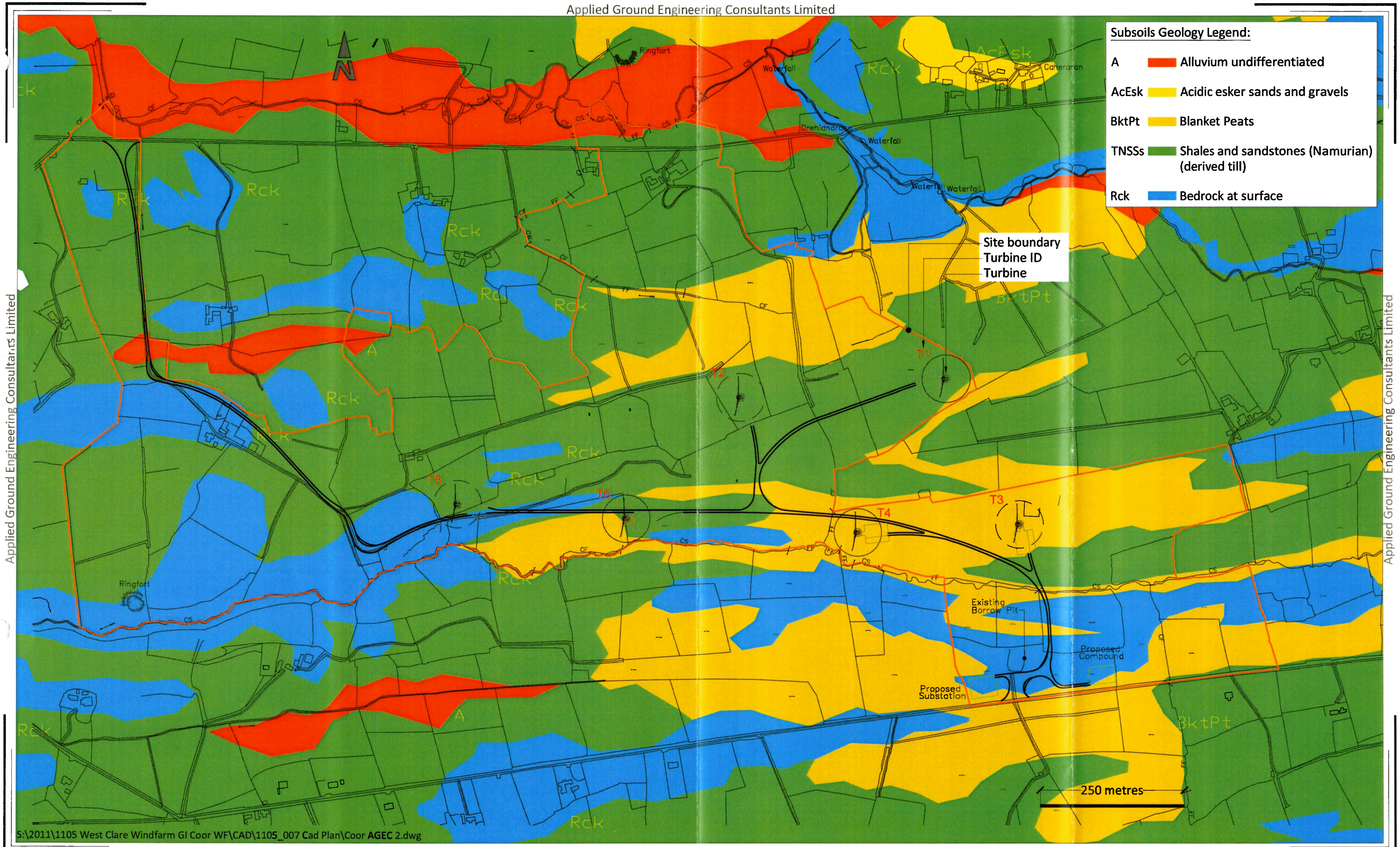

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Checked: I.H.
Date: 18 April 2011
Revision: A
Drawn: P.O.R.
Based on:

Client:
INIS Environmental
Consultants Ltd.

Job:
Proposed Coor Windfarm
Co. Clare

Figure 7.1

Title:
Subsoils Geology Plan

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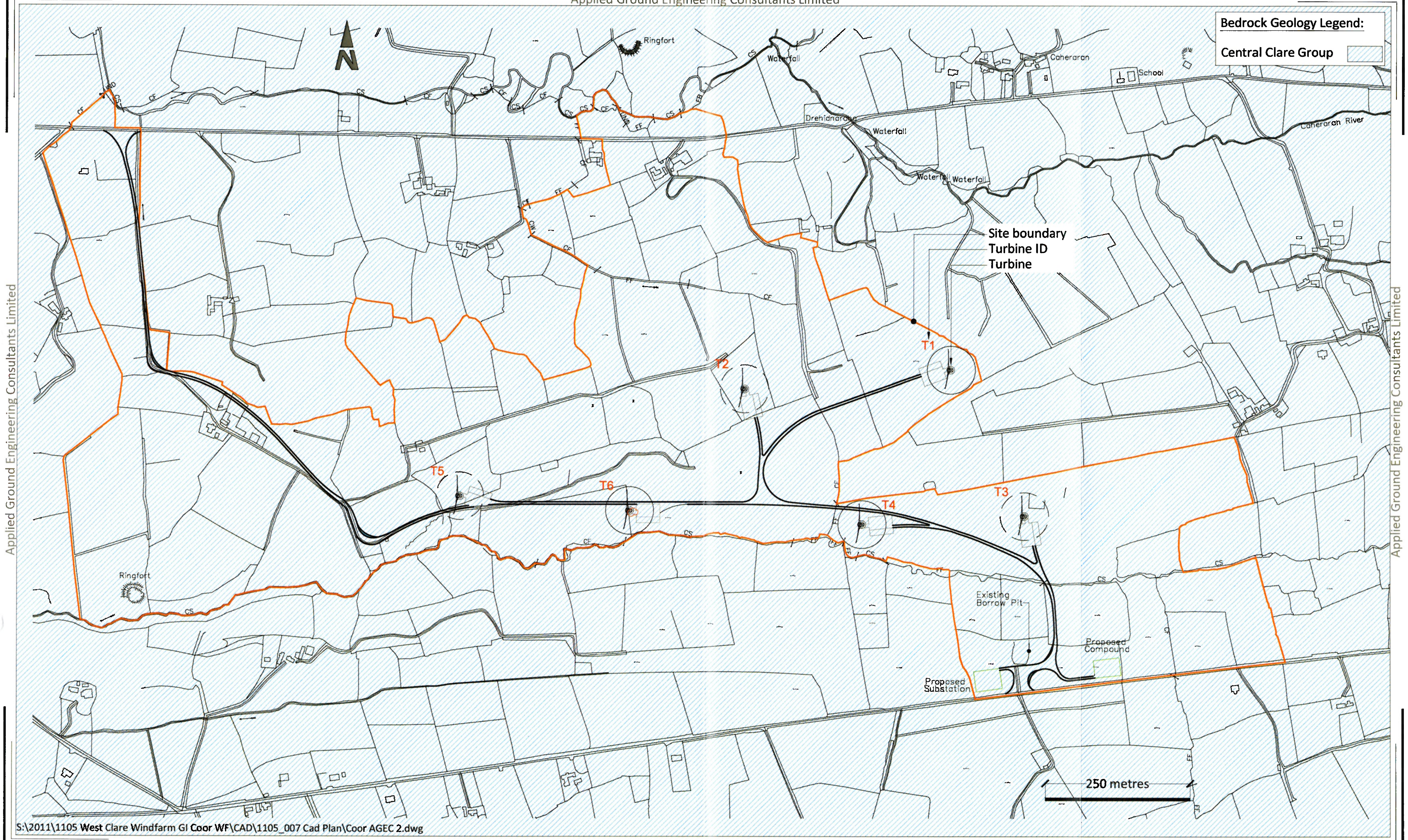

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Date: 18 April 2011	Revision: A
Drawn: P.O.R.	Based on:

Client:
INIS Environmental
Consultants Ltd.

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Job:
Proposed Coor Windfarm
Co. Clare

Figure 7.2

Title:
Bedrock Geology Plan

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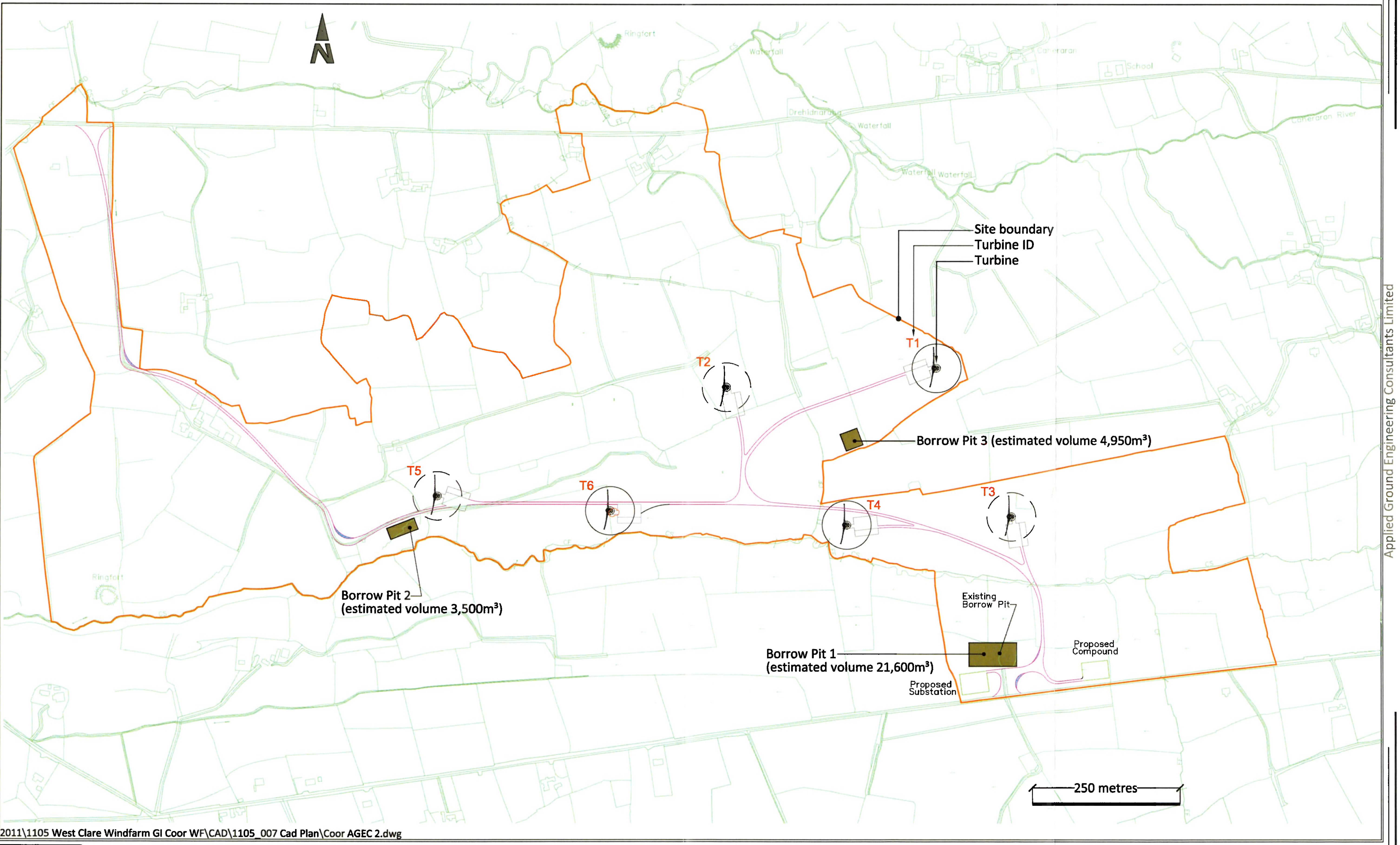

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Date: 20 April 2011
Revision: C
Drawn: P.O.R.
Based on:

Client:

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Figure 7.3

Title:

Borrow Pit Location Plan

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APPENDIX 7

AGEC Ltd., Peat Stability Assessment

REPORT ON

ASSESSMENT OF PEAT STABILITY

FOR

PROPOSED COOR EAST WIND FARM, CO. CLARE

Prepared for:
INIS Environmental Ltd

April 2011

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TABLE OF CONTENTS

TABLES (within text)

FIGURES (at end of text)

APPENDICES

ACRONYMS AND SYMBOLS

AGEC	Applied Ground Engineering Consultants Ltd
BS	British Standard
CMS	Construction Method Statement
c_u	Undrained strength
c′	Effective cohesion
FoS	Factor of Safety
GSI	Geological Survey of Ireland
kPa	Kilopascals
m	Metres
mm	Millimetres
m bgl	Metres below ground level
PHRAG	Peat Hazard and Risk Assessment Guide
ø′	Effective angle of shearing resistance

1 NON-TECHNICAL SUMMARY

Applied Ground Engineering Consultants Ltd (AGEC) was engaged by INIS Environmental Ltd to undertake an assessment of the proposed Coor Wind Farm site with respect to peat stability. The Coor Wind Farm comprises of Coor West, Shanavogh East & Shanavogh West in Co. Clare.

The proposed wind farm comprises 6 wind turbines with associated infrastructure.

The site is essentially an upland partially forested area with shallow or no peat cover. Where peat was encountered it was classified as peaty topsoil or soft black peat.

A walkover, desk study, ground investigation and stability analysis was carried out to assess the susceptibility of the site to peat failure. The main findings from the assessment was that the proposed wind farm development is located on relatively gentle slopes with shallow or no peat cover and as such is not considered to be at risk from peat failure.

Peat depth probing was carried out across the site and at locations of proposed works. Peat depths across the site ranged from 0 to 1.6m (Figure 2). Peat cover at the site is described as peaty topsoil with localised areas of soft black peat. Ground conditions below the peat cover comprised typically glacial till and weathered mudstone.

With respect to turbine locations, the peat depth varied from 0.3 to 0.7m with slope inclinations ranging from 1 to 5 degrees. Given the shallow depth of peat cover, the potential for peat instability would be considered minimal. A stability analysis check of the peat slopes showed an acceptable and large margin of safety (Figure 3), which confirms the minimal potential for peat failure.

The access roads for the wind farm will comprise existing forestry tracks and newly constructed tracks. With respect to access roads, the peat depth varied from 0 to 1.6m with an average of 0.4m. Given the relatively shallow depth of peat cover, the potential for peat instability would again be considered minimal.

In conclusion, based on detailed stability assessment of the peat slopes on the Coor Wind Farm site it is shown that the site has an acceptable and large margin of safety. Therefore in relation to peat stability at the proposed Coor wind farm site:

(a) There is considered to be an insignificant risk of peat failure, and

(b) No adverse impacts on the integrity of the site or surrounding area.

1 INTRODUCTION

1.1 Objectives

Applied Ground Engineering Consultants Ltd (AGEC) was engaged in March 2011 by INIS Environmental Ltd to undertake an assessment of the proposed wind farm site with respect to peat stability.

The proposed East Wind Farm is at a site located approximately 10km east of Miltown Malbay, Co Clare.

The proposed wind farm comprises of 6 wind turbines numbered T1 to T6 with associated infrastructure (Figure 1 & 2). The associated infrastructure includes a substation, access roads and borrow pits.

AGEC undertook the assessment following the principles in Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive, 2007). The Peat Hazard and Risk Assessment Guide (PHRAG) is used in this report as it provides best practice methods to identify, mitigate and manage peat slide hazards and associated risks in respect of consent applications for electricity generation project.

The best practice guide was produced following peat failures in the Shetland Islands, Scotland in September 2003 but more pertinently following the peat failure in October 2003, during the construction of a wind farm at Derrybrien, County Galway, Ireland.

The assessment of peat stability at the proposed site included the following activities:

(1) Walkover survey of the site.

(2) Stability assessment.

(3) Findings of the above to assess the potential risk of a peat slide, in particular at turbine locations and along access roads.

(4) Peat thickness zonation plan

(5) Risk register for design/construction control measures to mitigate against potential for peat failure.

1.2 Peat Failure Definition

Peat failure in this report refers to a significant mass movement of a body of peat that would have an adverse impact on proposed wind farm development and the surrounding environment. Peat failure excludes localised movement of peat that would occur (say) below an access road, creep movement or erosion type events.

The potential for peat failure at this site is examined with respect to wind farm construction and associated activity.

2 SITE DESCRIPTION

The proposed wind farm comprises 6 wind turbines at the site numbered T1 to T6 with associated infrastructure (Figure 1 & 2). The site is essentially an upland partially forested area with little or no peat cover.

The site is an upland area with elevations varying from 100mOD to 150mOD. A significant amount of the site has existing access tracks.

Peat depths recorded at the site during the walkover survey range from 0.0 to 1.6m. The peat recorded on the site ranged from peaty topsoil to soft black peat. Close to turbine locations, recorded peat depths were between 0.0 and 0.7m with an average depth of approximately 0.55m.

Slope angles across the site generally vary from 0 to 14 degrees. These readings are based on site readings.

The existing tracks which are shown on the site plan run across the centre of the site. The existing tracks appear to have been founded on mineral soil.

The site is drained by a stream which forms most of the southern boundary to the site.

3 DESK STUDY AND SITE RECONNAISSANCE

3.1 Desk Study

The main relevant sources of interest with respect to the site include:

- Geological plans
- Ordnance Survey plans
- Literature review of peat failures

The Geological Survey of Ireland (GSI) geological plans for the site were used to verify the bedrock conditions.

The Ordnance Survey plans have been used to compile the topographic plans of the site.

The desk study also included a review of published literature on peat failures in the vicinity of the site.

3.2 Site Reconnaissance

As part of the assessment of potential peat failure at the proposed site, AGEC carried out a site reconnaissance. This comprised a walk-over inspection of the site with recording of salient geomorphological features with respect to the wind farm development and to provide peat thickness and preliminary assessment of peat strength.

The following salient geomorphological features were considered:

- Active, incipient or relict instability (where present) within the peat deposits
- Presence of shallow valley or drainage line
- Wet areas
- Any change in vegetation
- Peat depth
- Slope inclination and break in slope

The survey covered the proposed locations for the turbine base and associated infrastructure.

The method adopted for carrying out the site reconnaissance relied on practitioners carrying out a visual assessment of the site supplemented with measurement of slope inclinations.

4 FINDINGS OF SITE RECONNAISSANCE

4.1 Previous Failures

The investigation works carried out at the site have been used in conjunction with desk study review to assess the susceptibility of the site to peat failure.

There are no recorded peat failures close to Coor (GSI, 2006). The nearest recorded peat failure is located some 20km to the north of the site within an upland area called Ballaghline. The failure recorded by Geological Survey of Ireland (GSI) occurred in 1900 however no description of the failure is given.

Other failures recorded by GSI that occurred in County Clare are at Corbehagh and Derryulk. The failure at Corbehagh occurred in 1934 and was described as a peat flow. The failure at Derryulk occurred in 2005 and was described as an earth slide (unspecified).

The presence, or otherwise, of relict peat failures or clustering of relict failures within an area is an indicator that particular site conditions exist that pre-dispose a site to failure or not as the case may be.

4.2 Findings of Site Reconnaissance

The site reconnaissance comprised a walk-over inspection of the site from 24th to 25th March 2011. Weather conditions were dry during the site visit.

The walkover was carried out by geotechnical engineers experienced in peat failure assessment.

The main findings of the site reconnaissance are as follows:

(1) The site has variable thicknesses of peaty topsoil and peat, from 0 to 1.6m. Deeper pockets of peat may be present across the site but none were encountered during the walkover.

(2) The site typically consists of mineral soil over siltstone and mudstone. The mineral soil was described as firm to stiff brown gravelly Silt/Clay with occasional cobbles, with a soft to firm grey blue sandy Silt recorded in places.

(3) Some rock outcrops of mudstone are evident across the site.

(4) The existing access tracks appear to have been founded on mineral soil.

(5) Slope angles range from 1 to 5 degrees at turbine locations.

(6) No evidence of past failures or signs of instability were noted on site.

(7) The conclusions of the site reconnaissance are as follows:

    (a) In general the site is covered by little or no peat. Where peat is encountered it is relatively thin i.e. less than 1.6m and is underlain by mineral soil and bedrock.

    (b) Several exposures of mineral soil and outcrops of rock are evident across the site.

(8) The above site reconnaissance conclusions are considered with the quantitative peat stability assessment in combined peat stability and risk assessment, see Section 10 and Appendix A.

5 SITE GROUND CONDITIONS

5.1 Superficial Deposits

The superficial deposits for the site can be briefly classified into the following main types.

- Peat
- Mineral soil
- Bedrock

A summary of the deposits is given below and are based on the trial pit logs which were carried out by Irish Drilling Ltd and are included in Appendix B.

(1) Peat

The site contained little or no peat cover. Where peat was recorded it was essentially peaty topsoil, with pockets of black soft fibrous peat. Depths of 0.0 to 1.0m were recorded for the peat. The peat was typically described as firm brown fibrous peat. The peat was noted as being well drained and shear strength values of 28 to 100kPa were recorded.

Based on site observations, the peaty topsoil and peat is underlain by mineral soil and bedrock.

(2) Mineral soil

The mineral soil below the peat comprises glacial till and weathered rock. These deposits were recorded in the trial pits dug across the site.

Based on the field strength descriptions for the glacial till, an undrained shear strength of between 40 - 100kPa (firm to stiff) and locally 20kPa (soft) is estimated for the material immediately below the peat in places. The material was typically described as a grey gravelly SILT/CLAY with cobbles & boulders.

The weathered rock where recorded was typically described as MUDSTONE.

5.2 Bedrock

The underlying bedrock strata at the Coor site are mapped as Undifferentiated Namurian Shales of the Central Clare Group. This is a laminated shale/siltstone/sandstone and consists of a number of cyclothems separated with marine Goniatite bands.

No major faults occur within or in the vicinity of the study area. An east-north east to west-southwest fault occurs to the northwest at a distance of approximately 4 km from the study area.

There are also a number borrow pits around the site. Inspected outcrops were found to contain grey shale and siltstone bedrock which is consistent with the description of the Central Clare Group rocks described by the Geological Survey maps (GSI, 1999).

There are no recorded Geological Heritage sites within the proposed development area.

6 PEAT

As part of the ground investigation, in situ peat strength was recorded at various locations across the site. Peat depth probes were carried out at or near to proposed turbine locations and access roads. At turbine locations probes were carried out around the turbine location. The testing was carried out in-situ using a Geonor H-60 Hand-Field Vane Tester. It is important to stress from AGEC's experience that hand vanes give indicative results for insitu strength of peat. The results derived from hand vane testing should be used with caution when assessing peat strength on a site. Where a larger mechanical vane is used with rods protected against contact with the ground, such as a Geonor H-10, more representative strength values can be obtained.

Where peaty topsoil and pockets of peat were encountered across the site, the depths varied in thickness from 0 to 1.6m. The probe results have been utilised to produce peat thickness zonation plan for the site (Figure 2).

A summary of the peat depths at the turbine and structure locations is given in Table 1.

Table 1 Peat Depths at Proposed Turbine & Structure Locations

Turbine	Easting (2)	Northing (2)	Peat Depth (m) (1)	Slope Angle (°) (3)
T1	111091	175077	0.5	5
T2	110736	175045	0.5	5
T3	111217	174826	0.7	3
T4	110939	174812	0.5	4
T5	110247	174861	0.6	1
T6	110538	174836	0.4	2
Substation	111176	174563	0.3	2

Note (1) Based on Probe Results from Walkover
Note (2) Co-ordinates provided by INIS Environmental.
Note (3) Slope angle obtained by sighting during site survey by AGEC

In addition to probing, in situ shear vane testing was carried out as part of the ground investigation. Strength testing was carried out at selected locations across the site to provide a representative coverage of indicative peat strengths. The results of the vane testing are presented in Figure 4.

The results indicate undrained shear strengths in the range 28 to 100kPa, with an average value of about 60kPa. These strengths would be typical of shallower, more fibrous peat deposits. These types of deposit are more likely to fail due to extreme rainfall events, rather than the bearing failure which occurs in deeper peat deposits.

Peat strength at sites of known peat failures (assuming undrained loading failure) are generally very low, for example the undrained shear strength at the Derrybrien failure (AGEC, 2004) as derived from essentially back-analysis, though some testing was carried out, was estimated at 2.5kPa.

7 INFRASTRUCTURE AND BORROW AREAS

As part of the ground investigation, the locations for proposed borrow areas were reviewed. Locations for the substation and proposed construction compound were also reviewed.

7.1 Borrow Area 1

Borrow area 1 is located in the southwest of the site, adjacent to the substation. It is proposed to remove rock from this location to construct the access roads, and then to use the borrow area as a peat storage area following removal of the bedrock. Bedrock is visible at the surface. This area has already been used as a small borrow pit.

7.2 Borrow Area 2

Borrow area 2 is located in the central section of the site, close to T5. It is proposed to remove rock from this location to construct the access roads, and then to use the borrow area as a peat storage area following removal of the bedrock. This location has already been used as a borrow pit. No peat is present in this area.

7.3 Borrow Area 3

Borrow area 3 is located in the eastern section of the site, close to T1. It is proposed to remove rock from this location to construct the access roads, and then to use the borrow area as a peat storage area following removal of the bedrock. This location has already been used as a borrow pit. No peat is present in this area.

7.4 Substation

The proposed substation location is located in the southwestern section of the site. A peaty topsoil 0.3m in thickness was recorded at this location. Soil strengths were recorded as 100kPa.

8 PEAT STABILITY ASSESSMENT

8.1 Methodology for Peat Stability Assessment

Stability of a peat slope is dependent on several factors working in combination. The main factors that influence peat stability are slope angle, shear strength of peat, depth of peat, pore water pressure and loading conditions.

An adverse combination of factors could potentially result in peat sliding. An adverse condition of one of the above-mentioned factors alone is unlikely to result in peat failure. To assess the factor of safety for a peat slide, an undrained and drained analysis has been undertaken to determine the stability of the peat slopes on site.

The infinite slope model (Skempton and DeLory, 1957) is used to combine these factors to determine a factor of safety for peat sliding. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

Based on the findings of the Derrybrien failure, undrained loading during construction was found to be the critical failure mechanism. The undrained loading condition applies in the short term during construction and until construction induced pore water pressures dissipate. Undrained shear strength values (c_u) for peat are used for the total stress analysis.

The proposed construction method for most of the access tracks through the deeper areas of peat at the wind farm site is to excavate the in-situ peat and found the tracks on more competent strata below the peat. This will result in the formation of cuttings along the tracks within the peat. These cuttings will be subject to variations in groundwater level and therefore an effective (drained) stress analysis was also conducted.

A drained analysis requires effective cohesion (c') and effective friction angle (ø') values for the calculations. These values can be difficult to obtain because of disturbance experienced when sampling peat and the difficulties in interpreting test results due to the excessive strain induced within the peat. To determine suitable drained strength values a review of published information on peat was carried out.

Table 2 shows a summary of the published information on peat together with drained strength values.

Table 2 List of Effective Cohesion and Friction Angle Values

Reference	Cohesion, c′ (kPa)	Friction Angle, ø′ (degs)	Testing Apparatus/ Comments
Hanrahan et al (1967)	5 to 7	36 to 43	From triaxial apparatus
Rowe and Mylleville (1996)	2.5	28	From simple shear apparatus
Landva (1980)	2 to 4	27.1 to 32.5	Mainly ring shear apparatus for normal stress greater than 13kPa
	5 to 6	-	At zero normal stress
Carling (1986)	6.5	0	-
Farrell and Hebib (1998)	0	38	From ring shear and shear box apparatus. Results are not considered representative.
	0.61	31	From direct simple shear (DSS) apparatus. Result considered too low therefore DSS not considered appropriate
Rowe, Maclean and Soderman (1984)	1.1	26	From simple shear apparatus
	3	27	From DSS apparatus
Sandorini et al (1984)	4.5	28	From triaxial apparatus
McGreever and Farrell (1988)	6	38	From triaxial apparatus using soil with 20% organic content
	6	31	From shear box apparatus using soil with 20% organic content
Hungr and Evans (1985)	3.3	-	Back-analysed from failure
Madison et al (1996)	10	23	-
Dykes and Kirk (2006)	3.2	30.4	Test within acrotelm
Dykes and Kirk (2006)	4	28.8	Test within catotelm
Warburton et al (2003)	5	23.9	Test in basal peat
Warburton et al (2003)	8.74	21.6	Test using fibrous peat
Entec (2008)	3.8	36.8	Generalised values derived from various peat tests (shear box and triaxial)

From Table 3 the values for c′ ranged from 1.1 to 10kPa and ø′ ranged from 21.6 to 43°. The average c′ and ø′ values are 5kPa and 30° respectively. Based on the above, it was considered to adopt a conservative approach and to use design values below the averages.

For design the following general drained strength values have been used for the site:

c′ = 4kPa
ø′ = 25 degrees

8.2 Analysis to Determine Factor of Safety

8.2.1 Factor of Safety

The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes and mineral soil below the peat using an infinite slope analysis. The analysis was carried out at the turbine and various other locations across the site.

The FoS provides a direct measure of the degree of stability of the slope. A FoS of less than unity indicates that a slope is unstable, a FoS of greater than unity indicates a stable slope.

The acceptable safe range for FoS typically ranges from 1.3 to 1.4. Where there is minimal risk from a slope failure a FoS of just greater than 1 may in some cases be acceptable (Geotechnical Engineering Office, 1984). The previous code of practice for earthworks BS 6031:1981 (BSI, 1981), provided advice on design of earthworks slopes. It stated that for a first time failure with a good standard of site investigation the design FoS should be greater than 1.3.

Eurocode 7 (EC7) (IS EN 1997-1:2005) has been recently introduced and now serves as the reference document and the basis for design geotechnical engineering works. The design philosophy used in EC7 applies partial factors to soil parameters, actions and resistances. Unlike the traditional approach, EC7 does not provide a direct measure of stability, since global Factors of Safety are not used.

As such, and in order to provide a direct measure of the level of safety on a site, EC7 partial factors have not been used in this stability assessment. The results are given in terms of FoS.

For the analysis undrained shear strength values are based on lowest c_u recorded at each location and where no c_u data is present an assumed lower bound value is used.

The formula used to determine the factor of safety for the undrained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c_u}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c_u = Undrained strength
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
α = Slope angle

The formula used to determine the factor of safety for the undrained condition in the mineral soil below the peat is a revision of the above formula (Bromhead, 1986) and is as follows:

$$F = \frac{c_u}{(\gamma_p z_p + \gamma_m z_m)\sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c_u = Undrained strength
γ_p = Bulk unit weight of peat
z_p = Depth of peat
γ_m = Bulk unit weight of mineral soil
z_m = Depth of failure plane in mineral soil
α = Slope angle

The formula used to determine the factor of safety for the drained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2\alpha \tan\phi'}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c' = Effective cohesion
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
γ_w = Unit weight of water
h_w = Height of water table above failure plane
α = Slope angle
ϕ' = Effective friction angle

For the drained analysis the level of the water table above the failure surface is required to calculate the factor of safety for the slope. Since the water level in blanket peat can be variable, it is not feasible to establish its precise location throughout the site. Therefore a sensitivity analysis using water level ranging between 0 and 100% of the peat depth was conducted, where 0% equates to the peat been completely dry and 100% equates to the peat been fully saturated.

The following general assumptions were used in the analysis of peat slopes at each turbine base:

(1) Peat depths are based on the maximum peat depth recorded at each location from the walkover survey.
(2) Undrained shear strength values are based on lowest c_u recorded at that location and where no c_u data is present an assumed lower bound value is used.
(3) Slope angle on base of sliding assumed to be parallel to ground surface.

For the stability analysis two load conditions were examined, namely

Condition (1): no surcharge loading

Condition (2): surcharge of 10 kPa, equivalent to 1 m of stockpiled peat assumed as a worst case.

8.3 Results of Analysis

8.3.1 Undrained Analysis for the peat

The results of the undrained analysis for the peat are presented in Appendix D.

For the Coor site the calculated FoS for load condition (1) is in excess of 1.30 for each Turbine and access track locations analysed with a FoS of ranging from 29 to in excess of 100 or greater at all turbine and track locations.

The calculated FoS for load condition (2) is in excess of 1.30 for each location analysed with a FoS of 15 or greater at all locations.

8.3.2 Drained Analysis for the peat

The results of the drained analysis for the peat are presented in Appendix D.

For the Coor site the calculated FoS for load condition (1) ranges from 2.4 to in excess of 10 at all turbine and access track locations

The calculated FoS for load condition (2) ranges from 2.1 to in excess of 10 at all locations.

9 RISK ASSESSMENT

9.1 Methodology for Risk Assessment

A risk assessment has been carried out for the turbine locations at the proposed wind farm development. This approach follows the guidelines for geotechnical risk management as given in Clayton (2001), as referenced in PHRAG, and takes into account the approach of MacCulloch (2005).

The risk assessment uses the results of the stability calculations in combination with qualitative factors, which cannot be reasonably included in a stability calculation but nevertheless may affect the occurrence of peat instability (such as evidence of sub-surface flow, surface water flow and presence of previous failure scars) to assess the risk for each infrastructure element (Table 3).

Table 3 Contributory Factors used to Assess Potential for Peat Failure

Contributory Factors	Comments
Combination of factors (shear strength, slope angle, peat depth with 10 kPa applied load)	Factor of safety based on infinite slope analysis.
Evidence of Sub Peat Water flow	Based on site walkover observations.
Surface Water Flow	Based on site walkover observations.
Evidence of previous slips	Based on site walkover observations.
Other	e.g. Mechanically cut peat

9.2 Geotechnical Risk Register

The result of the risk assessment for potential peat failure at infrastructure elements is presented as a Geotechnical Risk Register in Appendix A.

These contributory factors are each assigned a probability and impact value from which the level of control required is determined.

9.3 Probability

The likelihood of a hazard (peat failure) occurring has been based on the results of the stability calculation FoS and peat susceptibility zonation together with qualitative factors, where present.

The probability assigned to the FoS, peat stability susceptibility zonation and qualitative factors is judged on a qualitative scale (Table 4).

Table 4 Probability Scale

Scale	Factor of Safety	Probability
1	1.30 or greater	Negligible/None
2	1.29 to 1.20	Unlikely
3	1.19 to 1.11	Likely
4	1.01 to 1.10	Probable
5	≤1.0	Very Likely

Scale	Susceptibility Zone	Probability of Failure
1	Low	Least
3	Medium	
5	High	Greatest

Scale	Likelihood of Qualitative Factor leading to Peat Failure	Probability of Failure
1	Negligible/None	Least
2	Unlikely	
3	Likely	
4	Probable	
5	Very Likely	Greatest

9.4 Impact

The severity of the risk is also assessed qualitatively in terms of impact. The impact of a peat failure on the environment within and beyond the immediate wind farm site is assessed based on the potential travel distance of a peat failure. Where a peat failure enters a water course it can travel a considerable distance downstream. Therefore the proximity of a potential peat failure to a drainage course is a significant indicator of the likely potential impact.

The risk is determined based on the combination of hazard and impact. A qualitative scale has been derived for the impact of the hazard based on distance of infrastructure element to a watercourse (Table 5).

The location of watercourses is based on topographic maps and supplemented by site observations from walkover survey. Note that not all watercourses are shown on maps.

Table 5 Impact Scale

Scale	Criteria	Impact
1	Proposed infrastructure element greater than 150m of watercourse	Negligible/None
2	Proposed infrastructure element within 150 to 101m of watercourse	Low
3	Proposed infrastructure element within 100 to 51m of watercourse	Medium
4	Proposed infrastructure element within 50 m of watercourse	High

9.5 Risk Rating

The degree of risk is determined as the product of probability (P) and impact (I), which gives the Risk Rating (R) as follows:

The Risk Rating is calculated from: $R = P \times I$

The Risk Rating can range from 1 to 20 as shown in Table 6.

Table 6 Qualitative Risk Rating

		Probability				
		1	**2**	**3**	**4**	**5**
Impact	**4**	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5

Risk Rating & Control Measures

10 to 20	Unacceptable: re-location or significant control measures required
5 to 9	Substantial: notable control measures required
3 to 4	Tolerable: only routine control measures required
1 to 2	Trivial: none or only routine control measures required

Note. Where any individual contributory factor is given a probability of 5 then this defaults to an 'Unacceptable' risk rating irrespective of the impact.

In many cases a simple 4- to 5-level scale is considered sufficient (Clayton, 2001); in this case a 4-level scale is used. The control measures in response to the qualitative risk ratings are included in the Geotechnical Risk Register for each turbine in Appendix A.

The risk rating is calculated individually for each contributory factor.

Control measures are required to reduce the risk to at least a 'Tolerable' risk rating.

10 SUMMARY OF CONSTRUCTION RISKS AND MANAGEMENT

10.1 General Construction Risks in Peat

General factors which are considered to influence natural and construction induced mass movement of peat are as follows:

The Geotechnical Risk Register provides specific control measures for each turbine (see Appendix A). However the following general factors are considered to influence natural and construction induced peat instability and are provided for general guidance:

- Peat movement (failure) is a natural process of a peatland;
- Movement can occur during severe rainstorm events, frequently following summer storms particularly after relatively dry periods;
- Movement can occur following over-loading of peat slopes e.g. by placement of fill, stockpiling, end-tipping directly on to weak peat.
- Tension cracks (caused by desiccation or mass movement) increase instability;
- Failures may be more frequent as climate changes and as development moves into peatland areas;
- Failures are generally by translational sliding;
- Failure of internal drainage, and high groundwater conditions are key factors;
- An increase in porewater pressure lowers the stability of the slope;
- Failure tends to occur at or above the peat / mineral interface;
- In extreme events, peat can act as a viscous fluid and travel over very shallow slopes;
- The rate of construction can have a major influence, i.e. by overloading and /or altering permeability;
- Excavation across a slope particularly convex slope/break in slope can induce failure;
- Deposition of peat/fill directly on to in situ peat can induce failure of the in situ peat.

The consequence of peat failure at the site may result in:

- Death or injury to site personnel;
- Damage to machinery;
- Damage or loss of access tracks;
- Drainage disrupted;
- Site works damaged or unstable;
- Contamination of watercourses, water supplies by particulates;
- Degradation of the environment.

A subjective assessment of the risk of the project has been presented in the previous sections.

10.2 Design Risk Management Guidelines

The following issues incorporated into the design of the project will assist in the management of the risk from peat instability for this site. These issues have been specifically applied to each turbine and structure location, as appropriate.

- The use of experienced competent personnel;
- Mapping of features and establishing hydrology in "High" impact areas;
- Identifying and zoning the project for environmental impact should a failure occur;
- Consider micro-siting of turbines;
- Consider settlement rates to assist in determining method and time of floating road construction (if used);
- Design drainage systems for the control of silt;
- Set out contingency plan should peat movement occur;
- Set out the basis for the Geotechnical Risk Register.

10.3 Construction Risk Management Guidelines

The following issues incorporated into the construction phase of the project will assist in the management of the risks for this site.

- Appoint experienced and competent contractors;
- The site should be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project (be aware that decreasing the construction time has the potential to increase the risk of initiating a peat movement);
- Prevent undercutting of slopes and unsupported excavations;
- Maintain a managed robust drainage system;
- Prevent placement of loads/overburden on marginal ground;
- Set up, maintain and report findings from monitoring systems;
- Ensure construction method statements are followed or where agreed modified/ developed;
- Revise and amend the Geotechnical Risk Register as construction progresses.

11 FINDINGS OF ASSESSMENT

The following findings of the assessment are given.

(1) An assessment of the Coor Wind Farm site was carried out with respect to potential for peat failure. Coor Wind Farm comprises 6 nos. wind turbines and associated infrastructure.

(2) The site typically consists of mineral soil over siltstone and shale with localised areas containing a thin cover of peaty topsoil and pockets of peat varying in thickness from 0 to 1.6m.

(3) The location of the proposed turbines and associated facilities were inspected as part of a walkover survey by AGEC. Based on visual inspection at these locations no apparent signs of failure or instability within the peat were identified.

(4) Based on the thin peat thickness encountered on site, the stability of peat is considered satisfactory and this is evident from the calculated Factor of Safety (Appendix D).

(5) In general, the high FoS determined for the peat slopes at the proposed site indicates that there is minimal potential for peat failure.

(6) Specific design/construction and control measures at all turbine locations been identified within the Geotechnical Risk Register presented in Appendix A. Further general mitigation measures and best practise to ensure adequate management of peat instability at the site are given below, see recommendations.

12 CONCLUSION AND RECOMMENDATIONS

12.1 Conclusions

The following conclusions are given.

(1) The Coor site comprises 6 wind turbines and associated infrastructure (Figure 1 & 2).

(2) Peat depth across the sites ranges from 0 to 1.6m based on probe results. Deeper pockets of peat may be present across the site.

(3) Slope angles recorded for the site ranged from 0 to 14 degrees.

(4) The site typically consists of mineral soil over bedrock with areas containing a thin cover of peaty topsoil, and occasional pockets of peat. The bedrock was siltstone and shale.

(5) The results indicate undrained shear strengths in the range 28 to 100kPa for the peaty topsoil and peat.

(6) No signs of past failures or signs of instability were noted on site.

(7) There are existing tracks which run across the site and are in general are in relatively good condition. The existing tracks appear to have been founded on mineral soil.

(8) An analysis of peat sliding instability was carried out for each of the turbines across the site for both the drained and undrained conditions. The purpose of the analysis was to determine the Factor of Safety (FoS) of the peat slopes.

(9) For the undrained condition for the peat, the calculated FoS for load conditions (1) & (2) are in excess of 1.30 for each location analysed with a FoS of 10 or greater at all locations.

(10) For the drained condition for the peat, the calculated FoS for load conditions (1) & (2) range from 2.1 to in excess of 10 at all locations.

(11) The risk assessment at each turbine identified a number of control measures to reduce the potential risk of peat failure. Access roads to turbines should be subject to the same control measures that apply to the nearest turbine.

(12) In summary, the stability analysis results show that the FoS's for the Coor site are acceptable and are greater than the required minimum value of 1.3.

12.2 Recommendations

The following general recommendations are given.

(1) The control measures identified in the risk assessment and factors listed in Section 10 and Appendix A are to be implemented and amended throughout construction works.

(2) To minimise the risk of construction activity causing potential peat instability it is recommended that the Construction Method Statements (CMSs) for the project take into account, but not be limited, to the recommendations above. This will

ensure that best practice guidance regarding the management of peat stability will be inherent in the construction phase.

(3) A detailed analysis of the construction methods to be employed in the works is beyond the scope of this report, though good practice recommendations are included in the above sections.

13 REFERENCES

Applied Ground Engineering Consultants (AGEC) (2004). Derrybrien Wind Farm Final Report on Landslide of October 2003.

Bromhead, E.N. (1986). The Stability of Slopes.

Clayton, C.R.I. (2001). Managing Geotechnical Risk. Institution of Civil Engineers, London.

Dykes, A.P. and Kirk, K.J. (2006). Slope instability and mass movements in peat deposits. In Martini, I.P., Martinez Cortizas, A. and Chesworth, W. (Eds.) Peatlands: Evolution and Records of Environmental and Climatic Changes. Elsevier, Amsterdam.

Farrell, E.R. & Hebib, S. (1998). The determination of the geotechnical parameters of organic soils. Proceedings of International Symposium on problematic soils, IS-TOHOKU 98, Sendai, Japan.

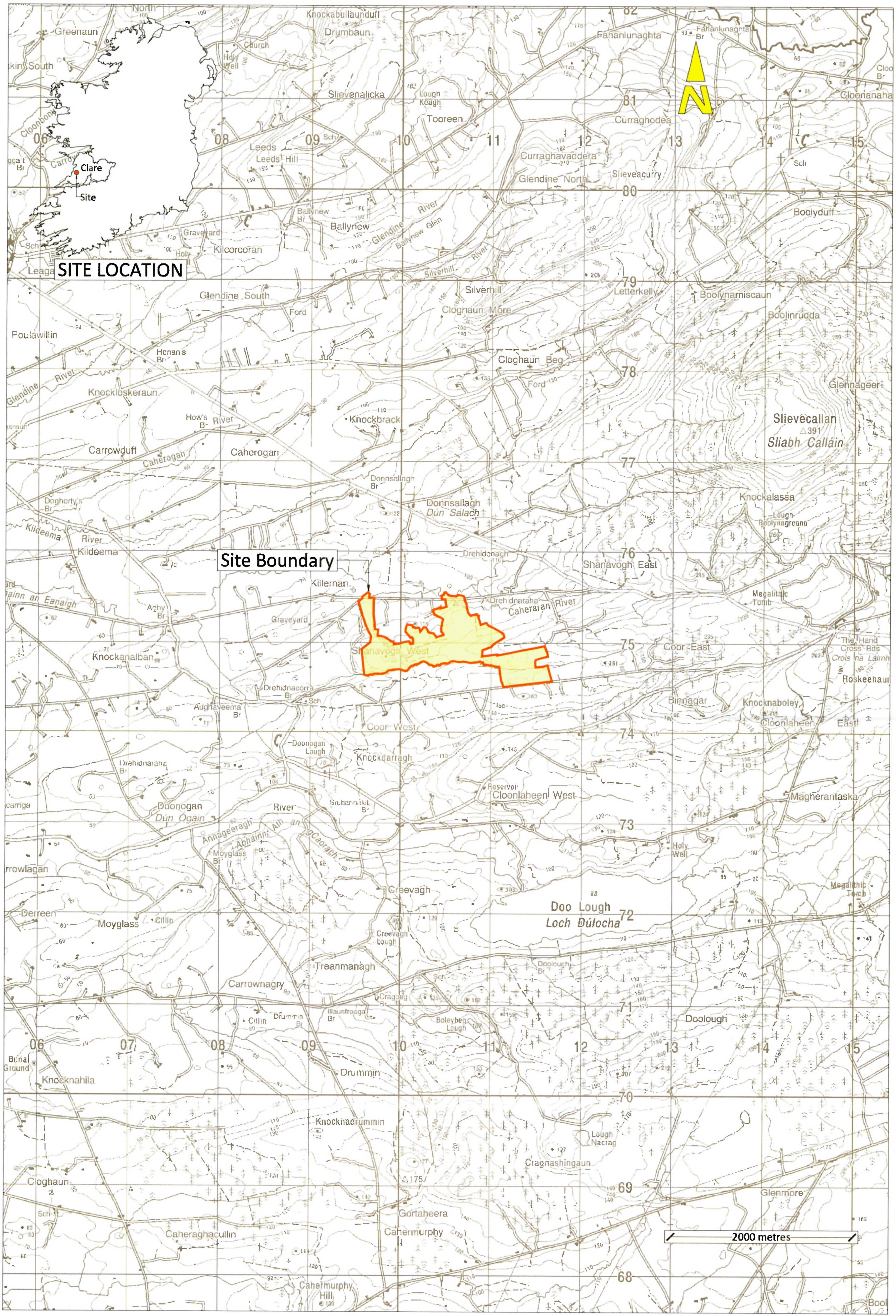
Geological Survey of Ireland (2006). Landslides in Ireland. Geological Survey of Ireland - Irish Landslides Group. July 2006.

Geological Survey of Ireland (1999). Sheet 17; Geology of the Shannon Estuary.

Hanrahan, E.T., Dunne, J.M. and Sodha, V.G. (1967). Shear strength of peat. Proc. Geot. Conf., Oslo, Vol. 1.

MacCulloch, F. (2005). Guidelines for the Risk Management of Peat Slips on the Construction of Low Volume/Low Cost Roads over Peat. RoadEx 11 Northern Periphery.

FIGURES



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Date: 11 April 2011
Drawn: POR
Checked: I.H.
Revision: A
Based on:

Client:
INIS Environmental Consultants Ltd.
Inis

Job:
Proposed Coor Wind Farm, Co. Clare.

Title:
Site Location

Drg. No. Figure 1

AGEC Ltd
The Grainstore
Singletons Lane
Bagenalstown
Carlow
Ireland

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Fax: +353 59 972 3793

agec

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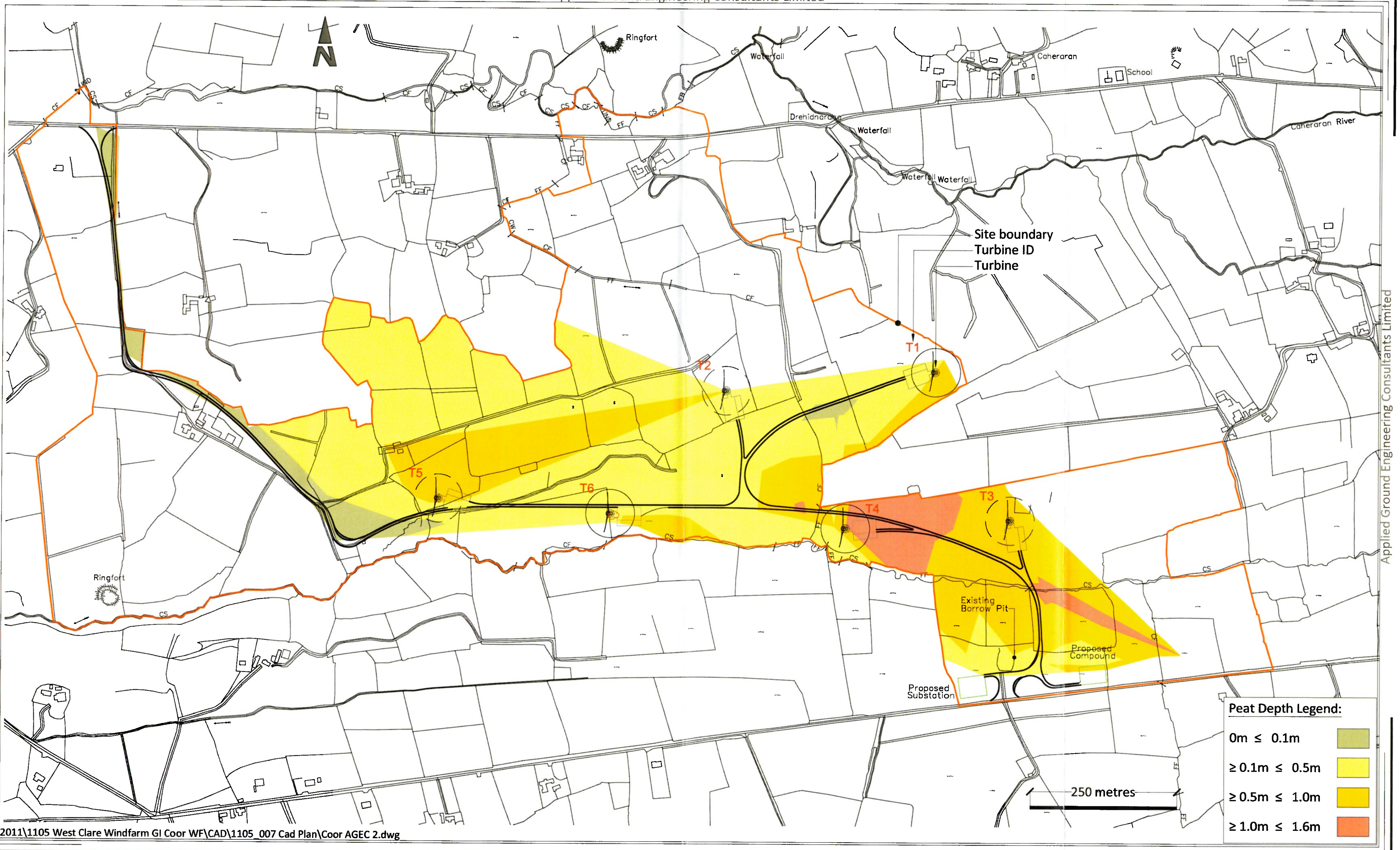

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Checked: I.H.
Date: 18 April 2011
Revision: A
Drawn: P.O.R.
Based on:

Client:
INIS Environmental Consultants Ltd.

