total
Actual Probing Data	No. of points	931 (616)	1095 (915)	1176 (1137)	1929 (2294)	614 (783)	**5745**
	% of points	16 (11)	19 (16)	20 (20)	34 (40)	11 (14)	**100**
Indicative Peat Depth Grid	No. of cells	157	2364	3996	7308	1422	**15,247**
	% of cells	1	16	26	48	9	**100**

Please note: the above data include all the peat probing data measured on the site.

The second phase of peat depth surveying was undertaken between November 2007 and February 2008, with additional supporting work in November 2008. This phase of peat depth sampling was carried out after Viking Energy had produced a layout of roads and turbines for the proposed wind farm. Peat depth measurements were taken at 50m intervals along the proposed track layout and at each turbine base location. At each turbine point, a further four peat depths were recorded 20-25m to the north, east, south and west of the centre point to give a better indication of peat depths at each turbine base. These data are also useful to provide information on depth trends to inform micrositing, where applicable. As before, probing locations were determined using handheld GPS units and peat depths were recorded up to a maximum of 4m.

All the collated peat depth data are presented in Figure 14.1.PS07 (in Volume 4b).

5 PRELIMINARY STABILITY ANALYSIS

With the collated peat depth data, a preliminary analysis of slope stability can be carried out using the infinite slope model. The stability of a slope can be assessed by calculating the Factor of Safety *F* which is the ratio of the sum of resisting forces (shear strength) and the sum of the destabilising forces (shear stress):

$$F = \frac{c' + (\gamma - m\gamma_w)z\,Cos^2\beta\,Tan\phi'}{\gamma\,z\,Sin\beta\,Cos\beta}$$

In this equation, c' is the effective cohesion, γ is the unit weight of saturated peat, γ_w is the unit weight of water, m is the height of the water table as a fraction of the peat depth, z is the peat depth in the direction of normal stress, β is the angle of the slope from the horizontal and φ' is the effective angle of internal friction.

The Factor of Safety (FoS), F, represents the ratio of the forces resisting a slide divided by the forces causing the material to slide. Clearly, if F > 1 then the slope is stable, and normally if F > 1.3 then there is a degree of comfort that the slope will not fail.

To get an indication of the stability of the peat at the proposed wind farm infrastructure locations, the factor of safety can be calculated for each Phase 2 peat probing location. In addition, to gain a better view of peat stability in the areas surrounding the infrastructure, factor of safety calculations can be carried out for the grid cells of the indicative peat depth map in the vicinity of the infrastructure.

In order to do this, we must know or be able reasonably to infer the parameters for the FoS equation for each probing location and grid cell under consideration.

The slope angle, β, can be derived from the DEM for the site. With the peat probing locations, a single slope angle value is generated for each point, whilst the DEM is interrogated for minimum, maximum and average slope values for each grid cell. The average slope angle has been used in the grid FoS calculations, although the other statistics provide useful supporting information on the variability of slope within the cells.

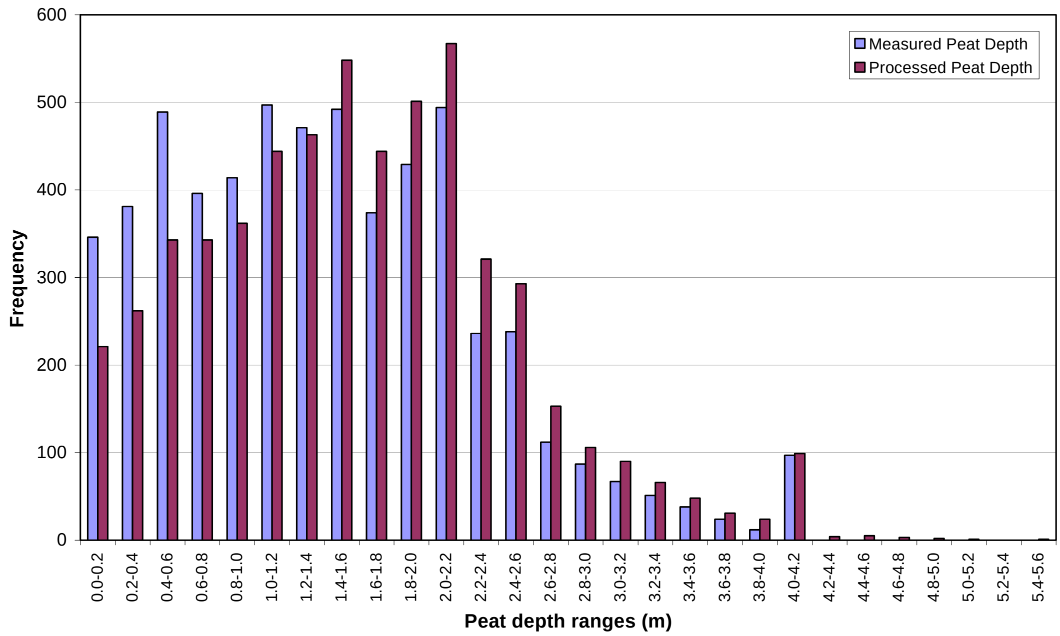
The actual peat depth measurements recorded for each probing location are used in calculating the point FoS values. For the grid-based FoS assessment it is necessary to convert the indicative peat depth ranges into a specific figure for each range for use within the calculation. Taking a conservative approach, the upper bound of each range has been used. In the case of ‘Very Deep’ peat (>2.5m), selecting the maximum depth is complicated by the fact that measurement of peat depths was limited to 4m. However, the peat depth histogram in Figure 35 shows that the frequency of deeper peat tails off rapidly, suggesting that 4m is close to the likely maximum peat depth and therefore represents a reasonable figure to use.

It should be noted that the small spike on the histogram at 4.0-4.2m peat depth is owing to the number of locations where peat depths were recorded as greater than 4m, which have been treated as being exactly 4m for ease of numerical analysis.

The small number of points returning results deeper than 4m in the processed dataset is a consequence of the data processing. For example, a measured peat depth of 3.8m in a gully with a measured bank height of 1m would return a processed depth of 4.8m.

Figure 35 shows both measured and processed peat depth data to allow comparison of the two datasets. The histogram indicates clearly that the processed data generally return deeper peat depths, and provide confirmation that use of processed peat depths in the analysis is the more conservative technique.

Figure 35 Histogram of measured and processed peat depth data



The unit weight of water, γ_w, is known to be 1.0Mg/m^3. The bulk density of peat varies with the level of decomposition. A literature review has found quoted *in situ* undrained bulk densities ranging from 0.5Mg/m^3 to 1.4Mg/m^3, with a typical value of 1.2Mg/m^3. This typical value has been used in the FoS calculations.

If it is assumed that the site is covered with active blanket mire, it follows that the peat must be completely saturated with a water table at or very close to the surface. On-site observations support this assumption as ground conditions were wet underfoot across most of the site. Consequently, a water table ratio, *m*, of 1 has been chosen.

The angle of internal friction in peat also varies, decreasing with increasing decomposition and moisture content. In some instances, 'quaking bog' has been observed where the peat takes the form of a slurry beneath a surface mat of vegetation. In such a situation the angle of internal friction will be very low. For the FoS calculations a φ' value of 5° has been selected in line with the conservative approach.

Finally, a value for the effective cohesion, *c'*, must be derived. Literature values for *c'* in peat vary widely, ranging from 4.5kN/m^2 to 60kN/m^2. To provide an indication of the cohesive strength of the peat at Viking a back calculation using the FoS equation and actual peat depth probing data for the site has been used. The techniques involved are discussed below.

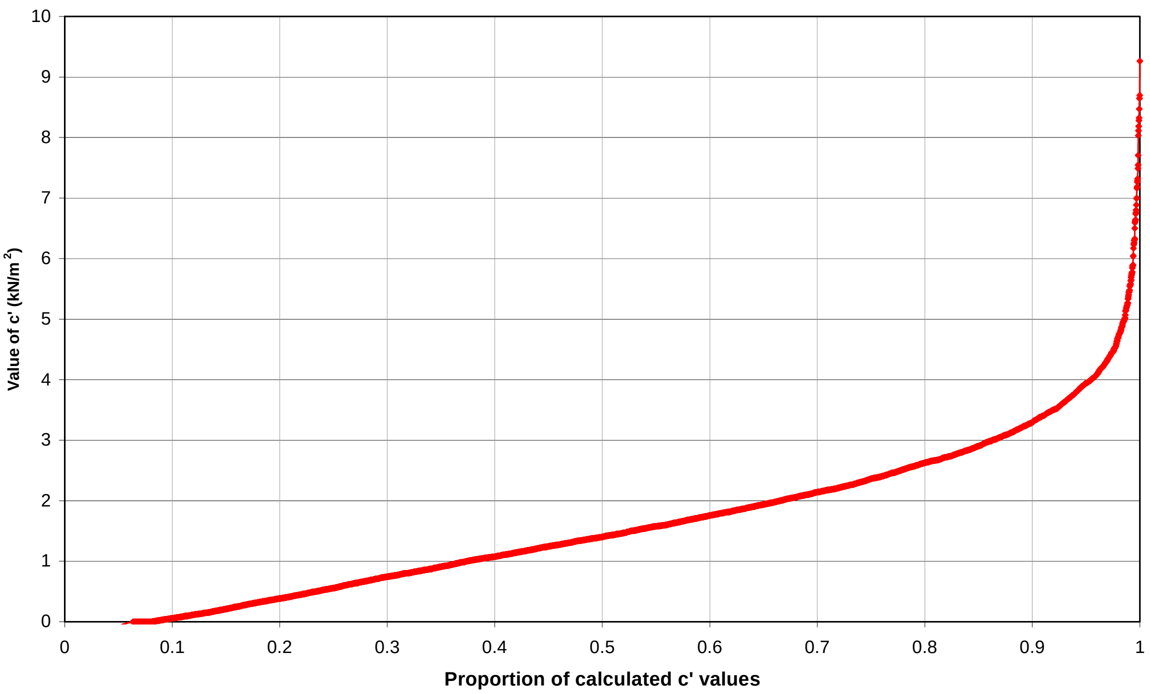
5.1 Estimation of Cohesive Strength

A range of field and laboratory tests can be carried out to determine the effective cohesion of a material. However, owing to its fibrous and thixotropic nature and the variation in strength with decomposition, peat is a particularly difficult material to analyse both in the field and in the laboratory. An alternative approach to assessing the strength of the peat is to rearrange the FoS equation to calculate a value of *c'* at actual peat probing locations. Essentially, this approach assumes that if the hillside is stable then the material must have at least a certain minimum strength.

Each peat probing location has been visited, is known to have been stable at the time of the visit and therefore must have a FoS of at least 1. If we assume conservatively that *F*=1 and use values for the other parameters as discussed above, the FoS equation can be rearranged to allow derivation of a value for *c'* at each probing location. Slope angles for the probing points are generated from the DEM. It is important to note that the value of *c'* calculated for each location represents the *minimum* cohesive strength necessary for the peat to be stable at that location. In fact, the shear strength may be, and in most cases probably is, considerably higher.

At Viking 5745 locations have been probed during the different phases of fieldwork. *c'* values for each of these have been calculated and the distribution of these values is shown in Figure 36. For example, reading from the graph, 0.8 (or 80%) of the probing locations required a *c'* value of 2.63kN/m^2 or less to be stable and retain peat on the slope.

Figure 36 Estimate of minimum cohesive strength, *c'*



From this work it is possible to state, with considerable confidence, that across the site as a whole the shear strength of the peat is unlikely to be less than 5.45kN/m^2 as this is the value of the 99 percentile point on the graph. The basis for making this statement depends on:

- The deliberate choice of conservative values for assumed parameters such as bulk density and water table level, coupled with the assumption of a FoS equal to one when back calculating c' values;
- Recognition of what the calculations are stating, which is that these are the minimum strengths that would be required, not the actual in situ strengths. Therefore, where slopes are gentle and the peat shallow, very little shear strength is required to ensure stability of the slope. This accounts for the vast majority of the lower values;
- Assuming a reasonable degree of homogeneity for peat properties, in particular strength, across the site. This seems reasonable, except for very shallow peat

where the acrotelm, which is more fibrous, represents a significant proportion of the total depth. Such areas are, in any case, unlikely to be areas of concern;

- Given the above considerations, it is the higher strength values that are relevant. If this were not the case then one would expect large areas of the site to be denuded of peat as it would not have the strength to adhere to the hillsides.

For the purposes of the Factor of Safety Assessment a *c'* value of 5.45 kN/m^2 has been used. This value is in reasonable agreement with estimates derived from other similar sites around Scotland. The actual effective cohesion of the peat at Viking is likely to be higher than 5.45 kN/m^2; however, this value has been chosen to ensure a conservative assessment whilst also using data from the site.

5.2 Preliminary Stability Analysis Results

Having assigned, measured or inferred values for each parameter in the FoS equation it is now possible to calculate a FoS value for each probing location coinciding with proposed infrastructure and for each cell of the indicative peat depth grid in the vicinity of the infrastructure. The FoS assessment maps generated with these values are given in Figure 14.1.PS09 (in Volume 4b).

In selecting the 99 percentile value of the back calculated *c'* strengths one is implicitly condemning 1% of the sample locations to failure, plus any similar cells across the site as a whole. As can be seen, there is a small number of cells with a FoS value of less than 1; in theory these should either have failed or currently be failing. In reality this is unlikely to be the case and these results are a consequence of the conservative approach adopted.

A number of points and cells have a FoS between 1.0 and 1.3, where stability can be considered marginal. The cells that fall into both these categories are scattered in clusters across the site. 90% of the site has a FoS of greater than 1.3, where stability can be assumed with a degree of comfort. The results of the FoS assessment for the probing points and site grid are summarised in Table 6.

Table 6 Summary of quantitative assessment

Factor of Safety	No. of Points	% of Points	No. of Cells	% of Cells
2.5 +	3920	68	1996	38
1.3 - <2.5	1610	28	2544	48
1 - <1.3	158	3	480	9
<1	57	1	212	4

The results demonstrate that the majority of the wind farm infrastructure will be built in areas where there is a degree of comfort in inferring stability. Comparison of the point and grid cell results highlights the conservative nature of the grid assessment. The cells identified as having marginal stability are generally clustered into areas where very deep peat and moderate or steep slopes occur within the same grid cell.

6 HAZARD RANKING

Based on the data collated from the desk study, reconnaissance survey, peat probing and preliminary stability analysis the peat landslide hazard across the site can be ranked. The Scottish Government guidance (Scottish Executive, 2006) defines the hazard ranking as a function of hazard and exposure:

$$\text{Hazard Ranking} = \text{Hazard} \times \text{Exposure}$$

where Hazard is defined as the likelihood of a (peat) landslide occurring and Exposure is the impact and consequences that the event may have.

Both Hazard and Exposure are determined using expert judgement based on the collated data, and are given qualitative ratings as shown in Table 7 and Table 8 respectively. Hazard and Exposure ratings have been assigned to each cell in the peat assessment grid. In determining the Hazard, the number of peat landslide indicators present in each cell has been taken into account. As this peat slide risk assessment has been carried out in support of an EIA the Exposure rating relates to the environmental impact a peat landslide could have. In considering the Exposure rating, the proximity to waterbodies has been taken into consideration, as has the steepness of intervening slopes.

The maps of Hazard and Exposure zonation are given in Figures 14.1.PS10 and 14.1.PS11 respectively (in Volume 4b) and the results summarised in Table 7 and Table 8.

Table 7 Qualitative rating scale for Hazard

Scale	Hazard	No. of Grid Cells	Percentage of Grid Cells
5	Almost certain	0	0
4	Probable	207	4
3	Likely	485	9
2	Unlikely	2645	51
1	Negligible	1895	36

Table 8 Qualitative rating scale for Exposure

Scale	Exposure	No. of Grid Cells	Percentage of Grid Cells
5	Extremely high impact	0	0
4	Very high impact	75	1
3	High impact	1623	31
2	Low impact	3076	59
1	Very low impact	458	9

The results of the Hazard and Exposure zonation reflect the nature of the site. The dominant topography of long flat-topped ridges and wide valleys means that much of the side has very low slope angles. This combines with the smooth character of the erosion profile and variability of the bedrock to give limited rock exposure across much of the site. Where bedrock is exposed there is often considerable outcrop across a short distance, coinciding with a particular resistant rock unit. Consequently, areas with good bedrock exposure have been considered to have a lower peat slide hazard as the presence of bedrock exposure indicates discontinuous peat formation.

The prevalence of low slope angles has allowed development of fairly extensive areas with deep or very deep peat. The distinct ridge lines are often marked by very distinct breaks in slope, which indicate not only the change from shallow to steep slope but also tend to coincide with the change from deeper to shallower peat. This juxtaposition of deep peat and steep slopes has resulted in a comparatively high hazard rating for the site.

The remote nature of the site means that, for most of the site a peat landslide occurrence would have no impact upon human habitation, transport routes or drinking water supplies. However, there are some areas around the margins of the site where a peat slide, should one occur, could have a direct impact on these factors and the exposure rating has been graded to take this into account. Waterbodies throughout the site have been assigned high quality status and support a range of fisheries interests. There is a risk that they may be impacted upon by a peat landslide occurring nearby. In addition, some areas of the blanket peat across the site have been assigned high activity status and would be adversely affected by a peat slide. In consequence of these factors, much of the site has been assessed as potentially having a high impact exposure rating.

Multiplying the Hazard and Exposure ratings together gives the Hazard Ranking for each cell. The qualitative categories of hazard ranking, the results and appropriate mitigation actions are shown in Table 9. The resulting Hazard Ranking map is shown in Figure 14.1.PS12 (in Volume 4b).

Table 9 Hazard Ranking and Appropriate Mitigations

Hazard Ranking		No. of Grid Cells	% of Grid Cells	Appropriate Mitigation
17 - 25	Serious	0	0	Avoid project development at these locations
11 - 16	Substantial	60	1	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less
5-10	Significant	1392	27	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation and re-design at these locations
1 - 4	Insignificant	3780	72	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

As can be seen, the majority of the site has been assessed as having an insignificant risk of peat landslide hazard. The grid cells identified with significant or substantial risk tend to cluster together across the site, and some of the clusters coincide with areas of infrastructure. A total of 272 cells, grouped into 51 areas, have been identified as meriting further discussion.

7 GROUND INVESTIGATION

Following the hazard ranking assessment, a number of areas were highlighted as having significant or substantial risk of peat landslide. Owing to the large area of the site and the difficulties of access to large areas it was decided after discussion with Viking Energy to select representative areas from across the whole site to undertake ground investigations. These included 4 control points assessed as having an insignificant hazard ranking, and a range of locations assessed as having significant or substantial hazard ranking. The locations are detailed in Table 10.

Table 10 Ground investigation locations

Location ID	Grid reference	Quadrant	Comment
1	HU 4049 7028	Delting	
2	HU 3844 6714	Delting	
3	HU 3760 6730	Delting	Control
4	HU 4185 6608	Collafirth	
5	HU 4216 6583	Collafirth	
6	HU 4164 6042	Nesting	
7	HU 4605 5817	Nesting	
8	HU 4573 5660	Nesting	
9	HU 4413 5556	Nesting	Control
10	HU 4071 6080	Kergord	
11	HU 3903 6084	Kergord	Control
12	HU 4002 5683	Kergord	
13	HU 4085 5520	Kergord	Control
14	HU 3824 5535	Kergord	
15	HU 3784 5214	Kergord	

The ground investigation work was carried out in two stages. The first stage was undertaken by Mouchel in November 2008, when peat samples were taken by Russian Corer. Weather conditions were variable, mostly windy and cold with snow showers and snow cover at times. The second stage was undertaken by Fugro Engineering Services in December 2008 and January 2009. The weather conditions during this work were poor, generally wet, overcast and fairly windy, with wet conditions underfoot.

At each location measurements were made or samples taken to determine the following parameters:

- In-situ shear strength, determined by vane test;
- Peat / Soil stratigraphy, determined by Russian Corer;
- Von Post classification;
- Bulk density.

A probing rod was used to determine the total peat depth prior to the shear vane testing. Shear strength was measured at 1m depth intervals to the base of the peat, with the final measurement being taken at or close to the base of the peat. At least two separate vane tests were carried out at each depth, with a third undertaken if the first two were dissimilar, to provide some confidence on the repeatability of the tests. The nature of the test requires separate holes within close proximity for each test at a given depth. Most of the tests were undertaken using a large vane of 200mm x 100mm owing to the expected low shear strength of the peat. In some areas, where the shear strength was higher, a smaller vane of 100mm x 50mm was used.

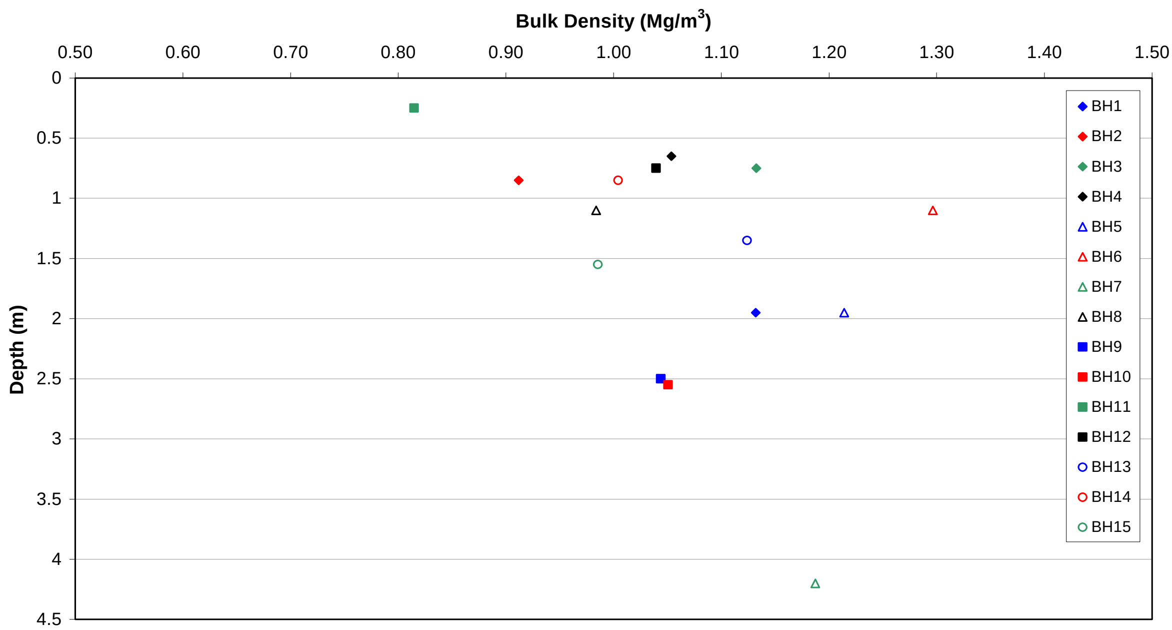
From previous site visits and peat probing it was known that the peat was very deep and soft at some of the GI locations. As a result, trial pits were not considered appropriate owing to the significant health and safety risks associated with pit wall stability, precluding manual digging, and use of a mechanical digger in these conditions. A Russian corer was used instead to take samples of the peat from just above the base of the peat column. The peat stratigraphy and Von Post classification of each sample were determined in the field, while a known volume of the sample was collected for laboratory analysis of bulk density.

7.1 Results

The full results of the shear vane testing are presented in the FES factual site investigation draft report presented in Appendix A. Results obtained from the peat coring are presented in Appendix B.

Bulk density was found to vary from 0.81 to 1.30Mg/m^3, with an average value of 1.06 Mg/m^3. Previous investigations have indicated that bulk density is generally lowest close to the surface and increases with depth and these findings are supported by this work, as shown is Figure 37. The lower bulk densities at shallow depth are a reflection of the relatively undecomposed nature of the peat in the upper layers. Comparing the bulk density values at similar depths, it can be seen that the scatter decreases with depth although this may in part be a result of the greater number of samples at shallower depths.

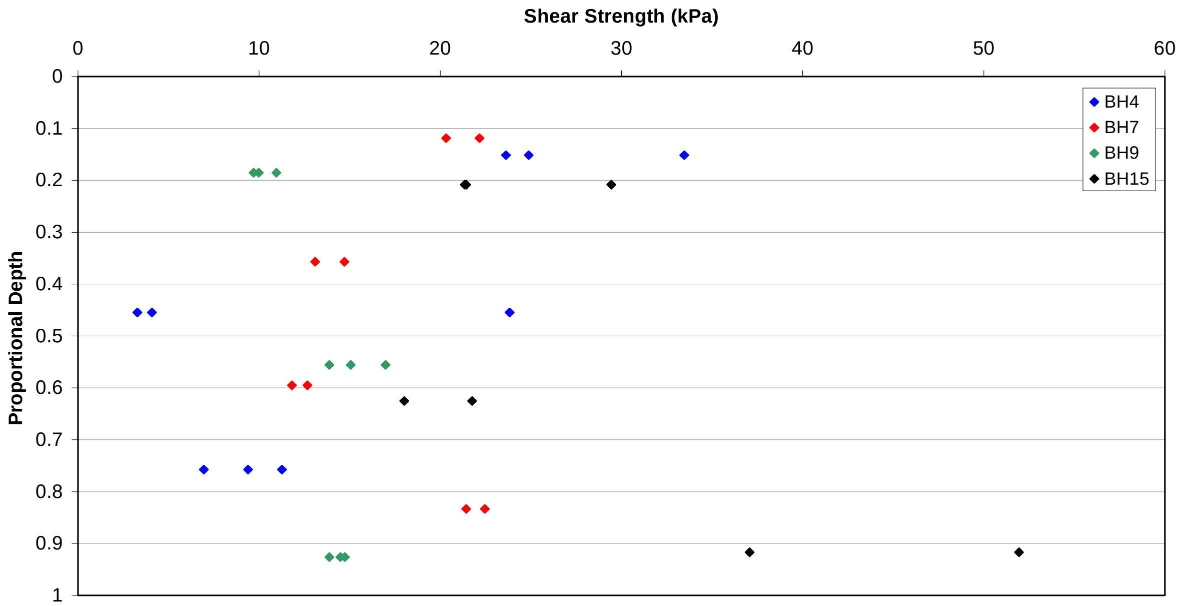
Figure 37 Bulk density variation with depth



The von Post classification of the peat showed a strong correlation with depth, with the degree of decomposition increasing with depth as would be expected. Shallow cores, up to 1m in depth, had von Post classifications between H2 and H4 (almost undecomposed to weakly decomposed), whilst cores from around 2m or greater depth returned von Post classifications of H6 to H8 (strongly to very strongly decomposed).

The recorded peak shear strengths varied between 3.27 and 51.95kPa. Generally, high shear strengths were recorded in the upper 0.5m of peat, owing to the more fibrous nature of the peat at this depth. For locations where shear strength was measured at more than two depths, minimum strength was typically recorded in the central part of the peat column with a slight increase close to the total depth. As this occurred regardless of the total depth of peat, this is best demonstrated by comparing shear strength with proportional depth, where the ground surface is 0 and the base of the peat is 1. The results are shown in Figure 38. The other test sites, where measurements were taken at one or two depths, indicated a general trend for shear strength to decrease with depth.

Figure 38 Shear strength variation with proportional depth



In most cases the slight increase in shear strength at the base of the peat may result from the presence of a transitional gley-like material. The exceptionally high results returned from the base of BH15 are more likely to represent shear strength of the underlying drift material rather than peat as they are outwith the usual range of peat shear strength values.

These results suggest that the weakest material within the peat itself may not necessarily be at the peat-substrate interface. The recorded history of peat slides does, however, indicate that failures tend to occur at or very close to this interface. Many of these events have been linked to abnormal rainfall conditions and in such circumstances it is conceivable that increased porewater pressures and uplift would operate at the interface, combining with increased weight of the overburden and the down-slope component of force to cause destabilisation of the slope (e.g. Halcrow, 2004).

8 DETAILED ASSESSMENT

Please note: Section 8 DETAILED ASSESSMENT of this report is included within Volume 4b as Figure 14.1.PS and should be referred to at this point. The introductory section is duplicated here for ease of reference.

Following the ground investigation works a more detailed assessment of the peat landslide hazard has been carried out for each of the locations previously identified.

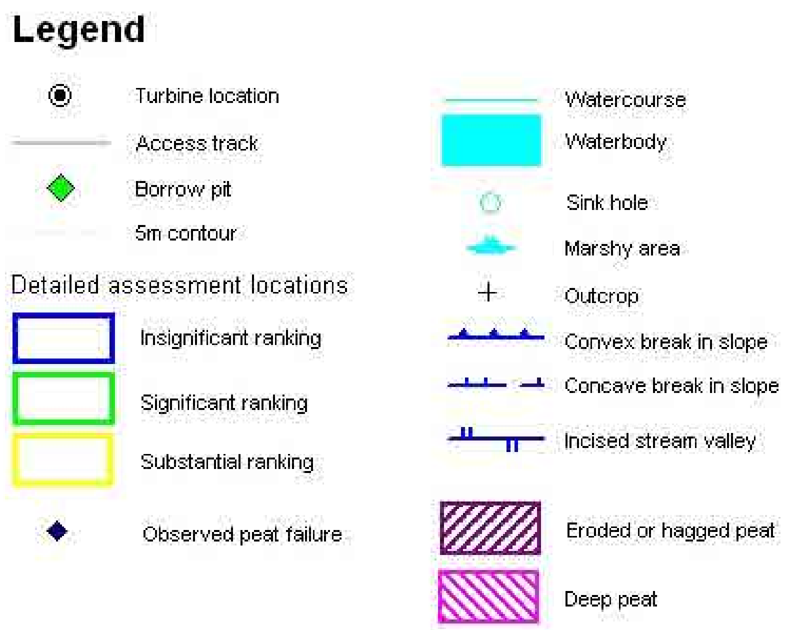
The following pages contain detailed information on each of the locations, including the collated results of the ground investigation works where applicable, calculated factors of safety based on these results, aerial photography of the location overlaid with pertinent geomorphological information, and a discussion/interpretation of the presented information. An indication of possible peat slide parameters is given for reference. This assumes that the peat will fail for the full length of the slope and is considered to give a worst-case estimate.

Where relevant, mitigation measures are recommended. Finally, the hazard ranking of each location has been reappraised in the light of the presented information and proposed mitigation.

The factor of safety calculations presented are based on the collated GI data. FoS values have been calculated for each measured shear strength value and using the bulk density value from the relevant peat sample. The minimum calculated FoS value has been taken into account when reappraising the hazard ranking at each location. FoS calculations are provided in Appendix C.

In the following pages, the insert maps are a composite of aerial photography and geomorphological information. The wider context may be viewed if required by reference to Figures 14.1.PS04 and 14.1.PS05 in Volume 4b. A legend for the symbols used in the insert maps is given in Figure 39 below. The detailed assessment locations are based on 100m x 100m cells, giving an idea of scale on the associated images.

Figure 39 Legend for the detailed assessment insert maps



Mitigation measures have been recommended for a number of the locations assessed in detail. In several cases the primary mitigation recommendation has been micrositing of the access track away from the area of concern.

9 MITIGATION

Specific mitigation measures have been detailed, where appropriate, in the preceding Detailed Assessment section. These measures, which are primarily micrositing of track or use of floating track construction, should be implemented to ensure that the risk of a peat landslide is reduced.

In addition to these specific measures, there are a number of good practice measures that will be implemented across the site. The following list contains some of these measures but is not exhaustive:

- A geotechnical risk register or similar management system will be created and maintained throughout the detailed design and construction phases;
- This risk assessment will be re-visited and re-appraised during the detailed design and construction phases as new information becomes available. The risk register will be updated with this information;
- A geotechnical specialist will be on-site during the construction phase to undertake advance inspection, carry out regular monitoring and provide advice;
- Micrositing will be used, in consultation with the statutory consultees, to maximise avoidance of possible problem areas;
- Construction staff will be made aware of peat slide indicators and emergency procedures *(see below);*
- Emergency procedures will include steps to be taken upon detection of an incipient peat slide or of the event occurring;
- Site drainage will be appropriately designed and installed to ensure flows are not concentrated onto slopes or into excavations;
- Stand pipes or piezometers will be installed to monitor groundwater levels and pore water pressures;
- Sediment control measures will be incorporated into all artificial drainage measures;
- Earthmoving activities will be restricted during and immediately after intense and prolonged rainfall events;
- The extent and duration of open excavations and bare ground will be minimised;
- The volume and storage timescale for excavated material will be minimised;
- Excavated material or other forms of loading will not be placed on or close to breaks in slope or other potentially unstable slopes;
- Vegetation cover will be re-established as soon as possible to improve slope stability and provide sediment transport control. This will largely be done by relaying the peat turf previously excavated. This turf will be stored separately, in such a way as to maintain its integrity;
- Grazing pressure, including grazing by sheep, rabbits or other animals, will be reduced to minimise damage to the surface layers of the peat.

On-site staff who are close to the project are often the best placed to provide advance notification of potential problems, provided they are trained to do so and there is a reporting mechanism in place. There are a number of recognised indicators for slope failures and these may indicate the potential for, or the commencement of, a peatslide event. The suspected identification of any of these indicators should be assessed by specialist geotechnical personnel. The factors discussed below are particularly applicable to low velocity peatslides:

- The development of tension fracture cracking across the slope or in semi-circular patterns;
- Boggy ground or new springs appearing at base of slopes;
- Sudden reactivation of spring lines;
- Creep and bulging of ground;

- Unusual displacement and leaning of trees, fence posts, dykes etc.;
- Breaking of underground services.

9.1 Additional Ground Investigation Work

Additional ground investigation work is recommended for areas highlighted in the initial hazard ranking as at ‘substantial’ risk of peatslide but that were not surveyed under the first phase of ground investigation work (Dc, Dh, Nb). Investigation is also recommended for Location Db, owing to the presence of an observed instability and suggested track realignment for this location. Site-specific information in all cases would enable the peat stability assessment to be revised further to address the local situation.

Whilst it was decided to be inappropriate to undertake trial pitting at this stage in the investigation, such intrusive work will be required to inform the detailed design stage of the project. Extra care will be required to ensure the safety of on site staff during the excavation and surveying of trial pits owing to the soft consistency of the peat in parts of the site. This work will enable collection of samples from the material underlying the peat in these areas, for geotechnical testing in the laboratory.

Areas to be included in such additional investigations would be borrow pit sites and sites identified for watercourse crossings. Site-specific data are required for such locations to provide a detailed assessment of aggregate quality and quantity for borrow pits, and for detailed design of foundations for watercourse crossings. Excavations in both situations may increase the risk of peat landslide and consequently the peat landslide risk assessment should be revisited in the light of such ground investigation work and updated as appropriate.

10 CONCLUSIONS

A multi-stage assessment of peat slide risk has been carried out for the proposed Viking Wind Farm. This initially involved desk study, interpretation of aerial photography, site reconnaissance and geomorphological mapping, extensive peat depth probing and preliminary slope stability calculations. Based on these collated data an initial assessment of peat stability was made, with 50 locations identified as having a significant or substantial risk of peat landslide.

The size of the wind farm site is such that it was not practicable to conduct ground investigation works for all highlighted significant or substantial risk locations. Fifteen areas were selected from across the site on the basis of their hazard rank, to provide a representative cross section of areas with different hazard rankings. These included three with insignificant risk of peat slide, to act as control sites.

Ground investigation works were commissioned for the 15 selected locations. During the ground investigation works, *in-situ* shear vane measurements were made, the peat was sampled and classified using the von Post classification system and lab tests to determine bulk density were commissioned.

The data from these investigations and the information previously collated were used for a detailed assessment of the 50 locations highlighted as being at risk of peat instability. In a number of cases it was found upon detailed inspection of the location that there was insignificant risk of peat landslide; these included the ‘control’ locations as well as several others. In such situations no specific mitigation was required to reduce the peat instability risk. The confirmation of the insignificant risk of peat landslide at the ‘control’ locations provides confidence in the initial assessment, particularly the preliminary slope stability calculations.

10.1 Delting Quadrant

In Delting quadrant it has been recommended that micrositing is carried out to move sections of access track away from potential risk areas in six locations (Db, Dc, Dd, Dh, Di and Dl). Micrositing has also been recommended for three turbines (Turbines D3, D7 and D23); this is of particular importance with respect to Turbine D7 as its current location has been highlighted as having substantial risk of peat instability. Micrositing has also been suggested for Location Dn and the presence of peat pipes in or adjacent to Locations Dd, De, Dh and Dl has been identified. The peat pipe locations will require further investigation at the detailed design stage in order to minimise the chance of collapse or failure during construction.

Locations Db and Dh both include substantial sections of proposed micrositing owing to the local settings at these locations and the hazard ranking of substantial for these locations. Turbine D7 lies within Location Dh.

Three locations (Dd, Dh and Dj) have recommendations relating to the use of floating track construction, including the use of suitable drainage measures to ensure that subsurface flow is not disrupted.

10.2 Collafirth Quadrant

Five detailed assessment locations are present in Collafirth. Of these, micrositing of access track has been recommended for one location (Location Cd) to avoid an area where a tension crack was identified within the peat. Micrositing of track alignment has been suggested for Locations Cb and Ce and the presence of peat piping in or adjacent to Locations Cb and Cc has been highlighted. As before, the locations of peat pipes will require further investigation at the detailed design stage to minimise the chance of collapse or failure during construction.

Floating construction is recommended for three locations (Locations Cb, Cc and Cd), including the use of suitable drainage measures to maintain continuity of subsurface flow.

10.3 Kergord Quadrant

Kergord has 20 detailed assessment locations, of which micrositing of access track has been recommended for three locations (Locations Kc, Ki and Km) in order to move the track away from identified risk areas. Micrositing of access track and/or turbines has been suggested as potential mitigation at ten locations (Locations Kc, Ke, Kg, Kh, Kk, Km, Kn, Kp, Kr and Ks). Peat pipes have been identified in or adjacent to five locations (Locations Kd, Kf, Kh, Ki and Kl); these locations will require further investigation during the detailed design stage to minimise the chance of collapse or failure during construction.

Floating track construction has been recommended for five locations (Locations Kd, Kf, Kk, Kn and Kt), which should include the use of appropriate drainage measures to ensure that subsurface flow is not disrupted. Suitable drainage will also be required at Locations Kg and Ko, as these areas both have considerable numbers of drainage channels within the peat.

10.4 Nesting Quadrant

Fourteen detailed assessment locations occur within Nesting. These include four locations (Nb, Nd, Nj and Nm) where micrositing of access track sections has been recommended in order to move the track away from identified risk areas. Of these, Location Nb contains quite a substantial section of proposed micrositing owing to the local setting in this area and the location’s hazard ranking of substantial. Micrositing suggestions have been made for five locations, Na, Nd, Ne, Nk and Nn. This includes micrositing both for sections of access track and for turbine positions. Peat pipes have been identified within or adjacent to only two locations, Na and Nn; further investigation will be required during the detailed design stage to minimise the chance of collapse or failure during construction.

For eight locations the use of floating track construction has been recommended (Locations Na, Nb, Nc, Nh, Ni, Nk, Nm and Nn). This is coincident with the need for the use of appropriate drainage measures to maintain continuity of subsurface flow across the area.

10.5 Site-wide Conclusions

In addition to the location-specific mitigation recommendations, site-wide best practice measures have been outlined. These include the need for ongoing re-appraisal of the peat landslide risk assessment throughout the detailed design and construction stages. A geotechnical engineer should be employed on site during construction to undertake advance inspection, carry out regular monitoring and provide advice.

The hazard ranking of the 50 locations identified for detailed assessment has been re-appraised. Providing that the recommended mitigation measures are put in place, the risk of peat landslide occurring at any of these locations is insignificant.

11 REFERENCES

HALCROW (2004) *Shetland A970 Channerwick Peat Slides – Interpretative Report draft, report no. R5917*

MOUCHEL (2009) *Viking Wind Farm Environmental Statement – Soil and Water (Chapter 14)*

SCOTTISH EXECUTIVE (2006) *Peat landslide hazard and risk assessments: Best practice guide for proposed electricity generation developments.*

SHETLAND TIMES (2008) Changing climate could lead to more landslides, say scientists. *The Shetland Times*, 1st August 2008.

Author Background and Experience

The author of this report, Catherine Isherwood, is a qualified geologist with an MA and PhD in Geological Sciences from Cambridge University. She has been a Fellow of the Geological Society since 2007 and is currently working towards Chartership. She has two and a half years' experience in environmental impact assessment and peat stability assessment with Mouchel and worked previously in environmental education and ecological habitat assessment. Catherine is currently studying part-time for an MSc in Hydrogeology at Newcastle University.

The work in this report has been extensively supported and reviewed by senior members of the team. Details of the principal members involved in assessment methodology and production of this report are included below.

Robert Bone is a Chartered Engineer with over 30 years' experience in civil and hydraulic design, hydrology and environmental impact assessment. He has considerable experience of working on soil mechanics and slope stability problems and has worked on peat stability assessment since it was raised as an issue related to wind farm developments. He has recently been involved in landslide susceptibility mapping in Ireland.

Sarah Sutherland has ten years' experience in water and environmental consultancy with a specific focus on environmental impact assessment and hydrological and hydrogeological assessments. She has worked on more than 20 wind farm EIAs in the last six years and has been involved in peat stability assessment since 2005.

Stuart Bone is a Chartered Environmentalist with ten years' experience in the water industry, with specific focus on environmental management and environmental impact assessments. He has been responsible for Project Managing the deliverables for Mouchel's involvement with Viking Wind Farm.

Malcolm Macfie is a Chartered Chemist and Chartered Scientist with over 20 years' experience in the chemical industry and environmental consultancy, with specific focus on environmental management and environmental impact assessments. He has been involved in a number of wind farm EIAs and peat stability assessments since 2005.

APPENDIX A

Fugro Engineering Services
Factual Report on Ground Investigation

APPENDIX B

Peat Coring Field Notes

Bam Ritchies
Laboratory Analyses

Peat Coring Field Notes

Sample ID	Grid Reference	Location	Von Post Classification	Peat Depth (m)	Sample Length (m)	Description
BH01	HU 4049 7028	Delting North	H6	1.95	0.3	Dark brown strongly decomposed amorphous PEAT. Few fine and coarse fibres. Some indication of horizontal banding in upper levels. Possible woody fragments near base of core.
BH02	HU 3844 6714	Kergord South	H4-5	0.85	0.3	Very dark brown weakly to moderately decomposed fibrous to amorphous PEAT. Few fine and coarse fibres. Some horizons contain sand-size grains, especially towards base of sample.
BH03	HU 3760 6730	Delting South	H4	0.75	0.3	Mid- to dark brown weakly decomposed fibrous PEAT. Some fine and coarse fibres. Strongly banded in lower half of sample, indicating changes in *Sphagnum* content.
BH04	HU 4185 6608	Collafirth South	H2	0.65	0.3	Mid-brown almost undecomposed fibrous PEAT. Many fine and coarse fibres. Plant material dominated by *Sphagnum* with some *Eriophorum* stems present.
BH05	HU 4216 6583	Collafirth South	H6	1.95	0.3	Mid- to dark brown strongly decomposed amorphous PEAT. Few fine and coarse fibres. Indistinct colour banding present throughout.
BH06	HU 4164 6042	Nesting North	H3	1.10	0.2	Very dark brown very weakly decomposed fibrous PEAT. Many fine and coarse fibres. Plant material dominated by *Sphagnum* with some *Eriophorum* stems present.
BH07	HU 4605 5817	Nesting North	H8	4.20	0.24	Mid- to dark brown very strongly decomposed amorphous PEAT. Few fine and coarse fibres. Some indistinct colour banding in mid-section of sample with possible woodly fragments present.
BH08	HU 4573 5660	Nesting South	H5-6	1.10	0.23	Mid- to dark brown moderately to strongly decomposed PEAT. Some fine and coarse fibres. Some colour banding in lower half of sample.

Sample ID	Grid Reference	Location	Von Post Classification	Peat Depth (m)	Sample Length (m)	Description
BH09	HU 4413 5556	Nesting South	H8	2.50	0.25	Dark to very dark brown very strongly decomposed amorphous PEAT. Few fine and coarse fibres. Sample is fairly uniform with very minor indistinct banding.
BH10	HU 4071 6080	North Mid Kame, Kergord	H6	2.55	0.3	Dark brown strongly decomposed amorphous PEAT. Few fine and coarse fibres. Very little indistinct banding. Plant material dominated by *Sphagnum*.
BH11	HU 3903 6084	Kergord North	H4	0.25	0.1	Dark brown weakly decomposed fibrous PEAT. Many fine and coarse fibres with roots in upper section. Clear remains of *Calluna, Sphagnum* and *Eriophorum* throughout sample.
BH12	HU 4002 5683	Kergord South	H3	0.75	0.3	Mid- to dark brown very weakly decomposed fibrous PEAT. Many fine and coarse fibres. Sample is fairly uniform with plant material dominated by *Sphagnum* especially in lower levels.
BH13	HU 4085 5520	South Mid Kame, Kergord	H5-7	1.50	0.3	Dark brown moderately to strongly decomposed amorphous PEAT. Some fine and coarse fibres. Indistinct colour banding throughout. Sample almost clay-like in consistency. Plant material dominated by *Sphagnum*.
BH14	HU 3824 5535	Kergord South	H4	0.85	0.3	Dark brown weakly decomposed fibrous PEAT. Many fine and coarse fibres. Clear remains of *Sphagnum* and *Eriophorum* throughout sample.
BH15	HU 3784 5214	Kergord South	H4	1.55	0.3	Mid-brown weakly decomposed fibrous PEAT. Many fine and coarse fibres. Plant material dominated by *Sphagnum* with possible woody or *Calluna* fragments in central section, some roots near top of sample.

