9. VISUAL IMPACT

9.1 INTRODUCTION

9.1.1 General

This Chapter of the Environmental Statement (ES) addresses issues relating to the potential impacts upon the visual amenity of the study area likely to result from the proposals. The assessment has been undertaken by ASH design+assessment.

Included with this chapter at Section 9.9 is an assessment of shadow flicker effects. This part of the assessment has been carried out by Airtricity. Because it is a separate, but related, assessment, it is dealt with in a separate section at the end of this chapter.

9.1.2 Related Subjects

Landscape character and visual impact assessment, although closely related to one another, have been considered separately in this document for reasons of clarity and robustness. However, in line with best practice, cumulative landscape and visual impacts are assessed together, towards the end of this Chapter. Other related subjects include recreation and tourism, ecology and cultural heritage. Reference is made to these topics as part of the assessment. However, consideration of them here is limited to the extent to which they influence the visual amenity of the proposed development site and the wider area. Impacts and their effects that are specific to these topics are addressed in the relevant sections of the Environmental Statement:

- Landscape Character Assessment – Chapter 8
- Cumulative Landscape and Visual Assessment – Chapter 9, Section 9.7
- Ecology – Chapter 10
- Cultural Heritage – Chapter 13
- Recreation and Tourism – Chapter 19

9.1.3 Design Development

The design of the proposed development has undergone a series of iterations which have been informed by many different constraints and considerations, of which visibility and visual impact where important elements. See Chapter 3, Site Selection and Chapter 4, Development Description for more details.

9.2 SCOPE OF ASSESSMENT

9.2.1 Project Interactions

Development of a wind farm would introduce a number of large or extensive elements, including turbines and tracks, which would be present in the landscape, and which would be visible from outwith the site.

9.2.2 Study Area

The proposed site is located in the centre of mainland Shetland, approximately 15km north of Lerwick. The proposed development consists of four areas which originally comprised the proposed Muckla Moor Wind Farm and the smaller Viking Energy Limited (VEL) Wind Farm. The total study area for the landscape and visual topic at scoping was taken to be an area within 30km of the periphery of the wind farm. For the purposes of this assessment the periphery of the wind farm is taken as a line drawn around the outer turbines, rather than the planning application boundary.

The study area defined for the visual assessment in this chapter extends for 35km from the perimeter of the development site (i.e. from the outer turbines) in accordance with current Best Practice as set out in the guidelines by Scottish Natural Heritage (SNH)[1] and is shown on Figure 9.1.

The 35km study area corresponds to that used for the landscape character assessment detailed in Chapter 8. This allows for assessment of the visual relationship between the proposed development and the wider visual resource of the study area in terms of potential detriment to the value of the visual amenity.

9.2.3 Scoping and Consultation

The consultation responses to the scoping report of particular relevance to landscape character and visual impact are summarised in Table 9.1

Table 9.1 Landscape Character and Visual Impact Issues Raised During Scoping

Consultee	Response	Action
Scottish Government	The Scottish Government response summarised many of the comments received from their consultees and other bodies likely to be concerned by the proposed development. The following are the most relevant to the landscape and visual assessment: -Consideration of and reference to various Planning Policies, Guidance and Advice Notes and the Shetland Islands Development Plans is required. -The response also refers to various SNH guidance notes which should be taken into account.	A review of relevant planning policies and guidance is included in section 8.3 and taken into account in EIA methodology (sections 8.4 & 9.4)

[1] University of Newcastle (2002) Visual Assessment of Windfarms: Best Practice, Scottish Natural Heritage.

Consultee	Response	Action
Shetland Islands Council (SIC)	-The Council requires all interlinked elements of construction activity to be assessed together. -The impacts of tracks and borrow pits should be taken into account when determining impacts. -The effects of decommissioning should be assessed and restoration proposals should be outlined. -It is important to consider effects of the 4 quadrants at each property.	Taken into account in EIA methodology (sections 8.4 & 9.4)
	-The council states that locations of viewpoints have already been discussed.	Appendix 9.1 outlines the process of viewpoint selection. See Figure 9.2.1 for location of viewpoints and Appendix 9.2 for detailed visual assessment of each.
	-Direct and indirect effects of the proposals on all designated sites should be clearly set out.	Effects on designated sites have been addressed in section 8.5.5 & 8.6.3
	-Cumulative impact assessment to include the interconnector for the sub-sea link	Cumulative effects on all existing and proposed wind farms and the converter station have been addressed in section 9.8
Scottish Natural Heritage (SNH)	-The EIA should consider the impact of grid connection infrastructure directly associated with the proposed development. -The effects of the development on the landscape and visual amenity are a high priority for consideration in the EIA. -Construction impacts should be taken into consideration when assessing impacts.	Taken into account in EIA methodology (sections 8.4 & 9.4)
	-There are a number of properties listed in the Inventory of Gardens and Designed Landscape within the study area	Designed Landscapes reviewed in section 8.5.5
Royal Society for the Protection of Birds (RSPB)	-Tracks and borrow pits should be assessed as having likely significant effects on the landscape and crane pads and underground cables as having possible significant effects on the landscape. -Construction should be phased to avoid large scale disturbance across the site	Taken into consideration in the assessment
RFACFS (now Architecture & Design Scotland)	-Design issues are addressed at an early stage and that reference should be made to SPP1: The Planning System; 'Designing Places' – a statement for Scotland used as material consideration in determining planning applications; and 'A Policy on Architecture For Scotland' which recognises the importance and value of good design in the built environment. -The routing of tracks and design of control buildings should also be discussed and, unless the site boundaries are clearly defined by the landscape, the layout may relate to the landscape in a	Taken into consideration in the turbine and tracks layout design and in the assessment. See Chapter 4 for details of design development.

Consultee	Response	Action
	completely arbitrary way. -The wind farm location should be considered and determine whether it is a sensible location in relation to wind, access to the grid and the character of the landscape.	

9.2.4 Effects to be Assessed

Tables 9.2 and 9.3 present the potential effects identified in scoping and form the basis of this assessment.

Table 9.2 Potential Construction Effects - Landscape Character and Visual Impact

Construction Effects	Impact	Potential Effects on Receptors	Specific Receptor Identified in Scoping
Mobile plant operations; Borrow pit operations; Traffic; Cable-Laying; Construction Compounds	Presence of machinery in landscape and views; visible disturbance of vegetation; presence of trenches or compounds in landscape and views	Temporary effects on landscape character; Temporary effects on visual amenity	None

Possible secondary effects upon recreation and tourism within the study area were identified. These are reviewed in Chapter 19.

In light of the preliminary scoping and subsequent consultee responses the following potential issues have been assessed:

- The impact of the proposed turbines, associated structures and required access tracks on the visual amenity of the study area.

Table 9.3 Potential Ongoing (Operational) Effects - Landscape Character and Visual Impact

Ongoing Effects	Impact	Potential Effects on Receptors	Specific Receptor Identified in Scoping
Likely Significant Effects	Presence of turbines in landscape and views; Presence of tracks in landscape and views	Effect on landscape character; Effect on visual amenity	None
Possibly Significant Effects	Presence of sub-station/ control building in landscape views; Change of landform and landcover by borrow-pits	Effect on landscape character; Effect on visual amenity	None

Effects of Unknown Significance	Modification to Layout and appearance of public roads	Effect on landscape character; Effect on visual amenity	None

9.2.5 Effects Scoped Out of Assessment

Effects arising from the process of decommissioning have been scoped out since they are of a similar nature to construction issues, but of a smaller scale and shorter duration.

9.3 POLICY CONTEXT

Statutes and national planning policy make no direct provision for the protection or conservation of specific views. They are, however, an implicit part of the values and qualities recognised in broader landscape designations that seek to protect areas of high scenic quality. Policy with broad relation to landscape and visual issues has been outlined in Chapter 8, Landscape Character.

9.4 METHODOLOGY

9.4.1 Overview

The following paragraphs outline the method adopted for the visual impact assessment.

The assessment has been prepared with reference to the Guidelines for Landscape and Visual Impact Assessment (GLVIA), Second Edition, published by the Landscape Institute and the Institute of Environmental Assessment in 2002. The guidelines suggest that visual impacts should be assessed from a clear understanding of the development proposed and any related landscape mitigation measures. They call for an understanding of the visual form of the existing landscape, its quality and sensitivity to change taking into account the nature of the development. They further call for an evaluation of the sensitivity of potential visual receptors (viewers) and of the magnitude of change likely to result from the implementation and use of the development.

Reference has also been made to the following guidelines:

- Guidelines on the Environmental Impacts of Windfarms & Small-Scale Hydroelectric Schemes (SNH February 2001);
- Assessment of Cumulative Landscape & Visual Impacts Arising from Wind Farm Developments (SNH March 2002);
- Visual Assessment of Windfarms: Best Practice (prepared by University of Newcastle for SNH, 2002);
- Visual Representation of Windfarms Good Practice Guidance (SNH October 2006); and
- Basic Principles of Landscape and Visual Impact Assessment for Sponsors of Development (Shetland Islands Council, 2006).

The assessment has involved five key stages:

- Preliminary assessment and scoping;
- determination of the main areas where impacts would occur as a result of the location and orientation of the receptor, and establishment of the baseline conditions relating to the visual context of the study area and the location and sensitivity of potential visual receptors;
- evaluation of the potential impacts anticipated to result from the introduction of the development into the baseline context;
- assessment of the effects of the anticipated impacts based on magnitude and sensitivity to change taking into account mitigation measures related to site selection and site planning;
- description of the anticipated effects and their significance.

Appreciation of the baseline conditions, evaluation of the predicted impacts and assessment of effects related to predicted impacts have been undertaken in accordance with guidelines in GLVIA, taking cognisance of SNH recommendations.