Job:
Proposed Coor Windfarm
Co. Clare

Figure 2

Title:
Peat Thickness Zonation Plan

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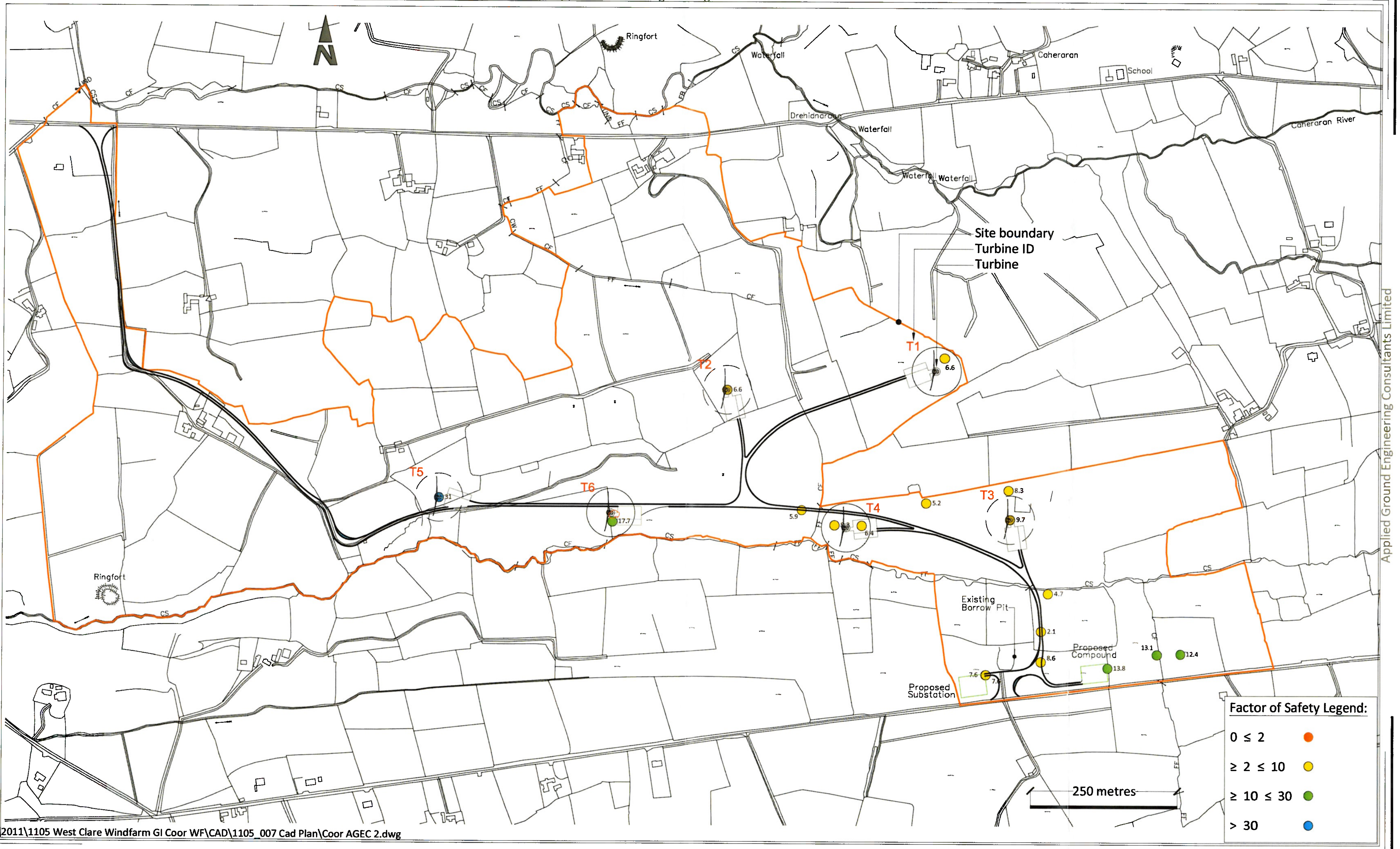

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Scale: 1:6000 @ A3
Checked: I.H.
Date: 18 April 2011
Revision: A
Drawn: P.O.R.
Based on:

Client:
INIS Environmental
Consultants Ltd.

Job:
Proposed Coor Windfarm
Co. Clare

Figure 3

Title:
Factor of Safety Plan

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Fax: +353 59 972 3793
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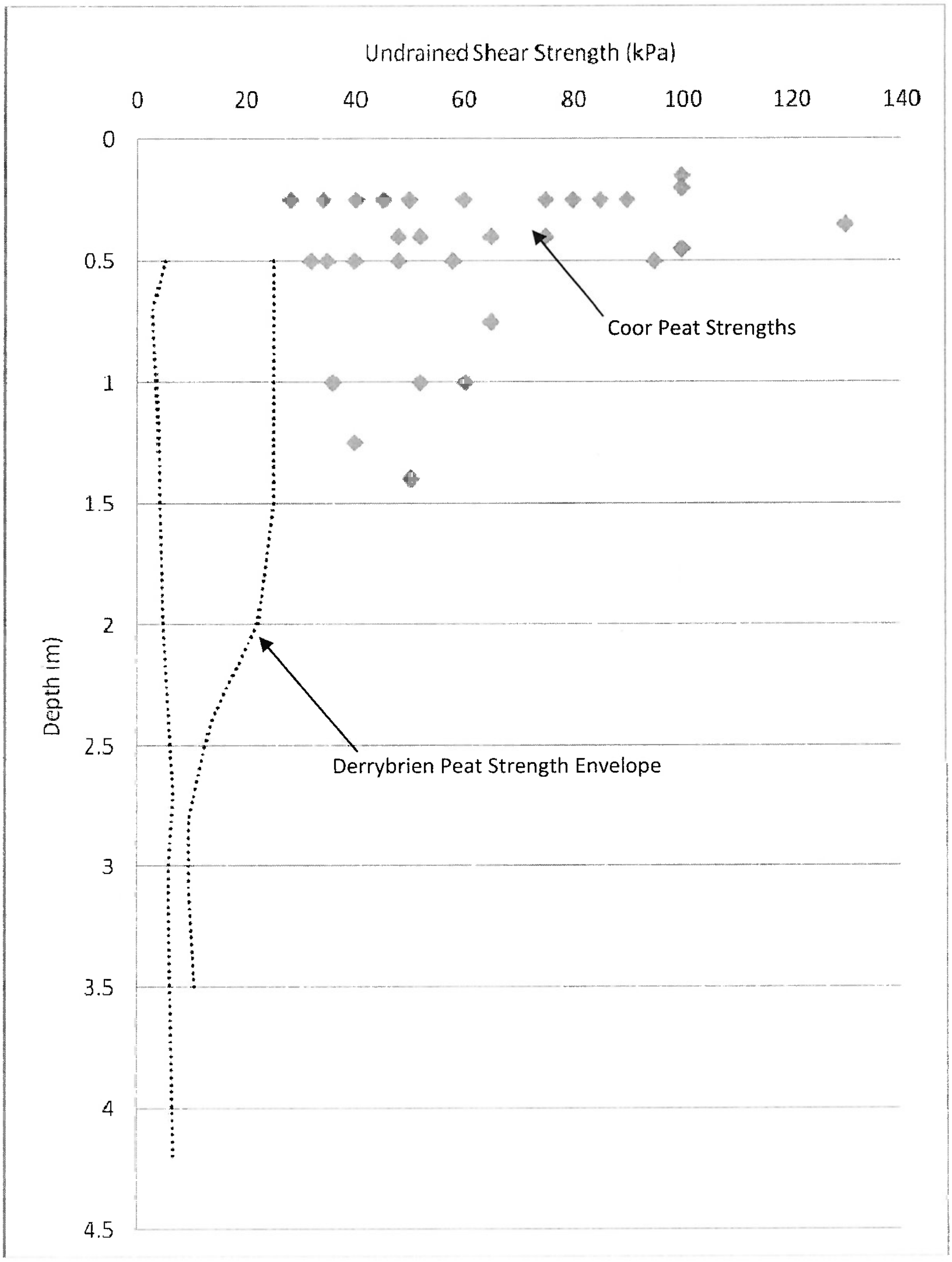


Figure 4: Undrained Shear Strength (C_u) Profile for Peat with Depth

APPENDIX A

GEOTECHNICAL RISK REGISTER

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 1**

Grid Reference (Eastings, Northings):	**111091 175077**
Distance to Watercourse (m)	**>150**
Indicative Measured Peat Depth (m):	**0.5**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 65 (u), 6.6 (d) within zone of low susceptibilty	1	1	1	Trivial	No	See Below	1	1	1	Trivial
2	Evidence of sub peat water flow	1	1	1	Trivial	No		1	1	1	Trivial
4	Surface water flow	1	1	1	Trivial	No		1	1	1	Trivial
5	Evidence of previous slips	1	1	1	Trivial	No		1	1	1	Trivial
6	Other	0	1	0	Not applicable	No		0	1	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 1**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available;

Note

(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 2**

Grid Reference (Eastings, Northings):	**110736 175045**
Distance to Watercourse (m)	**>150**
Indicative Measured Peat Depth (m):	**0.5**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 38 (u), 6.6 (d) within zone of low susceptibilty	1	1	1	Trivial	No	See Below	1	1	1	Trivial
2	Evidence of sub peat water flow	1	1	1	Trivial	No		1	1	1	Trivial
4	Surface water flow	1	1	1	Trivial	No		1	1	1	Trivial
5	Evidence of previous slips	1	1	1	Trivial	No		1	1	1	Trivial
6	Other	0	1	0	Not applicable	No		0	1	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 2**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available;

Note

(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 3**

Grid Reference (Eastings, Northings):	**111217 174826**
Distance to Watercourse (m)	**100**
Indicative Measured Peat Depth (m):	**0.7**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 54 (u), 9.7 (d) within zone of low susceptibilty	1	3	3	Tolerable	No	See Below	1	2	2	Trivial
2	Evidence of sub peat water flow	1	3	3	Tolerable	No		1	2	2	Trivial
4	Surface water flow	1	3	3	Tolerable	No		1	2	2	Trivial
5	Evidence of previous slips	1	3	3	Tolerable	No		1	2	2	Trivial
6	Other	0	3	0	Not applicable	No		0	2	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 3**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available;

Note

(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 4**

Grid Reference (Eastings, Northings):	**110939 174812**
Distance to Watercourse (m)	**40**
Indicative Measured Peat Depth (m):	**0.5**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 62 (u), 8.3 (d) within zone of low susceptibilty	1	4	4	Trivial	No	See Below	1	2	2	Trivial
2	Evidence of sub peat water flow	1	4	4	Trivial	No		1	2	2	Trivial
4	Surface water flow	1	4	4	Trivial	No		1	2	2	Trivial
5	Evidence of previous slips	1	4	4	Trivial	No		1	2	2	Trivial
6	Other	0	4	0	Not applicable	No		0	2	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 4**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available:

Note

(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 5**

Grid Reference (Eastings, Northings):	**110247 174861**
Distance to Watercourse (m)	**85**
Indicative Measured Peat Depth (m):	**0.6**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 122 (u), 31 (d) within zone of low susceptibilty	1	3	3	Tolerable	No	See Below	1	2	2	Trivial
2	Evidence of sub peat water flow	1	3	3	Tolerable	No		1	2	2	Trivial
4	Surface water flow	1	3	3	Tolerable	No		1	2	2	Trivial
5	Evidence of previous slips	1	3	3	Tolerable	No		1	2	2	Trivial
6	Other	0	3	0	Not applicable	No		0	2	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 5**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available;

Note

(1) FOS abbreviations are: u: FOS for undrained analysis, d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

Coor Geotechnical Risk Register for Potential Peat Failure (Rev 1)

Location:	**Turbine 6**

Grid Reference (Eastings, Northings):	**110538 174836**
Distance to Watercourse (m)	**40**
Indicative Measured Peat Depth (m):	**0.4**
Control Required:	**No**

		Pre-Control Measure Implementation						Post-Control Measure Implementation			
Ref.	Contributory Factors to Potential Peat Failure	Prob	Impact	Risk	Risk Rating	Control Required	Control measures to be implemented during construction	Prob	Impact	Risk	Risk Rating
1	FOS = 153 (u), 177 (d) within zone of low susceptibilty	1	4	4	Tolerable	No	See Below	1	2	2	Trivial
2	Evidence of sub peat water flow	1	4	4	Tolerable	No		1	2	2	Trivial
4	Surface water flow	1	4	4	Tolerable	No		1	2	2	Trivial
5	Evidence of previous slips	1	4	4	Tolerable	No		1	2	2	Trivial
6	Other	0	4	0	Not applicable	No		0	2	0	Not applicable

	Control Measures to be Implemented Prior to/and During Construction for **Turbine 6**
i	Maintain hydrology of area as far as possible;
ii	Use of experienced geotechnical staff for site investigation;
iii	Use of experienced contractors and trained operators to carry out the work.
iv	Detailed Ground investigation to determine bedrock, peat, glacial till thickness;
v	Calculate the FOS for the excavation and overburden storage (where permitted);
vi	A Factor of Safety (FOS) against peat instability calculated when further detailed GI and design available;

Note

(1) FOS abbreviations are: u: FOS for undrained analysis. d: FOS for drained analysis.

(2) For the FOS contributory factor the lowest of the FOS (u or d) or susceptibilty zone is used to determine probability risk.

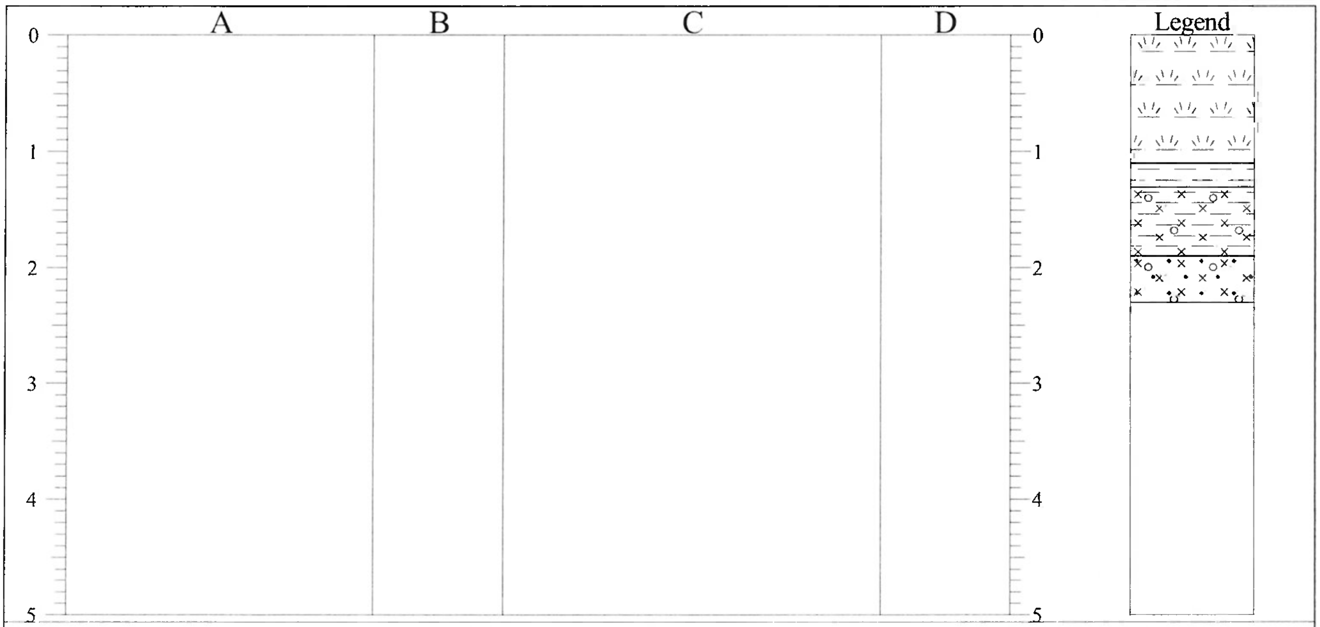
APPENDIX B

SITE INVESTIGATION LOGS

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

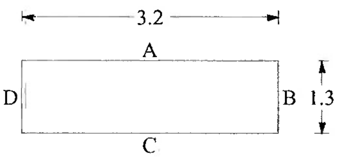
TRIAL PIT LOG

Project Coor Wind Farm		Location Miltown Malbay, County Clare	TRIAL PIT No **TP B1**
Job No	Date 24-03-11 24-03-11	Ground Level (m)	Co-Ordinates ()
Engineer AGEC	GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet 1 of 1 Rev.



STRATA				SAMPLES & TESTS			
Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-1.10		Rushes overfirm black PEAT (H2).			0.80	B	
1.10-1.30		Soft dark grey CLAY.					
1.30-1.90		Firm bluish grey SILT interbedded with bands of slightly gravelly CLAY. Gravel is angular, fine.		1 ▽ 1 ▼	1.30	B	
1.90-2.30		Firm bluish grey SILT interbedded with lenses of wet grey slightly sandy silty gravel. Gravel is angular, fine.					
2.30		Pit terminated - refusal, possible rock.					

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

Water ingress at 2.30m depth.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project Coor Wind Farm		Location Miltown Malbay, County Clare		TRIAL PIT No **TP B2**
Job No	Date 24-03-11 24-03-11	Ground Level (m)	Co-Ordinates ()	
Engineer AGEC		GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet 1 of 1 Rev.

A B C D

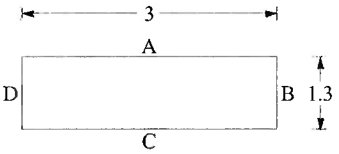
Legend

STRATA

SAMPLES & TESTS

Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-0.50		MADE GROUND - Dark brown silty gravel with cobbles and boulders.Gravel is angular and subangular.					
0.50-0.80		Probable weathered ROCK: Recovered as reddish brown angular to subangular, flat and elongate GRAVEL. Gravel is medium to coarse.			0.80	B	
0.80-1.00		Angular fragments of MUDSTONE.					
1.00		Pit terminated - refusal, intact rock.		▽1 ▼1			

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

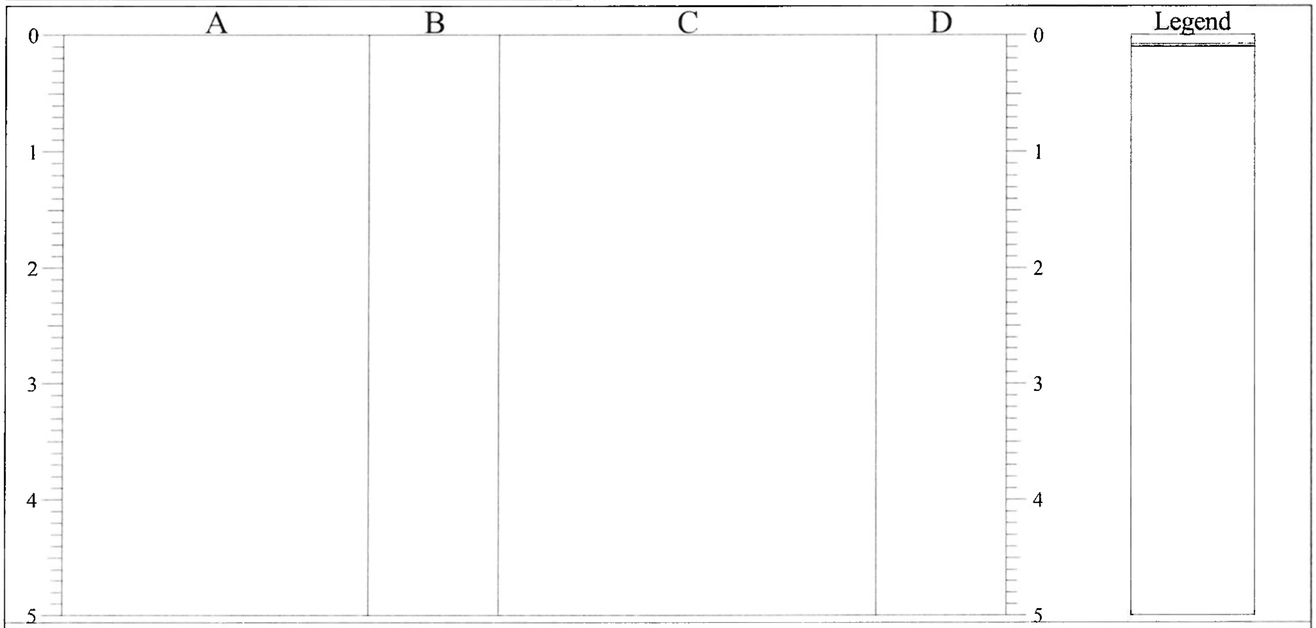
Water ingress at 0.40m depth.
Rock breaker used from 0.80m depth to obtain rock samples.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project Coor Wind Farm		Location Miltown Malbay, County Clare		TRIAL PIT No **TP B3**
Job No	Date 24-03-11 24-03-11	Ground Level (m)	Co-Ordinates ()	
Engineer AGEC		GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet Rev. 1 of 1

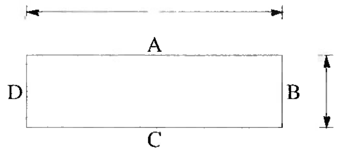


STRATA

SAMPLES & TESTS

Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-0.10		Angular fragments of blue grey ,moderately weak MUDSTONE.			0.10	B	
0.10		Pit terminated - refusal, intact rock.					
				1 ▽			
				1 ▼			

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

Pit location moved 30m west to obtain rock samples from existing quarry face.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project: Coor Wind Farm		Location: Miltown Malbay, County Clare		TRIAL PIT No **TP B4**
Job No	Date: 24-03-11 24-03-11	Ground Level (m)	Co-Ordinates () E 110,950.0 N 174,979.0	
Engineer: AGEC		GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to(@ 20 min.): 1.40m Sealed at:	Sheet Rev. 1 of 1

A B C D

Legend: ▨

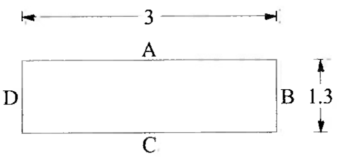
STRATA

Depth	No	DESCRIPTION
0.00-0.50		Grey brown flat, elongate and angular COBBLES and BOULDERS of mudstone.
0.50		Pit terminated - refusal, intact rock.

SAMPLES & TESTS

In Situ Tests	Water	Depth (m)	No	Remarks/Tests
		0.50	B	
	▽1 ▼1			

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

Pit dry during excavation. Rock breaker used at 0.50m depth to obtain rock samples.

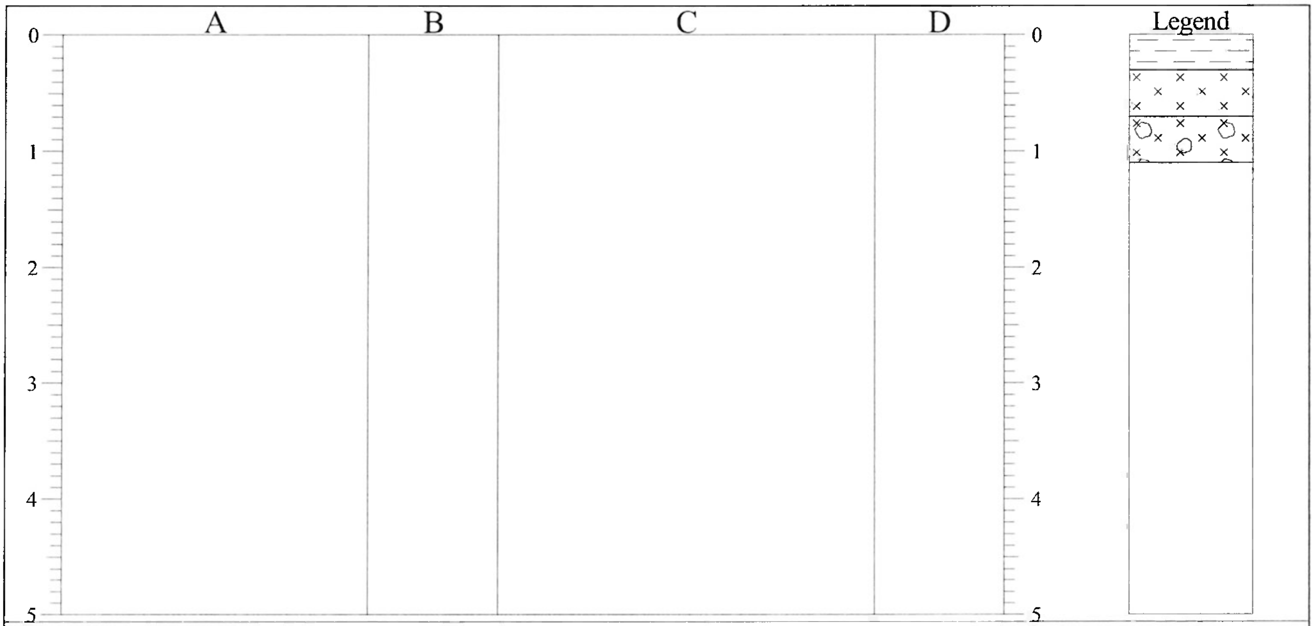
All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used: Hitachi13T	Bit Design	Driller	Logged By: MM

IDL AGS3 UK TP COOR WIND FARM.GPJ AGS 3_1.GDT 12/4/11

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project Coor Wind Farm		Location Miltown Malbay, County Clare		TRIAL PIT No **TP T1**
Job No	Date 25-03-11 25-03-11	Ground Level (m)	Co-Ordinates ()	
Engineer AGEC		GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet 1 of 1 Rev.



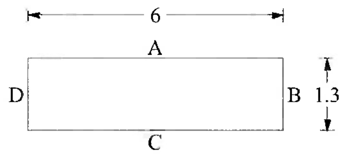
STRATA

Depth	No	DESCRIPTION
0.00-0.30		Grass over firm brown peaty TOPSOIL.
0.30-0.70		Firm grey organic SILT.
0.70-1.10		Stiff mottled blue grey orange SILT with many flat, angular and elongated mudstone boulders.
1.10		Pit terminated - refusal, intact rock.

SAMPLES & TESTS

In Situ Tests	Water	Depth (m)	No	Remarks/Tests
		1.10	B	

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

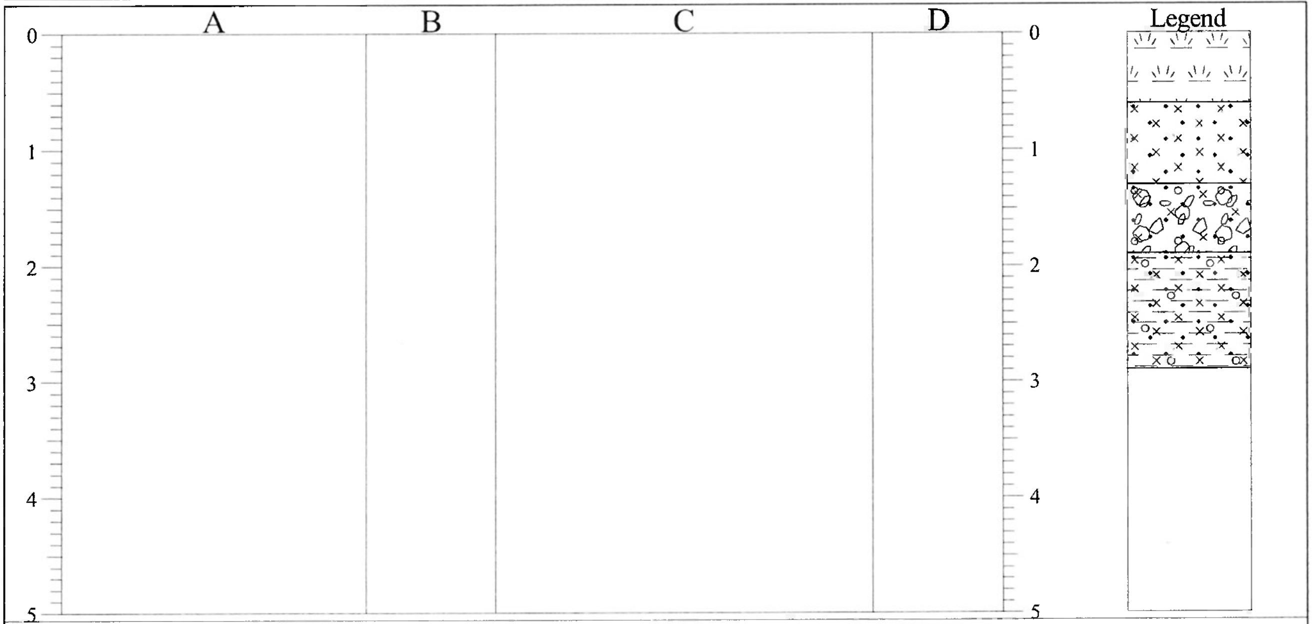
Water seepage at 1.10m depth.
Pit extended to expose rock face to west of pit.
Rock breaker used at 1.10m depth to recover rock samples.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project Coor Wind Farm		Location Miltown Malbay, County Clare	TRIAL PIT No **TP T2**
Job No	Date 25-03-11 25-03-11	Ground Level (m)	Co-Ordinates ()
Engineer AGEC	GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet Rev. 1 of 1

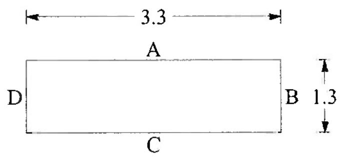


STRATA

SAMPLES & TESTS

Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-0.60		Grass and reeds over firm black PEAT (H2,W3).			0.30	B	
0.60-1.30		Soft grey slightly sandy SILT.					
1.30-1.90		Grey silty sandy GRAVEL (wet) interbedded with stiff grey SILT and occasional blocky, angular and subangular cobbles of mudstone.Gravel is fine, angular to subangular.		1 ▽ 1 ▼			
1.90-2.90		Stiff damp brown bluish grey slightly sandy gravelly SILT/CLAY. Gravel is fine to medium.			2.00	B	
2.90		Pit terminated - refusal. Possible rock or boulder.					

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

Pit dry during excavation.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

IDL AGS3 UK TP COOR WIND FARM.GPJ AGS 3_1.GDT 12/4/11

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

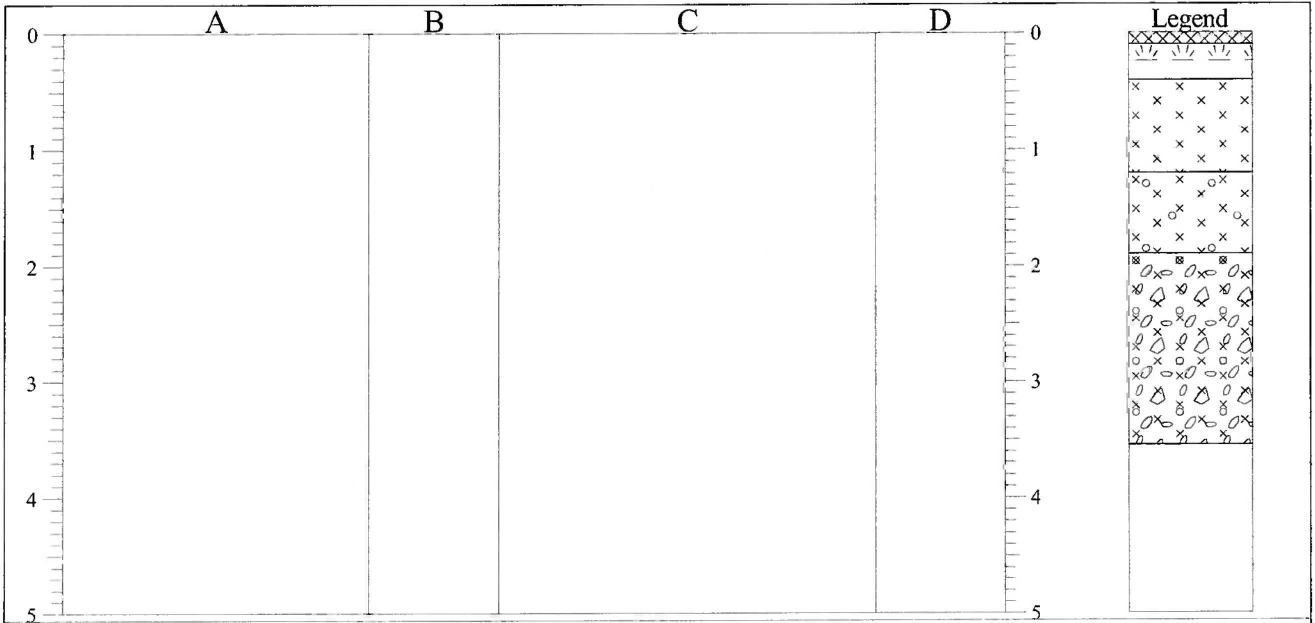
Project: Coor Wind Farm
Location: Miltown Malbay, County Clare
TRIAL PIT No: **TP T4**

Job No:
Date: 24-03-11 24-03-11
Ground Level (m):
Co-Ordinates ():

Engineer: AGEC

GROUNDWATER STRIKES	Water strikes:	Rose to (@ 20 min.):	Sealed at:
	1st: 1.70m	1.40m	
	2nd:		
	3rd:		

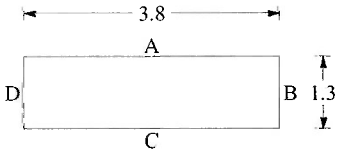
Sheet
Rev. 1 of 1



STRATA | SAMPLES & TESTS

Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-0.10		MADE GROUND - Rushes over firm brown damp sandy silty topsoil.					
0.10-0.40		Firm black PEAT (H2).					
0.40-1.20		Soft mottled blue grey orange organic SILT.					
1.20-1.90		Probable weathered ROCK. Recovered as brown mottled orange grey very gravelly SILT. Gravel is angular.		▽ ▼			
1.90-3.55		Probable weathered ROCK. Recovered as grey brown very silty fine to coarse GRAVEL. Gravel is angular, flat and elongate.			2.00	B	
3.55		Pit terminated - refusal. Possible rock.					

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

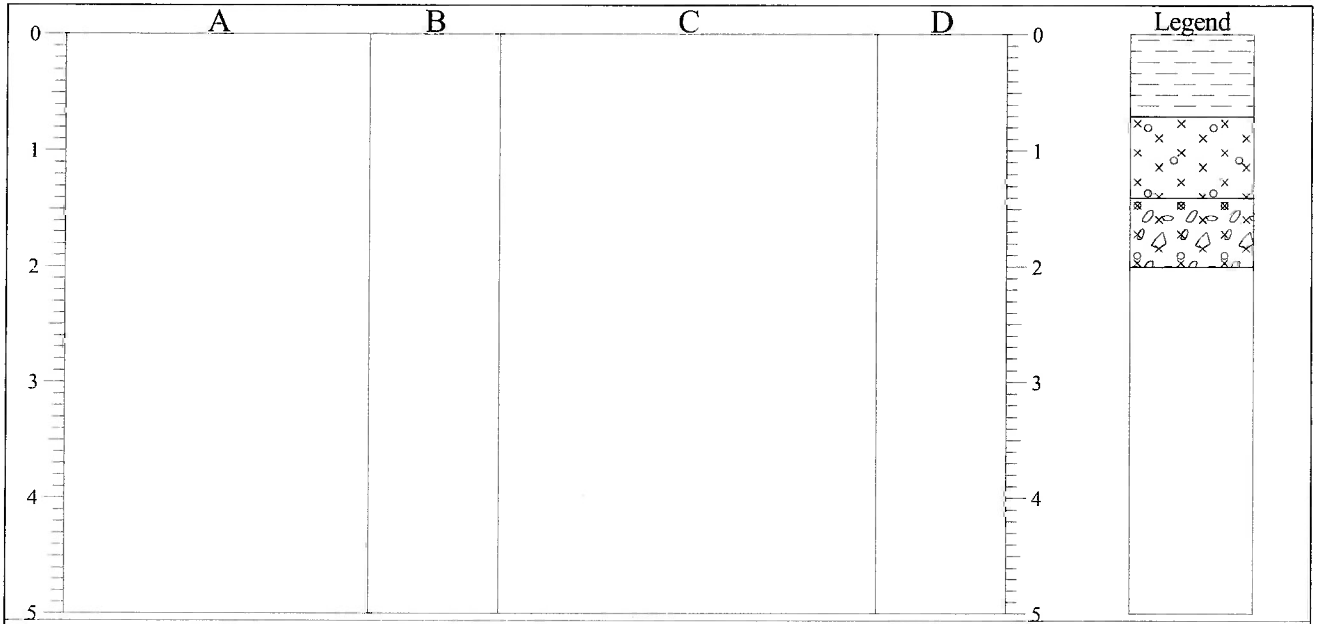
Water ingress at 3.00m depth.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used Hitachi13T	Bit Design	Driller	Logged By MM

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

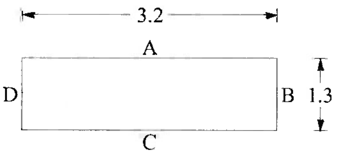
Project: Coor Wind Farm	Location: Miltown Malbay, County Clare		TRIAL PIT No **TP T5**
Job No:	Date: 24-03-11 24-03-11	Ground Level (m):	Co-Ordinates ():
Engineer: AGEC	GROUNDWATER STRIKES: Water strikes: 1st: 1.70m; Rose to (@ 20 min.): 1.40m; Sealed at: 2nd: 3rd:		Sheet 1 of 1 Rev.



STRATA / SAMPLES & TESTS

Depth	No	DESCRIPTION	In Situ Tests	Water	Depth (m)	No	Remarks/Tests
0.00-0.70		Trees and rushes over firm brown peaty TOPSOIL.					
0.70-1.40		Stiff damp grey gravelly SILT. Gravel is fine, angular.					
1.40-2.00		Possible weathered ROCK. Recovered as grey brown very silty fine to coarse GRAVEL with many cobbles and boulders. Gravel is angular, flat and elongate.		1			
2.00		Pit terminated - refusal. Possible intact rock.			2.00	B	

Shoring/Support:
Stability: Pit stable during excavation.



GENERAL REMARKS

Water seepage at 2.00m depth.

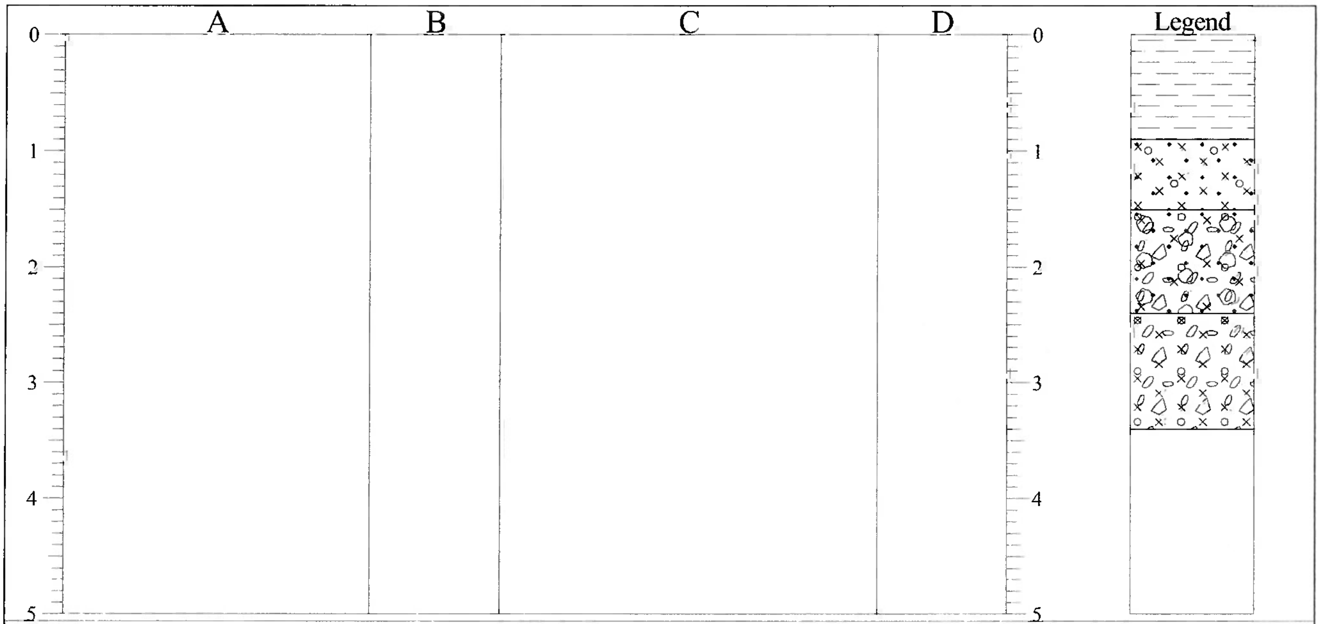
All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used: Hitachi13T	Bit Design	Driller	Logged By: MM

IDL AGS3 UK TP COOR WIND FARM.GPJ AGS 3_1.GDT 12/4/11

Irish Drilling Limited
Old Galway Road
Loughrea, Co. Galway
Telephone: 091 841274

TRIAL PIT LOG

Project: Coor Wind Farm		Location: Miltown Malbay, County Clare	TRIAL PIT No **TP T6**
Job No	Date: 24-03-11 24-03-11	Ground Level (m)	Co-Ordinates ()
Engineer: AGEC	GROUNDWATER STRIKES	Water strikes: 1st: 1.70m 2nd: 3rd: Rose to (@ 20 min.): 1.40m Sealed at:	Sheet 1 of 1 Rev.



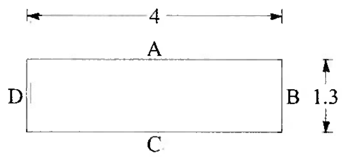
STRATA

Depth	No	DESCRIPTION
0.00-0.90		Grass and rushes over brown peaty TOPSOIL.
0.90-1.50		Stiff mottled orange grey slightly sandy gravelly SILT. Gravel is fine, angular.
1.50-2.40		Stiff bluish grey slightly sandy SILT interbedded with layers of wet sandy fine to medium angular to subangular GRAVEL with many cobbles and boulders.
2.40-3.40		Probable weathered ROCK. Recovered as grey brown silty fine to medium GRAVEL. Gravel is angular, flat and elongate.
3.40		Pit terminated - refusal. Possible intact rock.

SAMPLES & TESTS

In Situ Tests	Water	Depth (m)	No	Remarks/Tests
	▽ 1 ▼			
		3.00	B	

Shoring/Support:
Stability: Pit unstable form 2.40m depth.



GENERAL REMARKS

Pit dry during excavation.

All dimensions in metres Scale 1:62.5	Client	Method/ Plant Used: Hitachi13T	Bit Design	Driller	Logged By: MM

APPENDIX C

CASE HISTORY OF SOME IRISH PEAT FAILURES

Location and Reference	Type (2)	Regional Slope	Comment
Derrybrien Wind Farm (AGEC, 2004)	Slide	4°	Failure initiated by placement of peat arisings onto peat surface at head of shallow valley feature. Degraded into a flow.
Straduff, Sligo (Alexander et al., 1985)	Flow	3-5°	Other failures noted in area, clay rich drift may have precipitated failures.
Tullymascreen Townland, (Alexander et al., 1985)	Flow	2-3° dipping to 7°	Turf cutting in area. Heavy rainfall noted. Volume:11,000m2
Slieve an Orra, Co. Antrim (Tomlinson & Gardner, 1982)	Slide(s)	8-17° (compound slope)	Seven slides were reported in close proximity. Slides occurred between horizons of sandy and more clayey glacial till, following heavy rain.
Carrowmaculla, Fermanagh, (Tomlinson, 1981)	Flow	2-5°	Failure took place with heavy rainfall at a break in slope, a boundary drain had been excavated at the front face.
Slieve Rushen Ballyconnell, Co. Cavan (Colhoun, 1965)	Flow	5-8°	Failure followed intense rainfall. Top layer of brown upper fibrous peat slid over lower black amorphous peat (1)
Meenacharry, Co. Donegal (Bishop & Mitchell, 1946)	Flow	5.5°	Failure caused by breach of firm dry peat located at break in slope and followed heavy rain and snow.
Wicklow Mountains, (Mitchell, 1938)	Slide	8-14°	Slide took place along interface of humified peat and bedrock.
Slieve Aughty mountains, Co. Clare (Mitchell, 1935)	Flow	4°	Failure caused by breach of firm dry peat located at convex break in slope and followed heavy rain.
Knockmageeha, Killarney, (Praeger, 1897)	Flow	2°	Large flow from 1-3m thick cutting. Unsupported trench excavation had taken place at toe and material appeared to ooze from beneath

Note:

(1) Labelled as a flow by author but description of the failure is reminiscent of sliding mode.

(2) Many slides degrade into flows therefore some of the failure types may be misclassified.

Table B.1 Case History of Some Irish Peat Failures

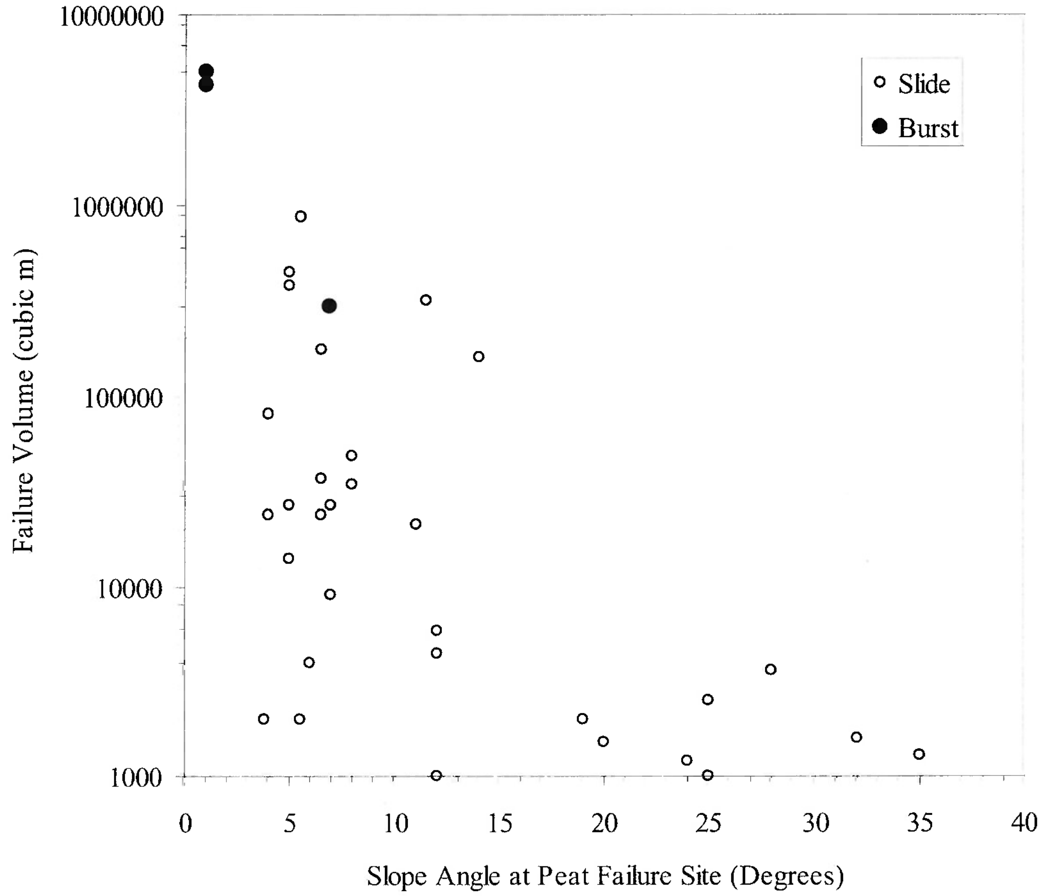


Figure B.1 Slope Angles and Failure Volumes at Sites of Some Irish Peat Failures

Notes:

(1) Peat failure data based on review of some 30 Irish failures from 19th and 20th century.

(2) Peat failure data is based on reported information or field measurement.

APPENDIX D

CALCULATED FOS FOR TURBINES & ACCESS ROADS

Calculated FoS of Peat Slopes for Coor Windfarm (Undrained Analysis)

Turbine Location or Waypoint	Easting	Northing	Slope	Undrained shear strength	Bulk unit weight of Peat	Peat Depth	Surcharge Equivalent Placed Fill Depth (m)	Factor of Safety for Load Condition	
			β (deg)	c_u (kPa)	γ (kN/m^3)	(m)	Condition (2)	Condition (1)	Condition (2)
								100% Water	100% Water
Infrastructure Locations e.g. Turbines, Substation, Construction Compound									
T1	111105	175099	5	85	10.0	0.5	1.5	**195.80**	**65.27**
T2	110736	175045	5	50	10.0	0.5	1.5	**115.18**	**38.39**
T3	111217	174826	3	48	10.0	0.7	1.7	**131.20**	**54.02**
T4	110920	174816	4	65	10.0	0.5	1.5	**186.82**	**62.27**
T5	110247	174861	1	34	10.0	0.6	1.6	**324.74**	**121.78**
T6	110541	174821	2	75	10.0	0.4	1.4	**537.58**	**153.60**
Construction compound	111507	174599	2	35	10	1	2.0	**100.35**	**50.17**
Substation	111176	174563	5	100	10	0.3	1.3	**383.92**	**88.60**
Access tracks									
18	110864	174842	4	40	10	1.1	2.1	**52.26**	**27.37**
23	111269	174637	14	80	10	0.7	1.7	**48.69**	**20.05**
25	111176	174563	5	100	10	0.3	1.3	**383.92**	**88.60**
27	111269	174585	4	75	10	0.45	1.5	**239.51**	**74.33**
29	111467	174598	2	45	10	0.9	1.9	**143.36**	**67.91**
31	110965	174815	3	52	10	1.6	2.6	**62.18**	**38.27**
WP001	111281	174701	5	28	10	1.1	2.1	**29.32**	**15.36**
WP002	111382	174575	2	40	10	0.8	1.8	**143.36**	**63.71**
WP006	111214	174876	4	60	10	0.5	1.5	**172.45**	**57.48**
WP007	111075	174854	4	32	10	1.4	2.4	**32.85**	**19.16**

Minimum =	29.32	15.36
Maximum =	537.58	153.60
Average =	182.41	61.46

Notes:

(1) Assuming a bulk unit weight for peat of 10kN/m^3

(2) Assuming a surcharge equivalent to fill depth of 1m of peat.

(3) Slope inclination (β) based on site readings & estimated inclinations based on closest recorded values are highlighted as: ▨

(4) Undrained shear strength values also based on lowest recorded value at each location. Where no data is present, an assumed lower bound value is used and is highlighted as: ☐

(5) Peat depths based on peat depth probes.

(6) For load conditions see Report text.

Calculated FoS of Peat Slopes for Coor Windfarm (Drained Analysis)

Turbine Location or Waypoint	Slope	Design c'	Bulk unit weight of Peat	Unit weight of Water	100% Water to height of Peat	Depth of In situ Peat	Friction Angle	Surcharge Equivalent Placed Fill Depth (m)	Equivalent Total Depth of Peat (m)	Factor of Safety for Load Condition	
	α (deg)	c' (kPa)	γ (kN/m^3)	γ_w (kN/m3)	(m)	(m)	ø' (deg)	Condition (2)	Condition (2)	Condition (1)	Condition (2)
										100% Water	100% Water
Infrastructure Locations e.g. Turbines, Substation, Construction Compound											
T1	5	4	10.0	10.0	0.5	0.5	25	1.0	1.50	**9.21**	**6.62**
T2	5	4	10.0	10.0	0.5	0.5	25	1.0	1.50	**9.21**	**6.62**
T3	3	4	10.0	10.0	0.7	0.7	25	1.0	1.70	**10.93**	**9.74**
T4	4	4	10.0	10.0	0.5	0.5	25	1.0	1.50	**11.50**	**8.28**
T5	1	4	10.0	10.0	0.6	0.6	25	1.0	1.60	**38.20**	**31.02**
T6	2	4	10.0	10.0	0.4	0.4	25	1.0	1.40	**28.67**	**17.73**
Construction compound	2	4	10.0	10.0	1.0	1	25	1.0	2.00	**11.47**	**12.41**
Substation	5	4	10.0	10.0	0.3	0.3	25	1.0	1.30	**15.36**	**7.64**
Access Tracks											
18	4	4	10.0	10.0	1.1	1.1	25	1.0	2.10	**5.23**	**5.91**
23	14	4	10.0	10.0	0.7	0.7	25	1.0	1.70	**2.43**	**2.10**
25	5	4	10.0	10.0	0.3	0.3	25	1.0	1.30	**15.36**	**7.64**
27	4	4	10.0	10.0	0.5	0.45	25	1.0	1.45	**12.77**	**8.56**
29	2	4	10.0	10.0	0.9	0.9	25	1.0	1.90	**12.74**	**13.06**
31	3	4	10.0	10.0	1.6	1.6	25	1.0	2.60	**4.78**	**6.37**
WP001	5	4	10.0	10.0	1.1	1.1	25	1.0	2.10	**4.19**	**4.73**
WP002	2	4	10.0	10.0	0.8	0.8	25	1.0	1.80	**14.34**	**13.79**
WP006	4	4	10.0	10.0	0.5	0.5	25	1.0	1.50	**11.50**	**8.28**
WP007	4	4	10.0	10.0	1.4	1.4	25	1.0	2.40	**4.11**	**5.17**

Minimum =	**2.43**	**2.10**
Maximum =	**38.20**	**31.02**
Average =	**12.33**	**9.76**

Notes:

(1) Assuming a bulk unit weight of peat of 10 (kN/m^3)

(2) Assuming a surcharge equivalent to fill depth of 1.0 (m)

(3) Slope inclination (β) based on site readings & estimated inclinations based on closest recorded values are highlighted as: ▨

(4) FoS is based on slope inclination and shear test results obtained from published data.

(5) Peat depths based on peat depth probes.