APPENDIX C

Detailed Assessment Slope Stability Calculations

Bore-hole	Location ID	Slope Angle (°)	Corer Base Depth (m)	Bulk Density (Mg/m^3)	Bulk Density (kg/m^3)	Moisture Content (%)	Dry Density (Mg/m^3)	Von Post	Vane Centre Depth (m)	Peak Shear 1 (kPa)	Peak Shear 2 (kPa)	Peak Shear 3 (kPa)	FoS 1	FoS 2	FoS 3	Min. FoS
BH1	Dj	0.815	1.95	1.13	1131.91	234	0.04	H6	0.5	11.03093	9.92280	13.9523	140.4	126.4	177.4	126.4
BH1	Dj	0.815	1.95	1.13	1131.91	234	0.04	H6	1.5	8.915412	8.61319	9.46947	38.4	37.1	40.7	37.1
BH2	Dm	9.077	0.85	0.91	911.83	283	0.06	H4	0.5	21.91076	13.8264	15.1108	31.4	19.8	21.6	19.8
BH3	Do	12.584	0.75	1.13	1132.46	570	0.04	H4	0.5	8.00876	29.4158	16.9241	6.8	25.0	14.4	6.8
BH4	Ca	4.533	0.65	1.05	1053.64	604	0.04	H2	0.5	33.47057	24.8825	23.6233	82.3	61.2	58.1	58.1
BH4	Ca	4.533	0.65	1.05	1053.64	604	0.04	H2	1.5	4.079934	3.27402	23.8248	3.4	2.7	19.6	2.7
BH4	Ca	4.533	0.65	1.05	1053.64	604	0.04	H2	2.5	11.2576	6.95099	9.39392	5.6	3.5	4.7	3.5
BH5	Cb/Cc	8.041	1.95	1.21	1214.20	365	0.07	H6	0.5	24.78182	30.121	31.4054	30.2	36.6	38.2	30.2
BH5	Cb/Cc	8.041	1.95	1.21	1214.20	365	0.07	H6	1.5	23.8248	13.2471	17.8308	9.7	5.5	7.3	5.5
BH6	Nc	13.39	1.1	1.30	1296.37	756	0.03	H3	0.5	8.487271	19.5937	23.5477	6.0	13.8	16.5	6.0
BH7	Nh	5.742	4.2	1.19	1187.34	536	0.04	H8	0.5	22.16261	20.3241		38.4	35.2		35.2
BH7	Nh	5.742	4.2	1.19	1187.34	536	0.04	H8	1.5	14.70791	13.0960		8.6	7.7		7.7
BH7	Nh	5.742	4.2	1.19	1187.34	536	0.04	H8	2.5	11.81166	12.6679		4.2	4.5		4.2
BH7	Nh	5.742	4.2	1.19	1187.34	536	0.04	H8	3.5	22.46482	21.4322		5.7	5.4		5.4
BH8	Nj	11.002	1.1	0.98	983.77	552	0.03	H5	0.5	12.51684	11.4338	12.4161	13.8	12.6	13.7	12.6
BH8	Nj	11.002	1.1	0.98	983.77	552	0.03	H5	1.1	8.109499	4.23104	8.05912	4.1	2.1	4.0	2.1
BH9	Nl	0.8995	2.5	1.04	1043.77	680	0.03	H8	0.5	9.973173	9.69614	10.9553	124.3	120.9	136.6	120.9
BH9	Nl	0.8995	2.5	1.04	1043.77	680	0.03	H8	1.5	13.87681	16.9745	15.0605	57.8	70.6	62.7	57.8
BH9	Nl	0.8995	2.5	1.04	1043.77	680	0.03	H8	2.5	13.87681	14.7331	14.4812	34.8	36.9	36.3	34.8
BH10	Ks	11.347	2.55	1.05	1050.52	592	0.04	H6	0.5	24.55516	47.5740	24.3033	24.7	47.9	24.5	24.5
BH10	Ks	11.347	2.55	1.05	1050.52	592	0.04	H6	1.5	14.12866	14.2294	11.7361	4.8	4.8	4.0	4.0
BH11	Kb	6.523	0.25	0.81	814.68	843	0.01	H4	0.5	29.41582	36.1149	24.3788	65.0	79.9	53.9	53.9
BH12	Kj	10.483	0.75	1.04	1039.44	669	0.03	H3	0.5	36.2409	45.0303	37.3742	39.7	49.4	41.0	39.7
BH12	Kj	10.483	0.75	1.04	1039.44	669	0.03	H3	1.5	>518			>189			
BH13	Kq	6.331	1.5	1.12	1123.90	619	0.04	H5	0.5	14.45606	14.1286	14.0782	24.0	23.5	23.4	23.4
BH13	Kq	6.331	1.5	1.12	1123.90	619	0.04	H5	1	12.51684	14.2042	12.4161	10.4	11.8	10.4	10.4
BH14	Kl	10.962	0.85	1.00	1004.19	711	0.03	H4	0.4	17.64655	15.0689	18.8362	24.0	20.5	25.6	20.5

Bore-hole	Location ID	Slope Angle (°)	Corer Base Depth (m)	Bulk Density (Mg/m^3)	Bulk Density (kg/m^3)	Moisture Content (%)	Dry Density (Mg/m^3)	Von Post	Vane Centre Depth (m)	Peak Shear 1 (kPa)	Peak Shear 2 (kPa)	Peak Shear 3 (kPa)	FoS 1	FoS 2	FoS 3	Min. FoS
BH14	Kl	10.962	0.85	1.00	1004.19	711	0.03	H4	0.8	36.08621	17.25	32.1206	24.5	11.7	21.8	11.7
BH15	Kp	11.681	1.55	0.99	985.40	643	0.03	H4	0.5	21.35669	21.4322	29.4410	22.3	22.4	30.7	22.3
BH15	Kp	11.681	1.55	0.99	985.40	643	0.03	H4	1.5	21.75965	18.0071		7.6	6.3		6.3
BH15	Kp	11.681	1.55	0.99	985.40	643	0.03	H4	2.2	51.94828	37.0775		12.3	8.8		8.8

For all above assessments, the Factor of Safety equation, given below, has been used. Parameter values are defined below, with values as given.

$$F = \frac{c' + (\gamma - m\gamma_w) z \, Cos^2\beta \, Tan\phi'}{\gamma \, z \, Sin\beta \, Cos\beta}$$

F factor of safety (calculated value)
c' shear strength (kPa); measured value
γ bulk density of peat, undrained in situ (kg/m^3); measured value
γ_w bulk density of water (kg/m^3); measured value
m water table elevation as a ration of peat depth (m); taken as 1 for all calculations
z peat depth perpendicular to slope (m); vane centre depth used for all calculations
β slope angle (degrees); derived from DEM
φ' angle of internal friction (degrees); taken as 5 for all calculations

APPENDIX 2.4: PEAT MANAGEMENT PLAN

Peat Management Plan
Main Wind Farm Development
Updated Stage 1: Post-Consent Phase

Viking Wind Farm
(Project Ref: LN000046)

Prepared by SLR Consulting Ltd

on behalf of

SSE Renewables Ltd

DOCUMENT CONTROL			
Version No.: 4.0 **Revision No.:**	**Peat Management Plan**		**Date: 2/11/2018**
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Prepared by:	David Nisbet	Senior Geologist	
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CONTENTS

Drawings

1 INTRODUCTION

1.1 Site and Development Overview

1.1.1 In April 2012, Viking Energy gained consent to build the 'Viking Wind Farm', comprising 103 wind turbines across mainland Shetland. The consented wind farms location and infrastructure are shown on Drawing 1: Main Wind Farm Infrastructure.

1.1.2 Since the project was initiated the number of turbines has been reduced from over 170 in 2006, to 127 in 2010, with a finally consented site of 103 turbines in 2012.

1.1.3 The following Peat Management Plan is based on the current proposed 103 turbine development, utilising all previous peat probing information (where relevant) gathered as part of the original ES. Data has been utilised from a number of layout variations and laterally a detailed survey of the current layout has been completed. Recent work in July/August 2018 included undertaking over 5800 additional peat probes across the site, along tracks, at each turbine and crane hardstanding locations and at consented and proposed borrow pits. A total of over 10,135 peat probe points have been used in the assessment.

1.1.4 This document does not review all the previous layout iterations; it is only using historic peat data where it influences the current layout. The previous studies are referenced in this document.

1.2 Peat Management Plan - Guidance & Context

1.2.1 Developments on peat soils and / or in peatland environments may in some cases generate waste excavated materials if no suitable re-use options are available on site. In such circumstances, excavated peat may constitute a waste and, consequently, regulatory controls apply to its management. In February 2010, the Scottish Environment Protection Agency (SEPA) produced the "*SEPA Regulatory Position Statement – Developments on Peat*" to help ensure a sustainable and consistent approach to the management of peat.

1.2.2 Guidance was subsequently published to ensure the consistent application of the principles contained within the SEPA position statement: '*Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste'*, Scottish Renewables and SEPA, Version 1, January 2012.

1.2.3 The guidance identifies three main stages in the development process and describes what data should be gathered and assessed at each to inform a site-specific Peat Management Plan (PMP):

- **Stage 1**: Environmental Impact Assessment (EIA);
- **Stage 2:** Post-consent / pre-construction; and
- **Stage 3:** Construction.

1.2.4 As part of the Viking Wind Farm Environmental Statement (ES, 2009) and the Addendum (Addendum ES, 2010), the following documents were prepared and submitted in accordance with the requirements of **Stage 1,** as part of the planning application:

- Viking Wind Farm, Peat Stability Assessment, Technical Appendix 14.1 to the ES;

- Viking Wind Farm, Outline Site Environmental Management Plan (SEMP[1], Technical Appendix A14.6 to the Addendum ES), including Technical Schedule TS7, Excavated Materials and Reinstatement Plan.

- Viking Wind Farm, Addendum Environmental Statement, Site Environmental Management Plan (SEMP), Technical Schedule No.7, Excavated Materials & Reinstatement Plan, 2010

- Viking Wind Farm, Addendum Environmental Statement, Technical Appendix A14.4, Estimated Peat Extraction Volume and Potential Reuse Options, 2010

- Viking Wind Farm, Habitat Management Plan 2016, Final version 1, RPS;

1.2.5 The data and information informing the above documents demonstrated to SEPA and other relevant parties that: (i) the extent and characteristics of peat at the study site were investigated; (ii) excavations in peat were minimised wherever possible through design iterations and adoption of appropriate design hierarchy[2]; and (iii) excavation and subsequent management of peat, including an estimation of quantities, was considered as part of the EIA.

1.2.6 This PMP has been prepared in accordance with the requirements of **Stage 1** and further refines the preliminary data submitted for the ES in 2012. The refinements to the PMP take into consideration further and more detailed ground intrusive investigation undertaken in 2018, as well as the reduced number of turbines for the consented scheme.

1.2.7 A more detailed Stage 2 PMP will be undertaken post consent following detailed site investigation and design.

1.2.8 Peat management will be monitored during construction (**Stage 3**) to ensure that excavated peat volumes continue to be minimised wherever possible through micro-siting and construction method refinements.

1.2.9 Where significant changes to the PMP are identified during construction (for example if unexpected ground conditions are encountered or changes to consented design are required), the PMP will be updated in consultation with SEPA where required.

1.2.10 Design decisions, proposed construction practices and peat management standards for this site are aligned with current good practice guidance (e.g. Good Practice During Windfarm Construction[3]' and 'Floating Roads on Peat[4], refer to Section 8) relating to the range of environmental and engineering constraints associated with developments on peatlands, such as ecological considerations, topography, construction issues, carbon accounting etc.

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1 Now called a Construction Environmental Management Plan (CEMP)

2 Design hierarchy as detailed within the SR/SEPA guidance: prevent excavation, reduce excavation volumes and reuse excavated peat in a manner to which it is suited.

3 *Good Practice During Windfarm Construction*, Scottish Renewables, Scottish Natural Heritage, Scottish Environment Protection Agency, Forestry Commission Scotland, Version 3, September 2015.

4 *Floating Roads on Peat*, Forestry Civil Engineering and Scottish Natural Heritage, August 2010.

1.3 Peat Management Plan – Scope & Objectives

1.3.1 This PMP provides further information to that previously submitted for the Viking Wind Farm. All of the probe data collected, which influences the current layout, has been included in the PMP; the existing data was validated by checking depths and interpretation. The previous data was suitable to be reused in the assessment.

1.3.2 This PMP is applicable to the works associated with the construction of the wind farm, herein known as the “works”. The works, as illustrated in Drawing 1: Main Site Infrastructure, entail:

- construction of ~71km of new access single and double tracks using both cut and floating construction methods (Drawing 2: Excavated/Floating Access Track)
- construction of foundations for 103 No. wind turbines and 7 No. meteorological masts;
- construction of 103 No. wind turbine crane hardstandings and 7 No. met mast crane hardstandings;
- construction of new watercourse crossings and upgrades to existing crossings;
- construction of temporary and permanent drainage;
- installation of electrical and communication cables;
- associated ancillary works, temporary construction sites, laydown areas and batching plants; and
- extraction of rock from up to 10 consented borrow pits.

1.3.3 The objectives of this PMP are as follows:

- to provide a description of the peat encountered during intrusive ground investigation to date;
- detail relevant works activities that are likely to generate peat, and demonstrate a sustainable approach to peat management via the guiding principles of reduce and re-use;
- consider the anticipated volumes of peat that will be excavated on site and estimated quantities required for re-use; and
- establish a sustainable approach to peat management during the works.

1.3.4 Following the completion of site-wide ground investigation and prior to the commencement of the Works, this PMP will be revisited to consider the management of peat in relation to all aspects of the development.

1.4 Available Information

1.4.1 The following sources of information have been consulted in the development of this PMP:

i. Viking Wind Farm, Peat Stability Assessment Report, Technical Appendix 14.1, Mouchel Ltd, March 2009.

ii. Viking Wind Farm, Estimated Peat Extraction and Re-use Volumes, Technical Appendix 14.4, Albion Environmental Ltd, September 2010.

iii. Viking Wind Farm, Addendum Peat Management Plan, Mouchel Ltd, September 2010.

iv. Kergord Access Track Supporting Statement, Arcus, April 2018.

v. Kergord Access Track, Peat Slide Hazard Risk Assessment, Jacobs, June 2016.

vi. Kergord Access Track, Peat Management Plan, Jacobs, June 2016.

vii. Kergord Access Track, Environmental Appraisal Report, Jacobs, June 2016.

viii. Habitat Management Plan 2016, Final Version 1, RPS Group 2016

ix. Peat Probe Map, September 2013 – SSE Renewables Ltd.

x. Kergord Cable Route Factual Report (GLRP 0003), May 2013. URS Corporation.

xi. Kergord Substation Factual Report (GLRP 0003), May 2013. URS Corporation.

xii. Sandwater Access Track, Peat Slide Hazard Risk Assessment, Jacobs, June 2016.

xiii. Sandwater Access Track, Peat Management Plan, Jacobs, June 2016.

xiv. Peat Probe Map, September 2013 – SSE Renewables Ltd.

xv. Sandwater Cable Route Factual Report (GLRP 0003), May 2013. URS Corporation.

xvi. Sandwater Substation Factual Report (GLRP 0003), May 2013. URS Corporation.

xvii. Sandwater Peat Work October 2013, van Post logs. Raeburn Drilling Ltd.

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2 PEAT MANAGEMENT PLAN DEVELOPMENT

The PMP was developed in consultation with SEPA, a summary of the consultation response(s) is detailed in Table 1. Table 1: Summary of SEPA Consultation in relation to the survey and management of peat related to recent peat survey work (July /August 2018).

Table 1: Consultation

Planning Office/Officer (SEPA)	Consultation method	General Aspect	Consultation Comments
Zoe Griffin Senior Planning Officer, Aberdeen	E-mail Consultation	Submitted proposed peat probing plan, prior to undertaking the works, this addressed the Sandwater Access Track, Kergord Access Track and the main wind farm.	SEPA commented on plan, we took on comments addressing issues where relevant. Responded to Zoe Griffin on 24/7/2018. Submitted proposed peat probing plan, prior to undertaking the works, this addressed the Kergord Track, Sandwater Track and the main wind farm. SEPA commented on plan outlining peat probing plan for Viking Wind Farm, SLR took on comments addressing issues where relevant. SEPA indicated all peat surveys should be carried out in accordance with Government guidance which can be found here: http://www.gov.scot/Resource/0051/00517174.pdf SEPA indicated the probing grid distances appear to be appropriate along the access roads, the proposed detailed probing for the proposed turbine bases, borrow pits and other supporting infrastructure appears not to comply with the 10m by 10m grid required in the guidance. SLR responded to Zoe Griffin on 24/7/2018. We are currently working through the site and are undertaking detailed grids along the tracks and at the turbines. As for the borrow pits we do not have a specific detailed design for the borrow pits as yet and as we are trying to avoid excavating in peaty areas for borrow pits. The grid is still on a larger grid, we are tackling search areas to help refine the designs and potential areas. There is a degree of uniformity on the peat so interpolating across areas is acceptable, and if we get into areas where the peat is significantly variable we will increase the frequency. Our grid is also complimenting previous data and we are happy we will have a very comprehensive understanding of the extent of peat on site.

3 DESIGN CONSIDERATIONS FOR REDUCING PEAT EXCAVATION

3.1.1 The development has been designed in recognition of a number of environmental and geological constraints, informed by detailed site surveys, constraints mapping and design interrogation. This iterative approach to the wind farm design was largely undertaken pre-planning, this process has continued post-consent in an attempt to optimise the scheme layout from an environmental, economic and geotechnical perspective. The design considerations outlined in this section considers peat excavation at the site in relation to the post consent layout where track realignment has occurred to mitigate environmental constraints.

3.1.2 The consideration of peat and peatland habitats has featured prominently throughout the evolution of the development and has influenced the design accordingly. The design has sought to avoid deeper areas of peat on site as far as reasonably practical. However, where this is considered impractical infrastructure has been located on the shallowest possible peat deposits within the confining limits of other environmental constraints and engineering feasibilities. Furthermore, as far as reasonably practicable, the infrastructure layout has endeavoured to avoid peatland habitats of notable ecological interest, which are often correlated with pockets of deeper peat.

3.1.3 The following design considerations and decisions have been taken during the post-consent refinement phase as a result of further survey, stakeholder discussion and information from intrusive ground investigations to minimise disturbance and avoid unnecessary excavation of peat. Some of these (e.g. micro-siting) will be reviewed on an on-going basis during the construction phase in order to further reduce peat excavation and disturbance wherever possible.

3.1.4 To minimise disturbance and avoid unnecessary excavation of peat at this site, a number of design considerations and decisions) were taken during the post-consent, project refinement phase. Aspects of the design were influenced as a result of further survey, stakeholder discussion and information from intrusive ground investigations.

- **Access Track Length Reduction** – Following identification of a number of environmental constraints on the site a review of the access track layout has been undertaken to avoid constraints and optimise where practicable, this has resulted in a significant reduction in the access track length from the consented layout of 117.5km to 71 km.

- **Cabling design** – At the time of writing the exact cabling installation method is still to be selected however where ground conditions allow, cable laying in peatland habitats will adopt a ploughing method to reduce excavation of peat. Where practical, cable duct installation will occur at the same time as track construction and shall be located alongside the track to reduce land disturbance and temporary storage times. Furthermore, in relation to floating tracks, cable ducts will be constructed in reinstated verges to avoid excavation of undisturbed peat. A possible solution also being considered is to lay the cables in very shallow trenches and use excavated peat to provide an adequate cover system.

- **Micro-siting and footprint reduction** – The planning consent allows for limited spatial deviation for the consented wind farm design (i.e. micro-siting), therefore, within the confines of the planning consent, design review, aimed at minimising peat excavation and disturbance, shall continue into the construction phase.

3.1.5 The detailed calculations of peat volumes associated with each of the excavation and reuse activities are presented in Table 6.

3.1.6 The peat volume was calculated from the 5m Digital Terrain Model (DTM) produced from LiDAR data and an interpolated ground surface derived from the peat probes. The interpolation method used was of a spline, with a barrier of 70m from the peat probe locations. Both the DTM and the peat depth interpolation were resampled to a resolution of 1m, to account for the irregular shape of the cut areas. The lower surface of the peat was calculated from the DTM minus the peat depth interpolation. The volume of peat was calculated by comparing the DTM to the calculated height of the lower surface of the peat, using the Cut and Fill tool of ArcGIS.

4 PEAT CONDITIONS

4.1 Peatland Landscape and Habitats

4.1.1 The surveys identified that the site is dominated by blanket bog, with smaller areas of acid grassland, dry heath, wet heath, heath and acid grassland mosaics and bare peat. Some blanket bog has been degraded and modified through grazing practices, with other large areas of good quality active bog also present.

4.1.2 The vast majority of the survey area and wider landscape is covered by blanket bog; the exceptions being the steeper, dryer eastern slopes of Scalla Field and Whaa Field, the shallower substrates bordering the Burn of Weisdale, and the few acid and base rich flushes dotted through the area (RPS, 2016).

4.1.3 All of the blanket mire within the survey area and the surrounding landscape has been modified to some extent through historical crofting activities. The majority appears to show signs of historic peat cutting, with alternating ridges, or banks, of dryer bog vegetation interspersed with much wetter bog vegetation. It is possible that some of these areas have recovered from previous erosion. At the north of the survey area in the valley of Kergord this alternate dry/wet complex of bog may be due to differences in hydrology caused by the more variable depth of peat overlying the bedrock

4.1.4 The Sandwater area was subject to **some** agricultural improvement in the 1950s and 1960s. This converted a large area of blanket bog into pasture for sheep grazing. A considerable amount of drainage work appears to have been undertaken with lime and fertiliser added and, in places, surface seeding. Agricultural improvement is also evident along the Burn of Weisdale. It is also apparent that some drains have been cut into the blanket bog vegetation in places, although these do not appear to be recent.

4.1.5 In broad terms of the habitats present, the vast majority of the survey area is generally actively peat forming and as such should be classed as blanket bog, currently showing very little sign of erosion. By Shetland standards, this can be described as relatively intact to moderately degraded blanket bog. A series of base rich flushes at the southern end of the survey site are present; these are highly likely to be ground water dependent and in a Shetland context of moderate to high conservation interest. A series of M6 flushes were identified which may be groundwater dependent however these are ubiquitous in Shetland and are more likely to be rainwater fed wetland flushes and therefore likely to be of less conservation interest.

4.2 Peat Depth Surveys to date

4.2.1 Numerous phases of peat probing have been undertaken on the site, the first round of peat probing at the ES stage (Mouchel) to determine peat depth across the site. During the ES stage, probes were carried out along the main site layout.

4.2.2 In addition, the access track and cable route were subject to further investigation in 2013 (Raeburn). Further probing was undertaken as part of the wind farm access tracks by RPS in 2016.

4.2.3 Since then various investigations have been undertaken, e.g. Kergord Access Track and Sandwater Access Track where additional probing has been undertaken.

4.2.4 The most recent survey undertaken by SLR Consulting Ltd, included a site walkover and further probing carried out in July 2018, to address the current 103 turbine layout with associated infrastructure. The current number of probes used in the analysis for the main site is 10135 no. probes.

4.3 Interpretation

4.3.1 Based on the accumulated peat probing survey results, peat depths at the site are consistent with those recorded at the ES stage and further investigation stages, i.e. predominately found to be an average depth of 1.36m over the entire site. The peat values recorded is demonstrated in the peat contour plan (Drawing 3 – Peat Contour Plan).

4.3.2 Limited peat coring was undertaken during the recent site visit; however work undertaken previously generally identified the peat as typically fibrous to around 1m with an increase in humification and water content as the peat became more catotelmic below 1.5m.

4.3.3 The percentage depth distribution for the site as a whole is illustrated in Table 2.

Table 2: Accumulated Peat Probes Depths

Depth	No. Probes	%Total
0-0.25	968	9.55%
0.25-0.5	674	6.65%
0.5-0.75	1020	10.06%
0.75-1	928	9.16%
1-1.25	1259	12.42%
1.25-1.5	633	6.25%
1.5-1.75	1396	13.77%
1.75-2	952	9.39%
2-2.25	890	8.78%
2.25-2.5	346	3.41%
2.5-2.75	485	4.79%
2.75-3	153	1.51%
3-3.25	152	1.50%
3.25-3.5	59	0.58%
3.5-3.75	97	0.96%
3.75-4	23	0.23%

Table 2: Accumulated Peat Probes Depths		
4-4.25	**67**	**0.66%**
4.25-4.5	**2**	**0.02%**
4.5-4.75	12	0.12%
4.75-5	6	0.06%
5-5.25	7	0.07%
5.25-5.5	4	0.04%
5.5-5.75	2	0.02%
Grand Total	**10135**	**100.00%**

4.3.4 Estimated volumes of peat and mineral soils to be reused at the site are detailed in Tables 5 & 6. These volumes have been calculated assuming excavation of peat for the following infrastructure elements, inclusive of the design refinements outlined in Section 1.3.2.

4.4 Classification of Excavated Material

4.4.1 The findings of the 2013 and 2018 Soil augers indicate that the majority of peat present can be described as acrotelmic (lower humification (H_0-H_5) and moisture content) over first 1-1.5m with more humified and wetter peat (H_6- H_{10}) at depths in excess of this, based in accordance with the Von Post Scale of Humification (Ekono 1981).

4.4.2 Following analysis and review of the trial pits/ soil augers/ peat probe logs and consulting the Von Post Scale, peat has been classified into one of three re-use suitability categories (i) Green, (ii) Yellow or (iii) Red (Table 3). The method of peat classification into these categories is determined by allocating a proportion of the Von Post Scale of Humification and Moisture Content descriptions with suitability for re-use description. The three categories are defined below:

Table 3 Re-use suitability characteristics

Category	Von Post Scale of Humification and moisture Content	Description
Green	H1:B1-4, H2:B1-B4, H3:B1-B3, H4:B1-B3, H5:B1-B2, H6:B1-2	This category represents fibrous to pseudo-fibrous material. The Low humification numbers are representative of undecomposed peat with fibrous structure ideal for reinstatement of upper peat layers. The latter humification numbers represent a Moderately to Moderately-Highly content of amorphous material, although the moisture content remains low. This category of material is considered suitable for all types of reinstatement as the peat structure is likely to remain unchanged during excavation, storage and handling.

Category	Von Post Scale of Humification and moisture Content	Description
Yellow	H1:B5, H2:B5, H3:B4-B5, H4:B4-B5, H5:B3-B4, H6:B3-B4, H7:B1-B3, H8:B1-B2	This category represents fibrous material with higher moisture content and further decomposed highly amorphous materials with Low moisture. This category of material is considered suitable for all types of reinstatement if handled, stored and managed strictly in accordance with the principles outlined in Section 4. Due to the diversity in this range and variable nature, the least fibrous material shall be used in the reinstatement of lower peat layers, complementing natural peat structure.
Red	H5:B5, H6:B5, H7:B4-B5, H8:B3-B5, H9:B1-B5, H10:B1-5	This category represents Very Highly to Completely decomposed amorphous peat with all moisture contents and the middle-scale of humification with High and Very High moisture content. This category is considered the most challenging for excavation, storage and handling on site and generally only suitable for reinstatement in limited areas due to its amorphous nature.

4.4.3 Table 6 (below) provides a summary of the Works peat data classified according to the above descriptions. The data analysis indicates that the peat to be excavated is likely to be classified as 54% ‘Green’, 35% ‘Yellow’ and 11% ‘Red’.

4.4.4 An analysis of ground investigation data and likely peat classification for each of the separate infrastructure elements is summarised in Table 4.

Table 4: Peat Classifications for Main Infrastructure Elements

	Peat Characteristics %		
Infrastructure Peat Data	Green	Yellow	Red
New Access Tracks (Cut Construction)	70	25	5
New Access Tracks (Floating Construction)	0	0	0
WTG Foundations (103 No.)	65	30	5
Crane Hardstandings (103 No.)	65	30	5
Borrow Pits (up to 10)	90	10	0
Cable Routes	100	0	0
Construction Compound	90	10	0
Temporary Laydown Areas (WTS)	90	10	0
Temporary Laydown Area (Cables)	90	10	0
Batching Plants (1 No.)	90	10	0

5 PEAT MANAGEMENT PROPOSALS

5.1 Excavation Activities

5.1.1 The following activities require excavation, including stripping of vegetation turves and excavation of underlying soils, including peat, down to formation level (e.g. excavation down to a stratum with suitable engineering properties to meet required design criteria.

- ‘Cut’ track construction (in areas of peat <1m deep or where floating track construction is not physically possible);
- Wind turbine and crane hardstanding excavations, compounds, and where overburden stripping is required at borrow pits and temporary laydown and construction areas.
- Excavation of cable trenches for underground cabling (e.g. where not mole-ploughed or laid in previously reinstated material at road edge);
- Temporary construction compounds and laydown areas (to be finalised).

5.1.2 The updated CEMP will include a requirement for details relating to excavated materials to be recorded throughout the construction phase by the Contractor in a Materials Excavation Register.

5.2 Excavation and Reinstatement Standards

5.2.1 The outline SEMP submitted as part of the ES will be updated to a pre-construction CEMP. This CEMP will then be submitted to the planning authority for discharge of relevant pre-commencement planning conditions in line with the Consent. The CEMP will include requirements for the Contractor to strictly adopt good practice standards in relation to the excavation, storage and reuse of peat during the construction phase of the project. Updated excavation and reinstatement standards will be detailed in the CEMP.

5.2.2 In accordance with reinstatement good practice, consideration will be given to the existing landform associated with the area of the Works. Principally, this will involve the avoidance of the creation of uniformed construction batters and straight-lined infrastructure edges. Shallow construction batters will be favoured to ensure a subtle transition from construction slopes to existing land.

5.2.3 Temporary storage locations will be appropriately located and designed to avoid environmental constraints (e.g. sensitive habitats, watercourses, etc.) and, thus, minimise ecological impact, prevent risks from material instability and avoid sediment-laden run-off discharging directly into watercourses.

5.2.4 The precise location of temporary peat stockpiles will be determined at a site-level following consideration and assessment of suitable areas by the ECoW and Contractor to ensure locations are optimal in terms of environment, construction practicality and safety.

5.3 Re-use Activities

5.3.1 During and upon completion of the Works, there will be a requirement for the reinstatement of infrastructure edges and embankments, including:

i. verge reinstatement and landscaping to cut access tracks (to compliment surrounding topography, reduce visual impacts, establish vegetation and reduce erosion etc);

ii. verge reinstatement and landscaping to floating access tracks (to compliment surrounding topography, reduce visual impacts, establish vegetation and reduce erosion etc.);

iii. reinstatement around watercourse crossing structures;

iv. reinstatement of existing construction compound; and

v. reinstatement of cable trenches.

5.3.2 The Habitat Management Plan (HMP) sets out proposed measures for habitat restoration and enhancement and is provided as Technical Appendix 8.9: Habitat Management Plan and Technical Appendix 8.10: Habitat Management Plan Figures. Proposed measures include the restoration of peatland habitat throughout the area. Candidate areas for blanket bog restoration provided in the HMP include up to c.260ha of restoration which can be split across the reduced S36 boundary. There would be sufficient area to utilise peat generated on site for habitat improvement.

5.3.3 Whilst the HMP identifies that surplus peat could be reused in proximity to the development's infrastructure. Areas may be ruled as unsuitable due to other environmental factors not considered during this process. Similarly, careful consideration will need to be given to the nature of the peat excavated and its suitability for peat restoration purposes, the methods of excavation, transportation, and reuse to satisfy SEPA that this is a legitimate use for peat.

5.3.4 The HMP shows sufficient areas will be present surrounding infrastructure to reuse c.68,000m^3 of material. Although the HMP generally excluded areas of 20-50% bare peat consideration will be given during the construction phase to these areas as these areas may contain gullies which might benefit from the reuse of excavated peat. Where appropriate, areas will be included within HMP actions and will aid in targeting the reuse of materials in close proximity to the source of excavation. Such consideration will further limit transport requirements and the risks associated with such activities.

5.3.5 Peatland restoration work on site will operate as part of the construction process, and although not directly part of the HMP, it will be integrated to ensure peatland related obligations are met. At this stage it is proposed that the works will be implemented under the project's CEMP, and aim to minimise the excavation, movement and storage of peat. Construction will nonetheless generate blanket bog turfs and volumes of peat, a significant proportion of which have the potential to be used for additional peatland restoration at locations in proximity to wind farm and access track construction. This restoration work will therefore contribute to the HMP's blanket bog objectives.

5.3.6 The progression of this restoration work will be complex and will require significant forward planning. Peat management during construction also maximizes its contribution to the delivery of the wider blanket bog restoration. It is also important that information on peat volumes, peat storage and peat slide risk are also shared across the construction and restoration teams so that overall peat protection, blanket bog restoration, pollution prevention and health and safety requirements are met. To this end therefore, the wider environment team (ECoW, Contractors Environmental representative and Geotechnical Clerk of Works in particular) will be aware of the HMP and its activities and objectives, so that 'on site' handling of blanket bog vegetation and peat during construction and reinstatement can be orchestrated to best overall use.

5.3.7 Based on the peat characteristics described in Section 4, it is anticipated that the peat excavated on site will be of a suitable composition for reuse in all of the applications listed above. However, if any wet, amorphous (e.g. conveying characteristics consistent with the Red category as described in Section 3) peat is encountered it would be placed in appropriate locations such as the base of a borrow pits, or in eroded haggy areas where it can be dressed with a sequence of semi-fibrous and fibrous peat (e.g. peat representative of the Yellow and Green class outlined in Section 3).

5.3.8 Potential areas for disposal of catotelmic peat are limited but areas such as borrow pits and alternatively in potential restoration areas identified as a potential Habitat Management area in the HMP.

5.4 Proposed Mitigation During Construction

5.4.1 There are a number of ways in which detailed design and construction activities can be specified to minimise impacts on peatlands. The detailed construction environmental mitigation will be outlined in detail in the CEMP; the following section outlines briefly the likely mitigation based on the reuse of peat specific to key elements of the road development.

Access Tracks

5.4.2 In comparison to infrastructure specific to wind turbines, there is considerably more guidance available to support access track design in peatlands. Guidance is generally focused on floating tracks and excavated tracks, and is summarised below.

5.5 Excavated Access Tracks

5.5.1 Excavated tracks require complete excavation of peat to a competent substrate. Excavated tracks are generally undertaken where peat depths are less than 1m. This peat would require storage ahead of re-use elsewhere on site. Good practice guidance relates mainly to drainage in association with excavated tracks:

- trackside ditches should capture surface water (within the acrotelm) before it reaches the road;
- interceptor drains should be shallow and flat bottomed (and preferably entirely within the acrotelm to limit drawdown of the water table);
- any stripped peat turves should be placed back in the invert and sides of the ditch to assist regeneration; and
- culverts and cross drains should be installed under excavated tracks to maintain subsurface drainage pathways (such as natural soil pipes or flushes). Discharge from constructed drainage should allow for as much diffuse dispersion of clean (silt free) water as possible while minimising disturbance to existing peatland as far as possible. Silt mitigation measures will be incorporated into all constructed drainage as per the requirements of the CEMP.

5.5.2 Although excavation is normally undertaken in peat of minor thickness (< 1.0m), there is a possibility of minor slippage from the cut face of the peat mass. Accordingly:

- free faces should be inspected for evidence of instability (cracking, bulging, excessive discharge of water or sudden cessation in discharge); and
- where significant depths of peat are to be stored adjacent to an excavation, stability analysis should be conducted to determine Factor of Safety (FoS) and an acceptable FoS adopted for loaded areas.

5.5.3 As with floating tracks, monitoring should be scheduled post-construction to ensure that hydrological pathways and track integrity have been suitably maintained.

5.6 Floating Access Tracks

5.6.1 Over deeper peat (typically >1.0m), floating tracks are used to remove the requirement for peat excavation and limit disruption of hydrological pathways. The success of construction requires careful planning to take account of the unique characteristics of peat soils. Specific guidance[5] is available on design, the duration and timing of construction, the sequence of construction and the re-use of peat on the shoulders of the floating access track.

Design of Floating Access Tracks

5.6.2 The following issues should be considered during detailed design of floating access tracks:

- adopting conservative values for peat geotechnical properties during detailed design (post-consent);
- applying a maximum depth rule whereby an individual layer of geogrid and aggregate should not normally exceed 450mm without another layer of geogrid being added;
- on gently sloping ground and where the access track runs transverse to the prevailing slope, accommodating natural hydrological pathways such as flushes and peat pipes through installation of a permanent conduit within or underneath the track and allowing for as much diffuse discharge (while minimising disturbance to existing peatland) on the downslope as possible;
- ensuring transitions between floating tracks and excavated tracks (or other forms of track not subject to long term settlement) are staged in order to minimise likelihood of track failure at the boundary between construction types;
- scheduling access track construction to accommodate for, and reduce, peat settlement characteristics; and
- Re-use of existing roads (with upgrading if required), where possible.

Duration and Timing of Construction of Floating Access Tracks

5.6.3 The critical factor in successful construction of floating access tracks is the timescale of construction, and the following good practice guidance is provided:

- the settlement characteristics of peat; should be accommodated by appropriate scheduling of access track construction, as follows:
- prior to construction works, the setting out the centreline of the proposed access track to identify any ground instability concerns or particularly wet zones;
- identifying ‘stop’ rules, i.e. weather dependent criteria for cessation of access track construction based on local meteorological data;
- maximising the interval between material deliveries over newly constructed access tracks that are still observed to be within the primary consolidation phase;

[5] Floating roads on peat (SNH, FCS; August 2010);

5.7 Sequence of Construction

The sequence of construction is normally stipulated in guidance provided by the supplier of the geotextile or geogrid layer, and suppliers are often involved in the detailed access track design. Good practice in relation to the sequence of access track construction is as follows:

- retaining rather than stripping the vegetation layer (i.e. the acrotelm, providing tensile strength), and laying the first geotextile/geogrid directly on the peat surface;
- adding the first rock layer;
- adding the second geotextile/geogrid, and add overlying graded rockfill as a running surface;
- heavy plant and Heavy Goods Vehicles (HGV) using the access tracks during the construction period should be trafficked slowly in the centre of the track to minimise dynamic loading from cornering, breaking and accelerating;
- ensuring wheel loads should remain at least 0.5m from the edge of the geogrid, markers should be laid out, monitored and maintained on the access track surface to clearly emphasise these boundaries; and
- initial ‘toolbox’ talks and subsequent feedback to construction and maintenance workers and drivers to emphasise the importance of the implementing the above measures.

Use of peat as trackside shoulders

5.7.- A key opportunity to re-use peat is to employ it in landscaping of constructed access tracks. Wedge-shaped reinstatement at the margins of a floating access track (which is elevated above the peat surface) is termed shoulders, and good practice guidance is as follows:

- re-using peat excavated from elsewhere on site as shoulders adjacent to the floating track;
- peat shoulders should taper from just below the track sides (thereby preventing over high shoulders from causing ponding on the track surface) to join the surrounding peat surface, keeping as natural a profile as possible to tie in with existing slope profiles; and
- limiting the width of peat shoulders to avoid unnecessary smothering of intact vegetation adjacent to the floating track.

5.8 Cable Trenches

Cable trenches either require peat excavation specifically for this purpose, or they can be constructed within landscaping of shoulders adjacent to floating tracks. Guidance is as follows:

- utilise peat shoulders for cable lays where possible to minimise peat excavations specifically for this purpose, in this case, peat shoulders should be 1.0m to 1.5m thick;
- where cable trenching is constructed adjacent to a floating road, ensure the trench is backfilled to prevent void filling by material migration;
- minimise time between excavation of the cable trench and peat reinstatement, preferably avoiding excavation until the electrical contractor has cables on-site ready for installation; and

- avoid incorporating substrate materials in the excavation, to minimise contamination of the peat to be reinstated. Replace excavated materials sequentially.

5.9 Peat Excavation, Storage and Transport

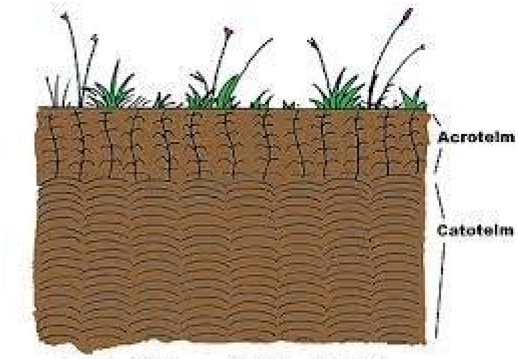
5.9.1 If peat is to be re-used or reinstated with the intention that its supported habitat continues to be viable, the following good practice applies:

Excavation

5.9.2 Excavated peat should be excavated as turves, including the acrotelm (surface vegetation) and a layer of adjoining catotelm (more humified peat) typically up to 500mm thick in total, or as blocks of catotelm; the acrotelm should not be separated from its underlying peat;

- the turves should be as large as possible to minimise desiccation during storage;
- contamination of excavated peat with substrate materials should be avoided; and
- consider timing of excavation activities to avoid very wet weather and multiple handling to minimise the likelihood of excavated peat losing structural integrity.

5.9.3 If possible, extract intact full depth acrotelm layers from the top surface of the peat deposit. This technique will maintain connectivity between the surface vegetation and the partially decomposed upper layers of the catotelm.



Hydrological Layers in Bogland Habitat

Storage

- peat turves should be stored in wet conditions or irrigated in order to prevent desiccation (once dried, peat will not rewet);
- stockpiling of peat should be in large volumes to minimise exposure to wind and sun (and desiccation), but with due consideration for slope stability;
- excavated peat and topsoils should be stored to a maximum of 1m thickness;
- stores of non-turf (catotelm) peat should be bladed off to reduce the surface area and desiccation of the stored peat; and
- monitor areas of steep peat and peat storage areas during periods of very wet weather, or during snowmelt, to identify early signs of peat instability.

Temporary Storage

5.9.4 As an example, for the average volume (~600m^3), this would require a temporary storage area near to the construction works of approximately 25m x 25m to a height of 1.0m. Where peat cannot be transferred immediately to an appropriate restoration area, short term storage will be required. In this case, the following good practice applies:

- peat should be stored around the turbine perimeter at sufficient distance from the cut face to prevent overburden induced failure,
- local gullies, diffuse drainage lines (or very wet ground) and locally steep slopes should be avoided for peat storage;
- stored upper turves (incorporating vegetation) should be organised and identified according to NVC community (assisted by the Environmental Clerk of Works, ECoW) for reinstatement adjacent to like communities in the intact surrounding peat blanket;
- drying of stored peat should be avoided by irrigation (although this is unlikely to be significant for peat materials stored less than 2 months).

Transport

- movement of turves should be kept to a minimum once excavated, and therefore it is preferable to transport peat planned for translocation and reinstatement to its destination at the time of excavation; and
- if HGVs that are used for transporting non-peat material are also to be used for peat materials, measures should be taken to minimise cross-contamination of peat soils with other materials.

Handling

5.9.5 Following refinement of the wind farm peat model, a detailed storage and handling plan should be prepared as a detailed PMP forming part of the detailed CEMP:

- best estimate excavation volume at each infrastructure location (including peat volumes split into area / volume of 'acrotelm' or 'turf', and volume of catotelm);
- volume to be stored locally and volume to be transferred directly on excavation to restoration areas elsewhere (e.g. disused quarries, borrow pits or forest drains) in order to minimise handling;
- location and size of storage area relative to turbine foundation, crane hardstanding and natural peat morphology / drainage features;
- Irrigation requirements and methods to minimise desiccation of excavated peat during short term storage.

These parameters are best determined post-consent in light of detailed ground investigation with the micro-siting areas for each element of infrastructure.

5.10 Restoration

- carefully evaluate potential restoration sites, such as borrow pits for their suitability, and agree that these sites are appropriate with the ECoW, landowners and relevant consultees;
- undertake restoration and revegetation work as soon as possible;
- where required, consider exclusion of livestock from areas of the site undergoing restoration, to minimise impacts on revegetation; and
- as far as reasonably practicable, restoration should be carried out concurrently with construction rather than at its conclusion.

6 ESTIMATION OF EXCAVATION AND RE-USE VOLUMES

6.1 General

6.1.- Summary peat excavation and reuse volumes for the site are provided in Table 5 & 6 below.

Table 5: Summary of Peat Excavation and Reuse Volumes				
		Assumed Characteristic		
Volume Comparison	Total	(m^3)	(m^3)	(m^3)
Volume of peat excavated (m^3)	962407	63	31	6
Volume of reinstated peat for infrastructure(m^3)	894451	70	20	10
Volume of reinstated peat available for habitat restoration(m^3)	67956	10	10	80
Net Balance	**0**			

Table 6: Summary of Peat Excavation and Reuse Volumes by Infrastructure		
Infrastructure	Estimated Total Peat Excavation Volume (m^3)	Estimated Total Peat Reinstatement Volume (m^3)
New Access Tracks (Cut Construction)	529807	134811
New Access Tracks (Floating Construction)	0	125371
WTG Foundations (103 No.)	62873	31518
Crane Hardstandings (103 No.)	225956	49440
Crane Pads Ancillary	5006	16068
Borrow Pits (up to 10)	102690	288000
Cable Routes	0	213168
Construction Compound	20000	20000
Temporary Laydown Areas (WTS)	2025	2025
Temporary Laydown Area (Cables)	3750	3750
Meteorological Masts	300	300
Batching Plants (1 No.)	10000	10000
Habitat Management (see HMP)	0	(67956)
Total	**962407**	**894451**

6.2 Results

6.2.1 All excavated material is considered suitable for site reuse. The current volume estimates indicate that there is no significant surplus or deficit of peat on site. This balanced volume estimate is considered acceptable at this stage.

6.2.2 The generation of 'waste' (according to legal definition of waste) peat during construction and a deficit of peat found during construction is considered unlikely due to the following factors;

- The excavated volume estimates are based on conservative input parameters and further design refinements will be possible during construction to further reduce the volume of excavated peat.
- The reinstatement volume estimates are based on a conservative input and further design refinements will be possible during construction.
- The nature of the peat is such that it is considered suitable for reuse as a material for both engineering and environmental purposes.