9.4.2 Baseline Assessment

(a) **Desk Surveys**

The following specific desk-based tasks have been undertaken:

- Consultation with Scottish Natural Heritage and Shetland Islands Council regarding key views and viewing locations;
- identification of the Zone of Theoretical Visibility (visual envelope) for the proposed development;
- identification and field assessment of potential receptors within the visual envelope; and
- appreciation of the nature of existing views experienced by the identified receptors.

(b) **Field Survey Techniques**

An initial site appraisal of potential impacts upon visual amenity was carried out in September 2006 by a team of four qualified and experienced landscape architects. A further site appraisal was carried out in August 2008 to verify the initial appraisal. Site recording involved the completion of standardised recording forms and annotation of 1:50,000 Ordnance Survey plans, supported by a photographic record of views from key receptor locations.

9.4.3 Effects Evaluation

(a) **Identification of the Zone of Theoretical Visibility**

The Zone of Theoretical Visibility (ZTV) indicates those areas of land where the proposed wind farm might appear as part of a view. The ZTV provides a means of identifying

potential receptors (viewers) in order that impact assessments can be undertaken. The envelope is not representative of visual impact in itself nor does the presence of a receptor within the boundary indicate that the development would necessarily appear in views currently experienced by that receptor.

ZTVs have been prepared using the *Resoft Windfarm* (Version 4) programme that analyses a computer based model that has landform as the key determinant of availability or obstruction of view. The landform model is based on contours at 10m intervals derived from 1:50,000 Ordnance Survey Land-Form tiles.

As the proposals have developed, further ZTVs specific to the proposed development throughout the design stages have been generated. These ZTVs are based on the distance of 35km from the periphery of the development as required by SNH guidelines. Figure 9.1 shows a ZTV covering an area of 35km from the development periphery, with proposed turbines of 145m blade tip height. Colour coding was used to indicate where 1-37, 38-75, 76-112 and 113-150 turbines potentially could be visible.

(b) **Photomontages and Wireframes**

Figures 9.3.1 – 9.3.43 show panoramic views and/or wireframes from a series of viewpoints (previously agreed with SNH and Shetland Islands Council – See Appendix 9.2: Viewpoint Selection Criteria) looking towards the proposed development. Where photomontages are shown, these have been superimposed with the proposed turbines as viewed from that location, based on "wireframe" diagrams generated from "Resoft Windfarm" software. The photographs were taken from the stated grid reference using a digital camera at a focal length equivalent to a 50mm lens on a standard SLR camera. In line with current best practice, these are intended to be viewed from a distance of 300mm in order to replicate as closely as possible the view as seen from the viewpoint location.

(c) **Identification of Receptors**

For there to be a visual impact a viewer (receptor) is required. Receptors include people at residential properties, work places, recreational facilities and other outdoor sites used by the public, road users and pedestrians, who would be likely to experience a change in existing views as a result of the construction and operation of the proposed development.

The ZTV for the proposed development was reviewed to aid identification of potential receptors likely to be subject to impacts and these were then validated by site survey.

(d) **Appreciation of Existing Views**

This involved an initial desk based review of OS mapping to establish the wider context within which views initially appear to be set followed by site surveys to establish the form and nature of specific views and the role of the proposed development area in such views.

Site survey notes were recorded using a standardised checklist that included the following factors:

- Receptor type and number (for example dwelling, footpath, open space, school);
- existing view (composition and quality);
- distance of view;

- viewpoint position (e.g. elevated view looking down on the development or focussed view 'framing' the development);
- angle of view (oblique or face-on); and
- extent of view.

The evaluation involved the following tasks:

- Analysis of the sensitivity of receptors to the anticipated change in their view; and
- identification of the anticipated magnitude of change in existing views.

(e) **Receptor Sensitivity**

Sensitivity of a receptor to the proposed development considers the nature of the receptor; for example the inhabitants of a residential dwelling are generally considered more sensitive to change than workers in a factory unit. The importance of the view experienced by the receptor also contributes to an understanding of sensitivity to change; scenic quality and value of the view are therefore considered.

The sensitivity of a receptor depends on the nature of the receptor, and the importance to that receptor of the view being changed. In this assessment sensitivity is ranked as follows, adapted from GLVIA methodology:

High Sensitivity

- Dwellings where the changed landscape is an important element in the view; and
- walking routes, and vantage points where the changed landscape is an important element in the view.

Medium Sensitivity

- Dwellings where the changed landscape is a less important element in the view;
- walking routes and vantage points where the changed landscape is a less important element in the view;
- roads where the changed landscape is an important element in the view; and
- farm buildings not used as dwellings and industrial buildings where the changed landscape is an important element in the view.

Low Sensitivity

- Dwellings where the changed landscape is an unimportant element in the view;
- walking routes and vantage points where the changed landscape is an unimportant element in the view;
- roads where the changed landscape is a less important element in the view; and
- farm buildings not used as dwellings and industrial buildings where the changed landscape is a less important element in the view.

(f) **Magnitude of Change**

Magnitude of change considers the extent of development visible, the percentage of the existing view that would be occupied by the development, the influence of the development within the view and the viewing distance from the receptor to the development. This has involved a combination of site and desk-based analysis. On site, the percentage and elements of the development site potentially visible were recorded on the site survey sheets by the assessors. The analysis also involved the use of wireframe projections and draft photomontages to assist the assessors with the evaluation.

In the assessment of visual impact the magnitude of change is considered in terms of the type of change taking place in a view from a receptor and the degree of change which would take place in that view.

Magnitude of change is measured on the following scale, adapted from GLVIA methodology:

High Magnitude

Where the development would cause a significant change in the existing view.

Medium Magnitude

Where the development would cause a very noticeable change in the existing view.

Low Magnitude

Where the development would cause a noticeable change in the existing view.

Negligible

Where the development would cause no noticeable change in the existing view.

(g) **Assessment of Effects**

The main criteria used to evaluate visual impacts are centred on the extent to which the proposed development would modify established views. The assessment of effects is based on consideration of both sensitivity to change and magnitude of change taking into account mitigation measures associated with site selection and site planning.

Anticipated impacts are reported in terms of a descriptive scale ranging from substantial - moderate - slight adverse through negligible to an ascending scale of slight - moderate - substantial beneficial.

Taking these factors into account and using professional judgement, the final assessment adopts the following criteria to assess the level of visual impact:

Substantial Adverse (or Beneficial) Impact

Significant deterioration or improvement in the existing view.

Moderate Adverse (or Beneficial) Impact

Noticeable deterioration or improvement in the existing view.

Slight Adverse (or Beneficial) Impact

Barely noticeable deterioration or improvement in the existing view.

Negligible Impact

No discernable deterioration or improvement in the existing view.

All residential properties, public buildings, work spaces, recreational buildings, roads, walking routes and ferry routes within the study area potentially gaining a view of the proposals were assessed. The assessment has been made of the visual impacts which would occur as a result of the proposed development. The visual prominence of the turbines would vary according to weather conditions. Therefore the assessment has been carried out in accordance with best practice, by assuming the "worst case" scenario; that is, on a clear, bright day in winter, when visibility is unaffected by haze or foreground foliage. The assessment also takes into account changes in vehicle movement patterns and other proposal-related operations.

Finally the assessed effects relating to the various predicted impacts have been reviewed, taking into account primary mitigation measures, culminating in a statement of the predicted impacts and their significance on the existing visual context of the study area.

9.4.4 Limitations of Assessment

The Landscape Institute (2002) guidelines recommend that visual surveys should be carried out during both summer and winter months primarily to reflect the implications of the screening value of tree cover when deciduous species are in and out of leaf. In the case of this study there are few deciduous trees, except in sheltered locations, and consequently the worst-case situation has been adopted; that is, winter.

The assessment of visual effects has been undertaken from the nearest public road, footpath or open space to each property and assumptions have been made about the types of rooms, and about the types and importance of views obtained from these rooms. As the receptor is the occupier of the building, only buildings that are in use have been assessed. Derelict buildings or those considered to be unoccupied at the time of the survey were not assessed.

A blade-tip ZTV has been prepared and is shown on Figure 9.1. It shows those parts of the study area from where there may be views of the proposed development. The ZTV shows areas predicted to have views of the turbines based on bare ground analysis, i.e. the Ordnance Survey 1:50,000 digital terrain model, and shows areas from where any part of the turbines up to the 145m overall height may potentially be visible. The ZTV does not take into account local variations in topography, hedgerows, individual trees, walls or similar features, particularly those which are close to the viewpoint, that can alter the visual envelope locally. Therefore, while there is the potential to view the proposed development site from within the areas indicated, not all locations within the visual envelope would necessarily have a view of the proposed development. Nevertheless the

visual envelopes are valuable tools in both landscape character and visual impact assessment.

Photomontages are also a valuable tool in both landscape and visual assessment. A series of 43 viewpoints has been selected throughout the study area to represent a cross section of potential visibility of the proposals; See Appendix 9.2, Viewpoint Selection Criteria. These viewpoints include the larger settlements, main routes, important tourism and recreational locations and designated landscapes (including National Scenic Areas (NSAs) and Designed Landscapes). It was agreed with SNH and Shetland Islands Council Department of Planning that wireframe diagrams would be produced to demonstrate potential visibility of the proposed development from the more remote and distant locations.

9.5 VISUAL IMPACT BASELINE CONDITIONS

9.5.1 Overview

The baseline landscape and its broad visual context are described in Chapter 8, Landscape Character. Potential receptors have been identified through assessment of the ZTV for the proposed development (Figure 9.1). Potential visibility of these receptors has then been validated in the field.

In general, receptors within the study area would be residents of buildings and users of outdoor locations such as hilltops, walking routes and roads.

Receptor locations fall into the following categories:

- Those with distant views (15 km to 35 km from proposed development); and
- those with local views (15km or less from the proposed development).

9.5.2 Description of baseline conditions; potential views of proposed development

Exact locations of the viewpoints and receptors referred to below are shown on Figures 9.2.1 to 9.2.11.