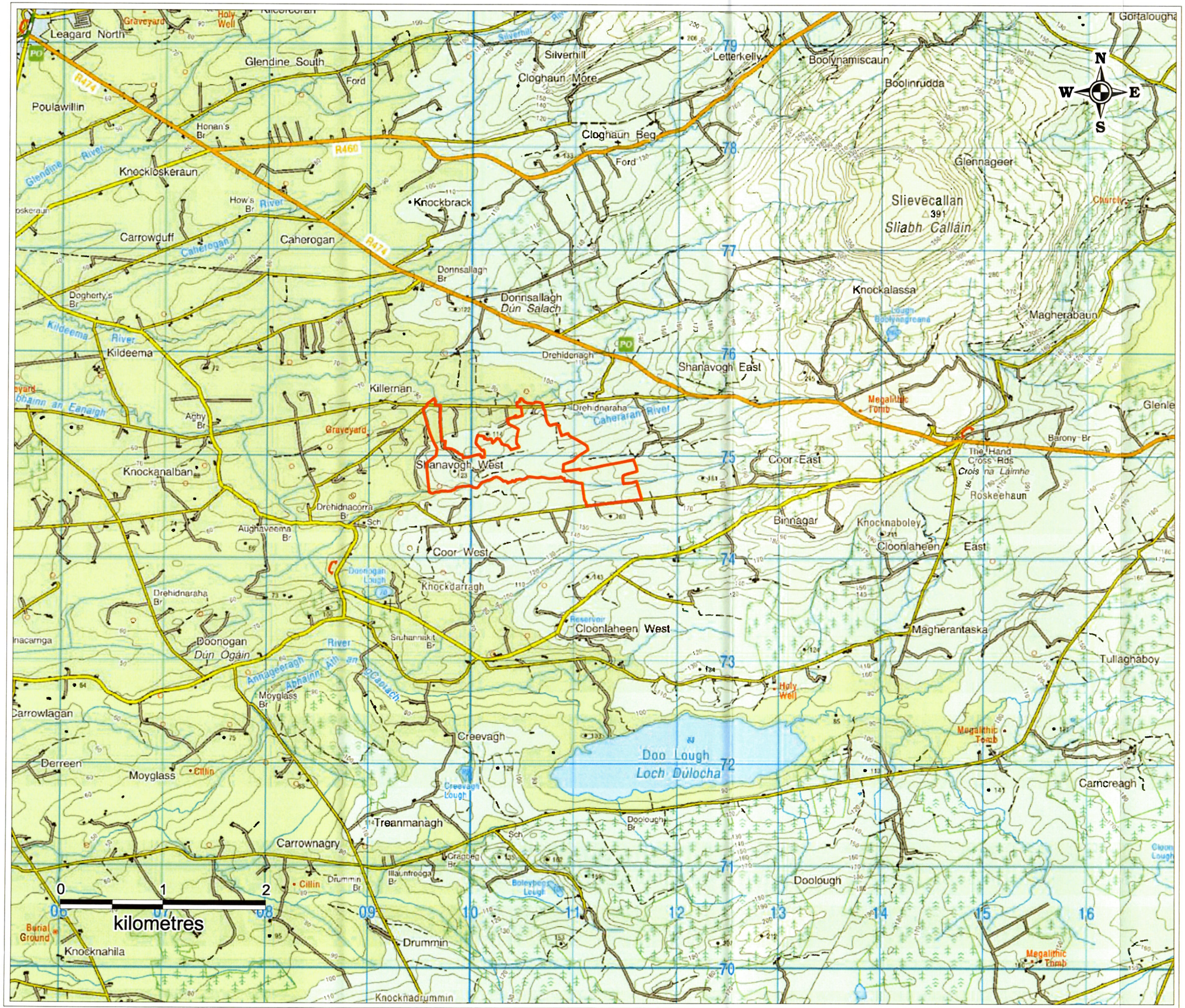
(6) For load conditions see Report text.

(7) Minimum acceptable factor of safety required of 1.3 for first-time failures based on BS: 6031:1981 Code of practice for Earthworks.

8

APPENDIX 8

HYDRO Environmental Services; Figures for Chapter 8 Hydrology & Hydrogeology Assessment



Legend:

▭ Site Boundary

HYDRO-ENVIRONMENTAL SERVICES

22 Lower Main Street
Dungarvan, Co. Waterford

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

Tel: +353-58-44 122
Fax: +353-58-44 244
E-mail: maill@cablesurf.com

Title: Site Location Map

Client: INIS Environmental Ltd

Job: Coor/Shanavogh WF, Co. Clare

Project No: P1179

Figure No: 8.1

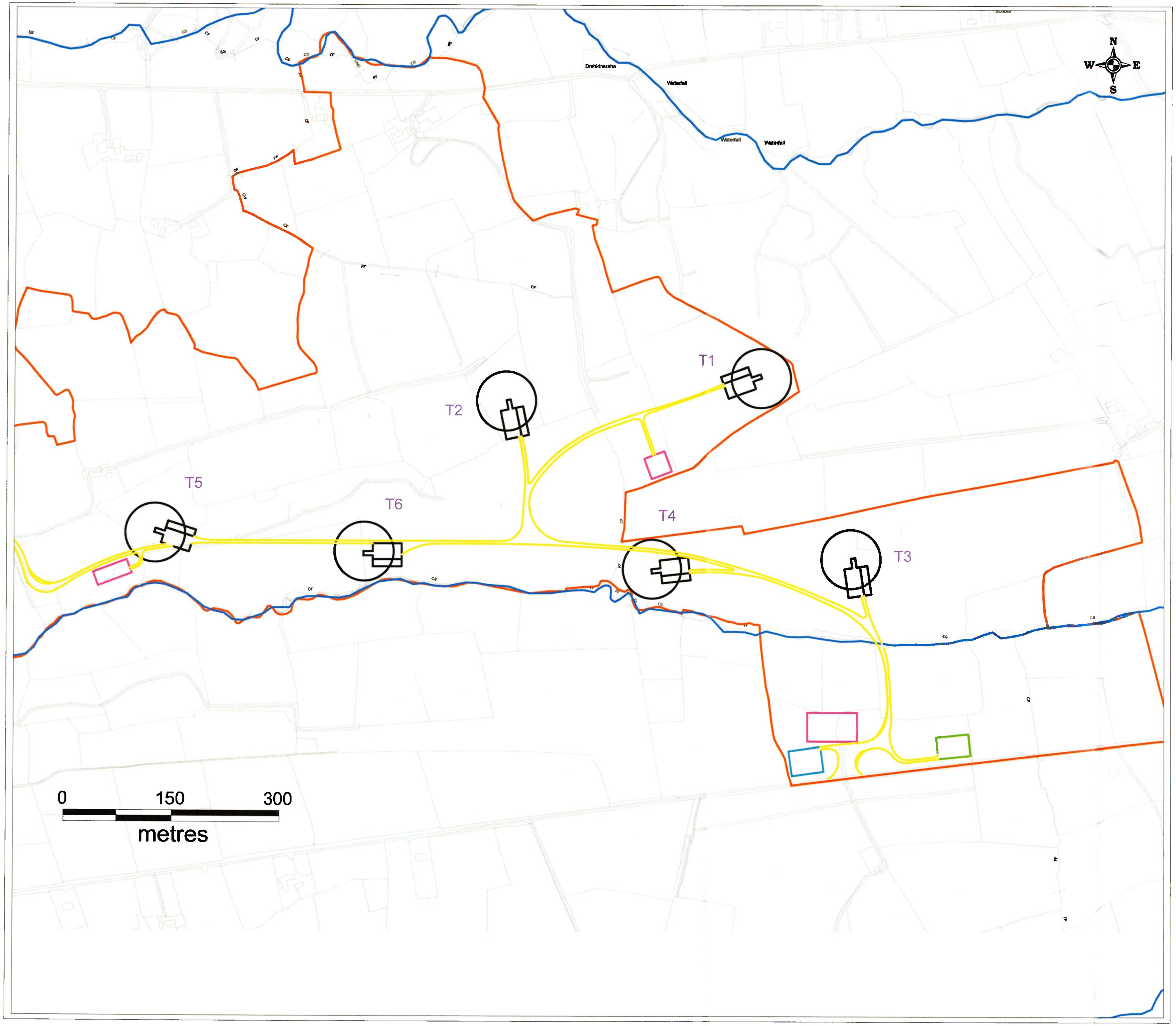
Sheet Size: A4

Drawing No: P1179-0411-A4-801-00A

Date: - 18/04/2011

Scale: - 1:50000

Drawn By: DB	Checked By: MG



HYDRO-ENVIRONMENTAL SERVICES

22 Lower Main Street
Dungarvan, Co. Waterford

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

Tel: +353-58-44 122
Fax: +353-58-44 244
E-mail: mgill@cablesurf.com

Client: INIS Environmental Ltd

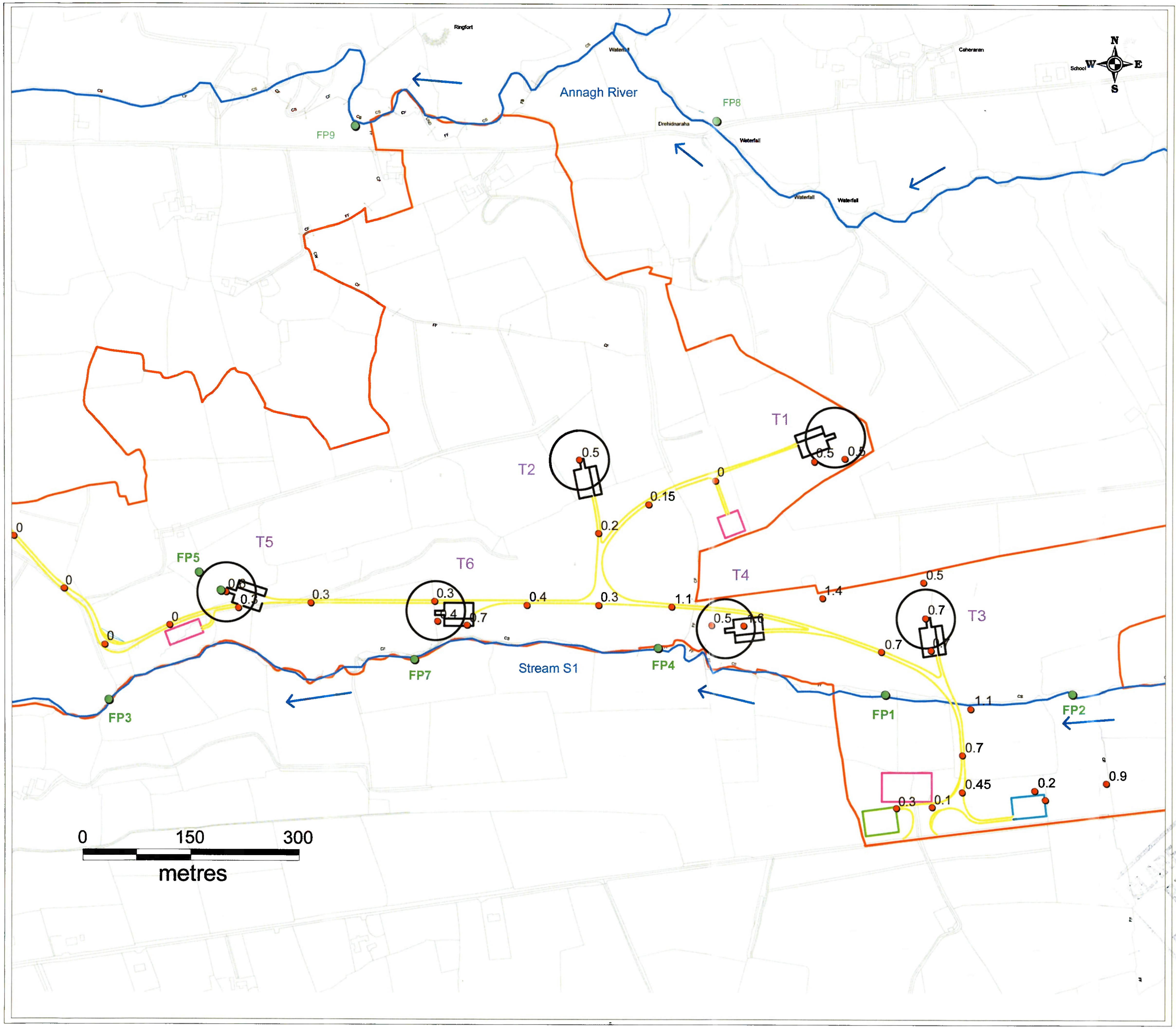
Job: Coor / Shanavogh WF, Co. Clare

Title: Proposed Site Layout Map

Figure No: 8.2

Drawing No: P1179-0411-A3-802-00A

Sheet Size: A3	Project No: P1179
Scale: - 1:5000	Drawn By: DB
Date: - 20/04/2011	Checked By: MG



LEGEND:

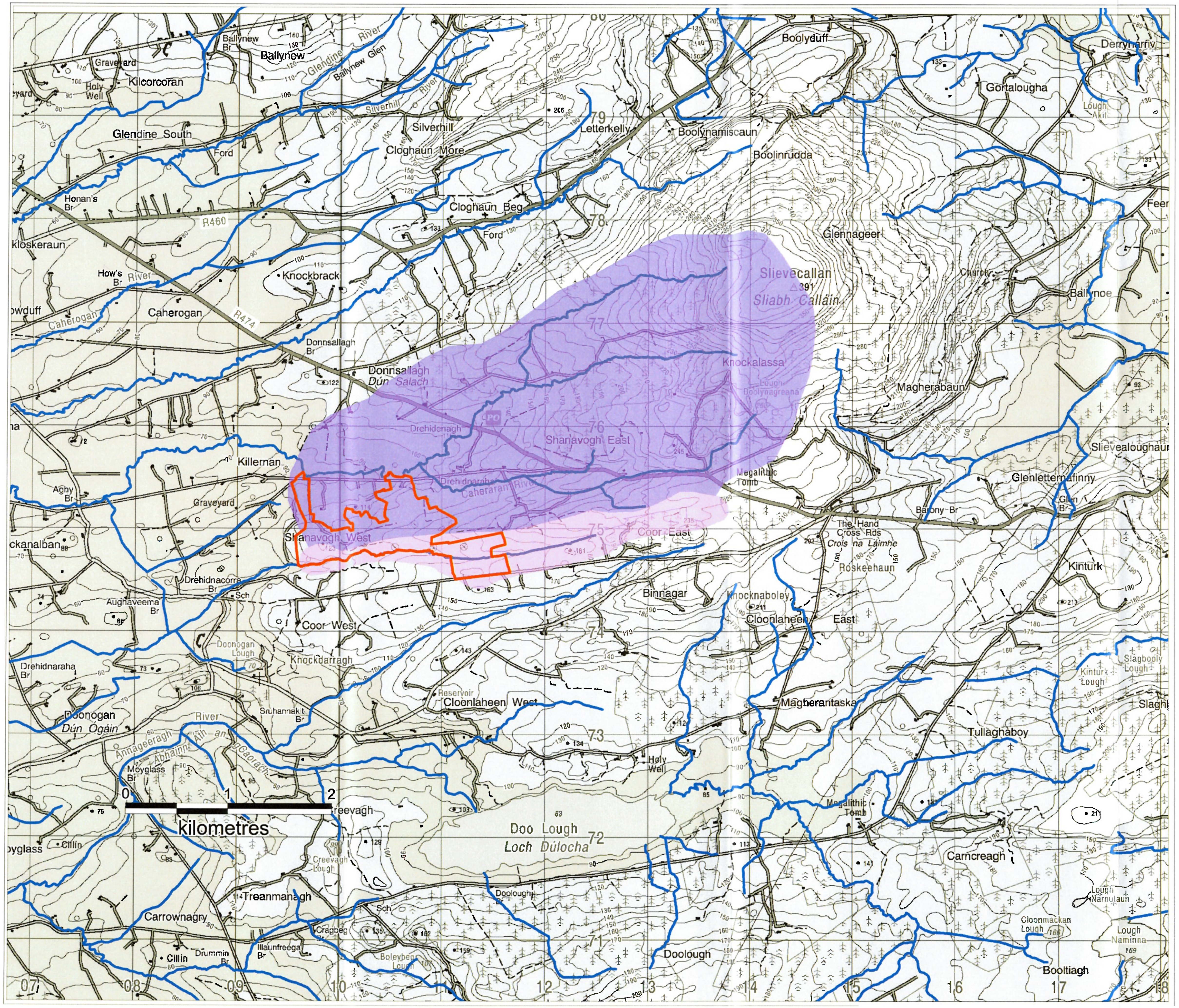
🟥	Site Boundary
🟥	Borrow Pit
🟦	Proposed Compound
🟩	Proposed Substation
—	Proposed Site Access Road
—	Stream/ River
●	AGEC Ltd Peat Probe Depth (m)
●	Field Parameter Location
→	Flow Direction

HYDRO-ENVIRONMENTAL SERVICES

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

22 Lower Main Street
Dungarvan, Co. Waterford
Tel: +353-58-44 122
Fax: +353-58-44 244
E-mail: mgill@cablesurf.com

Client: INIS Environmental Ltd	
Job: Coor / Shanavogh WF, Co. Clare	
Title: Site Investigation Map	
Figure No: 8.3	
Drawing No: P1179-0411-A3-803-00A	
Sheet Size: A3	Project No: P1179
Scale: - 1:5000	Drawn By: DB
Date: - 20/04/2011	Checked By: MG



Legend:

🟥 Site Boundary

🟪 Annagh River Catchment*

🟪 Stream S1 Catchment*

— Stream/River

* Up-gradient of the proposed Development

Title: Regional Hydrology

Client: INIS Environmental Ltd

Job: Coor WF, Co. Clare

Project No. P1179

Figure No. 8.4

Sheet Size: A4

Drawing No. P1179-0411-A4-804-00A

Date: 20/04/2011

Scale: 1:50,000

Drawn by:DB

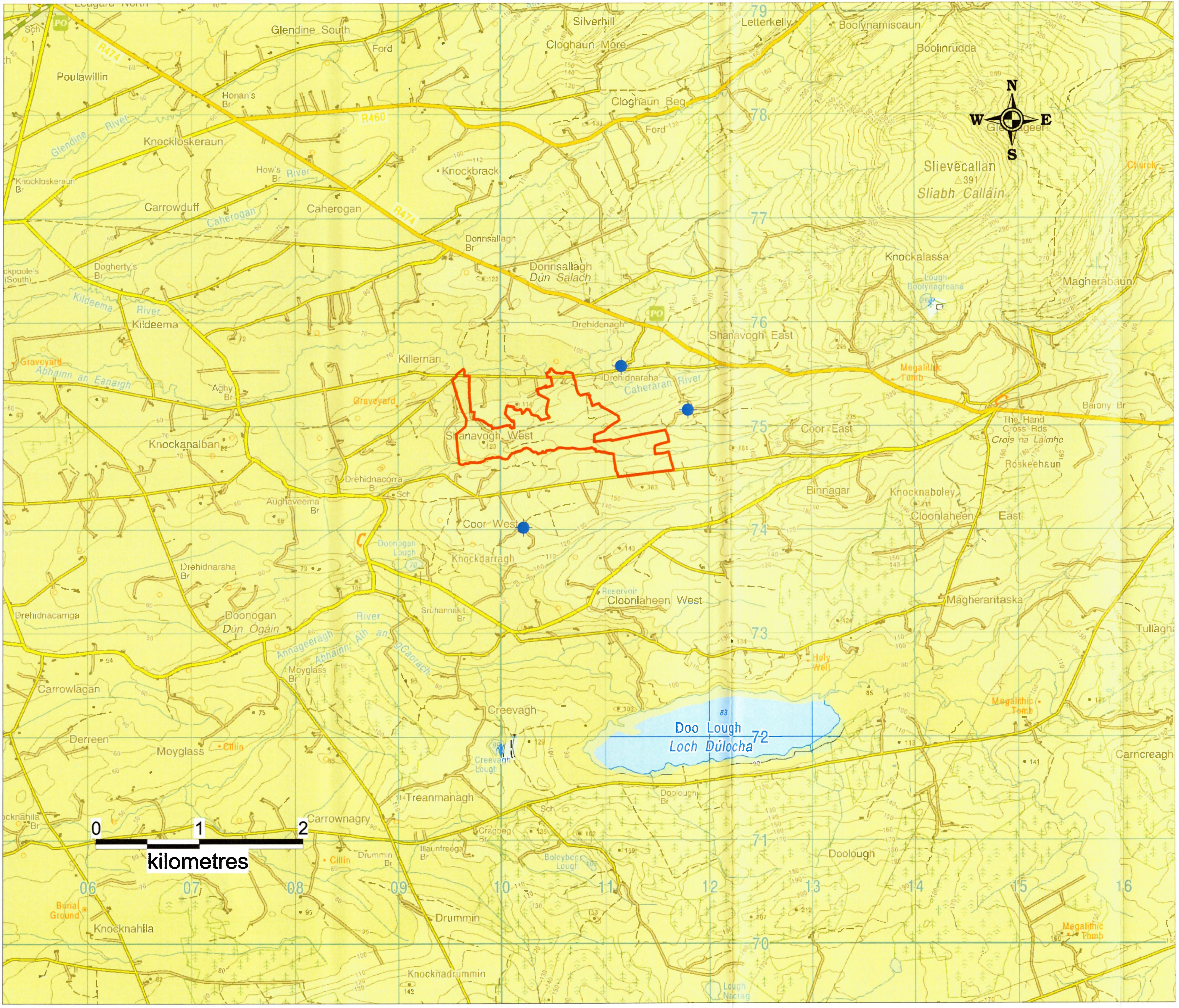
Checked by: MG

HYDRO-ENVIRONMENTAL SERVICES

22 Lower Main Street
Dungarvan, Co. Waterford

ENVIRONMENTAL ENGINEERING
HYDROLOGY HYDROGEOLOGY

Tel: +353-58-44 122
Fax: +353-58-44 244
E-mail: mgill@cablesurf.com



Legend:

🟥	Site Boundary
🟨	Poorly Productive Aquifer of the Central Clare Group
●	Mapped Wells*

*GSI Well Database

Title: Regional Aquifer Map

Client: INIS Environmental Ltd

Job: Coor/Shanavogh WF, Co. Clare

Project No. P1179

Figure No. 8.5

Sheet Size: A4

Drawing No. P1179-0411-A4-805-00A

Date: 20/04/2011

Scale: 1:50,000

Drawn by:DB Checked by: MG

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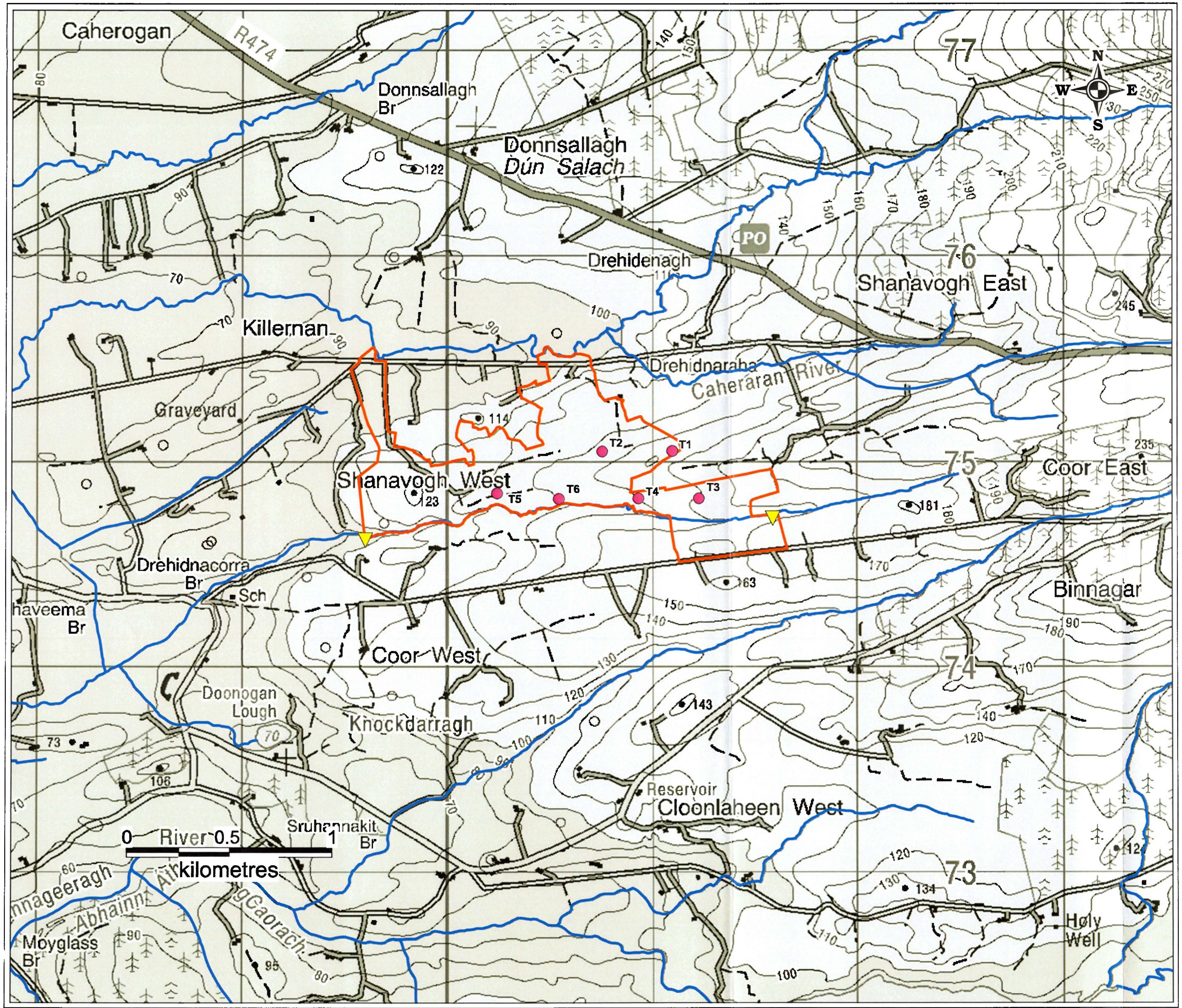

Legend:

▭	Site Boundary
●	Proposed Turbine Location
—	Stream/River
▼	Recommended Surface Water Sampling Locations

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E-mail: maill@cablesurf.com

Title: Local Drainage Map

Client: INIS Environmental

Job: Coor WF, Co. Clare

Project No: P1179

Figure No: 1

Sheet Size: A4

Drawing No: P1179-0411-A4-101-00A

Date: - 04/04/2011

Scale: - 1:25000

Drawn By: DB | Checked By: MG

9

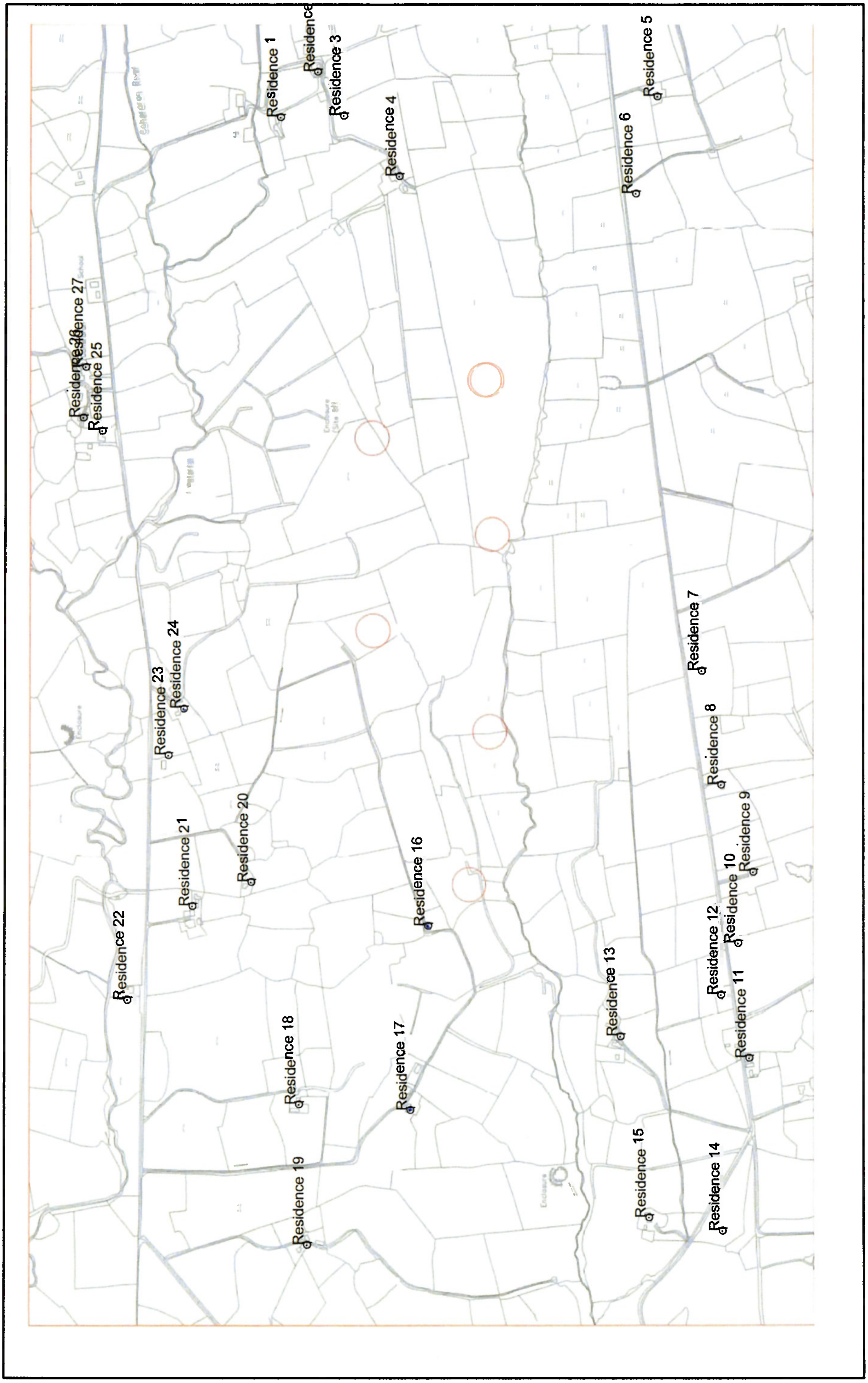
APPENDIX 9

Noise Impact Assessment Figures

NOISE IMPACT ASSESSMENT FIGURES & TABLES SCHEDULE	
Figure A9.1	Noise Sensitive Locations
Figure A9.2	Noise Measurement Locations
Figure A9.3	ETSU Curve – No Mitigation
Figure A9.4	ETSU Curve – With Mitigation
Figure A9.5	Wind Speed 5 m/s
Figure A9.6	Wind Speed 6 m/s – No Mitigation
Figure A9.7	Wind Speed 7 m/s – No Mitigation
Figure A9.8	Wind Speed 8 m/s – No Mitigation
Figure A9.9	Wind Speed 9 m/s – No Mitigation
Figure A9.10	Wind Speed 6 m/s – With Mitigation
Figure A9.11	Wind Speed 7 m/s – With Mitigation
Table A9.1	House number key

Coor Wind Farm
Noise Sensitive Locations

Figure 9.1



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - initial model [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm\] , Predictor Type 7810 V6.00

Coor Wind Farm
Noise Measurement Locations

Figure 9.2

Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - initial model [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm\] , Predictor Type 7810 V6.00

Figure 9.3 Coor Windfarm ETSU Curve - No mitigation

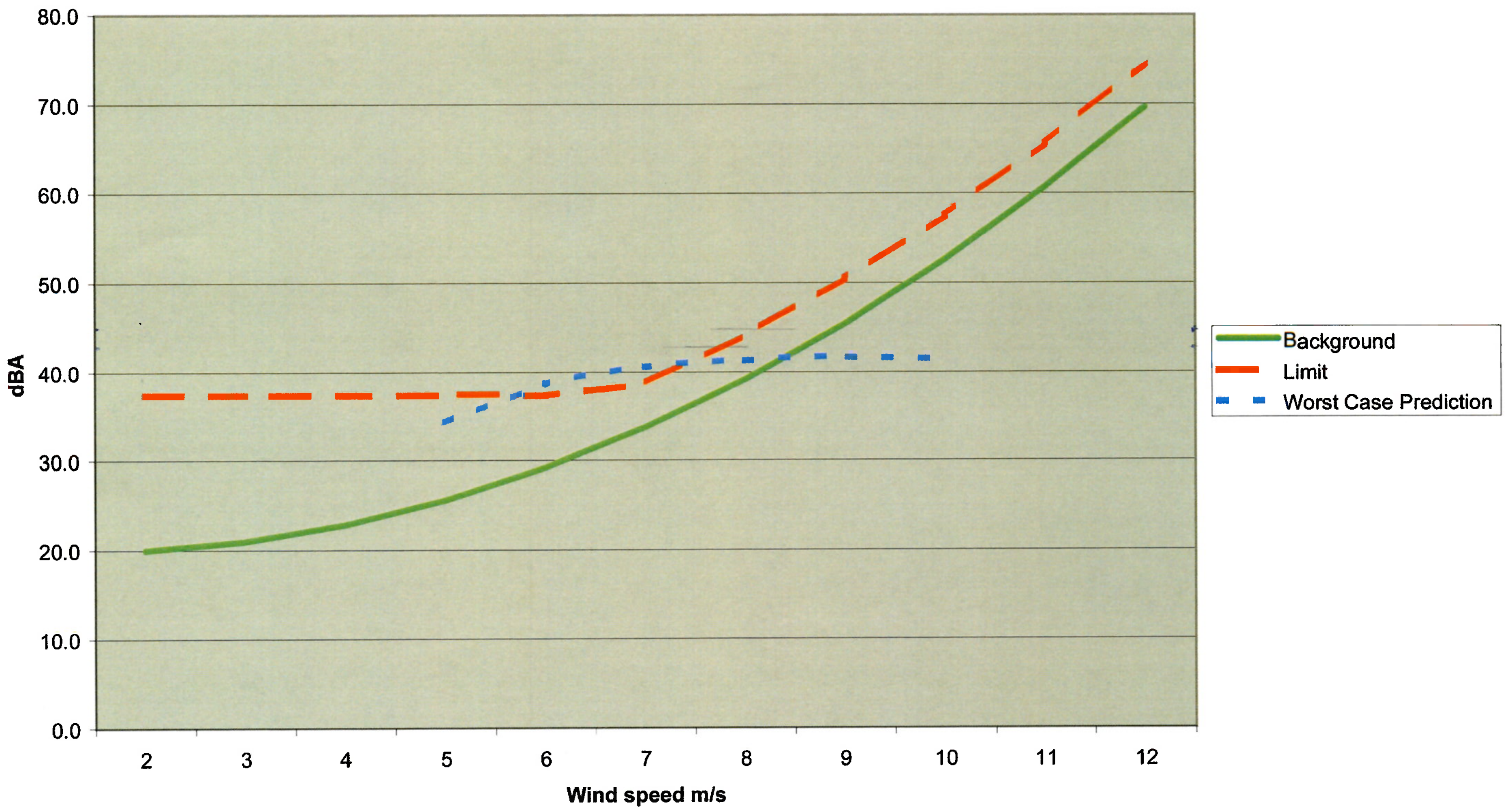
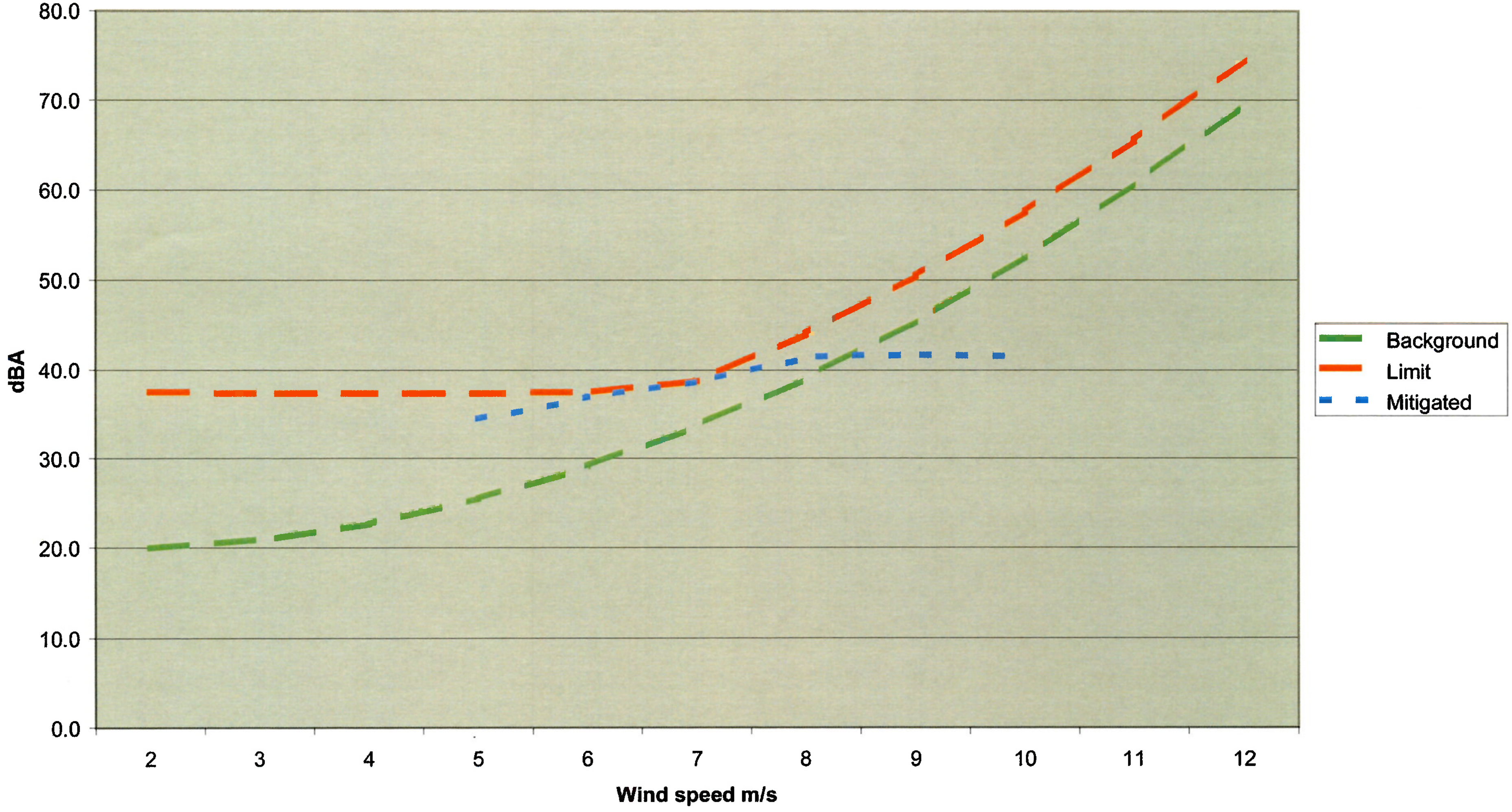
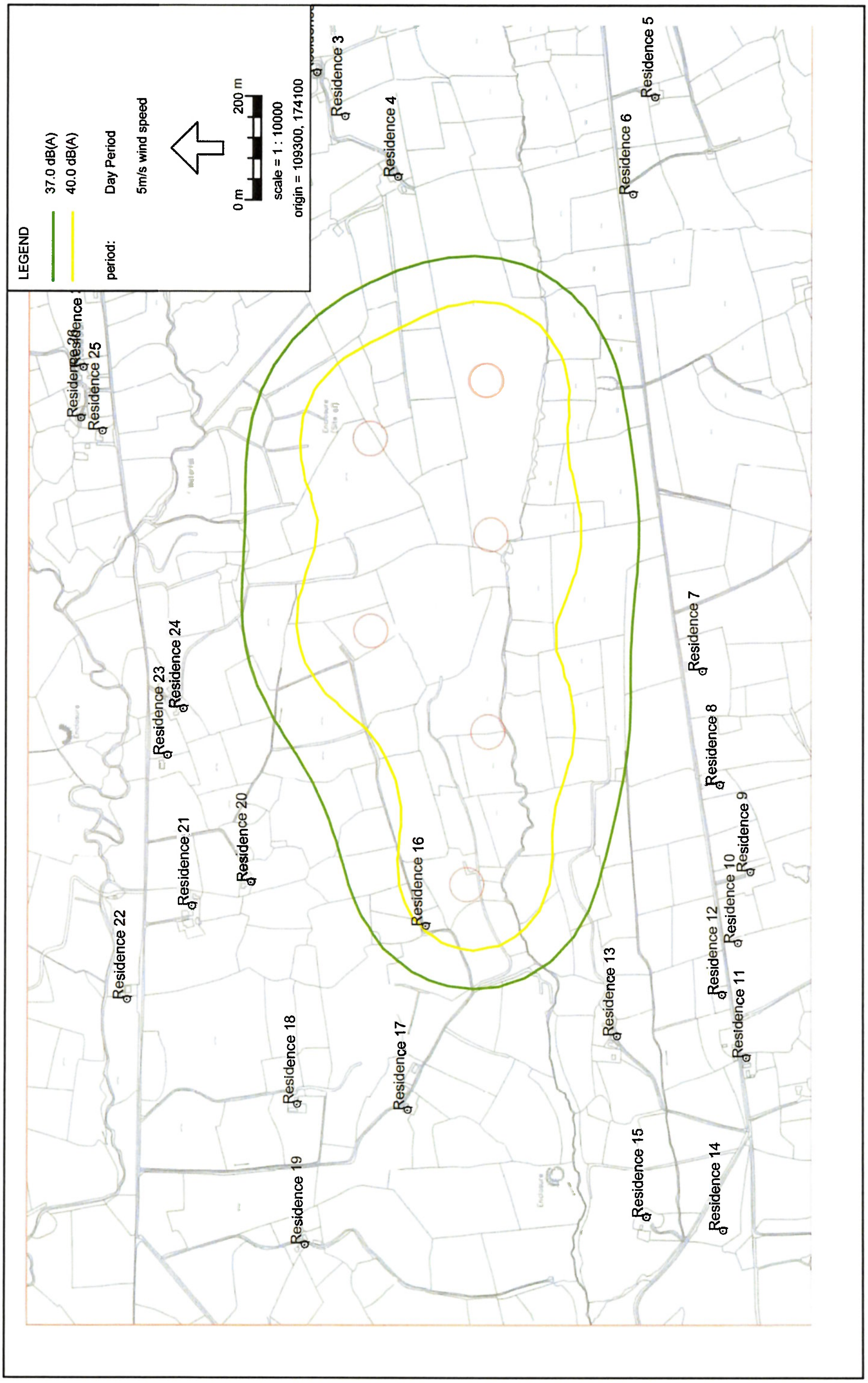


Figure 9.4 Coor Windfarm ETSU Curve - With mitigation



Coor Wind Farm
Wind Speed 5m/s

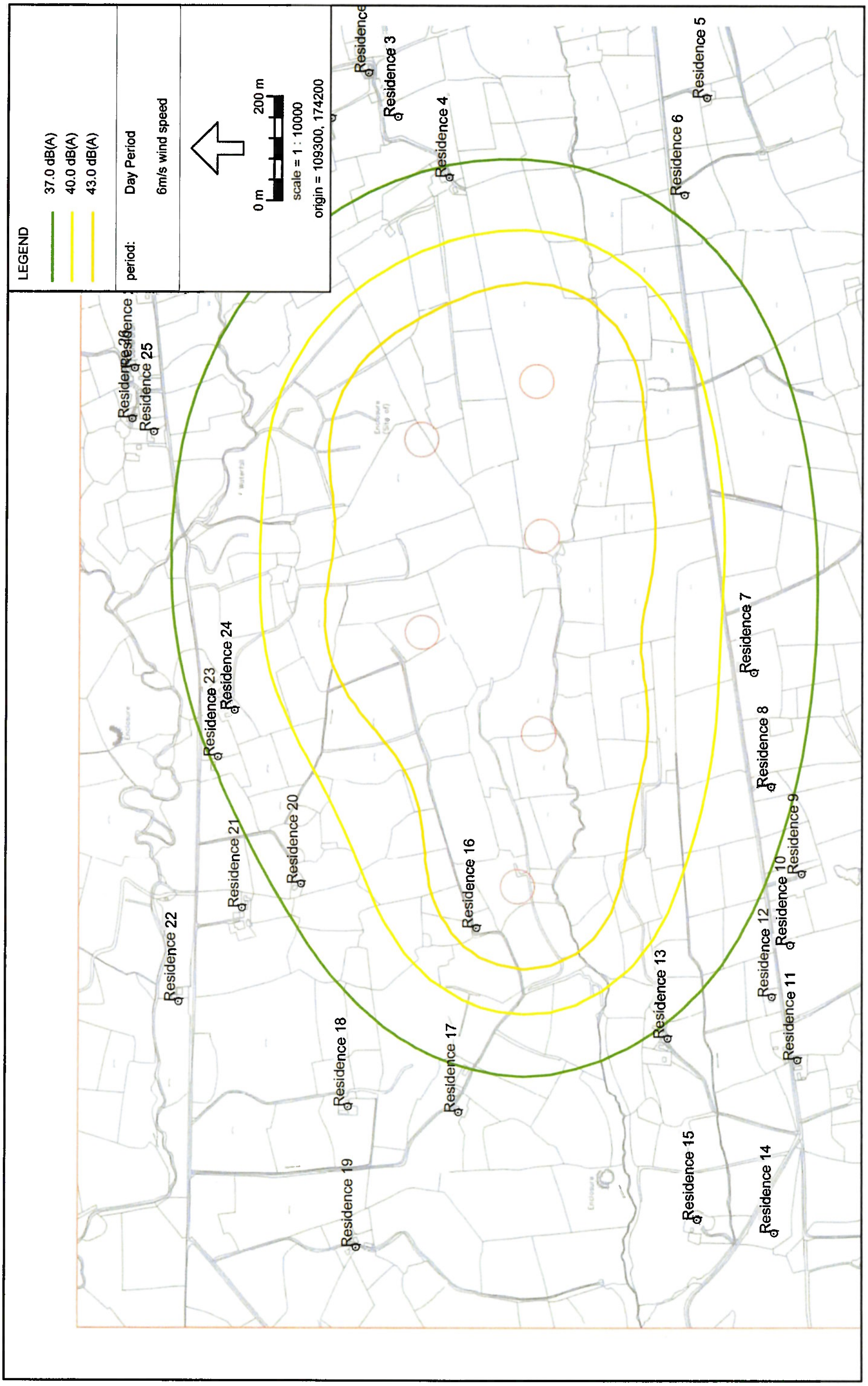
Figure 9.5



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - 5m/s wind speed [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Coor Wind Farm
6m/s Wind Speed No Mitigation

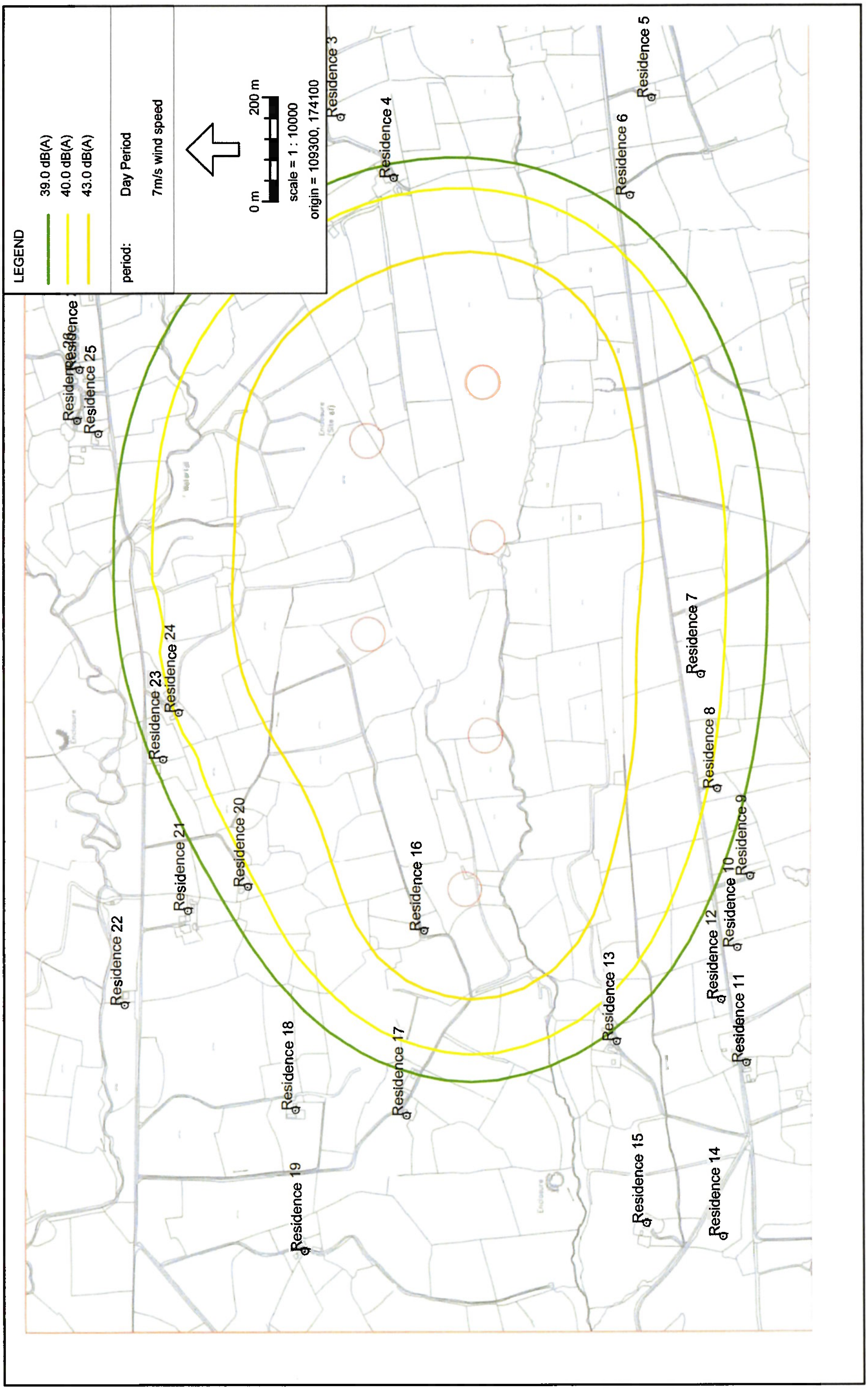
Figure 9.6



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - Coor Baseline Mapping - 6m/s wind speed [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Coor Wind Farm
7m/s Wind Speed No Mitigation

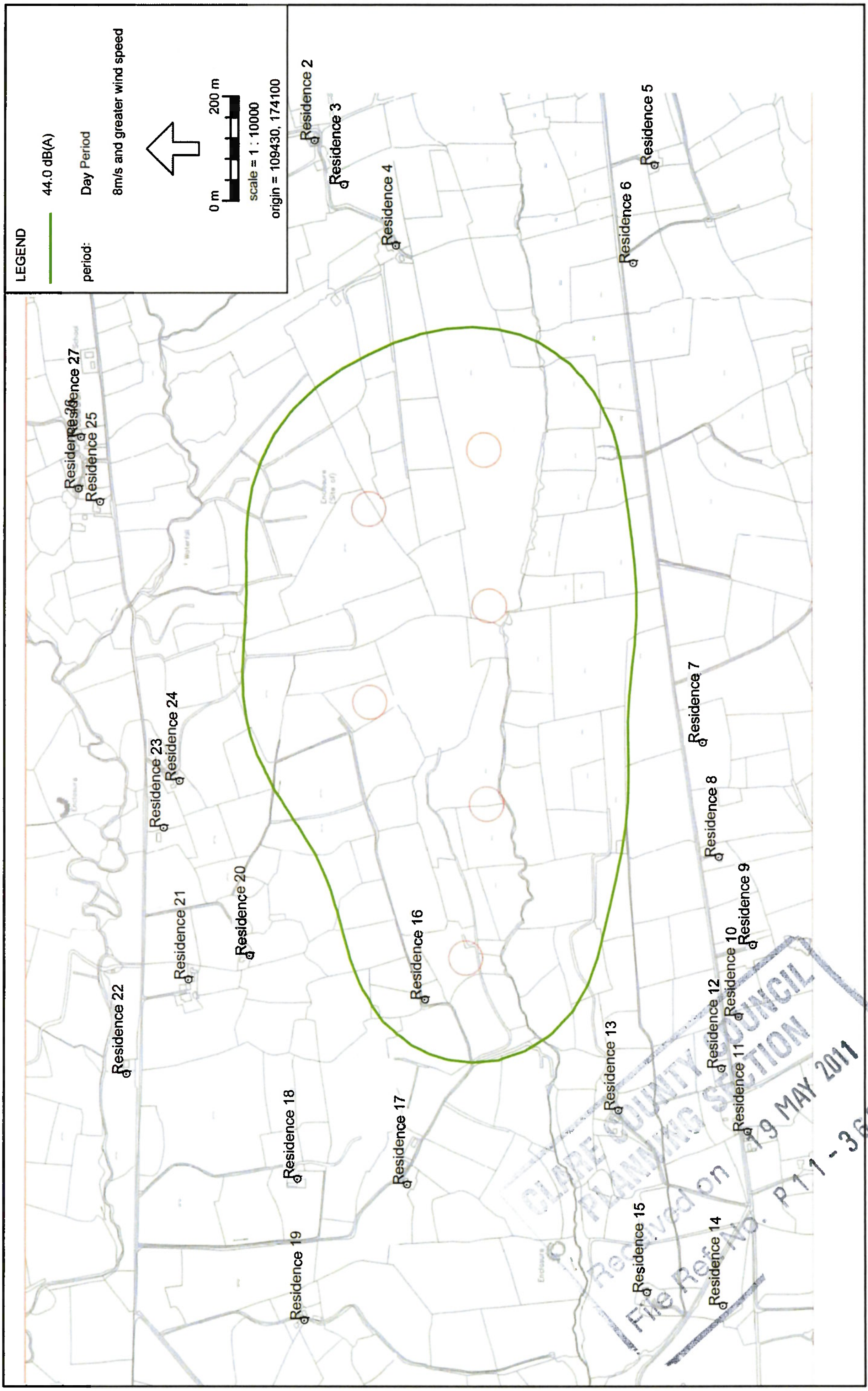
Figure 9.7



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - Coor Baseline Mapping - 7m/s wind speed [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm\] , Predictor Type 7810 V6.00