7 CONCLUSIONS

7.1.1 This updated PMP (Stage 1) presents a pre-construction assessment of the expected peat extraction and reuse volumes associated with the Works phase of the construction of the Main Wind Farm.

7.1.2 Through a process of continued design refinement (focused on minimising peat excavation volumes) and adoption of best practice working method, the development is expected to achieve an overall peat balance, i.e. the volume (and character) of excavated peat compliments requirements for reuse and reinstatement. Thus, all excavated material will be required for reuse as part of the works and no surplus peat is anticipated.

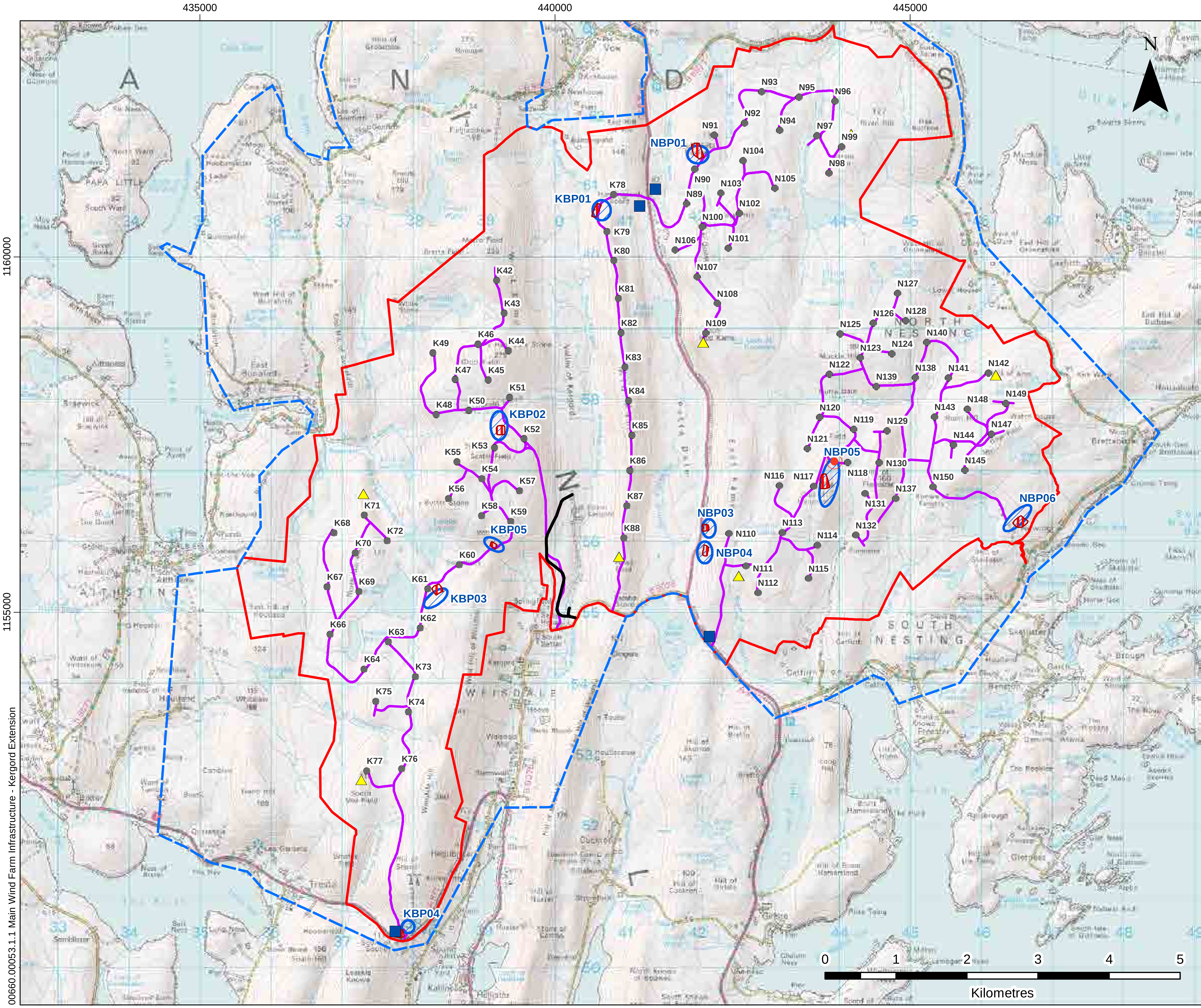
7.1.3 The site supports peat of moderately decomposed peat with a very distinct plant structure that is considered suitable for reuse during reinstatement work, e.g. dressing of infrastructure edges, restoration and borrow pit restoration. Good practice standards, which will be outlined in the updated CEMP, relating to excavation, handling and storage of peat, shall ensure against any compromise to the structural integrity of the peat and its associated suitability for reuse.

7.1.4 Avoidance of localised pockets of deep peat that would otherwise require excavation will continue to be a key design refinement objective. Furthermore, it is expected that such micro-siting onto land supporting shallower peat deposits shall be possible during the Works.

8 REFERENCES

Legislation relevant to the management of peat includes the following:

- The UK Climate Change Act 2008 (c 27);
- Environmental Protection Act 1990 (as amended);
- Landfill (Scotland) Regulations 2003 (as amended);
- The Waste Management Licensing (Scotland) Regulations 2011; and
- Scottish Planning Policy (2014).
- There are a number of guidance documents appropriate to the activities planned on site which have been used to guide this assessment, as follows:
- Guidance on Developments on Peatland (SNH, SEPA 2017);
- Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (SR, SEPA, January 2012);
- SEPA Regulatory Position Statement – Developments on Peat (SEPA, February 2010);
- Good practice during wind farm construction (SR, SNH, SEPA, FCS, HES; September 2015);
- Floating roads on peat (SNH, FCS; August 2010);
- Constructed tracks in the Scottish Uplands (SNH, September 2015); and
- Restoration techniques using peat spoil from construction works (SEPA 2011).



LEGEND

- SITE BOUNDARY CONSENTED S36
- SITE BOUNDARY REDUCED UNOFFICIAL
- PROPOSED TURBINE LOCATION
- PROPOSED ACCESS TRACK
- KERGORD ROAD EXTENSION
- BORROW PIT EXTRACTION AREA
- BORROW PIT SEARCH AREA
- CONSTRUCTION COMPOUND
- PERMANENT MET MAST
- SUBSTATION

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VIKING WIND FARM

PEAT MANAGEMENT PLAN

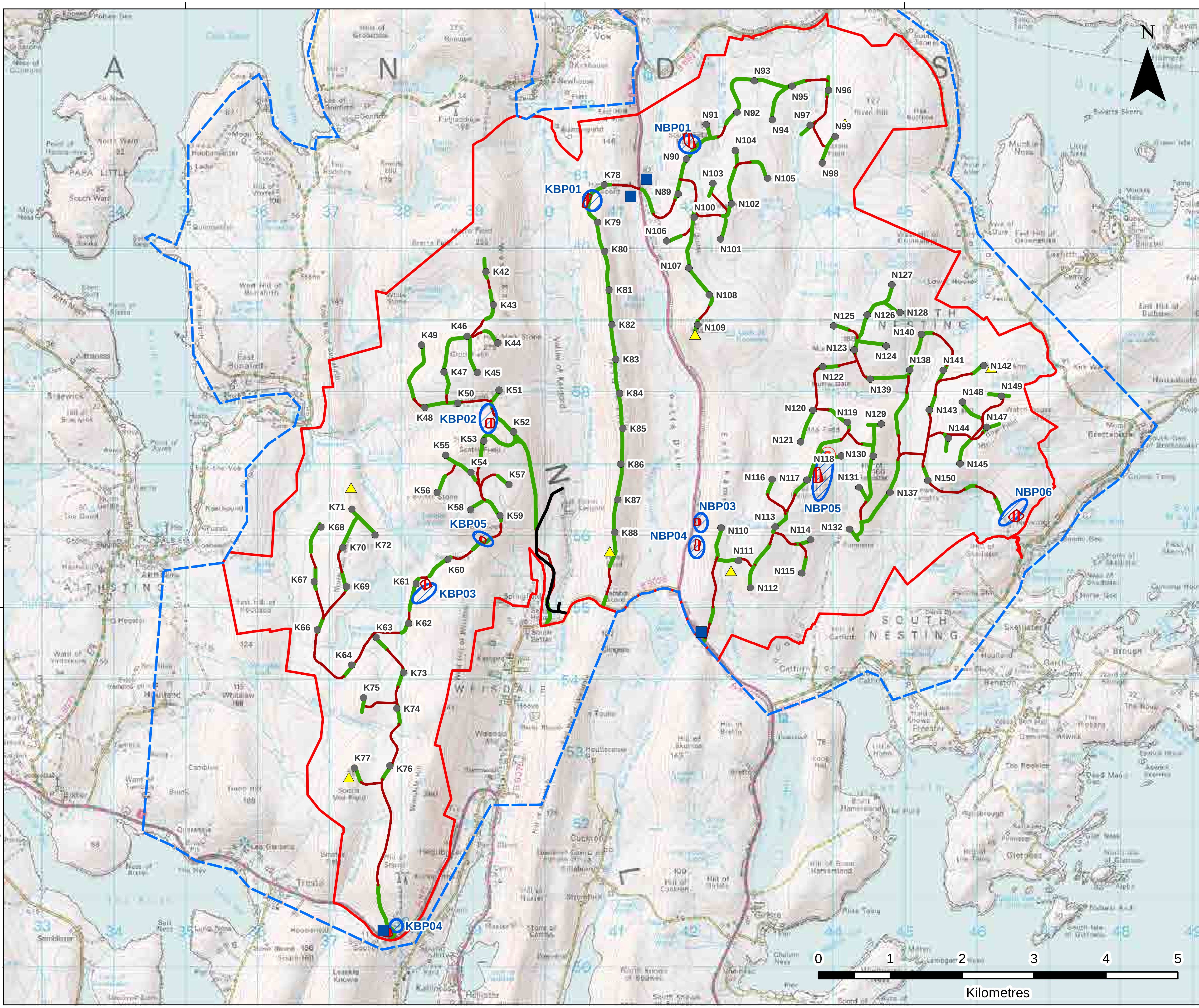
MAIN WIND FARM INFRASTRUCTURE

1

Scale 1:50,000 @ A3

Date NOVEMBER 2018

00660.00053.1.1 Main Wind Farm Infrastructure - Kergord Extension



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- PROPOSED FLOATED TRACK
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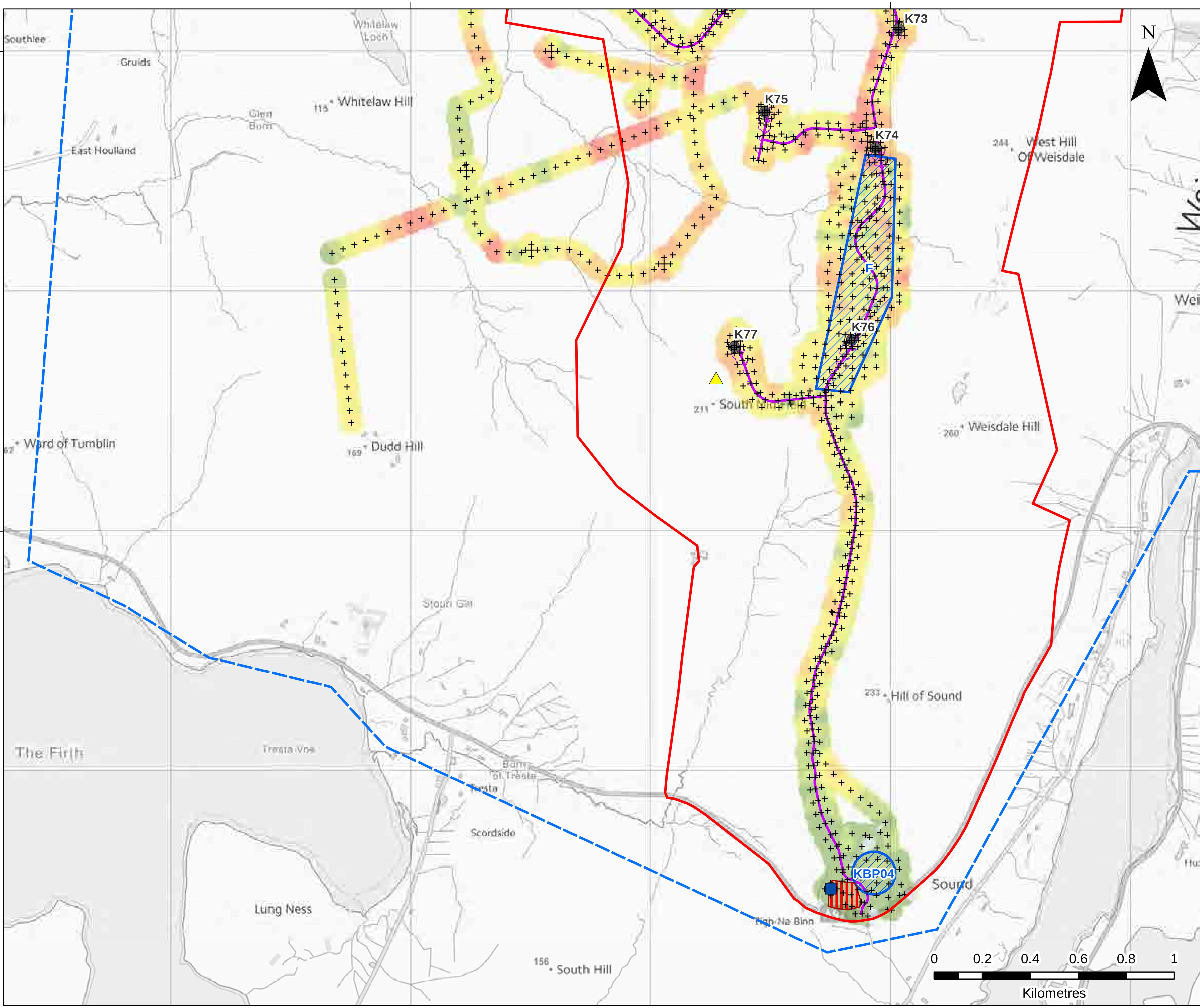
PEAT MANAGEMENT PLAN

EXCAVATED / FLOATING ACCESS TRACK

2

Scale	Date
1:50,000 @ A3	NOVEMBER 2018

00660.00053.2.1 Floated Tracks - Kergord Extension



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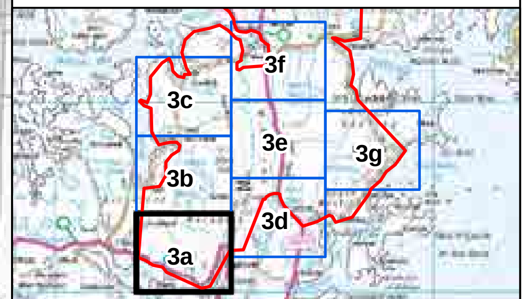
- BORROW PIT SEARCH AREA
- CONSTRUCTION COMPOUND
- PERMANENT MET MAST
- SUBSTATION
- PEAT PROBE

PEAT DEPTH (m)

0	1.5 - 2
0 - 0.5	2 - 2.5
0.5 - 1	2.5 - 3
1 - 1.5	> 3



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VIKING WIND FARM

PEAT MANAGEMENT PLAN

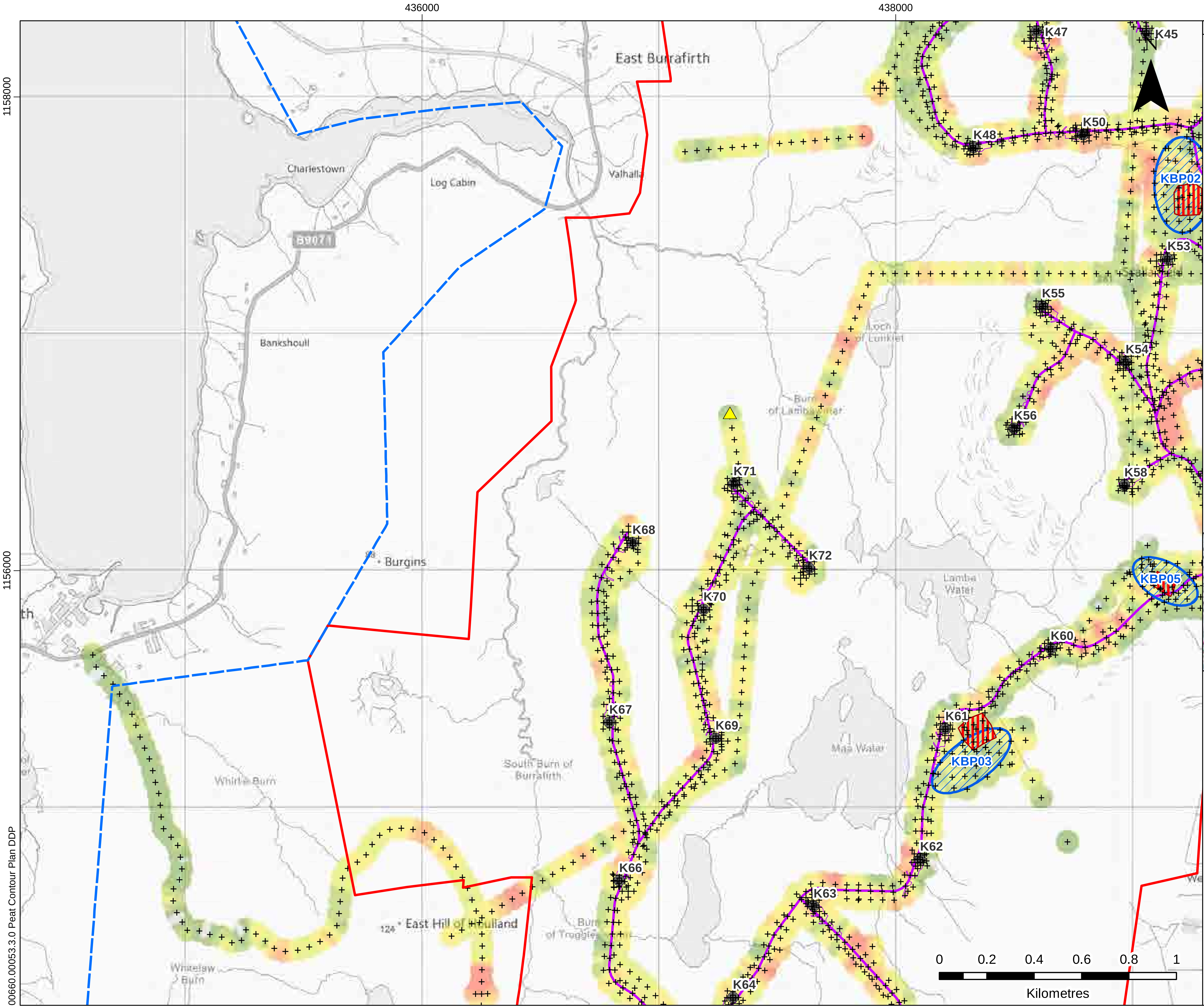
PEAT CONTOUR PLAN ALONG PROPOSED MAIN WIND FARM LAYOUT

3a

Scale 1:15,000 @ A3

Date OCTOBER 2018

00660.00053.3.0 Peat Contour Plan DDP



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SITE BOUNDARY REDUCED UNOFFICIAL

PROPOSED TURBINE LOCATION

PROPOSED TURBINE HARDSTANDING

PROPOSED ACCESS TRACK

BORROW PIT EXTRACTION AREA

BORROW PIT SEARCH AREA

CONSTRUCTION COMPOUND

PERMANENT MET MAST

SUBSTATION

PEAT PROBE

PEAT DEPTH (m)

0	1.5 - 2
0 - 0.5	2 - 2.5
0.5 - 1	2.5 - 3
1 - 1.5	> 3

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PEAT MANAGEMENT PLAN

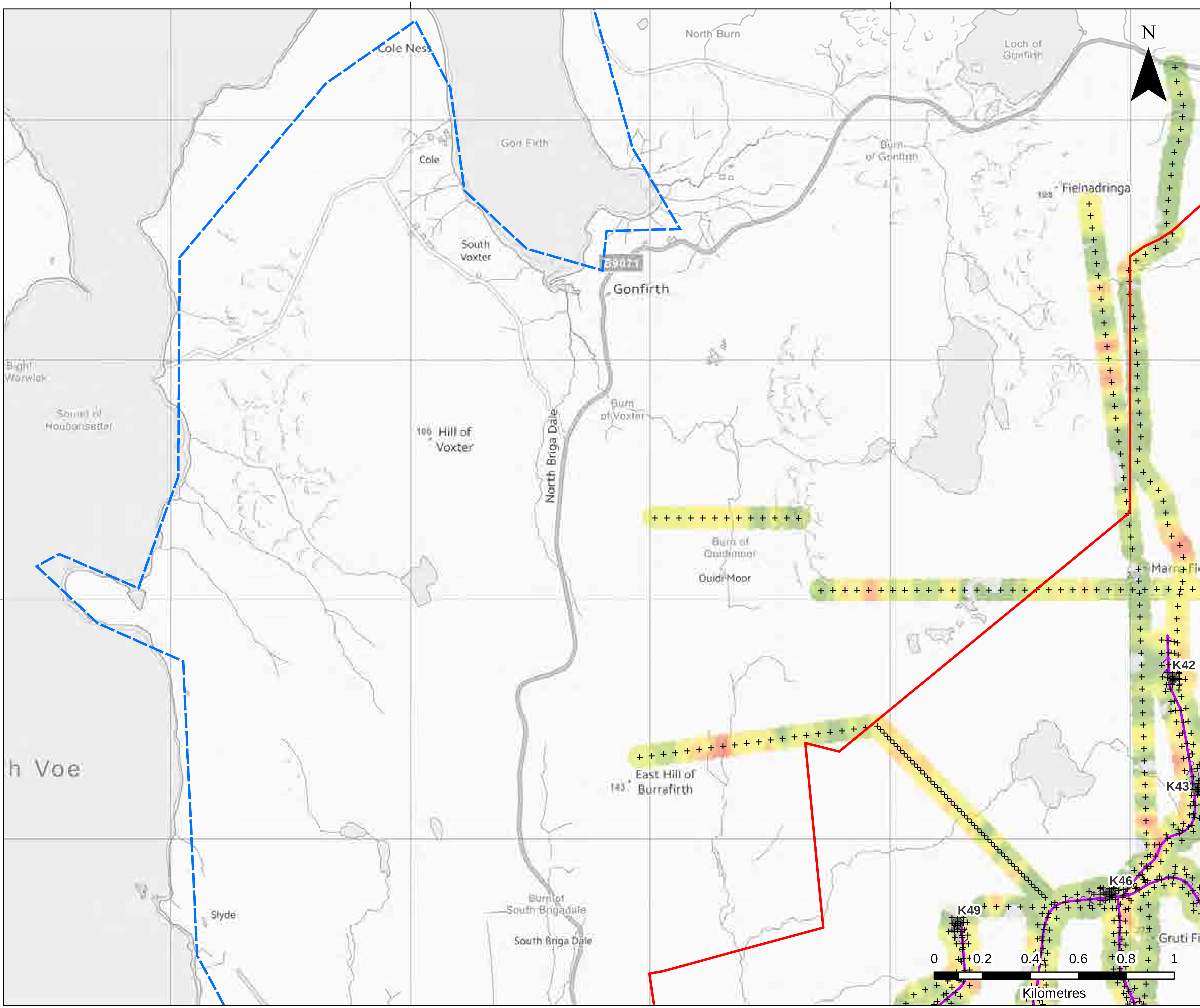
PEAT CONTOUR PLAN ALONG PROPOSED MAIN WIND FARM LAYOUT

3b

Scale 1:15,000 @ A3

Date OCTOBER 2018

0660.00053.3.0 Peat Contour Plan DDP



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- BORROW PIT SEARCH AREA
- CONSTRUCTION COMPOUND
- PERMANENT MET MAST
- SUBSTATION
- PEAT PROBE

PEAT DEPTH (m)

0	1.5 - 2
0 - 0.5	2 - 2.5
0.5 - 1	2.5 - 3
1 - 1.5	> 3

3f
3c
3e
3g
3b
3d
3a

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PEAT MANAGEMENT PLAN

PEAT CONTOUR PLAN ALONG PROPOSED MAIN WIND FARM LAYOUT

3c

Scale 1:15,000 @ A3

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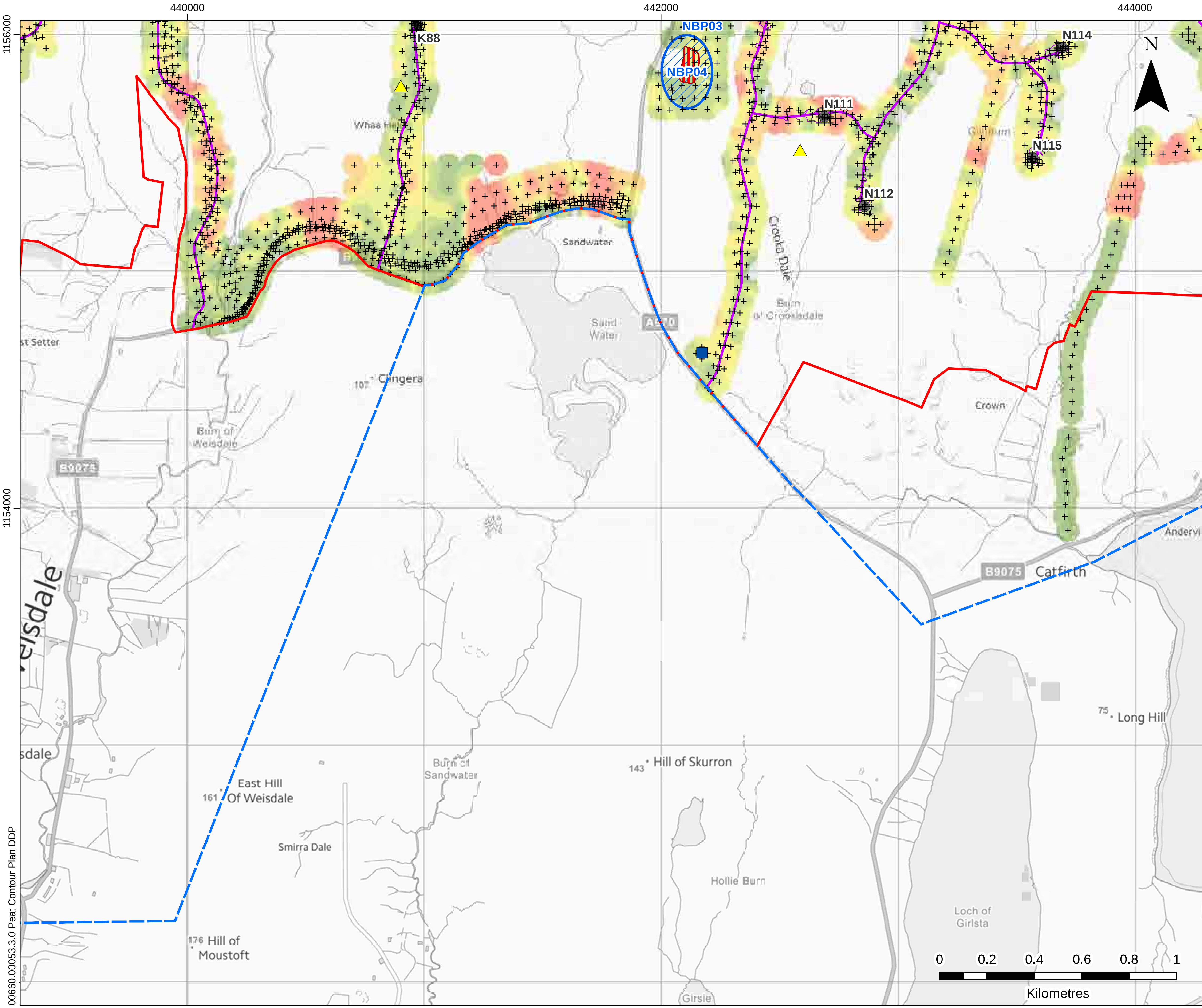
0660.00053.3.0 Peat Contour Plan DDP



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PEAT DEPTH (m)

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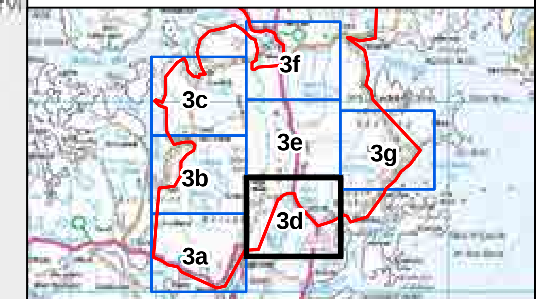
1 - 1.5	> 3



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PEAT MANAGEMENT PLAN

PEAT CONTOUR PLAN ALONG PROPOSED MAIN WIND FARM LAYOUT

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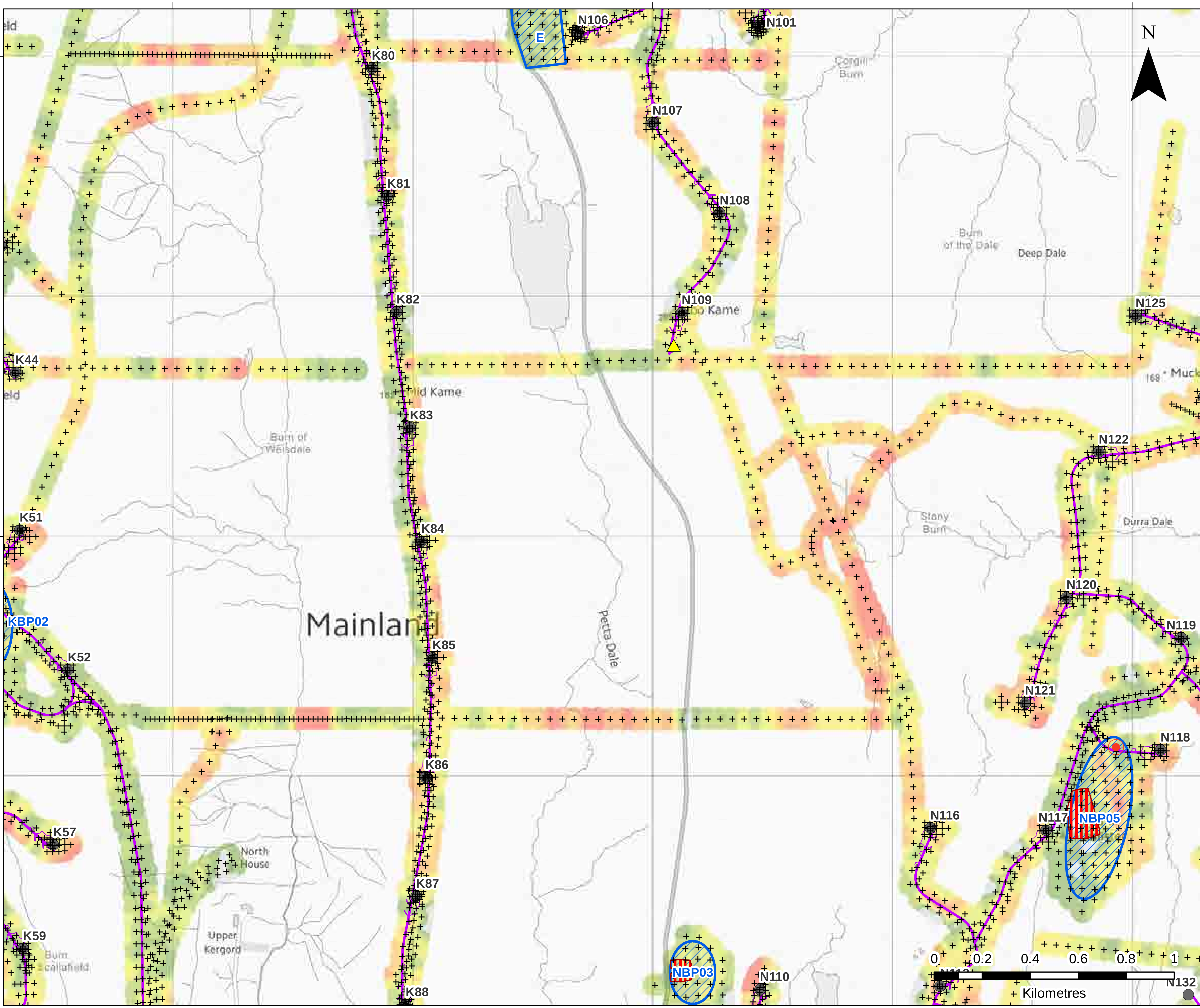
Scale	Date
1:15,000 @ A3	OCTOBER 2018

0660.00053.3.0 Peat Contour Plan DDP



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	BORROW PIT SEARCH AREA
	CONSTRUCTION COMPOUND
	PERMANENT MET MAST
	SUBSTATION
+	PEAT PROBE

PEAT DEPTH (m)

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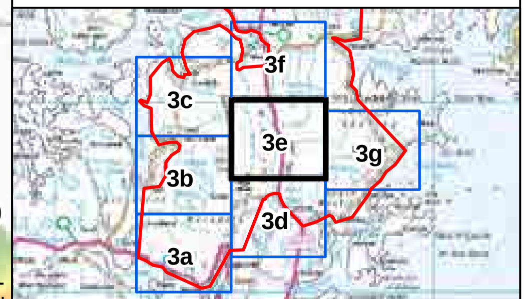
1 - 1.5	> 3



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PEAT MANAGEMENT PLAN

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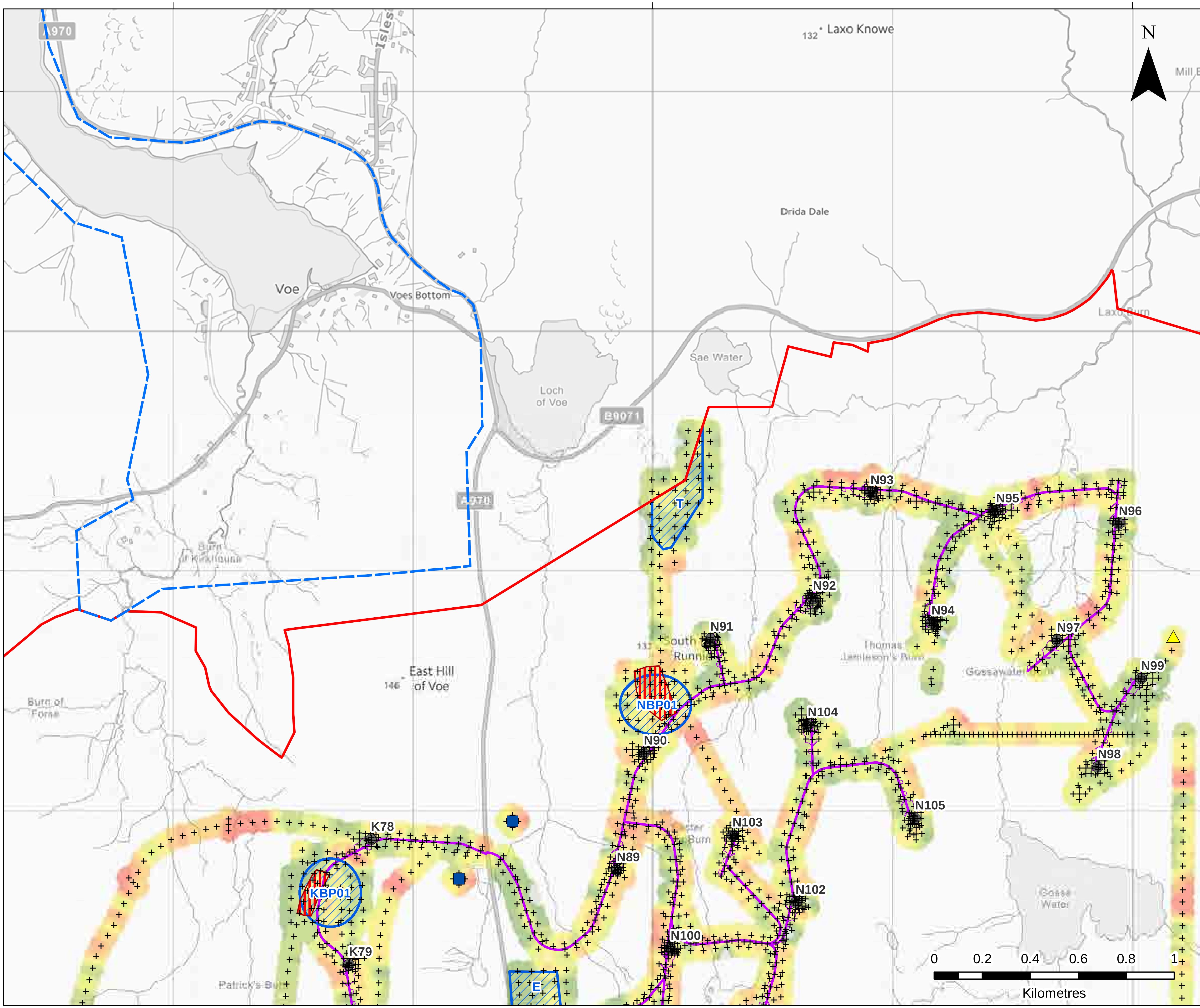
Scale 1:15,000 @ A3

Date OCTOBER 2018



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PROPOSED TURBINE HARDSTANDING

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BORROW PIT EXTRACTION AREA

BORROW PIT SEARCH AREA

CONSTRUCTION COMPOUND

PERMANENT MET MAST

SUBSTATION

+ PEAT PROBE

PEAT DEPTH (m)

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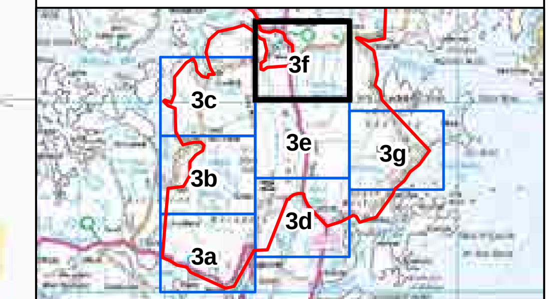
0.5 - 1	2.5 - 3
1 - 1.5	> 3



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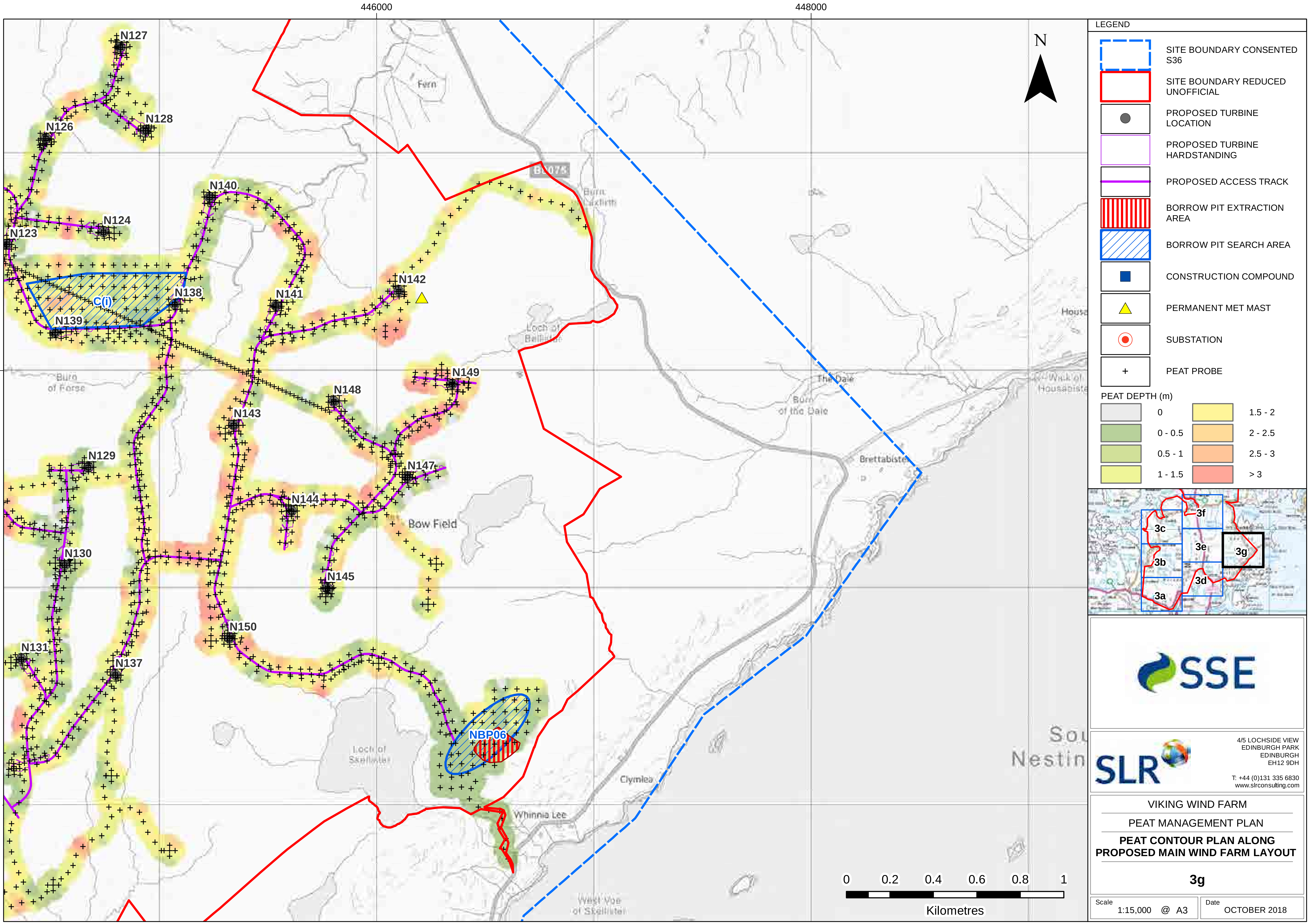

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PEAT MANAGEMENT PLAN

PEAT CONTOUR PLAN ALONG PROPOSED MAIN WIND FARM LAYOUT

3g

Scale	Date
1:15,000 @ A3	OCTOBER 2018

00660.00053.3.0 Peat Contour Plan DDP

APPENDIX 2.5: BORROW PIT ASSESSMENT

Information contained within the 2009 Borrow Pit Assessment was seen as relevant to support the 2018 EIA, thus has been included.

Viking Energy Partnership

Viking Wind Farm

Technical Appendix 14.2
Borrow Pit Assessment

March 2009

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FINAL ISSUE	Name	Signature	Date
Prepared by	Catherine Isherwood	Catherine Isherwood	15/01/2009
Checked by	Stuart Bone	Stuart Bone	11/03/2009
Approved by	Malcolm Macfie	Malcolm J Macfie	11/03/2009

CONTENTS

TABLES

FIGURES

APPENDICES

See Environmental Statement Volumes 3 and 4b for all A3 Figures and Technical Drawings

This report is presented to Viking Energy Ltd in respect of Viking Wind Farm and may not be used or relied on by any other person or by the client in relation to any other matters not covered specifically by the scope of this report.

Notwithstanding anything to the contrary contained in the report, Mouchel Ltd is obliged to exercise reasonable skill, care and diligence in the performance of the services required. Viking Energy and Mouchel shall not be liable except to the extent that they have failed to exercise reasonable skill, care and diligence, and this report shall be read and construed accordingly.

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1 INTRODUCTION

This report forms a Technical Appendix to Chapter 14 (Soil and Water) of the Environmental Statement for Viking Wind Farm (Mouchel, 2009) and should be read with reference to this chapter.

Viking Energy Ltd are currently progressing proposals for a wind farm on North Mainland in the Shetland Islands. The proposed wind farm site is located approximately 27km north of Lerwick and is roughly centred on the settlement of Voe (grid reference HU 4077 6320). The area of interest is divided into four quadrants, with two quadrants to either side of the main A970/A968 route which runs north–south across the island. The quadrants are known as; Delting, Collafirth, Kergord and Nesting. All four quadrants of the proposed 150-turbine wind farm comprise areas of open moorland used mainly for rough grazing.

To minimise the volume of foreign material brought onto the site and any consequent environmental impact, borrow pits located within the site will be used to source as much of the necessary material for track construction as possible. Viking Energy has calculated that 1,420,000m^3 of aggregate material will be required for the construction of access tracks, turbine base back-fill, compounds and hard-standing areas.

Mouchel was commissioned to undertake a borrow pit assessment for this development site. The aims of this assessment were to provide:

- A preliminary indication of the suitability of the bedrock as a road building material;
- Potential borrow pit locations;
- Indicative borrow pit dimensions;
- Indicative extraction volumes;
- Estimates of overburden at borrow pit locations;
- Indication of potential extraction methods;
- Recommendations for geotechnical testing;
- Preliminary borrow pit reinstatement and rehabilitation proposals.

This document outlines Mouchel's method for borrow pit assessment along with the analysis undertaken, conclusions drawn and recommendations for borrow pit design and location.

It should be noted that all borrow pit information provided within this report is indicative only, and is based on desk study and reconnaissance survey alone. No intrusive investigation has been carried out, and consequently the suitability of the rock, suggested extraction methods and volumes are broad estimates and should be treated as such.

2 PROJECT METHODOLOGY

The project involved a desk study and engineering geology walkover surveys.

The desk study consisted of a review of information with regard to the Viking Wind Farm site which included examining available geological and hydrogeological data together with additional information relating to the site. These included:

- 1:50,000 and 1:10,000 Ordnance Survey topographic maps;
- Digital elevation model (DEM) data;

- DiGMap GB digital geology mapping, British Geological Survey;
- British Regional Geology guide vol. 1: Orkney & Shetland, Institute of Geological Sciences (now British Geological Survey) 1976;
- The Geology of Scotland (4^{th} Edition);
- Aerial photographs;
- Groundwater vulnerability map of Scotland;
- Hydrogeological map of Scotland 1:625,000;
- Soil Survey of Scotland 1:250,000 Sheet 1.