(a) **Key Potential Distant Views (15 km to 35 km from development periphery)**

Views of the site from these potential receptors are distant and only possible under clear weather conditions.

Yell (north of Otterswick)

Receptors in this area are largely found along the coast and gain open panoramic views out across the sea. The majority of potential views are likely to be limited to south and west facing slopes and higher ground, primarily in locations without settlements. Properties in West Sandwick (viewpoint 24) would potentially obtain views of the proposals.

Unst (south)

Receptors in this area are very limited and are generally found along the coast, typically with open panoramic views out across the water. South-west facing slopes and some coastal areas, including Uyesound (viewpoint 20) and Belmont House (viewpoint 38) would potentially obtain views of the proposals.

Bluemull Sound Ferry (Yell – Unst – Fetlar)

Views of turbines are unlikely on the crossing between Yell and Unst and are likely to be limited to part of the journey to and from Fetlar.

Fetlar

The majority of receptors on Fetlar are found to the south, overlooking Wick of Tresta. Views tend to be open and panoramic, focussed across the bay and out to sea. Views of turbines are likely to be from south-west facing slopes and higher ground, predominantly in areas without settlement, but including Brough Lodge (viewpoint 37).

Out Skerries

The majority of receptors found on the Out Skerries are located around Skerries Bridge, which links the Islands of Bruray and Housay. Views from these receptors tend to be focussed across the inlets and out to sea. Views of turbines are likely to be limited to western parts of Housay, Grunay and Bruray, predominantly outwith the main settlement (viewpoint 26).

Whalsay (east of Skaw Voe)

Potential receptors within this area are limited to a small settlement, airfield and golf club. Views from these properties are generally elevated, open panoramas across the coast towards the sea to the north and south. Views of turbines are likely from some of this small area, except from a strip along the southern coast. There is very little settlement within this area.

Bressay (south of Leira Ness)

Potential receptors within this area of Bressay are generally found along the west coast and west facing slopes. Views are typically open and widespread, looking across the Sound of Bressay towards mainland Shetland. Views of turbines are limited to the north-west facing slopes, on which the majority of the settlements within this area are located, including Kirkabister Ness Lighthouse (viewpoint 31).

Isle of Noss

Potential receptors on the Isle of Noss are limited to a visitor centre and coastal footpaths. However, views are likely to be limited to the north coast and high points such as the Noup of Noss (viewpoint 4).

Mousa and Northlink Ferry

Potential receptors on Mousa are limited to coastal footpaths and the Broch of Mousa (the main attraction on the Island). The focus of views tends to be along the coast and back towards mainland Shetland. Views from the ferry are generally to the sides and rear with forward views limited. Views of turbines are likely to be limited to the northern coast and north facing slopes. Views of the proposals are unlikely to the south of Mid Field, including from the Broch of Mousa (viewpoint 32). Views from the Northlink Ferry (Aberdeen – Kirkwall – Lerwick) (viewpoint 30) are likely.

South Mainland Shetland (south of Brindister)

The majority of potential receptors in this area are found along the coast, and as such views tend to be open, panoramas out towards the sea or along the coast. Views of turbines are likely to be limited to higher ground, such as the Clift Hills and some coastal areas, particularly to the west. The majority of settlement in this area is found in the east and with only small areas gaining potential views of turbines, such as from viewpoint 27, settled areas are unlikely to be affected by the proposed development.

Burra and southern Trondra

Potential receptors tend to be found along the coast forming and therefore receive generally open views across the Sounds and Voes or out to sea. Views of turbines are likely to be limited to the north facing coast and slopes and higher ground, including the main settlement of Hamnavoe (viewpoint 21).

West Mainland Shetland (west of Stourbrough Hill/ Mid Walls)

Potential receptors in this area are predominantly limited to two areas, at Melby to the north and Mid Walls to the south. Both of these receptor clusters are close to the coast and as such views tend to be focused towards the sea. Views from some receptors are limited by the undulating nature of the landscape. Views of turbines are likely to be limited to the east and north-east facing slopes and higher ground. Visibility of the proposed wind farm is likely to be patchy due to the undulating nature of the ground in this area.

Papa Stour

The majority of potential receptors on Papa Stour are located to the eastern coast. Views from these tend to be open, panoramic and focused across the Sound of Papa towards mainland Shetland. Views of turbines are likely to be limited to east facing coast and slopes and higher ground. Views are also likely from the passenger ferry which runs between Papa Stour (viewpoint 16) and West Burrafirth on mainland Shetland.

North Mainland Shetland (Esha Ness and north of Ronas Hill)

Potential receptors within this area tend to be found along the south coast of Esha Ness and the east coast of North Roe. Views tend to be open, panoramic and focused out to sea or across Yell Sound. Views of turbines are likely to be limited to south and south-east facing slopes and higher ground and predominantly in areas without settlement, including

parts of the Esha Ness NSA (viewpoint 36) and the Uyea Isle and Fethaland NSA (viewpoint 35).

(b) **Key Potential Local Views (15 km or less from development periphery)**

Yell (south of Otterswick)

Like the northern area of Yell potential receptors in this area are also limited to coastal areas, particularly in the south. Views therefore tend to be open and panoramic, orientated towards the sea. Views of turbines from this area would be relatively widespread, increasing with elevation. The main settlements in this area are found along the southern coast and include Burravoe (viewpoint 19). The ferry connecting Yell to mainland Shetland is also within this area and is likely to gain views of the proposals.

Lunna Ness and Lunnasting

The majority of potential receptors in this area are found around Vidlin Voe with a handful of other receptors along the coast of Lunna Ness. Views are generally focused across the voe and to the rolling hills beyond. Views of turbines are likely to be widespread with the exception of east facing slopes. Views are likely from Vidlin (viewpoint 15), the main settlement of the area, and from Lunna House (viewpoint 6).

Whalsay (west of Skaw Voe)

The majority of potential receptors on Whalsay are located along the west coast, although there are also a small number on the south east coast. Views tend to be slightly elevated and therefore wide panoramas, looking across Linga Sound towards mainland Shetland. Views of turbines are likely to be widespread with the exception of east facing slopes and much of the south-east coast. Much of the main settlement of Symbister (viewpoint 17) is likely to gain views of the proposals, as are passengers on the ferry connecting to Laxo and Vidlin on mainland Shetland.

Bressay (north of Leira Ness)

The majority of potential receptors are located along the western coast although there are a small number further inland. Views of turbines are likely from much of this area with the exception of south-east facing slopes and low lying areas. Many of the properties within this area, including Gardie House (viewpoint 42), are unlikely to gain important views of the proposals.

South Mainland Shetland (Hellister/Wadbister to northern Trondra and Gulberwick)

Potential receptors in this area are fairly widespread, with the majority being found along the coast and along the Tingwall valley. This area includes Lerwick and Scalloway, two of the largest population centres in Shetland. Views from the coastal receptors tend to be focused across the voes and sounds and out to sea. The inland receptors, generally found along the wider valleys, tend to have more limited views across the valley or distant framed views along the valley floor. Views from the larger settlements are variable with properties along the fringe often gaining open extensive views, and other properties

receiving more restricted and limited views. Views of turbines are likely to be limited to north-west facing slopes and higher ground (viewpoint 10 – Scord of Scalloway and viewpoint 33 - Wormadale Hill), although it is likely to be more widespread in areas closer to the proposals. Views of turbines from the main settlements of Lerwick (viewpoint 8 – Knab Road and viewpoint 9 – North Ness) and Scalloway are likely to be relatively limited. There are also likely to be limited views of the proposals from the tourist destination of Law Ting Holm (viewpoint 7).

Western Mainland Shetland (Bixter to Stourbrough Hill/Mid Walls)

Potential visual receptors within this area are scattered, with the larger settlement clusters located on the coast. Views from coastal receptors tend to be open panoramas focused out to sea. Due to the undulating nature of the landscape views from inland receptors tend to be fairly limited. The majority of receptors are located to the south and north of this area with few in the central inland section. Views of turbines in this area are likely to be concentrated on the east and north-east facing slopes and higher ground. Visibility is likely to be limited from Walls, Bixter and Twatt, which are the main settlements in this area. Views of turbines from the A971 (viewpoint 13), which bisects this area, are likely. However, these may be sporadic and dependant on the direction of travel.

Northern Mainland Shetland (Northmavine; Isbister to Mavis Grind and Hillswick; Muckle Roe and Brae)

Potential receptors in this area are generally located along the coast, with occasional properties along the valleys extending inland. Views are predominantly open and extensive and focused across the voes and along the coast. The majority of potential receptors, with the exception of properties in Brae centre are located on the east facing coast with views across the voes towards the central mainland. Views of turbines are likely to be limited to south-east and east facing coast and slopes and higher ground such as Ronas Hill (viewpoint 5). Views of turbines are likely from the settlements of Hillswick (viewpoint 23), Ollaberry (viewpoint 25) and Brae (viewpoint 22 & viewpoint 39) and also the tourist destination of Mavis Grind (viewpoint 34).

Central Mainland Shetland (Voe/Laxo to Sullom Voe)

Potential receptors in this area are generally found along the coast with additional receptors located along the steep sided valley running between Voe and Dales Voe. The coastal views tend to be open and panoramic, looking across voes and out to sea or framed along voes by steeply sloping sides. Other views are along the Voe / Dales Voe valley. Views of turbines within this area are likely to be widespread, with the exception of some north-east and north-west facing slopes. Views are likely from the main settlements within this area including from Voe (viewpoint 40) and Mossbank (viewpoint 18) and from the main routes (viewpoint 14 – Loch of Voe, viewpoint 29 – Scatsta and viewpoint 41 – Laxo).

Central Mainland Shetland (east of A970 - North and South Nesting)

The majority of potential receptors within this area are found along or near to the coast with very few inland receptors. Views tend to be focused towards the sea. Inland views

are often more restricted by the rolling nature of the landscape. Much of this area is within the wind farm area and therefore views of turbines are likely to be widespread, with the exception of a small number of east and south-east facing slopes. The main settlement areas are at Laxfirth (viewpoint 11) and Benston/Garth/Sellister (viewpoint 12).