Coor Wind Farm
8 m/s Wind Speed No Mitigation

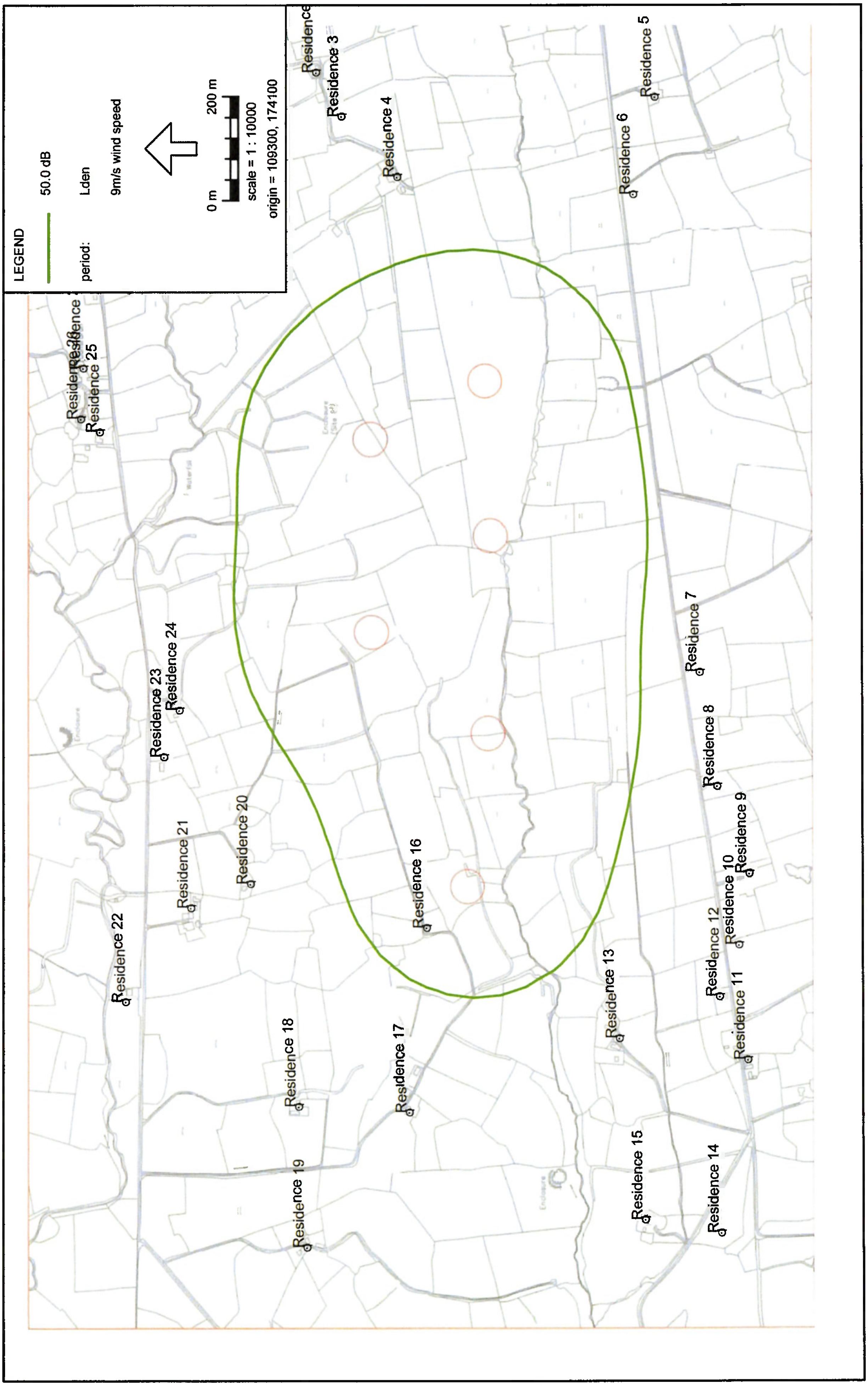
Figure 9.8



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - 8m/s and greater wind speed [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Coor Wind Farm
9m/s Wind Speed and higher

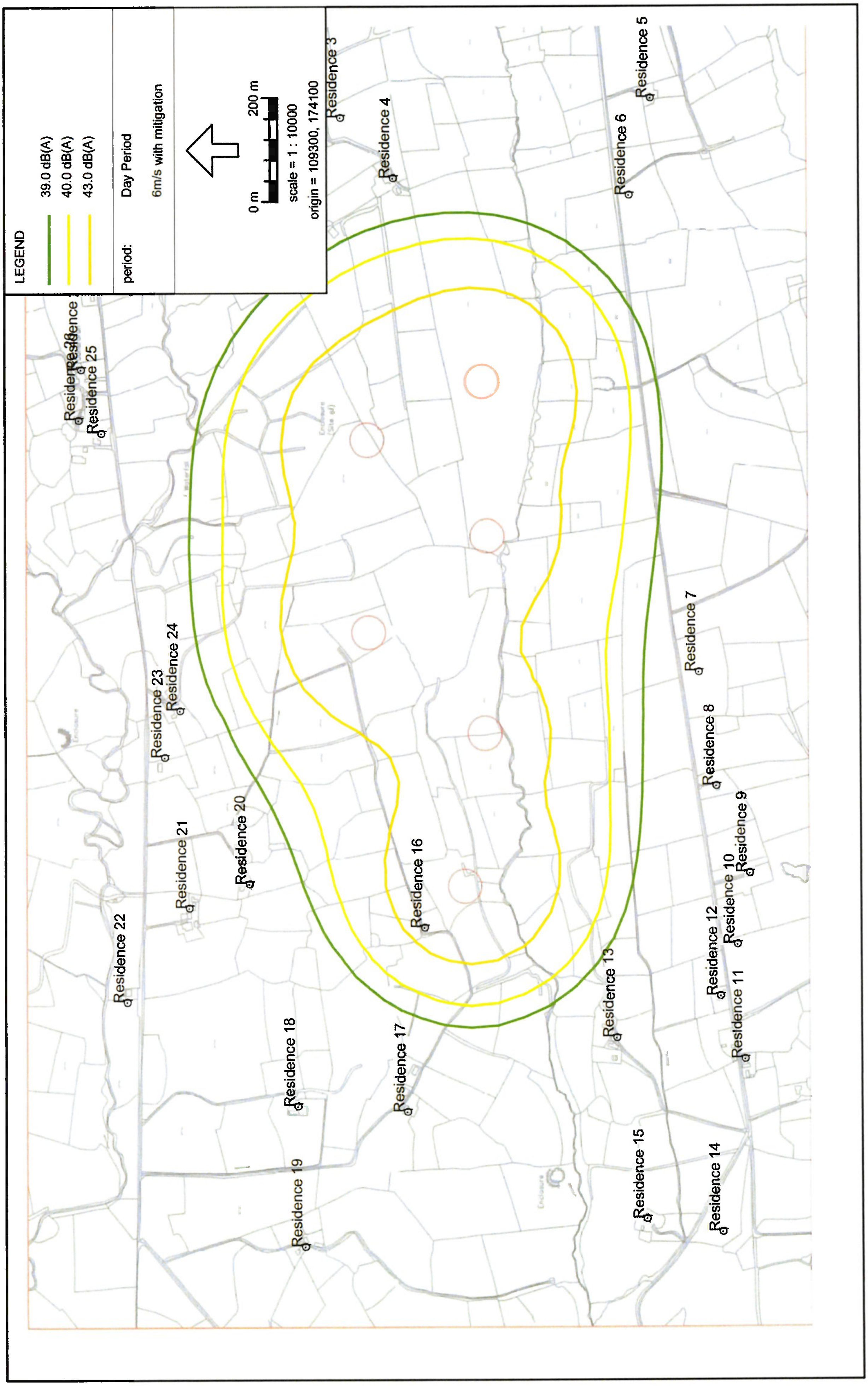
Figure 9.9



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - Coor Baseline Mapping - 9m/s wind speed [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Coor Wind Farm
6m/s Wind Speed With Mitigation

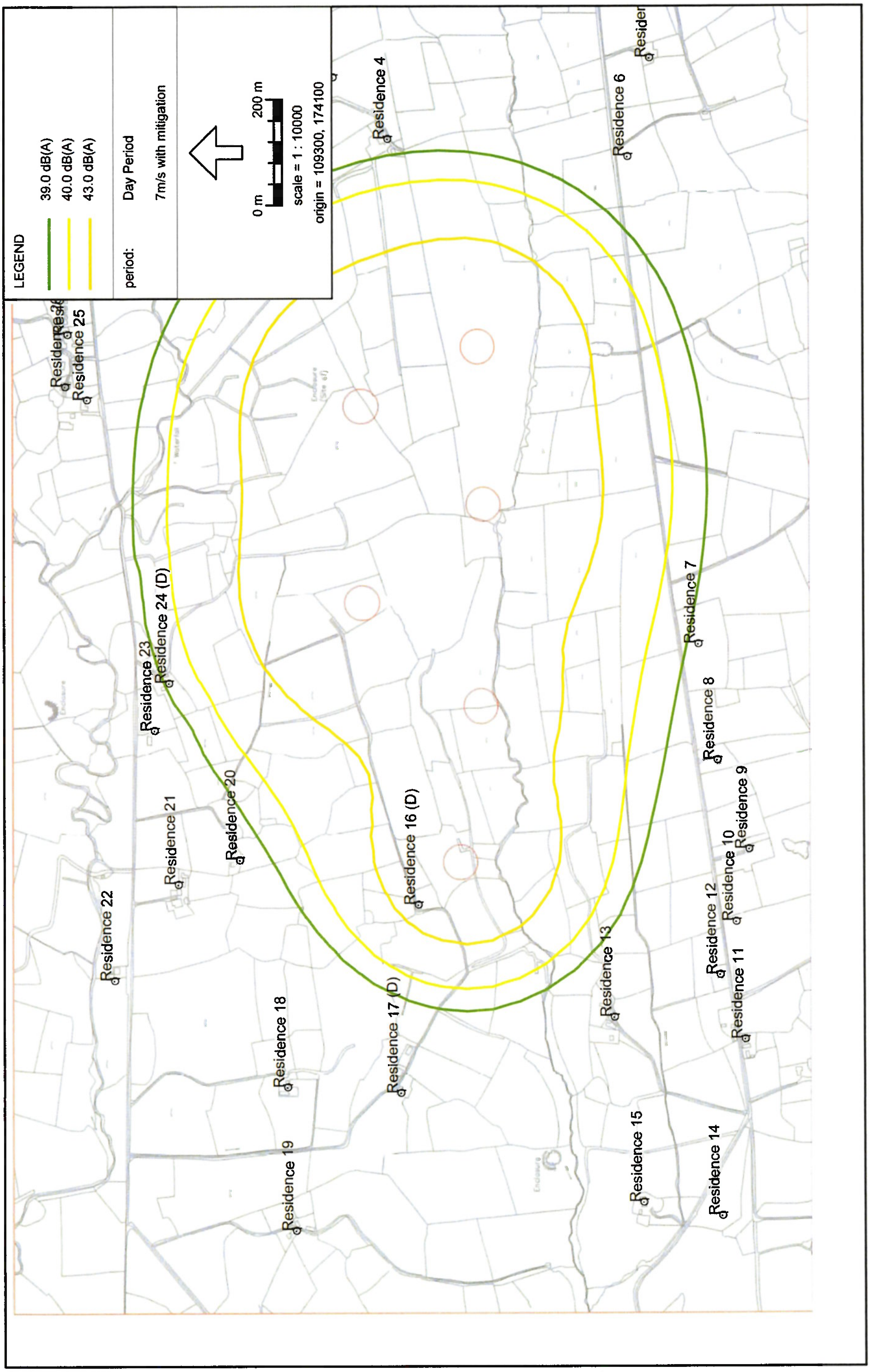
Figure 9.10



Industrial Noise - ISO 9613.1/2, Coor Baseline Mapping - Coor Baseline Mapping - 6m/s with mitigation [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Coor Wind Farm
7m/s Wind Speed with Mitigation

Figure 9.11



Industrial Noise - ISO 9613.1/2. Coor Baseline Mapping - Coor Baseline Mapping - 7m/s with mitigation [F:\Essential Files\2011\Coor Windfarm\Noise Model\Coor Windfarm] , Predictor Type 7810 V6.00

Table 9.1 House number key.

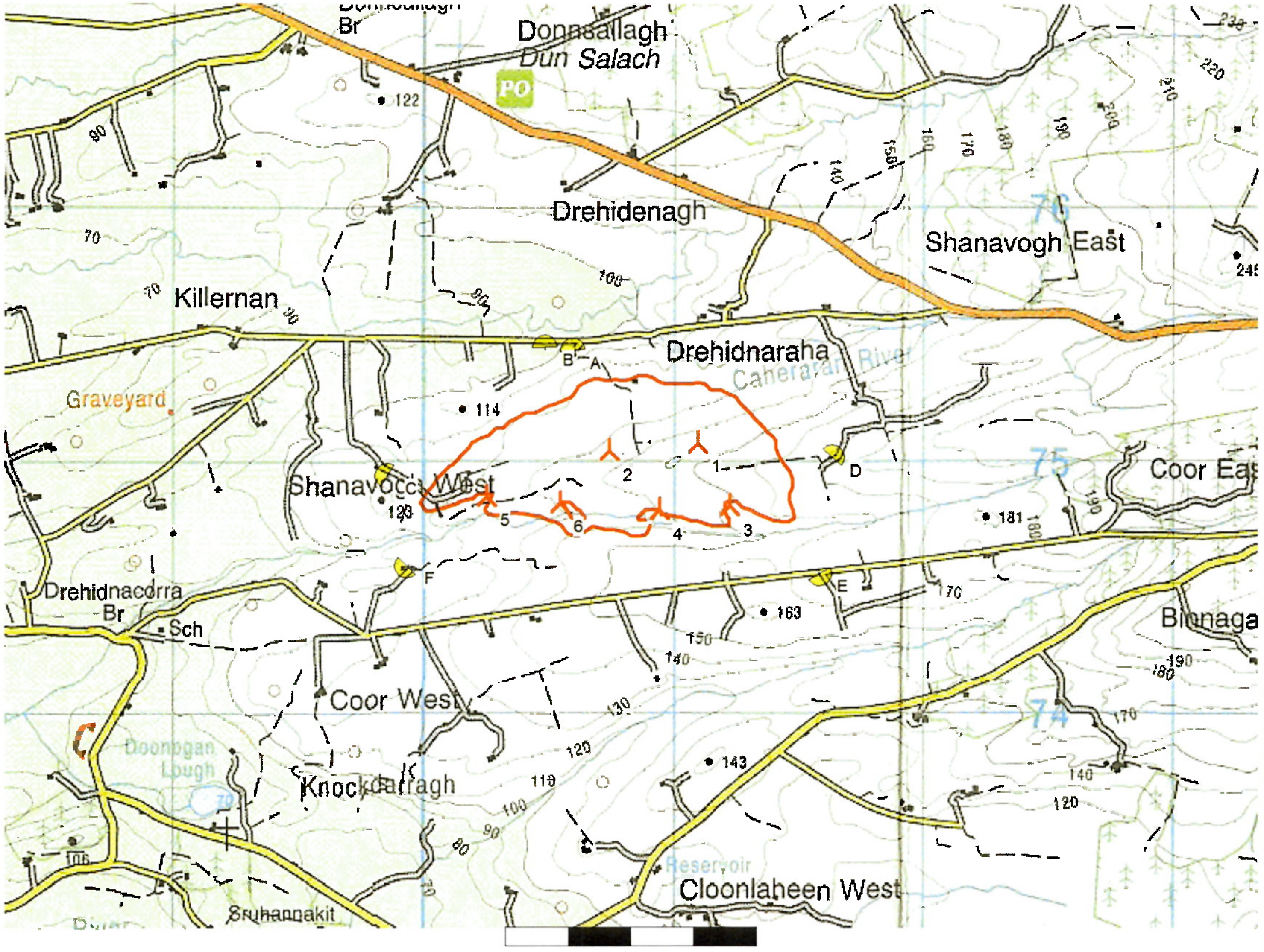
House Number	Name
1	N Other
2	M Ni Cleirigh
3	Hayes 2
4	Hayes 1
5	F Marsh
6	M Talty
7	McMahon
8	S Tubridy
9	USA Summerhouse
10	P O'Brien
11	M Nugent
12	S Nugent
13	M McMahon
14	AN
15	M Coyle
16	M Crowley
17	J McMahon (D)
18	Camey
19	JJ Tuttle
20	P Droney
21	O Neill
22	JP (French)
23	Glynn
24	M Glynn (D)
25	Names Required

1

APPENDIX 10

Shadow Flicker Assessment Tables and Figures

SHADOW FLICKER ASSESSMENT FIGURES & TABLES SCHEDULE	
Figure A10.1	Shadow Map
Figure A10.2	Graphical Shadow Calendar (Receptors)
Figure A10.3	Graphical Shadow Calendar (per WTG)
Table A10.4	Shadow Flicker Assumptions & Main Results
Table A10.5	Shadow Calendar
Table A10.6	Shadow Calendar per WTG
Figure A10.7	Pim De Ridder CV



Map: Coor 50k location , Print scale 1:25.000, Map center Irish Grid East: 110.790 North: 174.930

⅄ New WTG

◔ Shadow receptor

Isolines showing shadow in Hours per year, real case

▬ 30

Project:

Coor Shanavogh (updated micro siting)

SHADOW - Map

Calculation:
6 Enercon E82 (position def)

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Project:
Coor Shanavogh (updated micro siting)

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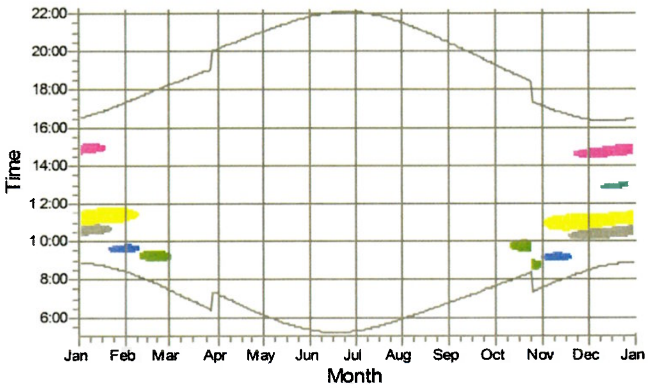
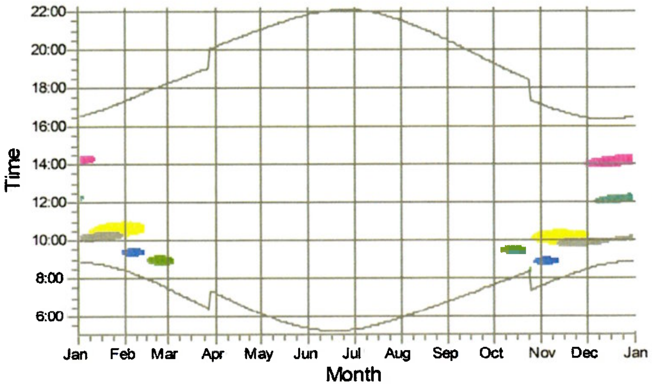
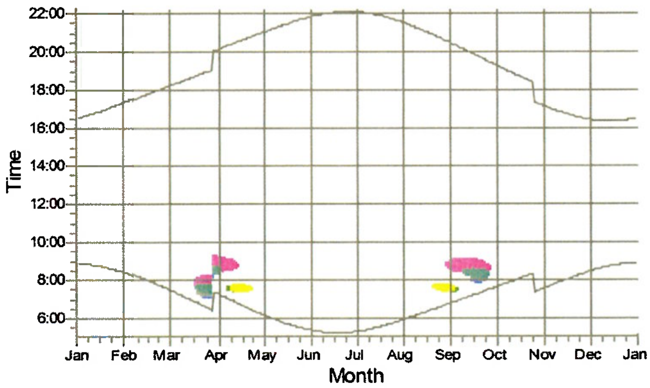
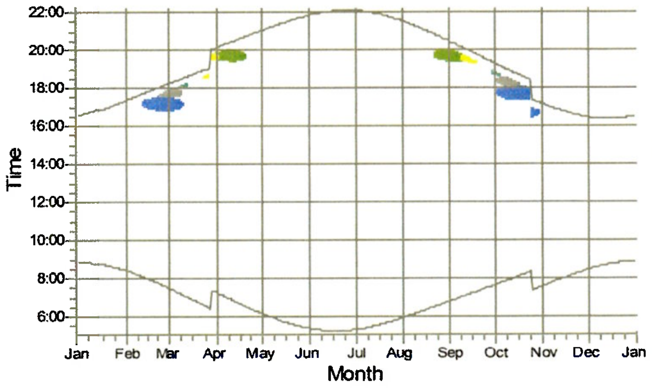
SHADOW - Calendar, graphical

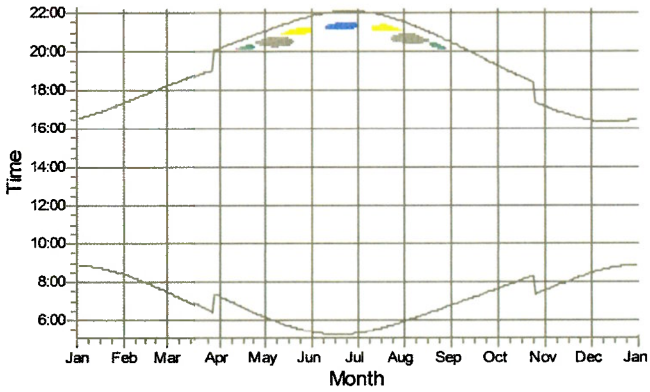
Calculation: 6 Enercon E82 (positon de f)

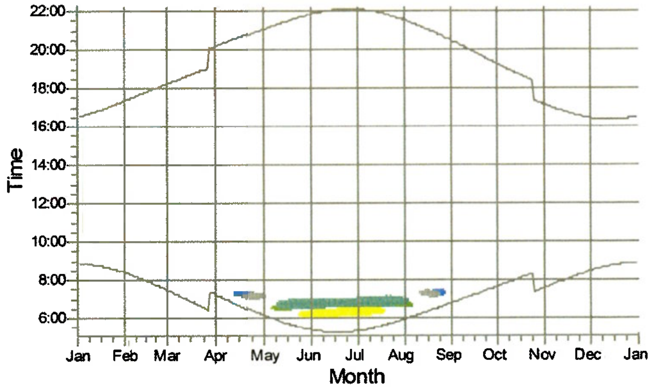

A: Shadow Receptor: 1,0 × 1,0 Azimuth: -8,8° Slope: 90,0° (1)


B: Shadow Receptor: 1,0 × 1,0 Azimuth: -4,8° Slope: 90,0° (2)


C: Shadow Receptor: 1,0 × 1,0 Azimuth: -60,5° Slope: 90,0° (3)


D: Shadow Receptor: 1,0 × 1,0 Azimuth: 41,9° Slope: 90,0° (4)


E: Shadow Receptor: 1,0 × 1,0 Azimuth: 149,4° Slope: 90,0° (5)


F: Shadow Receptor: 1,0 × 1,0 Azimuth: -136,1° Slope: 90,0° (6)

WTGs

🟩	1: ENERCON E-82 E2 2300 82.0 !O!hub: 84,6 m (15)	⬛	4: ENERCON E-82 E2 2300 82.0 !O!hub: 84,6 m (18)
🟨	2: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (16)	🟥	5: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (19)
🟦	3: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (17)	🟩	6: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (20)

Project:
Coor Shanavogh (updated micro siting)

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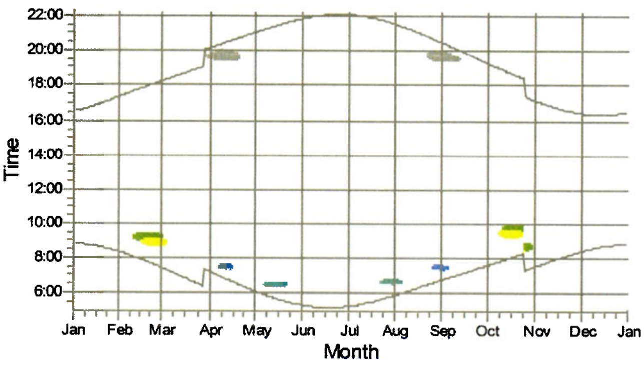
Calculated:
12-4-2011 11:27/2.7.453

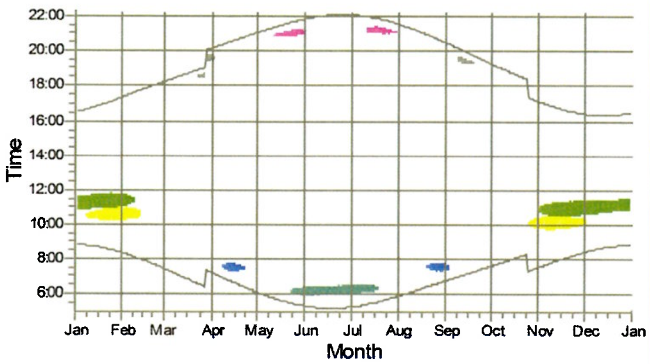
SHADOW - Calendar per WTG, graphical

Calculation: 6 Enercon E82 (position def)

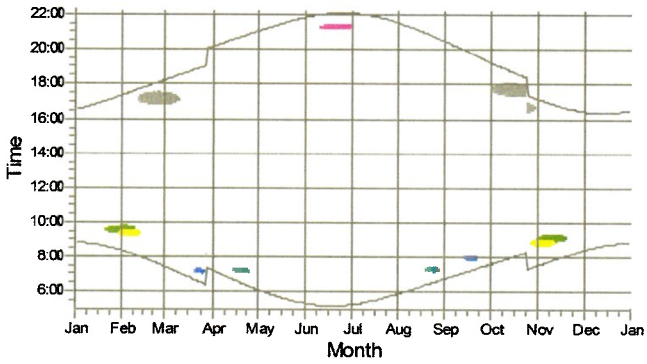
1: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (15)



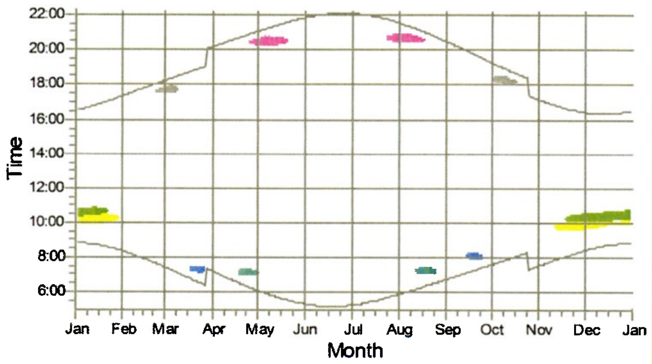
2: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (16)



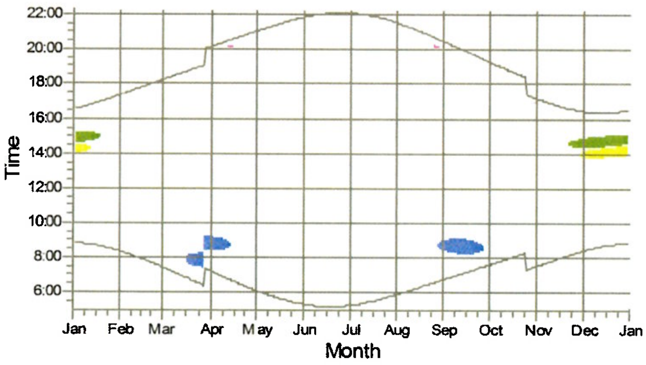
3: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (17)



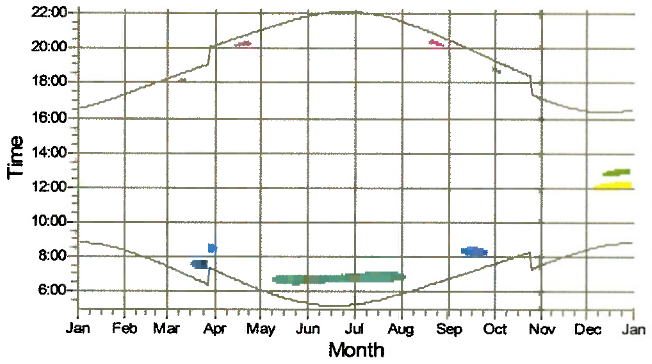
4: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (18)



5: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (19)



6: ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (20)



WTGs

🟩	A: Shadow Receptor: 1,0 × 1,0 Azimuth: -8,8° Slope: 90,0° (1)
🟨	B: Shadow Receptor: 1,0 × 1,0 Azimuth: -4,8° Slope: 90,0° (2)
🟦	C: Shadow Receptor: 1,0 × 1,0 Azimuth: -60,5° Slope: 90,0° (3)
▨	D: Shadow Receptor: 1,0 × 1,0 Azimuth: 41,9° Slope: 90,0° (4)
🟥	E: Shadow Receptor: 1,0 × 1,0 Azimuth: 149,4° Slope: 90,0° (5)
🟩	F: Shadow Receptor: 1,0 × 1,0 Azimuth: -136,1° Slope: 90,0° (6)

Project:

Coor Shanavogh (updated micro siting)

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Calculated:

12-4-2011 11:27/2.7.453

SHADOW - Main Result

Calculation: 6 Enercon E82 (position def)

Assumptions for shadow calculations

Maximum distance for influence
Calculate only when more than 20 % of sun is covered by the blade
Please look in WTG table

Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

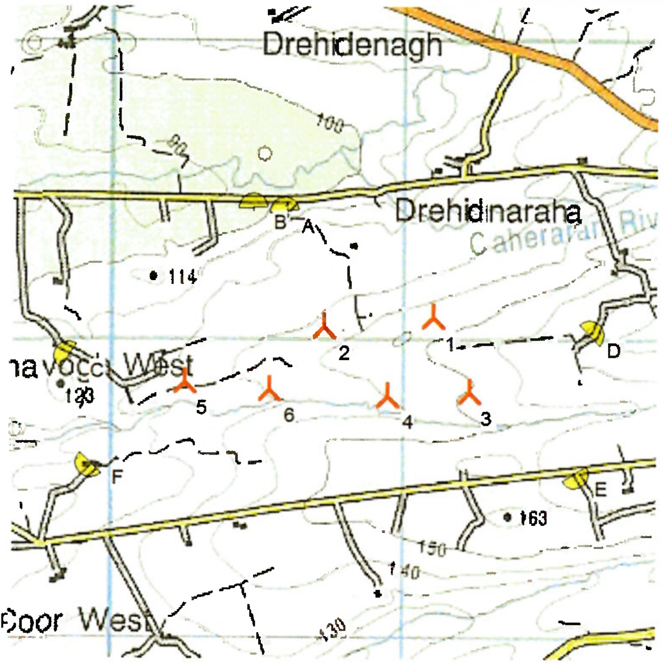
Operational hours are calculated from WTGs in calculation and wind distribution:
Site data 12 sectors; Radius: 20.000 m (1)

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

A ZVI (Zones of Visual Influence) calculation is performed before flicker calculation so non visible WTG do not contribute to calculated flicker values. A WTG will be visible if it is visible from any part of the receiver window. The ZVI calculation is based on the following assumptions:
Height contours used: Height Contours: CONTOURLINE_ONLINEDATA_0.wpo
Obstacles used in calculation
Eye height: 1,5 m
Grid resolution: 10 m



Scale 1:25.000

⅄ New WTG ◔ Shadow receptor

WTGs

	IG East	North	Z	Row data/Description	WTG type Valid	Manufact.	Type-generator	Power, rated	Rotor diameter	Hub height	Shadow data Calculation distance	RPM
	IG		[m]					[kW]	[m]	[m]	[m]	[RPM]
1	111.091	175.077	142,5	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0
2	110.736	175.045	132,3	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0
3	111.217	174.826	150,0	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0
4	110.939	174.812	140,0	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0
5	110.247	174.861	121,1	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0
6	110.538	174.836	130,0	ENERCON E-82 E2 2300 82.0 !O! hub...	Yes	ENERCON	E-82 E2-2.300	2.300	82,0	84,6	1.602	18,0

Shadow receptor-Input

No.	IG East	North	Z	Width	Height	Height a.g.l.	Degrees from south cw	Slope of window	Direction mode
			[m]	[m]	[m]	[m]	[°]	[°]	
A	110.590	175.436	104,8	1,0	1,0	1,0	-8,8	90,0	Fixed direction
B	110.480	175.448	97,6	1,0	1,0	1,0	-4,8	90,0	Fixed direction
C	109.850	174.945	110,0	1,0	1,0	1,0	-60,5	90,0	Fixed direction
D	111.631	175.018	170,0	1,0	1,0	1,0	41,9	90,0	Fixed direction
E	111.580	174.554	161,8	1,0	1,0	1,0	-210,6	90,0	Fixed direction
F	109.926	174.587	110,7	1,0	1,0	1,0	-136,1	90,0	Fixed direction

Calculation Results

Shadow receptor

	Shadow, expected values
No.	Shadow hours per year [h/year]
A	18:17
B	13:13

To be continued on next page...

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Main Result

Calculation: 6 Enercon E82 (position def)

...continued from previous page

Shadow, expected values

No.	Shadow hours per year [h/year]
C	9:50
D	10:13
E	5:50
F	12:10

Total amount of flickering on the shadow receptors caused by each WTG

No.	Name	Worst case [h/year]	Expected [h/year]
1	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (15)	54:56	9:29
2	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (16)	143:12	20:04
3	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (17)	61:00	9:17
4	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (18)	88:49	12:37
5	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (19)	78:17	10:54
6	ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (20)	64:15	10:27

Project:
Coor Shanavogh (updated micro siting)

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Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** A - Shadow Receptor: 1,0 × 1,0 Azimuth: -8,8° Slope: 90,0° (1)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January			February			March			April	May	June
1	08:50		10:15 (4)	08:22		09:23 (3)	07:27		09:00 (1)	07:14	06:07	05:20
	16:32	97	15:04 (5)	17:21	62	11:41 (2)	18:15	18	09:18 (1)	20:11	21:04	21:52
2	08:50		10:16 (4)	08:20		09:23 (3)	07:24		09:01 (1)	07:12	06:05	05:19
	16:33	98	15:05 (5)	17:23	60	11:40 (2)	18:17	13	09:14 (1)	20:13	21:06	21:53
3	08:50		10:16 (4)	08:19		09:23 (3)	07:22			07:09	06:03	05:18
	16:34	98	15:05 (5)	17:25	58	11:39 (2)	18:19			20:15	21:07	21:54
4	08:50		10:16 (4)	08:17		09:24 (3)	07:20			07:07	06:01	05:18
	16:35	99	15:05 (5)	17:27	55	11:39 (2)	18:21			20:16	21:09	21:55
5	08:50		10:17 (4)	08:15		09:25 (3)	07:18			07:05	05:59	05:17
	16:37	99	15:06 (5)	17:29	51	11:37 (2)	18:22			20:18	21:11	21:56
6	08:49		10:17 (4)	08:14		09:25 (3)	07:15			07:02	05:58	05:16
	16:38	99	15:06 (5)	17:31	47	11:36 (2)	18:24			20:20	21:13	21:57
7	08:49		10:17 (4)	08:12		09:26 (3)	07:13			07:00	05:56	05:16
	16:39	98	15:06 (5)	17:33	40	11:33 (2)	18:26			20:22	21:14	21:58
8	08:48		10:18 (4)	08:10		09:28 (3)	07:11			06:58	05:54	05:15
	16:41	100	15:07 (5)	17:35	31	11:30 (2)	18:28			20:23	21:16	21:59
9	08:48		10:19 (4)	08:08		09:30 (3)	07:08			06:55	05:52	05:14
	16:42	98	15:06 (5)	17:37	17	11:25 (2)	18:30			20:25	21:18	22:00
10	08:47		10:19 (4)	08:06			07:06			06:53	05:50	05:14
	16:43	98	15:06 (5)	17:39			18:32			20:27	21:19	22:01
11	08:47		10:19 (4)	08:04		09:04 (1)	07:04			06:51	05:48	05:14
	16:45	98	15:06 (5)	17:41	12	09:16 (1)	18:33			20:29	21:21	22:01
12	08:46		10:21 (4)	08:02		09:01 (1)	07:01			06:48	05:47	05:13
	16:46	97	15:07 (5)	17:43	18	09:19 (1)	18:35			20:31	21:23	22:02
13	08:45		10:21 (4)	08:01		09:00 (1)	06:59			06:46	05:45	05:13
	16:48	96	15:07 (5)	17:45	21	09:21 (1)	18:37			20:32	21:24	22:03
14	08:44		10:22 (4)	07:59		08:59 (1)	06:57			06:44	05:43	05:13
	16:49	94	15:06 (5)	17:46	23	09:22 (1)	18:39			20:34	21:26	22:03
15	08:44		10:23 (4)	07:57		08:58 (1)	06:54			06:42	05:42	05:12
	16:51	92	15:06 (5)	17:48	25	09:23 (1)	18:41			20:36	21:28	22:04
16	08:43		10:23 (4)	07:55		08:57 (1)	06:52			06:39	05:40	05:12
	16:53	88	15:04 (5)	17:50	27	09:24 (1)	18:42			20:38	21:29	22:05
17	08:42		10:24 (4)	07:53		08:56 (1)	06:50			06:37	05:39	05:12
	16:54	86	15:04 (5)	17:52	29	09:25 (1)	18:44			20:39	21:31	22:05
18	08:41		10:25 (4)	07:50		08:55 (1)	06:47			06:35	05:37	05:12
	16:56	81	15:03 (5)	17:54	29	09:24 (1)	18:46			20:41	21:32	22:05
19	08:40		10:26 (4)	07:48		08:55 (1)	06:45			06:33	05:36	05:12
	16:58	74	15:00 (5)	17:56	30	09:25 (1)	18:48			20:43	21:34	22:06
20	08:39		10:28 (4)	07:46		08:55 (1)	06:43			06:30	05:34	05:12
	16:59	64	11:42 (2)	17:58	30	09:25 (1)	18:50			20:45	21:35	22:06
21	08:37		10:29 (4)	07:44		08:55 (1)	06:40			06:28	05:33	05:12
	17:01	62	11:42 (2)	18:00	30	09:25 (1)	18:51			20:46	21:37	22:06
22	08:36		09:29 (3)	07:42		08:55 (1)	06:38			06:26	05:31	05:13
	17:03	63	11:43 (2)	18:02	30	09:25 (1)	18:53			20:48	21:38	22:07
23	08:35		09:27 (3)	07:40		08:54 (1)	06:35			06:24	05:30	05:13
	17:05	61	11:43 (2)	18:04	30	09:24 (1)	18:55			20:50	21:40	22:07
24	08:34		09:25 (3)	07:38		08:55 (1)	06:33			06:22	05:29	05:13
	17:07	61	11:43 (2)	18:06	29	09:24 (1)	18:57			20:52	21:41	22:07
25	08:32		09:25 (3)	07:36		08:55 (1)	06:31			06:20	05:28	05:14
	17:08	63	11:44 (2)	18:07	28	09:23 (1)	18:59			20:53	21:43	22:07
26	08:31		09:24 (3)	07:33		08:56 (1)	06:28			06:17	05:26	05:14
	17:10	64	11:43 (2)	18:09	27	09:23 (1)	19:00			20:55	21:44	22:07
27	08:30		09:23 (3)	07:31		08:56 (1)	06:26			06:15	05:25	05:14
	17:12	65	11:43 (2)	18:11	25	09:21 (1)	19:02			20:57	21:45	22:07
28	08:28		09:23 (3)	07:29		08:58 (1)	06:24			06:13	05:24	05:15
	17:14	65	11:43 (2)	18:13	21	09:19 (1)	19:04			20:59	21:47	22:07
29	08:27		09:23 (3)				07:21			06:11	05:23	05:15
	17:16	64	11:42 (2)				20:06			21:00	21:48	22:06
30	08:25		09:22 (3)				07:19			06:09	05:22	05:16
	17:18	65	11:42 (2)				20:07			21:02	21:49	22:06
31	08:24		09:23 (3)				07:16				05:21	
	17:20	63	11:42 (2)				20:09				21:50	
Potential sun hours	255			276			367			418	489	504
Total, worst case		2550			885			31				
Sun reduction		0,19			0,21			0,24				
Oper. time red.		0,99			0,99			0,99				
Wind dir. red.		0,63			0,64			0,65				
Total reduction		0,12			0,13			0,15				
Total, real		307			119			5				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** A - Shadow Receptor: 1,0 × 1,0 Azimuth: -8,8° Slope: 90,0° (1)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October			November			December		
1	05:17	05:55	06:47	07:38			07:33		09:03 (3)	08:26		10:02 (4)
	22:06	21:33	20:28	19:17			17:09	2	09:05 (3)	16:27	96	14:48 (5)
2	05:17	05:56	06:48	07:39			07:35		08:59 (3)	08:28		10:02 (4)
	22:06	21:31	20:26	19:15			17:07	21	10:56 (2)	16:26	98	14:49 (5)
3	05:18	05:58	06:50	07:41			07:37		08:57 (3)	08:29		10:03 (4)
	22:05	21:29	20:24	19:12			17:05	34	11:01 (2)	16:25	98	14:50 (5)
4	05:19	06:00	06:52	07:43			07:39		08:56 (3)	08:31		10:03 (4)
	22:05	21:27	20:21	19:10			17:03	41	11:03 (2)	16:25	99	14:51 (5)
5	05:20	06:01	06:53	07:45			07:41		08:55 (3)	08:32		10:03 (4)
	22:04	21:25	20:19	19:07			17:01	48	11:06 (2)	16:24	99	14:52 (5)
6	05:21	06:03	06:55	07:46			07:43		08:54 (3)	08:33		10:03 (4)
	22:04	21:24	20:17	19:05			16:59	52	11:07 (2)	16:24	99	14:52 (5)
7	05:22	06:04	06:57	07:48			07:45		08:54 (3)	08:35		10:03 (4)
	22:03	21:22	20:14	19:03			16:58	55	11:09 (2)	16:23	99	14:52 (5)
8	05:23	06:06	06:58	07:50			07:46		08:54 (3)	08:36		10:05 (4)
	22:02	21:20	20:12	19:00			16:56	58	11:10 (2)	16:23	97	14:53 (5)
9	05:24	06:08	07:00	07:52			07:48		08:53 (3)	08:37		10:05 (4)
	22:02	21:18	20:10	18:58			16:54	61	11:11 (2)	16:23	98	14:54 (5)
10	05:25	06:09	07:02	07:53			07:50		08:53 (3)	08:38		10:05 (4)
	22:01	21:16	20:07	18:56			16:53	63	11:12 (2)	16:22	98	14:54 (5)
11	05:26	06:11	07:03	07:55		09:38 (1)	07:52		08:54 (3)	08:39		10:05 (4)
	22:00	21:14	20:05	18:54	8	09:46 (1)	16:51	64	11:13 (2)	16:22	98	14:54 (5)
12	05:27	06:13	07:05	07:57		09:34 (1)	07:54		08:54 (3)	08:40		10:06 (4)
	21:59	21:12	20:02	18:51	16	09:50 (1)	16:49	65	11:14 (2)	16:22	96	14:55 (5)
13	05:28	06:14	07:07	07:59		09:32 (1)	07:56		08:54 (3)	08:41		10:06 (4)
	21:58	21:10	20:00	18:49	20	09:52 (1)	16:48	65	11:14 (2)	16:22	100	14:55 (5)
14	05:29	06:16	07:09	08:00		09:30 (1)	07:57		08:55 (3)	08:42		10:07 (4)
	21:57	21:08	19:58	18:47	23	09:53 (1)	16:46	64	11:15 (2)	16:22	104	14:56 (5)
15	05:30	06:18	07:10	08:02		09:29 (1)	07:59		08:56 (3)	08:43		10:07 (4)
	21:56	21:06	19:55	18:44	25	09:54 (1)	16:45	65	11:16 (2)	16:22	105	14:56 (5)
16	05:32	06:20	07:12	08:04		09:27 (1)	08:01		08:57 (3)	08:44		10:08 (4)
	21:55	21:04	19:53	18:42	27	09:54 (1)	16:43	64	11:16 (2)	16:22	106	14:57 (5)
17	05:33	06:21	07:14	08:06		09:26 (1)	08:03		08:58 (3)	08:45		10:08 (4)
	21:54	21:02	19:50	18:40	29	09:55 (1)	16:42	63	11:17 (2)	16:22	107	14:58 (5)
18	05:34	06:23	07:15	08:08		09:26 (1)	08:05		08:59 (3)	08:46		10:09 (4)
	21:53	21:00	19:48	18:38	29	09:55 (1)	16:40	61	11:17 (2)	16:22	107	14:58 (5)
19	05:35	06:25	07:17	08:09		09:25 (1)	08:06		09:01 (3)	08:46		10:09 (4)
	21:52	20:57	19:46	18:36	31	09:56 (1)	16:39	61	11:17 (2)	16:23	107	14:58 (5)
20	05:37	06:26	07:19	08:11		09:25 (1)	08:08		09:04 (3)	08:47		10:10 (4)
	21:50	20:55	19:43	18:33	31	09:56 (1)	16:38	63	11:18 (2)	16:23	109	14:59 (5)
21	05:38	06:28	07:20	08:13		09:25 (1)	08:10		10:05 (4)	08:48		10:11 (4)
	21:49	20:53	19:41	18:31	31	09:56 (1)	16:37	62	11:18 (2)	16:23	107	15:00 (5)
22	05:40	06:30	07:22	08:15		09:25 (1)	08:12		10:04 (4)	08:48		10:11 (4)
	21:48	20:51	19:38	18:29	31	09:56 (1)	16:35	64	11:18 (2)	16:24	107	15:00 (5)
23	05:41	06:31	07:24	08:17		09:25 (1)	08:13		10:04 (4)	08:49		10:11 (4)
	21:47	20:49	19:36	18:27	30	09:55 (1)	16:34	73	14:37 (5)	16:24	108	15:00 (5)
24	05:43	06:33	07:26	08:19		09:25 (1)	08:15		10:02 (4)	08:49		10:12 (4)
	21:45	20:47	19:34	18:25	30	09:55 (1)	16:33	81	14:40 (5)	16:25	107	15:01 (5)
25	05:44	06:35	07:27	07:20		08:26 (1)	08:17		10:02 (4)	08:50		10:12 (4)
	21:44	20:44	19:31	17:23	28	08:54 (1)	16:32	86	14:42 (5)	16:26	107	15:01 (5)
26	05:45	06:36	07:29	07:22		08:26 (1)	08:18		10:02 (4)	08:50		10:12 (4)
	21:42	20:42	19:29	17:21	27	08:53 (1)	16:31	88	14:43 (5)	16:26	107	15:02 (5)
27	05:47	06:38	07:31	07:24		08:27 (1)	08:20		10:02 (4)	08:50		10:13 (4)
	21:41	20:40	19:26	17:19	25	08:52 (1)	16:30	90	14:45 (5)	16:27	107	15:02 (5)
28	05:49	06:40	07:32	07:26		08:28 (1)	08:22		10:01 (4)	08:50		10:14 (4)
	21:39	20:38	19:24	17:17	23	08:51 (1)	16:29	94	14:45 (5)	16:28	106	15:03 (5)
29	05:50	06:42	07:34	07:28		08:30 (1)	08:23		10:02 (4)	08:50		10:14 (4)
	21:37	20:35	19:22	17:15	20	08:50 (1)	16:28	95	14:47 (5)	16:29	104	15:04 (5)
30	05:52	06:43	07:36	07:30		08:31 (1)	08:25		10:02 (4)	08:50		10:14 (4)
	21:36	20:33	19:19	17:13	17	08:48 (1)	16:27	97	14:48 (5)	16:30	102	15:03 (5)
31	05:53	06:45		07:32		08:34 (1)				08:50		10:14 (4)
	21:34	20:31		17:11	11	08:45 (1)				16:31	98	15:04 (5)
Potential sun hours	507	456	381	330			263			239		
Total, worst case					512			1900			3180	
Sun reduction					0,25			0,22			0,16	
Oper. time red.					0,99			0,99			0,99	
Wind dir. red.					0,65			0,63			0,63	
Total reduction					0,16			0,14			0,10	
Total, real					83			265			319	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Coor Shanavogh (updated micro siting)

Printed/Page

12-4-2011 20:31 / 3

Licensed user:

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Calculated:

12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** B - Shadow Receptor: 1,0 × 1,0 Azimuth: -4,8° Slope: 90,0° (2)