During the desk study potentially suitable sites for borrow pits were identified across the site area.

Visual site inspection and general geological survey work were undertaken in March 2006, with targeted geological fieldwork undertaken on 19-25 February 2008 and 17-28 November 2008. Photographs and detailed field notes were taken at each site, recording the geological and hydrogeological aspects of each identified location. A hand-held GPS unit was used to determine grid references to at least 30m accuracy.

In excess of 60 potentially suitable sites were identified around the site, including existing quarries or borrow pits near the site boundary. Using the estimated volume of aggregate required for the infrastructure, minimising the number of borrow pits whilst at the same time keeping a good coverage across the site, 14 possible borrow pits have been assessed in detail from the potentially suitable sites identified. These include 11 sites within the wind farm boundary and three existing quarries.

A map of the borrow pit locations is given in Figure 14.2.BP01 (in Volume 4b), showing all the identified sites and highlighting the 14 chosen localities.

3 DESK STUDY

3.1 Geology

The geology of Shetland consists partly of metamorphosed sedimentary rocks of Moinian and Dalradian age, and partly of sedimentary and igneous rocks of Devonian age. The Shetland Islands are elongate and dominated by north–south trending geological units cut by a series of similar trending faults.

North Mainland is cut by several major strike-slip faults trending north–south, in particular the Walls Boundary Fault (WBF), the Nesting Fault and the Melby Fault. The WBF is thought to be the northward extension of the Great Glen Fault and has undergone several phases of movement during its geological history. The rocks within the proposed development area lie predominantly between the Walls Boundary Fault to the west and the Nesting Fault to the east, with a small section of the Nesting quadrant lying to the east of the Nesting Fault.

Shetland is divided into two geologically distinct sections, typically called East and West Shetland and separated by the WBF. The East Shetland succession, east of the WBF, consists of a thick sequence of north–south trending metasediments with a vertical or steep dip, younging to the east. The rock types vary from schist and gneiss to quartzite and metalimestone. The sequence has been intruded by plutonic igneous complexes of variable composition, and is cut by a sequence of sills and dykes. The development area lies entirely within the East Shetland succession.

The solid geology is extensively covered by drift deposits, mostly composed of blanket peat and glacial material. Blanket peat is fairly extensive across the development area, forming a nearly unbroken cover over much of the site. There has been significant erosion on some hill and ridge tops, in places exposing the mineral soil. The peat is slightly more broken further south, giving more bedrock exposure especially in the Kergord quadrant and the area to the east of the Nesting Fault in the Nesting quadrant.

The peat is often underlain by a thin irregular layer of glacial till; the till is sometimes exposed in stream and road sections, especially in areas where peat is absent. Hummocky till or moraine deposits are noted in some localised areas with thin peat. Alluvium is present in small amounts in some river valleys but is very minor in extent, as are the occasional lacustrine deposits. Marine beach deposits are present along much of the coastline with minor blown sand in places. Glaciofluvial material is confined to a small area south of the Kergord quadrant.

Maps of the solid and drift geology are presented in ES Figures 14.1 and 14.2, respectively (both in Volume 3).

3.2 Hydrogeology

The Viking Wind Farm site is mostly underlain by impermeable Pre-Cambrian basement rocks. These rocks have very restricted groundwater flow, mostly through shallow, near-surface fracture systems, joints and along fault lines. Groundwater storage is equally restricted to these fractures and faults, as the crystalline nature of the rocks themselves prevents significant infiltration by groundwater. There are a few bands of metalimestone or marble that cross the site; these are susceptible to chemical weathering and dissolution, particularly along lines of pre-existing fractures, joints or bedding planes. In consequence, there may be increased groundwater flow and storage capacity within these bands, through these widened fractures and discontinuities.

Groundwater infiltration in the study area, based on geology, topography and baseflow data, is estimated to be between 100 and 300mm per year (Robins, 1988).

Given the impermeability of the underlying solid geology throughout the site it is likely that perched water tables exist in the more permeable overlying drift deposits. This will be most evident in peat deposits in areas of low relief or hollows, which will be almost fully saturated with a water table close to or at the surface. As a result there is little capacity for storage and most rainfall will become surface run-off. Lateral seepage through the peat provides a low baseflow for local watercourses. Where peat is located on steeper slopes the water table will be depressed and the area drier.

The impermeable nature of the bedrock across the area means that water may accumulate at the peat/bedrock interface. Such pooling of water may reduce the cohesion between the peat matrix and the bedrock and could act as a trigger for peatslides; however, this is difficult to assess without intrusive site investigation.

The groundwater in this area is dominantly classed as 4d (vulnerable) with small areas of classes 4a-c and 5. This classification reflects the low permeability and low groundwater storage capacity of the metamorphic and igneous bedrock combined with the very variable soil and drift cover, meaning that any contaminant could potentially enter the groundwater rapidly but would be slow to disperse or dilute once in the aquifer. In areas with deep peat, the peat would act as a barrier to the entry of contaminants into the groundwater although it would also serve to restrict access of water into the bedrock for dilution purposes.

3.3 Suitability of Bedrock as Aggregate

Many of the igneous and metamorphic rocks on Shetland have been used to supply aggregate for road construction (Mykura, 1976). The igneous rocks present are mostly coarse-grained, such as granite and gabbro. Granites and some mafic igneous rocks are currently quarried as aggregate on Mainland. The less foliated metasedimentary rocks are likely to provide good aggregate (Collis & Fox, 1985); these include gneisses, quartzites, psammites and marbles. The more fissile schists may be suitable but are likely to have greater variability and their use should be subject to appropriate testing. Schists and phyllitic schists are also quarried as aggregate on Mainland Shetland.

3.4 Assessment of Possible Flood Risk

The widespread occurrence of small perched lochans across the wind farm site poses a significant hazard to construction work, especially to blasting related to borrow pit excavation. The blasting could damage the peat dam holding the water, causing sudden catastrophic flooding; this could, in turn, flood the borrow pit locality if topography is not properly considered prior to borrow pit development.

This risk has been evaluated for each proposed borrow pit presented in the following assessment. In all cases, the borrow pits are sited well away from perched lochans and as they form topographic highs they are very unlikely to be subject to flooding.

4 ENGINEERING GEOLOGY WALKOVER SURVEY

A walkover survey of the site was conducted during March 2006 by a Chartered Engineering Geologist, with supporting fieldwork conducted on the 19-25 February 2008 and 17-28 November 2008. Visual site inspections, photographs and detailed field notes were taken reporting the geological and hydrogeological aspects of each of the identified locations. A hand-held GPS unit was used to obtain locations to at least 30m accuracy.

During the desk study and walkover survey a total of 61 potential borrow pit locations were identified around the site. These included 32 within the development area and 29 existing borrow pits or quarries nearby. Of these 61 sites, 14 were chosen for further detailed assessment. These choices included considerations of the amount of aggregate required, a good coverage of the site to restrict necessary aggregate transport and minimising the total number of borrow pits in order to limit the environmental and noise impact of the extraction.

The chosen sites include 11 within the development area and three existing quarries which lie near entry points for site access routes. The following sections give specific information about each site and are accompanied by A3 technical drawings presented in Volume 4b as Figure 14.2.BP-DBP01 etc. Note that the borrow pit list is not sequential (i.e. there are no NBP02, NBP07 or NBP08 pits).

Due to the large size of the site it is anticipated that all the borrow pit sites within the site boundary will be required to produce aggregate. Extraction from existing quarries or borrow pits is dependent on the granting of appropriate permissions, which may not be practical owing to potentially increased disruption to local residents, traffic on public highways and disturbance of recognised geological features. For this reason, borrow pits DBP01, NBP03 and NBP04 have been assessed on the basis that some of these will be used, rather than all. This gives an extra allowance of aggregate built in to the calculations.

4.1 Borrow Pit DBP01

Borrow Pit DBP01 is an existing disused site, known as Valayre Quarry, beside the B9076. It lies approximately 2km north of Brae, at grid reference HU 3689 6949. It should be noted that Valayre Quarry has been designated as a Site of Special Scientific Interest (SSSI) for its rock exposures.

This location is situated roughly halfway between two of the access routes into Delting quadrant, which makes it a good place from which to make the relatively small volume initial extractions before the borrow pits within the site itself are reached, whilst at the same time avoiding aggregate loads being transported through the settlements of Brae and Voe. The main quarry face is about 270m long and up to 20m high (Figure 1). Slope angles are in the range of 5-10° and the site is at an elevation of 15-40m above ordnance datum (AOD). Peat depths were not measured due to the difficulty of gaining access to the top of the quarry wall, but are likely to be thin.

Figure 1 Photograph of DBP01: View of main quarry face looking south-east

The proposed extraction would follow the existing quarry face, cutting back into the hill to the south-east of the quarry. The lithology, shown in Figure 2, has a variable texture:

- Dark grey;
- Medium- to coarse-grained;
- Well-foliated and platy, with foliation varying from mm-scale to over 1m;
- Some fracturing and jointing;
- Fresh to discoloured;
- Schistose GNEISS;
- Strong to very strong.

Figure 2 Close-ups of bedrock at DBP01: (a) Variable fabric, fracturing and shearing (hammer 30cm long); (b) Massive gneissose banding (scale bar 2m).

4.2 Borrow Pit DBP02

Borrow Pit DBP02 (grid reference HU 3771 6691) lies on the south-west access route into Delting quadrant, 2.4km south-east of Brae. It is situated on a moderately steep west to south-west facing slope with extensive but scatttered rock outcrop (Figure 3a). Good outcrop extends north from the proposed site for at least 400m, allowing for flexibility of position should this be required. The site elevation ranges between 90 and 125m AOD with slope angles in the range of 5-25°. Peat depths are variable across the site, usually <0.7m but in some places are over 1m.

The proposed borrow pit would lie along an axis running SW–NE and cutting back into the main slope of the hill, making use of existing breaks-in-slope and outcrop where possible. The rock identified at this site (Figure 3b) is:

- Pale to dark grey;
- Medium- to coarse-grained;
- Strongly banded, usually 1-10cm wide, with folding, some jointing and massive quartz veins present;
- Fresh to discoloured;
- Gneissose SCHIST;
- Strong.

Figure 3 Photographs of DBP02: (a) Overview of site from the south-west; (b) Close-up of bedrock, showing foliation and jointing (peat probe marked in 10cm divisions)

4.3 Borrow Pit DBP03

Borrow Pit DBP03, grid reference HU 4065 6985, lies in the central section of Delting quadrant on the north-east ridge of the Hill of Dale and near to the proposed track route between Turbines 12 and 16. The site takes advantage of the break-in-slope on the northern side of the ridge and covers an area of exposed mineral soil with bedrock outcrops (Figure 4). Slope angles range between <1 and 15°, and the site is at an elevation of 195-215m AOD. Recorded peat depths around this site indicate it is mostly fairly shallow at <0.5m.

Figure 4 Photographs of DBP03: (a) View uphill over site showing mineral soil exposure (peat probe 1m long); (b) Close-up of rock-step (hammer 30cm long).

The proposed borrow pit would lie along an axis running NNW–SSE into the side of the hill. The rock identified at this site (Figure 4b) is:

- Pale grey to white;
- Medium- to coarse-grained;
- Well-developed pervasive platy foliation, usually 5-10mm wide, with some folding and jointing;
- Fresh;
- QUARTZITE & PSAMMITE;
- Strong to very strong.

4.4 Borrow Pit CBP01

Borrow Pit CBP01, grid reference HU 4174 6604, is the only borrow pit in the Collafirth quadrant and is situated on the main access route into the site from the north-west. The site lies on the northern end of the Hill of Susetter where the slope steepens. Slope angles range between 3 and 18° with elevation between 95 and 110m AOD. Peat cover is mostly thin, typically between 0.3 and 0.7m, although is likely to deepen south and east from the exposed bedrock.

Figure 5 Photographs of CBP01: (a) View north-west over site showing rocky ridge; (b) Close-up of rock outcrop (hammer 30cm long)

The proposed borrow pit lies on the break-in-slope with a main axis running NNW–SSE. There are small outcrops near the top of the site, forming rocky ridges (Figure 5a) with small craggy outcrops towards the northern margin of the site. The lithology present is shown in Figure 5b and is:

- Pale to dark grey;
- Medium- to coarse-grained;
- Very strongly foliated with distinct colour banding, pegmatitic areas and quartz veins, tight folds visible in places;
- Fresh to discoloured;
- Gneissose SCHIST;
- Moderate to strong.

4.5 Borrow Pit KBP01

Borrow Pit KBP01 lies at the northern end of Mid Kame Ridge, beside the access route from the A970, at grid reference HU 4058 6073. It is situated on a moderately steep north-west facing slope immediately adjacent to the proposed track route. Slope angles range between 8 and 20° and the site is at an elevation of 90-115m AOD. No bedrock is exposed at the site, although there are areas of mineral soil across this part of the hill slope (Figure 6).

Peat cover is very variable, from 0.6m in the areas of mineral soil, to >1m both above and below the proposed site. It is also likely that the upper part of the bedrock is significantly affected by weathering, although cannot be confirmed without intrusive investigation.

Figure 6 Photographs of KBP01: (a) View across the site to the south-west; (b) View downhill over the site to the north-west (peat probe 1m)

The proposed borrow pit lies along a NW–SE axis to take advantage of the slope angle. In the absence of exposed bedrock, the lithology has been described using mineral soil exposure alone, as shown in Figure 7, and is consequently incomplete:

- Pale grey;
- Medium- to coarse-grained;
- Well-banded;
- Granitic GNEISS;
- Strong to very strong.

Figure 7 Photograph of KBP01: close-up of mineral soil (peat probe 1m)

4.6 Borrow Pit KBP02

Borrow Pit KBP02 is situated in the north-central section of Kergord quadrant at grid reference HU 3918 5763. It lies on the northern ridge of Scalla Field leading down to the col at Scallafield Scord and is adjacent to the proposed track route. The site is at an altitude of 205-240m AOD with slope angles ranging from 8 to 30°. Peat cover is very variable, from <0.1m adjacent to outcrop to >1m in other sections.

Figure 8 Photographs of KBP02: (a) View south-west across borrow pit site to Scalla Field; (b) Rocksteps exposed on the northern end of the ridge (peat probe 1m)

The proposed borrow pit lies on the western side of the ridge to take advantage of the steeper rocky slopes in this area (Figure 8a). Bedrock is exposed across the site as a series of small rocksteps (Figure 8b), rough slabs and rocky knolls, becoming more poorly exposed on flatter ground to both the east and the west. The lithology is:

- Mid- to pale grey;
- Medium to coarse-grained;
- Well-foliated with distinct folding (Figure 9a), colour banding and a porphyroblastic texture in places (Figure 9b);
- Fresh to discoloured;
- Psammitic SCHIST;
- Strong.

Figure 9. Photographs of KBP02: (a) Close-up of folded psammite; (b) Close-up of foliated schist with porphyroblasts (scale bars marked in 10cm sections)

4.7 Borrow Pit KBP03

Borrow Pit KBP03 is located in the central section of Kergord quadrant, at grid reference HU 3834 5527. It is situated on the north-west ridge of the West Hill of Weisdale which runs down to the division between Maa Water and Lamba Water. The ridge section has considerable but scattered rocky outcrop (Figure 10a), mostly as a series of rough slabs. Peat depths are quite variable, with pockets of >1m, although it is <0.6m across most of the site. The site is at an elevation of 140-170m AOD and has slope angles ranging from 2-23°.

Figure 10 Photographs of KBP03: (a) View north-west over borrow pit site; (b) Close-up of narrowly foliated bedrock (scale bar 20cm)

The proposed borrow pit has an axis running NW–SE to follow the ridge line and make best advantage of the slope angles. The lithology, shown in Figure 10b, at the site is:

- Pale grey;
- Fine to medium grained;
- Very well and narrowly foliated on a mm-scale with distinct colour banding throughout;
- Fresh to discoloured;
- SCHIST & PSAMMITE;
- Strong to very strong.

4.8 Borrow Pit KBP04

Borrow Pit KBP04 lies at the southern tip of Kergord quadrant adjacent to the main southern access route, at grid reference HU 3792 5057. The site is on the south-facing slope of the Hill of Sound just above the A971. The slope has a moderately steep gradient and a small scattering of bedrock and boulders (Figure 11a). Slope angles range from 4-25° and the site is at an elevation of 125-150m AOD. Peat cover is shallow across the whole slope, mainly in the range of 0.2-0.3m.

The proposed borrow pit follows a N–S axis to take best advantage of the slope in this area. The exposed lithology, described from the small amount of outcrop visible at the site (Figure 11b), is:

- Pale grey;
- Medium to coarse-grained;
- Very well-banded with pervasive but poorly developed foliation;
- Fresh to discoloured;
- Gneissose SCHIST;
- Strong to very strong.

Figure 11 Photographs of KBP04: (a) View south over borrow pit site; (b) Close-up of bedrock (peat probe 1m, marked in 10cm sections)

4.9 Borrow Pit NBP01

Borrow Pit NBP01 lies at the northern end of the Nesting quadrant at grid reference HU 4198 6151. It forms the main borrow pit for the northern section of the Nesting quadrant. It is sited on the southern ridge of South Filla Runnie, cutting into the west-facing slope where there is good bedrock exposure and a suitable break-in-slope. Site elevation is between 110 and 130m AOD with slope angles up to 17°. Recorded peat depths are shallow, mostly <0.5m.

Figure 12 Photographs of NBP01: (a) View of main outcrop looking south; (b) Close-up of marble showing jointing and included chert band (GPS handset 11cm long)

This proposed borrow pit cuts into the ridge along a ENE–WSW axis. Bedrock is exposed in a series of ice-smoothed outcrops across the top and side of the ridge with rocksteps to about 3m high (Figure 12a). The rock type is:

- Mid- to pale grey-brown;
- Fine to medium-grained;
- Well-jointed with folding and some colour banding, including small chert and pegmatite bodies;
- Fresh to discoloured;
- MARBLE;
- Strong to very strong.

Figure 12b shows a close-up of the exposed marble, including a chert band just above the GPS handset.

4.10 Borrow Pit NBP03

Borrow Pit NBP03, grid reference HU 4211 5619, is an existing disused borrow pit immediately east of the A970 (Figure 13). In common with NBP04, this borrow pit is situated near the main access to South Nesting as well as fairly close to the access routes to North Nesting and Mid Kame ridge in the Kergord quadrant. This makes it an excellent place from which to source aggregate for immediate access requirements, until borrow pits within the site can be reached.

Figure 13 Photographs of NBP03: View of existing borrow pit back wall looking east (peat probe 1m long)

The proposed extraction would extend the existing borrow pit back into the side of East Kame ridge along an E–W axis and would also widen the pit both north and south of its current position. Slope angles in the area are between 10 and 20° and the elevation ranges from 65-95m AOD. Peat depths were not measured due to difficulties of access but are likely to be shallow.

The rock present at the location is:

- Pale grey;
- Coarse-grained;
- Massive with some jointing in places and a poorly developed foliation;
- Fresh to discoloured;
- Gneissose GRANITE;
- Strong to very strong.

Figure 14 Close-up of bedrock at NBP03: detail of exposed granitic bedrock showing massive nature (GPS handset 11cm long)

4.11 Borrow Pit NBP04

Borrow Pit NBP04 is situated 300m south of NBP03, at grid reference HU 4212 5587, and is also a disused quarry. Like NBP03, it lies immediately east of the A970 and is currently disused although the extraction here was more extensive than at NBP03. The quarry has been partially back-filled (Figure 15), which restricts access to the existing quarry walls and which may require removal if the quarry is to be reopened.

Figure 15 Photograph of NBP04: View of main backwall of quarry looking east, showing partial back-fill at right-hand side of photograph

The proposed extraction would extend the quarry back into the side of East Kame ridge along an ESE–WNW axis. Slope angles in the area range between 10 and 16° with the elevation ranging from 75 to 100m AOD. Peat angles were not measured due to difficulty of access but are likely to be shallow.

The lithology present at the site is shown in Figure 16 and comprises:

- Mid- to pale brown;
- Medium- to coarse-grained;
- Heavily fractured with strong and pervasive colour banding, quartz veins in places;
- Variably discoloured to disintegrated, decomposed to a sand-like consistency in places;
- Gneissose GRANITE;
- Moderately weak to strong.

Figure 16 Close-ups of bedrock at NBP04: (a) View of exposed bedrock in backwall of quarry (peat probe marked in 10cm sections; (b) Close-up of water-worn channel through bedrock (GPS handset 11cm long)

4.12 Borrow Pit NBP05

Borrow Pit NBP05 lies near the south end of Nesting quadrant, near the main access route into the site, at grid reference HU 4380 5684. It is situated just north of the summit of the Dud of Flamister and takes advantage of the slope to the east side of the hill. The area has been subject to extensive peat erosion, with large sections of the hilltop eroded to the mineral soil (Figure 17a), some of which has begun to revegetate. The site is at an altitude of 155-170m AOD with slope angles ranging between 1 and 15°. Recorded peat depths are up to 0.6m although some remnant peat banks on the hill summit may be up to 1.5m thick.

The proposed borrow pit is oriented nearly E–W to take advantage of the steeper slope and exposed mineral soil. There is no exposed bedrock at the site so the lithological description has been derived entirely from mineral soils and is consequently incomplete. The lithology, shown in Figure 17b, is:

- Pale to mid-grey;
- Medium-grained;
- Well-foliated and platy with some limited colour banding;
- Fresh to discoloured;
- PSAMMITE;
- Strong to very strong.

Figure 17 Photographs of NBP05: (a) View across site looking north (scale bar 1m); (b) Close-up of mineral soil (scale bar 30cm)

4.13 Borrow Pit NBP06

Borrow Pit NBP06 is located on the eastern access route into the Nesting quadrant at grid reference HU 4656 5629. It lies on a well-defined rocky ridge with bedrock exposed as small rocksteps and slabs (Figure 18a). Slope angles range between <1 and 20° and the site is at an altitude of 75-100m AOD. Peat cover is variable across the site; on the ridge is it mostly no more than 0.5m but is deeper towards the edges and away from the rocky outcrops.

Figure 18 Photographs of NBP06: (a) View south down the ridge towards the access track (peat probe 1m); (b) Close-up of bedrock (hammer 30cm)

The proposed borrow pit is oriented N–S to take advantage of the steeper slope and thinner peat overburden on this side of the ridge. The lithology exposed at the site (Figure 18b) is:

- Mostly mid- to pale grey;
- Medium- to coarse-grained;
- Well-banded with jointing, folded in places;
- Fresh to discoloured;
- Granitic GNEISS;
- Strong to very strong.

4.14 Borrow Pit NBP09

Borrow Pit NBP09 is a small borrow pit site beside the eastern access route into the Nesting quadrant and immediately adjacent to the B9075. It is situated at grid reference HU 4651 5575 on the lower slopes of the Hill of Skellister. Bedrock is exposed in a series of rocky knolls and small rocksteps across the slope (Figure 19) and down towards the sea. The site is at an elevation of 40-50m AOD and slope angles range from 3 to 20°. Peat cover across the site ranges from <0.1m in areas adjacent to rock outcrops to >1m in the more boggy sections.

Figure 19 Photographs of NBP09: (a) View W over site showing rocky knolls and rocksteps; (b) Knoll at top of site (peat probe 1m)

The main axis of the proposed borrow pit runs nearly E–W to take advantage of the natural slope angles. Two rock types are exposed at the site. At the lower, eastern, end the lithology (Figure 20a) is:

- Mostly pale grey;
- Medium- to coarse-grained;
- Well-jointed with some gneissose foliation and colour banding visible in places;
- Fresh to discoloured;
- Granitic GNEISS;
- Strong to very strong.

At the western end, including the top of the site, the lithology (Figure 20b) is:

- Pale brown to grey;
- Fine to medium-grained;
- Well-banded with some jointing;
- Fresh to discoloured;
- MARBLE;
- Strong to very strong.

Figure 20 Close-ups of bedrock at NBP09: (a) Gneissic bedrock in lower part of site (scale 20cm); (b) Part of marble outcrop showing banded texture (peat probe 1m)

5 POTENTIAL BORROW PIT ASSESSMENT

The main part of the borrow pit assessment is in the form of technical drawings which can be found in Figure 14.2.BP-DBP01 etc (in Volume 4b). Each technical drawing includes a location map for the borrow pit within the site, a photograph of the borrow pit, a site plan showing the proposed borrow pit footprint and a schematic cross-section. It should be noted that the borrow pit footprints and cross-sections illustrated have been produced using available DEM data and field observations where appropriate and consequently they are not detailed designs but are indicative only.

Table 1 illustrates the proposed borrow pit dimensions for each of the 14 sites. The volumes given have been calculated from cross-sections of the borrow pit, taking into account the benches and gradients of the extraction face, and not from the borrow pit footprint dimension and depth approximations shown. It is anticipated that the borrow pits will be excavated predominantly by drilling and blasting given the hard and resistant nature of the metamorphic and igneous bedrock prevailing in the Shetland Islands. The approach at specific sites may vary given site-specific requirements or constraints; for example, extra care would be required for blasting should extraction be undertaken at Valayre Quarry (DBP01) to avoid damage to the protected exposures.

It should be noted that the given borrow pit dimensions and volumes are estimates. Detailed ground investigations and geotechnical testing will be required to inform detailed design of the borrow pits.

Table 1. Indicative borrow pit dimensions & extraction volumes

Pit ID	NGR Location	Approximate footprint dimensions (m) *	Approximate footprint area (m^2)	Max. depth (m)	Approximate volume (m^3)	Probable extraction method
DBP01	HU 3689 6949	65 x 87	2,980	22	40,000	Drilling & blasting
DBP02	HU 3771 6691	114 x 174	17,190	25	195,000	Drilling & blasting
DBP03	HU 4065 6985	109 x 124	12,130	15	115,000	Drilling & blasting
CBP01	HU 4174 6604	98 x 107	9,520	10	73,000	Drilling & blasting
KBP01	HU 4057 6069	87 x 100	7,730	20	80,000	Drilling & blasting
KBP02	HU 3918 5763	118 x 105	11,020	25	148,000	Drilling & blasting
KBP03	HU 3834 5527	130 x 98	10,460	25	131,000	Drilling & blasting
KBP04	HU 3792 5057	96 x 90	8,090	18	80,000	Drilling & blasting
NBP01	HU 4198 6151	140 x 138	17,700	10	138,000	Drilling & blasting
NBP03	HU 4211 5619	90 x 93	7,750	23	83,500	Drilling & blasting
NBP04	HU 4212 5587	68 x 130	8,420	20	83,500	Drilling & blasting
NBP05	HU 4380 5684	132 x 145	16,890	15	161,000	Drilling & blasting
NBP06	HU 4657 5630	140 x 130	15,560	15	169,000	Drilling & blasting
NBP09	HU 4651 5575	56 x 38	1,920	10	10,500	Drilling & blasting
Total estimated volume (m^3):					**1,507,500**	

* Please note that borrow pits are not regular in shape. Footprint dimensions represent the maximum length and width whereas footprint area is derived from the indicative design.

It will be observed that the total estimated volume is considerably in excess of the volume estimated as required for the construction work. During the assessment it was considered appropriate to assume that either but not both of borrow pits NBP03 and NBP04 would be used to supply aggregate, as they are situated so close together. Also, borrow pit NBP09 has a larger volume than is required, in order to make it exploitable. Should it be decided against reopening Valayre Quarry (DBP01), there should be sufficient capacity in locations elsewhere to source the relevant volume of material.

It is anticipated that, upon completion, the borrow pits will be partially reinstated. This will involve the reworking of faces to stabilise them, partial infilling with surplus material and landscaping. At each site there may be the potential for environmental enhancement by creating small wetlands or other desirable habitats. Reinstatement plans for Valayre Quarry, if applicable, would be discussed with Scottish Natural Heritage.

An assessment of the effects of the borrow pits on the local hydrology and hydrogeology has been undertaken and incorporated into the soil and water chapter of the Environmental Statement (Mouchel, 2009). This includes:

- Limiting entry of surface run-off into borrow pits;
- Limiting entry of groundwater into borrow pits;
- Drainage and treatment of water collecting in borrow pits;
- Storage of excavated material for post-use restoration and rehabilitation.

6 CONCLUSIONS & RECOMMENDATIONS

Engineering geology walkover surveys have been carried out across the site and 14 potential borrow pit locations have been identified from fieldwork visual appraisals and measurements and desktop data analysis. The surveys demonstrated that the areas of greatest potential in terms of bedrock excavation were located on the breaks in slope, slope sides and existing quarry sites. The peat depths at these sites are generally shallow and generally ≤0.5m.

Using the information gathered, an assessment of borrow pit locations was carried out. Borrow pit dimensions and volumes were estimated and probable extraction methods identified. It is estimated that the total rock volume which could be extracted from the 14 identified sites is approximately 1,507,500m^3 if all sites are used.

Detailed ground investigations, slope stability assessments and geotechnical testing will be required to inform the detailed design of the borrow pits.

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We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available. Having issued the range of conclusions it is for the client to decide which borrow pits to use and the methods of extraction, stabilisation and restoration appropriate to each site.

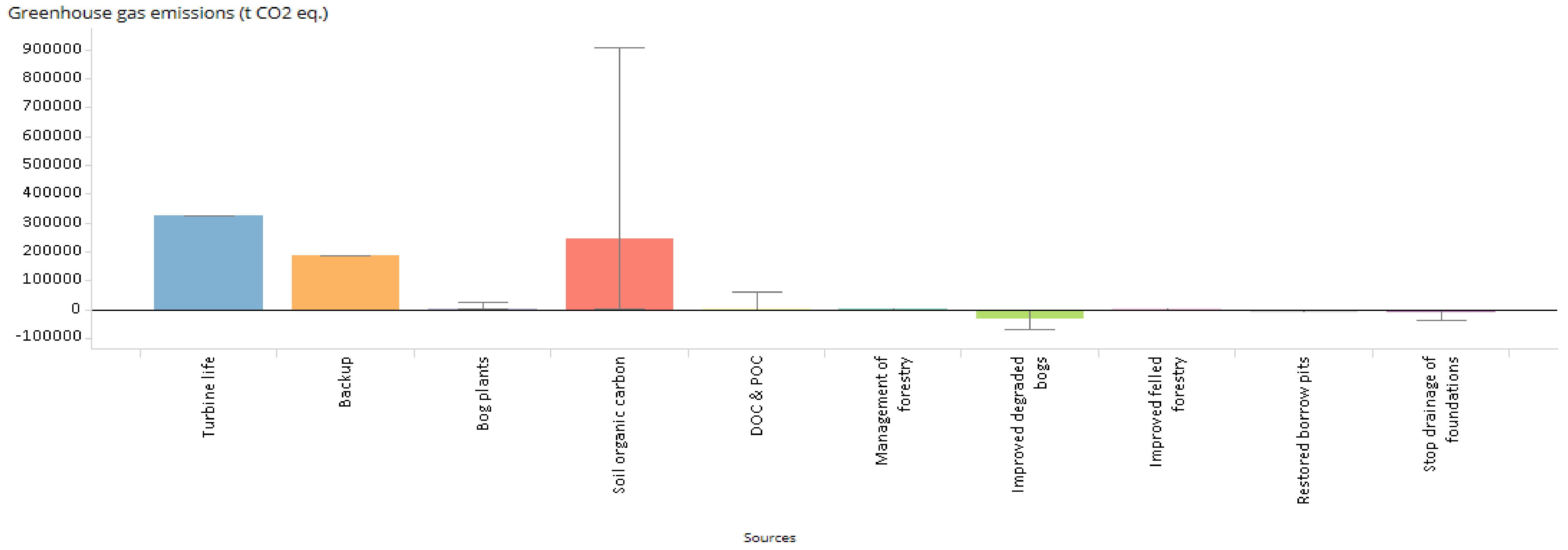
APPENDIX 2.6: CARBON CALCULATOR

This Technical Appendix provides a comparison of Carbon Calculator v1.5 results between the consented Viking wind farm and the proposed varied development

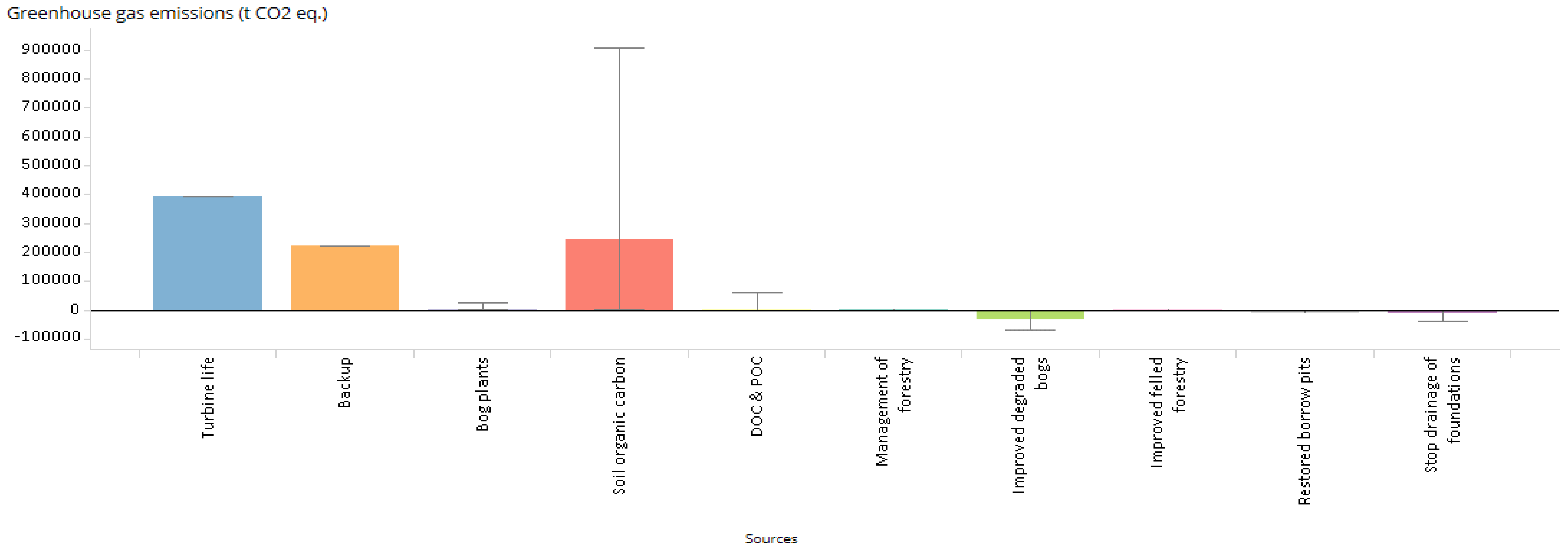
2.6.1 Carbon Calculator - Output Data

	Consented Viking Wind Farm (Ref: RRM0-8UB3-26BR v2)			**Proposed Varied Development (Ref: RRM0-8UB3-26BR v1)**		
1. Windfarm CO2 emission saving over...	**Exp.**	**Min.**	**Max.**	**Exp.**	**Min.**	**Max.**
...coal-fired electricity generation (t CO2 / yr)	1380598.839	1142050.444	1619147.235	1649048.613	1364115.808	1933981.419
...grid-mix of electricity generation (t CO2 / yr)	422421.135	349432.6019	495409.668	504558.5779	417377.8301	591739.3257
...fossil fuel-mix of electricity generation (t CO2 / yr)	691803.3398	572269.2854	811337.3942	826320.6559	683543.8687	969097.4431
Energy output from windfarm over lifetime (MWh)	37598007.6	31101591.6	44094423.6	44908731.3	37149123.3	52668339.3
Total CO2 losses due to wind farm (tCO2 eq.)	Exp.	Min.	Max.	Exp.	Min.	Max.
2. Losses due to turbine life (eg. manufacture, construction, decomissioning)	323608.6548	323608.6548	323608.6548	390975.2898	390975.2898	390975.2898
3. Losses due to backup	186771.96	186771.96	186771.96	223088.73	223088.73	223088.73
4. Lossess due to reduced carbon fixing potential	5255.768359	1576.692424	23319.02556	5255.768359	1576.692424	23319.02556
5. Losses from soil organic matter	242968.5413	3974.100968	907377.2967	242968.5413	3974.100968	907377.2967
6. Losses due to DOC & POC leaching	3880.070391	172.8476632	60275.52914	3880.070391	172.8476632	60275.52914
7. Losses due to felling forestry	0	0	0	0	0	0
Total losses of carbon dioxide	762484.9948	516104.2559	1501352.466	866168.3998	619787.6609	1605035.871
8. Total CO2 gains due to improvement of site (t CO2 eq.)	Exp.	Min.	Max.	Exp.	Min.	Max.
8a. Change in emissions due to improvement of degraded bogs	-30173.85275	0	-68493.88406	-30173.85275	0	-68493.88406
8b. Change in emissions due to improvement of felled forestry	0	0	0	0	0	0
8c. Change in emissions due to restoration of peat from borrow pits	-1671.167229	0	-2994.874283	-1671.167229	0	-2994.874283
8d. Change in emissions due to removal of drainage from foundations & hardstanding	-2468.38371	0	-36385.13798	-2468.38371	0	-36385.13798
Total change in emissions due to improvements	-34313.40369	0	-107873.8963	-34313.40369	0	-107873.8963
RESULTS	Exp.	Min.	Max.	Exp.	Min.	Max.
Net emissions of carbon dioxide (t CO2 eq.)	728171.5911	408230.3595	1501352.466	831854.9961	511913.7645	1605035.871
Carbon Payback Time						
...coal-fired electricity generation (years)	0.527431699	0.252126768	1.314611342	0.504445405	0.264694252	1.176612618
...grid-mix of electricity generation (years)	1.723804826	0.824025823	4.296543762	1.648678731	0.865100125	3.845522583
...fossil fuel-mix of electricity generation (years)	1.052570216	0.503157333	2.623506982	1.00669757	0.528237659	2.348109528
Ratio of soil carbon loss to gain by restoration (not used in Scottish applications)	7.19	0.04	No gains!	7.19	0.04	No gains!
Ratio of CO2 eq. emissions to power generation (g/kWh) (for info. only)	19.37	9.26	48.27	18.52	9.72	43.21
Homes powered equivalent…(based on household consumption at 3.781 MWh pa, July 2018 (renewable UK)						
(lifetime, based on 2018 consumption data)	9,943,932.19	8,225,758	11,662,106	11,877,475	9,825,211.13	13,929,737.98
(pa)	397,757.29	329,030.33	466,484.25	475,098.98	393,008.45	557,189.52

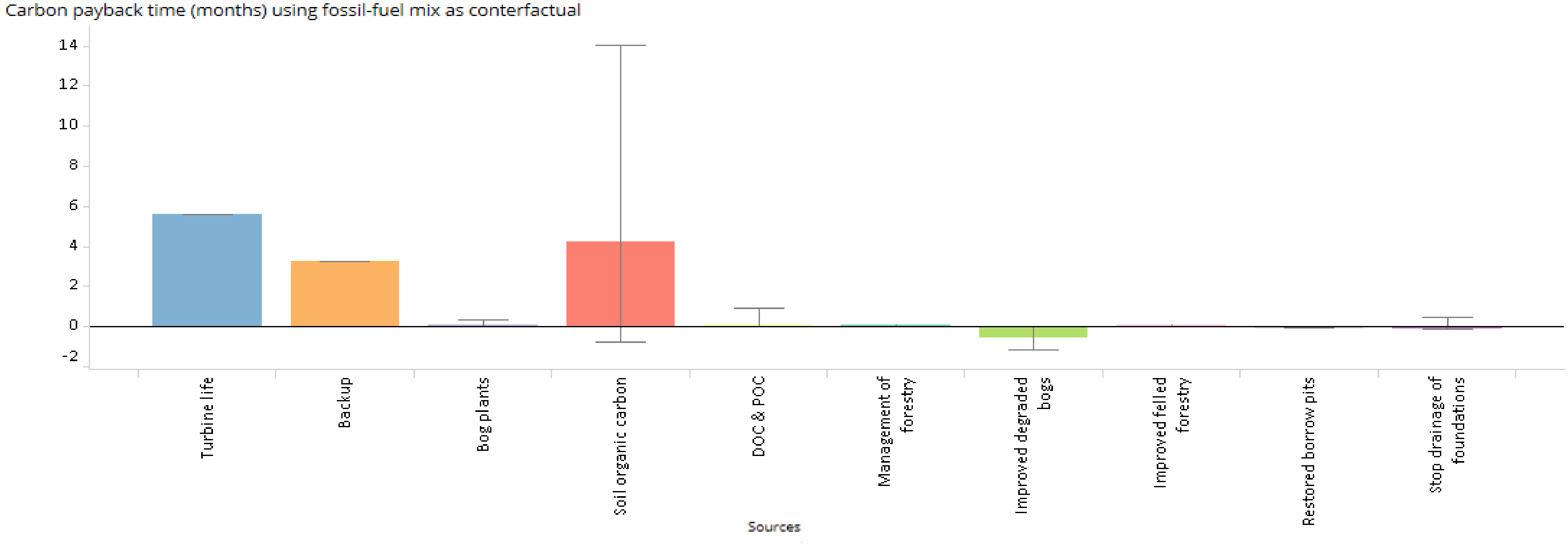
2.6.2 Consented Viking Wind Farm - GHG emissions



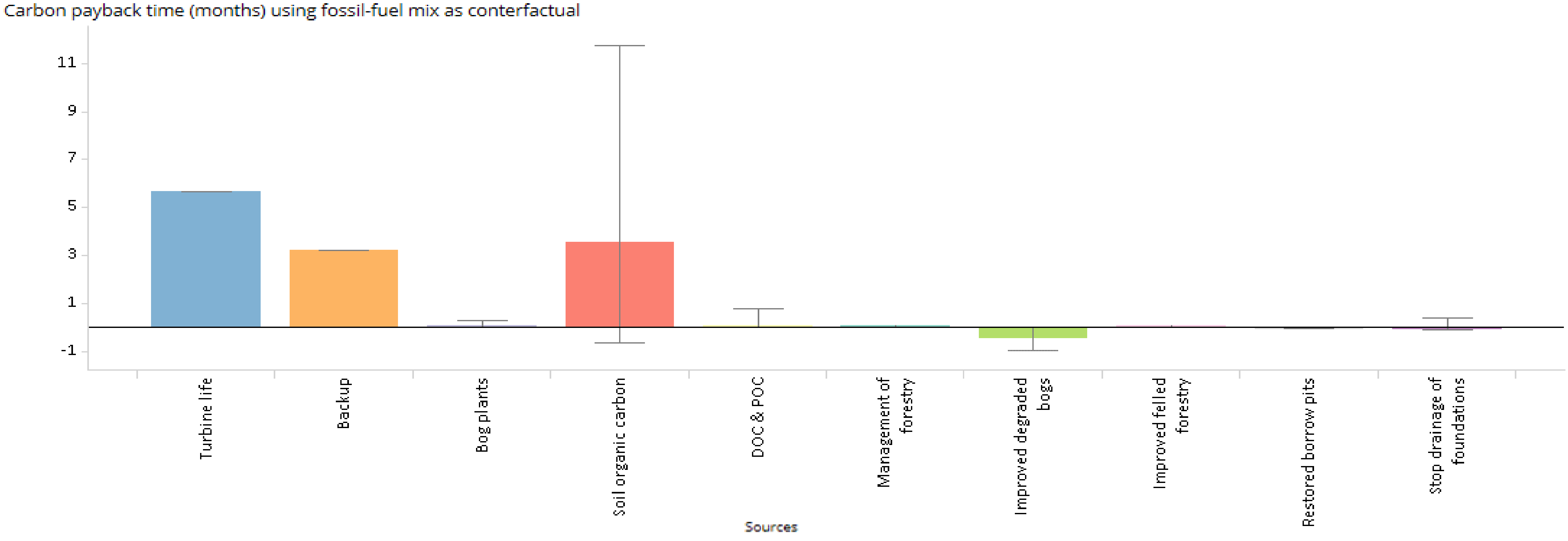
2.6.3 Proposed Varied Development - GHG emissions



2.6.4 Consented Viking Wind Farm - Carbon Payback time

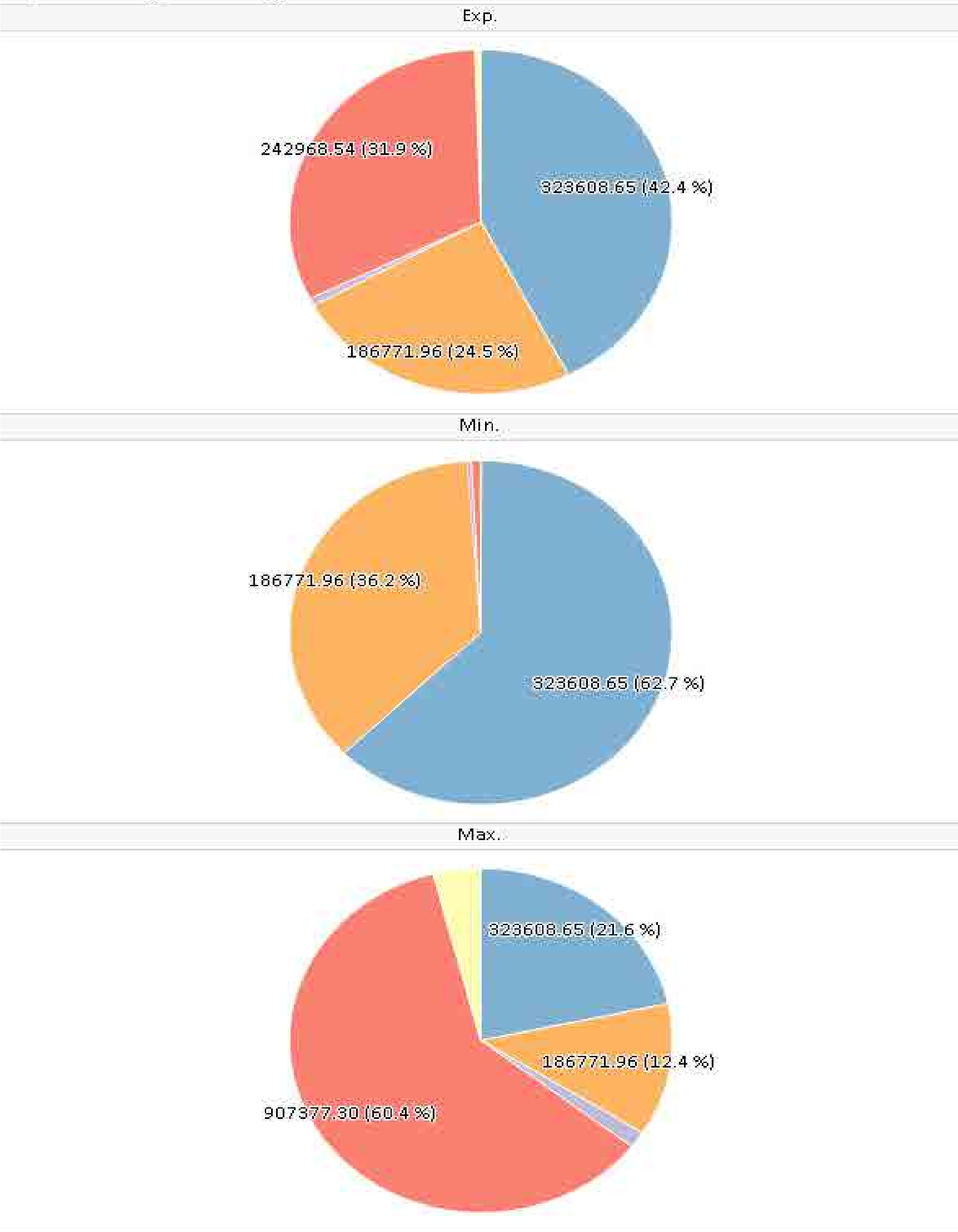


2.6.5 Proposed Varied Development - Carbon Payback time



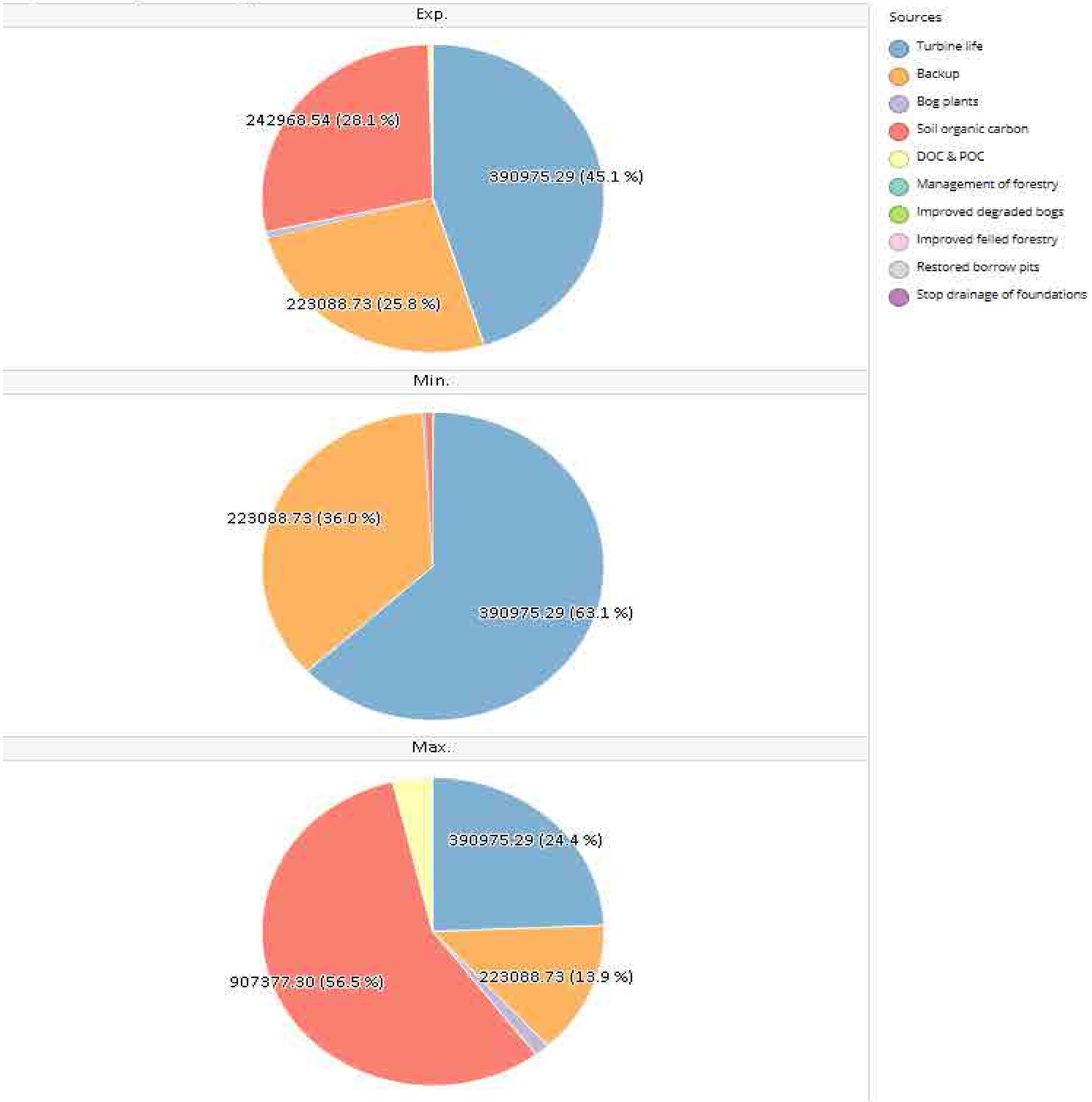
2.6.6 Consented Viking Wind Farm - sources of GHG

Proportions of greenhouse gas emissions from different sources



2.6.7 Proposed Varied Development - sources of GHG

Proportions of greenhouse gas emissions from different sources



APPENDIX 2.7: WATERCOURSE CROSSING DETAILS

Information contained within the 2009 ES on stream crossings was seen as relevant to support the 2018 EIA, thus has been included.