Central Mainland Shetland (west of A970 – Mid Kame/Weisdale to Aith/Bixter)

Potential receptors are largely located along the coast, although there are clusters of settlement in the larger valleys at Weisdale and Cuckron. Coastal views tend to be open and widespread, looking across the voes and towards the central or western mainland. Views from Weisdale and Cuckron tend to be framed by the steep valley sides and therefore focused towards the Kames to the north and the coast to the south. As above, a large part of this area is within the development periphery and therefore views of turbines are likely to be widespread. Views are likely from the main settlements of Aith (viewpoint 2) and Kalliness/Weisdale (viewpoint 3), from the main transport routes (viewpoint 28 – A970 north of Petta Water and viewpoint 43 – A971 at Heglibister) and the tourist destination of Burn of Lunklet (viewpoint 1).

9.6 MITIGATION

9.6.1 Introduction

Primary mitigation of potential landscape and visual impacts involved the implementation of a combination of planning and design principles targeted at preventing or reducing predicted impacts. This involved input into the layout design in order to attempt to reduce potential impacts from building receptors and other visually sensitive areas, such as the National Scenic Areas and designed landscapes and is described in more detail in Chapter 4 and Appendix 4.7. See also Chapter 10 for details of ecological mitigation measures.

9.6.2 Principles of Mitigation as Applied to the Scheme

There are three main principles of mitigation which have been applied to this scheme are *Prevention, Reduction* and *Offsetting* as described below:

- Prevention – Primary mitigation, by the prevention of adverse impacts at source, in this case through layout design. (see Chapter 4)
- Reduction – Primary mitigation, by the reduction of those adverse impacts which cannot be eliminated through prevention, in this case by detailed layout design. (see Chapter 4)
- Offsetting– Secondary mitigation, by the provision of alternative or compensatory measures where appropriate and feasible. (see potential landscape planting proposals below)

9.6.3 Mitigation

Prior to photographic rendering, wireframes were used to guide the design of the wind farm from important viewpoints in order to minimise visual impact, for example by

avoiding "bunching" of turbines and moving outlying turbines inwards to create a more evenly distributed and homogenous grouping. This process has been described in more detail in Chapter 4 and Appendix 4.7.

It is also the intention to implement in due course, dependant on the permission and co-operation of local landowners, crofters and tenants, a strategy of landscape management and planting/ habitat creation in order to help offset potential impacts.

It is important to note, however, that potential sites for these have yet to be agreed and consequently any mitigation of potential landscape and visual impacts by offsetting of this nature has not been taken account of in the assessment process in this ES.

Due to the prevailing climatic conditions all planting groups would be situated below 50m AOD in generally south-facing, sheltered locations.

Three different types of planting would be envisaged to perform specific mitigation roles, and these are described below:

(a) **Woodland Screen Planting**

Woodland screen planting consists of a mix of native woodland species and non native, faster growing 'nurse species'. Non- native species would be specifically chosen for their ability to grow in harsh northerly climates therefore helping to more quickly establish a woodland screen (within a period of ten to fifteen years) while providing a more desirable microclimate for the native species to establish. The primary initial role of this type of planting would be to provide a degree of localised screening of the proposed development therefore reducing potential visual impacts.

(b) **Native Woodland Planting**

Native woodland planting would consist of a mix of native tree and scrub species and would primarily be used to improve the scenic quality of a landscape while providing habitat opportunities and screening in the longer term. This planting type would generally be associated with settlements and existing blocks of woodland.

(c) **Native Scrub Planting**

Native scrub planting would consist of a mix of native species and would primarily be used to provide additional habitat opportunities, particularly along watercourses.

9.7 EFFECTS EVALUATION

9.7.1 Basis of assessment

(a) **Development Characteristics**

The key elements and characteristics of the proposed wind farm development which may give rise to visual impacts are described in Chapter 4.

(b) **Assessment of Impacts on Visual Amenity**

This section assesses the visual impact of the proposed scheme by determining the degree of anticipated change in the visual amenity of people using buildings and areas of public open space and routes that would occur as a result of the proposed development. Figure 9.1 shows the blade-tip ZTV for the proposed development and Figures 9.3.1 - 9.3.43 show wireframes and photomontages from selected agreed viewpoints. The assessment of visual effects is presented in Appendix 9.1, summarised in Table 9.4 and illustrated on Figures 9.2.1 to 9.2.12. Note that walking routes and viewpoints are counted as one receptor each and each section of the road and ferry routes receiving different impacts are also counted as one receptor each. *Impacts of moderate and above are considered to be significant* and in this instance, all significant impacts are adverse. The assessment of impacts on buildings, outdoor sites, routes and viewpoints was made on the basis of the proposed scheme and scheme components as described in Chapter 4.

9.7.2 Views from viewpoints and receptors

Exact locations of the viewpoints and receptors referred to below are shown on Figures 9.2.1 to 9.2.11 inclusive.

(a) **Distant Viewpoints and Receptors (15 km to 35 km from development periphery)**

Although views of the development from receptors beyond 15km would be possible these generally would not result in significant impacts. Where views from receptors beyond 15km are possible, the proposals would appear as only a small part of the overall view. Therefore the magnitude of change to the view caused by the wind farm is low, which in turn generally leads to a reduced impact. That said, however, there are a small number of building receptors (viewpoints 66, 67 and 192), one viewpoint receptor (viewpoint 36) outwith 15km which have been assessed as receiving Moderate impacts. Receptors 66 and 67 and viewpoint 36 are located in Esha Ness and have elevated views over the coast, Receptor 192 is located on Papa Stour and has slightly elevated views across sound of Papa towards mainland Shetland. The proposed development would be central to these views and as it is being viewed side on, along its longer north to south axis, it would appear in a larger part of the overall view.

(b) **Local Viewpoints and Receptors (15km or less from development periphery)**

Yell (south of Otterswick)

Views of turbines in this area would be relatively widespread. However, settlement is restricted to around the coast with inland areas being uninhabited moorland. There are a number of receptors within this area that would receive significant impacts. These tend to be south facing and elevated with panoramic views over Yell Sound towards the mainland. In addition the Yell ferry route would receive significant impacts.

Lunna Ness and Lunnasting

Visibility of the proposed development in this area would be widespread, with the exception of east facing slopes. The elevated parts of Vidlin, the largest settlement in this

area, would be likely to receive significant impacts. In addition, one walking route would receive significant impacts.

Whalsay (west of Skaw Voe)

Visibility of the proposed development in this area would be widespread, with the exception of east facing slopes and much of the south east coast. The centre of Symbister, which is the main settlement on Whalsay, is not likely to receive significant impacts as a result of the proposed development. However, significant impacts are generally likely on the outskirts of the settlement and hamlets, such as Brough and Cready Knowe, where receptors are elevated with panoramic views over the sea westwards towards mainland Shetland. In addition, one viewpoint and the Whalsay ferry route would both receive substantial impacts.

Bressay (north of Leira Ness)

Potential visibility of the proposed development would be relatively widespread. However those receiving significant impacts are limited to two receptor groups on the north coast of the island, due to their northerly orientation. All other receptors within this area, including viewpoint 42, one walking route and the Lerwick to Bressay ferry route, would receive lesser, and therefore not significant, impacts.

South Mainland Shetland (Hellister/Wadbister to northern Trondra and Gulberwick)

Views of turbines from this area would be generally limited to north-west facing slopes and higher ground, although more widespread in the north of this area which is nearer to the wind farm. Visibility from the main settlements of Lerwick and Scalloway is very limited and distant. As a result a majority of building or outdoor site receptors or receptor groups in this area in addition to five routeway receptors and five viewpoint receptors would not receive significant impacts.

Western Mainland Shetland (Bixter to Stourbrough Hill/Mid Walls)

Potential visibility of the proposed development from this area would be generally limited to the east and north facing slopes and higher ground and a small number of receptors at the extreme east of this area, close to the proposals. Visibility from the main settlements is limited. Consequently a majority of receptors or receptor groups in this area, including two route receptors, would be unlikely to receive significant impacts. In addition to this there are a large number of receptors that would receive no views at all of the proposed development.

Northern Mainland Shetland (Northmavine; Isbister to Mavis Grind and Hillswick; Muckle Roe and Brae)

Potential views of the proposed development in Northmavine would be limited to south east and east facing slopes and the east-facing coast (especially between Sullom and Ollaberry) and also from higher ground. The main settlements of this area are all located in areas which would be able to see the proposed wind farm and a number of these would receive significant impacts. However, some of these receptors would have reduced

sensitivity to the proposals as a result of foreground views of Sullom Voe Oil Terminal, Scatsta Airfield and Sella Ness industrial area and where relevant this is reflected in the assessment. Most of the route receptors have limited views to the proposals and impacts for these are generally, therefore, not significant. However there would be some limited significant impacts on elevated south-facing receptors above Hillswick, on account of the open panoramic views to the proposals across St. Magnus Bay. There would also be significant impacts upon receptors on the east side of Muckle Roe and the more elevated parts of the west side of Brae, all of which would have open and elevated east-facing views to the proposals across Buster Voe.

Central Mainland Shetland (Voe/Laxo to Sullom Voe)

Much of this area is within the development periphery and therefore visibility of the development would be widespread. That said, however, there are relatively few building receptors within this area beyond the main settlements of Voe and Mossbank, the majority of which are unlikely to receive significant impacts due to the layout design which has taken advantage of the foreground screening effects of the steeper valley sideslopes. However those elevated peripheral areas and smaller outlying settlements such as Laxo and individual crofts and farms not having foreground topographic screening would be likely to experience significant impacts. All the route receptors and viewpoint receptors in this area would also receive significant impacts.