Assumptions for shadow calculations

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472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January			February			March			April	May	June
1	08:50		09:55 (4)	08:22		09:11 (3)	07:27		08:41 (1)	07:14	06:07	05:20
	16:32	57	14:23 (5)	17:21	56	10:54 (2)	18:15	23	09:04 (1)	20:11	21:04	21:52
2	08:50		09:55 (4)	08:20		09:10 (3)	07:24		08:41 (1)	07:12	06:05	05:19
	16:33	56	14:24 (5)	17:23	58	10:54 (2)	18:17	21	09:02 (1)	20:13	21:06	21:53
3	08:50		09:55 (4)	08:19		09:09 (3)	07:22		08:42 (1)	07:09	06:03	05:18
	16:34	54	14:23 (5)	17:25	59	10:53 (2)	18:19	18	09:00 (1)	20:15	21:07	21:54
4	08:50		09:55 (4)	08:17		09:10 (3)	07:20		08:44 (1)	07:07	06:01	05:18
	16:35	51	14:23 (5)	17:27	58	10:54 (2)	18:21	14	08:58 (1)	20:16	21:09	21:55
5	08:50		09:56 (4)	08:15		09:09 (3)	07:18		08:47 (1)	07:05	05:59	05:17
	16:37	45	14:24 (5)	17:29	58	10:53 (2)	18:22	7	08:54 (1)	20:18	21:11	21:56
6	08:49		09:55 (4)	08:14		09:09 (3)	07:15			07:02	05:58	05:16
	16:38	42	14:23 (5)	17:31	57	10:53 (2)	18:24			20:20	21:13	21:57
7	08:49		09:55 (4)	08:12		09:09 (3)	07:13			07:00	05:56	05:16
	16:39	41	14:23 (5)	17:33	56	10:52 (2)	18:26			20:22	21:14	21:58
8	08:48		09:55 (4)	08:10		09:09 (3)	07:11			06:58	05:54	05:15
	16:41	42	14:23 (5)	17:35	55	10:52 (2)	18:28			20:23	21:16	21:59
9	08:48		09:55 (4)	08:08		09:10 (3)	07:08			06:55	05:52	05:14
	16:42	45	14:22 (5)	17:37	52	10:51 (2)	18:30			20:25	21:18	22:00
10	08:47		09:55 (4)	08:06		09:11 (3)	07:06			06:53	05:50	05:14
	16:43	50	14:21 (5)	17:39	47	10:49 (2)	18:32			20:27	21:19	22:01
11	08:47		09:55 (4)	08:04		09:11 (3)	07:04			06:51	05:49	05:14
	16:45	50	14:20 (5)	17:41	45	10:48 (2)	18:33			20:29	21:21	22:01
12	08:46		09:56 (4)	08:02		09:13 (3)	07:01			06:48	05:47	05:13
	16:46	50	14:19 (5)	17:43	37	10:46 (2)	18:35			20:31	21:23	22:02
13	08:45		09:56 (4)	08:01		09:15 (3)	06:59			06:46	05:45	05:13
	16:48	43	10:39 (2)	17:45	30	10:44 (2)	18:37			20:32	21:24	22:03
14	08:44		09:56 (4)	07:59		10:27 (2)	06:57			06:44	05:43	05:13
	16:49	45	10:41 (2)	17:46	14	10:41 (2)	18:39			20:34	21:26	22:03
15	08:44		09:56 (4)	07:57			06:54			06:42	05:42	05:12
	16:51	46	10:42 (2)	17:48			18:41			20:36	21:28	22:04
16	08:43		09:57 (4)	07:55		08:51 (1)	06:52			06:39	05:40	05:12
	16:53	47	10:44 (2)	17:50	5	08:56 (1)	18:42			20:38	21:29	22:05
17	08:42		09:56 (4)	07:53		08:47 (1)	06:50			06:37	05:39	05:12
	16:54	48	10:44 (2)	17:52	13	09:00 (1)	18:44			20:39	21:31	22:05
18	08:41		09:57 (4)	07:50		08:44 (1)	06:47			06:35	05:37	05:12
	16:56	48	10:45 (2)	17:54	17	09:01 (1)	18:46			20:41	21:32	22:05
19	08:40		09:57 (4)	07:48		08:43 (1)	06:45			06:33	05:36	05:12
	16:58	50	10:47 (2)	17:56	20	09:03 (1)	18:48			20:43	21:34	22:06
20	08:39		09:58 (4)	07:46		08:42 (1)	06:43			06:30	05:34	05:12
	16:59	50	10:48 (2)	17:58	22	09:04 (1)	18:50			20:45	21:35	22:06
21	08:37		09:58 (4)	07:44		08:41 (1)	06:40			06:28	05:33	05:12
	17:01	50	10:48 (2)	18:00	24	09:05 (1)	18:51			20:46	21:37	22:06
22	08:36		09:59 (4)	07:42		08:41 (1)	06:38			06:26	05:31	05:13
	17:03	50	10:49 (2)	18:02	25	09:06 (1)	18:53			20:48	21:38	22:07
23	08:35		10:00 (4)	07:40		08:39 (1)	06:35			06:24	05:30	05:13
	17:05	50	10:50 (2)	18:04	26	09:05 (1)	18:55			20:50	21:40	22:07
24	08:34		10:00 (4)	07:38		08:39 (1)	06:33			06:22	05:29	05:13
	17:07	51	10:51 (2)	18:06	27	09:06 (1)	18:57			20:52	21:41	22:07
25	08:32		10:01 (4)	07:36		08:39 (1)	06:31			06:20	05:28	05:14
	17:08	51	10:52 (2)	18:07	27	09:06 (1)	18:59			20:53	21:43	22:07
26	08:31		10:02 (4)	07:33		08:40 (1)	06:28			06:17	05:26	05:14
	17:10	50	10:52 (2)	18:09	26	09:06 (1)	19:00			20:55	21:44	22:07
27	08:30		10:03 (4)	07:31		08:39 (1)	06:26			06:15	05:25	05:14
	17:12	49	10:52 (2)	18:11	26	09:05 (1)	19:02			20:57	21:45	22:07
28	08:28		10:05 (4)	07:29		08:40 (1)	06:24			06:13	05:24	05:15
	17:14	48	10:53 (2)	18:13	24	09:04 (1)	19:04			20:59	21:47	22:07
29	08:27		10:06 (4)				07:21			06:11	05:23	05:15
	17:16	47	10:53 (2)				20:06			21:01	21:48	22:06
30	08:25		09:14 (3)				07:19			06:09	05:22	05:16
	17:18	52	10:54 (2)				20:07			21:02	21:49	22:06
31	08:24		09:12 (3)				07:16				05:21	
	17:20	54	10:54 (2)				20:09				21:50	
Potential sun hours	255			276			367			418	489	504
Total, worst case		1512			964			83				
Sun reduction		0,19			0,21			0,24				
Oper. time red.		0,99			0,99			0,99				
Wind dir. red.		0,64			0,65			0,65				
Total reduction		0,12			0,14			0,15				
Total, real		183			131			13				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:31 / 4

Licensed user:

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** B - Shadow Receptor: 1,0 × 1,0 Azimuth: -4,8° Slope: 90,0° (2)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	July	August	September	October			November			December		
1	05:17	05:55	06:47	07:38			07:33		08:40 (3)	08:26		09:37 (4)
	22:06	21:33	20:28	19:17			17:09	49	10:19 (2)	16:27	51	14:02 (5)
2	05:17	05:56	06:48	07:39			07:35		08:39 (3)	08:28		09:38 (4)
	22:06	21:31	20:26	19:15			17:07	53	10:20 (2)	16:26	50	14:04 (5)
3	05:18	05:58	06:50	07:41			07:37		08:39 (3)	08:29		09:39 (4)
	22:05	21:29	20:24	19:12			17:05	55	10:21 (2)	16:25	45	14:06 (5)
4	05:19	06:00	06:52	07:43			07:39		08:39 (3)	08:31		09:39 (4)
	22:05	21:27	20:21	19:10			17:03	56	10:22 (2)	16:25	41	14:07 (5)
5	05:20	06:01	06:53	07:45			07:41		08:39 (3)	08:32		09:41 (4)
	22:04	21:25	20:19	19:08			17:01	58	10:23 (2)	16:24	41	14:09 (5)
6	05:21	06:03	06:55	07:46			07:43		08:39 (3)	08:33		09:41 (4)
	22:04	21:24	20:17	19:05			17:00	58	10:23 (2)	16:24	42	14:09 (5)
7	05:22	06:04	06:57	07:48			07:45		08:40 (3)	08:35		09:42 (4)
	22:03	21:22	20:14	19:03			16:58	59	10:24 (2)	16:23	44	14:10 (5)
8	05:23	06:06	06:58	07:50			07:46		08:40 (3)	08:36		09:43 (4)
	22:02	21:20	20:12	19:00			16:56	58	10:24 (2)	16:23	51	14:11 (5)
9	05:24	06:08	07:00	07:52		09:20 (1)	07:48		08:41 (3)	08:37		09:44 (4)
	22:02	21:18	20:10	18:58	11	09:31 (1)	16:54	57	10:24 (2)	16:23	54	14:12 (5)
10	05:25	06:09	07:02	07:53		09:17 (1)	07:50		08:42 (3)	08:38		09:44 (4)
	22:01	21:16	20:07	18:56	16	09:33 (1)	16:53	56	10:25 (2)	16:22	57	14:13 (5)
11	05:26	06:11	07:04	07:55		09:16 (1)	07:52		08:43 (3)	08:39		09:45 (4)
	22:00	21:14	20:05	18:54	19	09:35 (1)	16:51	54	10:25 (2)	16:22	56	14:13 (5)
12	05:27	06:13	07:05	07:57		09:14 (1)	07:54		08:45 (3)	08:40		09:46 (4)
	21:59	21:12	20:02	18:51	22	09:36 (1)	16:49	53	10:25 (2)	16:22	58	14:14 (5)
13	05:28	06:14	07:07	07:59		09:13 (1)	07:56		09:38 (4)	08:41		09:47 (4)
	21:58	21:10	20:00	18:49	24	09:37 (1)	16:48	47	10:25 (2)	16:22	58	14:14 (5)
14	05:29	06:16	07:09	08:00		09:13 (1)	07:57		09:37 (4)	08:42		09:48 (4)
	21:57	21:08	19:58	18:47	25	09:38 (1)	16:46	48	10:25 (2)	16:22	59	14:15 (5)
15	05:30	06:18	07:10	08:02		09:12 (1)	07:59		09:35 (4)	08:43		09:49 (4)
	21:56	21:06	19:55	18:44	26	09:38 (1)	16:45	50	10:25 (2)	16:22	59	14:16 (5)
16	05:32	06:20	07:12	08:04		09:11 (1)	08:01		09:35 (4)	08:44		09:50 (4)
	21:55	21:04	19:53	18:42	26	09:37 (1)	16:43	50	10:25 (2)	16:22	58	14:16 (5)
17	05:33	06:21	07:14	08:06		09:11 (1)	08:03		09:34 (4)	08:45		09:51 (4)
	21:54	21:02	19:50	18:40	26	09:37 (1)	16:42	51	10:25 (2)	16:22	59	14:17 (5)
18	05:34	06:23	07:15	08:08		09:11 (1)	08:05		09:34 (4)	08:46		09:52 (4)
	21:53	21:00	19:48	18:38	26	09:37 (1)	16:40	51	10:25 (2)	16:22	60	14:18 (5)
19	05:35	06:25	07:17	08:09		09:11 (1)	08:06		09:34 (4)	08:46		09:52 (4)
	21:52	20:57	19:46	18:36	25	09:36 (1)	16:39	50	10:24 (2)	16:23	58	14:18 (5)
20	05:37	06:26	07:19	08:11		09:11 (1)	08:08		09:34 (4)	08:47		09:53 (4)
	21:51	20:55	19:43	18:33	25	09:36 (1)	16:38	50	10:24 (2)	16:23	58	14:19 (5)
21	05:38	06:28	07:20	08:13		09:12 (1)	08:10		09:34 (4)	08:48		09:54 (4)
	21:49	20:53	19:41	18:31	23	09:35 (1)	16:37	50	10:24 (2)	16:23	58	14:20 (5)
22	05:40	06:30	07:22	08:15		09:13 (1)	08:12		09:34 (4)	08:48		09:54 (4)
	21:48	20:51	19:38	18:29	21	09:34 (1)	16:35	50	10:24 (2)	16:24	58	14:20 (5)
23	05:41	06:31	07:24	08:17		09:14 (1)	08:13		09:34 (4)	08:49		09:54 (4)
	21:47	20:49	19:36	18:27	19	09:33 (1)	16:34	50	10:24 (2)	16:24	58	14:20 (5)
24	05:43	06:33	07:26	08:19		09:15 (1)	08:15		09:34 (4)	08:49		09:55 (4)
	21:45	20:47	19:34	18:25	16	09:31 (1)	16:33	48	10:22 (2)	16:25	58	14:21 (5)
25	05:44	06:35	07:27	07:20		08:17 (1)	08:17		09:34 (4)	08:50		09:55 (4)
	21:44	20:44	19:31	17:23	12	08:29 (1)	16:32	48	10:22 (2)	16:26	60	14:21 (5)
26	05:45	06:36	07:29	07:22			08:18		09:35 (4)	08:50		09:55 (4)
	21:42	20:42	19:29	17:21			16:31	47	10:22 (2)	16:26	58	14:21 (5)
27	05:47	06:38	07:31	07:24		10:01 (2)	08:20		09:35 (4)	08:50		09:55 (4)
	21:41	20:40	19:26	17:19	5	10:06 (2)	16:30	46	10:21 (2)	16:27	59	14:21 (5)
28	05:49	06:40	07:32	07:26		08:47 (3)	08:22		09:35 (4)	08:50		09:56 (4)
	21:39	20:38	19:24	17:17	20	10:12 (2)	16:29	45	10:20 (2)	16:28	60	14:23 (5)
29	05:50	06:42	07:34	07:28		08:44 (3)	08:23		09:36 (4)	08:50		09:56 (4)
	21:38	20:35	19:22	17:15	32	10:14 (2)	16:28	43	10:19 (2)	16:29	59	14:23 (5)
30	05:52	06:43	07:36	07:30		08:42 (3)	08:25		09:37 (4)	08:50		09:55 (4)
	21:36	20:33	19:19	17:13	39	10:16 (2)	16:27	50	14:00 (5)	16:30	58	14:22 (5)
31	05:53	06:45		07:32		08:41 (3)				08:50		09:55 (4)
	21:34	20:31		17:11	45	10:18 (2)				16:31	58	14:23 (5)
Potential sun hours	507	456	381	330			263			239		
Total, worst case					503			1540			1703	
Sun reduction					0,25			0,22			0,16	
Oper. time red.					0,99			0,99			0,99	
Wind dir. red.					0,65			0,64			0,62	
Total reduction					0,16			0,14			0,10	
Total, real					82			218			168	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

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12-4-2011 20:31 / 5

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** C - Shadow Receptor: 1,0 × 1,0 Azimuth: -60,5° Slope: 90,0° (3)

Assumptions for shadow calculations

Maximum distance for influence	2.000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January	February	March			April			May	June	July	August			September			October	November	December
1	08:50	08:22	07:27			07:14		08:18 (6)	06:07	05:20	05:17	05:55			06:47		07:20 (1)	07:38	07:33	08:26
	16:32	17:22	18:15			20:11	52	09:10 (5)	21:04	21:52	22:06	21:33			20:28	46	08:56 (5)	19:17	17:09	16:27
2	08:50	08:20	07:25			07:12		08:20 (6)	06:05	05:19	05:17	05:56			06:48		07:20 (1)	07:39	07:35	08:28
	16:33	17:23	18:17			20:13	49	09:09 (5)	21:06	21:53	22:06	21:31			20:26	48	08:58 (5)	19:15	17:07	16:26
3	08:50	08:19	07:22			07:09		08:25 (5)	06:03	05:18	05:18	05:58			06:50		07:20 (1)	07:41	07:37	08:29
	16:34	17:25	18:19			20:15	44	09:09 (5)	21:07	21:54	22:05	21:29			20:24	49	08:59 (5)	19:12	17:05	16:25
4	08:50	08:17	07:20			07:07		08:24 (5)	06:01	05:18	05:19	06:00			06:52		07:21 (1)	07:43	07:39	08:31
	16:35	17:27	18:21			20:16	43	09:07 (5)	21:09	21:55	22:05	21:27			20:21	48	09:00 (5)	19:10	17:03	16:25
5	08:50	08:15	07:18			07:05		08:25 (5)	05:59	05:17	05:20	06:01			06:53		07:23 (1)	07:45	07:41	08:32
	16:37	17:29	18:22			20:18	42	09:07 (5)	21:11	21:56	22:04	21:25			20:19	46	09:01 (5)	19:08	17:01	16:24
6	08:49	08:14	07:15			07:02		08:25 (5)	05:58	05:16	05:21	06:03			06:55		08:21 (5)	07:46	07:43	08:33
	16:38	17:31	18:24			20:20	41	09:06 (5)	21:13	21:57	22:04	21:24			20:17	40	09:01 (5)	19:05	17:00	16:24
7	08:49	08:12	07:13			07:00		07:26 (1)	05:56	05:16	05:22	06:05			06:57		08:20 (5)	07:48	07:45	08:35
	16:39	17:33	18:26			20:22	46	09:04 (5)	21:14	21:58	22:03	21:22			20:14	42	09:02 (5)	19:03	16:58	16:23
8	08:48	08:10	07:11			06:58		07:24 (1)	05:54	05:15	05:23	06.06			06:58		08:19 (5)	07:50	07:46	08:36
	16:41	17:35	18:28			20:23	48	09:03 (5)	21:16	21:59	22:02	21:20			20:12	44	09:03 (5)	19:01	16:56	16:23
9	08:48	08:08	07:08			06:55		07:23 (1)	05:52	05.15	05:24	06:08			07:00		08:18 (5)	07:52	07:48	08:37
	16:42	17:37	18:30			20:25	49	09:02 (5)	21:18	22:00	22:02	21:18			20:10	44	09:02 (5)	18:58	16:54	16:23
10	08:47	08:06	07:06			06:53		07:21 (1)	05:50	05:14	05.25	06:10			07:02		08:14 (6)	07:53	07:50	08:38
	16:43	17:39	18:32			20:27	48	08:59 (5)	21:19	22:01	22:01	21.16			20:07	48	09:02 (5)	18:56	16:53	16:22
11	08:47	08:04	07:04			06:51		07:21 (1)	05:49	05:14	05:26	06:11			07:04		08:11 (6)	07:55	07:52	08:39
	16:45	17:41	18:33			20:29	46	08:57 (5)	21:21	22:01	22:00	21:14			20:05	52	09:03 (5)	18:54	16:51	16:22
12	08:46	08:02	07:01			06:48		07:20 (1)	05:47	05:13	05:27	06:13			07:05		08:09 (6)	07:57	07:54	08:40
	16:46	17:43	18:35			20:31	44	08:55 (5)	21:23	22:02	21:59	21:12			20:02	53	09:02 (5)	18:51	16:49	16:22
13	08:45	08:01	06:59			06:46		07:20 (2)	05:45	05:13	05:28	06:15			07:07		08:08 (6)	07:59	07:56	08:41
	16:48	17:45	18:37			20:32	39	08:52 (5)	21:24	22:03	21:58	21:10			20:00	54	09:02 (5)	18:49	16:48	16:22
14	08:44	07:59	06:57			06:44		07:19 (2)	05:43	05:13	05:29	06:16			07:09		07:56 (3)	08:00	07:58	08:42
	16:50	17:47	18:39			20:34	31	08:47 (5)	21:26	22:03	21:57	21:08			19:58	57	09:01 (5)	18:47	16:46	16:22
15	08:44	07:57	06:54			06:42		07:19 (2)	05:42	05:13	05:30	06:18			07:10		07:53 (3)	08:02	07:59	08:43
	16:51	17:48	18:41			20:36	21	07:40 (2)	21:28	22:04	21:56	21:06			19:55	68	09:01 (5)	18:45	16:45	16:22
16	08:43	07:55	06:52			06:39		07:19 (2)	05:40	05:12	05:32	06:20			07:12		07:51 (3)	08:04	08:01	08:44
	16:53	17:50	18:43			20:38	21	07:40 (2)	21:29	22:05	21:55	21:04			19:53	70	09:01 (5)	18:42	16:43	16:22
17	08:42	07:53	06:50		07:29 (6)	06:37		07:19 (2)	05:39	05:12	05:33	06:21			07:14		07:49 (3)	08:06	08:03	08:45
	16:54	17:52	18:44	21	08:00 (5)	20:39	21	07:40 (2)	21:31	22:05	21:54	21:02			19:51	70	08:59 (5)	18:40	16:42	16:22
18	08:41	07:50	06:47		07:17 (4)	06:35		07:19 (2)	05:37	05:12	05:34	06:23			07:15		07:49 (3)	08:08	08:05	08:46
	16:56	17:54	18:46	41	08:04 (5)	20:41	20	07:39 (2)	21:32	22:05	21:53	21:00			19:48	70	08:59 (5)	18:38	16:41	16:22
19	08:40	07:48	06:45		07:13 (4)	06:33		07:20 (2)	05:36	05:12	05:36	06:25			07:17		07:49 (3)	08:09	08:06	08:46
	16:58	17:56	18:48	52	08:05 (5)	20:43	18	07:38 (2)	21:34	22:06	21:52	20:57			19:46	69	08:58 (5)	18:36	16:39	16:23
20	08:39	07:46	06:43		07:11 (4)	06:30		07:19 (2)	05:34	05:12	05:37	06:26		07:31 (2)	07:19		07:48 (3)	08:11	08:08	08:47
	17:00	17:58	18:50	56	08:07 (5)	20:45	17	07:36 (2)	21:35	22:06	21:51	20:55	5	07:36 (2)	19:43	68	08:56 (5)	18:33	16:38	16:23
21	08:37	07:44	06:40		07:06 (3)	06:28		07:21 (2)	05:33	05:13	05:38	06:28		07:28 (2)	07:20		07:49 (3)	08:13	08:10	08:48
	17:01	18:00	18:52	62	08:08 (5)	20:46	14	07:35 (2)	21:37	22:06	21:49	20:53	11	07:39 (2)	19:41	66	08:55 (5)	18:31	16:37	16:24
22	08:36	07:42	06:38		07:04 (3)	06:26		07:22 (2)	05:31	05:13	05:40	06:30		07:25 (2)	07:22		07:51 (3)	08:15	08:12	08:48
	17:03	18:02	18:53	65	08:09 (5)	20:48	11	07:33 (2)	21:38	22:07	21:48	20:51	15	07:40 (2)	19:38	63	08:54 (5)	18:29	16:35	16:24
23	08:35	07:40	06:35		07:03 (3)	06:24		07:26 (2)	05:30	05:13	05:41	06:31		07:24 (2)	07:24		07:55 (4)	08:17	08:13	08:49
	17:05	18:04	18:55	67	08:10 (5)	20:50	3	07:29 (2)	21:40	22:07	21:47	20:49	17	07:41 (2)	19:36	56	08:51 (5)	18:27	16:34	16:25
24	08:34	07:38	06:33		07:02 (3)	06:22			05:29	05:13	05:43	06:33		07:22 (2)	07:26		07:56 (4)	08:19	08:15	08:49
	17:07	18:06	18:57	68	08:10 (5)	20:52			21:41	22:07	21:45	20:47	19	07:41 (2)	19:34	53	08:49 (5)	18:25	16:33	16:25
25	08:32	07:36	06:31		07:02 (3)	06:20			05:28	05:14	05:44	06:35		07:22 (2)	07:27		07:58 (4)	07:20	08:17	08:50
	17:08	18:08	18:59	69	08:11 (5)	20:54			21:43	22:07	21:44	20:44	20	07:42 (2)	19:31	46	08:47 (5)	17:23	16:32	16:26
26	08:31	07:33	06:28		07:01 (3)	06:18			05.26	05:14	05:46	06:36		07:21 (2)	07:29		08:10 (6)	07:22	08:18	08:50
	17:10	18:09	19:00	70	08:11 (5)	20:55			21:44	22:07	21:42	20:42	22	07:43 (2)	19:29	28	08:44 (5)	17:21	16:31	16:26
27	08:30	07:31	06:26		07:02 (3)	06:15			05.25	05:14	05:47	06:38		07:20 (2)	07:31		08:29 (5)	07:24	08:20	08:50
	17:12	18:11	19:02	69	08:11 (5)	20:57			21:45	22:07	21:41	20:40	22	07:42 (2)	19:27	10	08:39 (5)	17:19	16:30	16:27
28	08:28	07:29	06:24		07:03 (3)	06:13			05:24	05.15	05:49	06:40		07:21 (2)	07:32			07:26	08:22	08:50
	17:14	18:13	19:04	68	08:11 (5)	20:59			21:47	22:07	21:39	20:38	21	07:42 (2)	19:24			17:17	16:29	16:28
29	08:27		07:21		08:05 (3)	06:11			05:23	05:16	05:50	06:42		07:20 (2)	07:34			07:28	08:23	08:50
	17:16		20:06	60	09:11 (5)	21:01			21:48	22:07	21:38	20:35	32	08:48 (5)	19:22			17:15	16:28	16:29
30	08:25		07:19		08:16 (6)	06:09			05:22	05:16	05:52	06:43		07:20 (2)	07:36			07:30	08:25	08:50
	17:18		20:08	55	09.11 (5)	21:02			21:49	22:06	21:36	20:33	40	08:52 (5)	19:19			17:13	16:27	16:30
31	08:24		07:16		08:17 (6)				05:21		05:53	06:45		07:20 (1)				07:32		08:51
	17:20		20:09	54	09:11 (5)				21:50		21:34	20:31	44	08:55 (5)				17:11		16:31
Potential sun hours	255	276	367			418			489	504	507	456			381			330	263	239
Total, worst case				877			768						268			1408				
Sun reduction				0,24			0,31						0,26			0,28				
Oper. time red.				0,99			0,99						0,99			0,99				
Wind dir. red.				0,65			0,65						0,65			0,65				
Total reduction				0,15			0,20						0,17			0,18				
Total, real				135			156						46			253				

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:31 / 6
Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl
Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** D - Shadow Receptor: 1,0 × 1,0 Azimuth: 41,9° Slope: 90,0° (4)

Assumptions for shadow calculations

Maximum distance for influence	2.000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	January	February			March			April			May	June
1	08:50	08:22			07:27		16:47 (3)	07:14		19:28 (2)	06:07	05:20
	16:32	17:21			18:15	59	17:48 (4)	20:11	17	19:45 (1)	21:04	21:52
2	08:50	08:20			07:24		16:47 (3)	07:12		19:30 (1)	06:05	05:19
	16:33	17:23			18:17	60	17:50 (4)	20:13	17	19:47 (1)	21:06	21:53
3	08:50	08:19			07:22		16:47 (3)	07:09		19:28 (1)	06:03	05:18
	16:34	17:25			18:19	62	17:52 (4)	20:14	20	19:48 (1)	21:07	21:54
4	08:50	08:17			07:20		16:48 (3)	07:07		19:27 (1)	06:01	05:18
	16:35	17:27			18:20	61	17:54 (4)	20:16	23	19:50 (1)	21:09	21:55
5	08:50	08:15			07:18		16:48 (3)	07:05		19:26 (1)	05:59	05:17
	16:37	17:29			18:22	60	17:54 (4)	20:18	26	19:52 (1)	21:11	21:56
6	08:49	08:13			07:15		16:50 (3)	07:02		19:25 (1)	05:57	05:16
	16:38	17:31			18:24	56	17:54 (4)	20:20	28	19:53 (1)	21:13	21:57
7	08:49	08:12			07:13		16:51 (3)	07:00		19:24 (1)	05:56	05:16
	16:39	17:33			18:26	52	17:53 (4)	20:22	31	19:55 (1)	21:14	21:58
8	08:48	08:10			07:11		16:52 (3)	06:58		19:24 (1)	05:54	05:15
	16:41	17:35			18:28	49	18:01 (6)	20:23	33	19:57 (1)	21:16	21:59
9	08:48	08:08			07:08		16:55 (3)	06:55		19:24 (1)	05:52	05:14
	16:42	17:37			18:30	41	18:03 (6)	20:25	35	19:59 (1)	21:18	22:00
10	08:47	08:06			07:06		16:58 (3)	06:53		19:23 (1)	05:50	05:14
	16:43	17:39			18:32	31	18:06 (6)	20:27	35	19:58 (1)	21:19	22:01
11	08:47	08:04			07:04		17:03 (3)	06:51		19:23 (1)	05:48	05:14
	16:45	17:41			18:33	11	18:07 (6)	20:29	35	19:58 (1)	21:21	22:01
12	08:46	08:02		17:01 (3)	07:01		18:01 (6)	06:48		19:23 (1)	05:47	05:13
	16:46	17:43	13	17:14 (3)	18:35	8	18:09 (6)	20:30	34	19:57 (1)	21:23	22:02
13	08:45	08:00		16:58 (3)	06:59		18:02 (6)	06:46		19:23 (1)	05:45	05:13
	16:48	17:44	18	17:16 (3)	18:37	8	18:10 (6)	20:32	34	19:57 (1)	21:24	22:03
14	08:44	07:58		16:56 (3)	06:57		18:05 (6)	06:44		19:23 (1)	05:43	05:13
	16:49	17:46	22	17:18 (3)	18:39	6	18:11 (6)	20:34	32	19:55 (1)	21:26	22:03
15	08:43	07:56		16:55 (3)	06:54			06:41		19:24 (1)	05:42	05:12
	16:51	17:48	25	17:20 (3)	18:41			20:36	31	19:55 (1)	21:28	22:04
16	08:43	07:54		16:53 (3)	06:52			06:39		19:24 (1)	05:40	05:12
	16:53	17:50	29	17:22 (3)	18:42			20:38	30	19:54 (1)	21:29	22:04
17	08:42	07:52		16:51 (3)	06:50			06:37		19:25 (1)	05:39	05:12
	16:54	17:52	32	17:23 (3)	18:44			20:39	28	19:53 (1)	21:31	22:05
18	08:41	07:50		16:50 (3)	06:47			06:35		19:27 (1)	05:37	05:12
	16:56	17:54	35	17:25 (3)	18:46			20:41	24	19:51 (1)	21:32	22:05
19	08:40	07:48		16:50 (3)	06:45			06:33		19:27 (1)	05:36	05:12
	16:58	17:56	36	17:26 (3)	18:48			20:43	22	19:49 (1)	21:34	22:06
20	08:38	07:46		16:49 (3)	06:42			06:30		19:29 (1)	05:34	05:12
	16:59	17:58	38	17:27 (3)	18:50			20:45	17	19:46 (1)	21:35	22:06
21	08:37	07:44		16:48 (3)	06:40			06:28		19:32 (1)	05:33	05:12
	17:01	18:00	40	17:28 (3)	18:51			20:46	11	19:43 (1)	21:37	22:06
22	08:36	07:42		16:48 (3)	06:38			06:26			05:31	05:13
	17:03	18:02	41	17:29 (3)	18:53			20:48			21:38	22:06
23	08:35	07:40		16:47 (3)	06:35			06:24			05:30	05:13
	17:05	18:04	41	17:28 (3)	18:55			20:50			21:40	22:07
24	08:34	07:38		16:47 (3)	06:33		18:29 (2)	06:22			05:29	05:13
	17:06	18:06	45	17:38 (4)	18:57	2	18:31 (2)	20:52			21:41	22:07
25	08:32	07:35		16:47 (3)	06:31		18:29 (2)	06:20			05:28	05:14
	17:08	18:07	49	17:40 (4)	18:59	4	18:33 (2)	20:53			21:43	22:07
26	08:31	07:33		16:47 (3)	06:28		18:27 (2)	06:17			05:26	05:14
	17:10	18:09	53	17:43 (4)	19:00	7	18:34 (2)	20:55			21:44	22:07
27	08:30	07:31		16:46 (3)	06:26		18:27 (2)	06:15			05:25	05:14
	17:12	18:11	55	17:44 (4)	19:02	9	18:36 (2)	20:57			21:45	22:07
28	08:28	07:29		16:47 (3)	06:23		18:27 (2)	06:13			05:24	05:15
	17:14	18:13	57	17:46 (4)	19:04	11	18:38 (2)	20:59			21:47	22:07
29	08:27				07:21		19:27 (2)	06:11			05:23	05:15
	17:16				20:06	12	19:39 (2)	21:00			21:48	22:06
30	08:25				07:19		19:27 (2)	06:09			05:22	05:16
	17:18				20:07	14	19:41 (1)	21:02			21:49	22:06
31	08:24				07:16		19:27 (2)				05:21	
	17:19				20:09	15	19:42 (1)				21:50	
Potential sun hours	255	276			367			418			489	504
Total, worst case			629			638			563			
Sun reduction			0,21			0,24			0,31			
Oper. time red.			0,99			0,99			0,99			
Wind dir. red.			0,65			0,65			0,66			
Total reduction			0,14			0,15			0,20			
Total, real			86			99			115			

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm) Sun set (hh:mm)	Minutes with flicker	First time (hh:mm) with flicker Last time (hh:mm) with flicker	(WTG causing flicker first time) (WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:31 / 7

Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
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Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** D - Shadow Receptor: 1,0 × 1,0 Azimuth: 41,9° Slope: 90,0° (4)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

```
                    |July  |August               |September            |October              |November|December
                    |      |                     |                     |                     |       |
                  1 | 05:17 | 05:55               | 06:47     19:22 (1) | 07:37     18:41 (6) | 07:33 | 08:26
                    | 22:06 | 21:32               | 20:28  35 19:57 (1) | 19:17   8 18:49 (6) | 17:09 | 16:27
                  2 | 05:17 | 05:56               | 06:48     19:22 (1) | 07:39     18:39 (6) | 07:35 | 08:28
                    | 22:06 | 21:31               | 20:26  35 19:57 (1) | 19:15   8 18:47 (6) | 17:07 | 16:26
                  3 | 05:18 | 05:58               | 06:50     19:21 (1) | 07:41     17:38 (3) | 07:37 | 08:29
                    | 22:05 | 21:29               | 20:24  35 19:56 (1) | 19:12  24 18:45 (6) | 17:05 | 16:25
                  4 | 05:19 | 06:00               | 06:52     19:21 (1) | 07:43     17:33 (3) | 07:39 | 08:30
                    | 22:05 | 21:27               | 20:21  33 19:54 (1) | 19:10  38 18:41 (6) | 17:03 | 16:25
                  5 | 05:20 | 06:01               | 06:53     19:21 (1) | 07:44     17:30 (3) | 07:41 | 08:32
                    | 22:04 | 21:25               | 20:19  31 19:52 (1) | 19:07  45 18:39 (6) | 17:01 | 16:24
                  6 | 05:21 | 06:03               | 06:55     19:21 (1) | 07:46     17:28 (3) | 07:43 | 08:33
                    | 22:04 | 21:24               | 20:17  28 19:49 (1) | 19:05  49 18:28 (4) | 16:59 | 16:24
                  7 | 05:22 | 06:04               | 06:57     19:21 (1) | 07:48     17:26 (3) | 07:45 | 08:34
                    | 22:03 | 21:22               | 20:14  26 19:47 (1) | 19:03  55 18:29 (4) | 16:58 | 16:23
                  8 | 05:23 | 06:06               | 06:58     19:21 (1) | 07:50     17:25 (3) | 07:46 | 08:36
                    | 22:02 | 21:20               | 20:12  23 19:44 (1) | 19:00  58 18:30 (4) | 16:56 | 16:23
                  9 | 05:24 | 06:08               | 07:00     19:22 (1) | 07:51     17:23 (3) | 07:48 | 08:37
                    | 22:02 | 21:18               | 20:10  20 19:42 (1) | 18:58  61 18:29 (4) | 16:54 | 16:22
                 10 | 05:25 | 06:09               | 07:02     19:23 (1) | 07:53     17:22 (3) | 07:50 | 08:38
                    | 22:01 | 21:16               | 20:07  17 19:40 (1) | 18:56  62 18:27 (4) | 16:53 | 16:22
                 11 | 05:26 | 06:11               | 07:03     19:21 (2) | 07:55     17:21 (3) | 07:52 | 08:39
                    | 22:00 | 21:14               | 20:05  16 19:37 (1) | 18:54  61 18:25 (4) | 16:51 | 16:22
                 12 | 05:27 | 06:13               | 07:05     19:20 (2) | 07:57     17:20 (3) | 07:54 | 08:40
                    | 21:59 | 21:12               | 20:02  15 19:35 (1) | 18:51  61 18:23 (4) | 16:49 | 16:22
                 13 | 05:28 | 06:14               | 07:07     19:19 (2) | 07:59     17:20 (3) | 07:56 | 08:41
                    | 21:58 | 21:10               | 20:00  14 19:33 (1) | 18:49  59 18:21 (4) | 16:48 | 16:22
                 14 | 05:29 | 06:16               | 07:09     19:17 (2) | 08:00     17:20 (3) | 07:57 | 08:42
                    | 21:57 | 21:08               | 19:58  13 19:30 (2) | 18:47  56 18:18 (4) | 16:46 | 16:22
                 15 | 05:30 | 06:18               | 07:10     19:17 (2) | 08:02     17:19 (3) | 07:59 | 08:43
                    | 21:56 | 21:06               | 19:55  11 19:28 (2) | 18:44  54 18:16 (4) | 16:45 | 16:22
                 16 | 05:32 | 06:19               | 07:12     19:17 (2) | 08:04     17:18 (3) | 08:01 | 08:44
                    | 21:55 | 21:04               | 19:53   9 19:26 (2) | 18:42  51 18:13 (4) | 16:43 | 16:22
                 17 | 05:33 | 06:21               | 07:14     19:16 (2) | 08:06     17:18 (3) | 08:03 | 08:45
                    | 21:54 | 21:02               | 19:50   7 19:23 (2) | 18:40  48 18:11 (4) | 16:42 | 16:22
                 18 | 05:34 | 06:23               | 07:15     19:16 (2) | 08:08     17:18 (3) | 08:05 | 08:46
                    | 21:53 | 21:00               | 19:48   5 19:21 (2) | 18:38  45 18:09 (4) | 16:40 | 16:22
                 19 | 05:35 | 06:25               | 07:17     19:17 (2) | 08:09     17:18 (3) | 08:06 | 08:46
                    | 21:52 | 20:57               | 19:46   2 19:19 (2) | 18:36  41 17:59 (3) | 16:39 | 16:23
                 20 | 05:37 | 06:26               | 07:19               | 08:11     17:19 (3) | 08:08 | 08:47
                    | 21:50 | 20:55               | 19:43               | 18:33  40 17:59 (3) | 16:38 | 16:23
                 21 | 05:38 | 06:28               | 07:20               | 08:13     17:19 (3) | 08:10 | 08:48
                    | 21:49 | 20:53               | 19:41               | 18:31  39 17:58 (3) | 16:37 | 16:23
                 22 | 05:40 | 06:30     19:36 (1) | 07:22               | 08:15     17:19 (3) | 08:12 | 08:48
                    | 21:48 | 20:51  13 19:49 (1) | 19:38               | 18:29  38 17:57 (3) | 16:35 | 16:24
                 23 | 05:41 | 06:31     19:34 (1) | 07:24               | 08:17     17:20 (3) | 08:13 | 08:49
                    | 21:46 | 20:49  18 19:52 (1) | 19:36               | 18:27  37 17:57 (3) | 16:34 | 16:24
                 24 | 05:42 | 06:33     19:31 (1) | 07:25               | 08:18     17:21 (3) | 08:15 | 08:49
                    | 21:45 | 20:46  22 19:53 (1) | 19:34               | 18:25  35 17:56 (3) | 16:33 | 16:25
                 25 | 05:44 | 06:35     19:29 (1) | 07:27               | 07:20     16:22 (3) | 08:17 | 08:49
                    | 21:44 | 20:44  25 19:54 (1) | 19:31               | 17:23  31 16:53 (3) | 16:32 | 16:26
                 26 | 05:45 | 06:36     19:27 (1) | 07:29               | 07:22     16:23 (3) | 08:18 | 08:50
                    | 21:42 | 20:42  28 19:55 (1) | 19:29               | 17:21  28 16:51 (3) | 16:31 | 16:26
                 27 | 05:47 | 06:38     19:26 (1) | 07:31               | 07:24     16:24 (3) | 08:20 | 08:50
                    | 21:41 | 20:40  30 19:56 (1) | 19:26               | 17:19  25 16:49 (3) | 16:30 | 16:27
                 28 | 05:48 | 06:40     19:25 (1) | 07:32               | 07:26     16:26 (3) | 08:22 | 08:50
                    | 21:39 | 20:37  32 19:57 (1) | 19:24               | 17:17  21 16:47 (3) | 16:29 | 16:28
                 29 | 05:50 | 06:41     19:24 (1) | 07:34               | 07:28     16:28 (3) | 08:23 | 08:50
                    | 21:37 | 20:35  32 19:56 (1) | 19:22               | 17:15  17 16:45 (3) | 16:28 | 16:29
                 30 | 05:52 | 06:43     19:23 (1) | 07:36     18:42 (6) | 07:30     16:32 (3) | 08:25 | 08:50
                    | 21:36 | 20:33  34 19:57 (1) | 19:19   9 18:51 (6) | 17:13  11 16:43 (3) | 16:27 | 16:30
                 31 | 05:53 | 06:45     19:23 (1) |                     | 07:31               |       | 08:50
                    | 21:34 | 20:31  34 19:57 (1) |                     | 17:11               |       | 16:31
Potential sun hours | 507   | 456                 | 381                 | 330                 | 263   | 239
  Total, worst case |       |       268           |       384           |      1206           |       |
      Sun reduction |       |      0,26           |      0,28           |      0,25           |       |
    Oper. time red. |       |      0,99           |      0,99           |      0,99           |       |
     Wind dir. red. |       |      0,66           |      0,66           |      0,65           |       |
    Total reduction |       |      0,17           |      0,18           |      0,16           |       |
        Total, real |       |        46           |        70           |       197           |       |
```

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Coor Shanavogh (updated micro siting)

Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** E - Shadow Receptor: 1,0 × 1,0 Azimuth: 149,4° Slope: 90,0° (5)

Assumptions for shadow calculations

Maximum distance for influence	2.000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April			May			June		
1	08:50	08:22	07:27	07:14			06:07		20:16 (4)	05:20		21:00 (2)
	16:32	17:21	18:15	20:11			21:04	19	20:35 (4)	21:52	6	21:06 (2)
2	08:50	08:20	07:24	07:12			06:05		20:15 (4)	05:19		
	16:33	17:23	18:17	20:13			21:06	21	20:36 (4)	21:53		
3	08:50	08:19	07:22	07:09			06:03		20:16 (4)	05:18		
	16:34	17:25	18:19	20:14			21:07	22	20:38 (4)	21:54		
4	08:50	08:17	07:20	07:07			06:01		20:15 (4)	05:18		
	16:35	17:27	18:20	20:16			21:09	25	20:40 (4)	21:55		
5	08:50	08:15	07:18	07:05			05:59		20:15 (4)	05:17		
	16:37	17:29	18:22	20:18			21:11	26	20:41 (4)	21:56		
6	08:49	08:13	07:15	07:02			05:58		20:14 (4)	05:16		
	16:38	17:31	18:24	20:20			21:13	29	20:43 (4)	21:57		
7	08:49	08:12	07:13	07:00			05:56		20:14 (4)	05:16		
	16:39	17:33	18:26	20:22			21:14	28	20:42 (4)	21:58		
8	08:48	08:10	07:11	06:58			05:54		20:15 (4)	05:15		
	16:41	17:35	18:28	20:23			21:16	28	20:43 (4)	21:59		
9	08:48	08:08	07:08	06:55			05:52		20:14 (4)	05:14		
	16:42	17:37	18:30	20:25			21:18	28	20:42 (4)	22:00		
10	08:47	08:06	07:06	06:53			05:50		20:14 (4)	05:14		
	16:43	17:39	18:32	20:27			21:19	28	20:42 (4)	22:01		
11	08:47	08:04	07:04	06:51			05:48		20:15 (4)	05:14		21:11 (3)
	16:45	17:41	18:33	20:29			21:21	27	20:42 (4)	22:01	6	21:17 (3)
12	08:46	08:02	07:01	06:48			05:47		20:15 (4)	05:13		21:10 (3)
	16:46	17:43	18:35	20:30			21:23	26	20:41 (4)	22:02	9	21:19 (3)
13	08:45	08:00	06:59	06:46		20:05 (5)	05:45		20:16 (4)	05:13		21:09 (3)
	16:48	17:45	18:37	20:32	2	20:06 (5)	21:24	27	20:54 (2)	22:03	11	21:20 (3)
14	08:44	07:58	06:57	06:44		20:05 (5)	05:43		20:17 (4)	05:13		21:09 (3)
	16:49	17:46	18:39	20:34	2	20:06 (5)	21:26	26	20:55 (2)	22:03	13	21:22 (3)
15	08:43	07:56	06:54	06:41		20:06 (5)	05:42		20:18 (4)	05:12		21:08 (3)
	16:51	17:48	18:41	20:36	2	20:08 (5)	21:27	26	20:57 (2)	22:04	15	21:23 (3)
16	08:43	07:54	06:52	06:39		20:07 (5)	05:40		20:18 (4)	05:12		21:08 (3)
	16:53	17:50	18:42	20:38	3	20:10 (5)	21:29	27	20:58 (2)	22:04	15	21:23 (3)
17	08:42	07:52	06:50	06:37		20:07 (6)	05:39		20:20 (4)	05:12		21:08 (3)
	16:54	17:52	18:44	20:39	5	20:12 (6)	21:31	25	20:59 (2)	22:05	16	21:24 (3)
18	08:41	07:50	06:47	06:35		20:06 (6)	05:37		20:22 (4)	05:12		21:08 (3)
	16:56	17:54	18:46	20:41	8	20:14 (6)	21:32	24	21:01 (2)	22:05	16	21:24 (3)
19	08:40	07:48	06:45	06:33		20:06 (6)	05:36		20:23 (4)	05:12		21:08 (3)
	16:58	17:56	18:48	20:43	9	20:15 (6)	21:34	21	21:02 (2)	22:06	17	21:25 (3)
20	08:38	07:46	06:42	06:30		20:06 (6)	05:34		20:27 (4)	05:12		21:08 (3)
	16:59	17:58	18:50	20:45	10	20:16 (6)	21:35	16	21:04 (2)	22:06	17	21:25 (3)
21	08:37	07:44	06:40	06:28		20:07 (6)	05:33		20:52 (2)	05:12		21:08 (3)
	17:01	18:00	18:51	20:46	11	20:18 (6)	21:37	13	21:05 (2)	22:06	17	21:25 (3)
22	08:36	07:42	06:38	06:26		20:07 (6)	05:31		20:51 (2)	05:13		21:08 (3)
	17:03	18:02	18:53	20:48	13	20:20 (6)	21:38	15	21:06 (2)	22:06	17	21:25 (3)
23	08:35	07:40	06:35	06:24		20:09 (6)	05:30		20:52 (2)	05:13		21:09 (3)
	17:05	18:04	18:55	20:50	10	20:19 (6)	21:40	15	21:07 (2)	22:07	17	21:26 (3)
24	08:34	07:38	06:33	06:22		20:13 (6)	05:29		20:52 (2)	05:13		21:09 (3)
	17:07	18:06	18:57	20:52	2	20:14 (6)	21:41	17	21:09 (2)	22:07	17	21:26 (3)
25	08:32	07:35	06:31	06:20			05:28		20:53 (2)	05:14		21:09 (3)
	17:08	18:07	18:59	20:53			21:43	17	21:10 (2)	22:07	16	21:25 (3)
26	08:31	07:33	06:28	06:17		20:23 (4)	05:26		20:53 (2)	05:14		21:10 (3)
	17:10	18:09	19:00	20:55	4	20:27 (4)	21:44	17	21:10 (2)	22:07	16	21:26 (3)
27	08:30	07:31	06:26	06:15		20:21 (4)	05:25		20:54 (2)	05:14		21:10 (3)
	17:12	18:11	19:02	20:57	7	20:28 (4)	21:45	16	21:10 (2)	22:07	15	21:25 (3)
28	08:28	07:29	06:23	06:13		20:20 (4)	05:24		20:55 (2)	05:15		21:11 (3)
	17:14	18:13	19:04	20:59	10	20:30 (4)	21:47	14	21:09 (2)	22:07	14	21:25 (3)
29	08:27		07:21	06:11		20:18 (4)	05:23		20:56 (2)	05:15		21:12 (3)
	17:16		20:06	21:00	13	20:31 (4)	21:48	13	21:09 (2)	22:06	12	21:24 (3)
30	08:25		07:19	06:09		20:17 (4)	05:22		20:56 (2)	05:16		21:13 (3)
	17:18		20:07	21:02	16	20:33 (4)	21:49	12	21:08 (2)	22:06	11	21:24 (3)
31	08:24		07:16				05:21		20:57 (2)			
	17:20		20:09				21:50	10	21:07 (2)			
Potential sun hours	255	276	367	418			489			504		
Total, worst case					127			658			293	
Sun reduction					0,31			0,33			0,26	
Oper. time red.					0,99			0,99			0,99	
Wind dir. red.					0,64			0,65			0,65	
Total reduction					0,20			0,21			0,17	
Total, real					25			140			49	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:31 / 9
Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl
Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** E - Shadow Receptor: 1,0 × 1,0 Azimuth: 149,4° Slope: 90,0° (5)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

```
                  |July                        |August                      |September|October |November|December
                  |                            |                            |         |        |        |
                1 | 05:17          21:14 (3) | 05:55          20:25 (4) | 06:47   | 07:37  | 07:33  | 08:26
                  | 22:06      8   21:22 (3) | 21:32     26   20:51 (4) | 20:28   | 19:17  | 17:09  | 16:27
                2 | 05:17                    | 05:56          20:25 (4) | 06:48   | 07:39  | 07:35  | 08:28
                  | 22:06                    | 21:31     27   20:52 (4) | 20:26   | 19:15  | 17:07  | 16:26
                3 | 05:18                    | 05:58          20:25 (4) | 06:50   | 07:41  | 07:37  | 08:29
                  | 22:05                    | 21:29     27   20:52 (4) | 20:24   | 19:12  | 17:05  | 16:25
                4 | 05:19                    | 06:00          20:25 (4) | 06:52   | 07:43  | 07:39  | 08:30
                  | 22:05                    | 21:27     28   20:53 (4) | 20:21   | 19:10  | 17:03  | 16:25
                5 | 05:20                    | 06:01          20:24 (4) | 06:53   | 07:44  | 07:41  | 08:32
                  | 22:04                    | 21:25     28   20:52 (4) | 20:19   | 19:07  | 17:01  | 16:24
                6 | 05:21                    | 06:03          20:24 (4) | 06:55   | 07:46  | 07:43  | 08:33
                  | 22:04                    | 21:24     29   20:53 (4) | 20:17   | 19:05  | 16:59  | 16:24
                7 | 05:22                    | 06:04          20:24 (4) | 06:57   | 07:48  | 07:45  | 08:34
                  | 22:03                    | 21:22     27   20:51 (4) | 20:14   | 19:03  | 16:58  | 16:23
                8 | 05:23                    | 06:06          20:24 (4) | 06:58   | 07:50  | 07:46  | 08:36
                  | 22:02                    | 21:20     26   20:50 (4) | 20:12   | 19:00  | 16:56  | 16:23
                9 | 05:24                    | 06:08          20:24 (4) | 07:00   | 07:51  | 07:48  | 08:37
                  | 22:02                    | 21:18     24   20:48 (4) | 20:10   | 18:58  | 16:54  | 16:23
               10 | 05:25                    | 06:09          20:24 (4) | 07:02   | 07:53  | 07:50  | 08:38
                  | 22:01                    | 21:16     22   20:46 (4) | 20:07   | 18:56  | 16:53  | 16:22
               11 | 05:26          21:08 (2) | 06:11          20:25 (4) | 07:03   | 07:55  | 07:52  | 08:39
                  | 22:00      5   21:13 (2) | 21:14     20   20:45 (4) | 20:05   | 18:54  | 16:51  | 16:22
               12 | 05:27          21:06 (2) | 06:13          20:25 (4) | 07:05   | 07:57  | 07:54  | 08:40
                  | 21:59      9   21:15 (2) | 21:12     18   20:43 (4) | 20:02   | 18:51  | 16:49  | 16:22
               13 | 05:28          21:05 (2) | 06:14          20:26 (4) | 07:07   | 07:59  | 07:56  | 08:41
                  | 21:58     11   21:16 (2) | 21:10     15   20:41 (4) | 20:00   | 18:49  | 16:48  | 16:22
               14 | 05:29          21:04 (2) | 06:16          20:26 (4) | 07:09   | 08:00  | 07:57  | 08:42
                  | 21:57     13   21:17 (2) | 21:08     13   20:39 (4) | 19:58   | 18:47  | 16:46  | 16:22
               15 | 05:30          21:04 (2) | 06:18          20:27 (4) | 07:10   | 08:02  | 07:59  | 08:43
                  | 21:56     14   21:18 (2) | 21:06     10   20:37 (4) | 19:55   | 18:44  | 16:45  | 16:22
               16 | 05:32          21:04 (2) | 06:19          20:28 (4) | 07:12   | 08:04  | 08:01  | 08:44
                  | 21:55     15   21:19 (2) | 21:04      7   20:35 (4) | 19:53   | 18:42  | 16:43  | 16:22
               17 | 05:33          21:03 (2) | 06:21          20:31 (4) | 07:14   | 08:06  | 08:03  | 08:45
                  | 21:54     17   21:20 (2) | 21:02      2   20:33 (4) | 19:50   | 18:40  | 16:42  | 16:22
               18 | 05:34          21:03 (2) | 06:23                    | 07:15   | 08:08  | 08:05  | 08:46
                  | 21:53     17   21:20 (2) | 21:00                    | 19:48   | 18:38  | 16:40  | 16:22
               19 | 05:35          21:02 (2) | 06:25          20:17 (6) | 07:17   | 08:09  | 08:06  | 08:46
                  | 21:52     17   21:19 (2) | 20:57      5   20:22 (6) | 19:46   | 18:36  | 16:39  | 16:23
               20 | 05:37          21:02 (2) | 06:26          20:14 (6) | 07:19   | 08:11  | 08:08  | 08:47
                  | 21:50     17   21:19 (2) | 20:55     11   20:25 (6) | 19:43   | 18:33  | 16:38  | 16:23
               21 | 05:38          21:02 (2) | 06:28          20:12 (6) | 07:20   | 08:13  | 08:10  | 08:48
                  | 21:49     15   21:17 (2) | 20:53     12   20:24 (6) | 19:41   | 18:31  | 16:37  | 16:23
               22 | 05:40          21:01 (2) | 06:30          20:11 (6) | 07:22   | 08:15  | 08:12  | 08:48
                  | 21:48     15   21:16 (2) | 20:51     12   20:23 (6) | 19:38   | 18:29  | 16:35  | 16:24
               23 | 05:41          21:01 (2) | 06:31          20:11 (6) | 07:24   | 08:17  | 08:13  | 08:49
                  | 21:46     13   21:14 (2) | 20:49     10   20:21 (6) | 19:36   | 18:27  | 16:34  | 16:24
               24 | 05:42          20:35 (4) | 06:33          20:09 (6) | 07:25   | 08:18  | 08:15  | 08:49
                  | 21:45     19   21:13 (2) | 20:46      9   20:18 (6) | 19:34   | 18:25  | 16:33  | 16:25
               25 | 05:44          20:33 (4) | 06:35          20:09 (6) | 07:27   | 07:20  | 08:17  | 08:49
                  | 21:44     23   21:12 (2) | 20:44      7   20:16 (6) | 19:31   | 17:23  | 16:32  | 16:26
               26 | 05:45          20:32 (4) | 06:36          20:08 (6) | 07:29   | 07:22  | 08:18  | 08:50
                  | 21:42     24   21:11 (2) | 20:42      6   20:14 (6) | 19:29   | 17:21  | 16:31  | 16:26
               27 | 05:47          20:30 (4) | 06:38          20:09 (5) | 07:31   | 07:24  | 08:20  | 08:50
                  | 21:41     25   21:09 (2) | 20:40      3   20:12 (5) | 19:26   | 17:19  | 16:30  | 16:27
               28 | 05:48          20:28 (4) | 06:40          20:07 (5) | 07:32   | 07:26  | 08:21  | 08:50
                  | 21:39     26   21:07 (2) | 20:37      3   20:10 (5) | 19:24   | 17:17  | 16:29  | 16:28
               29 | 05:50          20:28 (4) | 06:41          20:05 (5) | 07:34   | 07:28  | 08:23  | 08:50
                  | 21:37     26   21:06 (2) | 20:35      2   20:07 (5) | 19:22   | 17:15  | 16:28  | 16:29
               30 | 05:52          20:27 (4) | 06:43                    | 07:36   | 07:30  | 08:25  | 08:50
                  | 21:36     25   21:05 (2) | 20:33                    | 19:19   | 17:13  | 16:27  | 16:30
               31 | 05:53          20:27 (4) | 06:45                    |         | 07:31  |        | 08:50
                  | 21:34     24   20:51 (4) | 20:31                    |         | 17:11  |        | 16:31
Potential sun hours | 507                    | 456                      | 381     | 330    | 263    | 239
  Total, worst case |          378           |           429            |         |        |        |
     Sun reduction  |          0,25          |           0,26           |         |        |        |
     Oper. time red.|          0,99          |           0,99           |         |        |        |
     Wind dir. red. |          0,65          |           0,65           |         |        |        |
    Total reduction |          0,16          |           0,17           |         |        |        |
        Total, real |          62            |           73             |         |        |        |
```