Viking Energy Partnership

Viking Wind Farm

Technical Appendix 14.3
Stream Crossing Guidance

February 2009

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Appendix B Individual Stream Crossing Descriptions
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1 INTRODUCTION

This report forms a Technical Appendix to Chapter 14 (Soil and Water) of the Environmental Statement for Viking Wind Farm (Mouchel, 2009) and should be read with reference to this chapter.

Viking Energy Partnership are currently progressing proposals for a wind farm on North Mainland in the Shetland Islands. The proposed wind farm site is located approximately 27km north of Lerwick and is roughly centred on the settlement of Voe (grid reference HU 4077 6320). The area of interest is divided into four quadrants, with two quadrants to either side of the main A970/A968 route which runs north–south across the island. The quadrants are known as; Delting, Collafirth, Kergord and Nesting. All four quadrants of the proposed 150-turbine wind farm comprise areas of open moorland used mainly for rough grazing.

In addition to requiring planning consent the ***Water Framework Directive*** (WFD) represents a significant piece of environmental legislation which has implications for the proposed development. The WFD has been transposed into Scottish legislation as the ***Water Environment and Water Services (Scotland) Act 2003*** (or WEWS) and has given Scottish ministers powers to introduce regulatory controls over activities in order to protect and improve Scotland's water environment. The water environment includes wetlands, rivers, lochs, transitional waters (estuaries), coastal waters and groundwater. These regulatory controls, the ***Water Environment (Controlled Activities) (Scotland) Regulations 2005*** (known as CAR), were passed by the Scottish Parliament on 1 June 2005. The Regulations mean that it is an offence to undertake the following activities without a CAR authorisation:

- discharges to all wetlands, surface waters and groundwaters (replacing the ***Control of Pollution Act 1974*** (CoPA));
- disposal to land (replacing the ***Groundwater Regulations 1998***);
- abstractions from all wetlands, surface waters and groundwaters;
- impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters;
- engineering works in inland waters and wetlands.

With respect to stream crossings it is the final point that is relevant and comes under Section E of CAR. Three different types of authorisation under CAR allow for proportionate and risk-based regulation. The authorisation process operates at three levels which are:

- General Binding Rules;
- Registration;
- Licence.

These levels cover activities with increasing levels of potential impact upon the environment. In the case of the Viking Wind Farm development, some of the watercourse crossings will require licensing. Minor, additional, watercourses which do not feature on the 1:50,000 scale Ordnance Survey mapping do not come within the CAR process. We have, however, also taken account of these minor crossings (known as additional crossings) within this report.

The Scottish Environment Protection Agency (SEPA) has produced a Controlled Activity Regulations internal guideline - Regulatory Method WAT-RM-02 (SEPA, 2006a), this lists four types of test that will be applied when determining a licence application. The most significant of these is ‘best practice’ and, in the case of Viking Wind Farm, this test will be applied to the geometry of the access tracks linking up the turbine locations. The best approach to assimilating the rules is to consult the document - Water Environment (Controlled Activities) (Scotland) Regulations 2005: A Practical Guide (SEPA, 2006b).

2 ROUTE SELECTION

Before considering stream crossings in detail SEPA will wish to satisfy themselves that 'best 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 link up the turbines (and other infrastructure) for construction and operational purposes. The main factors that would be considered in determining a route include:

- Maximum track gradient suitable for the type of traffic and loads;
- Other track geometry factors such as bends and junction layouts;
- Stability and bearing capacity of the ground and adjacent slopes;
- The volumes of 'cut' and 'fill' to ensure a suitable track alignment;
- Land take (primarily determined by route length);
- The type and nature of bridging structures;
- Sensitivity (flora, fauna, soils, water, human, etc.);
- Whole life costs (construction and maintenance).

Given this non-exhaustive list, an optimum track geometry has been determined to link up the turbines and other development infrastructure. The development of access tracks is inevitably a compromise between several constraints. The desire to site turbines on areas of stable and or shallow peatland, a series of environmental constraints and the aim of routing access tracks away from difficult terrain means that the track geometry is constrained by ecological and topographical features. Cost is also a pertinent constraint and when taken in conjunction with physical factors results in an access network which is 'optimum'.

There is not a direct link between that 'optimum' and 'best practice' in the WFD context, which is oriented towards the water environment; however, there are should not be obvious redundant crossings or crossings that are readily avoidable.

3 ACCESS TRACK DESIGN

Input was provided as an integral part of the iterative design process to ensure minimal stream crossings, crossings will only occur where there is a demonstrable access requirement.

The site for the Viking Wind Farm consists mainly of open heather and grass moorland with an extensive network of small water bodies. A small proportion of the site is served by existing tracks at entry locations, these would be expected to require upgrade for development purposes. Developing the windfarm will necessitate the construction/upgrade of approximately 118km of site access tracks, including several entry routes from the existing public roads to reach the development site - 3 for both Delting and Nesting, a single route for Collafirth and 5 for Kergord. Figure 14.3.SC01 (in Volume 4b) provides maps of the northern and southern areas of development.

An objective of the scheme was to try to ensure crossings were perpendicular to the associated stream, thereby reducing the disturbance both at the crossing location and in the riparian corridor. Where feasible the tracks have been sited along higher ground and outwith the 50m hydrological feature buffer zone applied as standard across the site in order to avoid water bodies. Stream crossing locations are in upland areas of site catchments, thereby avoiding positions where stream migration (such as meandering) would be more likely to occur. There are a number of open water bodies across the site, particularly in Kergord and Nesting, care has been taken to route the tracks at a suitable distance from these.

At a small number of locations there are crossings which have been identified at the planning stage but which may not be built if deemed surplus at detailed design stage for construction/operational purposes.

Wherever it can be accommodated within the construction programme, track crossing structures on double-width track sections will be limited to single-width dimensions to minimise disturbance.

General site construction activities are anticipated as primarily occurring during 6 month ‘summer’ periods, this avoidance of ‘winter’ periods reduces construction activity around streams during periods with more likely heavy/frequent rainfall events and high flows. Further, the construction of crossing structures will take account of the fish spawning season; September to March. These items combine to result in an overall objective to conduct stream crossing construction activities between April and August. However, this will necessarily be subject to construction programme requirements with crossing works to be considered on a case-by-case basis. In all cases the Environmental Manager will be involved in the pre-construction crossing assessment, agreeing method statements, pre-requisite construction conditions (such as particular rainfall/flow conditions) and empowered to immediately halt any construction works that are raising concerns.

3.1 Site Entry Access Tracks

Site entry tracks are discussed below, with descriptions provided from north to south of each quadrant.

In Delting quadrant there are 3 proposed access points to the wind farm infrastructure. The first is from the B9076 opposite Houb of Scatsa. From there, the track travels south-east for 0.9km to turbine D1. The second access track is off the A968 near the Hill of Swinister, heading west and then south-west for roughly 3km to turbine D16. The third access route involves the upgrading of an existing track to enable borrow pit access, opposite the campsite at Otervik, south of Brae on the A970 and travels north-east for about 1.3km to the provisional construction compound location and then north and east for a further 1.4km to turbine D31.

The proposed access route into Collafirth is via a small unclassified road at HU413661, close to the A970 between Garth of Susetter and Souther House. The track heads roughly east for 1.2km before it splits, one track heads east for 0.3km to turbine C34 and the other south for around 0.8km to turbine C38.

For the Kergord quadrant of the wind farm there are 5 proposed site access points. One operational site access track leaves the B9071 at the northern end of Peta Vale, west of Voe, the proposed track heads south roughly following the West Kame for about 2.7km to turbine K42. The second access route is located off the A970 at the north-east end of the site, the track leaves the public road and heads west for approximately 0.5km to turbine K78. The third access is from the B9075 at Lamba Scord and the southern end of Mid Kame, the track runs north upslope for approximately 1km to turbine K88. The fourth access track leaves from the B9075 at Weisdale and heads north for about 1.4km before it divides and the eastern track heads north for a further 1km to the proposed convertor station location. The western track heads NNE for about 1.25km to turbine K52. The fifth, most southerly, access point is from the A971 at the Scord of Sound, here the track heads over low ground for roughly 2.2 km to turbine K76.

At Nesting, there are 3 planned site access tracks. The first is from the A970 adjacent to the access track to the Kergord quadrant. The track follows the contour of the land and skirts south before turning east and then north, this route avoids the need for the construction of several water crossings over the head waters of Wester Filla Burn. The second proposed access route is also from the A970 at the southerly end of East Kame, the track will head north, avoiding the flood plain of the Burn of Crookdale, for just over 1.5km to turbine N110. The third access point is from the B9075, just south of Newing, this commences with an existing track to be upgraded for borrow pit access which then heads north-west and west around Loch of Skellister for approximately 1.5km to turbine N150.

3.2 On-Site Access Tracks

In the Delting quadrant the main arterial track runs north-west to south-east through the site and incorporates 18 of the 30 turbines proposed for Delting. From the main tracks, spurs give direct access to turbines in other areas. Once again the route has been designed to limit the number of required crossings as far as possible.

In Collafirth the extent of the site has been restricted by the ground conditions (expanses of deep peat) and other constraints. The site tracks have been designed to minimise the number of crossings of the main watercourse in the area; the Seggie Burn.

In the Kergord quadrant the main arterial route runs from north to south through the site. The only major spur leaves the arterial route at K63 and avoids crossing the main watercourses with exception of one crossing over the main outflow stream from Truggles Water. There are a number other small branch tracks from the main arterial route and these have been sited wherever possible to avoid crossing any water bodies. The other major route in Kergord climbs to and runs along Mid Kame ridge, this track incorporates 11 turbines and does not require any stream crossings.

The Nesting quadrant is split into two areas; north and south. The northern part of the site has one arterial track with one main spur sited wherever possible along the slightly higher ground to avoid water bodies. The southern, larger, part of the site has again been designed to avoid the larger water bodies.

3.3 Removal of Existing Structures

Where a proposed new crossing is located adjacent to an existing crossing it will be considered best practice to remove the redundant structure (SEPA, 2008).

In addition, where historic watercourse obstructions are identified in catchments associated with the development, consideration will be given to the removal of such structures. The Fish Survey Technical Appendix (Waterside Ecology, 2009) provides further information on such structures.

Prior to removal of any structure, discussions will be held with SEPA, SNH and other identified stakeholders to ensure this is agreed as a beneficial action.

3.4 Cable Crossing Locations

As cables shall generally be laid alongside access tracks, cable crossings will normally be incorporated as part of track crossing structures.

Where cables are required to cross streams shown on Ordnance Survey 1:50,000 scale map, at locations without any associated track crossing structure, directional drilling techniques shall be employed to enable cable crossing below the stream bed in order to minimise disruption.

4 METHODOLOGY OF WATERCOURSE CROSSING ASSESSMENT

The catchment-based approach in this assessment follows that discussed in the associated Environmental Statement (Mouchel, 2009), with reference made to site hydrological catchment identification numbers as defined in that document.

The project involved a desk study and a walkover survey. The methodology for selection of appropriate stream crossing type is included as Appendix A.

4.1 Desk Study

The desk study consisted of a review of the information regarding Viking 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 (Ordnance Survey, 2003) which will require crossings (known as regulated crossings).

4.2 Walkover Survey

Subsequent to the initial desk study, a walkover survey of the site was conducted, during which the identified crossings were visited to obtain specific information about each location. This fieldwork was conducted between November 2007 and December 2008 as the design phase progressed. Photographs and detailed field notes were taken reporting dimensions of the watercourse channel and flood channel, where apparent, the type of substrate and type of crossing needed. A hand-held GPS unit was used to obtain locations to at least 30m accuracy.

4.3 SEPA Waterbody Risk Category Definitions

Under the terms of the Water Framework Directive, all river basin districts are required to be characterised. The characterisation process required SEPA to produce an initial assessment of the impact of all significant pressures acting on the water environment (SEPA, 2007).

Surface water bodies are defined as being whole or parts of rivers, canals, lochs, estuaries or coastal waters. The main purpose of identifying water bodies is so that their status can be described accurately and compared with environmental objectives.

The WFD applies to all surface waters, but for practical purposes SEPA have defined a size threshold above which a river or loch must be to qualify automatically for characterisation. For lochs, the threshold is a surface area of $0.5km^2$, rivers must have a catchment area of $10km^2$ or more. In addition to these larger water bodies, smaller waters have been characterised where there is justification by environmental concerns and to meet the requirements of regulatory legislation such as for drinking water supplies.

Each identified water body has been assigned a risk class indicating whether the water body is likely to meet the WFD's objectives. Table 1 provides the risk categories.

Table 1 SEPA Risk Categories used in Water Body Characterisation and Action

WFD reporting category	UK reporting category	Action
At Risk	(1a) Water bodies at significant risk	Consideration of appropriate measures can start as soon as possible
	(1b) Water bodies probably at significant risk but further information is needed to make sure this view is correct	Focus for more detailed risk assessments to determine whether or not the water bodies in this category are at similar risk in time for the interim overview of significant water management issues in 2007
Not At Risk	(2a) Water bodies probably not at significant risk	Focus on improving quality of information in time for second pressure and impact analysis report in 2013
	(2b) Water bodies not at significant risk	Review for next pressure and impact analysis report in 2013 to identify any significant changes in the situation

4.4 Ecological Provisions

For each crossing, there is an indication of the likelihood the stream is used by mammals, (principally otters) and migratory fish (principally Atlantic salmon and trout).

The data on mammals was provided by Celtic Ecology (2009) who conducted a survey of otter signs and activity throughout the site. In relation to otter passage, recognition is made to the 'Design Manual for Roads and Bridges' (Highways Agency, 2008). Tracks have avoided parallel construction alongside streams and the 50m hydrological buffer zone, as previously discussed, is a best practice measure for otter protection, although inevitably crossing locations necessitate entry into this zone. Where otter presence is suspected canalisation will be avoided and ledges/passages will be incorporated into design to enable otters to pass below crossing locations, including during high flow periods.

The data for migratory fish presence throughout the watercourses was provided by Waterside Ecology (2009). A survey was conducted to determine the presence and abundance of five species identified; european eel, atlantic salmon, brown and sea trout, three-spined stickleback and flounder and this information was used to produce a baseline assessment of fish populations. Along with the survey information provided by Waterside Ecology, the given stream crossing indication is based on the size and apparent quality of the stream and the nature of the substrate, knowing that salmonid fish need shallow fast-flowing water with gravel substrate for breeding redds and good access from the sea without significant waterfalls. Where there has not been a survey near the watercourse the indication is inevitably subjective but will provide some basis with which to work. Some watercourses are clearly inappropriate habitat, as fish are unlikely to pass through peat pipes or live in extremely heavily vegetated or ephemeral watercourses. Others are much harder to classify. In all cases, a conservative approach has been used, assuming that there are likely to be fish unless evidence is found to demonstrate this is unlikely.

5 STREAM CROSSING ASSESSMENT

5.1 1:50,000 (Regulated) Stream Crossings

With the final track layout there are a total of 53 crossings identified on the OS 1:50,000 scale mapping (Ordnance Survey, 2003) and therefore CAR-applicable (known as regulated crossings). These locations are shown on Figure 14.3.SC02 (in Volume 4b).

Detailed information about each regulated stream crossing is provided in the Individual Stream Crossing Description section within Appendix B. The regulated stream crossings have been numbered by quadrant identifier prefix (Delting - D, Collafirth - C, Kergord - K and Nesting - N) and have then been numbered from north to south, e.g. in Delting the most northerly stream crossing is DS01, then DS02 and so forth. Note that there is no KS04 due to a layout amendment.

Table 2 provides a summary of these regulated watercourse crossings, enumerating the stream sizes and different types of crossing required across the site. Stream sizes are defined in Appendix A (Section A1.8).

Table 2 Summary of Types and Sizes of 1:50,000 Watercourse Crossings

Crossing Type	**Stream Size (Defined in Appendix A)**			
	Large	**Medium**	**Small**	**Total**
Bridge	3			**3**
Rectangular culvert / arch		10	9	**19**
Rectangular culvert /arch with mammal passage		1	1	**2**
Circular culvert		3	11	**14**
Multiple circular culverts		3	2	**5**
Circular pipe			1	**1**
Multiple circular pipes				
Circular pipe with mammal passage				
Drainage layer (narrow crossing)				
Drainage layer and pipes (broad crossing)		4		**4**
Total new crossings	**3**	**21**	**24**	**48**
Existing crossing structures, with probable upgrade requirement		***2***	***3***	***5***
TOTAL (new + upgraded existing)	**3**	**23**	**27**	**<u>53</u>**

5.2 SEPA Risk Categories for Site Waterbodies

Within the hydrological catchments related to the Viking Wind Farm there are six characterised water bodies; shown on Figure 14.3.SC01 (in Volume 4b). These are all watercourses, as there are no lochs with surface area of 0.5km^2 or greater. Table 3 provides a summary of risk assessment of these water bodies and pressure types exerted on that waterbody (as applicable).

Table 3 Summary of Viking Water Body Risk Categorisation

Catchment ID	Waterbody	Risk Assessment	Pressure on Waterbody?	Pressure Type	Pressure Cause
1	Laxo Burn / Gossawater Burn	2b	None	-	-
2	Burn of Lunklet / South Burn of Burrafirth	2b	None	-	-
3	Burn of Sandwater / Burn of Pettawater	2b	None	-	-
4	Burn of Weisdale	1b	Yes	Morphological Alterations	Impounding - weir/dam at HU396531
5	Burn of Laxobigging	1a	Yes	Morphological Alterations	Mixed farming Impounding - dam at HU417726
6	Burn of Grunnafirth	2b	None	-	-

The largest catchment Laxo Burn/Gossawater Burn in Nesting/Collafirth has been classified as '**2b: Not at significant risk'**. The catchments associated with Burn of Lunklet/South Burn of Burrafirth, Burn of Sandwater/Burn of Pettawater and Burn of Grunnafirth share this classification.

Burn of Weisdale in Kergord/Nesting has been classified '**1b: Probably at risk**', this catchment is pressured due to the Weisdale weir at HU396531, this morphological alteration will influence flow regime in the catchment (Mouchel, 2009).

Burn of Laxobigging in Delting has been classified '**1a: At risk**'. There is a redundant dam at Graven on the Laxobigging Burn at HU417726 and, similarly to Burn of Weisdale, this morphological alteration will influence flow regime. Also, this watercourse has a high ecological and chemical water quality (Mouchel, 2009), with pressure due to local farming practices, this may logically lead to an escalation of risk categorisation in relation to loss of current (high water quality) status.

5.3 Additional (Non-Regulated) Stream Crossings

In addition to assessing the regulated 1:50,000 scale map stream crossings, other stream crossings were recorded, as found on OS 1:10,000 scale digital mapping (Ordnance Survey, 2006) and during field surveys, to inform the track design and construction process.

A further 44 crossings were identified and locations are shown in Figure 14.3.SC03 (in Volume 4b), with an accompanying table of details for these additional watercourse crossings in Appendix C (Table 5). The additional stream crossings in Appendix C give a representative coverage but cannot be comprehensive as these include ephemeral watercourses with size dependent on seasonality and recent weather patterns.

The additional stream crossings have also been numbered by quadrant, e.g. DX01. Note that references for the additional crossings are not sequential and are not numbered from north to south.

5.4 Limitations of Assessment

Following the final modification of the track layout, fieldwork was carried in November 2008, however, owing to inclement weather conditions, it was not possible to undertake the intended survey work at 5 of the additional (i.e. non-CAR) stream crossing locations. Results have been extrapolated for these locations using professional judgement based on nearby crossing sites and watercourses.

Three of the additional stream crossings identified during the desk study of the 1:10,000 scale Ordnance Survey mapping were not found at or close to the mapped locations at the time of field survey and it is probable that these streams are ephemeral. Although there was no flow at the time of survey it is important that any seasonal flow is not restricted by the wind farm infrastructure. Therefore an estimate of the size of these streams during flow conditions has been extrapolated based on information for nearby watercourses and a crossing type recommended accordingly.

Due to the very boggy nature of the site, there are areas where there is effectively sheet flow; these have not been specifically mentioned but will need to have appropriate drainage installed during construction to prevent disruption to surface flows and damage to the track.

6 SUMMARY OF RESULTS

The combined total of identified stream crossings is 97; representing 53 crossings shown on the OS 1:50,000 map and the additional 44 crossings identified from OS 1:10,000 map and during walkover. Table 4 shows the representation of stream crossings per hydrological catchment. Figure 14.3.SC04 (in Volume 4b) shows the combined watercourse crossing locations.

It is expected that detailed design stage will require additional data to that provided in this indicative study, e.g. in relation to dimensions of specific structures, CAR licencing and specialist otter passage advice.

7 REFERENCES

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Mouchel (2009) ***Viking Wind Farm Environmental Statement - Soil and Water (Chapter 14)***

Ordnance Survey (2003), ***Landranger 1:50,000 Scale Map - Sheet 3: Shetland (North Mainland)***. Published by Ordnance Survey.

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Scottish Environment Protection Agency (2006a) Controlled Activity Regulations internal guideline (Regulatory Method WAT-RM-02.

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Scottish Environment Protection Agency (2008), ***Engineering in the Water Environment, Good Practice Guide - Construction of River Crossings*** - http://www.sepa.org.uk/water/water_regulation/guidance/engineering.aspx. Published by SEPA.

Waterside Ecology (2009) Viking Wind Farm Environmental Statement - Ecology (Chapter 10): Technical Appendix 10.6 Fish Survey Data

We have used our reasonable endeavours to provide information that is correct and accurate and have discussed above the reasonable conclusions that can be reached on the basis of the information available.

Table 4 Summary of Stream Crossings per Site Hydrological Catchment

Catchment ID	Catchment Name	Area (km^2)	Site Quadrant	1:50,000 Stream Crossings	Additional Stream Crossings
1	Laxo Burn / Gossawater Burn	20.86	Collafirth/Nesting	CS01,CS02, CS03,NS03, NS04,NS05, NS06,NS07, NS08,NS09	CX01,CX02, CX03,CX04, CX05,CX06, CX07,CX08
2	Burn of Lunklet / South Burn of Burrafirth	18.47	Kergord	KS03,KS08, KS09,KS10, KS11,KS12, KS13,KS14, KS15	KX07,KX08, KX10,KX11, KX12,KX13, KX14,KX15, KX16
3	Burn of Sandwater / Burn of Pettawater	14.69	Kergord/Nesting		
4	Burn of Weisdale	13.17	Kergord	KS05,KS06, KS07	KX02,KX03, KX04,KX05, KX06
5	Burn of Laxobigging	11.33	Delting	DS01,DS02, DS03,DS04, DS05,DS06, DS07,DS08, DS09	DX01,DX03, DX04,DX05, DX06,DX08, DX18,DX19
6	Burn of Grunnafirth	10.60	Nesting	NS10,NS11, NS12,NS13	NX07,NX09
7	Catfirth	6.79	Nesting	NS19,NS20	NX08
8	Burn of Kirkhouse	5.88	Kergord	KS01,KS02	
9	Burn of Skelladale	4.82	Delting	DS10,DS11, DS12,DS13, DS14	DX09
10	Burn of Helligill / Trondavoe	4.72	Delting		
11	Burn of Wester Filla / Daal	4.46	Collafirth/Nesting/ Kergord	NS01,NS02	NX04,NX05
12	Scatsta	4.27	Delting		DX12,DX13, DX14,DX15
13	Burn of Sandgarth	4.04	Delting/Collafirth		
14	Burn of Susetter	3.95	Delting/Collafirth		
15	Burn of Voxter	3.26	Kergord		
16	Burn of Gonfirth	2.90	Kergord		
17	Burn of Quoys	2.91	Nesting	NS17,NS18	NX10
18	Burn of Firth	2.69	Delting		DX02
19	Burn of Laxfirth	2.61	Nesting		
20	Burn of Tactigill	2.69	Kergord		
21	Burn of the Dale	2.13	Nesting		
22	Burn of Valayre	2.01	Delting		
23	Mill Burn	1.66	Delting		
24	Loch of Skellister	1.69	Nesting	NS14,NS15, NS16	
25	Atler Burn	1.73	Nesting		
26	Burn of Foulawick	1.34	Delting	DS15	DX10
27	Burn of Grunnawater	0.93	Nesting		
28	Burn of Scudillswick	0.51	Nesting		
29	West Hill of Graven	0.43	Delting		DX17
30	Scord of Sound	0.36	Kergord	KS16	

Note KS04 crossing removed due to late layout amendment, locations shown on Figure 14.3.SC02 (Volume 4)

Appendix A

Watercourse Crossing Selection Guidelines
(Revised January 2009)

A1.1 Introduction

Wind farm developments have been proposed and constructed in a wide range of landscapes which have varying forms of topography, land use and habitat. In any new development there is the likelihood of new access roads being constructed which will require crossing water courses, ditches and other features, such as peat haggs. In some instances there may also be existing crossings that require to be upgraded. Clearly some of the features may only intermittently convey water.

In Scotland many of the developments are on hilltops thus the majority of the crossings are over small headwater burns or minor watercourses. In engineering terms the usual approach has been to place circular culverts into the stream bed and build the road on an embankment above the culvert. This approach, and associated good practice as given in The Forests and Water Guidelines (Forestry Commission, 2004), has been used for over 30 years in the construction of forestry access roads. Where a single circular culvert would be inadequate twin or triple culverts have been used or, as streams become even wider, rectangular culverts or conventional abutment bridges may be employed.

Although wind farm developments may be located in areas of similar terrain to forestry plantations the expected standards for watercourse crossings are changing. In part this is because some proposed developments are in areas where forestry would not have been considered in the past and there is a limited history of practical engineering solutions. But the main driver for a change from past practice is the introduction of the Water Framework Directive and its associated Regulations. Under these regulations it is ecological status that has primacy over engineering and the conveyance of flows.

From April 2006 nearly all proposals which will involve engineering activity in the vicinity of water have to be submitted to SEPA for appraisal and, depending on the scale of the work and sensitivity of the waters, may require registration or licensing.

In order to avoid a proliferation of ad-hoc approaches to the design of crossings it is considered that a set of guidelines would be of benefit to the developer and to SEPA. Following these guidelines would show commitment and provide comfort that a consistent best practice is being taken. A scheme of characterisation of water courses along with the potential means of spanning these will provide the developer and SEPA with a tool for evaluating the numbers, types and potential impacts of the crossing. It is intended that full cognisance should still be taken of the Forest and Water Guidelines as well as the CIRIA Culvert Design Guide (CIRIA, 1997) which focuses mainly on engineering features.

A1.2 Methodology

There are a limited number of watercourse morphologies or, more specifically, cross sectional shapes of channel, bank and flood plain. There are a limited number of engineering possibilities, namely fords, circular and rectangular culverts, arches and abutment supported bridges. Put simply, the objective of these guidelines is to ‘map’ watercourse characteristics to crossing mechanisms taking into account ecological issues. Thus the focus of this guide is to address hydrology and ecology and not detailed engineering design.

It is considered that ecological issues should consider not only the end result and possible requirement for features such as continuity of stream bed (to avoid significant negative local effects on aquatic ecological and fishery receptors) or the passage of mammals, but also the risks and duration of constructing the structure.

A1.3 Watercourses

Wind farm developments may potentially cross many types of water conveying features. Thus in the context of this document 'watercourse' needs to be seen in a broader sense than a burn or stream alone and needs to encompass the following:

- Natural burns and streams as normally perceived;
- Ditches and drains as encountered alongside roads, in moor gripping or forested areas;
- Incised channels in peat (also known as haggs or gullies);
- Peat pipes;
- Flushes.

Of these features it is the natural streams that perhaps display the greatest variety of sizes and cross-sectional profile. They may also be regarded as being the highest on the ecological agenda as they typically tend to support the most valuable assemblages of aquatic flora and fauna with high individual nature conservation and fishery value. However, it must be recognised that this guideline is not intended to cover major river crossings where many other factors would come into play.

In cross-section ditches and drains tend to be fairly regular and trapezoidal (at least when originally constructed) and have a flow regime which may be transient. Nevertheless they provide 'cover', corridors for movement and frequently a damp habitat for certain creatures, such as frogs.

Haggs and peat pipes are natural features within areas of blanket bog. Gullies between haggs are formed where water forces have eroded the peat and could be up to 5m deep and frequently take the form of an narrow irregular 'V' or broad 'U' shape. They act as drainage channels following periods of prolonged rainfall. The formation of peat pipes is not well understood, but these often occur at the peat / mineral soil interface and could be 0.5m diameter, but are usually significantly smaller.

Flushes usually occur at the headwaters of streams where flow is predominantly sub-surface interflow with perhaps some overland flow during wetter periods. Although perhaps located in a concave part of the hillside there is no defined channel and the width of the flush may vary considerably depending on terrain.

Within streams a large range of channel bed and bank materials may be encountered including organic soils, clays, gravels, boulders and bedrock.

It is clear from this definition that some of these channels only convey water intermittently. Furthermore aquatic ecology, in terms of fish, is confined to burns and streams although amphibians clearly have a more widespread habitat and may utilise the wet and damp conditions of ephemeral watercourses.

A1.4 Structures

The envisaged structural components of the crossing may comprise circular or rectangular culverts, segmental arch sections or a bridge deck set upon abutments. Construction may use a variety of techniques and materials – steel, precast and insitu concrete, plastics and timber. Table A1.1 sets out the generally available sizes and materials in which these elements may be procured.

Table A1.1 Structural Elements

Type	Materials	Size Range (mm)		Comments
Circular Culvert	Precast concrete	200[1]	2400	High strength and durable
	Corrugated metal	300	6000	
	Plastic	100	600	
Rectangular Culvert	Precast concrete	1000x600	4800x3000	Large range of widths and heights
Segmental Arch	Pre-cast concrete	2000	10000	No interference with stream bed
	Corrugated metal			
Bridge Decking	Pre-cast concrete	4000	10000	Standard Beam with in-situ deck
	Steel & Concrete			Steel Beam with in-situ deck
	Timber	2000	4000	Limited life / load capacity
Abutments	In-situ concrete	-	-	Conventional construction
	Pre-cast sections	-	-	Reinforced earth techniques
	Masonry	-	-	May be in the form of gabions

The suggested range of diameters or spans for which these different structures may be applied should be regarded as indicative. Clearly, particular manufacturers of pipes, box culverts and arch systems have a greater or lesser range and bespoke solutions such as bridges can be almost of any size.

A1.5 Ecological Provisions

Ecological provision for fish and mammals need only be provided where there is reasonable evidence that these animals occupy or migrate through the locus of the proposed crossing. For example fish may be entirely absent upstream of a natural barrier such as a waterfall or a reach with a non-navigable gradient and high flow velocities. Similarly field surveys may have failed to establish the presence of any of the designated mammals and that habitats are such as to be unlikely to attract inward migration.

Conversely, if the need for ecological provision has been established then this should take an appropriate form which will depend on the species being provided for and the physical nature of the crossing. In general the provisions at burns and streams may encompass:

- Mammal ledges within the crossing and at top of bank elevation;
- Mammal tunnels adjacent to the stream and accessible from bank level;
- Continuity of stream bed comprising natural indigenous material;
- Absence of a step in the water levels in excess of 300mm;
- No reduction in overall width or natural fluctuation of depth;
- Reinstatement of natural vegetation to provide ‘cover’.

This guideline does not provide any methodology for assessing the ecology of the site in general, or the specific location of the proposed watercourse crossing. Those matters are for other specialists; the only necessary information required is whether ecological provision is required or not at the candidate crossing locations.

[1] Although pipes may be available in these smaller sizes the CIRIA minimum recommended diameter for any circular culvert is 450mm.

A1.6 Hydraulic Sizing

The CIRIA Guidelines provide recommendations on calculation methods for the design flood to be passed through a culvert without risk of structural damage. In the absence of a historically significant period of actual flow records (which is often the case) the suggestion is to use the Flood Studies Report (Institute of Hydrology, 1993). Although valid at the time the guidelines were produced, the normal method now would be to use the Flood Estimation Handbook (Centre for Ecology and Hydrology, 2006) and the associated digital model of channel networks.

The design standard in terms of flood severity is normally expressed as a return period. Wind farms are typically located in rural areas with access tracks generally conforming to forestry type roads where bridging culverts have been designed to a 1:50 year return period. Due to climate change it is suggested that a 1:100 year standard is now adopted. For information, on the basis of the Flood Studies Report the approximate growth factors on Qbar (about 2 a year return period) for Region 1 (Scotland) for various return periods is set out in Table A1.2.

Table A1.2 Return Period Growth Factors

Return Period	Growth Factor
15	1.7
25	1.9
50	2.2
100	2.5
200	2.8
300	3.0
400	3.1
500	3.2

This shows that going from the 1:50 yr to 1:100 yr return period is in effect a 14% increase in flood flow (i.e. (2.5-2.2) / 2.2 = 0.14). This seems an adequate uplift for bridges or culverts where a small amount of transient upstream ponding would be of no consequence.

Furthermore, in terms of sizing rectangular culverts where there is a need to re-establish a natural stream bed, it is proposed that an additional 450mm is added to the vertical dimension so that the structure may be inserted into the stream bed.

Note, however, that the digitised channel network is based on the watercourses visible on a 1:25,000 scale Ordnance Survey map. It may be that many of the smaller crossings in a particular development do not feature at this scale, nor would other features such as drainage ditches or moor gripping. Thus, a pragmatic approach along with hydrological judgement may be required where definitive calculations are not practical. Thus, the range of options may comprise:

- Comprehensive use of FEH featuring the actual stream to be crossed;
- Utilise surrogate streams to calculate unit flow rates per hectare and then pro-rata to the specific crossing;
- Consider stream morphology to estimate 1-2 year return period flow based on bank full condition and then scale to design return period;
- Consider stream / channel morphology and ‘match’ conveyance capacity of existing channel so that crossing unlikely to form a restriction.

Although these may appear to be in decreasing order of sophistication it should be borne in mind that the regression equations for Mean Annual Flood (MAF) are not precise and may under or over estimate actual values. The error in the estimate does not improve when scaled up to the design return period. The channel morphology has been shaped by actual flow characteristics and taking cognisance of that can provide useful insight to past flood levels. Both calculation and observation have a role to play.

Where the crossing has to take regard of migratory fish the Scottish Executive (as was) issued guidelines (Scottish Executive, 2000) which provide important design criteria such a minimum width and depth of water, maximum velocity of flow and provision of rest pools. These parameters are species and culvert length dependant.

A1.7 Selection Process

The process of ‘mapping’ watercourse characteristics to a suitable form of crossing is conceptually fairly simple. It is a case of matching several physical / ecological criteria to the most appropriate crossing type.

In practice there are a large number of permutations of watercourse, topography, bed materials etc that can be considered although some are of unlikely combinations. The number of categories of each attribute is set out in Table A1.3.

Table A1.3 Description of Watercourse Attributes

Type of Attribute	Options	Cases
Watercourse types	5	Stream, Ditch, Peat Hagg, Peat Pipe, Flush
Setting / Context	6	Incised, Broad, Road drain, Land drain, Buried, Surface
Size	3	Small, Medium, Large (predominantly as in width)
Ecological Provision	2	Yes, No

If every one of these attributes were permutated without regard to feasibility there would be 180 permutations, however this reduces to 47 if anomalous physical combinations such as buried streams, surface peat pipes and the like are discounted.

The number of options can be further reduced to 25 by considering only those that make environmental sense - thus fish migration up peat pipes is not a recognised phenomenon for which provision needs to be made. The reduction in numbers has been based on removing 22 hypothetical cases of Ecological Provision where it is believed that the case for mammal ledges / passes and natural bed reinstatement either do not make sense or cannot be justified. Of these 6 relate to road side ditches or small land drains, 8 to peat haggs, 4 to peat pipes and 4 to flushes. In all of these cases fish are neither present nor mammals likely to be impeded.

The selection process can be reduced to a decision table, Table A1.5, provided at the rear of the report, where by working from left to right across the columns a watercourse crossing type is determined. This table is also available as a spreadsheet and, with auto-filtering, allows a rapid check to be made of alternatives where a classification is marginal. A summary count of the options is given in Table A1.4.

Table A1.4 Summary of crossing options

Water feature	Number of options	Arch / Bridge	Culvert/ Pipe	Comments
Streams	12	4	8	All large streams crossed by bridge / arch
Ditches	5		5	Only massive ditches would justify bridges
Peat Haggs	4		4	
Peat Pipes	2		2	Pipes ensure continuity of subsurface flows
Flush	2		2	
Total:	25			

A1.8 Decision Rationale

In drawing up the choice of crossing type and the form of ecological provision a number of assumptions have been made. In effect these are embedded in the table and the rationale for making certain choices is explained below.

Small, Medium and Large Crossings

Within the crossing type selection table watercourse size is expressed in terms of small / medium / large but without actual dimensions being stated. In part this is due to the fact that the table covers a range of features such as peat haggs, ditches and streams where “large” in one context may not be “large” in another. However, within the category of streams and for the following dimensions are proposed:

- Small - less that 1 metre;
- Medium - between 1 and 3 metres;
- Large - greater than 3 metres.

For other features such as haggs, flushes, etc the size differentiation is not significant in determining crossing type; it merely governs the diameter or number of circular conduits to ensure drainage is unimpeded.

Bridges

Where the watercourse is of significant width or the stream is within a deeply incised valley then a conventional abutment bridge may offer the best practical engineering solution whether or not ecological provision has to be made. In some cases the bridge may be multi-span with one of more supports required within the watercourse. Where technically possible the abutments would be set back by at least 1 metre from the banks of the watercourse, if these are well defined. However, over the passage of time erosion / deposition could change this marginal strip between the abutment and watercourse, unless “hard” engineering is employed, which may not be desirable.

Rectangular Culverts / Arches

Rectangular culverts and arches can be used where there are watercourses narrower than those appropriate for bridge construction but which have a requirement to provide mammal and/or fish passage and ensure sufficient hydraulic capacity during peak flow periods. Arches minimise disruption to stream base. Rectangular culverts may incorporate mammal ledges and can be buried below stream bed level to enable bed material replacement.

Circular Culverts
In all cases where there are no ecological provisions to be made it is assumed that neither natural bed material, or water velocity nor depth are critical other than in the purely hydraulic sense. Thus, circular culverts provide an economic and viable solution.

Multiple Culverts (Circular)
None of these cases has ecological implications, so the rationale above for singular circular culverts still applies. Multiple (usually twin) culverts have been considered a viable option where the crossing is wide and the use of a single circular culvert would require a disproportionately large diameter which would also raise the height of the crossing.

In the case of deeply incised streams culvert height may not be so much of an issue as it may be accommodated without the need to raise the road level. However, it has been assumed that in engineering terms handling two smaller pipes would be preferable to one large pipe – but that decision can be left to the engineer / contractor.

Multiple Culverts (Rectangular)
Multiple (usually twin) culverts have been considered a viable option where the crossing is wide. Although there is a reasonable range of width to depth ratios available for off-the-shelf precast units there may be occasions where the topography and channel morphology would favour multiple culverts.

The decision table includes cases where ecological provision needs to be made and this can be designed into rectangular box culverts. The fact that there are multiple culverts means that there will be one or more piers within the watercourse, but the culvert sizing can be such as to ensure the original cross-sectional width is maintained. With twin culverts it is also possible to set one at a lower elevation to act as a low flow channel.

'Flashy' streams, particularly within incised channels, may lend themselves to rectangular culverts as a large height to width ratio can be employed to accommodate larger water level changes than would a circular culvert.