Central Mainland Shetland (east of A970 - North and South Nesting)

As above much of this area is within the development periphery, visibility of the development would be widespread. Settlement within this area is relatively sparse and is generally concentrated along the coast. Just over half the building receptors or receptor groups in this area would receive significant impacts and all the route receptors and viewpoint receptors in this area would also receive significant impacts.

Central Mainland Shetland (west of A970 – Mid Kame/Weisdale to Aith/Bixter)

As with the two areas above much of this area is within the development periphery and therefore visibility of the development would be widespread. Settlement is largely restricted to Aith and the Weisdale Valley. Just over half of the building receptors or receptor groups in this area would receive significant impacts and all the route receptors and viewpoint receptors in this area would also receive significant impacts.

Table 9.4 Summary of Visual Impacts

Receptors	Construction				Operation			
	Significant			Not Significant	Significant			Not Significant
	Substantial	Moderate/ Substantial	Moderate	Negligible to Slight/ Moderate	Substantial	Moderate/ Substantial	Moderate	Negligible to Slight/ Moderate
Viewpoints	8	9	4	22	8	9	3	23
Buildings/	460	210	295	2525	460	209	270	2551

Outdoor								
Roads (including National Cycle Routes, the North Sea Cycle Route and local cycle routes)	2	5	4	17	2	4	5	17
Ferries	1	2	1	4	1	2	1	4
Walking Routes	1	1	2	16	1	1	2	16
Total	**472**	**227**	**306**	**2584**	**472**	**225**	**281**	**2611**

9.7.3 Conclusions; Significant Effects upon Visual Amenity of the Study Area

Table 9.4 provides a summary of the predicted visual impacts associated with the proposed development. The summary table indicates that out of a total of 3589 receptors or receptor groups assessed, 21 viewpoint receptors, 965 buildings or outdoor receptors or receptor groups, 11 road routes, 4 ferry routes and 4 walking routes are predicted to receive significant visual impacts as a result of construction of the proposed development. This would reduce to 20 viewpoint receptors, 939 buildings or outdoor receptors or receptor groups during the operation of the proposed development, with 11 road routes, 4 ferry routes and 4 walking routes remaining unaltered.

The ZTV for the study area (Figure 9.1), confirmed by field survey, indicates that the majority of locations where significant visual impacts would occur are within 15km of the development periphery. As far as possible the development has been designed to minimise impacts on building receptors and receptor groups.

In general, settlement throughout Shetland is located along the coast with views from properties largely focused out over the water. The coastline is defined by a series of voes and inlets, often penetrating into the centre of the landmass. As a result these views tend to be open and panoramic but with no consistent direction of focus. This results in a more scattered pattern of levels of impacts with those facing the development more likely to receive significant impacts. The settlements of Aith and Brae are good examples of this, with properties on the east side of the voe, (and therefore west facing), receiving only slight or negligible impacts and properties on the west side of the voe, (therefore east facing), receiving moderate or substantial impacts.

That said however, there are some large areas where the nature of the topography and landform restrict visibility and therefore lessen potential visual impacts. The largest and most significant of these areas are the west mainland (west of Bixter) and the south mainland (south of Gott/Tingwall). The west mainland landscape consists of a series of broad rounded hummocks, rocky outcrops and lochs. This results in relatively restricted views, particularly from low lying areas, where most settlement is located. The south mainland landscape is dominated by a series of north-east to south-west trending ridges which would restrict views towards the proposed development, particularly from south east facing slopes and low lying areas, where most settlement is located.

Routes in Shetland follow a similar pattern to the settlements, with the majority following the coastline. The main views are therefore along the coast and across the voes and sounds resulting in panoramic views but with no consistent direction. As with the settlements this results in a more scattered pattern of levels of impacts, with those orientated towards the development more likely to receive significant impacts. The main exception, however, is the main north-south arterial road (A970) which tends to take a more direct route, along

the centre of the island and through the centre of the proposed development. Inland routes tend to follow valley floors and therefore views from these are generally enclosed and focused along the valley, which results in the level of impact being more defined by landform and direction of travel. The majority of significant visual impacts on roads would be from within 5km of the development periphery. As might be expected, the greatest level of impact would be received by the A970 and B9071 as they pass through the centre of the development. The main cycle routes (National Cycle Route 1 and the North Sea Cycle route) are along the main roads and therefore have not been assessed separately.

Views from ferries tend to be low level, open panoramas of attractive coastal landscapes and therefore more visually sensitive and so, depending on magnitude of change, these would tend to receive greater impacts than road receptors. Significant impacts on ferry routes would generally be limited to those within 15km of the development periphery, with the highest level of impact being received by those within 10km of the proposed development.

There are few waymarked footpaths in Shetland. However a number of walking routes are promoted by Visit Shetland and these have been considered in this assessment. The majority of these routes are along the tops of the dramatic sea cliffs and voes. As with the ferry routes, views from walking routes tend to be of attractive coastal landscapes and so, depending on the magnitude of change, would tend to experience greater impacts than road receptors. That said however, the panoramic nature of the views result in the proposals appearing in a smaller proportion of the view and therefore the magnitude of change is often reduced because of this. Significant impacts on walking routes would generally be limited to those within 10km of the development periphery, with the highest levels of impact being experienced from those within 2km.

In conclusion, the majority of significant effects upon the visual amenity of Shetland would occur within 15km of the periphery of the proposed Viking Wind Farm. These would generally be located in the central and northern mainland and parts of Yell and Whalsay, where views are orientated towards the proposed development.

9.8 CUMULATIVE LANDSCAPE AND VISUAL IMPACT

9.8.1 General Approach

To date the Landscape Institute has not approved or endorsed any published guidelines that define a methodology for the assessment of cumulative effects of wind farm developments upon landscape and visual amenity. The approach adopted for this assessment is therefore founded upon the core principles laid out in Guidelines for Landscape and Visual Impact Assessment (GLVIA), Second Edition, published by the Landscape Institute and the Institute of Environmental Assessment in 2002.

In addition to the GLVIA, reference has been made to the following “best practice” guidelines in order to modify and enhance this core methodology:

- Cumulative Effects of Wind Turbines: A Guide to Assessing the Cumulative Effects of Wind Energy Development (Energy Technology Support Unit, 2000) (CEWT);

- Cumulative Effects of Wind Farms, Version 2 (SNH, 2005) (CEW); and
- Guidelines on the Environmental Impacts of Windfarms & Small-Scale Hydroelectric Schemes (SNH February 2001) (GEIW).

9.8.2 Cumulative Impact Methodology

The methodology used in this cumulative assessment has been based primarily on CEW, but has been informed by principles put forward in GLVIA, CEWT and GEIW.

(a) **GLVIA**

GLVIA states that "…cumulative landscape and visual effects result from additional changes to the landscape or visual amenity caused by the proposed development in conjunction with other developments (associated with or separate to it), or actions that occurred in the past, present, or are likely to occur in the foreseeable future." It goes on to note that such effects "…can also arise from the intervisibility of a range of developments …the separate effects of such individual….developments may not be significant, but together they may create an unacceptable degree of adverse effect on visual receptors within their combined visual envelopes." GLVIA also cites examples of the following effects which should be taken into account when assessing cumulative impacts:

- a restored landscape may be markedly different from the original and extend the impacts over a considerably longer timescale than the operations themselves;
- the duration and nature of the construction and decommissioning may be an important consideration; and
- extensions or additions to existing developments need to be addressed.

(b) **GEIW**

GEIW expands upon these themes by raising the following general issues to be considered in any cumulative assessment of wind farms:

- would numerous existing or proposed windfarms form a single, collective feature in the landscape or alternatively appear as separate, disunited individuals;
- a number of separate windfarms located close together can appear as one and conversely a single windfarm with disparate elements can appear to be several small windfarms;
- the cumulative impact of wind farms is not directly proportional to the total number of turbines; this would depend on scale, shape and complexity of design and sense of exposure rather than just size;
- numerous wind farms have a relationship to one another and the potential to create a confusing image is multiplied. This is accentuated when different treatments occur within the same landscape. Lack of consistency in design, height etc. is especially noticeable in a sequential experience; and

- wind farms that have different images from different locations may lead to the perception that wind farms in the area are more prolific than they actually are and this in turn may lead to them appearing so prolific as to alter the intrinsic character of an area.

(c) **CEWT**

CEWT offers more comprehensive guidance on assessment methodology. It identifies the following circumstances when cumulative impacts may be experienced:

- "..when two or more sites...are simultaneously visible from areas of mutual visibility (whether the sites are intervisible or not)"; and
- "..when two or more sites... are seen sequentially, but not simultaneously, whilst passing through the landscape."

In broad terms, the significance of visibility over longer distances is likely to be greater in respect of impacts on landscape character than impacts upon a particular visual receptor.

It also notes that where two geographically separate developments appear as one from certain viewpoints in the landscape, "visual coalescence" may occur. As with the other circumstances, the resultant impacts may be either adverse or beneficial.

CEWT advocates four steps in CLVIA. These are:

- identification of the scope of the study; specifically, which landscape and visual receptors require detailed investigation, identification of the extent of the total study area and a statement of which other existing and proposed wind farm developments would be assessed;
- description of the landscape and visual baseline conditions including sensitivity to wind farm developments of the type proposed. (N.B. in this study, baseline conditions are described within 35km of the periphery of the Viking site in this chapter. Outwith this area it is considered unlikely that any cumulative impacts associated with Viking would be significant);
- evaluation of the magnitude of the cumulative effects; and
- judgement of significance of impact.

(d) **CEW**

Amongst other references, CEW draws upon CEWT and further develops the methodology proposed therein (although it does not endorse all of its conclusions). One of the main differences is that CEW renames Simultaneous Visibility (as defined in CEWT) as **Combined Visibility** and sub-divides this into **Combination**, where several wind farms are within the observer's arc of vision at the same time and **Succession**, where the observer has to turn to see multiple wind farms. **Sequential Visibility** also is sub-divided, into **Frequently Sequential**, where features appear regularly with short time lapses in between because the observer is moving quickly and/ or there are short distances between viewpoints and **Occasionally Sequential**, where features appear irregularly with long time lapses in between because the observer is moving slowly and/ or there are long distances

between viewpoints. It is the CEW definitions which have been adopted in this methodology.