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** F - Shadow Receptor: 1,0 × 1,0 Azimuth: -136,1° Slope: 90,0° (6)

Assumptions for shadow calculations

Maximum distance for influence	2.000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	January	February	March	April			May			June		
1	08:50	08:22	07:27	07:14			06:07		07:00 (4)	05:20		05:59 (2)
	16:32	17:22	18:15	20:11			21:04	10	07:10 (4)	21:52	49	06:55 (6)
2	08:50	08:20	07:24	07:12			06:05		07:03 (4)	05:19		05:59 (2)
	16:33	17:23	18:17	20:13			21:06	3	07:06 (4)	21:53	49	06:55 (6)
3	08:50	08:19	07:22	07:09			06:03			05:18		05:59 (2)
	16:34	17:25	18:19	20:15			21:07			21:54	48	06:54 (6)
4	08:50	08:17	07:20	07:07			06:01			05:18		05:59 (2)
	16:36	17:27	18:21	20:16			21:09			21:55	49	06:55 (6)
5	08:50	08:15	07:18	07:05			05:59			05:17		05:59 (2)
	16:37	17:29	18:22	20:18			21:11			21:56	48	06:54 (6)
6	08:49	08:14	07:15	07:02			05:58		06:27 (1)	05:16		05:58 (2)
	16:38	17:31	18:24	20:20			21:13	2	06:28 (1)	21:57	49	06:54 (6)
7	08:49	08:12	07:13	07:00			05:56		06:24 (1)	05:16		05:59 (2)
	16:39	17:33	18:26	20:22			21:14	9	06:33 (1)	21:58	48	06:54 (6)
8	08:48	08:10	07:11	06:58			05:54		06:23 (1)	05:15		06:00 (2)
	16:41	17:35	18:28	20:23			21:16	11	06:34 (1)	21:59	47	06:55 (6)
9	08:48	08:08	07:08	06:55			05:52		06:21 (1)	05:15		05:59 (2)
	16:42	17:37	18:30	20:25			21:18	13	06:34 (1)	22:00	47	06:54 (6)
10	08:47	08:06	07:06	06:53			05:50		06:21 (1)	05:14		06:00 (2)
	16:43	17:39	18:32	20:27			21:19	24	06:45 (6)	22:01	46	06:54 (6)
11	08:47	08:04	07:04	06:51			05:49		06:20 (1)	05:14		05:59 (2)
	16:45	17:41	18:33	20:29			21:21	27	06:47 (6)	22:01	46	06:54 (6)
12	08:46	08:02	07:01	06:48			05:47		06:20 (1)	05:13		06:00 (2)
	16:46	17:43	18:35	20:31			21:23	28	06:48 (6)	22:02	46	06:54 (6)
13	08:45	08:01	06:59	06:46			05:45		06:20 (1)	05:13		06:00 (2)
	16:48	17:45	18:37	20:32			21:24	30	06:50 (6)	22:03	45	06:54 (6)
14	08:44	07:59	06:57	06:44			05:43		06:20 (1)	05:13		06:00 (2)
	16:50	17:47	18:39	20:34			21:26	30	06:50 (6)	22:03	45	06:54 (6)
15	08:44	07:57	06:54	06:42		07:09 (3)	05:42		06:20 (1)	05:13		06:01 (2)
	16:51	17:48	18:41	20:36	8	07:17 (3)	21:28	32	06:52 (6)	22:04	44	06:54 (6)
16	08:43	07:55	06:52	06:39		07:07 (3)	05:40		06:20 (1)	05:12		06:01 (2)
	16:53	17:50	18:43	20:38	12	07:19 (3)	21:29	32	06:52 (6)	22:05	44	06:54 (6)
17	08:42	07:53	06:50	06:37		07:06 (3)	05:39		06:21 (1)	05:12		06:01 (2)
	16:54	17:52	18:44	20:39	13	07:19 (3)	21:31	32	06:53 (6)	22:05	43	06:54 (6)
18	08:41	07:50	06:47	06:35		07:05 (3)	05:37		06:22 (1)	05:12		06:01 (2)
	16:56	17:54	18:46	20:41	15	07:20 (3)	21:32	32	06:54 (6)	22:05	44	06:55 (6)
19	08:40	07:48	06:45	06:33		07:03 (4)	05:36		06:22 (1)	05:12		06:01 (2)
	16:58	17:56	18:48	20:43	17	07:20 (3)	21:34	31	06:53 (6)	22:06	45	06:55 (6)
20	08:39	07:46	06:43	06:30		07:00 (4)	05:34		06:24 (1)	05:12		06:02 (2)
	17:00	17:58	18:50	20:45	19	07:19 (3)	21:35	30	06:54 (6)	22:06	44	06:55 (6)
21	08:37	07:44	06:40	06:28		06:59 (4)	05:33		06:25 (6)	05:13		06:02 (2)
	17:01	18:00	18:51	20:46	19	07:18 (3)	21:37	29	06:54 (6)	22:06	44	06:55 (6)
22	08:36	07:42	06:38	06:26		06:58 (4)	05:31		06:25 (6)	05:13		06:02 (2)
	17:03	18:02	18:53	20:48	19	07:17 (3)	21:38	30	06:55 (6)	22:07	44	06:55 (6)
23	08:35	07:40	06:35	06:24		06:58 (4)	05:30		06:24 (6)	05:13		06:02 (2)
	17:05	18:04	18:55	20:50	18	07:16 (3)	21:40	30	06:54 (6)	22:07	45	06:56 (6)
24	08:34	07:38	06:33	06:22		06:57 (4)	05:29		06:05 (2)	05:13		06:02 (2)
	17:07	18:06	18:57	20:52	19	07:16 (4)	21:41	36	06:54 (6)	22:07	44	06:56 (6)
25	08:32	07:36	06:31	06:20		06:57 (4)	05:28		06:03 (2)	05:14		06:02 (2)
	17:08	18:08	18:59	20:53	19	07:16 (4)	21:43	41	06:55 (6)	22:07	43	06:55 (6)
26	08:31	07:33	06:28	06:18		06:57 (4)	05:26		06:02 (2)	05:14		06:03 (2)
	17:10	18:09	19:00	20:55	18	07:15 (4)	21:44	43	06:55 (6)	22:07	44	06:56 (6)
27	08:30	07:31	06:26	06:15		06:57 (4)	05:25		06:01 (2)	05:14		06:03 (2)
	17:12	18:11	19:02	20:57	18	07:15 (4)	21:45	44	06:55 (6)	22:07	44	06:56 (6)
28	08:28	07:29	06:24	06:13		06:57 (4)	05:24		06:00 (2)	05:15		06:03 (2)
	17:14	18:13	19:04	20:59	17	07:14 (4)	21:47	46	06:55 (6)	22:07	45	06:57 (6)
29	08:27		07:21	06:11		06:58 (4)	05:23		06:00 (2)	05:16		06:03 (2)
	17:16		20:06	21:01	15	07:13 (4)	21:48	47	06:55 (6)	22:06	45	06:57 (6)
30	08:25		07:19	06:09		06:59 (4)	05:22		05:59 (2)	05:16		06:04 (2)
	17:18		20:08	21:02	13	07:12 (4)	21:49	48	06:55 (6)	22:06	46	06:58 (6)
31	08:24		07:16				05:21		05:59 (2)			
	17:20		20:09				21:50	48	06:54 (6)			
Potential sun hours	255	276	367	418			489			504		
Total, worst case					259			818			1370	
Sun reduction					0,31			0,33			0,26	
Oper. time red.					0,99			0,99			0,99	
Wind dir. red.					0,65			0,65			0,65	
Total reduction					0,20			0,21			0,17	
Total, real					52			175			232	

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:

Coor Shanavogh (updated micro siting)

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12-4-2011 20:31 / 11

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Pim de Ridder, pim@izzy-projects.nl

Calculated:

12-4-2011 11:27/2.7.453

SHADOW - Calendar

Calculation: 6 Enercon E82 (position def)**Shadow receptor:** F - Shadow Receptor: 1,0 × 1,0 Azimuth: -136,1° Slope: 90,0° (6)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	July			August			September	October	November	December
1	05:17		06:04 (2)	05:55		06:30 (1)	06:47	07:38	07:33	08:26
	22:06	46	06:59 (6)	21:33	28	06:58 (6)	20:28	19:17	17:09	16:27
2	05:17		06:04 (2)	05:56		06:31 (1)	06:48	07:39	07:35	08:28
	22:06	46	06:58 (6)	21:31	26	06:57 (6)	20:26	19:15	17:07	16:26
3	05:18		06:04 (2)	05:58		06:31 (1)	06:50	07:41	07:37	08:29
	22:05	47	06:59 (6)	21:29	23	06:54 (6)	20:24	19:12	17:05	16:25
4	05:19		06:05 (2)	06:00		06:32 (1)	06:52	07:43	07:39	08:31
	22:05	47	07:00 (6)	21:27	12	06:44 (1)	20:21	19:10	17:03	16:25
5	05:20		06:05 (2)	06:01		06:32 (1)	06:53	07:45	07:41	08:32
	22:04	48	07:01 (6)	21:25	11	06:43 (1)	20:19	19:08	17:01	16:24
6	05:21		06:05 (2)	06:03		06:35 (1)	06:55	07:46	07:43	08:33
	22:04	47	07:00 (6)	21:24	6	06:41 (1)	20:17	19:05	17:00	16:24
7	05:22		06:05 (2)	06:05			06:57	07:48	07:45	08:35
	22:03	48	07:01 (6)	21:22			20:14	19:03	16:58	16:23
8	05:23		06:05 (2)	06:06			06:58	07:50	07:46	08:36
	22:02	49	07:01 (6)	21:20			20:12	19:01	16:56	16:23
9	05:24		06:06 (2)	06:08			07:00	07:52	07:48	08:37
	22:02	49	07:02 (6)	21:18			20:10	18:58	16:54	16:23
10	05:25		06:06 (2)	06:10			07:02	07:53	07:50	08:38
	22:01	49	07:02 (6)	21:16			20:07	18:56	16:53	16:22
11	05:26		06:07 (2)	06:11		07:11 (4)	07:04	07:55	07:52	08:39
	22:00	47	07:02 (6)	21:14	6	07:17 (4)	20:05	18:54	16:51	16:22
12	05:27		06:07 (2)	06:13		07:08 (4)	07:05	07:57	07:54	08:40
	21:59	48	07:03 (6)	21:12	11	07:19 (4)	20:02	18:51	16:49	16:22
13	05:28		06:07 (2)	06:15		07:07 (4)	07:07	07:59	07:56	08:41
	21:58	49	07:03 (6)	21:10	13	07:20 (4)	20:00	18:49	16:48	16:22
14	05:29		06:08 (2)	06:16		07:05 (4)	07:09	08:00	07:57	08:42
	21:57	48	07:03 (6)	21:08	16	07:21 (4)	19:58	18:47	16:46	16:22
15	05:30		06:09 (2)	06:18		07:05 (4)	07:10	08:02	07:59	08:43
	21:56	46	07:03 (6)	21:06	17	07:22 (4)	19:55	18:45	16:45	16:22
16	05:32		06:10 (2)	06:20		07:05 (4)	07:12	08:04	08:01	08:44
	21:55	45	07:04 (6)	21:04	17	07:22 (4)	19:53	18:42	16:43	16:22
17	05:33		06:11 (2)	06:21		07:03 (4)	07:14	08:06	08:03	08:45
	21:54	43	07:04 (6)	21:02	19	07:22 (4)	19:50	18:40	16:42	16:22
18	05:34		06:12 (2)	06:23		07:04 (4)	07:15	08:08	08:05	08:46
	21:53	41	07:04 (6)	21:00	18	07:22 (4)	19:48	18:38	16:41	16:22
19	05:36		06:13 (2)	06:25		07:03 (4)	07:17	08:09	08:06	08:46
	21:52	38	07:04 (6)	20:57	18	07:21 (4)	19:46	18:36	16:39	16:23
20	05:37		06:34 (6)	06:26		07:03 (4)	07:19	08:11	08:08	08:47
	21:50	31	07:05 (6)	20:55	19	07:22 (3)	19:43	18:33	16:38	16:23
21	05:38		06:34 (6)	06:28		07:04 (4)	07:20	08:13	08:10	08:48
	21:49	31	07:05 (6)	20:53	19	07:23 (3)	19:41	18:31	16:37	16:24
22	05:40		06:34 (6)	06:30		07:04 (4)	07:22	08:15	08:12	08:48
	21:48	30	07:04 (6)	20:51	19	07:23 (3)	19:38	18:29	16:35	16:24
23	05:41		06:35 (1)	06:31		07:05 (4)	07:24	08:17	08:13	08:49
	21:47	30	07:05 (6)	20:49	18	07:23 (3)	19:36	18:27	16:34	16:25
24	05:43		06:33 (1)	06:33		07:06 (4)	07:26	08:19	08:15	08:49
	21:45	31	07:04 (6)	20:47	17	07:23 (3)	19:34	18:25	16:33	16:25
25	05:44		06:32 (1)	06:35		07:08 (3)	07:27	07:20	08:17	08:49
	21:44	32	07:04 (6)	20:44	15	07:23 (3)	19:31	17:23	16:32	16:26
26	05:46		06:32 (1)	06:36		07:09 (3)	07:29	07:22	08:18	08:50
	21:42	32	07:04 (6)	20:42	13	07:22 (3)	19:29	17:21	16:31	16:26
27	05:47		06:31 (1)	06:38		07:09 (3)	07:31	07:24	08:20	08:50
	21:41	32	07:03 (6)	20:40	11	07:20 (3)	19:27	17:19	16:30	16:27
28	05:49		06:31 (1)	06:40		07:11 (3)	07:32	07:26	08:22	08:50
	21:39	32	07:03 (6)	20:38	8	07:19 (3)	19:24	17:17	16:29	16:28
29	05:50		06:31 (1)	06:42			07:34	07:28	08:23	08:50
	21:38	31	07:02 (6)	20:35			19:22	17:15	16:28	16:29
30	05:52		06:30 (1)	06:43			07:36	07:30	08:25	08:50
	21:36	30	07:00 (6)	20:33			19:19	17:13	16:27	16:30
31	05:53		06:30 (1)	06:45				07:32		08:50
	21:34	30	07:00 (6)	20:31				17:11		16:31
Potential sun hours	507			456			381	330	263	239
Total, worst case		1253			380					
Sun reduction		0,25			0,26					
Oper. time red.		0,99			0,99					
Wind dir. red.		0,65			0,65					
Total reduction		0,17			0,17					
Total, real		207			65					

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)		First time (hh:mm) with flicker	(WTG causing flicker first time)
	Sun set (hh:mm)	Minutes with flicker	Last time (hh:mm) with flicker	(WTG causing flicker last time)

Project:
Coor Shanavogh (updated micro siting)

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12-4-2011 20:32 / 1

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Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 1 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (15)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January	February		March		April		May		June
1	08:50	08:22		07:27	08:41-09:05/24	07:14	19:31-19:45/14	06:07		05:20
	16:32	17:21		18:15	09:05-09:18/13	20:11		21:04		21:52
2	08:50	08:20		07:24	08:41-09:03/22	07:12	19:30-19:47/17	06:05		05:19
	16:33	17:23		18:17	09:03-09:14/11	20:13		21:06		21:53
3	08:50	08:19		07:22	08:42-09:00/18	07:09	19:28-19:48/20	06:03		05:18
	16:34	17:25		18:19		20:15		21:07		21:54
4	08:50	08:17		07:20	08:44-08:58/14	07:07	19:27-19:50/23	06:01		05:18
	16:35	17:27		18:21		20:16		21:09		21:55
5	08:50	08:15		07:18	08:47-08:54/7	07:05	19:26-19:52/26	05:59		05:17
	16:37	17:29		18:22		20:18		21:11		21:56
6	08:49	08:14		07:15		07:02	19:25-19:53/28	05:58	06:27-06:28/1	05:16
	16:38	17:31		18:24		20:20		21:13		21:57
7	08:49	08:12		07:13		07:00	07:26-07:33/7	05:56	06:24-06:33/9	05:16
	16:39	17:33		18:26		20:22	19:24-19:55/31	21:14		21:58
8	08:48	08:10		07:11		06:58	07:24-07:35/11	05:54	06:23-06:34/11	05:15
	16:41	17:35		18:28		20:23	19:24-19:57/33	21:16		21:59
9	08:48	08:08		07:08		06:55	07:23-07:36/13	05:52	06:21-06:34/13	05:14
	16:42	17:37		18:30		20:25	19:24-19:59/35	21:18		22:00
10	08:47	08:06		07:06		06:53	07:21-07:36/15	05:50	06:21-06:35/14	05:14
	16:43	17:39		18:32		20:27	19:23-19:58/35	21:19		22:01
11	08:47	08:04	09:04-09:16/12	07:04		06:51	07:21-07:36/15	05:48	06:20-06:35/15	05:14
	16:45	17:41		18:33		20:29	19:23-19:58/35	21:21		22:01
12	08:46	08:02	09:01-09:19/18	07:01		06:48	07:20-07:36/16	05:47	06:20-06:35/15	05:13
	16:46	17:43		18:35		20:30	19:23-19:57/34	21:23		22:02
13	08:45	08:00	09:00-09:21/21	06:59		06:46	07:21-07:36/15	05:45	06:20-06:36/16	05:13
	16:48	17:45		18:37		20:32	19:23-19:57/34	21:24		22:03
14	08:44	07:59	08:59-09:22/23	06:57		06:44	07:20-07:34/14	05:43	06:20-06:35/15	05:13
	16:49	17:46		18:39		20:34	19:23-19:55/32	21:26		22:03
15	08:44	07:57	08:58-09:23/25	06:54		06:41	07:21-07:33/12	05:42	06:20-06:36/16	05:12
	16:51	17:48		18:41		20:36	19:24-19:55/31	21:28		22:04
16	08:43	07:55	08:51-08:56/5	06:52		06:39	07:23-07:31/8	05:40	06:20-06:35/15	05:12
	16:53	17:50	08:57-09:24/27	18:42		20:38	19:24-19:54/30	21:29		22:04
17	08:42	07:52	08:47-09:01/14	06:50		06:37	19:25-19:53/28	05:39	06:21-06:35/14	05:12
	16:54	17:52	09:01-09:25/24	18:44		20:39		21:31		22:05
18	08:41	07:50	08:44-09:02/18	06:47		06:35	19:27-19:51/24	05:37	06:22-06:34/12	05:12
	16:56	17:54	09:02-09:24/22	18:46		20:41		21:32		22:05
19	08:40	07:48	08:43-09:04/21	06:45		06:33	19:27-19:49/22	05:36	06:22-06:33/11	05:12
	16:58	17:56	09:04-09:25/21	18:48		20:43		21:34		22:06
20	08:38	07:46	08:42-09:05/23	06:43		06:30	19:29-19:46/17	05:34	06:24-06:32/8	05:12
	16:59	17:58	09:05-09:25/20	18:50		20:45		21:35		22:06
21	08:37	07:44	08:41-09:06/25	06:40		06:28	19:32-19:43/11	05:33	06:26-06:31/5	05:12
	17:01	18:00	09:06-09:25/19	18:51		20:46		21:37		22:06
22	08:36	07:42	08:41-09:07/26	06:38		06:26		05:31		05:13
	17:03	18:02	09:07-09:25/18	18:53		20:48		21:38		22:07
23	08:35	07:40	08:39-09:06/27	06:35		06:24		05:30		05:13
	17:05	18:04	09:06-09:24/18	18:55		20:50		21:40		22:07
24	08:34	07:38	08:39-09:07/28	06:33		06:22		05:29		05:13
	17:07	18:06	09:07-09:24/17	18:57		20:52		21:41		22:07
25	08:32	07:36	08:39-09:07/28	06:31		06:20		05:28		05:14
	17:08	18:07	09:07-09:23/16	18:59		20:53		21:43		22:07
26	08:31	07:33	08:40-09:07/27	06:28		06:17		05:26		05:14
	17:10	18:09	09:07-09:23/16	19:00		20:55		21:44		22:07
27	08:30	07:31	08:39-09:06/27	06:26		06:15		05:25		05:14
	17:12	18:11	09:06-09:21/15	19:02		20:57		21:45		22:07
28	08:28	07:29	08:40-09:05/25	06:23		06:13		05:24		05:15
	17:14	18:13	09:05-09:19/14	19:04		20:59		21:47		22:07
29	08:27			07:21		06:11		05:23		05:15
	17:16			20:06		21:00		21:48		22:06
30	08:25			07:19	19:37-19:41/4	06:09		05:22		05:16
	17:18			20:07		21:02		21:49		22:06
31	08:24			07:16	19:33-19:42/9			05:21		
	17:20			20:09				21:50		
Potential sun hours	255	276		367		418		489		504
Sum of minutes with flicker	0		640		122		686		190	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 2

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 1 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (15)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	July		August		September		October		November	December
1	05:17		05:55	06:30-06:46/16	06:47	07:20-07:35/15	07:38		07:33	08:26
	22:06		21:32		20:28	19:22-19:57/35	19:17		17:09	16:27
2	05:17		05:56	06:31-06:46/15	06:48	07:20-07:35/15	07:39		07:35	08:28
	22:06		21:31		20:26	19:22-19:57/35	19:15		17:07	16:26
3	05:18		05:58	06:31-06:45/14	06:50	07:20-07:33/13	07:41		07:37	08:29
	22:05		21:29		20:24	19:21-19:56/35	19:12		17:05	16:25
4	05:19		06:00	06:32-06:44/12	06:52	07:21-07:32/11	07:43		07:39	08:30
	22:05		21:27		20:21	19:21-19:54/33	19:10		17:03	16:25
5	05:20		06:01	06:32-06:43/11	06:53	07:23-07:30/7	07:44		07:41	08:32
	22:04		21:25		20:19	19:21-19:52/31	19:07		17:01	16:24
6	05:21		06:03	06:35-06:41/6	06:55	19:21-19:49/28	07:46		07:43	08:33
	22:04		21:24		20:17		19:05		16:59	16:24
7	05:22		06:04		06:57	19:21-19:47/26	07:48		07:45	08:34
	22:03		21:22		20:14		19:03		16:58	16:23
8	05:23		06:06		06:58	19:21-19:44/23	07:50		07:46	08:36
	22:02		21:20		20:12		19:00		16:56	16:23
9	05:24		06:08		07:00	19:22-19:42/20	07:51	09:20-09:31/11	07:48	08:37
	22:02		21:18		20:10		18:58		16:54	16:23
10	05:25		06:09		07:02	19:23-19:40/17	07:53	09:17-09:33/16	07:50	08:38
	22:01		21:16		20:07		18:56		16:53	16:22
11	05:26		06:11		07:03	19:23-19:37/14	07:55	09:16-09:35/19	07:52	08:39
	22:00		21:14		20:05		18:54	09:38-09:46/8	16:51	16:22
12	05:27		06:13		07:05	19:25-19:35/10	07:57	09:14-09:37/23	07:54	08:40
	21:59		21:12		20:02		18:51	09:37-09:50/13	16:49	16:22
13	05:28		06:14		07:07	19:28-19:33/5	07:59	09:13-09:38/25	07:56	08:41
	21:58		21:10		20:00		18:49	09:38-09:52/14	16:48	16:22
14	05:29		06:16		07:09		08:00	09:13-09:39/26	07:57	08:42
	21:57		21:08		19:58		18:47	09:39-09:53/14	16:46	16:22
15	05:30		06:18		07:10		08:02	09:12-09:39/27	07:59	08:43
	21:56		21:06		19:55		18:44	09:39-09:54/15	16:45	16:22
16	05:32		06:19		07:12		08:04	09:11-09:38/27	08:01	08:44
	21:55		21:04		19:53		18:42	09:38-09:54/16	16:43	16:22
17	05:33		06:21		07:14		08:06	09:11-09:38/27	08:03	08:45
	21:54		21:02		19:50		18:40	09:38-09:55/17	16:42	16:22
18	05:34		06:23		07:15		08:08	09:11-09:38/27	08:05	08:46
	21:53		21:00		19:48		18:38	09:38-09:55/17	16:40	16:22
19	05:35		06:25		07:17		08:09	09:11-09:37/26	08:06	08:46
	21:52		20:57		19:46		18:36	09:37-09:56/19	16:39	16:23
20	05:37		06:26		07:19		08:11	09:11-09:37/26	08:08	08:47
	21:50		20:55		19:43		18:33	09:37-09:56/19	16:38	16:23
21	05:38		06:28		07:20		08:13	09:12-09:36/24	08:10	08:48
	21:49		20:53		19:41		18:31	09:36-09:56/20	16:37	16:23
22	05:40		06:30	19:36-19:49/13	07:22		08:15	09:13-09:35/22	08:12	08:48
	21:48		20:51		19:38		18:29	09:35-09:56/21	16:35	16:24
23	05:41	06:35-06:42/7	06:31	19:34-19:52/18	07:24		08:17	09:14-09:34/20	08:13	08:49
	21:46		20:49		19:36		18:27	09:34-09:55/21	16:34	16:24
24	05:42	06:33-06:43/10	06:33	19:31-19:53/22	07:25		08:19	09:15-09:32/17	08:15	08:49
	21:45		20:47		19:34		18:25	09:32-09:55/23	16:33	16:25
25	05:44	06:32-06:44/12	06:35	19:29-19:54/25	07:27		07:20	08:17-08:30/13	08:17	08:49
	21:44		20:44		19:31		17:23	08:30-08:54/24	16:32	16:26
26	05:45	06:32-06:45/13	06:36	19:27-19:55/28	07:29		07:22	08:26-08:53/27	08:18	08:50
	21:42		20:42		19:29		17:21		16:31	16:26
27	05:47	06:31-06:45/14	06:38	07:24-07:33/9	07:31		07:24	08:27-08:52/25	08:20	08:50
	21:41		20:40	19:26-19:56/30	19:26		17:19		16:30	16:27
28	05:48	06:31-06:46/15	06:40	07:23-07:35/12	07:32		07:26	08:28-08:51/23	08:22	08:50
	21:39		20:38	19:25-19:57/32	19:24		17:17		16:29	16:28
29	05:50	06:31-06:46/15	06:41	07:21-07:35/14	07:34		07:28	08:30-08:50/20	08:23	08:50
	21:37		20:35	19:24-19:56/32	19:22		17:15		16:28	16:29
30	05:52	06:30-06:46/16	06:43	07:21-07:35/14	07:36		07:30	08:31-08:48/17	08:25	08:50
	21:36		20:33	19:23-19:57/34	19:19		17:13		16:27	16:30
31	05:53	06:30-06:46/16	06:45	07:20-07:36/16			07:31	08:34-08:45/11		08:50
	21:34		20:31	19:23-19:57/34			17:11			16:31
Potential sun hours	507		456		381		330		263	239
Sum of minutes with flicker		118		407		373		760	0	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 3

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Calculated
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 2 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (16)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January		February		March		April		May		June	
1	08:50	10:52-11:31/39	08:22	10:13-10:54/41	07:27		07:14	19:28-19:44/16	06:07		05:20	05:59-06:19/20
	16:32		17:21	11:01-11:41/40	18:15		20:11		21:04		21:52	21:00-21:06/6
2	08:50	10:52-11:32/40	08:20	10:13-10:54/41	07:24		07:12	19:30-19:42/12	06:05		05:19	05:59-06:19/20
	16:33		17:23	11:02-11:40/38	18:17		20:13		21:06		21:53	
3	08:50	10:52-11:32/40	08:19	10:13-10:53/40	07:22		07:09	19:33-19:38/5	06:03		05:18	05:59-06:19/20
	16:34		17:25	11:03-11:39/36	18:19		20:15		21:07		21:54	
4	08:50	10:52-11:33/41	08:17	10:15-10:54/39	07:20		07:07		06:01		05:18	05:59-06:20/21
	16:35		17:27	11:05-11:39/34	18:21		20:16		21:09		21:55	
5	08:50	10:53-11:34/41	08:15	10:15-10:53/38	07:18		07:05		05:59		05:17	05:59-06:20/21
	16:37		17:29	11:06-11:37/31	18:22		20:18		21:11		21:56	
6	08:49	10:53-11:34/41	08:14	10:16-10:53/37	07:15		07:02		05:58		05:16	05:58-06:20/22
	16:38		17:31	11:08-11:36/28	18:24		20:20		21:13		21:57	
7	08:49	10:53-11:34/41	08:12	10:16-10:52/36	07:13		07:00		05:56		05:16	05:59-06:21/22
	16:39		17:33	11:10-11:33/23	18:26		20:22		21:14		21:58	
8	08:48	10:53-11:36/43	08:10	10:17-10:52/35	07:11		06:58		05:54		05:15	06:00-06:21/21
	16:41		17:35	11:13-11:30/17	18:28		20:23		21:16		21:59	
9	08:48	10:24-10:30/6	08:08	10:18-10:51/33	07:08		06:55	07:27-07:37/10	05:52		05:14	05:59-06:21/22
	16:42	10:53-11:36/43	17:37	11:18-11:25/7	18:30		20:25		21:18		22:00	
10	08:47	10:21-10:33/12	08:06	10:19-10:49/30	07:06		06:53	07:23-07:38/15	05:50		05:14	06:00-06:22/22
	16:43	10:53-11:37/44	17:39		18:32		20:27		21:19		22:01	
11	08:47	10:20-10:35/15	08:04	10:20-10:48/28	07:04		06:51	07:22-07:39/17	05:49		05:14	05:59-06:21/22
	16:45	10:53-11:37/44	17:41		18:33		20:29		21:21		22:01	
12	08:46	10:19-10:38/19	08:02	10:22-10:46/24	07:01		06:48	07:21-07:40/19	05:47		05:13	06:00-06:22/22
	16:46	10:54-11:39/45	17:43		18:35		20:30		21:23		22:02	
13	08:45	10:18-10:39/21	08:00	10:24-10:44/20	06:59		06:46	07:20-07:41/21	05:45	20:53-20:54/1	05:13	06:00-06:22/22
	16:48	10:54-11:39/45	17:45		18:37		20:32		21:24		22:03	
14	08:44	10:17-10:41/24	07:59	10:27-10:41/14	06:57		06:44	07:19-07:40/21	05:43	20:52-20:55/3	05:13	06:00-06:22/22
	16:49	10:54-11:40/46	17:46		18:39		20:34		21:26		22:03	
15	08:44	10:17-10:42/25	07:57		06:54		06:42	07:19-07:40/21	05:42	20:52-20:57/5	05:13	06:01-06:23/22
	16:51	10:54-11:40/46	17:48		18:41		20:36		21:28		22:04	
16	08:43	10:16-10:44/28	07:55		06:52		06:39	07:19-07:40/21	05:40	20:51-20:58/7	05:12	06:01-06:23/22
	16:53	10:54-11:40/46	17:50		18:42		20:38		21:29		22:05	
17	08:42	10:15-10:44/29	07:52		06:50		06:37	07:19-07:40/21	05:39	20:51-20:59/8	05:12	06:01-06:23/22
	16:54	10:54-11:41/47	17:52		18:44		20:39		21:31		22:05	
18	08:41	10:15-10:45/30	07:50		06:47		06:35	07:19-07:39/20	05:37	20:51-21:01/10	05:12	06:01-06:23/22
	16:56	10:55-11:41/46	17:54		18:46		20:41		21:32		22:05	
19	08:40	10:14-10:47/33	07:48		06:45		06:33	07:20-07:38/18	05:36	20:51-21:02/11	05:12	06:01-06:24/23
	16:58	10:55-11:42/47	17:56		18:48		20:43		21:34		22:06	
20	08:39	10:14-10:48/34	07:46		06:43		06:30	07:19-07:36/17	05:34	20:51-21:04/13	05:12	06:02-06:24/22
	16:59	10:56-11:42/46	17:58		18:50		20:45		21:35		22:06	
21	08:37	10:13-10:48/35	07:44		06:40		06:28	07:21-07:35/14	05:33	20:52-21:05/13	05:12	06:02-06:24/22
	17:01	10:55-11:42/47	18:00		18:51		20:46		21:37		22:06	
22	08:36	10:14-10:49/35	07:42		06:38		06:26	07:22-07:33/11	05:31	20:51-21:06/15	05:13	06:02-06:24/22
	17:03	10:56-11:43/47	18:02		18:53		20:48		21:38		22:07	
23	08:35	10:14-10:50/36	07:40		06:35		06:24	07:26-07:29/3	05:30	20:52-21:07/15	05:13	06:02-06:25/23
	17:05	10:57-11:43/46	18:04		18:55		20:50		21:40		22:07	
24	08:34	10:13-10:51/38	07:38		06:33	18:29-18:31/2	06:22		05:29	06:05-06:11/6	05:13	06:02-06:24/22
	17:07	10:56-11:43/47	18:06		18:57		20:52		21:41	20:52-21:09/17	22:07	
25	08:32	10:13-10:52/39	07:36		06:31	18:29-18:33/4	06:20		05:28	06:03-06:13/10	05:14	06:02-06:24/22
	17:08	10:57-11:44/47	18:07		18:59		20:53		21:43	20:53-21:10/17	22:07	
26	08:31	10:13-10:52/39	07:33		06:28	18:27-18:34/7	06:17		05:26	06:02-06:14/12	05:14	06:03-06:25/22
	17:10	10:57-11:43/46	18:09		19:00		20:55		21:44	20:53-21:10/17	22:07	
27	08:30	10:12-10:52/40	07:31		06:26	18:27-18:36/9	06:15		05:25	06:01-06:15/14	05:14	06:03-06:25/22
	17:12	10:57-11:43/46	18:11		19:02		20:57		21:45	20:54-21:10/16	22:07	
28	08:28	10:13-10:53/40	07:29		06:24	18:27-18:38/11	06:13		05:24	06:00-06:16/16	05:15	06:03-06:26/23
	17:14	10:59-11:43/44	18:13		19:04		20:59		21:47	20:55-21:09/14	22:07	
29	08:27	10:13-10:53/40			07:21	19:27-19:39/12	06:11		05:23	06:00-06:17/17	05:15	06:03-06:25/22
	17:16	10:59-11:42/43			20:06		21:00		21:48	20:56-21:09/13	22:06	
30	08:25	10:13-10:54/41			07:19	19:27-19:41/14	06:09		05:22	05:59-06:17/18	05:16	06:04-06:26/22
	17:18	10:59-11:42/43			20:07		21:02		21:49	20:56-21:08/12	22:06	
31	08:24	10:13-10:54/41			07:16	19:27-19:42/15			05:21	05:59-06:18/19		
	17:20	11:01-11:42/41			20:09				21:50	20:57-21:07/10		
Potential sun hours	255		276		367		418		489		504	
Sum of minutes with flicker		2068		710		74		282		329		660

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 2 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (16)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

```
                     |July                    |August                  |September               |October                 |November                |December
                     |                        |                        |                        |                        |                        |
                   1 | 05:17  06:04-06:26/22  | 05:55                  | 06:47  07:21-07:38/17  | 07:38                  | 07:33  09:48-10:19/31  | 08:26  10:01-10:17/16
                     | 22:06                  | 21:32                  | 20:28                  | 19:17                  | 17:09                  | 16:27  10:35-11:19/44
                   2 | 05:17  06:04-06:26/22  | 05:56                  | 06:48  07:22-07:37/15  | 07:39                  | 07:35  09:47-10:20/33  | 08:28  10:04-10:16/12
                     | 22:06                  | 21:31                  | 20:26                  | 19:15                  | 17:07  10:46-10:56/10  | 16:26  10:36-11:20/44
                   3 | 05:18  06:04-06:26/22  | 05:58                  | 06:50  07:24-07:34/10  | 07:41                  | 07:37  09:46-10:21/35  | 08:29  10:08-10:14/6
                     | 22:05                  | 21:29                  | 20:24                  | 19:12                  | 17:05  10:42-11:01/19  | 16:25  10:37-11:20/43
                   4 | 05:19  06:05-06:27/22  | 06:00                  | 06:52                  | 07:43                  | 07:39  09:46-10:22/36  | 08:30  10:37-11:20/43
                     | 22:05                  | 21:27                  | 20:21                  | 19:10                  | 17:03  10:39-11:03/24  | 16:25
                   5 | 05:20  06:05-06:27/22  | 06:01                  | 06:53                  | 07:44                  | 07:41  09:45-10:23/38  | 08:32  10:39-11:21/42
                     | 22:04                  | 21:25                  | 20:19                  | 19:07                  | 17:01  10:37-11:06/29  | 16:24
                   6 | 05:21  06:05-06:26/21  | 06:03                  | 06:55                  | 07:46                  | 07:43  09:45-10:23/38  | 08:33  10:39-11:20/41
                     | 22:04                  | 21:24                  | 20:17                  | 19:05                  | 16:59  10:36-11:07/31  | 16:24
                   7 | 05:22  06:05-06:26/21  | 06:04                  | 06:57                  | 07:48                  | 07:45  09:44-10:24/40  | 08:34  10:39-11:20/41
                     | 22:03                  | 21:22                  | 20:14                  | 19:03                  | 16:58  10:35-11:09/34  | 16:23
                   8 | 05:23  06:05-06:27/22  | 06:06                  | 06:58                  | 07:50                  | 07:46  09:44-10:24/40  | 08:36  10:41-11:21/40
                     | 22:02                  | 21:20                  | 20:12                  | 19:00                  | 16:56  10:34-11:10/36  | 16:23
                   9 | 05:24  06:06-06:27/21  | 06:08                  | 07:00  19:28-19:31/3   | 07:52                  | 07:48  09:44-10:24/40  | 08:37  10:41-11:21/40
                     | 22:02                  | 21:18                  | 20:10                  | 18:58                  | 16:54  10:33-11:11/38  | 16:23
                  10 | 05:25  06:06-06:27/21  | 06:09                  | 07:02  19:24-19:35/11  | 07:53                  | 07:50  09:44-10:25/41  | 08:38  10:41-11:21/40
                     | 22:01                  | 21:16                  | 20:07                  | 18:56                  | 16:53  10:32-11:12/40  | 16:22
                  11 | 05:26  06:07-06:26/19  | 06:11                  | 07:03  19:21-19:36/15  | 07:55                  | 07:52  09:44-10:25/41  | 08:39  10:42-11:21/39
                     | 22:00  21:08-21:13/5   | 21:14                  | 20:05                  | 18:54                  | 16:51  10:31-11:13/42  | 16:22
                  12 | 05:27  06:07-06:26/19  | 06:13                  | 07:05  19:20-19:35/15  | 07:57                  | 07:54  09:44-10:25/41  | 08:40  10:43-11:21/38
                     | 21:59  21:06-21:15/9   | 21:12                  | 20:02                  | 18:51                  | 16:49  10:31-11:14/43  | 16:22
                  13 | 05:28  06:07-06:26/19  | 06:14                  | 07:07  19:19-19:33/14  | 07:59                  | 07:56  09:45-10:25/40  | 08:41  10:43-11:21/38
                     | 21:58  21:05-21:16/11  | 21:10                  | 20:00                  | 18:49                  | 16:48  10:31-11:14/43  | 16:22
                  14 | 05:29  06:08-06:26/18  | 06:16                  | 07:09  19:17-19:30/13  | 08:00                  | 07:57  09:45-10:25/40  | 08:42  10:44-11:21/37
                     | 21:57  21:04-21:17/13  | 21:08                  | 19:58                  | 18:47                  | 16:46  10:31-11:15/44  | 16:22
                  15 | 05:30  06:09-06:25/16  | 06:18                  | 07:10  19:17-19:28/11  | 08:02                  | 07:59  09:45-10:25/40  | 08:43  10:45-11:22/37
                     | 21:56  21:04-21:18/14  | 21:06                  | 19:55                  | 18:44                  | 16:45  10:30-11:16/46  | 16:22
                  16 | 05:32  06:10-06:25/15  | 06:20                  | 07:12  19:17-19:26/9   | 08:04                  | 08:01  09:46-10:25/39  | 08:44  10:45-11:22/37
                     | 21:55  21:04-21:19/15  | 21:04                  | 19:53                  | 18:42                  | 16:43  10:30-11:16/46  | 16:22
                  17 | 05:33  06:11-06:24/13  | 06:21                  | 07:14  19:16-19:23/7   | 08:06                  | 08:03  09:46-10:25/39  | 08:45  10:46-11:22/36
                     | 21:54  21:03-21:20/17  | 21:02                  | 19:50                  | 18:40                  | 16:42  10:30-11:17/47  | 16:22
                  18 | 05:34  06:12-06:23/11  | 06:23                  | 07:15  19:16-19:21/5   | 08:08                  | 08:05  09:47-10:25/38  | 08:46  10:47-11:23/36
                     | 21:53  21:03-21:20/17  | 21:00                  | 19:48                  | 18:38                  | 16:40  10:30-11:17/47  | 16:22
                  19 | 05:35  06:13-06:21/8   | 06:25                  | 07:17  19:17-19:19/2   | 08:09                  | 08:06  09:48-10:24/36  | 08:46  10:47-11:23/36
                     | 21:52  21:02-21:19/17  | 20:57                  | 19:46                  | 18:36                  | 16:39  10:31-11:17/46  | 16:23
                  20 | 05:37  21:02-21:19/17  | 06:26  07:31-07:36/5   | 07:19                  | 08:11                  | 08:08  09:49-10:24/35  | 08:47  10:48-11:24/36
                     | 21:50                  | 20:55                  | 19:43                  | 18:33                  | 16:38  10:31-11:18/47  | 16:23
                  21 | 05:38  21:02-21:17/15  | 06:28  07:28-07:39/11  | 07:20                  | 08:13                  | 08:10  09:49-10:24/35  | 08:48  10:49-11:24/35
                     | 21:49                  | 20:53                  | 19:41                  | 18:31                  | 16:37  10:31-11:18/47  | 16:23
                  22 | 05:40  21:01-21:16/15  | 06:30  07:25-07:40/15  | 07:22                  | 08:15                  | 08:12  09:50-10:24/34  | 08:48  10:49-11:24/35
                     | 21:48                  | 20:51                  | 19:38                  | 18:29                  | 16:35  10:32-11:18/46  | 16:24
                  23 | 05:41  21:01-21:14/13  | 06:31  07:24-07:41/17  | 07:24                  | 08:17                  | 08:13  09:52-10:24/32  | 08:49  10:49-11:24/35
                     | 21:46                  | 20:49                  | 19:36                  | 18:27                  | 16:34  10:32-11:19/47  | 16:24
                  24 | 05:43  21:02-21:13/11  | 06:33  07:22-07:41/19  | 07:26                  | 08:19                  | 08:15  09:52-10:22/30  | 08:49  10:50-11:26/36
                     | 21:45                  | 20:47                  | 19:34                  | 18:25                  | 16:33  10:32-11:18/46  | 16:25
                  25 | 05:44  21:01-21:12/11  | 06:35  07:22-07:42/20  | 07:27                  | 07:20                  | 08:17  09:53-10:22/29  | 08:49  10:50-11:26/36
                     | 21:44                  | 20:44                  | 19:31                  | 17:23                  | 16:32  10:32-11:19/47  | 16:26
                  26 | 05:45  21:02-21:11/9   | 06:36  07:21-07:43/22  | 07:29                  | 07:22                  | 08:18  09:54-10:22/28  | 08:50  10:50-11:26/36
                     | 21:42                  | 20:42                  | 19:29                  | 17:21                  | 16:31  10:33-11:19/46  | 16:26
                  27 | 05:47  21:02-21:09/7   | 06:38  07:20-07:42/22  | 07:31                  | 07:24  10:01-10:06/5   | 08:20  09:56-10:21/25  | 08:50  10:50-11:27/37
                     | 21:41                  | 20:40                  | 19:26                  | 17:19                  | 16:30  10:34-11:19/45  | 16:27
                  28 | 05:49  21:02-21:07/5   | 06:40  07:21-07:42/21  | 07:32                  | 07:26  09:56-10:12/16  | 08:22  09:56-10:20/24  | 08:50  10:51-11:28/37
                     | 21:39                  | 20:38                  | 19:24                  | 17:17                  | 16:29  10:33-11:19/46  | 16:28
                  29 | 05:50  21:02-21:06/4   | 06:42  07:20-07:41/21  | 07:34                  | 07:28  09:53-10:14/21  | 08:23  09:58-10:19/21  | 08:50  10:52-11:29/37
                     | 21:37                  | 20:35                  | 19:22                  | 17:15                  | 16:28  10:34-11:19/45  | 16:29
                  30 | 05:52  21:03-21:05/2   | 06:43  07:20-07:41/21  | 07:36                  | 07:30  09:51-10:16/25  | 08:25  10:00-10:19/19  | 08:50  10:51-11:29/38
                     | 21:36                  | 20:33                  | 19:19                  | 17:13                  | 16:27  10:35-11:20/45  | 16:30
                  31 | 05:53                  | 06:45  07:21-07:40/19  |                        | 07:32  09:49-10:18/29  |                        | 08:50  10:51-11:29/38
                     | 21:34                  | 20:31                  |                        | 17:11                  |                        | 16:31
 Potential sun hours | 507                    | 456                    | 381                    | 330                    | 263                    | 239
Sum of minutes with flicker 581               213                      147                      96                       2210                     1222
```

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 5

Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 3 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (17)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

```
                            |January                 |February                |March                   |April                   |May      |June
                            |                        |                        |                        |                        |         |
                          1 | 08:50                  | 08:22  09:11-09:27/16  | 07:27  16:47-17:28/41  | 07:14                  | 06:07   | 05:20
                            | 16:32                  | 17:21  09:27-09:45/18  | 18:15                  | 20:11                  | 21:04   | 21:52
                          2 | 08:50                  | 08:20  09:10-09:28/18  | 07:24  16:47-17:26/39  | 07:12                  | 06:05   | 05:19
                            | 16:33                  | 17:23  09:28-09:45/17  | 18:17                  | 20:13                  | 21:06   | 21:53
                          3 | 08:50                  | 08:19  09:09-09:29/20  | 07:22  16:47-17:26/39  | 07:09                  | 06:03   | 05:18
                            | 16:34                  | 17:25  09:29-09:45/16  | 18:19                  | 20:15                  | 21:07   | 21:54
                          4 | 08:50                  | 08:17  09:10-09:30/20  | 07:20  16:48-17:25/37  | 07:07                  | 06:01   | 05:18
                            | 16:35                  | 17:27  09:30-09:45/15  | 18:21                  | 20:16                  | 21:09   | 21:55
                          5 | 08:50                  | 08:15  09:09-09:30/21  | 07:18  16:48-17:23/35  | 07:05                  | 05:59   | 05:17
                            | 16:37                  | 17:29  09:30-09:45/15  | 18:22                  | 20:18                  | 21:11   | 21:56
                          6 | 08:49                  | 08:14  09:09-09:30/21  | 07:15  16:50-17:22/32  | 07:02                  | 05:58   | 05:16
                            | 16:38                  | 17:31  09:30-09:44/14  | 18:24                  | 20:20                  | 21:13   | 21:57
                          7 | 08:49                  | 08:12  09:09-09:30/21  | 07:13  16:51-17:21/30  | 07:00                  | 05:56   | 05:16
                            | 16:39                  | 17:33  09:30-09:43/13  | 18:26                  | 20:22                  | 21:14   | 21:58
                          8 | 08:48                  | 08:10  09:09-09:30/21  | 07:11  16:52-17:19/27  | 06:58                  | 05:54   | 05:15
                            | 16:41                  | 17:35  09:30-09:42/12  | 18:28                  | 20:23                  | 21:16   | 21:59
                          9 | 08:48                  | 08:08  09:10-09:29/19  | 07:08  16:55-17:17/22  | 06:55                  | 05:52   | 05:14
                            | 16:42                  | 17:37  09:30-09:40/10  | 18:30                  | 20:25                  | 21:18   | 22:00
                         10 | 08:47                  | 08:06  09:11-09:28/17  | 07:06  16:58-17:14/16  | 06:53                  | 05:50   | 05:14
                            | 16:43                  | 17:39                  | 18:32                  | 20:27                  | 21:19   | 22:01
                         11 | 08:47                  | 08:04  09:11-09:28/17  | 07:04  17:03-17:07/4   | 06:51                  | 05:48   | 05:14  21:11-21:17/6
                            | 16:45                  | 17:41                  | 18:33                  | 20:29                  | 21:21   | 22:01
                         12 | 08:46                  | 08:02  09:13-09:26/13  | 07:01                  | 06:48                  | 05:47   | 05:13  21:10-21:19/9
                            | 16:46                  | 17:43  17:01-17:14/13  | 18:35                  | 20:30                  | 21:23   | 22:02
                         13 | 08:45                  | 08:00  09:15-09:25/10  | 06:59                  | 06:46                  | 05:45   | 05:13  21:09-21:20/11
                            | 16:48                  | 17:45  16:58-17:16/18  | 18:37                  | 20:32                  | 21:24   | 22:03
                         14 | 08:44                  | 07:58  16:56-17:18/22  | 06:57                  | 06:44                  | 05:43   | 05:13  21:09-21:22/13
                            | 16:49                  | 17:46                  | 18:39                  | 20:34                  | 21:26   | 22:03
                         15 | 08:43                  | 07:57  16:55-17:20/25  | 06:54                  | 06:41  07:09-07:17/8   | 05:42   | 05:12  21:08-21:23/15
                            | 16:51                  | 17:48                  | 18:41                  | 20:36                  | 21:28   | 22:04
                         16 | 08:43                  | 07:54  16:53-17:22/29  | 06:52                  | 06:39  07:07-07:19/12  | 05:40   | 05:12  21:08-21:23/15
                            | 16:53                  | 17:50                  | 18:42                  | 20:38                  | 21:29   | 22:04
                         17 | 08:42                  | 07:52  16:51-17:23/32  | 06:50                  | 06:37  07:06-07:19/13  | 05:39   | 05:12  21:08-21:24/16
                            | 16:54                  | 17:52                  | 18:44                  | 20:39                  | 21:31   | 22:05
                         18 | 08:41                  | 07:50  16:50-17:25/35  | 06:47                  | 06:35  07:05-07:20/15  | 05:37   | 05:12  21:08-21:24/16
                            | 16:56                  | 17:54                  | 18:46                  | 20:41                  | 21:32   | 22:05
                         19 | 08:40                  | 07:48  16:50-17:26/36  | 06:45                  | 06:33  07:05-07:20/15  | 05:36   | 05:12  21:08-21:25/17
                            | 16:58                  | 17:56                  | 18:48                  | 20:43                  | 21:34   | 22:06
                         20 | 08:38                  | 07:46  16:49-17:27/38  | 06:43                  | 06:30  07:04-07:19/15  | 05:34   | 05:12  21:08-21:25/17
                            | 16:59                  | 17:58                  | 18:50                  | 20:45                  | 21:35   | 22:06
                         21 | 08:37                  | 07:44  16:48-17:28/40  | 06:40  07:06-07:13/7   | 06:28  07:04-07:18/14  | 05:33   | 05:12  21:08-21:25/17
                            | 17:01                  | 18:00                  | 18:51                  | 20:46                  | 21:37   | 22:06
                         22 | 08:36  09:29-09:34/5   | 07:42  16:48-17:29/41  | 06:38  07:04-07:15/11  | 06:26  07:05-07:17/12  | 05:31   | 05:13  21:08-21:25/17
                            | 17:03                  | 18:02                  | 18:53                  | 20:48                  | 21:38   | 22:07
                         23 | 08:35  09:27-09:38/11  | 07:40  16:47-17:28/41  | 06:35  07:03-07:16/13  | 06:24  07:06-07:16/10  | 05:30   | 05:13  21:09-21:26/17
                            | 17:05                  | 18:04                  | 18:55                  | 20:50                  | 21:40   | 22:07
                         24 | 08:34  09:25-09:39/14  | 07:38  16:47-17:28/41  | 06:33  07:02-07:15/13  | 06:22  07:08-07:14/6   | 05:29   | 05:13  21:09-21:26/17
                            | 17:07                  | 18:06                  | 18:57                  | 20:52                  | 21:41   | 22:07
                         25 | 08:32  09:25-09:41/16  | 07:36  16:47-17:29/42  | 06:31  07:02-07:15/13  | 06:20                  | 05:28   | 05:14  21:09-21:25/16
                            | 17:08                  | 18:07                  | 18:59                  | 20:53                  | 21:43   | 22:07
                         26 | 08:31  09:24-09:42/18  | 07:33  16:47-17:29/42  | 06:28  07:01-07:14/13  | 06:17                  | 05:26   | 05:14  21:10-21:26/16
                            | 17:10                  | 18:09                  | 19:00                  | 20:55                  | 21:44   | 22:07
                         27 | 08:30  09:23-09:42/19  | 07:31  16:46-17:28/42  | 06:26  07:02-07:14/12  | 06:15                  | 05:25   | 05:14  21:10-21:25/15
                            | 17:12                  | 18:11                  | 19:02                  | 20:57                  | 21:45   | 22:07
                         28 | 08:28  09:23-09:44/21  | 07:29  16:47-17:28/41  | 06:23  07:03-07:12/9   | 06:13                  | 05:24   | 05:15  21:11-21:25/14
                            | 17:14                  | 18:13                  | 19:04                  | 20:59                  | 21:47   | 22:07
                         29 | 08:27  09:23-09:44/21  |                        | 07:21  08:05-08:09/4   | 06:11                  | 05:23   | 05:15  21:12-21:24/12
                            | 17:16                  |                        | 20:06                  | 21:00                  | 21:48   | 22:06
                         30 | 08:25  09:14-09:24/10  |                        | 07:19                  | 06:09                  | 05:22   | 05:16  21:13-21:24/11
                            | 17:18  09:24-09:44/20  |                        | 20:07                  | 21:02                  | 21:49   | 22:06
                         31 | 08:24  09:12-09:26/14  |                        | 07:16                  |                        | 05:21   |
                            | 17:20  09:26-09:45/19  |                        | 20:09                  |                        | 21:50   |
        Potential sun hours | 255                    | 276                    | 367                    | 418                    | 489     | 504
Sum of minutes with flicker         188                      942                      417                      120             0         287
```