Omega Culverts
There has been discussion on the feasibility of using a variation on rectangular culverts where instead of a lower slab the culvert has outward projecting footings (hence omega: Ω). This precast unit would be used in a similar manner to conventional culverts, but the stream bed would be left relatively undisturbed. However, as no such commercially available units have been identified in manufacturers' literature this crossing type has not been illustrated in Table A1.6.

Ecological Provision
This document does not aim to provide any means of determining the requirement for ecological provision as that discipline resides elsewhere. However, it is recognised that migratory fish may not be the only drivers as native resident species may also be present. Where ecological provision is required for fish the first priority is that a natural bed profile should remain, which can be accomplished by the use of rectangular deep culverts. Where preservation of the bank is also deemed essential the crossing type may be either a bridge or an arch so as to not interfere with the edge of the stream. Experience shows that in most cases the ground below a bridge or arch is unlikely to retain the former vegetation.

Where provision has to be made for the passage of mammals this can be accomplished by incorporating ledges, at bank level, within a rectangular culvert. Alternatively, a tunnel may be provided to one side of the watercourse.

The assumption has been made that wider crossings would be undertaken with a bridge resting on abutments which are clear of the stream edge. The smaller crossings may be constructed from segmental arches or similar – although small span bridges would be equally serviceable.

Inevitably, there will be some disturbance in the vicinity of the crossing during the construction period. The Environmental Management Plan / Pollution Prevention Plan (EMP / PPP) will address risk elimination and mitigation, particularly during the construction period. However, in addition to engineering, the reinstatement of vegetation must be integral to the design to provide ‘rest / cover’ areas.

Construction

As a rule, the more ***in situ*** construction, the more complex the task and the longer the duration of activity in the vicinity of a watercourse crossing; the greater is the risk of a hazardous or pollution incident arising. Thus, “constructability” is a relevant factor to consider when selecting the type of stream crossing solution.

For example it may be possible to span a 3m stream using either a rectangular culvert or conventional abutment bridge. A bridge may take weeks to construct and involve in-situ concrete pours and also require a temporary crossing to facilitate work at both sides. A bridging culvert could be put in place within days and with bed reinstatement it would appear no different from the bridge option. Thus, where there are competing options it would be prudent to evaluate all forms of risk during the construction and operational phase of the structure and not just the status of the structure when completed.

In addition to the cross-sectional geometry of the watercourse geotechnical factors also have an influence on constructability. The practicalities of excavation for foundations or bed preparation will depend upon the surrounding material being ‘hard’ and ‘soft’. If the bed or banks would require heavy percussion hammering, drilling, blasting etc then the material is ‘hard’. Where the bed can be excavated by hand or excavator then the material is ‘soft’, which may include rock that is weathered or weak. In either case it is assumed that the bed rock can be broken out to a depth sufficient to allow the normal 200mm of granular bedding on which to lay precast concrete units where this is the chosen option.

In the schedule of individual stream crossings an indication has been given as to what is considered to be the most appropriate crossing type. This is generally based on the selection matrix in Table A1.5 however this is intended as guidance only. On occasions specific channel characteristics or local morphology may suggest some variation on the selection table is more appropriate. For example, the table may suggest a single circular culvert, but due to topographic considerations multiple circular culvers may be more appropriate.

A particular issue that may arise with small / ephemeral water courses is that the channel is ill-defined and on the day of the site inspection an optimum position for the culvert is unclear. These conditions are most likely to arise on small headwater streams that are unmarked on the OS 1:50,000 scale maps or in peat hagged areas. In these cases it is anticipated that further observations will be available closer to the construction period. Also some ditching or realignment immediately upstream may be necessary to convey flows towards the culvert to minimise ponding upstream of the crossing point.

A further issue to consider, in some instances, will be the provision of temporary crossings, perhaps to facilitate the construction of the permanent crossing or for some other purpose of limited duration. In these circumstances ecological provision to a lower standard may be inevitable although, as this will be temporary and perhaps seasonally phased, the actual impact may be negligible.

A1.9 Diagrams

A selection of schematic diagrams has been produced to illustrate some of the watercourse crossings that may arise. These are shown in Table A1.6 and although not every permutation has been drawn, the selection attempts to cover the most frequent situations and at the same time show a variety of key design features.

In the majority of cases these diagrams only show cross-sections of the crossings, however it will be self evident that the length of culverts and arches will depend on the depth of the embankment material above the soffit of the pipe or crown of the arch and the arrangement of any entrance and exit structures. A single longitudinal section is given as a general illustration.

For example if the face of the embankment is at 45º and the road width (W), the fill material height above the soffit is F and the height of the opening is H then the length of the culvert will be; W + 2x(F + H) approximately. This excludes possible entrance and exit wing walls or pools.

Thus for a 6 metre wide road with 1.5 metres of fill on top of a 2 metre high rectangular culvert the length would be approximately 6 + 2x(1.5 + 2); giving 13 metres.

The situation is somewhat different for bridges as there is no fill placed above the stream, only the bridge deck which will be marginally wider than the road. However, the base of the abutments will be wider and this again depends on the height of the road embankment and the side slope.

A1.10 References

Centre for Ecology and Hydrology (2006), ***Flood Estimation Handbook*** (version 2), CD-ROM.

CIRIA (1997), ***CIRIA Report 168 - Culvert Design Guide***, published by CIRIA.

Institute for Hydrology (1993), ***Flood Studies Report***.

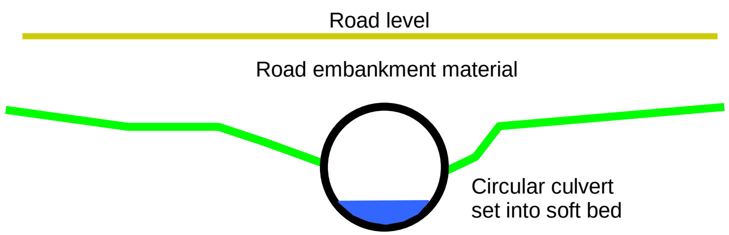
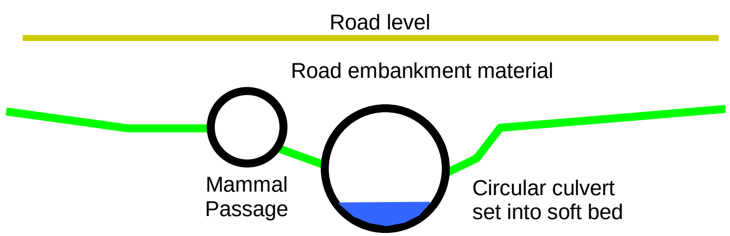
Forestry Commission (2004), ***Forests and Water Guidelines***, Fourth Edition, published by the Forestry Commission.

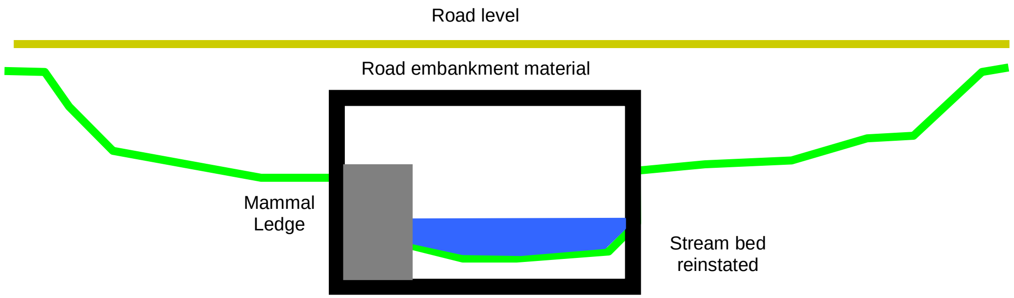
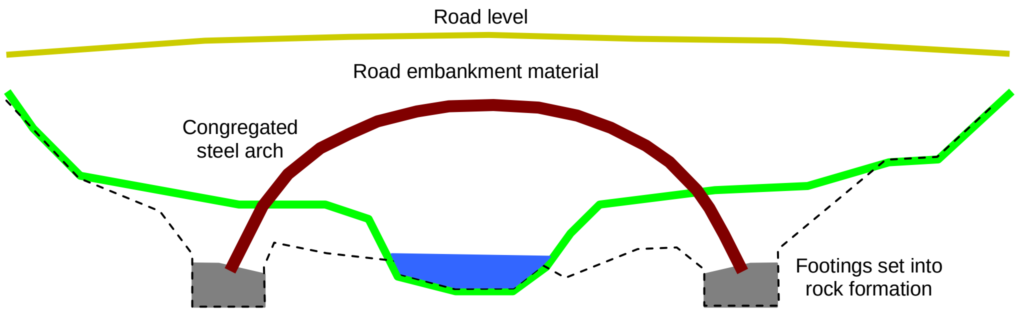
Scottish Executive (2000), ***River Crossings and Migratory Fish: Design Guidance***, published by the Scottish Executive.

Table A1.5 Crossing Type Selection Table

Code	Watercourse	Context	Size	Eco	Structure	Eco Provisions
S_IS_SN	Stream	Incised	Small	No	circular culvert	-
S_IS_SY	Stream	Incised	Small	Yes	rectangular culvert	Tunnel / Natural Bed / Velocity constraints
S_IM_SN	Stream	Incised	Medium	No	circular culvert	-
S_IM_SY	Stream	Incised	Medium	Yes	rectangular culvert	Tunnel / Natural Bed / Velocity constraints
S_IL_HN	Stream	Incised	Large	No	Bridge / Segmental arch	-
S_IL_HY	Stream	Incised	Large	Yes	Bridge / Segmental arch	Natural bank margin ~1m each side
S_BS_SN	Stream	Broad	Small	No	circular culvert	-
S_BS_SY	Stream	Broad	Small	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
S_BM_SN	Stream	Broad	Medium	No	circular culvert	-
S_BM_SY	Stream	Broad	Medium	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
S_BL_HN	Stream	Broad	Large	No	Bridge / Segmental arch	-
S_BL_HY	Stream	Broad	Large	Yes	Bridge / Segmental arch	Natural bank margin ~1m each side
D_RS_SN	Ditch	Road drain	Small	No	circular culvert	-
D_RL_SN	Ditch	Road drain	Large	No	circular culvert	-
D_LS_SN	Ditch (Grip)	Land drain	Small	No	circular culvert	-
D_LL_SN	Ditch	Land drain	Large	No	circular culvert	-
D_LL_SY	Ditch	Land drain	Large	Yes	rectangular culvert	Ledges / Natural Bed / Velocity constraints
P_IS_SN	Peat Hagg	Incised	Small	No	circular culvert	-
P_IL_SN	Peat Hagg	Incised	Large	No	circular culvert (multiple)	-
P_BS_SN	Peat Hagg	Broad	Small	No	circular culvert	-
P_BL_SN	Peat Hagg	Broad	Large	No	circular culvert (multiple)	-
P_BS_SN	Peat Pipe	Buried	Small	No	circular pipe	-
P_BL_SN	Peat Pipe	Buried	Large	No	circular pipe	-
F_SN_SN	Flush	Surface	Narrow	No	drainage layer	-
F_SB_SN	Flush	Surface	Broad	No	drainage layer & pipes	-

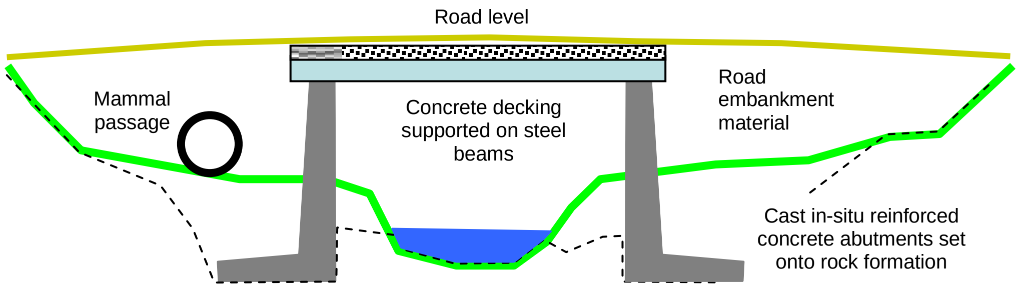
Table A1.6 Illustration of Watercourse Crossings

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
1	**Stream: Broad valley, Small channel, No Eco provision** 	Typical of small headwater burns on rolling topography, perhaps before slopes become steeper and streams gather volume and energy and are more incised. Altitude or downstream topographic features exclude the possibility of fish being present. A circular precast concrete or plastic pipe can be placed on bedding material so that the invert is aligned with the original bed level. The pipe diameter is sized by inspection of stream morphology because calculations alone may only provide the illusion of precision.
2	**Stream: Broad valley, Small channel, Eco provision** 	Typical of small burns on rolling topography, similar to (1) above but where there is a requirement for mammals to pass along the watercourse. A circular precast concrete or plastic pipe can be placed on bedding material so that the invert is aligned with the original bed level. The mammal passage should be at top of bank level and comply with minimum diameter requirements.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
3	**Stream: Broad valley, Medium channel, Eco provision** 	Typical of mid reach 'Highland' streams with granular and cobbled beds. The habitat is well suited to resident and migratory fish. Aquatic mammals are present. The rectangular box culvert structure contains a reinstated natural bed and the width allows for the provision of mammal ledges aligned with the banks. The freeboard provides passage for the design flood flows.
4	**Stream: Broad valley, Large channel, Eco provision (or not)** 	Typical of mid reach streams where superficial drift deposits are shallow. The stream has cut to the rock and the bed consists of boulders and intact rock. Placing rectangular box culvert(s) would require bedrock to be broken and excavated. An alternative to (5) using corrugated metal arch set into concrete footings which are clear of the stream banks. This also allows passage for mammals. The height of the arch will pass the design flood without surcharging.

<table>
<tr><th></th><th>Sketch of Channel Cross-Section / Longitudinal Section</th><th>Comments</th></tr>
<tr><td>5</td><td>

Stream: Broad valley, Large channel, Eco provision (or not)



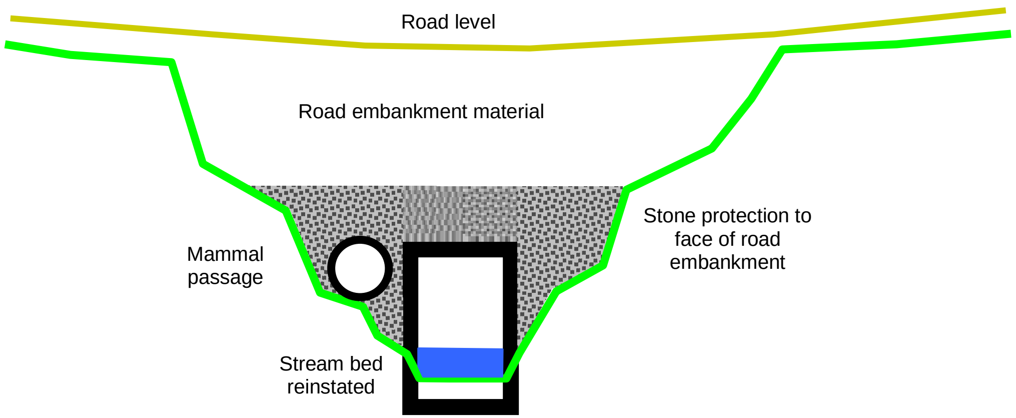
</td><td>

Typical of mid reach streams where superficial drift deposits are shallow. The stream has cut to the rock and the bed consists of boulders and intact rock.

Placing rectangular box culvert(s) would require bedrock to be broken and excavated. An alternative to (4) using concrete abutments and steel / concrete composite decking. Passage for mammals where necessary. The height of the bridge soffit will pass the design flood without surcharging.

</td></tr>
<tr><td>6</td><td>

Stream: Incised valley, Medium channel, Eco provision

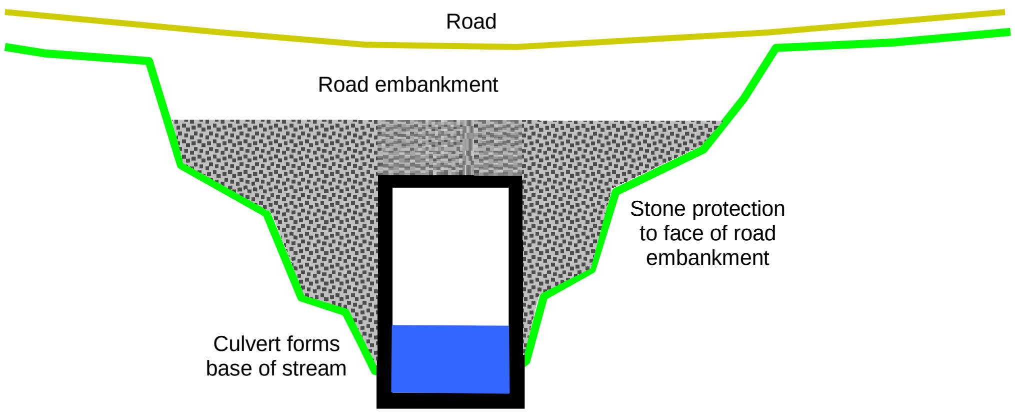
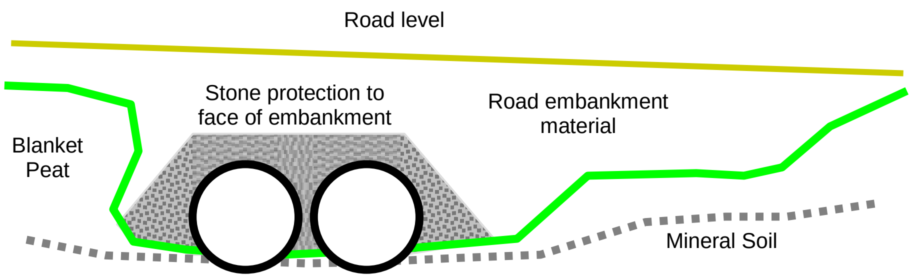


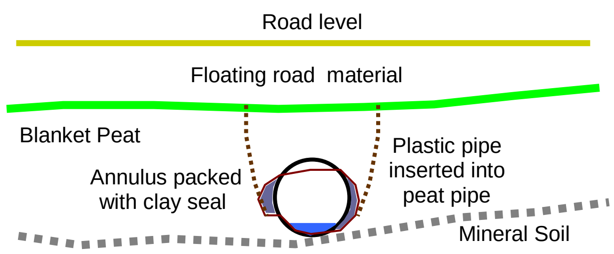
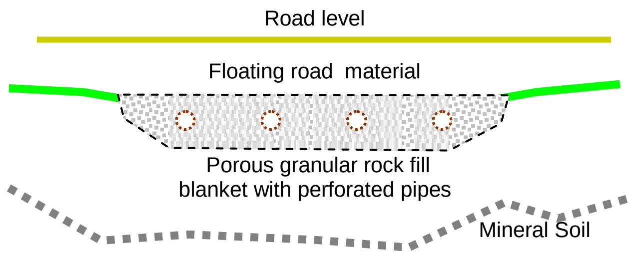
</td><td>

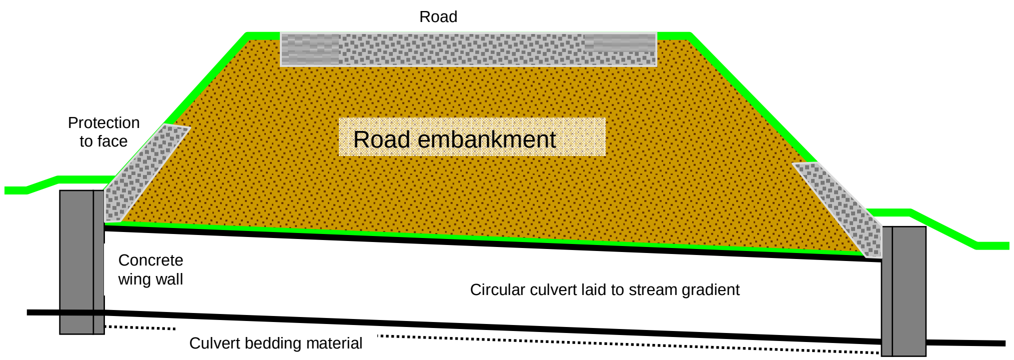
Typically found on energetic streams which have cut into deep clay or glacial deposits. As flood flows cannot spread latterly depth fluctuations may be considerable.

The rectangular box culvert structure contains a reinstated natural bed. As an alternative to mammal ledges a higher level circular pipe allows mammal passage. This would act as a high flow relief if required, but be above the majority of minor floods.

</td></tr>
</table>

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
7	**Stream: Incised valley, Large channel, No Eco provision** 	Typically found on energetic streams which have cut through superficial deposits and into the rock formation. Depth fluctuations may be considerable, as flood flows cannot spread laterally. The bedrock has been broken out to facilitate the placing of large rectangular box culvert which will pass the design flow without surcharging.
8	**Peat Hagg: Broad, Large (deep) channel, No Eco provision** 	Typically found in deep blanket peat where the gulley has bottomed out at the mineral soil / rock interface. Normally flows are small arising from seepage out of the peat, with intermittent large storm flows which may carry blocky peat fragments. The soil / bedrock has been excavated to allow for bedding and twin circular culverts set at a level which will avoid upstream ponding. The pipe diameter is sized by inspection of the gully morphology because calculations alone may only provide the illusion of precision.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
9	**Peat Pipe: Buried, Large size** 	These are encountered at random in blanket peat (and some may go un-noticed). Ensuring continuity of the bog hydrology is important. The section of peat pipe which will be below the road should be excavated and a 'best fit' plastic pipe should be inserted into the irregular ends. The space between the drainage pipe and the peat pipe requires to be sealed with natural material such as clay. The trench should be refilled with the excavated peat.
10	**Flushes: Various widths** 	Within the area of the flush there is no clearly defined channel, other than perhaps a broad concave area. Flow is predominantly by sub-surface interflow and it is important to ensure this continuity and avoid compaction of the flush by the road. A drainage blanket wrapped in geotextile placed below the road construction will provide flow continuity without concentrating the discharges into a narrow channel.

	Sketch of Channel Cross-Section / Longitudinal Section	Comments
11	**Longitudinal Section: Circular culvert, no Eco provision** 	In the case of crossings which have no need for particular ecological provision a circular culvert may be the preferred choice. This is generally laid to the stream gradient on prepared bedding material. The entrance and exit to the culvert require wing walls to locally stabilise the stream banks and the toe of the road embankment. Depending on the size of the opening various forms of wing wall construction may be used - concrete, gabions, stone. If there is a risk of surcharge then the embankment face may require protection.

Appendix B

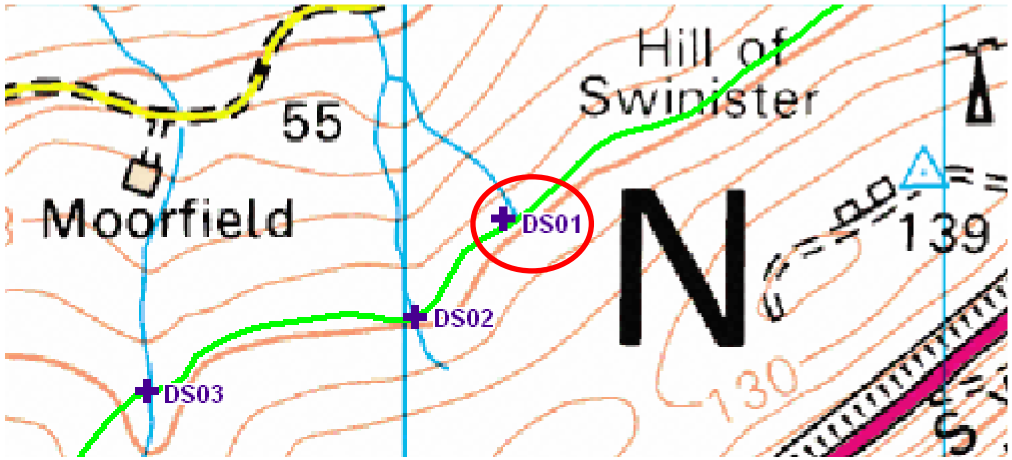
Watercourse Crossings Identified at 1:50,000 Scale

Individual Stream Crossing Descriptions:

DS01	CS01	KS01	NS01
DS02	CS02	KS02	NS02
DS03	CS03	KS03	NS03
DS04		KS05	NS04
DS05		KS06	NS05
DS06		KS07	NS06
DS07		KS08	NS07
DS08		KS09	NS08
DS09		KS10	NS09
DS10		KS11	NS10
DS11		KS12	NS11
DS12		KS13	NS12
DS13		KS14	NS13
DS14		KS15	NS14
DS15		KS16	NS15
			NS16
			NS17
			NS18
			NS19
			NS20

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS01
Route:	Access track between A968 & D16
Catchment ID:	5
Watercourse:	Stenswall Burn - feeder burn to North Burn
NGR:	HU 43186 72598
Description:	Small stream 0.3m wide in overgrown gully up to 2.5m wide by 1.2m deep with a water depth of 0.06m. Peat bed with some medium sized cobbles and peat banking.
CAR Category:	Small
Catchment Area:	0.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



Not to Scale

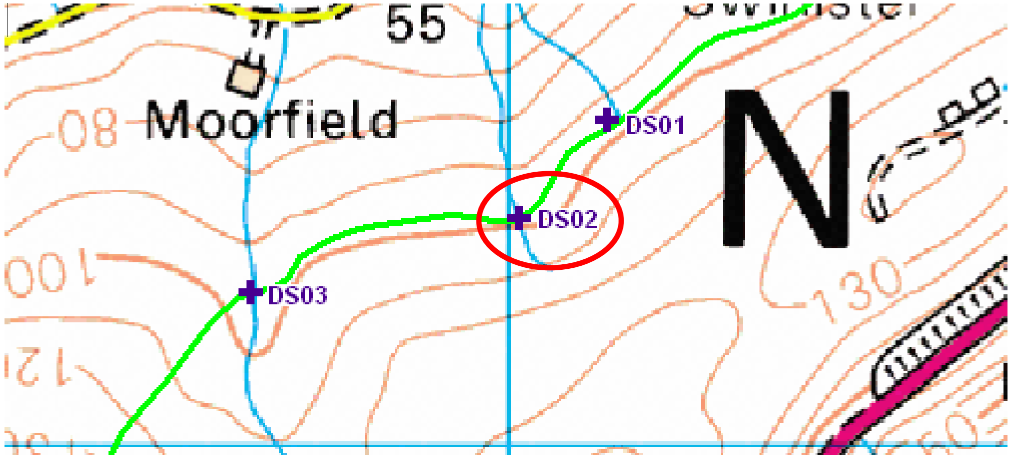
Looking across stream Viking DS01 across 1.jpg

Looking downstream Viking DS01 down.jpg

Looking upstream Viking DS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS02
Route:	Access track between A968 & D16
Catchment ID:	5
Watercourse:	Stenswall Burn feeder burn to North Burn
NGR:	HU 43021 72418
Description:	Small stream 0.5m wide with a water depth of 0.1m in a boggy area up to 10m wide by 1.8m deep. Peat bed & vegetated peat banks. Peat slightly undercut in places. No distinct channel.
CAR Category:	Small
Catchment Area:	0.21 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

Looking across stream Viking DS02 across 1.jpg

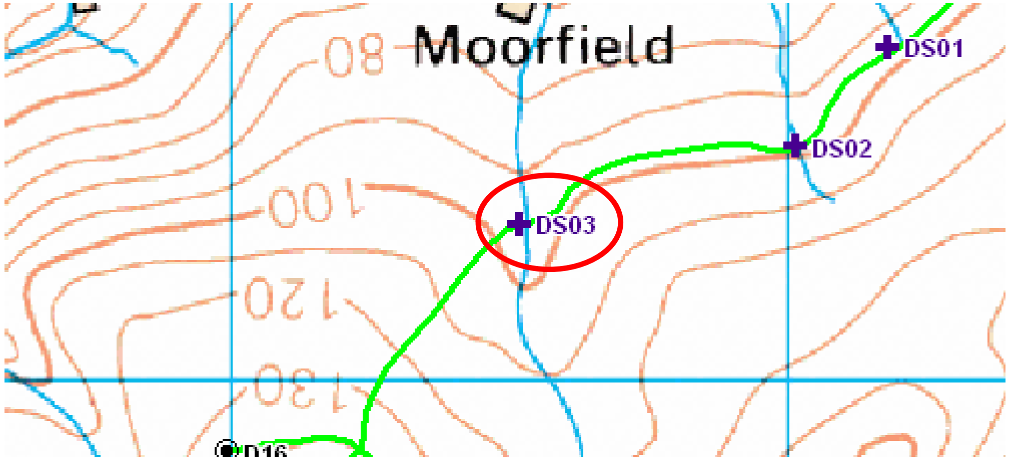
Looking downstream Viking DS02 down.jpg

Looking upstream Viking DS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing: DS03
Route: Access track between A968 & D16
Catchment ID: 5
Watercourse: Burn of Moorfield, tributary burn to North Burn
NGR: HU 42524 72280
Description: Small stream around 0.5m wide within broad flood channel 20m wide by 5m deep with a water depth of 0.3m. Peat bed with cobbles and boulders.

CAR Category: Small
Catchment Area: 0.53 km^2 (upstream of crossing location)
Ecology: Migratory fish, unlikely. Mammals, none
Crossing Type: New crossing: Rectangular culvert.



Not to Scale

Looking across stream		Viking DS03 across.jpg

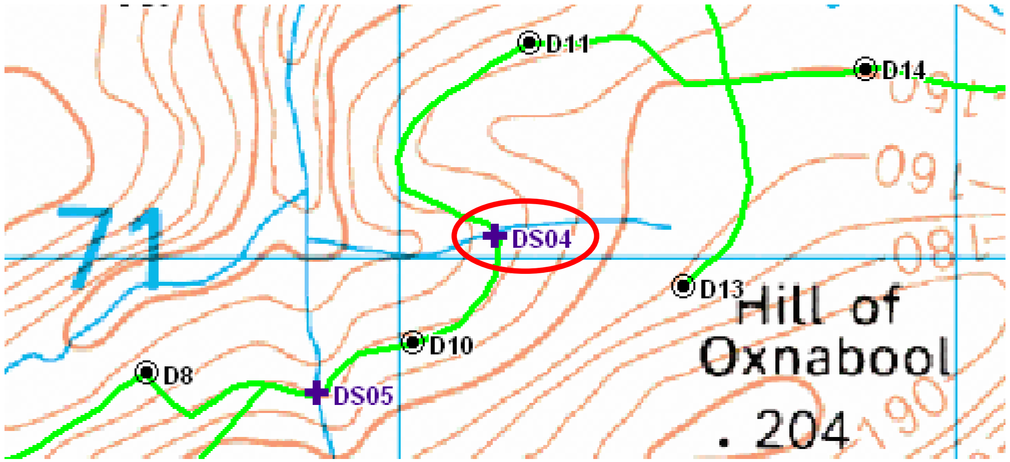
Looking downstream		Viking DS03 down.jpg

Looking upstream		Viking DS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing: DS04
Route: Access track between D10 & D11
Catchment ID: 5
Watercourse: Burn of Laxobigging
NGR: HU 41173 71040
Description: Boggy area 20m wide by 5m deep with a water depth of 0.3m. No distinct watercourse, peat bed with some exposed rock.

CAR Category: Medium
Catchment Area: 0.26 km^2 (upstream of crossing location)
Ecology: Migratory fish, unlikely. Mammals, none
Crossing Type: New crossing: Multiple circular culverts.



Not to Scale

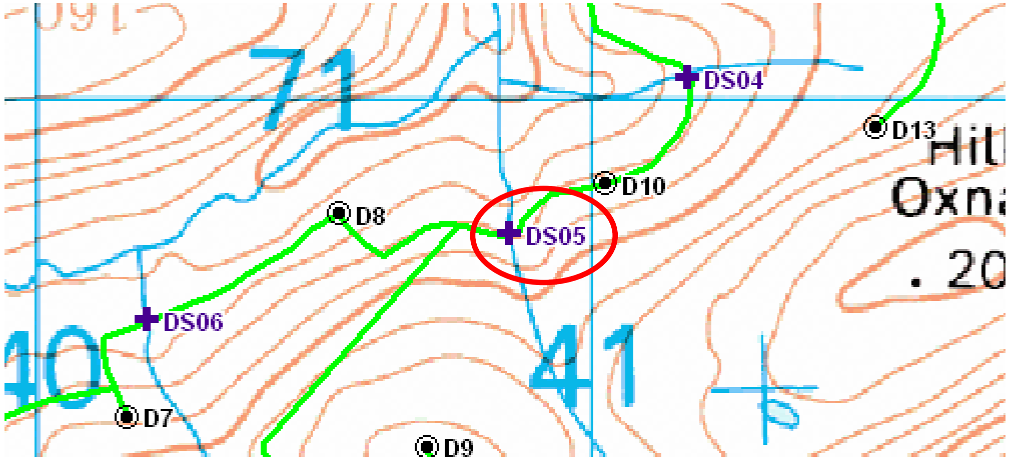
Looking across stream — Viking DS04 across.jpg

Looking downstream — Viking DS04 down.jpg

Looking upstream — Viking DS04 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS05
Route:	Track between D8 & D10
Catchment ID:	5
Watercourse:	Burn of Laxobigging
NGR:	HU 40853 70757
Description:	Small stream in well defined v-shaped channel up to 4m deep and 0.4-1.0m wide. Medium to coarse rock bed and grass and moss banking on flood channel which is up to 14m wide
CAR Category:	Small
Catchment Area:	0.57 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



Not to Scale

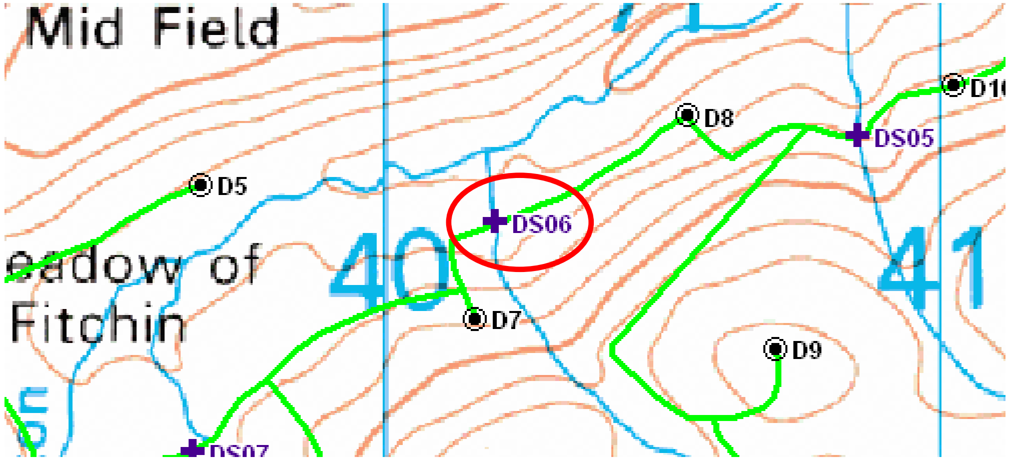
Looking across stream Viking DS05 across.jpg

Looking downstream Viking DS05 down.jpg

Looking downstream Viking DS05 down.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS06
Route:	Track between D7 & D8
Catchment ID:	5
Watercourse:	Burn of Oxnabool feeder burn to Burn of Laxobigging
NGR:	HU 40203 70602
Description:	Small stream 0.4m wide by 1m deep, water level 0.2m. Stream within a larger flood channel about 2-3m wide. Peaty bed with cobbles and large rocks on bed.
CAR Category:	Medium
Catchment Area:	0.51 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



Not to Scale

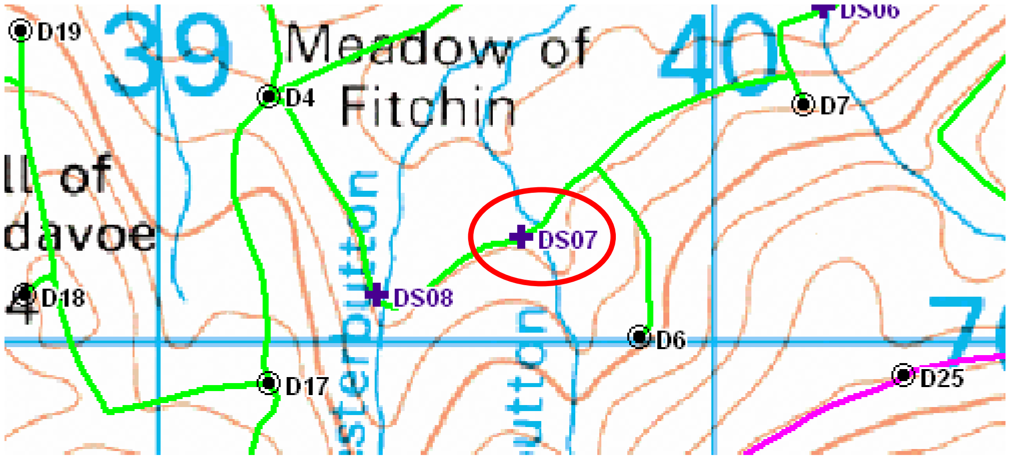
Looking across stream Viking DS06 across.jpg

Looking across stream Viking DS06 across.jpg

Looking upstream Viking DS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS07
Route:	Track between D4, D6 & D7
Catchment ID:	5
Watercourse:	Burn of Easterbutton
NGR:	HU 39658 70188
Description:	Channel 1.2m wide by roughly a 1m high with a water depth of 0.7m and a rocky bed. In a valley up 25m in width.
CAR Category:	Medium
Catchment Area:	1.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none.
Crossing Type:	New crossing: Rectangular culvert.



Not to Scale

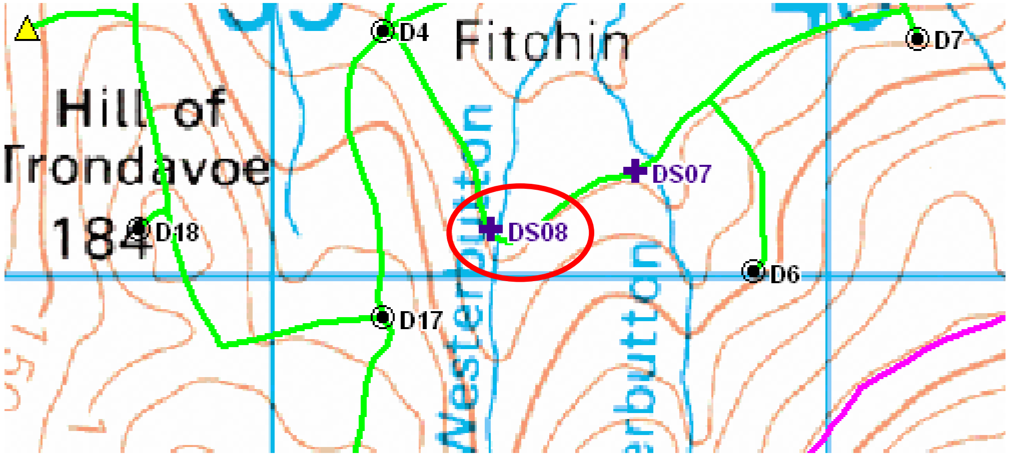
Looking across stream Viking DS07 across.jpg

Looking across stream Viking DS07 across.jp

Looking upstream Viking DS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS08
Route:	Track between D4, D6 & D7
Catchment ID:	5
Watercourse:	Burn of Westerbutton
NGR:	HU 39399 70083
Description:	Well defined channel with gently sloping grass banking. 0.8-1.2m wide with a flood channel of 9m. Water depth 0.3 - 0.5m with peat bed and banking.
CAR Category:	Medium
Catchment Area:	0.94 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

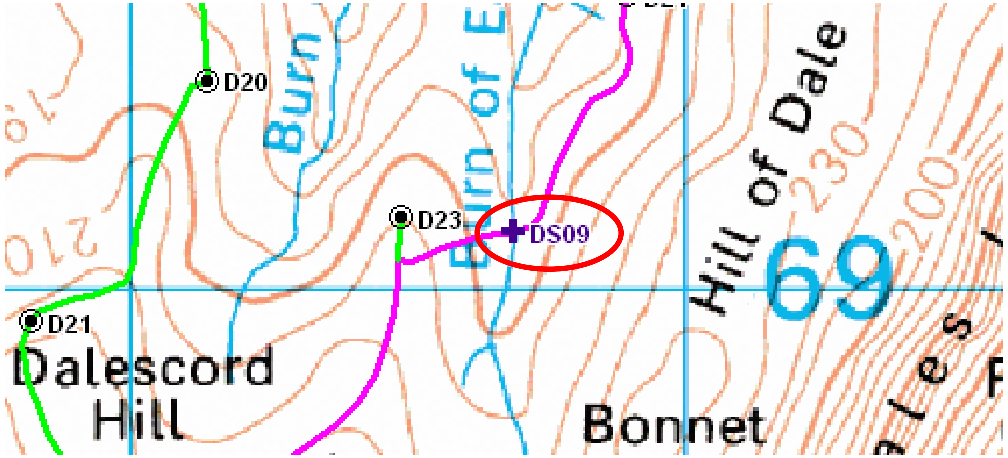
Looking across stream Viking DS08 across.jpg

Looking downstream Viking DS08 down.jpg

Looking upstream Viking DS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS09
Route:	Track between D23 & D24
Catchment ID:	5
Watercourse:	Burn of Easterbutton
NGR:	HU 39692 70083
Description:	Small stream in 0.6m wide with a water depth of 0.2m. Medium and coarse stones on peaty bed and peat banking. Stream widens at meanders and points of overground flow.
CAR Category:	Small
Catchment Area:	0.52 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

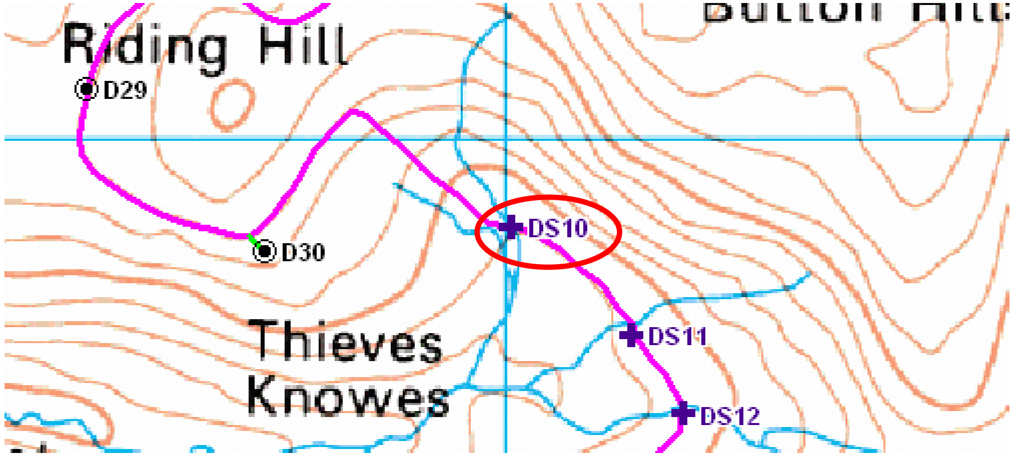
Looking across stream — Viking DS09 across 2.jpg

Looking downstream — Viking DS09 down.jpg

Looking upstream — Viking DS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS10
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributray to Burn of Skelladale
NGR:	HU 39011 67843
Description:	Small, shallow stream 0.3-0.6m, with a water depth of 0.1m. Peat bed and banking. Channel could dry up on occasion.
CAR Category:	Small
Catchment Area:	0.31 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



Not to Scale

No photograph Available

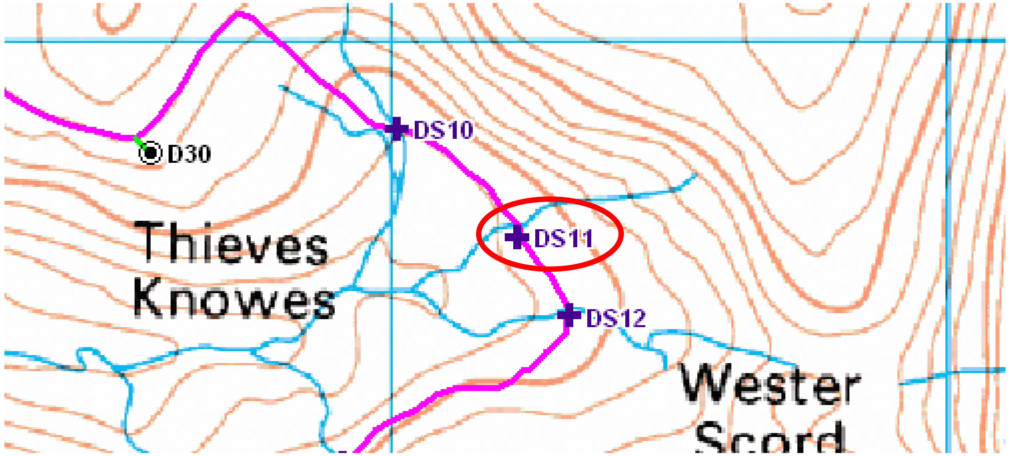
Looking across stream Viking DS10 across 2.jpg

Looking downstream Viking DS10 down.jpg

Looking upstream Viking DS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS11
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary to Burn of Skelladale
NGR:	HU 39230 67650
Description:	Small, poorly defined stream, boogy channel rather than a stream in places. Channel up 0.8m wide by 0.2m deep, with a water depth of 0.1m. Medium sized stone bed and grass banks.
CAR Category:	Small
Catchment Area:	0.33 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