CEW also enlarges on the steps, or stages in the cumulative assessment process, as follows:

- preparation of a base plan out to 60km from the centre point of the development, in order that any potential effects towards the edge of the 30km (sic) zone can be identified;
- ZTV analysis, identifying separately the areas where two, three, four or more wind farms may be visible;
- selection of appropriate viewpoints for combined and sequential cumulative effects;
- preparation of photomontage or wireline to describe and illustrate the nature and degree of cumulative effects;
- describing and assessing the nature and significance of cumulative visual effects; and
- describing and assessing the nature and significance of cumulative landscape effects.

These stages are described in more detail in Appendix 5 of CEW.

9.8.3 Scope of Cumulative Assessment

Due to the location of the proposed development within central Shetland and the relative isolation from other landmasses it was not necessary to create a baseplan covering an area 60km from the development periphery to identify potential cumulative sites. All wind farms, both existing and proposed, on Shetland were included in the cumulative assessment. Furthermore the scoping response identified the need to include the Converter Station (for the sub-sea link) in the cumulative assessment.

Cumulative landscape character effects are only assessed from the static viewpoints as the route receptors tend to pass through a number of areas of differing landscape character, and therefore sensitivity. However, cumulative visual assessment of route receptors has been undertaken.

Table 9.5 Wind Farms and Developments Included in Cumulative Impact Assessment

Development	Location	No of Turbines	Height	Status
Burradale Wind Farm	Central Mainland, West of Lerwick	5	3 at 68m and 2 at 70m to blade tip	Operational
Cullivoe Wind Farm	North Yell, South of Cullivoe	5	70m to blade tip	Planning
Converter Station	Central Mainland, Upper Kergord	n/a	15m approx.	Scoping

The location and extent of these developments is shown on Figure 9.4.1. It should be noted that it is the interaction of these within a 35km radius from the development periphery of the proposed Viking scheme, illustrated in Figures 9.4.1 and 9.4.4 inclusive, that has been used to guide the location of likely cumulative landscape and visual viewpoint receptors. Outwith this area it is considered unlikely that any cumulative impacts associated with Viking Wind Farm would be significant. This is consistent with CEW methodology. Sites more than 60km from a viewpoint are unlikely to be discernible and have been excluded from the assessment.

The Viking Wind Farm proposal therefore forms the focus of the cumulative assessment and the CLVIA provides a tool to consider ways in which the proposed wind farm may have additional impacts when considered together with the developments identified in Table 9.5, on the assumption that all of the proposed developments are constructed, (i.e. the "worst case scenario").

9.8.4 Cumulative ZTVs

Cumulative ZTVs were generated to show the extent of visibility of all developments (within the CLIVA Study Area). The technique is similar to that described under Visual Assessment. The ZTV in itself is not representative of visual impact nor does the presence of a receptor within its boundary indicate that the proposed development necessarily would appear in views currently experienced by that receptor. Figure 9.4.1 shows a composite ZTV of all the developments listed in Table 9.5 that identifies areas wherein the proposed Viking Wind Farm may be visible (shaded blue), areas wherein other developments may be visible (shaded yellow) and areas wherein both Viking Wind Farm and other wind farms/ the converter station may be visible (shaded green).

Using a similar colour key, Figures 9.4.2 to 9.4.4 show the ZTVs of each of the developments identified in conjunction with the ZTV of Viking Wind Farm. The purpose of these figures, together with the supporting text below, is to break down the composite picture of Figure 9.4.1 into its component parts as an aid to the cumulative assessment process.

9.8.5 Magnitude of Cumulative Change

This evaluation identifies the cumulative magnitude of change arising from the introduction of the proposed Viking Wind Farm development into the projected "worst case" baseline scenario that assumes that, in addition to Burradale Wind Farm, which is already in operation, the proposed Cullivoe wind farm and Converter Station have been constructed.

Due to the relatively small scale nature and limited visibility of the other developments (listed in Table 9.5) and the large scale nature of the proposed development, magnitude of cumulative change has been assessed as the change in magnitude of the combined visibility of the other developments with the proposed development from that of the likely impact of the proposed development when assessed alone.

On the basis of professional interpretation of this evaluation the cumulative magnitude of change to landscape and visual receptors that may arise from the introduction of the proposed development has been assessed using the criteria described in Chapter 8, section 8.4.3 and Chapter 9, section 9.4.3.

9.8.6 Sensitivity to Change

Sensitivity of landscape and visual receptors to wind farm development as an addition to the envisaged cumulative baseline position has been evaluated against the criteria described in sections 8.4.3 and 9.4.3.

9.8.7 Assessment of Cumulative Effects

Potential cumulative landscape and visual effects arise from the combined effects of all wind farms and the converter station. Cumulative effects relate to the following:

- combined visibility of wind turbines and converter station at particular locations in the landscape where no similar developments are currently visible;
- successive visibility of wind turbines and/ or the converter station across the landscape; and
- sequential visibility of wind turbines and/ or the converter station (continuously, frequently and occasionally).

9.8.8 Significance of Cumulative Effects

SNH guidance on cumulative assessment describes the need for understanding of whether a proposed wind farm crosses the threshold of acceptability for the total number of wind farms in an area. As no methodology exists to identify when a landscape has reached its capacity in terms of wind farm acceptance, it is necessary to revert to the SNH and Local Authority Guidance (refer to Chapter 8) that seeks to identify the landscape objectives and policies for the area. In the context of this ES, cumulative effects of moderate and above are considered to be significant; slight to moderate and below are not considered to be significant.

9.8.9 Combined and Sequential Visibility

The assessment considered whether the potential impacts would be experienced in Combination (where wind farms/ converter station would be observable at the same time) or in Succession (where observer would be required to turn to see wind farms/ converter station from the same receptor location).

For roads and ferry routes, cumulative impacts would be experienced Sequentially (either Continuously, Frequently or Occasionally) as the viewer travelled the route.

The following section describes the potential cumulative impacts likely to be experienced by the addition of Viking to each other development (existing or proposed).

(a) Viking and Burradale

Burradale Wind Farm is located approximately 4km north-west of Lerwick and 12km south of the proposed development. The wind farm consists of 5 turbines, 3 of approximately 68m and 2 of approximately 70m to blade tip, and is small in both height and extent when compared to other commercial wind farms in the UK.

The cumulative ZTV (Fig 9.4.2.) indicates that the Viking and Burradale Wind Farms may have combined visibility, in combination and in succession, from elevated areas of the central, western and southern mainland, parts of southern Whalsay, parts of Tingwall and Tingwall Valley, west facing slopes of Bressay and Noss, and north facing slopes on Burra. The main areas of combined visibility are described in Table 9.6.1.

The cumulative ZTV also indicates that there are instances within the study area where Viking and Burradale Wind Farms may be visible sequentially from route receptors.

Table 9.6.1: Areas of Combined Visibility (Viking and Burradale)

Areas within the study area where both Viking and Burradale wind farms may have combined visibility. (C) = Combination (wind farms are observable at same time), (S)=Succession (where observer has to turn to see wind farms)	
1	Central Mainland – From higher ground and south facing slopes, including within the Viking development periphery and parts of Nesting. (C)
2	Western Mainland, including Papa Stour – Generally limited to east facing slopes and higher ground. (C)
3	Southern Mainland – Very limited areas of higher ground. (C)
4	Whalsay – Isolated areas of the south west coast. (C)
5	Tingwall and the Tingwall Valley – Most of this area, except southwest facing slopes. (S) (C)
6	Bressay and Noss – Limited to west facing slopes and high points. (C)
7	Burra – Limited to north facing slopes and higher ground. (C)
Areas within the study area where Viking and Burradale wind farms may be visible sequentially (Continuous, Frequent or Occasional, as stated)	
1	A970 (south of Voe) – Very Occasional for most of the route but Frequent between Hill of Bretto and Frakkafield.
2	A971 – Occasional, limited to short sections at Wallacetown, Scord of Sound and Tingwall.
3	B9075 (Nesting) – Frequent between Brettabister and Catfirth.
4	B9075 (Weisdale) – Very Occasional, limited to a section at Lamba Scord.
5	B9071 (North) – Very Occasional, limited to a short section at Setter.
6	B9071 (South) – Very Occasional, limited to short sections at Garderhouse and Hestinsetter.
7	B9074 – Frequent along the length of this route.
8	B9073 – Very Occasional, very limited to a short section.
9	Ferry, Vidlin to Out Skerries – Occasional over about 20% of the route.
10	Ferry, Lerwick to Out Skerries – Continuous over about 90% of the route.
11	Ferry, Laxo/ Vidlin to Whalsay – Frequent over about 30% of the route.
12	Ferry, Lerwick to Aberdeen – Continuous over 65% of the route within the study area.

(b) **Viking and Cullivoe**

Cullivoe Wind Farm would be located in the North of Yell, approximately 2km south of Cullivoe and 30km north of the proposed development. The wind farm consists of 5 turbines, of approximately 70m to blade tip, and like Burradale, would be small in both height and extent when compared to other commercial wind farms in the UK.

The cumulative ZTV (Fig 9.4.3.) indicates that the Viking and Cullivoe Wind Farms may have combined visibility, in combination and in succession, from elevated areas of the North Roe/ north mainland, parts of Yell, Unst and Fetlar. The main areas of combined visibility are described in Table 9.6.2.

The cumulative ZTV also indicates that there are instances within the study area where Viking and Cullivoe Wind Farms may be visible sequentially from route receptors.