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def **WTG:** 3 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (17)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	July		August		September		October		November		December
1	05:17	21:14-21:22/8	05:55		06:47		07:38		07:33	08:40-08:58/18	08:26
	22:06		21:32		20:28		19:17		17:09	09:03-09:05/2	16:27
2	05:17		05:56		06:48		07:39		07:35	08:39-09:00/21	08:28
	22:06		21:31		20:26		19:15		17:07	09:00-09:10/10	16:26
3	05:18		05:58		06:50		07:41	17:38-17:50/12	07:37	08:39-09:00/21	08:29
	22:05		21:29		20:24		19:12		17:05	09:00-09:12/12	16:25
4	05:19		06:00		06:52		07:43	17:33-17:53/20	07:39	08:39-09:00/21	08:30
	22:05		21:27		20:21		19:10		17:03	09:00-09:13/13	16:25
5	05:20		06:01		06:53		07:44	17:30-17:55/25	07:41	08:39-09:00/21	08:32
	22:04		21:25		20:19		19:07		17:01	09:00-09:14/14	16:24
6	05:21		06:03		06:55		07:46	17:28-17:57/29	07:43	08:39-09:00/21	08:33
	22:04		21:24		20:17		19:05		16:59	09:00-09:15/15	16:24
7	05:22		06:04		06:57		07:48	17:26-17:58/32	07:45	08:40-09:00/20	08:34
	22:03		21:22		20:14		19:03		16:58	09:00-09:15/15	16:23
8	05:23		06:06		06:58		07:50	17:25-17:59/34	07:46	08:40-08:59/19	08:36
	22:02		21:20		20:12		19:00		16:56	08:59-09:16/17	16:23
9	05:24		06:08		07:00		07:51	17:23-17:59/36	07:48	08:41-08:59/18	08:37
	22:02		21:18		20:10		18:58		16:54	08:59-09:16/17	16:23
10	05:25		06:09		07:02		07:53	17:22-18:00/38	07:50	08:42-08:58/16	08:38
	22:01		21:16		20:07		18:56		16:53	08:58-09:16/18	16:22
11	05:26		06:11		07:03		07:55	17:21-18:00/39	07:52	08:43-08:57/14	08:39
	22:00		21:14		20:05		18:54		16:51	08:57-09:16/19	16:22
12	05:27		06:13		07:05		07:57	17:20-18:01/41	07:54	08:45-08:55/10	08:40
	21:59		21:12		20:02		18:51		16:49	08:55-09:16/21	16:22
13	05:28		06:14		07:07		07:59	17:20-18:01/41	07:56	08:54-09:16/22	08:41
	21:58		21:10		20:00		18:49		16:48		16:22
14	05:29		06:16		07:09	07:56-07:58/2	08:00	17:20-18:01/41	07:57	08:55-09:15/20	08:42
	21:57		21:08		19:58		18:47		16:46		16:22
15	05:30		06:18		07:10	07:53-08:01/8	08:02	17:19-18:01/42	07:59	08:56-09:15/19	08:43
	21:56		21:06		19:55		18:44		16:45		16:22
16	05:32		06:19		07:12	07:51-08:03/12	08:04	17:18-18:00/42	08:01	08:57-09:15/18	08:44
	21:55		21:04		19:53		18:42		16:43		16:22
17	05:33		06:21		07:14	07:49-08:03/14	08:06	17:18-18:00/42	08:03	08:58-09:14/16	08:45
	21:54		21:02		19:50		18:40		16:42		16:22
18	05:34		06:23		07:15	07:49-08:03/14	08:08	17:18-18:00/42	08:05	08:59-09:13/14	08:46
	21:53		21:00		19:48		18:38		16:40		16:22
19	05:35		06:25	07:13-07:20/7	07:17	07:49-08:03/14	08:09	17:18-17:59/41	08:06	09:01-09:12/11	08:46
	21:52		20:57		19:46		18:36		16:39		16:23
20	05:37		06:26	07:11-07:22/11	07:19	07:48-08:01/13	08:11	17:19-17:59/40	08:08	09:04-09:09/5	08:47
	21:50		20:55		19:43		18:33		16:38		16:23
21	05:38		06:28	07:11-07:23/12	07:20	07:49-08:00/11	08:13	17:19-17:58/39	08:10		08:48
	21:49		20:53		19:41		18:31		16:37		16:23
22	05:40		06:30	07:09-07:23/14	07:22	07:51-07:59/8	08:15	17:19-17:57/38	08:12		08:48
	21:48		20:51		19:38		18:29		16:35		16:24
23	05:41		06:31	07:09-07:23/14	07:24		08:17	17:20-17:57/37	08:13		08:49
	21:46		20:49		19:36		18:27		16:34		16:24
24	05:42		06:33	07:08-07:23/15	07:25		08:19	17:21-17:56/35	08:15		08:49
	21:45		20:46		19:34		18:25		16:33		16:25
25	05:44		06:35	07:08-07:23/15	07:27		07:20	16:22-16:53/31	08:17		08:49
	21:44		20:44		19:31		17:23		16:32		16:26
26	05:45		06:36	07:09-07:22/13	07:29		07:22	16:23-16:51/28	08:18		08:50
	21:42		20:42		19:29		17:21		16:31		16:26
27	05:47		06:38	07:09-07:20/11	07:31		07:24	16:24-16:49/25	08:20		08:50
	21:41		20:40		19:26		17:19		16:30		16:27
28	05:48		06:40	07:11-07:19/8	07:32		07:26	08:47-08:51/4	08:22		08:50
	21:39		20:38		19:24		17:17	16:26-16:47/21	16:29		16:28
29	05:50		06:41		07:34		07:28	08:44-08:55/11	08:23		08:50
	21:37		20:35		19:22		17:15	16:28-16:45/17	16:28		16:29
30	05:52		06:43		07:36		07:30	08:42-08:56/14	08:25		08:50
	21:36		20:33		19:19		17:13	16:32-16:43/11	16:27		16:30
31	05:53		06:45				07:31	08:41-08:57/16			08:50
	21:34		20:31				17:11				16:31
Potential sun hours	507		456		381		330		263		239
Sum of minutes with flicker		8		120		96		964		518	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 7
Licensed user:
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl
Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 4 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (18)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed: Cut in wind speed from power curve

	January		February		March		April		May		June
1	08:50	09:55-10:10/15	08:22		07:27	17:30-17:48/18	07:14		06:07	07:00-07:10/10	05:20
	16:32	10:15-10:43/28	17:21		18:15		20:11		21:04	20:16-20:35/19	21:52
2	08:50	09:55-10:11/16	08:20		07:24	17:29-17:50/21	07:12		06:05	07:03-07:06/3	05:19
	16:33	10:16-10:44/28	17:23		18:17		20:13		21:06	20:15-20:36/21	21:53
3	08:50	09:55-10:12/17	08:19		07:22	17:29-17:52/23	07:09		06:03	20:16-20:38/22	05:18
	16:34	10:16-10:44/28	17:25		18:19		20:15		21:07		21:54
4	08:50	09:55-10:13/18	08:17		07:20	17:30-17:54/24	07:07		06:01	20:15-20:40/25	05:18
	16:35	10:16-10:45/29	17:27		18:21		20:16		21:09		21:55
5	08:50	09:56-10:14/18	08:15		07:18	17:29-17:54/25	07:05		05:59	20:15-20:41/26	05:17
	16:37	10:17-10:46/29	17:29		18:22		20:18		21:11		21:56
6	08:49	09:55-10:15/20	08:14		07:15	17:30-17:54/24	07:02		05:58	20:14-20:43/29	05:16
	16:38	10:17-10:46/29	17:31		18:24		20:20		21:13		21:57
7	08:49	09:55-10:15/20	08:12		07:13	17:31-17:53/22	07:00		05:56	20:14-20:42/28	05:16
	16:39	10:17-10:46/29	17:33		18:26		20:22		21:14		21:58
8	08:48	09:55-10:17/22	08:10		07:11	17:31-17:51/20	06:58		05:54	20:15-20:43/28	05:15
	16:41	10:18-10:47/29	17:35		18:28		20:23		21:16		21:59
9	08:48	09:55-10:17/22	08:08		07:08	17:33-17:49/16	06:55		05:52	20:14-20:42/28	05:14
	16:42	10:19-10:47/28	17:37		18:30		20:25		21:18		22:00
10	08:47	09:55-10:18/23	08:06		07:06	17:36-17:46/10	06:53		05:50	20:14-20:42/28	05:14
	16:43	10:19-10:47/28	17:39		18:32		20:27		21:19		22:01
11	08:47	09:55-10:18/23	08:04		07:04		06:51		05:48	20:15-20:42/27	05:14
	16:45	10:19-10:47/28	17:41		18:33		20:29		21:21		22:01
12	08:46	09:56-10:20/24	08:02		07:01		06:48		05:47	20:15-20:41/26	05:13
	16:46	10:21-10:48/27	17:43		18:35		20:30		21:23		22:02
13	08:45	09:56-10:20/24	08:00		06:59		06:46		05:45	20:16-20:41/25	05:13
	16:48	10:21-10:48/27	17:45		18:37		20:32		21:24		22:03
14	08:44	09:56-10:21/25	07:59		06:57		06:44		05:43	20:17-20:40/23	05:13
	16:49	10:22-10:48/26	17:46		18:39		20:34		21:26		22:03
15	08:44	09:56-10:21/25	07:57		06:54		06:42		05:42	20:18-20:39/21	05:13
	16:51	10:23-10:48/25	17:48		18:41		20:36		21:28		22:04
16	08:43	09:57-10:22/25	07:55		06:52		06:39		05:40	20:18-20:38/20	05:12
	16:53	10:23-10:47/24	17:50		18:42		20:38		21:29		22:04
17	08:42	09:56-10:22/26	07:52		06:50		06:37		05:39	20:20-20:37/17	05:12
	16:54	10:24-10:47/23	17:52		18:44		20:39		21:31		22:05
18	08:41	09:57-10:22/25	07:50		06:47	07:17-07:21/4	06:35		05:37	20:22-20:36/14	05:12
	16:56	10:25-10:47/22	17:54		18:46		20:41		21:32		22:05
19	08:40	09:57-10:23/26	07:48		06:45	07:13-07:23/10	06:33	07:03-07:13/10	05:36	20:23-20:33/10	05:12
	16:58	10:26-10:46/20	17:56		18:48		20:43		21:34		22:06
20	08:38	09:58-10:23/25	07:46		06:43	07:11-07:25/14	06:30	07:00-07:14/14	05:34	20:27-20:30/3	05:12
	16:59	10:28-10:46/18	17:58		18:50		20:45		21:35		22:06
21	08:37	09:58-10:23/25	07:44		06:40	07:09-07:25/16	06:28	06:59-07:15/16	05:33		05:12
	17:01	10:29-10:44/15	18:00		18:51		20:46		21:37		22:06
22	08:36	09:59-10:23/24	07:42		06:38	07:09-07:26/17	06:26	06:58-07:15/17	05:31		05:13
	17:03	10:32-10:43/11	18:02		18:53		20:48		21:38		22:07
23	08:35	10:00-10:23/23	07:40		06:35	07:09-07:26/17	06:24	06:58-07:16/18	05:30		05:13
	17:05	10:36-10:40/4	18:04		18:55		20:50		21:40		22:07
24	08:34	10:00-10:22/22	07:38	17:34-17:38/4	06:33	07:08-07:25/17	06:22	06:57-07:16/19	05:29		05:13
	17:07		18:06		18:57		20:52		21:41		22:07
25	08:32	10:01-10:23/22	07:36	17:33-17:40/7	06:31	07:08-07:25/17	06:20	06:57-07:16/19	05:28		05:14
	17:08		18:07		18:59		20:53		21:43		22:07
26	08:31	10:02-10:22/20	07:33	17:32-17:43/11	06:28	07:08-07:23/15	06:17	06:57-07:15/18	05:26		05:14
	17:10		18:09		19:00		20:55	20:23-20:27/4	21:44		22:07
27	08:30	10:03-10:20/17	07:31	17:31-17:44/13	06:26	07:09-07:22/13	06:15	06:57-07:15/18	05:25		05:14
	17:12		18:11		19:02		20:57	20:21-20:28/7	21:45		22:07
28	08:28	10:05-10:20/15	07:29	17:30-17:46/16	06:23	07:11-07:20/9	06:13	06:57-07:14/17	05:24		05:15
	17:14		18:13		19:04		20:59	20:20-20:30/10	21:47		22:07
29	08:27	10:06-10:18/12			07:21		06:11	06:58-07:13/15	05:23		05:15
	17:16				20:06		21:00	20:18-20:31/13	21:48		22:06
30	08:25	10:11-10:15/4			07:19		06:09	06:59-07:12/13	05:22		05:16
	17:18				20:07		21:02	20:17-20:33/16	21:49		22:06
31	08:24				07:16				05:21		
	17:20				20:09				21:50		
Potential sun hours	255		276		367		418		489		504
Sum of minutes with flicker		1178		51		352		244		453	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 8

Licensed user
izzy projects
Fransestraat 2
NL-6524JA Nijmegen
+31 6 55710803
Pim de Ridder, pim@izzy-projects.nl

Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 4 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (18)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	July		August		September		October		November		December	
1	05:17		05:55	20:25-20:51/26	06:47		07:38		07:33		08:26	09:37-10:00/23
	22:06		21:32		20:28		19:17		17:09		16:27	10:02-10:29/27
2	05:17		05:56	20:25-20:52/27	06:48		07:39		07:35		08:28	09:38-10:01/23
	22:06		21:31		20:26		19:15		17:07		16:26	10:02-10:30/28
3	05:18		05:58	20:25-20:52/27	06:50		07:41	18:16-18:22/6	07:37		08:29	09:39-10:01/22
	22:05		21:29		20:24		19:12		17:05		16:25	10:03-10:31/28
4	05:19		06:00	20:25-20:53/28	06:52		07:43	18:11-18:25/14	07:39		08:30	09:39-10:01/22
	22:05		21:27		20:21		19:10		17:03		16:25	10:03-10:31/28
5	05:20		06:01	20:24-20:52/28	06:53		07:44	18:09-18:27/18	07:41		08:32	09:41-10:01/20
	22:04		21:25		20:19		19:07		17:01		16:24	10:03-10:32/29
6	05:21		06:03	20:24-20:53/29	06:55		07:46	18:08-18:28/20	07:43		08:33	09:41-10:01/20
	22:04		21:24		20:17		19:05		16:59		16:24	10:03-10:32/29
7	05:22		06:04	20:24-20:51/27	06:57		07:48	18:06-18:29/23	07:45		08:34	09:42-10:01/19
	22:03		21:22		20:14		19:03		16:58		16:23	10:03-10:32/29
8	05:23		06:06	20:24-20:50/26	06:58		07:50	18:06-18:30/24	07:46		08:36	09:43-10:01/18
	22:02		21:20		20:12		19:00		16:56		16:23	10:05-10:33/28
9	05:24		06:08	20:24-20:48/24	07:00		07:52	18:04-18:29/25	07:48		08:37	09:44-10:01/17
	22:02		21:18		20:10		18:58		16:54		16:23	10:05-10:33/28
10	05:25		06:09	20:24-20:46/22	07:02		07:53	18:03-18:27/24	07:50		08:38	09:44-10:01/17
	22:01		21:16		20:07		18:56		16:53		16:22	10:05-10:33/28
11	05:26		06:11	07:11-07:17/6	07:03		07:55	18:03-18:25/22	07:52		08:39	09:45-10:00/15
	22:00		21:14	20:25-20:45/20	20:05		18:54		16:51		16:22	10:05-10:34/29
12	05:27		06:13	07:08-07:19/11	07:05		07:57	18:03-18:23/20	07:54	09:41-09:46/5	08:40	09:46-10:00/14
	21:59		21:12	20:25-20:43/18	20:02		18:51		16:49		16:22	10:06-10:34/28
13	05:28		06:14	07:07-07:20/13	07:07		07:59	18:03-18:21/18	07:56	09:38-09:50/12	08:41	09:47-10:00/13
	21:58		21:10	20:26-20:41/15	20:00		18:49		16:48		16:22	10:06-10:34/28
14	05:29		06:16	07:05-07:21/16	07:09		08:00	18:03-18:18/15	07:57	09:37-09:52/15	08:42	09:48-10:00/12
	21:57		21:08	20:26-20:39/13	19:58		18:47		16:46		16:22	10:07-10:35/28
15	05:30		06:18	07:05-07:22/17	07:10	08:01-08:09/8	08:02	18:04-18:16/12	07:59	09:35-09:53/18	08:43	09:49-10:00/11
	21:56		21:06	20:27-20:37/10	19:55		18:44		16:45		16:22	10:07-10:35/28
16	05:32		06:19	07:05-07:22/17	07:12	07:59-08:11/12	08:04	18:04-18:13/9	08:01	09:35-09:55/20	08:44	09:50-10:00/10
	21:55		21:04	20:28-20:35/7	19:53		18:42		16:43		16:22	10:08-10:36/28
17	05:33		06:21	07:03-07:22/19	07:14	07:57-08:11/14	08:06	18:05-18:11/6	08:03	09:34-09:56/22	08:45	09:51-10:01/10
	21:54		21:02	20:31-20:33/2	19:50		18:40		16:42		16:22	10:08-10:36/28
18	05:34		06:23	07:04-07:22/18	07:15	07:56-08:12/16	08:08	18:06-18:09/3	08:05	09:34-09:56/22	08:46	09:52-10:01/9
	21:53		21:00		19:48		18:38		16:40		16:22	10:09-10:37/28
19	05:35		06:25	07:03-07:21/18	07:17	07:56-08:13/17	08:09		08:06	09:34-09:57/23	08:46	09:52-10:00/8
	21:52		20:57		19:46		18:36		16:39	10:10-10:14/4	16:23	10:09-10:37/28
20	05:37		06:26	07:03-07:21/18	07:19	07:54-08:12/18	08:11		08:08	09:34-09:58/24	08:47	09:53-10:01/8
	21:50		20:55		19:43		18:33		16:38	10:07-10:18/11	16:23	10:10-10:38/28
21	05:38		06:28	07:04-07:21/17	07:20	07:54-08:11/17	08:13		08:10	09:34-09:59/25	08:48	09:54-10:02/8
	21:49		20:53		19:41		18:31		16:37	10:05-10:20/15	16:23	10:11-10:38/27
22	05:40		06:30	07:04-07:19/15	07:22	07:55-08:11/16	08:15		08:12	09:34-09:59/25	08:48	09:54-10:02/8
	21:48		20:51		19:38		18:29		16:35	10:04-10:22/18	16:24	10:11-10:38/27
23	05:41		06:31	07:05-07:18/13	07:24	07:55-08:09/14	08:17		08:13	09:34-10:00/26	08:49	09:54-10:02/8
	21:46		20:49		19:36		18:27		16:34	10:04-10:23/19	16:24	10:11-10:39/28
24	05:43	20:35-20:43/8	06:33	07:06-07:15/9	07:25	07:56-08:08/12	08:19		08:15	09:34-09:59/25	08:49	09:55-10:03/8
	21:45		20:47		19:34		18:25		16:33	10:02-10:24/22	16:25	10:12-10:40/28
25	05:44	20:33-20:45/12	06:35		07:27	07:58-08:05/7	07:20		08:17	09:34-10:00/26	08:49	09:55-10:04/9
	21:44		20:44		19:31		17:23		16:32	10:02-10:25/23	16:26	10:12-10:40/28
26	05:45	20:32-20:47/15	06:36		07:29		07:22		08:18	09:35-10:00/25	08:50	09:55-10:04/9
	21:42		20:42		19:29		17:21		16:31	10:02-10:26/24	16:26	10:12-10:40/28
27	05:47	20:30-20:48/18	06:38		07:31		07:24		08:20	09:35-10:01/26	08:50	09:55-10:05/10
	21:41		20:40		19:26		17:19		16:30	10:02-10:27/25	16:27	10:13-10:40/27
28	05:49	20:28-20:49/21	06:40		07:32		07:26		08:22	09:35-10:00/25	08:50	09:56-10:07/11
	21:39		20:38		19:24		17:17		16:29	10:01-10:27/26	16:28	10:14-10:42/28
29	05:50	20:28-20:50/22	06:41		07:34		07:28		08:23	09:36-10:00/24	08:50	09:56-10:08/12
	21:37		20:35		19:22		17:15		16:28	10:02-10:28/26	16:29	10:14-10:42/28
30	05:52	20:27-20:50/23	06:43		07:36		07:30		08:25	09:37-10:01/24	08:50	09:55-10:08/13
	21:36		20:33		19:19		17:13		16:27	10:02-10:29/27	16:30	10:14-10:42/28
31	05:53	20:27-20:51/24	06:45				07:31				08:50	09:55-10:09/14
	21:34		20:31				17:11				16:31	10:14-10:43/29
Potential sun hours	507		456		381		330		263		239	
Sum of minutes with flicker		143		556		151		259		652		1290

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 5 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (19)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January		February	March		April		May	June
1	08:50	13:57-14:23/26	08:22	07:27		07:14	08:24-09:10/46	06:07	05:20
	16:32	14:34-15:04/30	17:21	18:15		20:11		21:04	21:52
2	08:50	13:58-14:24/26	08:20	07:24		07:12	08:24-09:09/45	06:05	05:19
	16:33	14:35-15:05/30	17:23	18:17		20:13		21:06	21:53
3	08:50	13:58-14:23/25	08:19	07:22		07:09	08:25-09:09/44	06:03	05:18
	16:34	14:35-15:05/30	17:25	18:19		20:15		21:07	21:54
4	08:50	13:59-14:23/24	08:17	07:20		07:07	08:24-09:07/43	06:01	05:18
	16:35	14:36-15:05/29	17:27	18:21		20:16		21:09	21:55
5	08:50	14:00-14:24/24	08:15	07:18		07:05	08:25-09:07/42	05:59	05:17
	16:37	14:37-15:06/29	17:29	18:22		20:18		21:11	21:56
6	08:49	14:01-14:23/22	08:14	07:15		07:02	08:25-09:06/41	05:58	05:16
	16:38	14:37-15:06/29	17:31	18:24		20:20		21:13	21:57
7	08:49	14:02-14:23/21	08:12	07:13		07:00	08:25-09:04/39	05:56	05:16
	16:39	14:38-15:06/28	17:33	18:26		20:22		21:14	21:58
8	08:48	14:03-14:23/20	08:10	07:11		06:58	08:26-09:03/37	05:54	05:15
	16:41	14:39-15:07/28	17:35	18:28		20:23		21:16	21:59
9	08:48	14:05-14:22/17	08:08	07:08		06:55	08:27-09:02/35	05:52	05:15
	16:42	14:39-15:06/27	17:37	18:30		20:25		21:18	22:00
10	08:47	14:06-14:21/15	08:06	07:06		06:53	08:28-08:59/31	05:50	05:14
	16:43	14:40-15:06/26	17:39	18:32		20:27		21:19	22:01
11	08:47	14:08-14:20/12	08:04	07:04		06:51	08:29-08:57/28	05:49	05:14
	16:45	14:40-15:06/26	17:41	18:33		20:29		21:21	22:01
12	08:46	14:11-14:19/8	08:02	07:01		06:48	08:31-08:55/24	05:47	05:13
	16:46	14:42-15:07/25	17:43	18:35		20:31		21:23	22:02
13	08:45	14:43-15:07/24	08:01	06:59		06:46	08:34-08:52/18	05:45	05:13
	16:48		17:45	18:37		20:32	20:05-20:06/1	21:24	22:03
14	08:44	14:44-15:06/22	07:59	06:57		06:44	08:37-08:47/10	05:43	05:13
	16:50		17:47	18:39		20:34	20:05-20:06/1	21:26	22:03
15	08:44	14:45-15:06/21	07:57	06:54		06:42	20:06-20:08/2	05:42	05:13
	16:51		17:48	18:41		20:36		21:28	22:04
16	08:43	14:46-15:04/18	07:55	06:52		06:39	20:07-20:10/3	05:40	05:12
	16:53		17:50	18:43		20:38		21:29	22:05
17	08:42	14:48-15:04/16	07:53	06:50	07:44-08:00/16	06:37		05:39	05:12
	16:54		17:52	18:44		20:39		21:31	22:05
18	08:41	14:50-15:03/13	07:50	06:47	07:41-08:04/23	06:35		05:37	05:12
	16:56		17:54	18:46		20:41		21:32	22:05
19	08:40	14:53-15:00/7	07:48	06:45	07:37-08:05/28	06:33		05:36	05:12
	16:58		17:56	18:48		20:43		21:34	22:06
20	08:39		07:46	06:43	07:36-08:07/31	06:30		05:34	05:12
	16:59		17:58	18:50		20:45		21:35	22:06
21	08:37		07:44	06:40	07:33-08:08/35	06:28		05:33	05:13
	17:01		18:00	18:51		20:46		21:37	22:06
22	08:36		07:42	06:38	07:32-08:09/37	06:26		05:31	05:13
	17:03		18:02	18:53		20:48		21:38	22:07
23	08:35		07:40	06:35	07:31-08:10/39	06:24		05:30	05:13
	17:05		18:04	18:55		20:50		21:40	22:07
24	08:34		07:38	06:33	07:29-08:10/41	06:22		05:29	05:13
	17:07		18:06	18:57		20:52		21:41	22:07
25	08:32		07:36	06:31	07:29-08:11/42	06:20		05:28	05:14
	17:08		18:07	18:59		20:53		21:43	22:07
26	08:31		07:33	06:28	07:27-08:11/44	06:18		05:26	05:14
	17:10		18:09	19:00		20:55		21:44	22:07
27	08:30		07:31	06:26	07:27-08:11/44	06:15		05:25	05:14
	17:12		18:11	19:02		20:57		21:45	22:07
28	08:28		07:29	06:24	07:26-08:11/45	06:13		05:24	05:15
	17:14		18:13	19:04		20:59		21:47	22:07
29	08:27			07:21	08:25-09:11/46	06:11		05:23	05:16
	17:16			20:06		21:00		21:48	22:06
30	08:25			07:19	08:25-09:11/46	06:09		05:22	05:16
	17:18			20:07		21:02		21:49	22:06
31	08:24			07:16	08:25-09:11/46			05:21	
	17:20			20:09				21:50	
Potential sun hours	255		276	367		418		489	504
Sum of minutes with flicker		698	0		563		490	0	0

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 5 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (19)

Assumptions for shadow calculations

Maximum distance for influence	2.000 m
Minimum sun height over horizon for influence	3 °
Day step for calculation	1 days
Time step for calculation	1 minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	July	August		September		October	November		December	
1	05:17	05:55		06:47	08:28-08:56/28	07:38	07:33		08:26	13:50-14:02/12
	22:06	21:33		20:28		19:17	17:09		16:27	14:23-14:48/25
2	05:17	05:56		06:48	08:27-08:58/31	07:39	07:35		08:28	13:49-14:04/15
	22:06	21:31		20:26		19:15	17:07		16:26	14:23-14:49/26
3	05:18	05:58		06:50	08:24-08:59/35	07:41	07:37		08:29	13:49-14:06/17
	22:05	21:29		20:24		19:12	17:05		16:25	14:23-14:50/27
4	05:19	06:00		06:52	08:23-09:00/37	07:43	07:39		08:31	13:48-14:07/19
	22:05	21:27		20:21		19:10	17:03		16:25	14:23-14:51/28
5	05:20	06:01		06:53	08:22-09:01/39	07:45	07:41		08:32	13:48-14:09/21
	22:04	21:25		20:19		19:08	17:01		16:24	14:24-14:52/28
6	05:21	06:03		06:55	08:21-09:01/40	07:46	07:43		08:33	13:47-14:09/22
	22:04	21:24		20:17		19:05	17:00		16:24	14:23-14:52/29
7	05:22	06:05		06:57	08:20-09:02/42	07:48	07:45		08:34	13:47-14:10/23
	22:03	21:22		20:14		19:03	16:58		16:23	14:23-14:52/29
8	05:23	06:06		06:58	08:19-09:03/44	07:50	07:46		08:36	13:47-14:11/24
	22:02	21:20		20:12		19:01	16:56		16:23	14:24-14:53/29
9	05:24	06:08		07:00	08:18-09:02/44	07:52	07:48		08:37	13:47-14:12/25
	22:02	21:18		20:10		18:58	16:54		16:23	14:24-14:54/30
10	05:25	06:09		07:02	08:18-09:02/44	07:53	07:50		08:38	13:47-14:13/26
	22:01	21:16		20:07		18:56	16:53		16:22	14:24-14:54/30
11	05:26	06:11		07:04	08:17-09:03/46	07:55	07:52		08:39	13:47-14:13/26
	22:00	21:14		20:05		18:54	16:51		16:22	14:24-14:54/30
12	05:27	06:13		07:05	08:16-09:02/46	07:57	07:54		08:40	13:47-14:14/27
	21:59	21:12		20:02		18:51	16:49		16:22	14:25-14:55/30
13	05:28	06:15		07:07	08:16-09:02/46	07:59	07:56		08:41	13:47-14:14/27
	21:58	21:10		20:00		18:49	16:48		16:22	14:25-14:55/30
14	05:29	06:16		07:09	08:15-09:01/46	08:00	07:57		08:42	13:47-14:15/28
	21:57	21:08		19:58		18:47	16:46		16:22	14:25-14:56/31
15	05:30	06:18		07:10	08:16-09:01/45	08:02	07:59		08:43	13:48-14:16/28
	21:56	21:06		19:55		18:45	16:45		16:22	14:26-14:56/30
16	05:32	06:20		07:12	08:16-09:01/45	08:04	08:01		08:44	13:48-14:16/28
	21:55	21:04		19:53		18:42	16:43		16:22	14:27-14:57/30
17	05:33	06:21		07:14	08:15-08:59/44	08:06	08:03		08:45	13:49-14:17/28
	21:54	21:02		19:50		18:40	16:42		16:22	14:27-14:58/31
18	05:34	06:23		07:15	08:16-08:59/43	08:08	08:05		08:46	13:49-14:18/29
	21:53	21:00		19:48		18:38	16:41		16:22	14:28-14:58/30
19	05:36	06:25		07:17	08:16-08:58/42	08:09	08:06		08:46	13:49-14:18/29
	21:52	20:57		19:46		18:36	16:39		16:23	14:28-14:58/30
20	05:37	06:26		07:19	08:16-08:56/40	08:11	08:08		08:47	13:50-14:19/29
	21:50	20:55		19:43		18:33	16:38		16:23	14:28-14:59/31
21	05:38	06:28		07:20	08:17-08:55/38	08:13	08:10		08:48	13:51-14:20/29
	21:49	20:53		19:41		18:31	16:37		16:23	14:29-15:00/31
22	05:40	06:30		07:22	08:18-08:54/36	08:15	08:12		08:48	13:51-14:20/29
	21:48	20:51		19:38		18:29	16:35		16:24	14:29-15:00/31
23	05:41	06:31		07:24	08:19-08:51/32	08:17	08:13	14:30-14:37/7	08:49	13:51-14:20/29
	21:47	20:49		19:36		18:27	16:34		16:24	14:29-15:00/31
24	05:43	06:33		07:26	08:20-08:49/29	08:19	08:15	14:27-14:40/13	08:49	13:52-14:21/29
	21:45	20:47		19:34		18:25	16:33		16:25	14:31-15:01/30
25	05:44	06:35		07:27	08:23-08:47/24	07:20	08:17	14:26-14:42/16	08:49	13:52-14:21/29
	21:44	20:44		19:31		17:23	16:32		16:26	14:31-15:01/30
26	05:46	06:36		07:29	08:25-08:44/19	07:22	08:18	14:25-14:43/18	08:50	13:53-14:21/28
	21:42	20:42		19:29		17:21	16:31		16:26	14:31-15:02/31
27	05:47	06:38	20:09-20:12/3	07:31	08:29-08:39/10	07:24	08:20	14:25-14:45/20	08:50	13:53-14:21/28
	21:41	20:40		19:26		17:19	16:30		16:27	14:31-15:02/31
28	05:49	06:40	20:07-20:10/3	07:32		07:26	08:22	14:23-14:45/22	08:50	13:54-14:23/29
	21:39	20:38		19:24		17:17	16:29		16:28	14:33-15:03/30
29	05:50	06:42	08:37-08:48/11	07:34		07:28	08:23	14:23-14:47/24	08:50	13:55-14:23/28
	21:37	20:35	20:05-20:07/2	19:22		17:15	16:28		16:29	14:33-15:04/31
30	05:52	06:43	08:33-08:52/19	07:36		07:30	08:25	13:52-14:00/8	08:50	13:55-14:22/27
	21:36	20:33		19:19		17:13	16:27	14:23-14:48/25	16:30	14:33-15:03/30
31	05:53	06:45	08:31-08:55/24			07:32			08:50	13:56-14:23/27
	21:34	20:31				17:11			16:31	14:33-15:04/31
Potential sun hours	507	456		381		330	263		239	
Sum of minutes with flicker	0		62		1015	0		153		1716

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:
Coor Shanavogh (updated micro siting)

Printed/Page
12-4-2011 20:32 / 11

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Calculated:
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 6 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (20)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	January		February	March		April		May		June	
1	08:50	12:03-12:19/16	08:22	07:27		07:14	08:18-08:35/17	06:07		05:20	06:26-06:55/29
	16:32		17:21	18:15		20:11		21:04		21:52	
2	08:50	12:05-12:19/14	08:20	07:24		07:12	08:20-08:33/13	06:05		05:19	06:26-06:55/29
	16:33		17:23	18:17		20:13		21:06		21:53	
3	08:50	12:06-12:18/12	08:19	07:22		07:09	08:25-08:27/2	06:03		05:18	06:26-06:54/28
	16:34		17:25	18:19		20:15		21:07		21:54	
4	08:50	12:08-12:17/9	08:17	07:20		07:07		06:01		05:18	06:27-06:55/28
	16:35		17:27	18:21		20:16		21:09		21:55	
5	08:50	12:12-12:15/3	08:15	07:18		07:05		05:59		05:17	06:27-06:54/27
	16:37		17:29	18:22		20:18		21:11		21:56	
6	08:49		08:14	07:15		07:02		05:58		05:16	06:27-06:54/27
	16:38		17:31	18:24		20:20		21:13		21:57	
7	08:49		08:12	07:13		07:00		05:56		05:16	06:28-06:54/26
	16:39		17:33	18:26		20:22		21:14		21:58	
8	08:48		08:10	07:11	18:00-18:01/1	06:58		05:54		05:15	06:29-06:55/26
	16:41		17:35	18:28		20:23		21:16		21:59	
9	08:48		08:08	07:08	18:00-18:03/3	06:55		05:52		05:15	06:29-06:54/25
	16:42		17:37	18:30		20:25		21:18		22:00	
10	08:47		08:06	07:06	18:01-18:06/5	06:53		05:50	06:34-06:45/11	05:14	06:30-06:54/24
	16:43		17:39	18:32		20:27		21:19		22:01	
11	08:47		08:04	07:04	18:00-18:07/7	06:51		05:49	06:32-06:47/15	05:14	06:30-06:54/24
	16:45		17:41	18:33		20:29		21:21		22:01	
12	08:46		08:02	07:01	18:01-18:09/8	06:48		05:47	06:30-06:48/18	05:13	06:30-06:54/24
	16:46		17:43	18:35		20:31		21:23		22:02	
13	08:45		08:01	06:59	18:02-18:10/8	06:46		05:45	06:29-06:50/21	05:13	06:31-06:54/23
	16:48		17:45	18:37		20:32		21:24		22:03	
14	08:44		07:59	06:57	18:05-18:11/6	06:44		05:43	06:27-06:50/23	05:13	06:31-06:54/23
	16:50		17:46	18:39		20:34		21:26		22:03	
15	08:44		07:57	06:54		06:42	20:07-20:08/1	05:42	06:27-06:52/25	05:13	06:32-06:54/22
	16:51		17:48	18:41		20:36		21:28		22:04	
16	08:43		07:55	06:52		06:39	20:07-20:10/3	05:40	06:26-06:52/26	05:12	06:32-06:54/22
	16:53		17:50	18:42		20:38		21:29		22:05	
17	08:42		07:53	06:50	07:29-07:34/5	06:37	20:07-20:12/5	05:39	06:26-06:53/27	05:12	06:33-06:54/21
	16:54		17:52	18:44		20:39		21:31		22:05	
18	08:41		07:50	06:47	07:25-07:39/14	06:35	20:06-20:14/8	05:37	06:26-06:54/28	05:12	06:33-06:55/22
	16:56		17:54	18:46		20:41		21:32		22:05	
19	08:40		07:48	06:45	07:22-07:40/18	06:33	20:06-20:15/9	05:36	06:25-06:53/28	05:12	06:33-06:55/22
	16:58		17:56	18:48		20:43		21:34		22:06	
20	08:39		07:46	06:43	07:20-07:41/21	06:30	20:06-20:16/10	05:34	06:25-06:54/29	05:12	06:33-06:55/22
	16:59		17:58	18:50		20:45		21:35		22:06	
21	08:37		07:44	06:40	07:18-07:42/24	06:28	20:07-20:18/11	05:33	06:25-06:54/29	05:13	06:33-06:55/22
	17:01		18:00	18:51		20:46		21:37		22:06	
22	08:36		07:42	06:38	07:18-07:42/24	06:26	20:07-20:20/13	05:31	06:25-06:55/30	05:13	06:33-06:55/22
	17:03		18:02	18:53		20:48		21:38		22:07	
23	08:35		07:40	06:35	07:17-07:43/26	06:24	20:09-20:19/10	05:30	06:24-06:54/30	05:13	06:34-06:56/22
	17:05		18:04	18:55		20:50		21:40		22:07	
24	08:34		07:38	06:33	07:16-07:43/27	06:22	20:13-20:14/1	05:29	06:24-06:54/30	05:13	06:34-06:56/22
	17:07		18:06	18:57		20:52		21:41		22:07	
25	08:32		07:36	06:31	07:16-07:43/27	06:20		05:28	06:24-06:55/31	05:14	06:34-06:55/21
	17:08		18:07	18:59		20:53		21:43		22:07	
26	08:31		07:33	06:28	07:15-07:42/27	06:17		05:26	06:24-06:55/31	05:14	06:34-06:56/22
	17:10		18:09	19:00		20:55		21:44		22:07	
27	08:30		07:31	06:26	07:15-07:42/27	06:15		05:25	06:25-06:55/30	05:14	06:34-06:56/22
	17:12		18:11	19:02		20:57		21:45		22:07	
28	08:28		07:29	06:24	07:15-07:41/26	06:13		05:24	06:25-06:55/30	05:15	06:35-06:57/22
	17:14		18:13	19:04		20:59		21:47		22:07	
29	08:27			07:21	08:15-08:40/25	06:11		05:23	06:25-06:55/30	05:15	06:34-06:57/23
	17:16			20:06		21:00		21:48		22:06	
30	08:25			07:19	08:16-08:39/23	06:09		05:22	06:25-06:55/30	05:16	06:34-06:58/24
	17:18			20:07		21:02		21:49		22:06	
31	08:24			07:16	08:17-08:38/21			05:21	06:25-06:54/29		
	17:20			20:09				21:50			
Potential sun hours	255		276	367		418		489		504	
Sum of minutes with flicker		54	0		373		103		581		716

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Project:

Coor Shanavogh (updated micro siting)

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12-4-2011 20:32 / 12

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Calculated
12-4-2011 11:27/2.7.453

SHADOW - Calendar per WTG

Calculation: 6 Enercon E82 (position def**WTG:** 6 - ENERCON E-82 E2 2300 82.0 !O! hub: 84,6 m (20)

Assumptions for shadow calculations

Maximum distance for influence	2.000	m
Minimum sun height over horizon for influence	3	°
Day step for calculation	1	days
Time step for calculation	1	minutes

Sunshine probability S (Average daily sunshine hours) [BIRR]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1,57	2,08	2,82	4,36	5,20	4,37	4,15	3,90	3,54	2,68	1,94	1,23

Operational time

N	NNE	ENE	E	ESE	SSE	S	SSW	WSW	W	WNW	NNW	Sum
472	478	423	509	987	793	820	994	961	870	864	541	8.713

Idle start wind speed Cut in wind speed from power curve

	July		August		September		October		November		December	
1	05:17	06:35-06:59/24	05:55	06:41-06:58/17	06:47		07:38	18:41-18:49/8	07:33		08:26	
	22:06		21:32		20:28		19:17		17:09		16:27	
2	05:17	06:34-06:58/24	05:56	06:43-06:57/14	06:48		07:39	18:39-18:47/8	07:35		08:28	
	22:06		21:31		20:26		19:15		17:07		16:26	
3	05:18	06:34-06:59/25	05:58	06:45-06:54/9	06:50		07:41	18:39-18:45/6	07:37		08:29	
	22:05		21:29		20:24		19:12		17:05		16:25	
4	05:19	06:35-07:00/25	06:00		06:52		07:43	18:37-18:41/4	07:39		08:30	
	22:05		21:27		20:21		19:10		17:03		16:25	
5	05:20	06:35-07:01/26	06:01		06:53		07:45	18:37-18:39/2	07:41		08:32	
	22:04		21:25		20:19		19:08		17:01		16:24	
6	05:21	06:34-07:00/26	06:03		06:55		07:46		07:43		08:33	
	22:04		21:24		20:17		19:05		17:00		16:24	
7	05:22	06:34-07:01/27	06:05		06:57		07:48		07:45		08:34	11:59-12:00/1
	22:03		21:22		20:14		19:03		16:58		16:23	
8	05:23	06:34-07:01/27	06:06		06:58		07:50		07:46		08:36	11:56-12:05/9
	22:02		21:20		20:12		19:00		16:56		16:23	
9	05:24	06:34-07:02/28	06:08		07:00		07:52		07:48		08:37	11:55-12:07/12
	22:02		21:18		20:10		18:58		16:54		16:23	
10	05:25	06:34-07:02/28	06:09		07:02	08:14-08:26/12	07:53		07:50		08:38	11:54-12:08/14
	22:01		21:16		20:07		18:56		16:53		16:22	
11	05:26	06:34-07:02/28	06:11		07:04	08:11-08:28/17	07:55		07:52		08:39	11:54-12:09/15
	22:00		21:14		20:05		18:54		16:51		16:22	
12	05:27	06:34-07:03/29	06:13		07:05	08:09-08:29/20	07:57		07:54		08:40	11:53-12:10/17
	21:59		21:12		20:02		18:51		16:49		16:22	
13	05:28	06:33-07:03/30	06:14		07:07	08:08-08:30/22	07:59		07:56		08:41	11:53-12:11/18
	21:58		21:10		20:00		18:49		16:48		16:22	12:46-12:50/4
14	05:29	06:33-07:03/30	06:16		07:09	08:06-08:30/24	08:00		07:57		08:42	11:53-12:12/19
	21:57		21:08		19:58		18:47		16:46		16:22	12:44-12:52/8
15	05:30	06:33-07:03/30	06:18		07:10	08:05-08:30/25	08:02		07:59		08:43	11:53-12:13/20
	21:56		21:06		19:55		18:44		16:45		16:22	12:44-12:54/10
16	05:32	06:34-07:04/30	06:20		07:12	08:04-08:31/27	08:04		08:01		08:44	11:54-12:14/20
	21:55		21:04		19:53		18:42		16:43		16:22	12:44-12:55/11
17	05:33	06:34-07:04/30	06:21		07:14	08:03-08:30/27	08:06		08:03		08:45	11:54-12:15/21
	21:54		21:02		19:50		18:40		16:42		16:22	12:44-12:56/12
18	05:34	06:34-07:04/30	06:23		07:15	08:03-08:30/27	08:08		08:05		08:46	11:54-12:16/22
	21:53		21:00		19:48		18:38		16:40		16:22	12:44-12:57/13
19	05:36	06:34-07:04/30	06:25	20:17-20:22/5	07:17	08:03-08:30/27	08:09		08:06		08:46	11:54-12:15/21
	21:52		20:57		19:46		18:36		16:39		16:23	12:44-12:57/13
20	05:37	06:34-07:05/31	06:26	20:14-20:25/11	07:19	08:02-08:29/27	08:11		08:08		08:47	11:55-12:16/21
	21:50		20:55		19:43		18:33		16:38		16:23	12:44-12:58/14
21	05:38	06:34-07:05/31	06:28	20:12-20:24/12	07:20	08:03-08:28/25	08:13		08:10		08:48	11:56-12:17/21
	21:49		20:53		19:41		18:31		16:37		16:23	12:45-12:59/14
22	05:40	06:34-07:04/30	06:30	20:11-20:23/12	07:22	08:04-08:27/23	08:15		08:12		08:48	11:56-12:17/21
	21:48		20:51		19:38		18:29		16:35		16:24	12:45-12:59/14
23	05:41	06:35-07:05/30	06:31	20:11-20:21/10	07:24	08:04-08:25/21	08:17		08:13		08:49	11:56-12:17/21
	21:46		20:49		19:36		18:27		16:34		16:24	12:45-12:59/14
24	05:43	06:35-07:04/29	06:33	20:09-20:18/9	07:26	08:05-08:24/19	08:19		08:15		08:49	11:57-12:18/21
	21:45		20:47		19:34		18:25		16:33		16:25	12:47-13:00/13
25	05:44	06:35-07:04/29	06:35	20:09-20:16/7	07:27	08:07-08:22/15	07:20		08:17		08:49	11:57-12:19/22
	21:44		20:44		19:31		17:23		16:32		16:26	12:47-13:00/13
26	05:46	06:36-07:04/28	06:36	20:08-20:14/6	07:29	08:10-08:19/9	07:22		08:18		08:50	11:58-12:19/21
	21:42		20:42		19:29		17:21		16:31		16:26	12:48-13:00/12
27	05:47	06:36-07:03/27	06:38	20:09-20:12/3	07:31		07:24		08:20		08:50	11:58-12:19/21
	21:41		20:40		19:26		17:19		16:30		16:27	12:48-13:00/12
28	05:49	06:37-07:03/26	06:40	20:09-20:10/1	07:32		07:26		08:22		08:50	12:00-12:20/20
	21:39		20:38		19:24		17:17		16:29		16:28	12:50-13:01/11
29	05:50	06:38-07:02/24	06:42		07:34		07:28		08:23		08:50	12:01-12:20/19
	21:37		20:35		19:22		17:15		16:28		16:29	12:52-13:00/8
30	05:52	06:38-07:00/22	06:43		07:36	18:42-18:51/9	07:30		08:25		08:50	12:01-12:19/18
	21:36		20:33		19:19		17:13		16:27		16:30	12:53-12:59/6
31	05:53	06:40-07:00/20	06:45				07:32				08:50	12:02-12:19/17
	21:34		20:31				17:11				16:31	
Potential sun hours	507		456		381		330		263		239	
Sum of minutes with flicker		854		116		376		28		0		654

Table layout: For each day in each month the following matrix apply

Day in month	Sun rise (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker
	Sun set (hh:mm)	First time (hh:mm) with flicker-Last time (hh:mm) with flicker/Minutes with flicker

Name	Pim de Ridder
Day of birth	16 juli 1971
Title	Drs. Ir. (MA. MSc.)
Function	Managing Izzy projects President Premier Renewable Energy
Specialisation	Wind energy business and project development
Telefoon	+31 6 55710803
E-mail	pim@izzy-projects.nl

Employment history

Premier Renewable Energy (since October 2007)
Function : Director
Activities: Managing the business and project development of the company. To date PRE has five projects under development in Canada in various stages of the development, with a combined portfolio size of 400MW. The first project is slated to be on-line late 2011.

Izzy-projects (since January 2006)
Function : Freelancer
Activities: As a freelance project developer and manager Izzy has undertaken various projects for various clients in developing, building, financing and contracting wind energy projects as well as due diligence and project purchase. The focus was on markets in Ireland, Canada and the US Pacific North West.

WEOM (1999-2006)
Function : Project developer wind energy
Activities: Employed by the Dutch wind energy developer WEOM I have developed several wind energy project. The development consist of selection and acquisition of sites, contracting the landowners, obtaining the necessary permits, lobbying at different political levels, achieving grid connections, selling the electricity and contacting the wind turbines.

Developments include a portfolio of sites in Ireland (14 sites), four projects in Poland (on behalf of Starke Wind) and several sites in Germany and The Netherlands (in conjunction with Nuon).

The last 5 years I had the responsibility for the management of the Irish subsidiary of WEOM. The portfolio in Ireland was 150MW of which 78MW are currently under construction.

Education

- Human geography, department of economic geography, Radboud Universiteit Nijmegen, The Netherlands, 2004-2007, MA
- Technology assessment, department of technology policies, Technische Universiteit Eindhoven, The Netherlands, 1995-1998, MSc
- Maritime Officer, Hogere Zeevaartschool Vlissingen, 1990-1995 BA
- Several training and courses with relevance to the wind energy sector incl training in software packages, wind resource measurements and analyses, project management and contract management

Expertise

- International wind energy business development
- Project development and management of wind energy projects
- Project finance of wind energy projects
- Wind energy due diligence
- Country specific knowledge of the wind energy sector that incl Canada (British Colombia, Alberta and Ontario), Ireland and The Netherlands

Recent conducted projects

- Purchase and co-development of the Skyway 125 wind energy project (50MW), Ontario;
- Equity deal structure for a 60MW wind energy project in Canada;
- Due diligence, deal structure and purchase of two projects (total 115MW) project in Oregon (US);
- Owner representative for the sale of two projects in Ireland;
- Acquisition and co-development of a 100MW wind energy project in the province of Ontario (Canada);
- Site prospecting and start-up of the development of 4 utility scale wind energy projects in the province of Alberta;
- Project finance for a 62,5MW wind energy project in Ireland;
- Preparation of tender for an Italian project portfolio of wind and solar projects (incl. finance of the project development);
- Managing the site selection for wind energy projects in the US Pacific North west;
- Project development in British Colombia - a portfolio of 4 projects;
- Incorporation and day to day management of Premier Renewable Energy;
- Acquisition of an existing portfolio of wind energy projects for an Irish investor;
- Development of a wind energy project in Moerdijk, The Netherlands;
- Permit application for an off shore wind energy project in The Netherlands, Scheveningen buiten;
- Turbine and EPC contracting for three Irish projects (in total 75MW);
- Feasibility study wind energy for a Dutch municipality;
- Measurement campaigns in Ireland and wind resource assessment studies for projects in The Netherlands.