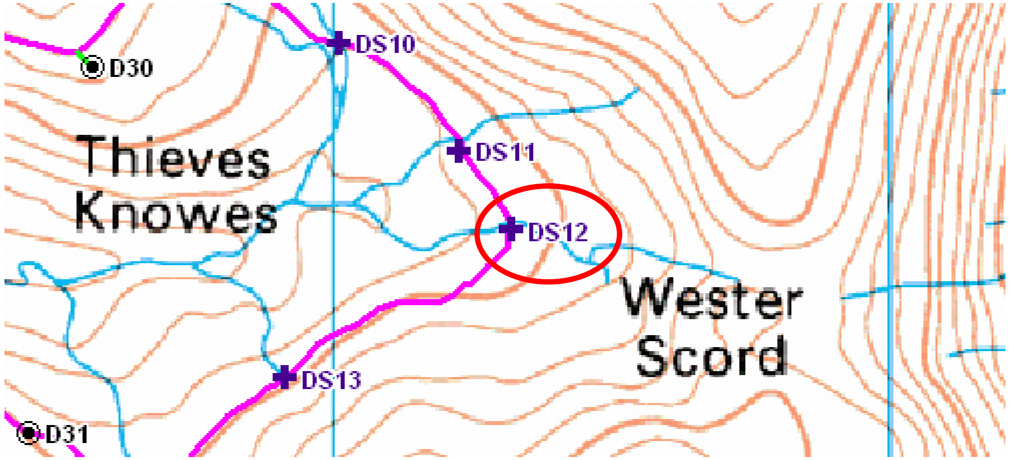
Looking across stream Viking DS11 across 2.jpg

Looking downstream Viking DS11 down.jpg

Looking upstream Viking DS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS12
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 39324 67507
Description:	Small stream up to 0.5m wide in well-defined U- shaped channel. Flood channel up to 8m wide and 2.6m high, with a water depth of 0.2m. Peat bed with some cobbles. Peat banking which is slightly undercut in places.
CAR Category:	Small
Catchment Area:	0.25 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



 Not to Scale

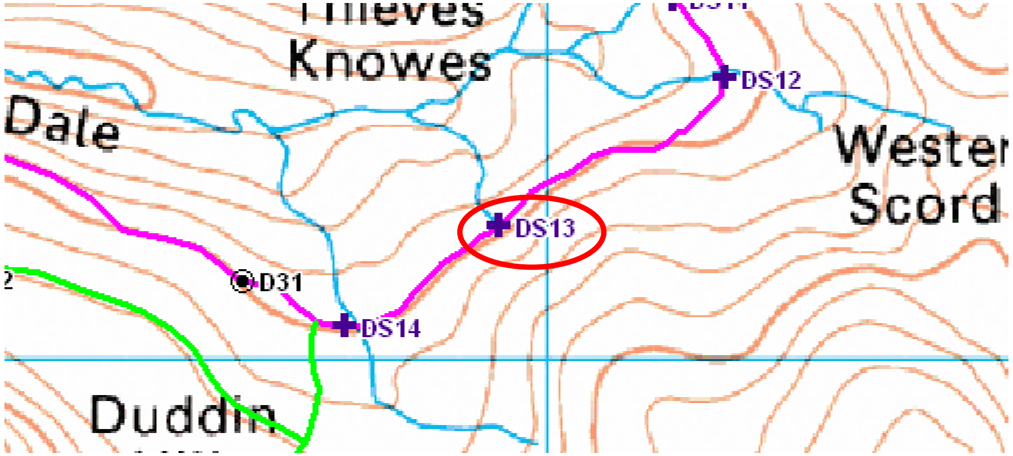
Looking across stream Viking DS12 across 2.jpg

Looking downstream Viking DS12 down.jpg

Looking upstream Viking DS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS13
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 38913 67240
Description:	Small stream channel 0.4m wide by 0.4m high with a water depth of 0.2m. Peat bed and peat banking.
CAR Category:	Small
Catchment Area:	0.32 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



Not to Scale

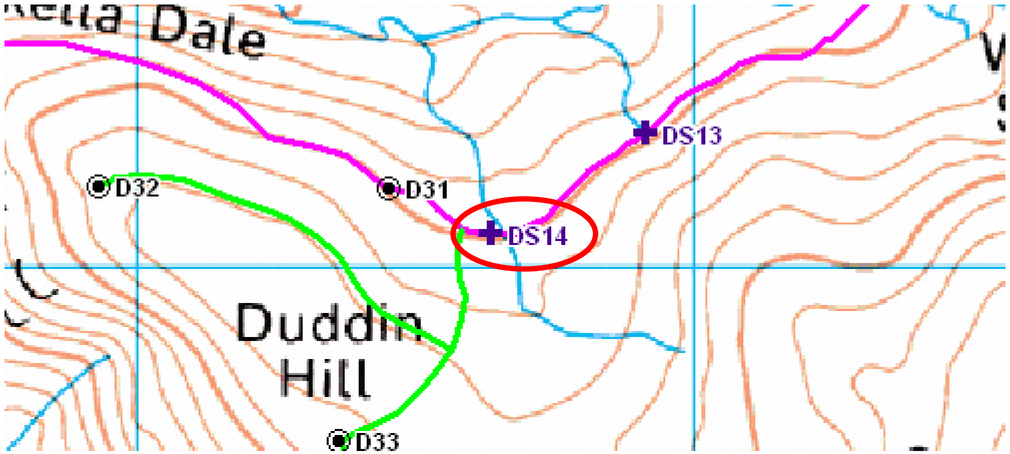
Looking across stream Viking DS13 across 2.jpg

Looking downstream Viking DS13 down.jpg

Looking upstream Viking DS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS14
Route:	Track between D30 & D31
Catchment ID:	9
Watercourse:	Unamed tributary burn to Burn of Skelladale
NGR:	HU 38638 67059
Description:	Small stream 0.5m wide in small to medium stream in channel 0.2-2m wide and 0.6-0.8m deep with a water level of 0.2m. Peat bed and banking.
CAR Category:	Small
Catchment Area:	0.31 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



 Not to Scale

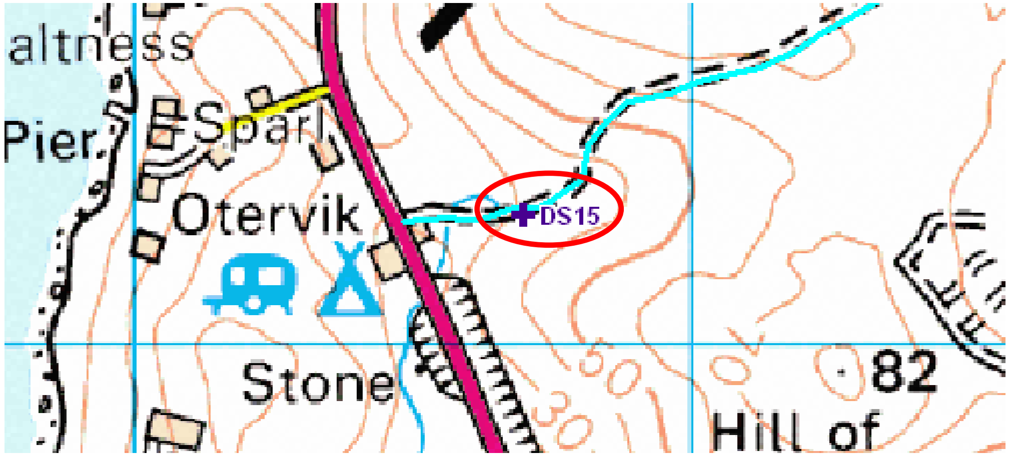

Looking across stream Viking DS14 across 2.jpg


Looking downstream Viking DS14 down.jpg


Looking upstream Viking DS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	DS15
Route:	Site access between A970 and D31
Catchment ID:	26
Watercourse:	Foulawick Burn
NGR:	HU 36700 66229
Description:	Medium stream in well-defined channel up to 2.4 m wide by 1m deep and a water depth of 0.2m. Bare rock bed. The burn culverted under existing road.
CAR Category:	Medium
Catchment Area:	0.50 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	Probably requiring upgrade of existing crossing: Rectangular culvert



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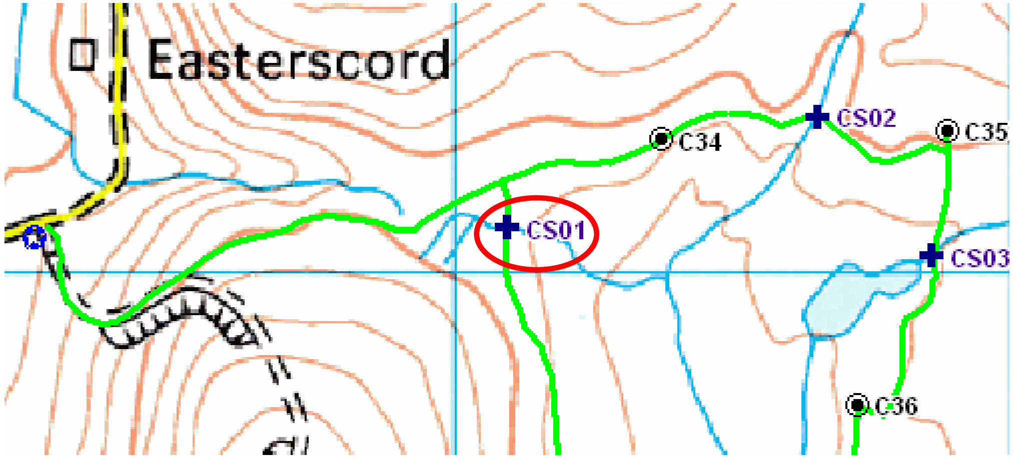
Looking across stream Viking DS15 across 2.jpg

Looking downstream Viking DS15 down.jpg

No Photograph Available

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS01
Route:	Between Access road and C34
Catchment ID:	1
Watercourse:	Unamed tributary burn to Seggie Burn
NGR:	HU 42095 66077
Description:	Small stream 0.5-0.7m wide and 0.9m deep with a water level of 0.1m. Peat bed with some sand and gravel. Vegetated peat banking. Good flow with some undercutting of the peat banking.
CAR Category:	Small
Catchment Area:	0.07 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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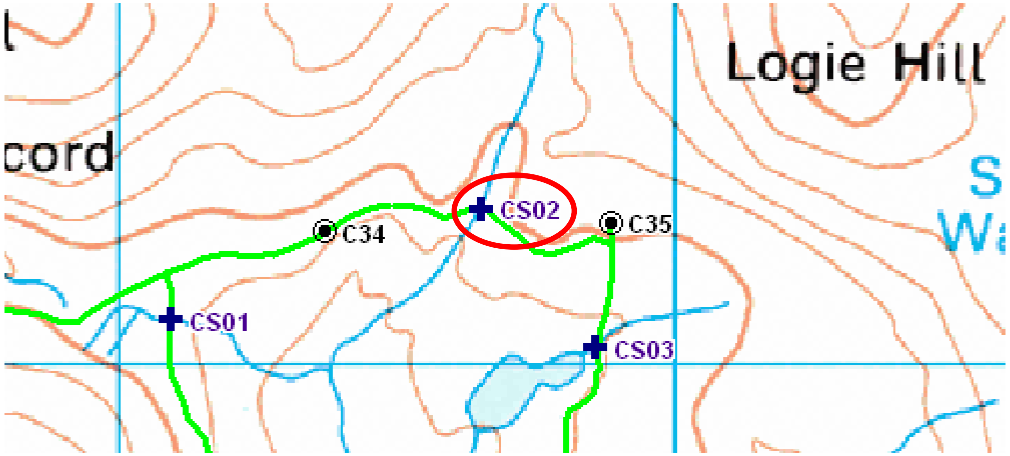
Looking across stream Viking CS01 across 1.jpg


Looking downstream Viking CS01 down.jpg


Looking upstream Viking CS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS02
Route:	Between C34 & C35
Catchment ID:	1
Watercourse:	Unnamed tributary burn to Seggie Burn
NGR:	HU 42652 66278
Description:	Small channel 0.04-0.08m wide by 1m deep. Water depth 0.2m deep. Fine silt and peat bed and peat banking.
CAR Category:	Small
Catchment Area:	0.56 km^2
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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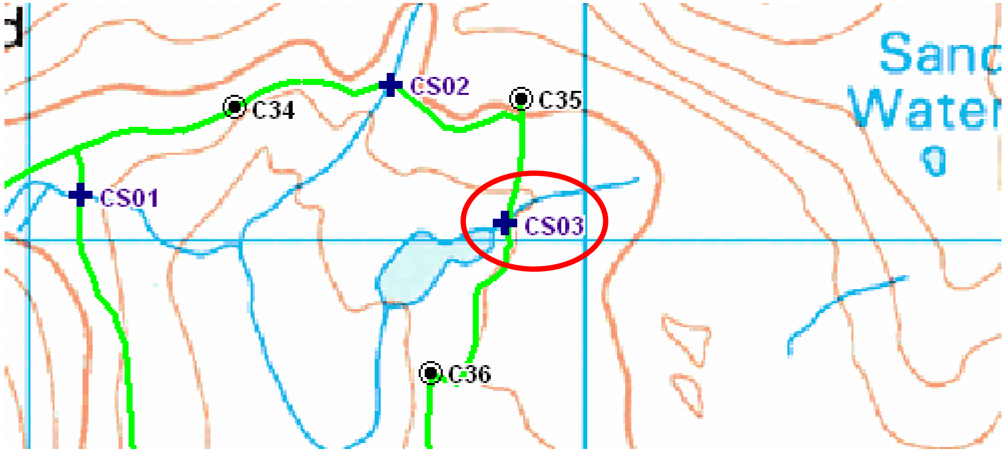
Looking across stream Viking CS02 across 1.jpg


Looking downstream Viking CS02 down.jpg


Looking upstream Viking CS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	CS03
Route:	Between C35 & C36
Catchment ID:	1
Watercourse:	Unnamed tributary to Seggie Burn
NGR:	HU 42858 66027
Description:	Small stream/peat pipe. Overground channel 1m wide by 1.5m deep. Flood channel 16m wide. Water depth 0.2m deep. Fine silt, cobble and peat bed and peat banking. Collapsed peat pipe which looks quite unstable.
CAR Category:	Small
Catchment Area:	0.24 km^2
Ecology:	Migratory fish, none. Mammals none
Crossing Type:	New crossing: Circular pipe



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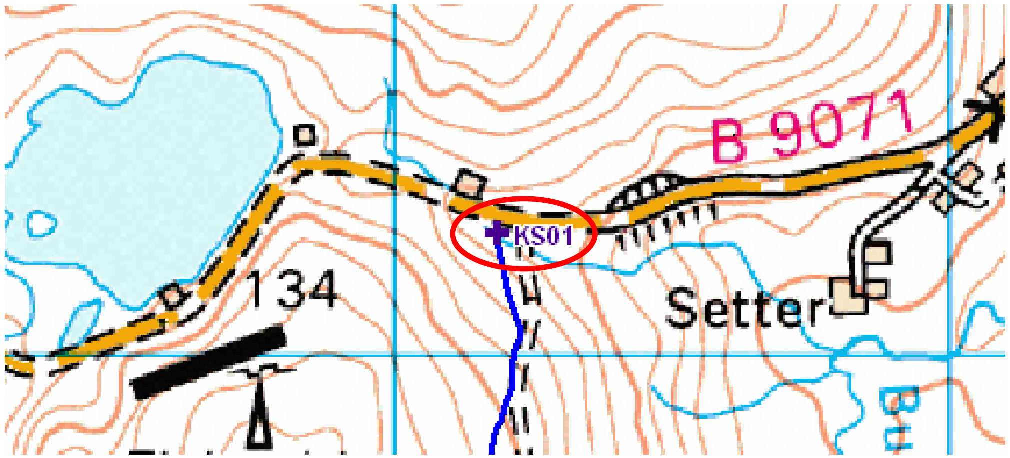
Looking across stream Viking CS03 across 1.jpg

Looking downstream Viking CS03 down.jpg

Looking upstream Viking CS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS01
Route:	Site access track just off B9071
Catchment ID:	8
Watercourse:	Unnamed feeder burn to Burn of Kirkhouse
NGR:	HU 39188 62220
Description:	Exiting circular steel culvert 900mm in diameter under existing track. Stream is in a shallow v-shaped channel 1m wide by 0.4-0.5m deep. Peat bed with silt and medium-coarse rock. Peat banking with some exposed rock.
CAR Category:	Small
Catchment Area:	0.19 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none.
Crossing Type:	Probably requiring upgrade of existing crossing: Circular culvert



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Looking across stream Viking KS01 across 1.jpg

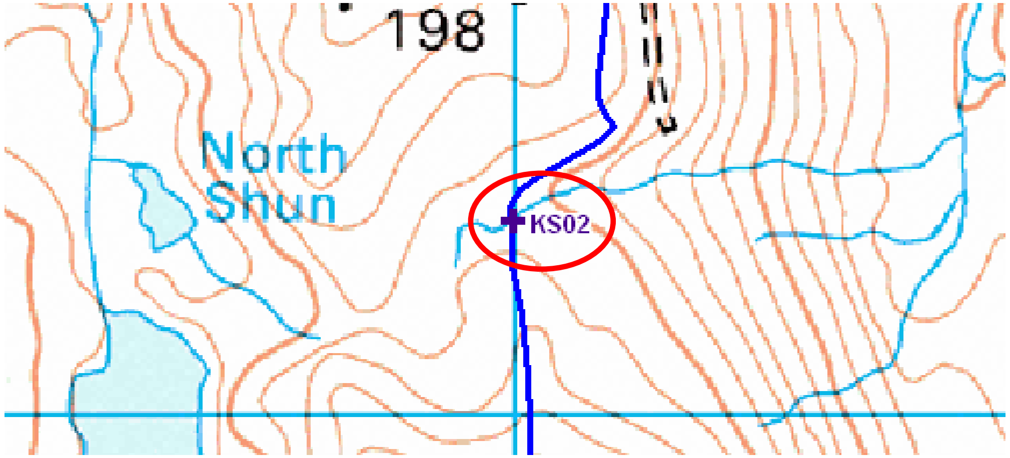
Looking downstream Viking KS01 down.jpg

Looking upstream Viking KS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing: KS02
Route: Site access track between B9071 & K42
Catchment ID: 8
Watercourse: Tributary to Burn of Kirkhouse
NGR: HU 39000 61347
Description: Small stream with good flow, water 0.1m deep. Well defined channel 0.5m wide by 0.6m deep cut into peat. Vegetated bed with some coarse rock exposed. Over hanging vegetated peat banks.

CAR Category: Small
Catchment Area: 0.21 km^2 (upstream of crossing location)
Ecology: Migratory fish, none. Mammals, none.
Crossing Type: New crossing: Circular culvert



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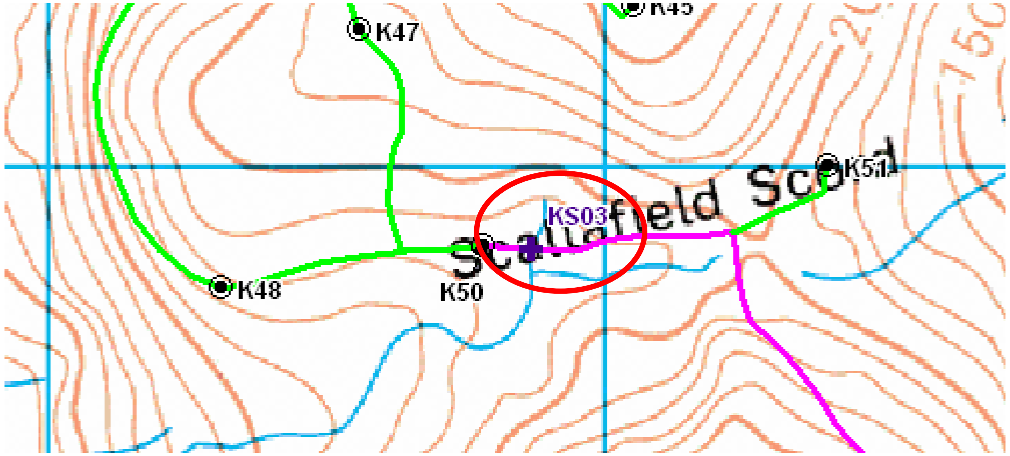
Looking across stream Viking KS02 across 1.jpg

Looking downstream Viking KS02 down.jpg

Looking upstream Viking KS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS03
Route:	Site Access Track between K50 & K51
Catchment ID:	2
Watercourse:	Unnamed tributary of Red Burn
NGR:	HU 38870 57849
Description:	Poorly defined stream with diffuse flow. Flush over the surface up to 3m wide. Poor flow.
CAR Category:	Medium
Catchment Area:	0.09 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none.
Crossing Type:	New crossing: Drainage layer and pipes



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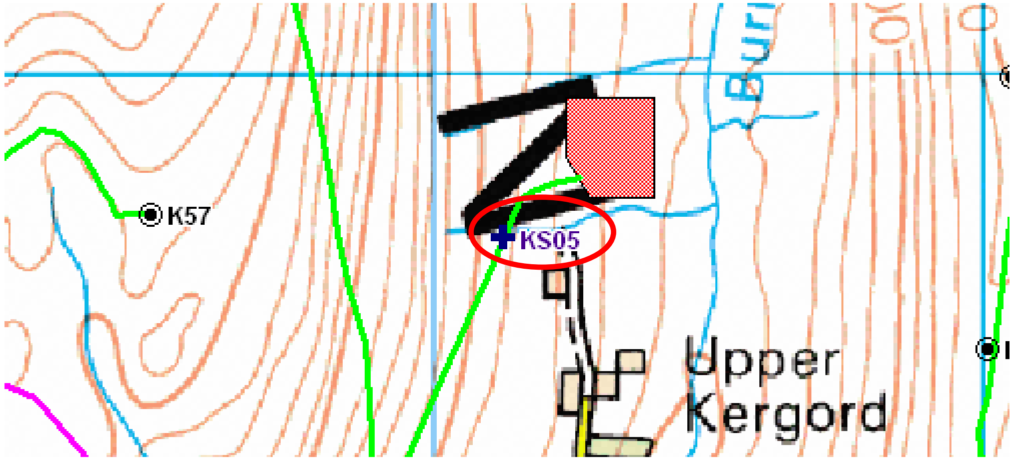
Looking across stream Viking KS03 across 1.jpg

Looking downstream Viking KS03 down.jpg

Looking upstream Viking KS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS05
Route:	Access track to convertor station
Catchment ID:	4
Watercourse:	Unnamed feeder burn to Burn of Weisdale
NGR:	HU 40027 56700
Description:	Small ditch, has been straightened and probably deepened. Channel 1.5m wide by 0.5m deep. Peat bed with some exposed rock and peat and vegetated banking. Note surveyed location was 100m W (upstream) of crossing position due to late layout amendment.
CAR Category:	Medium
Catchment Area:	0.06 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



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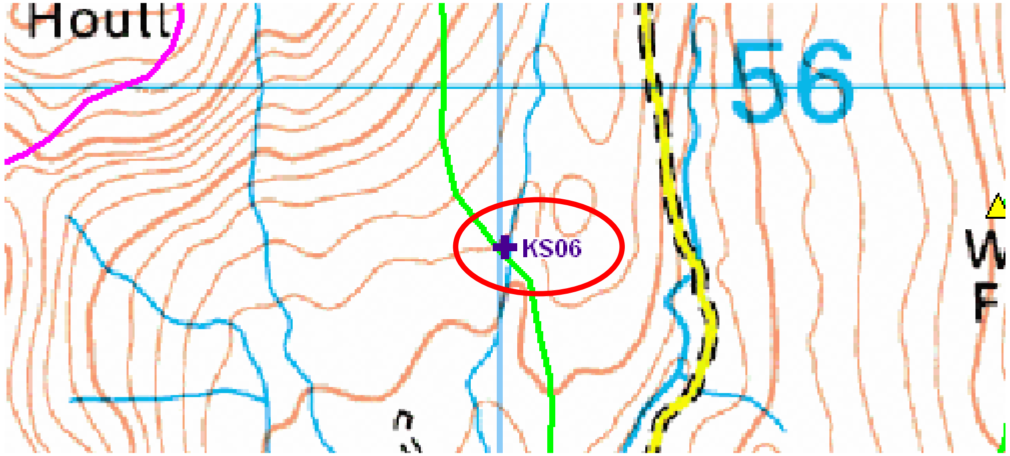
Looking across stream Viking KS05 across.jpg

Looking downstream Viking KS05 down.jpg

Looking upstream Viking KS05 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS06
Route:	Site access track between B9075 & K52
Catchment ID:	4
Watercourse:	Burn of Droswall
NGR:	HU 40013 55708
Description:	Small Stream 0.1-0.2m wide, with a water depth of 0.1m. Channel 0.6m wide by 0.6m deep. Flood channel 14m wide by 5.5m high. Peat bed and vegetated peat banks.
CAR Category:	Small
Catchment Area:	0.42 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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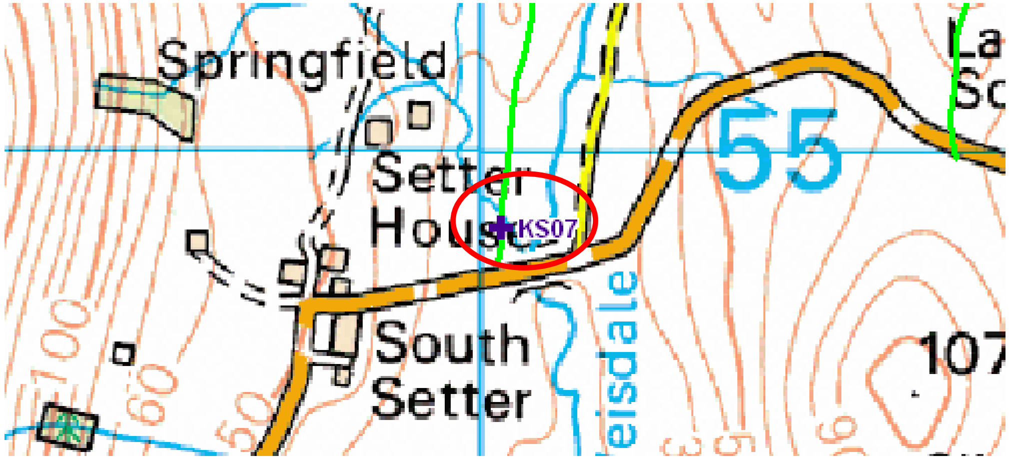
Looking across stream Viking KS06 across 2.jpg

Looking downstream Viking KS06 down.jpg

Looking upstream Viking KS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS07
Route:	Access track next to the B9075
Catchment ID:	4
Watercourse:	Burn of Weisdale
NGR:	HU 40039 54862
Description:	Small-Medium stream up to 1m wide in channel 0.5-2.0m wide by 0.5m deep, with a water depth of 0.2m. Peat bed and grass covered peat and mineral banks.
CAR Category:	Medium
Catchment Area:	2.17 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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Looking across stream Viking KS07 across 2.jpg

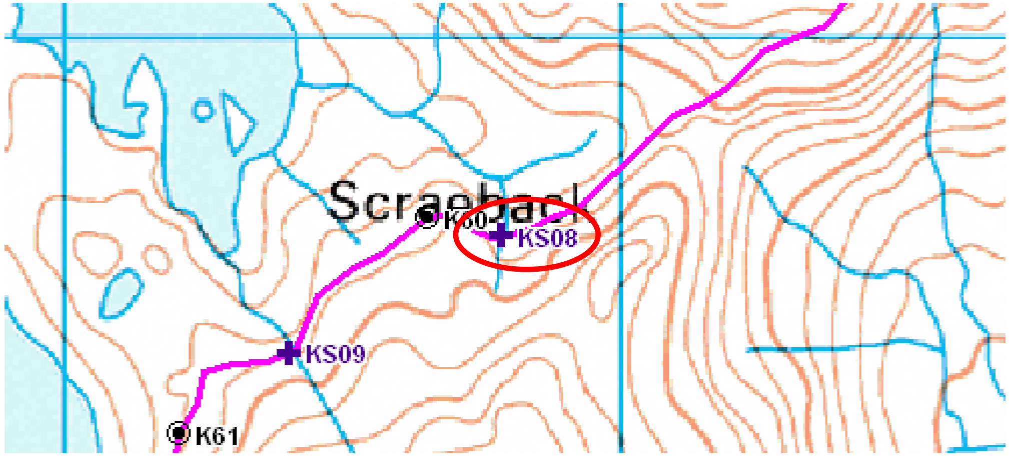
No Photograph Available

Looking downstream Viking KS07 down.jpg

Looking upstream Viking KS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS08
Route:	Between K59 & K60
Catchment ID:	2
Watercourse:	Unamed inflow burn to Lamba Water
NGR:	HU 38789 55638
Description:	Small poorly defined channel up to 1m wide and 0.1-0.4m deep. Deep peat bed >1m. Channel is boggy with a water depth of 0.1m and is very overgrown with grass, moss and water vegetation.
CAR Category:	Small
Catchment Area:	0.04 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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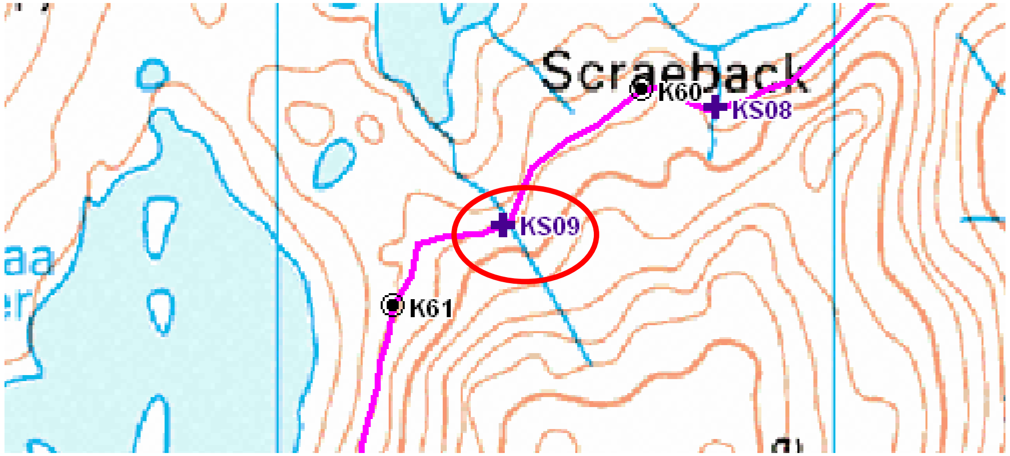
Looking across stream Viking KS08 across 2.jpg

Looking downstream Viking KS08 down.jpg

Looking upstream Viking KS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS09
Route:	Access track between K60 & K61
Catchment ID:	2
Watercourse:	Unamed inflow burn to Lamba Water
NGR:	HU 38406 55428
Description:	Poorly defined shallow channel up to 0.05m wide with a water depth of up to 0.01m. Vegetated bed.
CAR Category:	Small
Catchment Area:	0.21 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



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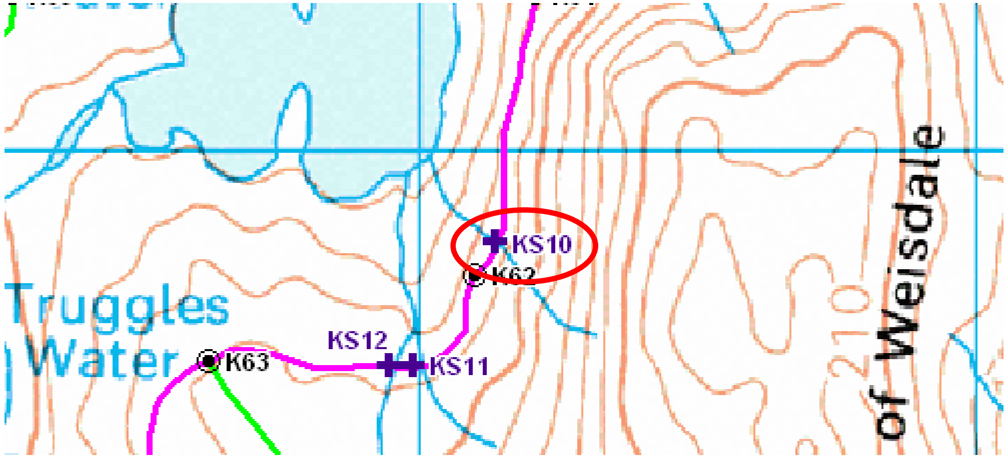
Looking across stream Viking KS09 across 2.jpg

Looking downstream Viking KS09 down.jpg

Looking upstream Viking KS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS10
Route:	Access track between K61 & K62
Catchment ID:	2
Watercourse:	Unamed inflow burn to Maa Water
NGR:	HU 37839 50613
Description:	Small stream up to 1m wide with 0.5-1m deep banking. Water 0.5m deep. No clear channel with peat bed and banking.
CAR Category:	Small
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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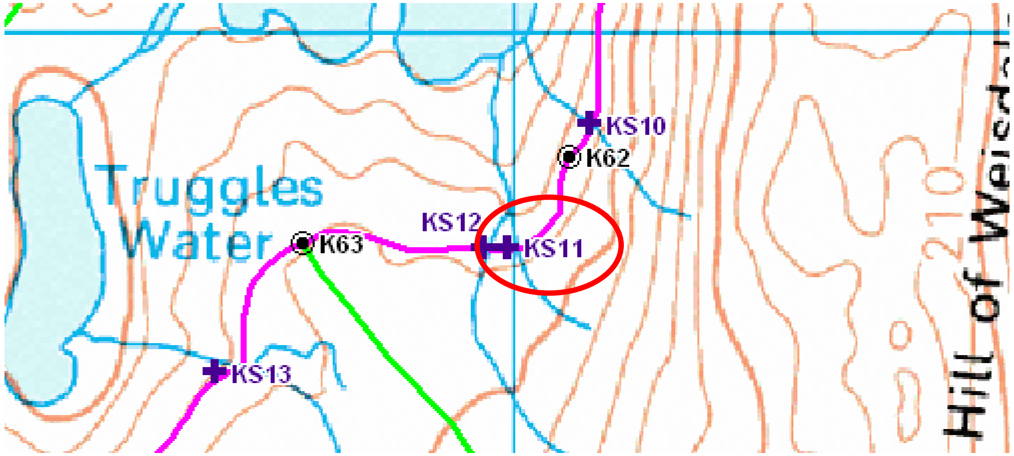
Looking across stream Viking KS10 across 2.jpg

Looking downstream Viking KS10 down.jpg

Looking upstream Viking KS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS11
Route:	Site access track between K62 and K63
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Maa Water
NGR:	HU 37990 55428
Description:	Small stream, water 0.2m deep. Defined channel 0.5-1.0m wide by 0.4m deep. Flood channel 12m wide by 1.2m high. Vegetated peat bed with some exposed coarse rock.
CAR Category:	Small
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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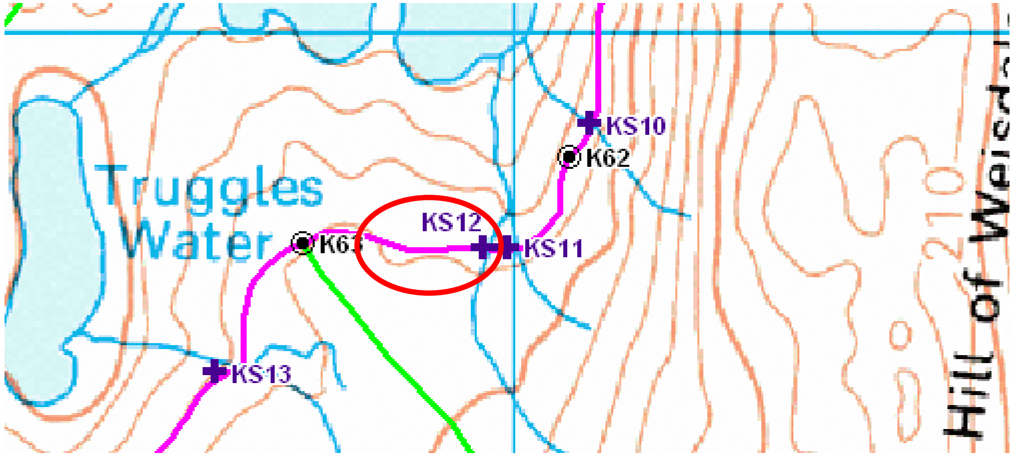
Looking across stream Viking KS11 across 2.jpg

Looking downstream Viking KS11 down.jpg

Looking upstream Viking KS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS12
Route:	Site access track between K62 & K63
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Maa Water
NGR:	HU 37945 54611
Description:	Well defined channel 0.5m wide but up to 1.1m wide in places by 0.5-1m deep. Water depth 0.3m. Flood channel 4.5m wide & 3m high. Coarse rock and peat bed with vegetated peat banks.
CAR Category:	Small
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert.



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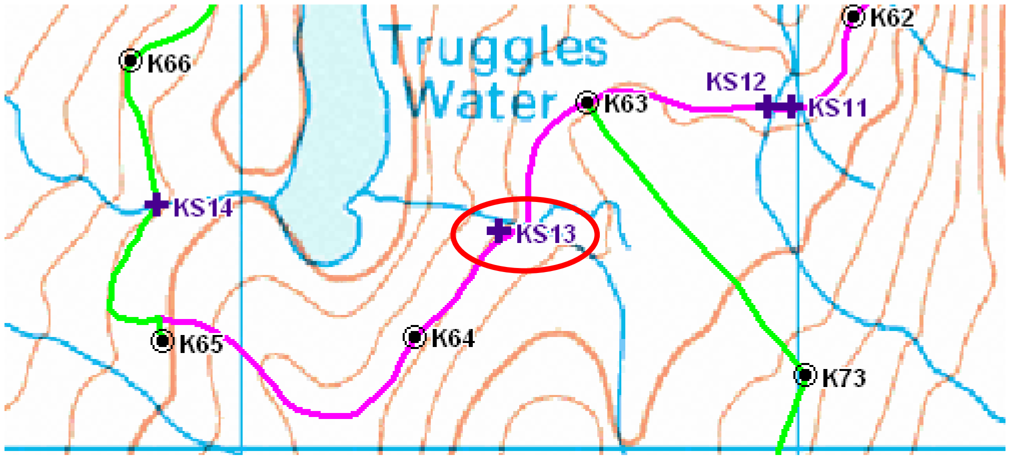
Looking across stream Viking KS12 across 2.jpg

Looking downstream Viking KS12 down.jpg

Looking upstream Viking KS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS13
Route:	Between K63 & K64
Catchment ID:	2
Watercourse:	Unnamed inflow burn to Truggles Water
NGR:	HU 37463 54387
Description:	Small to medium stream in V- shaped channel 0.5-1.1m wide by 0.5m deep, with a water depth of 0.2m. Predominantly cobbles and pebbles on stream bed and grass covered peat and mineral banks.
CAR Category:	Medium
Catchment Area:	0.36 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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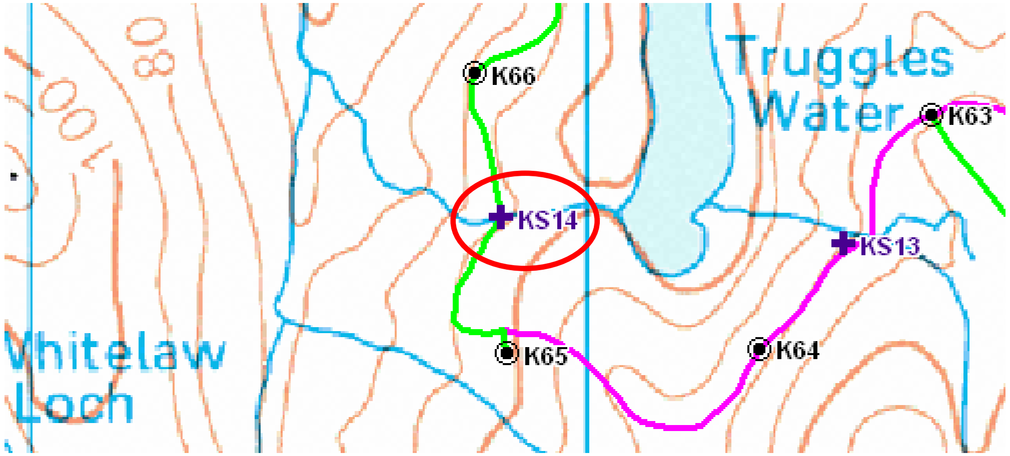
Looking across stream Viking KS13 across 2.jpg


Looking downstream Viking KS13 down.jpg


Looking upstream Viking KS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS14
Route:	Between K65 & K66
Catchment ID:	2
Watercourse:	Outflow burn from Truggles Water
NGR:	HU 36844 54434
Description:	Medium stream with good flow in well defined channel 1.5-2m wide by 0.8m deep, with a water depth of 0.2m. Predominantly boulders on stream bed and vegetated, peat and mineral banks. V shaped flood channel
CAR Category:	Medium
Catchment Area:	2.73 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



Not to Scale

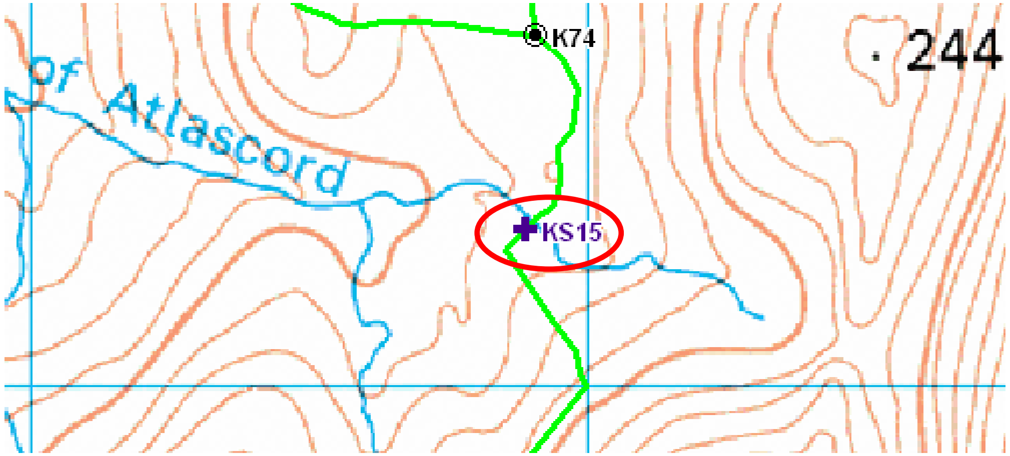
Looking across stream Viking KS14 across 2.jpg

Looking downstream Viking KS14 down.jpg

Looking upstream Viking KS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS15
Route:	Between K74 & K76
Catchment ID:	2
Watercourse:	Burn of Atlascord
NGR:	HU 37888 53278
Description:	Medium stream in well-defined channel 1m wide by 1.5m deep, with a water depth of 0.2m. Peat with fine silt/sand and gravel/pebble bed. Steep peat banks.
CAR Category:	Medium
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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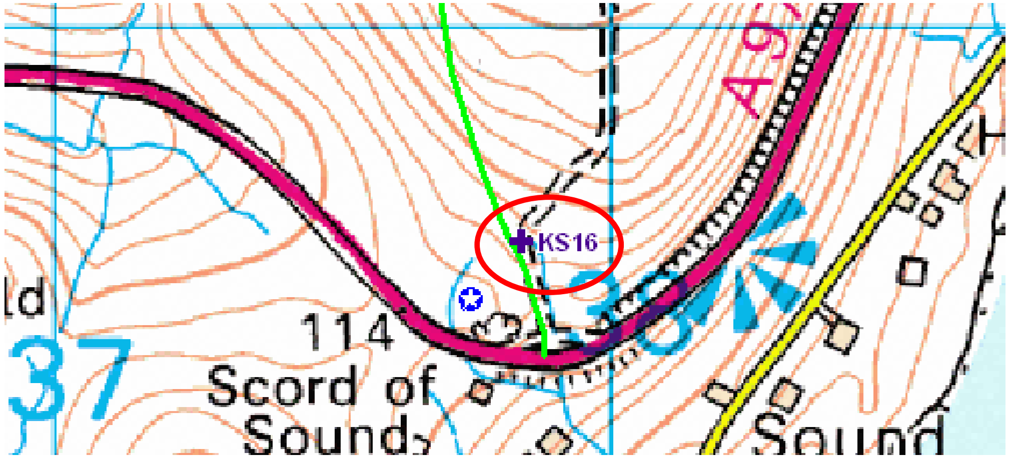
Looking across stream Viking KS15 across 2.jpg

Looking downstream Viking KS15 down.jpg

Looking upstream Viking KS15 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	KS16
Route:	Site access track south of K76
Catchment ID:	30
Watercourse:	Unamed feeder burn to Weisdale Voe
NGR:	HU 37839 50613
Description:	Small/medium stream in well-defined channel 0.9 -1.2m wide by 0.7 m deep and a water depth of 0.05m. Fine silt/sand and gravel/pebble bed. Burn culverted under existing road.
CAR Category:	Medium
Catchment Area:	0.03 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	Existing crossing: Possible upgrade with circular culvert



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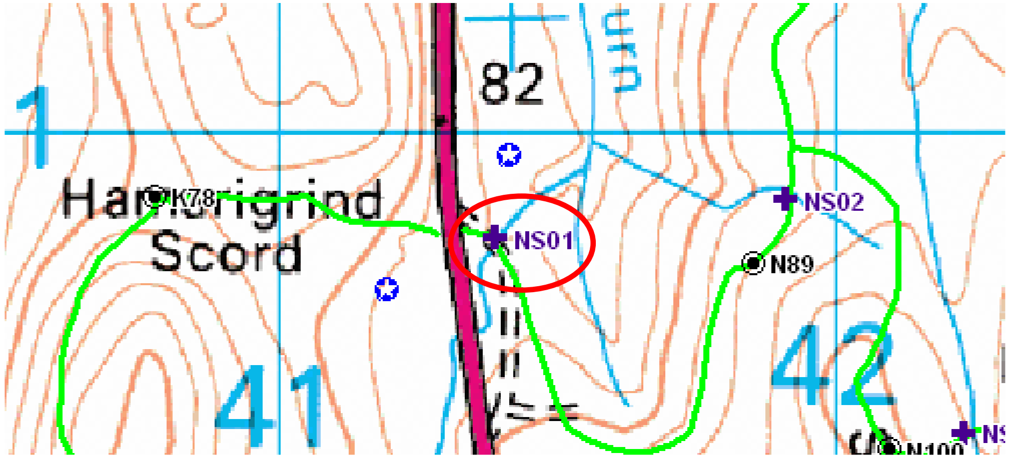
Looking across stream Viking KS16 across 2.jpg