Table 9.6.2: Areas of Combined Visibility (Viking and Cullivoe)

Areas within the study area where both Viking and Cullivoe wind farms may have combined visibility. (C) = Combination (wind farms are observable at same time), (S)=Succession (where observer has to turn to see wind farms)	
1	North Roe/ Northern Mainland – Limited to more elevated west facing slopes and hilltops, including a small area within the Viking development periphery. (S) (C)
2	Yell – Generally limited to hill tops and higher ground. (S)
3	Unst – Limited to higher ground and south west facing slopes. (S) (C)
4	Fetlar – Limited to elevated west facing slopes and hilltops. (S)
5	Whalsay and Out Skerries – Extremely limited to small areas of the north coast. (S)
Areas within the study area where Viking and Cullivoe wind farms may be visible sequentially (Continuous, Frequent or Occasional, as stated)	
1	B9088 (Fetlar) – Very Occasional, limited to west of Gallow Hill.
2	B9079 (Ollaberry) – Very Occasional, limited to north of The Roonans.
3	Ferry, Yell/ Unst to Fetlar – Frequent over about 60 – 75% of the route.
4	Ferry, Vidlin to Out Skerries – Continuous over about 70% of the route.
5	Ferry, Vidlin to Whalsay – Occasional, limited to a section north of West Linga.

(c) **Viking and Converter Station**

The site for the proposed converter station is located in the Valley of Kergord, north of Upper Kergord and is within the development periphery of the Viking Wind Farm.

The cumulative ZTV (Fig 9.4.4.) indicates that the Viking Wind Farm and the Converter Station may have combined visibility, in combination and in succession, from the upper slopes of Weisdale Valley, parts of Valley of Kergord and other isolated high points in the central mainland. The main areas of combined visibility are described in Table 9.6.3.

The cumulative ZTV also indicates that there are some instances within the study area where Viking Wind Farm and the Converter Station may be visible sequentially from route receptors.

Table 9.6.3: Areas of Combined Visibility (Viking and Converter Station)

Areas within the study area where both Viking Wind Farm and the Converter Station may have combined visibility. (C) = Combination (developments are observable at same time), (S)=Succession (where observer has to turn to see developments)	
1	Weisdale – Limited to upper slopes along Weisdale Valley and Weisdale Voe. (C)
2	Kergord – Limited to parts of the Valley of Kergord and its sides (along West Kame and Mid Kame). (C)
3	Very limited areas of higher ground adjacent to Kergord and Weisdale. (C)
Areas within the study area where Viking Wind Farm and the Converter Station may be visible sequentially (Continuous, Frequent or Occasional, as stated)	
1	A971 – Very Occasional, extremely limited, to sections at Heglibister and Cova
2	B9075 (Weisdale) – Very Occasional, limited to a section at Lamba Scord

9.8.10 Assessment of Cumulative Impact

Assessment of likely cumulative impact was made from eleven of the viewpoints adopted for the assessment of landscape and visual impact of the proposed development as described in earlier sections of this chapter. The composite ZTV (Figure 9.4.1) indicates that these are the only previously selected representative viewpoint locations likely to receive cumulative impacts. These assessments were aided by the use of wireframe projections (Figures 9.5.1-9.5.7). Wireframes are shown only for those viewpoints which would gain visibility of Viking Wind farm and another development in combination, within the same 90º view.

In addition to these viewpoints, cumulative assessments have been made of the main route receptors (major road and ferry routes, within a radius of 35km from the centre of the proposed Viking site), that have the potential to be subject to cumulative impact.

As noted in Paragraph 9.8.9, in the case of viewpoint receptors the assessment considered whether the potential impacts would be experienced in Combination (where wind farms/ the converter station would be observable at same time) or in Succession (where an observer would be required to turn to see wind farms/ converter station from the same receptor location).

For route receptors, (roads and ferry routes), cumulative impacts would be experienced sequentially as the viewer travelled the route. Because of the widespread potential visibility of the proposed development a third category of impact, in addition to Frequently Sequential (where features appear regularly with short time lapses in between) or Occasionally Sequential (where features appear irregularly with long time lapses in between), was considered wherein wind farms/ the converter station would potentially have combined visibility with the proposed Viking development continuously over extended lengths of the route; this has been termed Continuously Sequential.

A total of fifteen routes have been identified as route receptors and subjected to assessment; of these receptors ten are roads five are ferry routes.

The locations of the cumulative receptors, both viewpoints and routes are shown overlaid on the combined cumulative ZTV on Figure 9.4.1

The evaluation of sensitivity of receptors to, and the magnitude of change resulting from the development of Viking Wind Farm together with likely cumulative effects, is recorded in the Cumulative Effects Tables, Table 9.7 (Combined effects on Landscape Character), Table 9.8 (Combined effects on Visual Amenity) and Table 9.9 (Sequential effects on Visual Amenity). Significant effects (i.e., those adjudged to be moderate or above), both in combination and sequentially, are summarised in Table 9.10. This shows that a number of landscape and visual receptors (in the form of both viewpoints and routes) would experience significant effects if Viking Wind Farm were constructed in addition to the existing and the various proposed developments identified.

Table 9.7 Cumulative Effects on Landscape Character - Combined

Cumulative Viewpoint		Existing and Proposed Developments visible in combination with Viking Wind Farm		Landscape Character Sensitivity to Proposed Development at Viewpoint	Cumulative Magnitude of Change	Cumulative Impact on Landscape Character (Adverse Unless Stated Otherwise)
Number	**Description**	**Simultaneous**	**Succession**			
4	Noup of Noss	Cullivoe Burradale		Medium	Low	Slight
5	Ronas Hill	Burradale	Cullivoe	Medium	Negligible	Negligible
7	Loch of Tingwall		Burradale	Low	Negligible	Negligible
17	Whalsay		Burradale	Medium	Low	Slight
21	Hamnavoe	Burradale		Medium	Low/ Medium	Slight/ Moderate
28	A970, Petta Dale	Burradale		Medium	Low	Slight
30	Northlink Ferry, Off Mousa	Burradale		n/a	n/a	n/a
31	Kirkabister Ness, Bressay	Burradale		Medium	Negligible	Negligible
35	Fethaland Track		Cullivoe	Medium/ High	Low	Slight
37	Brough Lodge, Fetlar		Cullivoe	Medium/ High	Negligible	Negligible
38	Belmont House, Unst	Cullivoe		Low	Negligible	Negligible

Table 9.8 Cumulative Effects on Visual Amenity - Combined

Cumulative Viewpoint		Existing and Proposed Developments visible in combination with Viking Wind Farm		Visual Sensitivity at Viewpoint	Cumulative Magnitude of Change	Cumulative Impact on Visual Amenity (Adverse Unless Stated Otherwise)
Number	**Description**	**Simultaneous**	**Succession**			
4	Noup of Noss	Cullivoe Burradale		Medium	Low	Slight
5	Ronas Hill	Burradale	Cullivoe	Medium	Negligible	Negligible
7	Loch of Tingwall		Burradale	Low	Negligible	Negligible
17	Whalsay		Burradale	High	Low	Slight/ Moderate
21	Hamnavoe	Burradale		Medium/ High	Low	Slight/ Moderate
28	A970, Petta Dale	Burradale		High	Negligible	Slight
30	Northlink Ferry, Off Mousa	Burradale		Low	Negligible	Negligible
31	Kirkabister Ness, Bressay	Burradale		Low	Negligible	Negligible
35	Fethaland Track		Cullivoe	Low/ Medium	Low/ Medium	Slight/ Moderate
37	Brough Lodge, Fetlar		Cullivoe	Low	Negligible	Negligible
38	Belmont House, Unst	Cullivoe		Low	Negligible	Negligible

Table 9.9 Cumulative Effects on Visual Amenity - Sequential

Route Receptor		Existing and Proposed Developments visible sequentially with Viking Wind Farm			Visual Sensitivity of Route	Cumulative Magnitude of Change	Cumulative Impact on Visual Amenity (Adverse Unless Stated Otherwise)
Number	**Description**	**Continuous**	**Frequent**	**Occasional**			
R1 (FR1)	Ferry between Yell/ Unst and Fetlar		Cullivoe		Low	Negligible	Negligible
R2 (BR2)	B9088, Fetlar			Cullivoe	Low	Negligible	Negligible
R3 (BR4)	B9079, Ollaberry			Cullivoe	Low	Low	Slight
R4 (FR3)	Ferry between Vidlin and Out Skerries	Cullivoe		Burradale	High	Low	Slight/ Moderate
R5 (FR4)	Ferry between Lerwick and Out Skerries	Burradale			High	Low	Slight/ Moderate
R6 (FR5)	Ferry between Vidlin/ Laxo and Whalsay		Burradale	Cullivoe	High	Low	Slight/ Moderate
R7 (BR8)	B9071, Voe to Aith (including NCR1 and NSCR)			Burradale	Medium	Negligible	Negligible
R8 (AR9 & AR13)	A970, south of Voe (including NCR1 and NSCR)			Burradale	Medium	Medium	Moderate

Route Receptor		Existing and Proposed Developments visible sequentially with Viking Wind Farm			Visual Sensitivity of Route	Cumulative Magnitude of Change	Cumulative Impact on Visual Amenity (Adverse Unless Stated Otherwise)
Number	**Description**	**Continuous**	**Frequent**	**Occasional**			
R9 (BR10)	B9075, South Nesting (including NCR1 and NSCR)		Burradale		Medium	Medium	Moderate
R10 (BR11)	B9075, Weisdale			Burradale, Converter Station	Medium	Low	Slight
R11 (AR10-AR12)	A971, Wallacetown to Tingwall (including NCR1 and NSCR)			Burradale, Converter Station	Low	Medium	Slight/ Moderate
R12 (BR12)	A9071, Garderhouse to Culswick			Burradale	Low	Medium	Slight/ Moderate
R13 (BR13)	B9074, Tingwall to Burra (including NCR1)		Burradale		Medium	Low	Slight
R14 (BR14)	B9073, Run Hill (including NCR1)			Burradale	Low	Negligible	Negligible
R15 (FR8)	Ferry from Lerwick to Kirkwall/ Aberdeen	Burradale			Low	Negligible	Negligible

Table 9.10 Summary of Combined or Sequential Effects

Viewpoints		Level of Cumulative Landscape Impacts	Level of Cumulative Visual Impacts
VP4	Noup of Noss	Slight	Slight
VP5	Ronas Hill	Negligible	Negligible
VP7	Loch of Tingwall	Negligible	Negligible
VP17	Whalsay	Slight	Slight/ Moderate
VP21	Hamnavoe	Slight/ Moderate	Slight/ Moderate
VP28	A970, Petta Dale	Slight	Slight
VP30	Northlink Ferry, Off Mousa	n/a	Negligible
VP31	Kirkabister Ness, Bressay	Negligible	Negligible
VP35	Fethaland Track	Slight	Slight/ Moderate
VP37	Brough Lodge, Fetlar	Negligible	Negligible
VP38	Belmont House, Unst	Negligible	Negligible
Routes			
R1	Ferry, Yell/ Unst and Fetlar	n/a	Negligible
R2	B9088, Fetlar	n/a	Negligible
R3	B9079, Ollaberry	n/a	Slight
R4	Ferry, Vidlin and Out Skerries	n/a	Slight/ Moderate
R5	Ferry, Lerwick and Out Skerries	n/a	Slight/ Moderate
R6	Ferry, Vidlin/ Laxo and Whalsay	n/a	Slight/ Moderate
R7	B9071, Voe to Aith	n/a	Negligible
R8	A970, south of Voe	n/a	Moderate
R9	B9075, South Nesting	n/a	Moderate
R10	B9075, Weisdale	n/a	Slight
R11	A971, Wallacetown to Tingwall	n/a	Slight/ Moderate
R12	A9071, Garderhouse to Culswick	n/a	Slight/ Moderate
R13	B9074, Tingwall to Burra	n/a	Slight
R14	B9073, Run Hill	n/a	Negligible
R15	Ferry, Lerwick to Kirkwall/ Aberdeen	n/a	Negligible

9.9 SHADOW FLICKER

The Shadow Flicker Assessment has been carried out by Airtricity.

Shadow flicker may occur at some observation points for short periods over some weeks of the year, usually early in the morning or late in the afternoon when the sun is low in the sky, although this varies with the seasons and the relative position of an observer with respect to a turbine. In order for periodic shadow flicker to occur the observer would need to be relatively close to a wind turbine (within 10 turbine diameters as specified within PAN 45 (Scottish Government 2002)), at a time when it was sunny, and the line of sight from the observer toward the sun was intersected by the rotating wind turbine blades.

A typical maximum wind turbine rotation speed of around 20 rpm would translate into a maximum shadow flicker frequency of 1 Hz, assuming a standard three bladed turbine.

Potential shadow flicker has been assessed using GH Windfarmer Version 3.6.2., taking account of terrain topography and turbine locations as well as turbine hub height (90m) and rotor diameter (110m). A cumulative multiplier was applied to adjust the worst-case assessment to arrive at an estimated actual impact. Computer modelling of potential shadow flicker effects was conducted out to a range of 2000m from turbine locations, well beyond the region of significance.

The computer model is known to produce an over-estimate of possible impact (referred to as "worst case impact") due to the following:

- The sun is assumed to be shining during all daylight hours such that a noticeable shadow is cast. In reality it is often cloudy or overcast.
- The wind is assumed to be within the operating range of the turbine such that the turbine rotor is turning at all times, thus enabling a periodic shadow flicker. Occasionally it is not windy.
- The wind turbines are assumed to be available to generate (turn) at all times. In reality turbines may be switched off whilst in a maintenance state or for other technical or environmental reasons.
- The turbine rotor is considered (as a sphere) to present its maximum aspect to observers in all directions. In reality the wind direction and relative positions would cause a changing aspect presented by the turbine such that the rotor presents ellipses of varying eccentricity to observers from different directions. The time taken for the sun to pass across the sky behind a highly elliptical aspect will be smaller than the modelled maximum circular aspect.

It should also be noted that even if shadow flicker impact does occur at a specific location this does not imply that it would be witnessed. Potential witnesses may be sleeping or occupied in a room on another side of the house which is not impacted, or indeed absent from the location altogether (e.g. at work, on holiday, etc) during the time of shadow flicker events. Furthermore, trees, outbuildings and other obstacles may screen an observer from shadow flicker effects, although it is noted that Shetland is relatively free from trees.

Computer modelling has produced shadow flicker worst case impact zones as indicated by red-scale regions within the map in Figures 9.6.1 and 9.6.2. The deepest red shows where the worst case impact of more than 200 hours (cumulative total) in a year is theoretically possible. Typically this region would be very close to turbines. The lightest impact shading indicates a worst case impact of between 0 and 8 hours in a year which is considered to be insignificant; it includes areas where shadow flicker is clearly impossible, for example to the immediate south of turbines. The next lightest shade denotes worst case impact of between 9 and 50 hours per year. In reality this region is also unlikely to produce significant impact because these numbers are very much over-estimates for the reasons given above. There are further bandings (five in total) indicating 51-100 and 101-200 hours worst case impact per year. The map also shows a boundary in green which denotes ten turbine diameters (1100m, assuming 110m diameter as modelled) beyond which shadow flicker should not be significant, as stated in PAN 45.

In order to understand better the degree to which the worst case model prediction should be reduced in order to account for the portion of daylight hours which are sunny and windy, meteorological data have been studied. UK Meteorological Office monthly

sunshine data from Lerwick have been obtained and compared with daylight hours (calculated from daily sunrise and sunset times for Shetland). These show that it is likely to be sunny enough to cast shadows on Shetland less than 25% of the time overall, as shown in Table 9.11:

Table 9.11: Lerwick Met Office Data

Month	Daylight hours	Met Office typical sunlight hours at Lerwick	Monthly percentage of daylight hours which are sunny
Jan	209.00	22.6	10.8%
Feb	254.31	52.3	20.6%
Mar	365.33	85.6	23.4%
Apr	437.84	129.9	29.7%
May	534.18	168.3	31.5%
Jun	564.94	148.2	26.2%
Jul	560.30	120	21.4%
Aug	485.54	124.6	25.7%
Sep	387.53	100.8	26.0%
Oct	314.50	65.4	20.8%
Nov	225.67	33	14.6%
Dec	184.03	14.9	8.1%
Full Year	4523.16	1065.6	23.6%

Long term meteorological mast data from five masts were studied in order to establish the percentage of time when wind speeds corrected to 90m (hub height) would be within the range 4-25 m/s suitable for electricity generation from wind turbines. All five results indicate Shetland has a very strong wind resource ideal for wind generation with such wind speeds occurring greater than 90% of the time as shown in Table 9.12:

Table 9.12: Met Mast Data

Mast:	Percentage of Long Term Wind speed data between 4 and 25 m/s (adjusted to 90m height)
Shetland M70S	92.9%
Shetland M70N	91.0%
Shetland M100	92.9%
Shetland Logie Hill	90.5%
Shetland Muckle Hill	91.2%
Average of the above:	91.7%

From the point of view of turbine availability due to maintenance a typical wind industry availability factor might be 97% with the turbine unable to generate due to maintenance, etc for the remaining 3% of the time. Therefore the following Table 9.13 would denote a number of attenuation factors which can be expected to substantially reduce the possible shadow flicker impact periods overall:

Table 9.13: Attenuation Factors

	Percentage attenuation to worst case shadow flicker impact period
Percentage sunshine during daylight hours	23.6%
Percentage wind between 4 and 25 m/s	91.7%
Turbine generating availability	97.0%
Cumulative multiplier for adjusting worst-case assessment to arrive at an estimated actual impact	21.0%

These results must be considered indicative only and depend upon a number of assumptions as described above; but they provide a reasonable guide for planning purposes. Therefore, the worst case impact hours per year as indicated by the colour coding key in Figures 17.4.1 and 17.4.2 would likely translate in practice into an actual impact of 21% of worst case predictions. This is approximately one fifth of worst case. On this basis the region indicating up to 50 hours worst case impact would likely indicate less than 10 hours actual impact (especially considering that the turbine would not present its maximum circular aspect to all observers).

In the case of an occupied residence being significantly affected by shadow flicker it is possible to mitigate the impact by installing a turbine control system which would calculate the position of the sun in the sky and whether the given turbine coordinates and dimensions could give rise to potential shadow flicker impact at a set of pre-programmed impact locations (for example occupied houses). The control system may be set up to switch turbines off automatically during potential impact periods. Therefore it would be possible to eradicate any shadow flicker although this would be at some expense to renewable electricity generation since the turbines clearly cannot produce electricity when turned off.

It is concluded that shadow flicker is unlikely to produce a major problem on the basis that there are few occupied buildings within ten turbine diameters of the proposed layout. However, if significant shadow flicker did occur at a sensitive receptor location then control systems can be installed in order to mitigate the impact.

9.10 SUMMARY AND CONCLUSIONS

Table 9.10 provides a summary of the predicted cumulative landscape and visual impacts associated with the proposed development. The summary table indicates that out of a total of 26 viewpoint and route receptors none would receive significant cumulative landscape impacts and only 2 would receive significant cumulative visual impacts. Both significant impacts would be moderate and as a result of combined visibility with Burradale Wind Farm. No significant cumulative impacts would be experienced from the selected viewpoints or routes as a result of combined visibility with Cullivoe Wind Farm or the Converter Station.

It is considered that the relatively small scale extent of the Burradale and Cullivoe Wind Farms and the Converter Station in comparison with the proposed Viking Wind Farm (and the relatively localised and limited simultaneous and sequential visibility) would have the

effect of not increasing the overall significance of the adverse effects upon the landscape and visual resource of the study area.

Shadow flicker effects have been modelled and are not considered to be significant.

9.11 REFERENCES

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