Looking downstream Viking KS16 down.jpg

Looking upstream Viking KS16 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS01
Route:	Between A970 & N89
Catchment ID:	11
Watercourse:	Tributary channel of Wester Filla Burn
NGR:	HU 41389 60808
Description:	Medium stream in defined channel 0.9-1.5m wide by 0.4m deep. Water depth 0.2m. Flood channel 2m wide and up to 2.7m high. Coarse rock bed and mineral banking overlain by peat.
CAR Category:	Medium
Catchment Area:	0.44 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



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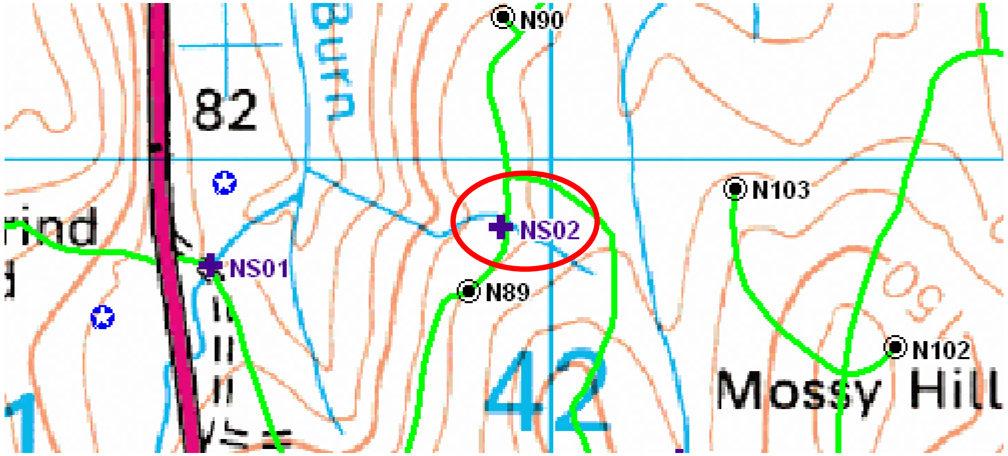
Looking across stream — Viking NS01 across 1.jpg

Looking downstream — Viking NS01 down.jpg

Looking upstream — Viking NS01 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS02
Route:	Between N89 & N90
Catchment ID:	11
Watercourse:	Tributary burn to Wester Filla Burn
NGR:	HU 41912 60877
Description:	Small stream 0.6-0.9m in peat channel 4.5m wide by 1.6m deep. Water 0.02m deep with very little flow. Peaty bed with silt and gravel deposits.
CAR Category:	Small
Catchment Area:	0.04 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



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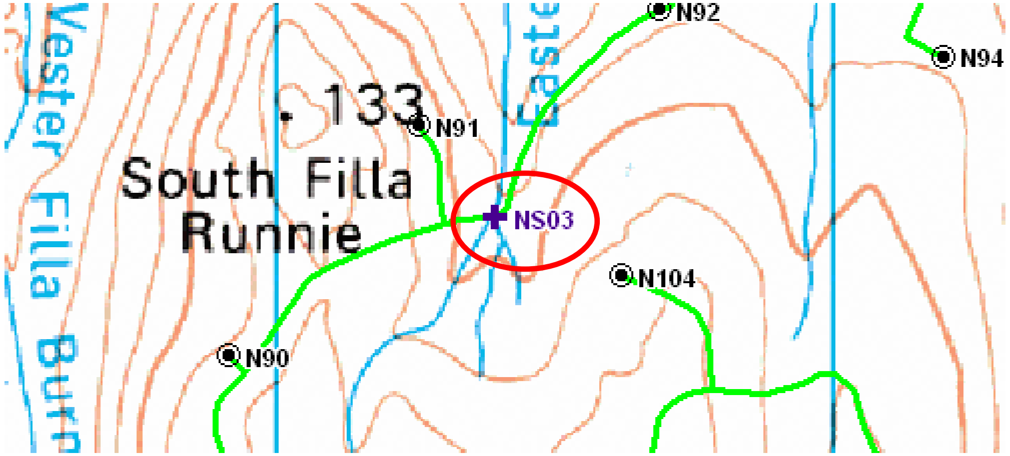
Looking across stream — Viking NS02 across 1.jpg

Looking downstream — Viking NS02 down.jpg

Looking upstream — Viking NS02 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS03
Route:	Between N90 & N92
Catchment ID:	1
Watercourse:	Easter Filla Burn
NGR:	HU 42394 61503
Description:	Small/medium stream in well defined channel 1-2 wide and 0.6-1m high. Water depth 0.2m. Bed of predominantly cobbles & coarse bare rock. Vegetated peat banking.
CAR Category:	Medium
Catchment Area:	0.59 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



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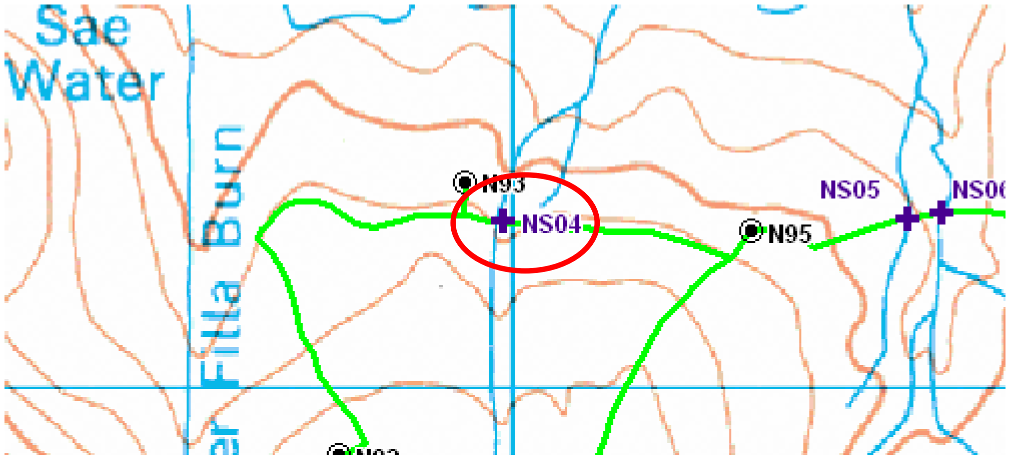
Looking across stream Viking NS03 across 1.jpg

Looking downstream Viking NS03 down.jpg

Looking upstream Viking NS03 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS04
Route:	Between N93 & N95
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Laxo Burn
NGR:	HU 42983 62299
Description:	Small stream in well defined channel. Channel 0.6-1m wide by 0.6m deep. Water depth 0.2m. V-shaped flood channel 5.5m wide by 3m deep. Peat bed with some coarse rock bed. Mineral and peat banking.
CAR Category:	Small
Catchment Area:	0.47 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, likely.
Crossing Type:	New crossing: Rectangular culvert /arch with mammal passage.



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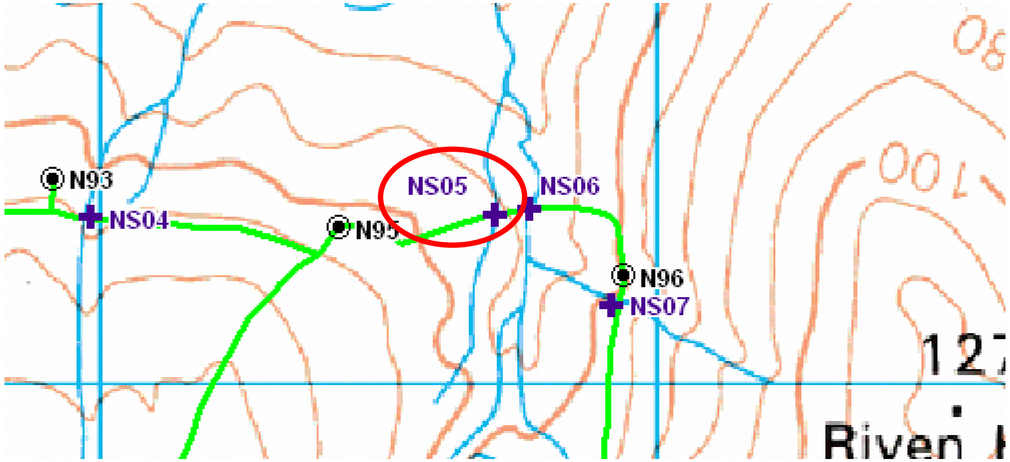
Looking across stream Viking NS04 across 1.jpg

Looking downstream Viking NS04 down.jpg

Looking upstream Viking NS04 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS05
Route:	Between N95 & N96
Catchment ID:	1
Catchment ID:	Unnamed tributary to Gossawater
Watercourse:	HU 43711 62305
NGR:	Small/medium 0.5-1.5m wide stream in flood channel up to 5.5m wide and 1.5m high. Water depth 0.05m. Peat and vegetated peat banks.
Description:	
CAR Category:	Medium
Catchment Area:	0.41 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



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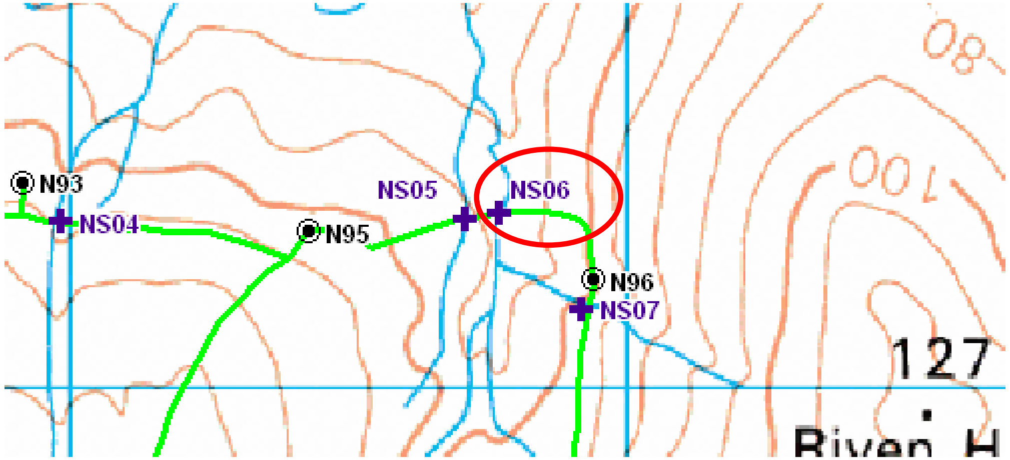
Looking across stream Viking NS05 across 2.jpg

Looking downstream Viking NS05 down.jpg

Looking upstream Viking NS05 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS06
Route:	Between N95 & N96
Catchment ID:	1
Watercourse:	Gossawater Burn feeding to Laxo Burn
NGR:	HU 43775 62316
Description:	Incised medium burn in well-defined channel 3m wide and up to 2.5m high, water 0.2m deep. Stony bed of predominantly cobbles and boulders, peat banking.
CAR Category:	Large
Catchment Area:	5.65 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, present
Crossing Type:	New crossing: Bridge



Not to Scale

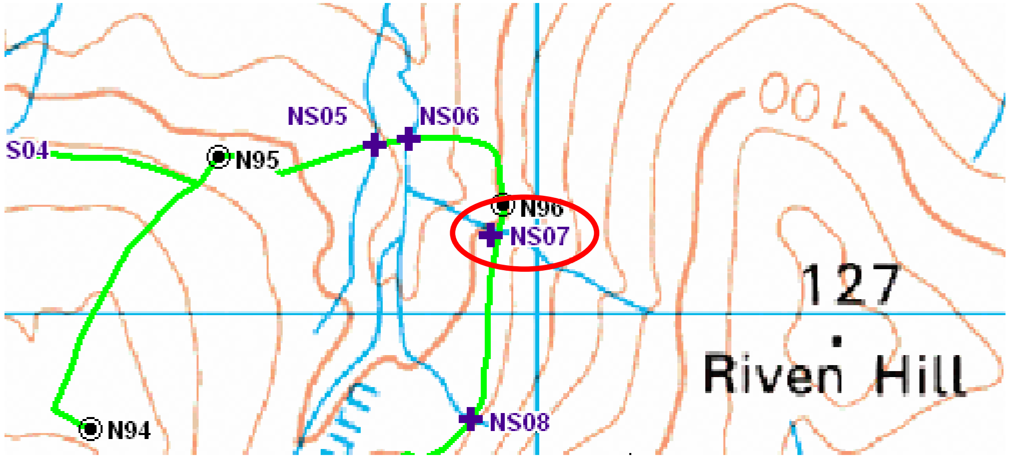
Looking across stream Viking NS06 across 1.jpg

Looking downstream Viking NS06 down.jpg

Looking upstream Viking NS06 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS07
Route:	Between N96 & N97
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Gossawater burn
NGR:	HU 43921 62142
Description:	Very shallow stream in shallow channel 1-2m wide by 0.2m deep. Almost no flow, area around stream very boggy. Vegetated peat bed and banks.
CAR Category:	Medium
Catchment Area:	0.07 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, unlikely
Crossing Type:	New crossing: Drainage layer and pipes



Not to Scale

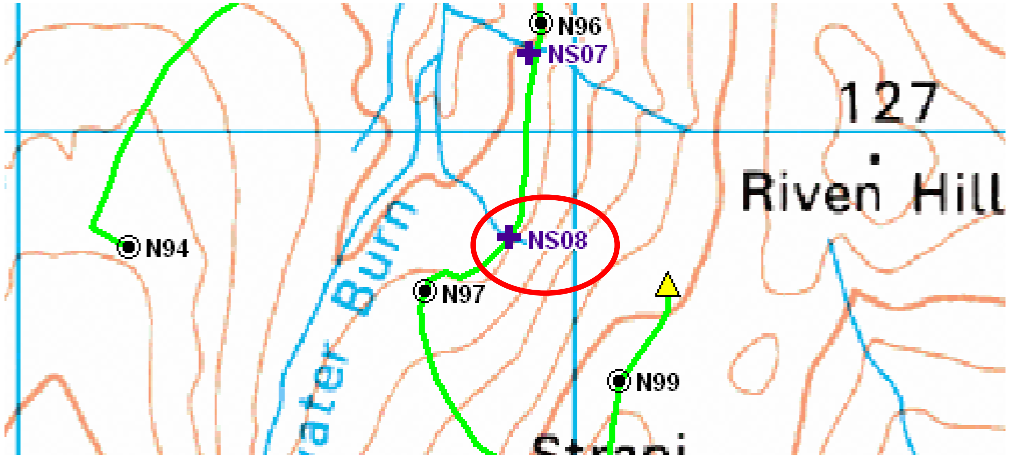
Looking across stream Viking NS07 across 2.jpg

Looking downstream Viking NS07 down.jpg

Looking upstream Viking NS07 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS08
Route:	Between N96 & N97
Catchment ID:	1
Watercourse:	Unnamed feeder burn to Gossawater Burn
NGR:	HU 43885 61810
Description:	Poorly defined stream, flush in places. Channel up to 1.5m wide and up to 0.5m deep. Water 0.05m deep with very little flow. Peat and vegetated bed.
CAR Category:	Medium
Catchment Area:	0.23 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Drainage layer and pipes.



Not to Scale

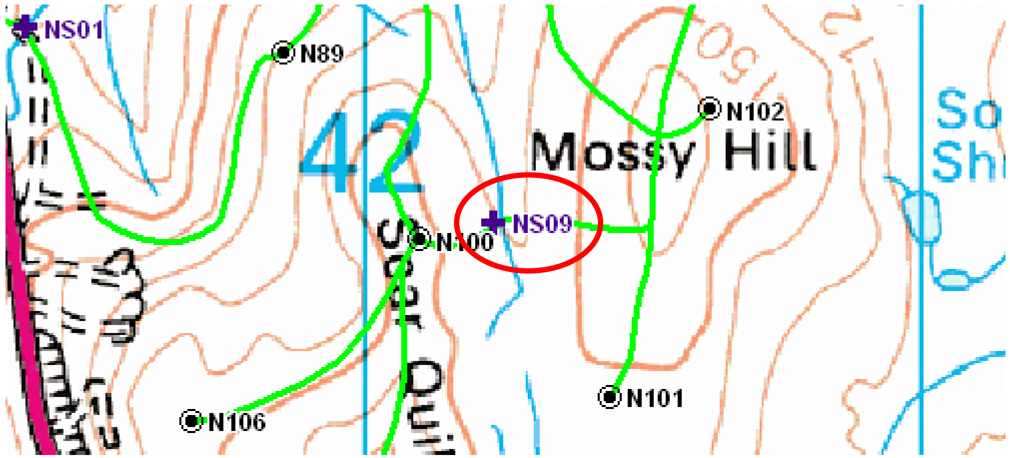
Looking across stream Viking NS08 across 2.jpg

Looking downstream Viking NS08 down.jpg

Looking upstream Viking NS08 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS09
Route:	Between N100, N101 & N102
Catchment ID:	1
Watercourse:	Easter Filla Burn
NGR:	HU 42231 60457
Description:	Broad medium burn in well-defined peat channel 2-4m wide and up to 4m high, water 0.2m deep. Flood channel up to 5m wide. Stony bed with peat banks.
CAR Category:	Medium
Catchment Area:	0.05 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



Not to Scale

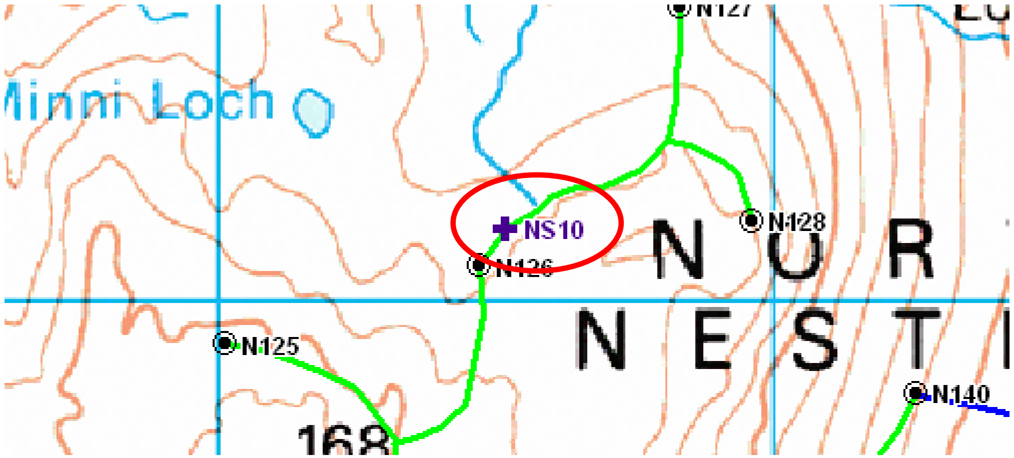

Looking across stream Viking NS09 across.jpg


Looking downstream Viking NS09 down.jpg


Looking upstream Viking NS09 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS10
Route:	Between N126 & N127
Catchment ID:	6
Watercourse:	Unnamed inflow burn to Quinni Loch
NGR:	HU 44517 59127
Description:	Small stream up to 0.5m wide by 2m deep, with a water depth of 0.05m. Flood channel 8m wide by 4m high. Medium sized stone bed and grass covered peat banks.
CAR Category:	Small
Catchment Area:	0.15 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

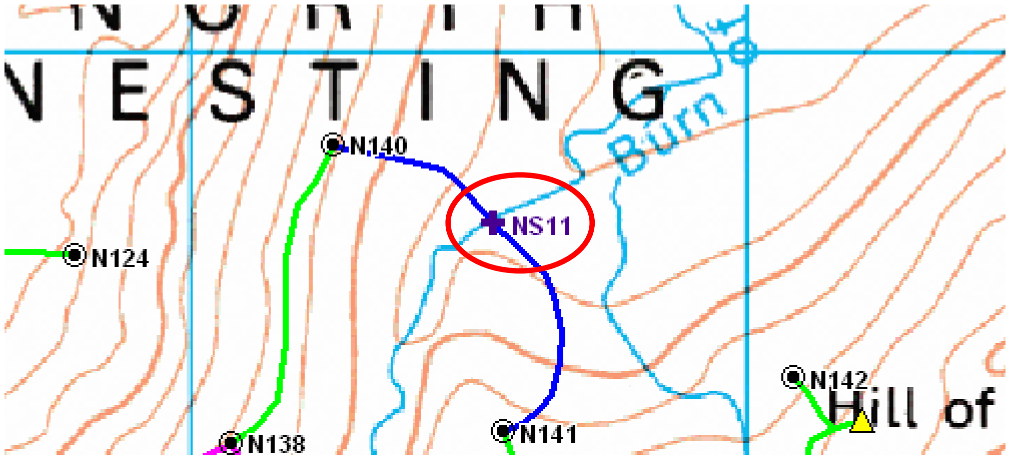

Looking across stream — Viking NS10 across 1.jpg


Looking downstream — Viking NS10 down.jpg


Looking upstream — Viking NS10 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS11
Route:	Site access track between N140 and N141
Catchment ID:	6
Watercourse:	Burn of Grunnafirth
NGR:	HU 45542 58690
Description:	Large well defined channel. Good fast flow. Channel 3m wide and 1m deep. Water depth 0.5m. Large rocks on bed
CAR Category:	Large
Catchment Area:	5.89 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, likely
Crossing Type:	New crossing: Bridge



Not to Scale

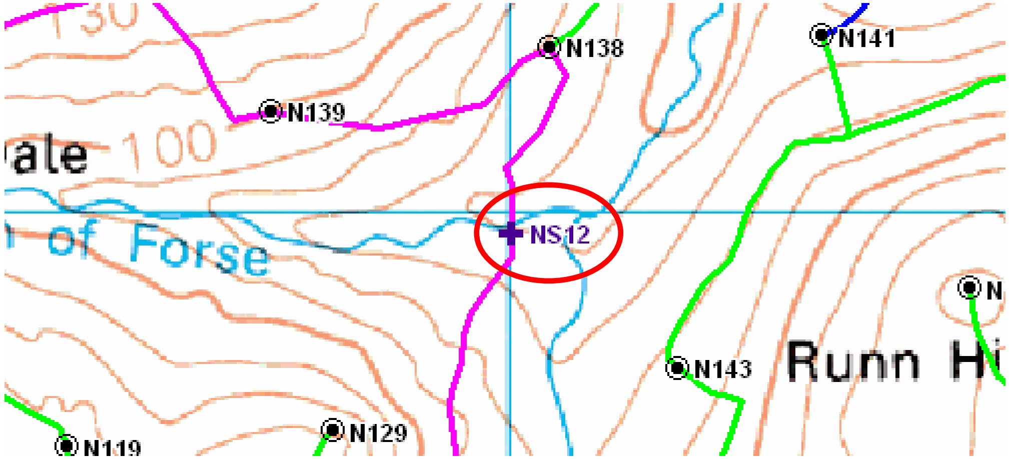
Looking across stream Viking NS11 across 2.jpg

Looking downstream Viking NS11 down.jpg

Looking upstream Viking NS11 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS12
Route:	Between N137 & N150
Catchment ID:	6
Watercourse:	Burn of Forse
NGR:	HU 45002 57960
Description:	Medium stream in well defined channel 3m wide by 1m deep. Water depth 0.5m. Predominantly cobble and pebble bed with some large boulders. No vegetation in channel. Peat banks slightly undercut. Exposed rock on banking.
CAR Category:	Large
Catchment Area:	3.95 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, possible
Crossing Type:	New crossing: Bridge



Not to Scale

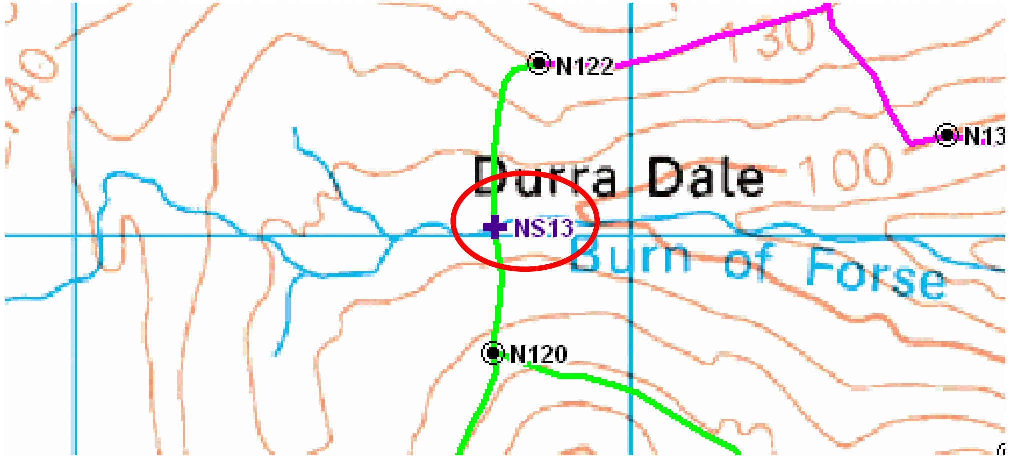
Looking across stream Viking NS12 across 1.jpg

Looking downstream Viking NS12 down.jpg

Looking upstream Viking NS12 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS13
Route:	Between N120 & N122
Catchment ID:	6
Watercourse:	Burn of Forse
NGR:	HU 43755 58013
Description:	Medium stream in channel 2-3m wide and 1-2m deep. Predominantly boulder, cobble and pebble bed. Water level 0.4m. Peat banking.
CAR Category:	Medium
Catchment Area:	2.41 km^2 (upstream of crossing location)
Ecology:	Migratory fish, present. Mammals, possible
Crossing Type:	New crossing: Rectangular culvert / arch with mammal passage.



 Not to Scale

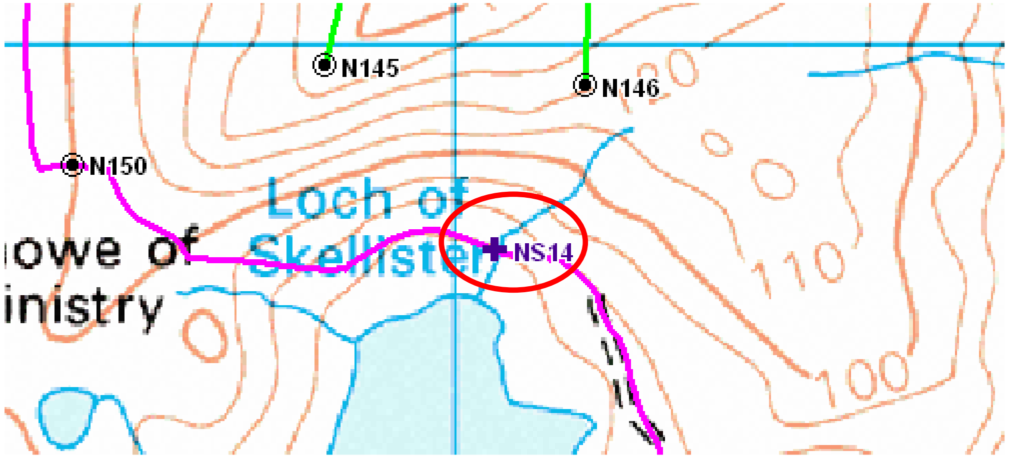
Looking across stream Viking NS13 across 1.jpg

Looking downstream Viking NS13 down.jpg

Looking upstream Viking NS13 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS14
Route:	Track between B9075 and N150
Catchment ID:	24
Watercourse:	Unnamed inflow burn into Loch of Skellister
NGR:	HU 46075 56627
Description:	Peat pipe with some overground flow. Channel 1m wide by 0.15m deep. Flood channel 11m wide by around 2.3m high. Vegetated peat bed and banking.
CAR Category:	Medium
Catchment Area:	0.14 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Circular culvert



Not to Scale

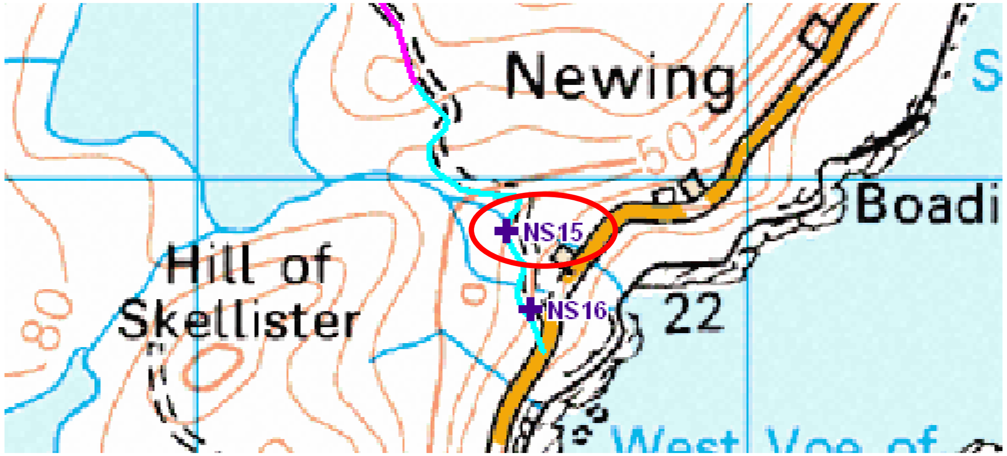
Looking across stream — Viking NS14 across 1.jpg

Looking downstream — Viking NS14 down.jpg

Looking upstream — Viking NS14 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS15
Route:	Site access track between B9075 and N150
Catchment ID:	24
Watercourse:	Unnamed inflow burn into Loch of Skellister
NGR:	HU 46566 55905
Description:	Well defined small stream. Estimated less than 1m wide by 0.5m deep. Flowing over bed rock
CAR Category:	Small
Catchment Area:	1.70 km^2 (upstream of crossing location)
Ecology:	Migratory fish, possible. Mammals, unlikely
Crossing Type:	Probably requiring upgrading of existing crossing: Rectangular culvert.



Not to Scale

No Photograph Available

Looking across stream — Viking NS15 across 1.jpg

Looking downstream — Viking NS15 down.jpg

Looking upstream — Viking NS15 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS16
Route:	Site access track between B9075 and N150
Catchment ID:	24
Watercourse:	Unamed ouflow from Loch of Skellister
NGR:	HU 46612 55763
Description:	Well defined small stream with good fast flow. 0.4-1m wide by 0.4m deep. Water depth of 0.2m flowing over bed rock. Large exposed bolders on banks. Culverted under existing B9075 road.
CAR Category:	Small
Catchment Area:	1.67 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, unlikely
Crossing Type:	Probably requiring upgrading of existing crossing: Rectangular culvert.

 Not to Scale

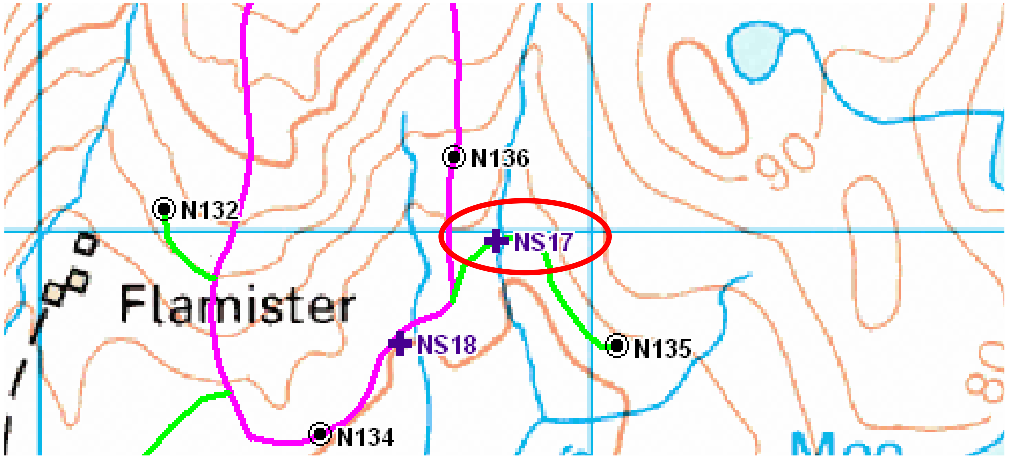

Looking across stream Viking NS16 across.jpg


Looking downstream Viking NS16 down.jpg


Looking upstream Viking NS16 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS17
Route:	Between N134 & N136
Catchment ID:	17
Watercourse:	Burn of Quoys
NGR:	HU 44831 55981
Description:	Small stream, with good flow, channel 0.7m wide by 0.5m deep. Water 0.2m deep. Coarse rocky bed, exposed rock and vegetation on banking.
CAR Category:	Small
Catchment Area:	0.73 km^2 (upstream of crossing location)
Ecology:	Migratory fish, likely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert / arch



Not to Scale

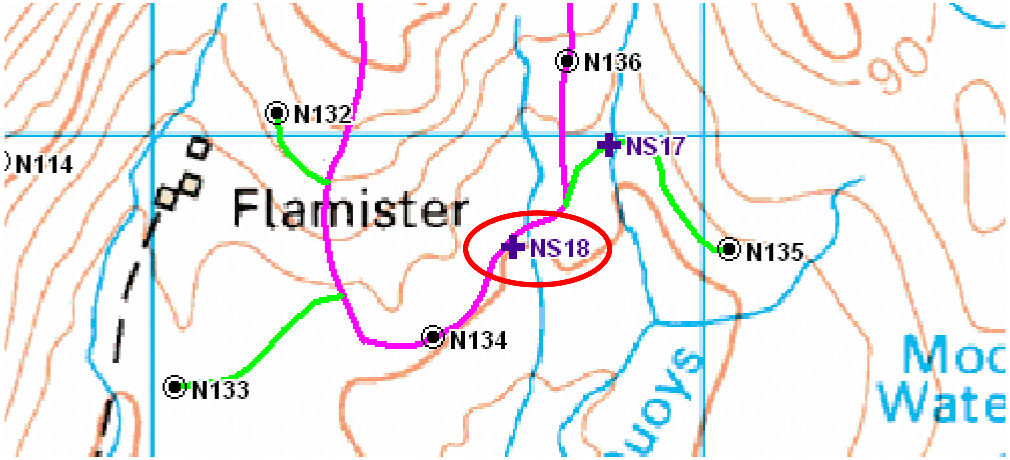
Looking across stream Viking NS17 across.jpg

Looking downstream Viking NS17 down.jpg

Looking upstream Viking NS17 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS18
Route:	Between N134 & N136
Catchment ID:	17
Watercourse:	Unamed tributary to Burn of Quoys
NGR:	HU 44654 55795
Description:	Shallow channel, poorly defined in places. Flow area ~0.2-2m wide in broad valley, water 0.2m depth. Vegetation predominantly grasses.
CAR Category:	Medium
Catchment Area:	0.29 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Drainage layer and pipes



 Not to Scale

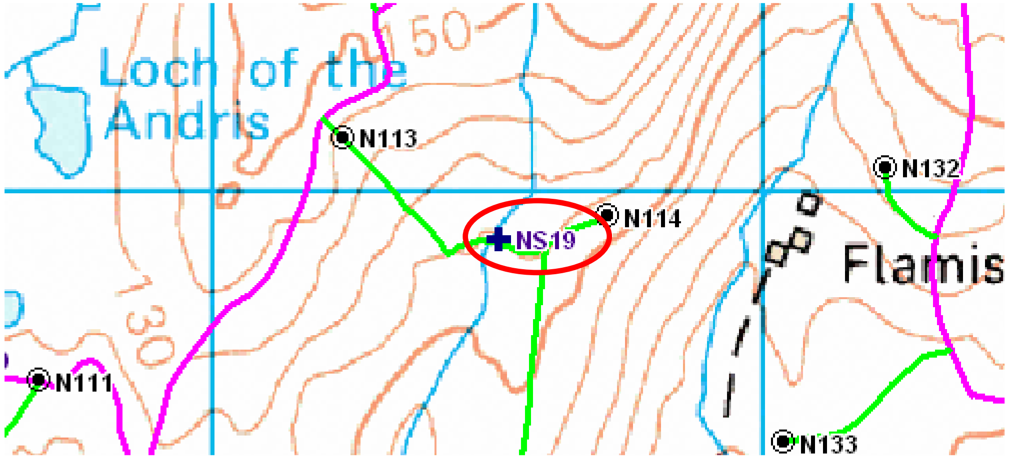
Looking across stream — Viking NS18 across.jpg

Looking downstream — Viking NS18 down.jpg

Looking upstream — Viking NS18 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS19
Route:	Between N113 & N114
Catchment ID:	7
Watercourse:	Gill Burn
NGR:	HU 43524 55909
Description:	Medium stream in 1-1.8m wide by 1.1m deep peat channel. Water level 0.2m deep with good flow. Rocky bed and vegetated peat banks.
CAR Category:	Medium
Catchment Area:	0.20 km^2 (upstream of crossing location)
Ecology:	Migratory fish, unlikely. Mammals, none
Crossing Type:	New crossing: Rectangular culvert



Not to Scale

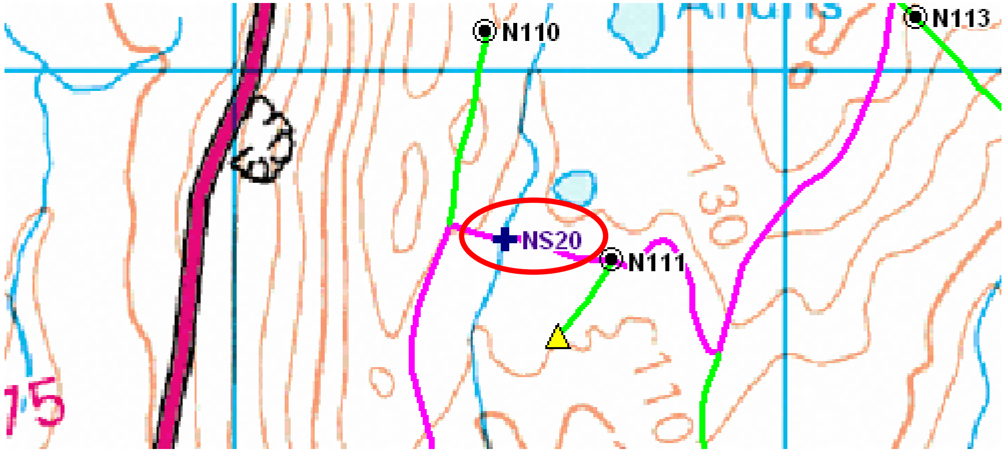

Looking across stream Viking NS19 across.jpg


Looking downstream Viking NS19 down.jpg


Looking upstream Viking NS19 up.jpg

Viking Wind Farm Survey of Stream Crossings

Crossing:	NS20
Route:	Between N110 & N111
Catchment ID:	7
Watercourse:	Burn of Crookdale
NGR:	HU 42494 55690
Description:	Poorly defined channel cut into peat. Up to 5m deep and 2-3m wide. Peaty bed with island areas of peat up to 1m above water level and some large boulders. Water level 0.05m. Peat banking.
CAR Category:	Medium
Catchment Area:	0.93 km^2 (upstream of crossing location)
Ecology:	Migratory fish, none. Mammals, none
Crossing Type:	New crossing: Multiple circular culverts



Not to Scale


Looking across stream Viking NS20 across.jpg


Looking downstream Viking NS20 down.jpg


Looking upstream Viking NS20 up.jpg

Appendix C

Table of Additional Watercourse Crossings

Table 5 Additional (non-CAR) Watercourse Crossing Details

ID	Grid reference	Watercourse type	Width (m)	Depth (m)	Crossing type	Comments
DX01	HU 3988 7004	Stream	1.0-2.0	0.7	Rectangular culvert	Wide and shallow
DX02	HU 3966 6923	Stream	0.6	0.6	Circular culvert	
DX03	HU 4280 7241	Flush	0.5-6	-	Drainage layer	
DX04	HU 4280 7241	Stream	1.2	0.5	Circular culvert	
DX05	HU 4217 7135	Flush	3	-	Drainage layer	
DX06	HU 4206 7130	Stream/Peat Pipe	2	-	Circular pipe	Peat Pipe
DX08	HU 3985 6937	Flush	2-6	-	Drainage layer	Boggy area
DX09	HU 3922 6740	Stream	1.1	1.1	Circular culvert	
DX10	HU 3680 6630	Stream	1.1	1.1	Existing crossing: circular culvert	Existing crossing
DX12	HU 4017 7142	Stream	0.6	0.7	Circular culvert	
DX13	HU 4002 7141	Stream	0.5-1	0.1	Circular culvert	
DX14	HU 3999 7141	Stream	0.4-0.9	1	Circular culvert	
DX15	HU 3955 7122	Stream	0.7	1.0	Circular culvert	
DX17	HU 4063 7225	Flush	6	-	Drainage layer	Boggy
DX18	HU 4236 7166	Wide Flush	Up to 8	-	Drainage layer and pipes	May not be apparent in the summer, braided channels and wetland
DX19	HU 4236 7166	Stream	0.3	0.1	Circular culvert	Not surveyed – see note[1]
CX01	HU 4297 6460	Stream	0.4	1.4	Circular culvert	Very shallow channel
CX02	HU 4223 6463	Stream	0.4	1.4	Circular culvert	
CX03	HU 4211 6516	Wide flush	8.0	-	Drainage layer & pipes	Confluence of 2 small streams, very wet area
CX04	HU 4219 6618	Stream	1.0-3.0	0.7	Circular culvert (multiple)	Top of stream, variable width and v. boggy
CX05	HU 4215 6616	Stream	0.5	0.7-1	Circular pipe	Peat pipes in places
CX06	HU 4272 6551	Stream	0.6-2.0	1.4	Circular pipe	Quite large peat pipe, downstream channel looks a bit collapsed in places
CX07	HU 4218 65520	Stream	0.5-1.0	1.0-1.5	Circular culvert	Probably Ephemeral – see note[*]
CX08	HU 4249 6629	Peat pipe	1.5-2	3	Circular pipe	Peat pipe
KX02	HU 4022 5680	Ditch	1.0-3.0	0.5	Circular culvert	Not surveyed – see note[2]
KX03	HU 4008 5657	Ditch	0.5-0.7	0.1	Circular culvert	Survey position was 60m W (upstream), due to late layout amendment, unlikely to influence crossing type.
KX04	HU 3986 5659	Ditch	0.5-0.7	0.1	Circular culvert	Not Surveyed – see note[3]
KX05	HU 3989 5639	Stream	0.3-0.5	0.5	Circular culvert	
KX06	HU 3998 5637	Stream	1	0.1	Circular culvert	
KX07	HU 3924 5904	Stream	0.5	0.1	Circular culvert	

ID	Grid reference	Watercourse type	Width (m)	Depth (m)	Crossing type	Comments
KX08	HU 3863 5815	Stream	1	0.1	Circular culvert	
KX10	HU 3860 5820	Stream	1	0.5	Circular culvert	
KX11	HU 3897 5880	Stream	0.5	0.2	Circular culvert	
KX12	HU 3808 5470	Flush	4	-	Circular culvert	Probably Ephemeral – see note*
KX13	HU 3853 5558	Flush	4	-	Drainage layer	
KX14	HU 3684 5597	Stream	1	0.5	Circular culvert	
KX15	HU 3719 5563	Stream	0.9	0.4	Circular culvert	Not Surveyed – see note[4]
KX16	HU 3716 5567	Stream	0.9	0.4	Circular culvert	Not Surveyed – see note[5]
NX04	HU 4168 6043	Stream	0.5-1	0.5	Circular culvert	
NX05	HU 4170 6043	Stream	0.6-1	0.2-1	Circular culvert	
NX07	HU 4517 5854	Stream	1.0	0.1-0.5	Circular culvert	Probably Ephemeral – see note*
NX08	HU 4245 5598	Stream	0.4-2	0.5-0.2	Circular culvert (multiple)	Very low flow through wide peat gully
NX09	HU 4518 5864	Stream	0.9	0.1-0.5	Circular culvert	Small stream in shallow channel
NX10	HU 4024 5565	Stream	0.3	0.2	Circular culvert	

Locations shown on Figure 14.3.SC03 (in Volume 4)

Notes

The additional crossings are not in sequential order and some have been removed due to layout amendment.

*Probably Ephemeral - these 3 streams were identified during the desk study of the 1:10,000 scale OS mapping but were not apparent at time of survey. It is likely that these streams are seasonal and therefore stream size has been extrapolated from survey information for nearby streams and a crossing type has been recommended accordingly.

[1] Unable to survey as a result of adverse weather, DX19 crosses (approximately 0.8km upstream) the same watercourse as DS03. Results from DS03 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[2] Unable to find in snow conditions. Results for KX02 have been estimated using information from KX03 (approximately 270m West) which crosses adjacent stream and from examination of the OS mapping looks similar in size and type. Note: a conservative estimate has been provided and the watercourse may be smaller.

[3] Unable to survey as a result of adverse weather, KX04 crosses (approximately 0.5km upstream) the same watercourse as KX03. Results from KX03 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[4] Unable to survey as a result of adverse weather, KX15 crosses (approximately 0.5km upstream) the same watercourse as KX14. Results from KX14 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.

[5] Unable to survey as a result of adverse weather, KX16 crosses (approximately 0.4km upstream) the same watercourse as KX14. Results from KX14 have been used to provide an estimate of the type and size of watercourse and the type of crossing that would be necessary. Note: a conservative estimate has been provided and the watercourse may be smaller.