1

APPENDIX 11

Turbine Delivery Route Selection Survey

Coor/Shanavogh Windfarm Route Survey

Co Clare

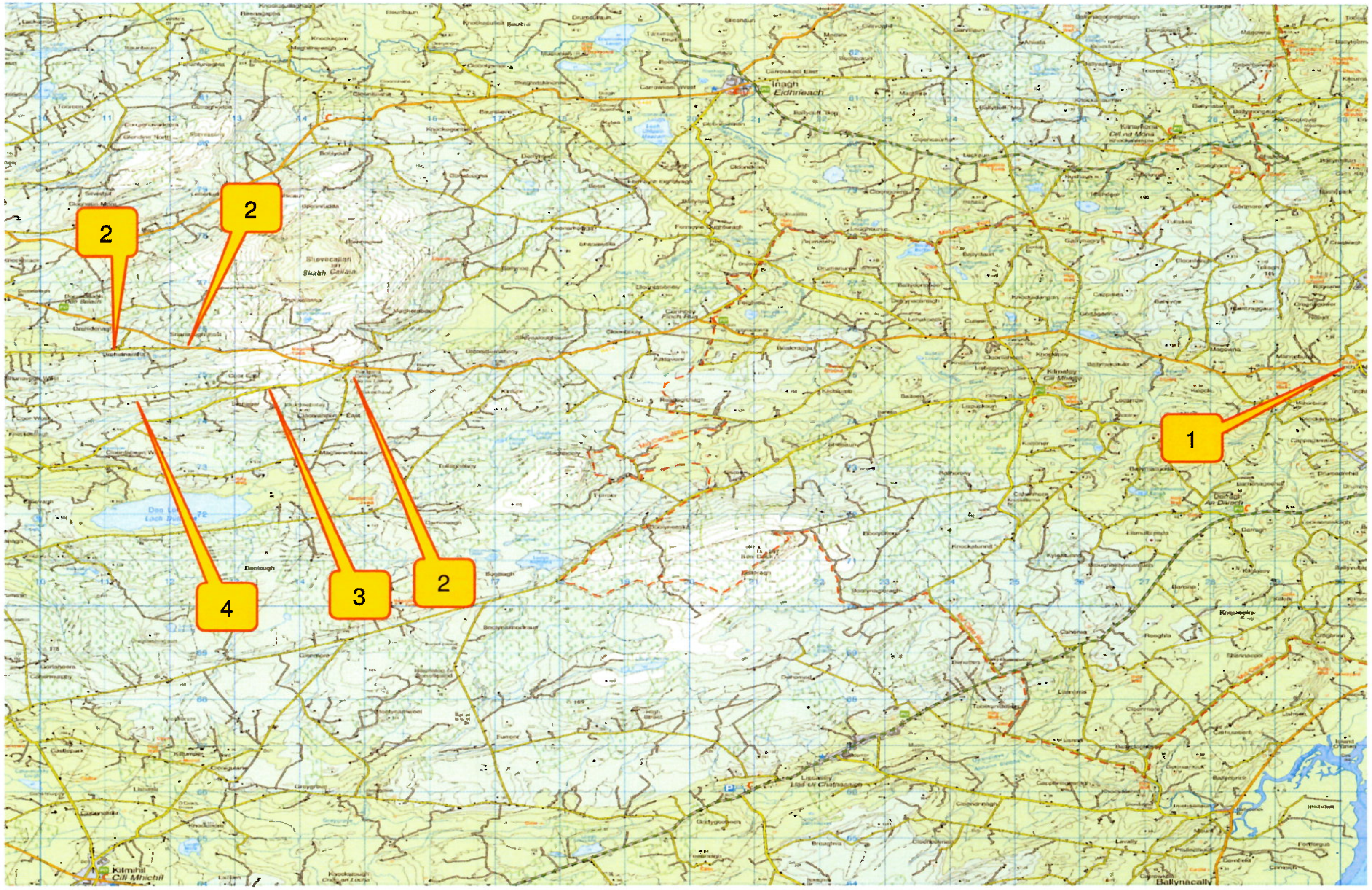
Presented by
Exceptional Load Services Ltd

February 2011 (R1)

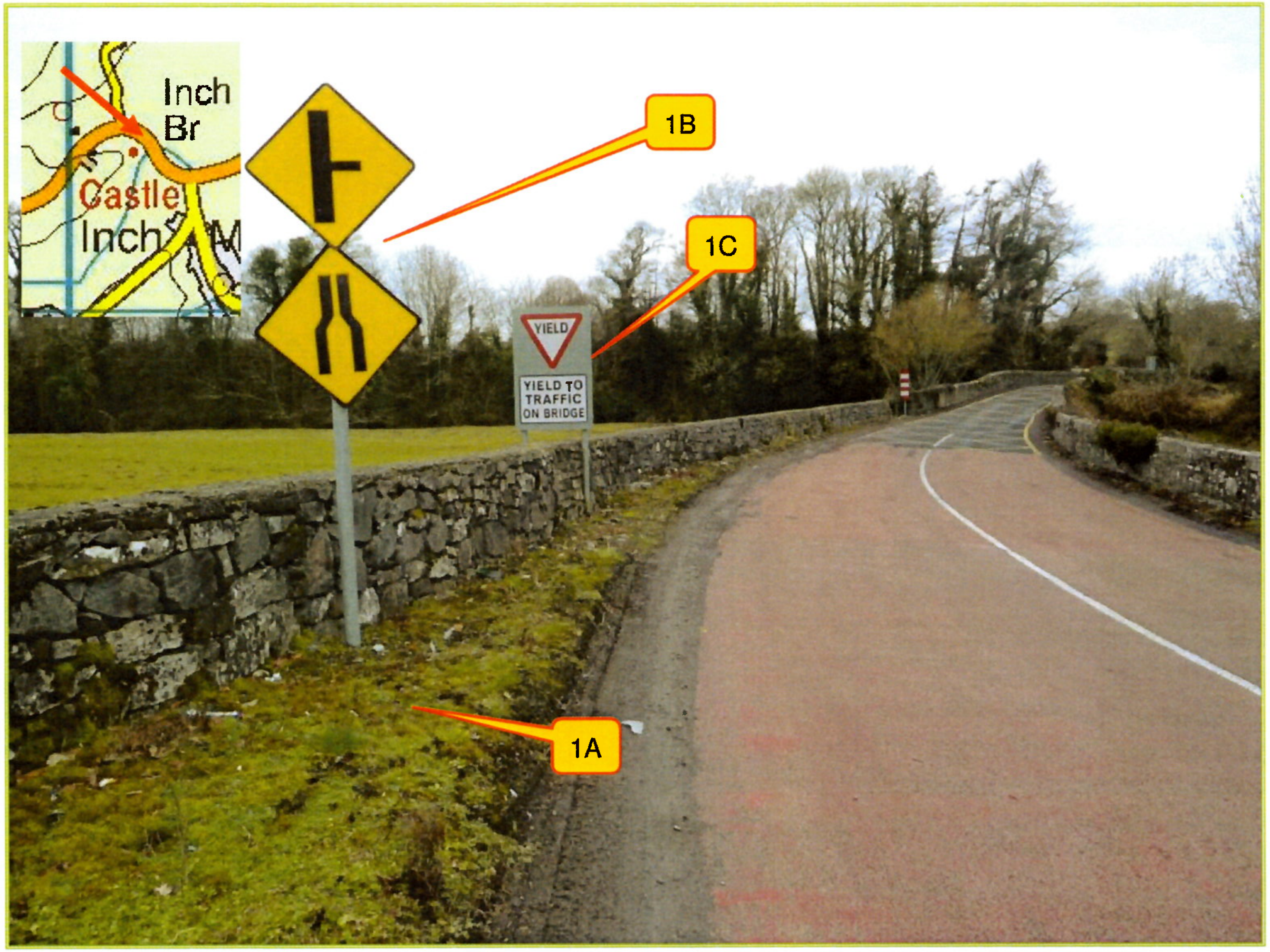
Coor Shanavogh Windfarm

Customer	INIS Environmental Consultants Ltd
Site	Coor Shanavogh
Load Parameters	Survey based Enercon E82 with 40m blades with 8m overhang and 25-29m tower sections.
Port of Entry	Preferred option; Foynes Ringaskiddy or Dublin possible
Proposed Route	M18/N18 to Ennis – Ring Rd – R474 – Coor East - to site

Area map. Ennis to site entrance.



Area 1. Inch Bridge XY 530163,675426



Area 1.Inch Bridge

This bridge while narrow has sufficient dimensions to accommodate up to 32m trailers when area 1A is filled to load bearing and with signs 1B and 1C removed to allow for blade overhang

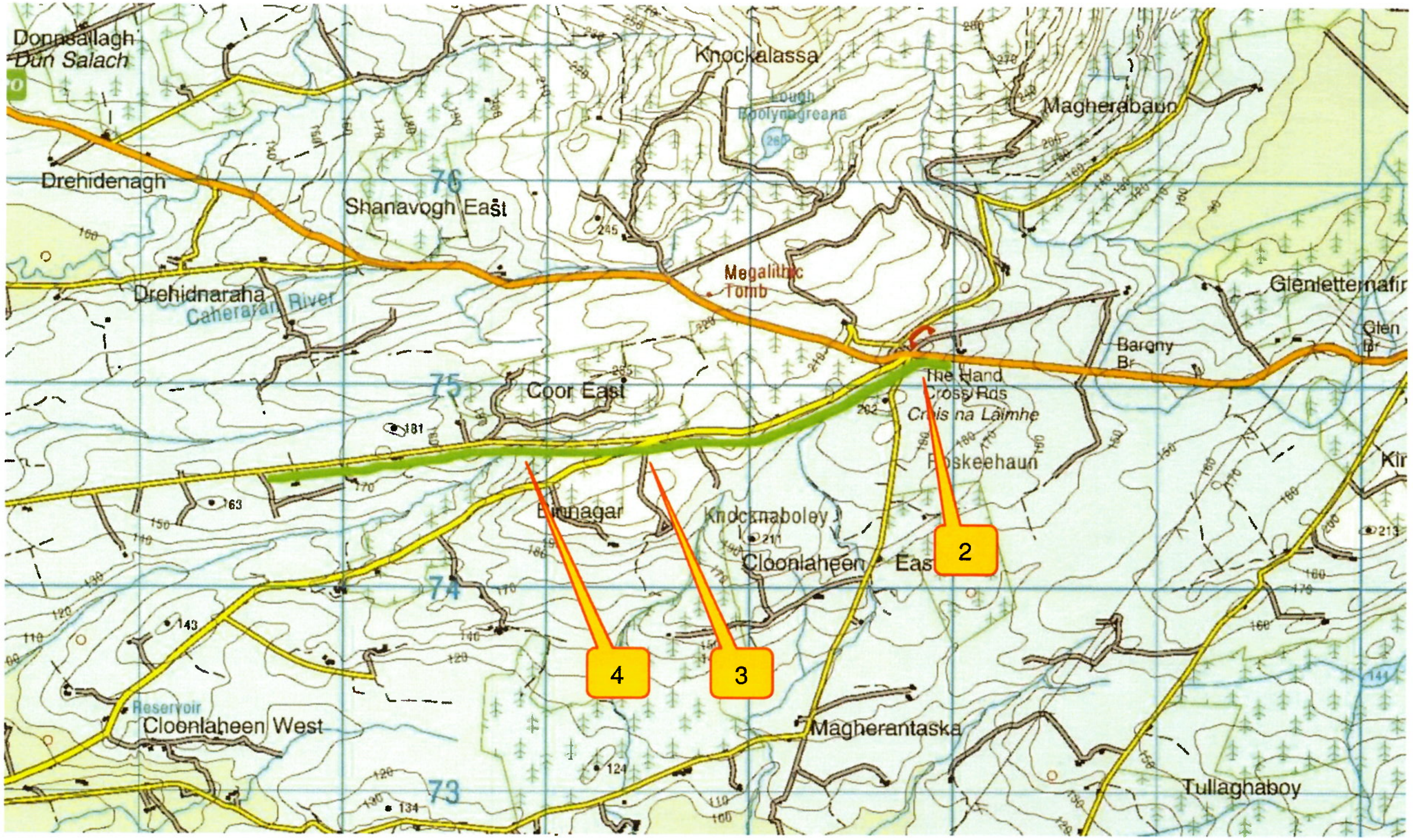
(Area 1A should be filled right up to wall).

Area 1. Inch Bridge XY 530163,675426

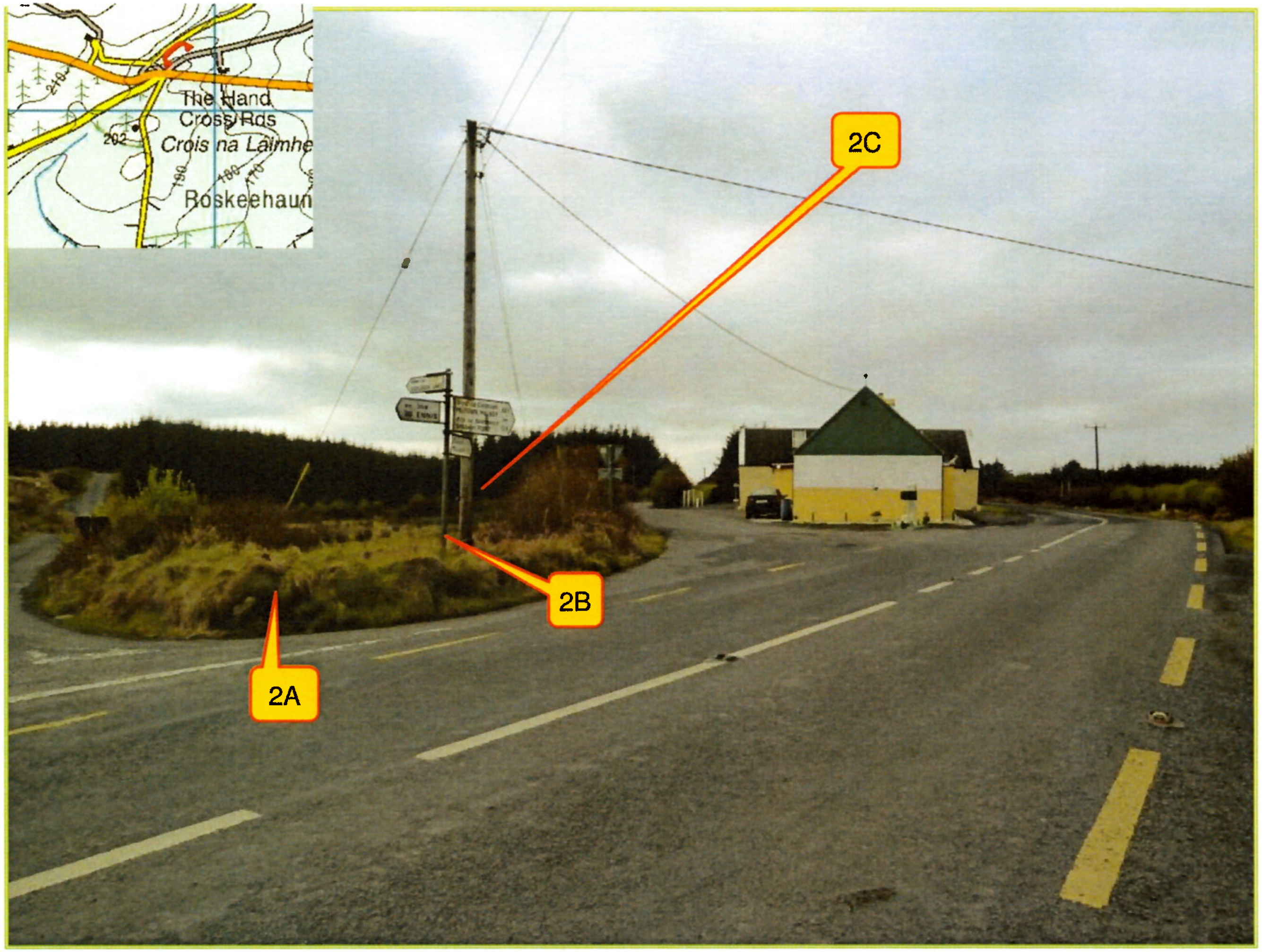
Area 1.Inch Bridge

This slide shows lead onto bridge, and while narrow it has sufficient clearance for trailers up to 32m rigid length.

Area map. Hand Cross to Coor Site Entrance. XY 514738,675200 to 511168,674565



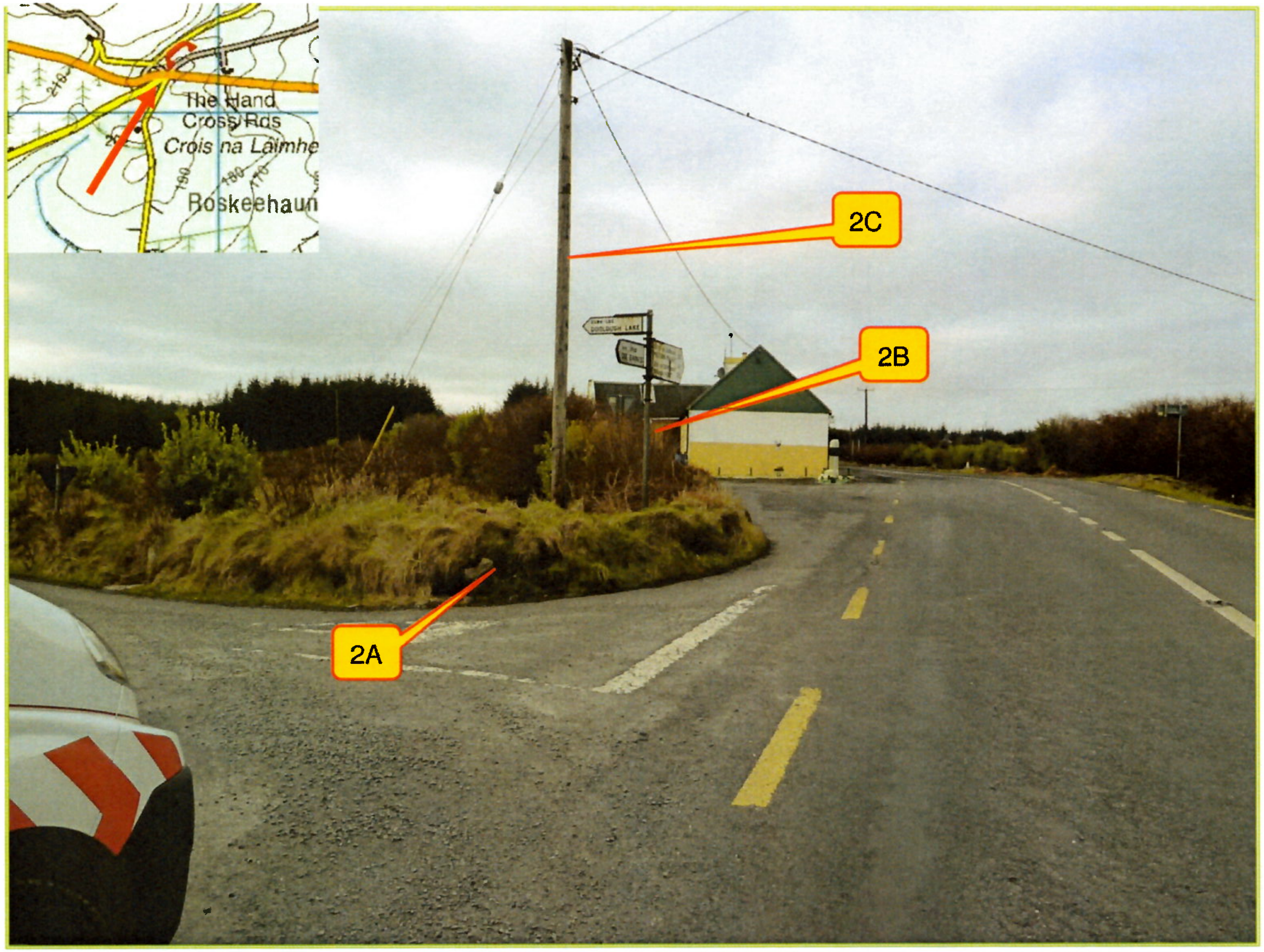
Area 2. Left turn off R474 at The Hand Cross XY 514738, 675200



Area 2.

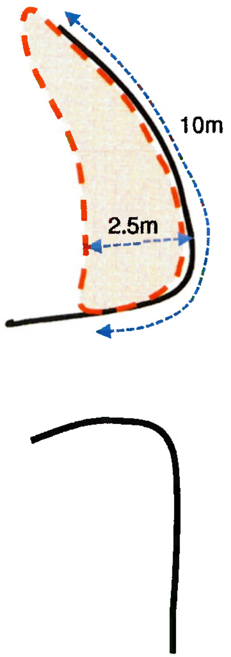
This left turn will require removal of bank (2A), re-location of road signs (2B) andESB pole (2C) as marked.

Area 2. Left turn off R474 at The Hand Cross XY 514738, 675200



Area 2.

This shows area of bank on left requiring removal



Area 3. Road to Site Entrance XY 513503, 674792

Area 3

This slide shows right turn onto site approach road. This road will require widening to 4.5m to 5m.

Current road width averages 2.9m

Area 4 Site approach road. XY 513503, 674787 to 511167, 674573

Area 3

This slide shows further along site approach road where rock is breaking surface. Road foundation should be good.

Area 4 Site approach road. XY 513503, 674787 to 511167, 674573

Area 3

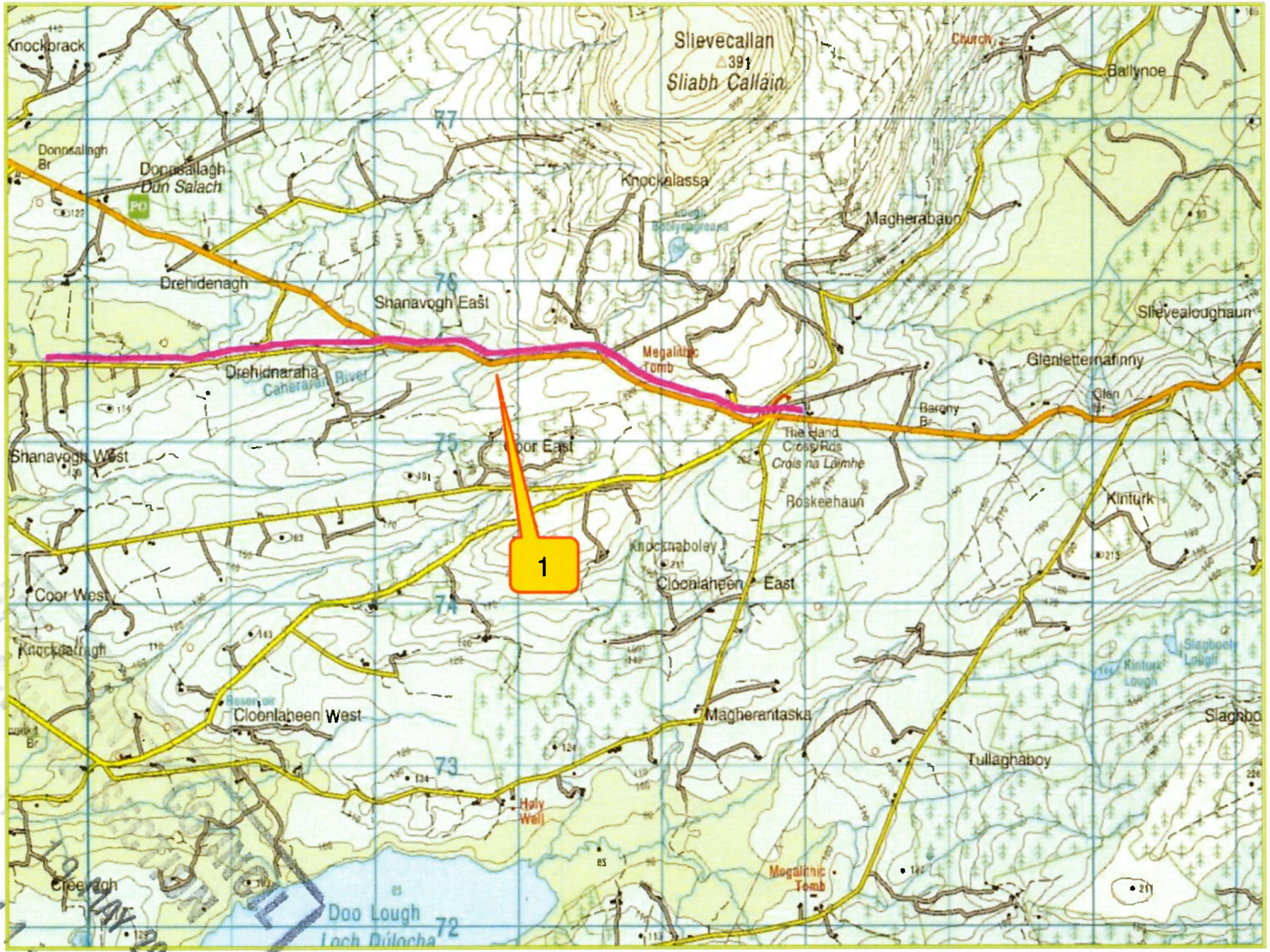
This slide shows further along site approach road with no apparent major obstacles to road widening.

Area 3. Site Entrance

Area 3

Site entrance should be widened to turbine manufacturers specification for bell mouth entrances or curves in conjunction with internal road design.

Route Option 2. Hand Cross to Shanavogh West. XY 514733, 675204 to 509650,675535



Route option #2 is based on northern entrance to site. This site approach road will also require widening to 4.5-5.0m. Due to surrounding terrain this road would be more difficult to widen.

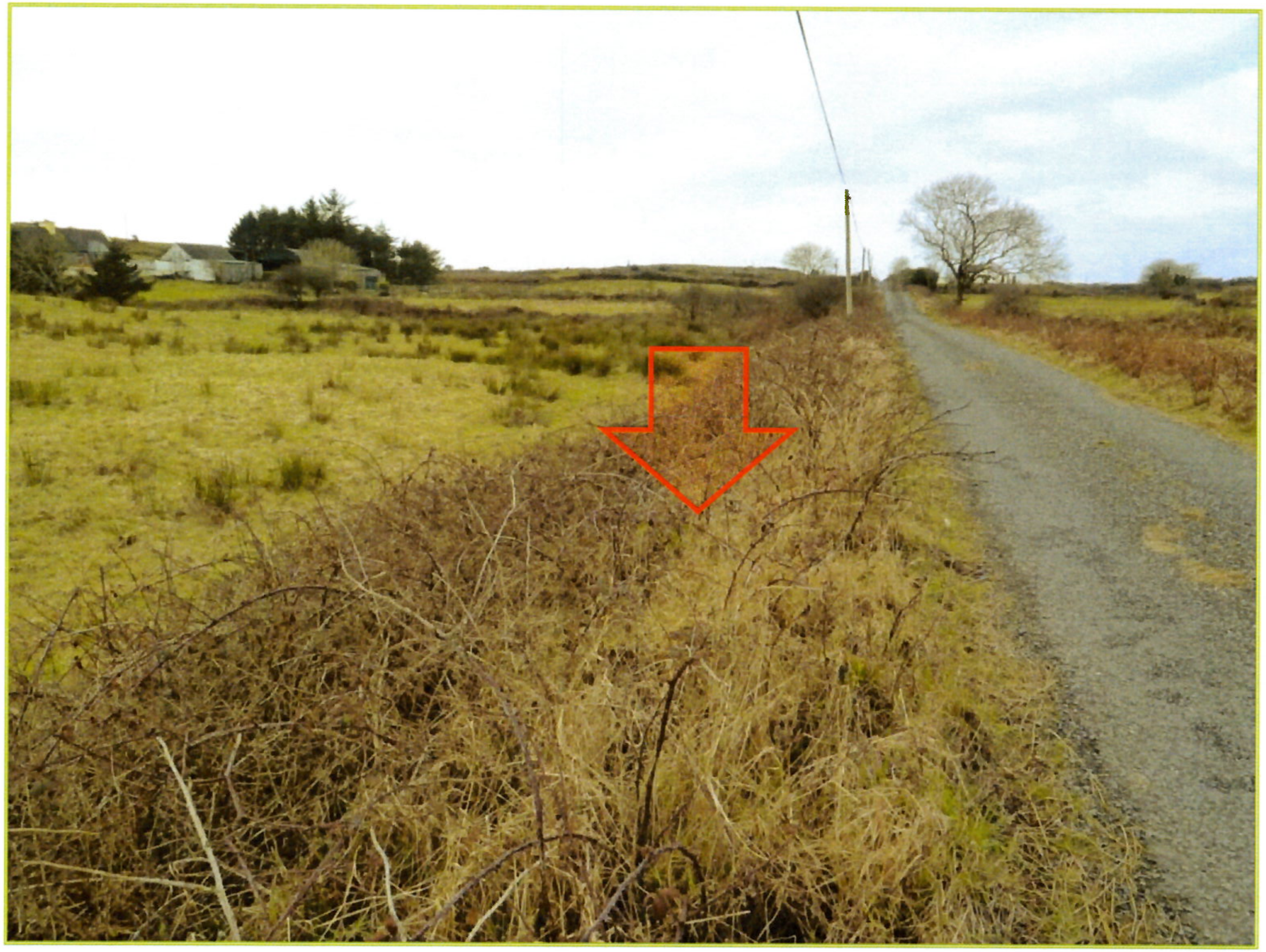
Route Option 2. Bends XY 510868, 675543

This slide shows bends that would require some re-alignment. However when road is widened and poles are re-located there is sufficient room for passage of loads.

Route Option 2. Narrow Road XY 510108, 675528

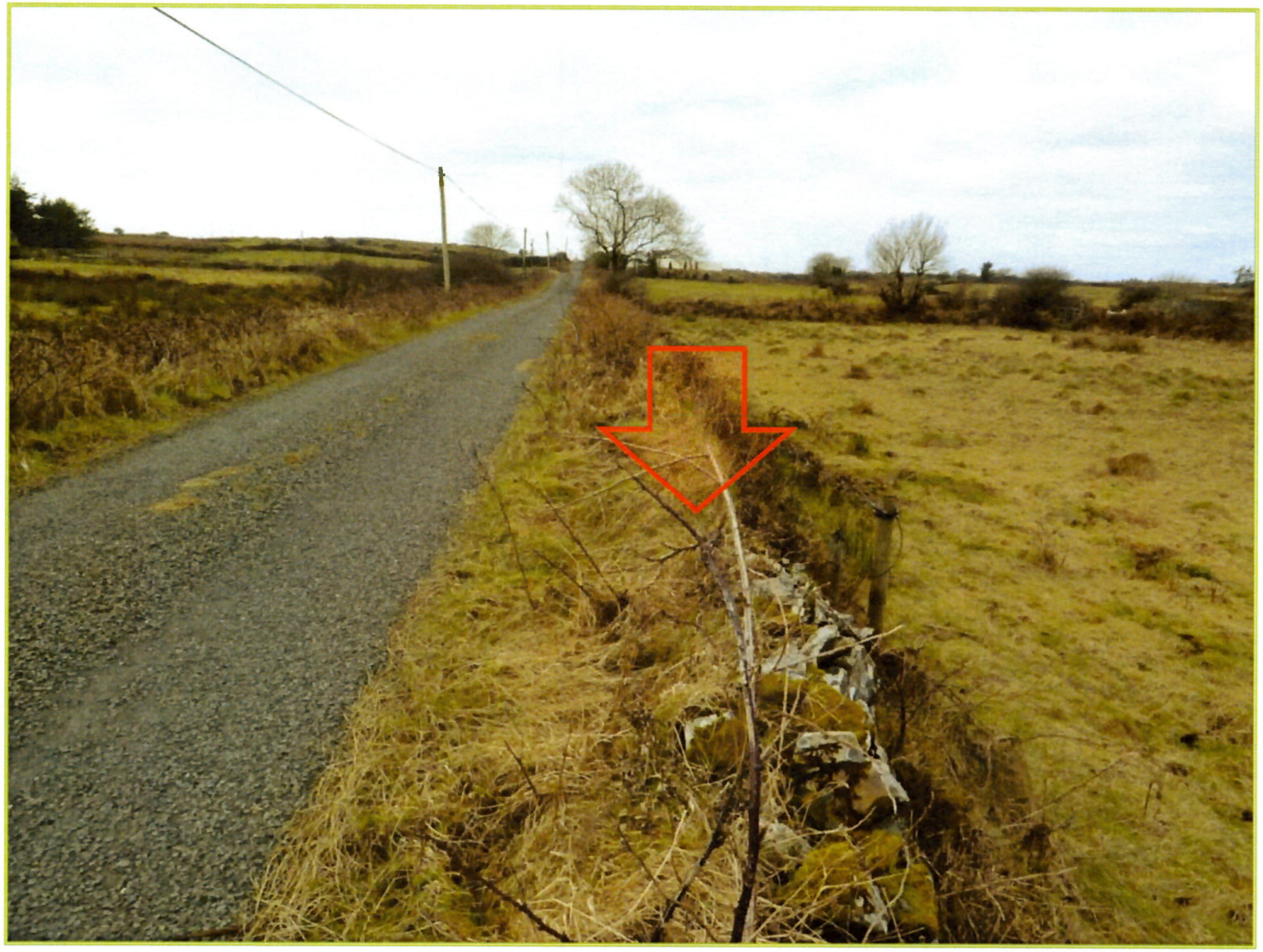
This and the next two slides show narrow road raised above surrounding terrain and would require extensive fill to widen to 5.0m.

Route Option 2. Narrow Road XY 510108, 675528



This slide shows hedge with drop off of 1.5m on left side.

Route Option 2. Narrow Road XY 510108, 675528



This slide shows hedge with drop off of 1.5m on right side.

Route Option 2.

This entrance to site would require extensive land take to widen to 5.0m

Conclusions

Route option #1 is very straightforward with no apparent private land take. Apart from road widening the only modifications required are at Hand Cross where a $10m^2$ area is required to allow for oversail.

Route option #2 is similar but requires more works to widen road.

Due to width and alignment restrictions at Inch Bridge it is important that ‘state-of-the-art’ wind turbine transport equipment is used.

There are currently no overhead cable or vegetation issues but this should be checked closer to erection date when transport equipment or haulier has been appointed

Edwin Sunderland
15/04/2011

1

APPENDIX 12

TVAS Ireland Ltd., Archaeological and Cultural Heritage Assessment Appendices

TVAS Ireland Ltd., Archaeological and Cultural Heritage Assessment Appendices Schedule

A12.1	TVAS Ireland Ltd., Letter regarding revised 2011 Coor Shanavogh wind farm site layout and its associated archaeological heritage impact.
A12.2	TVAS Ireland Ltd., Irish Grid Coordinates of archaeological features of interest.
A12.3	TVAS Ireland Ltd., RMP List
A12.4	TVAS Ireland Ltd., Archaeological and Cultural Heritage Assessment Report for the proposed 2010 Coor Shanavogh wind farm (please note figures in this report refer to the previous 2010 application layout, now withdrawn)

T V A S
I R E L A N D
L T D

Ahish, Ballinruan, Crusheen, Co. Clare
065 682 3533 • 087 969 3189 • fax 065 689 0980 • tvas@eircom.net
Archaeological Consultants

Keith Neary
INIS Environmental Consultants Ltd
Edenvale
Ennis
Co. Clare

23rd February 2011

Re: Coor Wind Farm – revised site layout and archaeological heritage impact

Dear Keith

As discussed, here follow our comments on the revised site layout of the proposed wind farm at Coor. These comments should be read in parallel with the Archaeological, Architectural and Cultural Heritage Assessment produced in 2010.

Revised site layout

The current proposed site layout is smaller than that under consideration in the 2010 assessment report, with the southern and western areas removed. The layout of the turbines and access roads has also been altered, with just six turbines included in the current proposal.

Impact of revised layout

Just one monument listed on the Record of Monuments and Places (RMP) lies within the current site boundary - CL039-015, a ringfort/rath. According to the submitted plans, although construction activity is proposed for this part of the site, it is over 300m from the ringfort/rath. In addition 'Enclosure (site of)' is marked on the modern Ordnance Survey of Ireland (OSI) 1:5000 digital mapping immediately outside the site boundary, north of Turbine T1. This potential monument is not illustrated on any historic maps, nor is there any protected monument in this location on the RMP. It is not clear why the label has been placed on the OSI current map but there is no evidence that there is an archaeological monument here.

Recommendations - archaeological monitoring and fencing

It is recommended that all groundworks associated with the construction be subject to archaeological monitoring. Particular attention should be paid to the area around Turbine T1 due to the uncertainty surrounding the 'Enclosure (site of)' nearby. Should any construction work take place within 200m of

monument RMP CL039-015, the monument should be protected with secure fencing to prevent accidental damage.

Archaeological excavation

Should any archaeological features or material be uncovered during the course of archaeological monitoring or any phase of the construction works, works will cease immediately, and the National Monuments Section of the Department of Environment, Heritage and Local Government should be informed. Time must be allowed for a suitably qualified archaeologist(s) to inspect and assess any such material. If it is established that archaeologically significant material is present full archaeological investigation and recording will be required. Archaeological excavation is the preservation by record of archaeological remains. Adequate financial and logistical provision should be made for any such archaeological excavation, related post-excavation, testing and/or conservation work and for the publication of the results.

Please note that the recommendations given here are subject to the approval of the National Monuments Section of the Department of Environment, Heritage and Local Government.

Yours sincerely

Milica Rajic

Coor Shanavogh grid coordinates of local Archaeological features of interest

10899, 15522	graveyard
10899, 17522	Holy well
10914, 17532	Ringfort
10738, 17494	Ringfort
10833, 17465	Ringfort
10906, 17523	Holy well
10930, 17448	Ringfort
10939, 17414	Ringfort
10968, 17475	Ringfort
10972, 17391	Ringfort
11021, 17307	Ringfort
11054, 17329	Ringfort
11071, 17377	Ringfort

SMRS	NAT_GRID_E	NAT_GRID_N	TLAND_NAME	CLASS	CLASSDESC
CL031-026001-	108990	175210	KILLERNAN	GRAVEYARD	Graveyard
CL031-026002-	108983	175229	KILLERNAN	RITUAL SITE - HOLY WELL	Ritual Site - Holy Well
CL031-027----	109131	175313	KILLERNAN	RINGFORT - RATH	Ringfort - Rath
CL031-028----	109322	176336	DOONSALLAGH WEST	RINGFORT - CASHEL	Ringfort - Cashel
CL031-029----	109661	176488	DOONSALLAGH WEST	RINGFORT - RATH	Ringfort - Rath
CL031-030----	109727	175998	KILLERNAN	HUT SITE	Hut Site
CL031-031----	110523	175641	KILLERNAN	RINGFORT - RATH	Ringfort - Rath
CL031-045----	109632	176306	DOONSALLAGH WEST	MOUND	Mound
CL039-008----	108226	174872	KILLERNAN	RINGFORT - RATH	Ringfort - Rath
CL039-009----	108598	175055	KILLERNAN	RINGFORT - RATH	Ringfort - Rath
CL039-010001-	108597	173505	DOONOGAN	REDUNDANT RECORD	Redundant Record
CL039-010002-	108595	173505	DOONOGAN	CASTLE - TOWER HOUSE	Castle - Tower House
CL039-011----	108835	174589	SHANAVOGH WEST	RINGFORT - RATH	Ringfort - Rath
CL039-012----	109072	175170	KILLERNAN	RITUAL SITE - HOLY WELL	Ritual Site - Holy Well
CL039-013----	109307	174417	COOR WEST	RINGFORT - RATH	Ringfort - Rath
CL039-014----	109399	174081	COOR WEST	RINGFORT - RATH	Ringfort - Rath
CL039-015----	109688	174685	SHANAVOGH WEST	RINGFORT - RATH	Ringfort - Rath
CL039-016----	109721	173851	COOR WEST	RINGFORT - RATH	Ringfort - Rath
CL039-017----	110203	173027	CLOONLAHEEN WEST	RINGFORT - RATH	Ringfort - Rath
CL039-018----	110540	173238	CLOONLAHEEN WEST	RINGFORT - RATH	Ringfort - Rath
CL039-019----	110712	173723	CLOONLAHEEN WEST	RINGFORT - RATH	Ringfort - Rath
CL039-020----	111845	173548	CLOONLAHEEN MIDDLE	REDUNDANT RECORD	Redundant Record
CL039-045----	109888	172373	CREEVAGH (IBRICKAN BY.)	REDUNDANT RECORD	Redundant Record

Wind Farm Project, Shanavogh/Coor
Ennis, Co. Clare

Archaeological, Architectural and Cultural Heritage Assessment component of Environmental Impact Statement

for

Eamonn Vaughan Consulting Engineering,
Knocknagore, Kilkee, Co. Clare

J10/17

Milica Rajic

TVAS Ireland Ltd

17th June 2010

(NGR 09527 74901)
(NGR 09989 74145)
(NGR 11025 73102)

Table of Contents

List of Appendices

List of Figures

List of Plates

Project Team

Name of the project: Wind Farm Project, Shanavogh/Coor, Ennis, Co Clare
Report author: Milica Rajic

Report signed off by

Kate Taylor

Executive Summary

At the request of Eamonn Vaughan Consulting Engineering, Knocknagore, Kilkee, Co. Clare, TVAS Ireland Ltd have undertaken the Environmental Impact Statement for the proposed wind farm project site at the townlands of Shanavogh West, Coor West and Cloonlaheen West in Co. Clare.

The proposed site consists of two sections. The northern section covers the area of 231 acres (93.48Ha) and is located in the townland of Shanavogh West (NGR 09527 74901) in the civil parish of Kilmurry-Ibrickan and the Barony of Ibrickan, approximately 4.5km north-east of the village of Mullagh, Co. Clare. The southern area stretches over 69 acres (28Ha) and comprises the townlands of Coor West (NGR 09989 74145) and Cloonlaheen West (NGR 11025 73102) in the civil parish of Kilmurry-Ibrickan and the Barony of Ibrickan, approximately 4km north-east of the village of Mullagh, Co. Clare.

The following report comprises the results of an intensive desktop survey of the area of the proposed development and the surrounding region.

There is limited information regarding the nature of the proposed development available at present, particularly regarding the level of ground disturbance, the depth of foundations, the service impact and the site works that will be involved.

However, the available planning drawing of the proposed development as provided by the Client indicates that one of the access roads would be located in the immediate proximity of a ringfort (SMR, CL039-015---) and that its construction may entail removal of a part, or all, of the monument. Similarly, one of the wind turbines (T9) appears to be located within 62.5m of another ringfort (SMR, CL039-011---) giving rise to concern that the level of ground disturbance may affect this monument as well.

While the proposed development does not appear to impact on any other known sites or monuments, there is a possibility that previously unrecorded archaeological material or finds will be encountered during ground disturbance associated with this development.

It is recommended that a consultant archaeologist be appointed to the project design team to advise on the archaeological implications of the development. Full details of the nature of ground disturbance associated with the proposed development should be made available to the project's consultant archaeologist. The consultant archaeologist should also advise the project design team on the best practice for carrying out any archaeological mitigation at the proposed development site.

1. Introduction

1.1. Site Location

The proposed site consists of two sections (see Figure 1). The northern section covers the area of 231 acres (93.48Ha) and is located in the townland of Shanavogh West (NGR 09527 74901) in the civil parish of Kilmurry-Ibrickan and the Barony of Ibrickan, approximately 4.5km north-east of the village of Mullagh, Co. Clare. The southern area stretches over 69 acres (28Ha) and comprises the townlands of Coor West (NGR 09989 74145) and Cloonlaheen West (NGR 11025 73102) in the civil parish of Kilmurry-Ibrickan and the Barony of Ibrickan, approximately 4km north-east of the village of Mullagh, Co. Clare.

The site of the proposed development is situated in the barony of Ibrickan which lies on the coast of Co. Clare in the province of Munster. The barony of Ibrickan is bounded on the north by Corcomroe; on the east by Inchiquin, Islands, and Clonderalaw; on the south, by Moyarta; and on the west, by the Atlantic. It extends on an area of over 57,028 acres (23,078Ha), with a greatest length of fifteen miles (24km) and a greatest breadth of eight miles (13km) S-SW and N-NE respectively. The barony is constituted by a part of the parish of Kilmacduane and the whole of the parishes of Kilfarboy, Killard, and Kilmurry. Ibrickan is partly in the Poor-law union of Ennistymon, and partly in that of Kilrush.

The townlands of Shanavogh West, Coor West and Cloonlaheen West in which the proposed development is located are situated in the civil parish of Kilmurry-Ibrickan which, extending east to west from the rocky Atlantic coast to the slopes of Slieve Callan, is mostly a low-hill countryside. The parish extends from Clohaninchy on the western seaboard to the Barony Bridge about three-quarters of a mile to the east of "The Hand". The river at the Barony Bridge is the boundary between the parish of Ibrickan and the Connolly parish area, an approximate distance of eleven miles. Its greatest breadth is from the shore of Caherush to the boundary between the townlands of Boulanavode (Kilmurry) and Cahermurphy (Kilmihil), a distance of five miles. Its area is approximately 25,857 acres (10,343Ha), of which 331 acres (132Ha) are in Lough Doolough. There are 40 acres (16Ha) in small lakes and 160 acres (64Ha) in sea grit islands. The elevations of the parish include the hills of Knocknaboula (701ft/214m) and Gortnaheera (700ft/213m). Eastwards from Doongan there is an ascent on all roads towards The Hand, the junction of three roads opening westwards into the northern, middle and southern areas of the Coor portion of the parish. Cloonlaheen and Shanavogh townlands are part of the Callan slope, though indeed no part of Slieve Callan lies within the parish boundary (Ryan 1969, 3).

The parish mostly comprises arable dairyland with mud subsoil. However, abundant rushes and similar swampy vegetation contribute to a considerable loss in pasturage. The bogs are located near the Callan slope at Cloonlaheen. Adjacent to these bogs there are considerable areas of reclaimed bogland which is suitable for tillage (Ryan 1969, 4).

1.2. Characteristics of the Proposed Development

The proposed development is a wind farm, a plan of which is shown on Figure 2. The development comprises two sections and includes the construction of nine wind turbines, six access roads and a substation in its northern section and five wind turbines and two access roads in its southern extent.

There is limited information regarding the nature of the proposed development available at present, particularly regarding the level of ground disturbance, the depth of foundations, the service impact and the site works that will be involved.

2. Methodology

2.1. Introduction

For the purpose of setting the proposed development within its wider archaeological and cultural heritage landscape, and to assess the archaeological potential of the site, a comprehensive paper survey of available archaeological, historical and cartographic sources was undertaken. A buffer of 500m from the edges of the site was applied around the development in order to assess the impact upon each of the known archaeological sites in the area. A survey of the historical and cultural heritage of the study area, which is comprised of the townlands of Shanavogh West, Killernan, Coor East, Coor West and Cloonlaheen West, was also undertaken. In addition to this, the history and archaeology of the greater surrounding region has been considered. In addition a field survey was undertaken of the area of the proposed development.

2.2. Desktop Study

2.2.1. Recorded Archaeological Monuments and Places

The *Record of Monuments and Places* (RMP) is compiled by the Archaeological Survey of Ireland (ASI) and comprises lists and maps of monuments known to the National Monuments Service. Monuments recorded in the Record of Monuments and Places are protected under the National Monuments Acts 1930 to 2004. The information contained within the RMP is derived from the earlier non-statutory *Sites and Monuments Record* (SMR); some entries, however, were not transferred to the statutory record, as they do not fall within the strict criteria for inclusion within the RMP; some, for instance, could not be located with sufficient accuracy. Such sites however remain part of the SMR. The record is a dynamic one and is updated so as to take account of on-going research.

There are fifteen recorded monuments and sites within the study area, defined by a 500m buffer (see Appendix 1). Of these fifteen features, three are located in the northern extent of the proposed development; one is situated in the southern section while the remaining eleven recorded monuments and sites are found within the buffer zone.

2.2.2. List of Monuments in State Ownership or Guardianship

National monuments may be acquired by the Minister whether by agreement or by compulsory order. The State or Local Authority may assume guardianship of any national monument (other than dwellings). The owners of national monuments (other than dwellings) may also appoint the Minister of the Local Authority as guardian of that monument if the State or Local Authority agrees. Once the site is in the ownership or guardianship of the State it may not be interfered with without the written consent of the Minister.

There are no National Monuments located within the study area.

2.2.3. List of Preservation Orders

Sites deemed to be in danger of damage or destruction can be allocated Preservation Orders under the 1930 National Monuments Act. Preservation Orders make any interference to the site illegal.

Temporary Preservation Orders can be attached under the 1954 Act. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation surrounding the site must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders by the written consent, and at the discretion of, the Minister.

There are no monuments with Preservation Orders located within the study area.

2.2.4. Recorded Archaeological Finds

The National Museum of Ireland's topographical files are a national archive of all known archaeological finds from Ireland. They relate primarily to artefacts but also include references to monuments and contain a unique archive of records of previous excavations. The topographical files were consulted to determine if any archaeological artefacts had been recorded from the area. No recorded finds were noted within the study area from a search of the published catalogues (Rattigan 2005).

2.2.5. Cartographic Sources

Reference to cartographic sources is important in tracing land use development within the area as well as providing important topographical information on sites and areas of archaeological potential. Primary cartographic sources consulted consisted of the Ordnance Survey 6" maps, first and later editions (Clare County Library Local Studies Centre: Clare, Sheets 31 and 39).

2.2.6. Previous Excavations

The excavation bulletin website (www.excavations.ie) was consulted to identify previous excavations that may have been carried out within the study area. This database contains summary accounts of excavations carried out in Ireland from 1970 to 2004. The available *Excavations* publications were also consulted. One published excavation has been undertaken in the area (see Appendix 2).

2.2.7. Historical research

Historical research began with a search of the British and Irish Archaeological Bibliography (www.biab.ac.uk) and the Royal Historical Society Bibliography (www.rhs.ac.uk/bibl/bibwel.asp). A number of local historical publications were consulted in addition to Lewis's *A Topographical Dictionary of Ireland* (1837). Other sources consulted include the Irish Tourist Association survey of the parish (ITA 1942-3), Joyce's study of place names (1995), *The Parliamentary Gazetteer of Ireland* (1845) and Westropp's study of antiquities in the area (1904-5).

2.3. Field Assessment

In addition to the desk-top research undertaken, and leading on from the results of that research, a field survey of the area of the proposed development was undertaken. The field survey was undertaken on Tuesday, 18th May 2010 under adverse weather conditions. The field inspection relates to the physical environment, the cultural landscape and the archaeological potential of the area of the proposed development. The primary purpose of the field assessment is the identification of potential low-visibility or previously unrecorded archaeological and/or historical features and areas of archaeological potential that may be impacted upon during development. Field inspection also aims to confirm the extent and location of recorded monuments, structures and features and considers the possible impacts of the proposed development on such. The field survey assesses the present topography and land-use and addresses the landscape potential of the area by examining the recorded human activity in the past in relation to a particular landscape and considering the possible interactions between existing monuments or sites.

2.4. Limitations of the Study

As noted above, this assessment included a comprehensive paper survey of archaeological, historical and cartographic sources available for the study area. Furthermore, as detailed designs are not currently available, it was not possible to fully assess the possible extent of any potential impacts.

3. Archaeological and Historical Background

There is no available written evidence of the prehistoric activity within the study area. Although, the Recorded Monuments and Sites define one of the relevant sites as a hut site (CL031-030---), "a structure usually discernible as a low, stone foundation or earthen bank enclosing a circular, oval or sub-rectangular area, generally less then 5m in maximum dimension. The remains are generally too insubstantial to classify as a house but the majority probably functioned as dwellings". These sites may date to any period from prehistory (c. 4000 BC – AD 400) to the medieval period (AD 400 - 1500). As can the ringforts –raths examined within the study area of the proposed development.

The barony of Ibrickan was in the pre Anglo-Norman period, in all probability, a separate Triocha Cet. A "Triocha Cet (triuca ceud) was originally the area from which 30 hundred fighting men might be drawn". By the 7th or 8th century the military significance of the Triuca Ceud changed to political or social one, i.e. it became more of a unit of topography in the modern sense. When the Normans came to Ireland in the later 12th century and royal grants for Irish land were made they based on the existing Triuca Ceud to a large extent (Ryan 1969, 3).

Ibrickan or Ui Bracain formed a part of the country of the Corca Baiscin until the end of the 12th century, when the Leinster family of MacGorman settled in it under the auspices of O'Brien. The MacGormans held the land in Carlow, under the tribe name of Ui Bairrché, being descendants of Daire Barrach, son of Cathaoir More, monarch of Ireland in the 2nd century. They were driven out by Walter de Riddlesford, who became the lord of Carlow around that time. The first of the family to come to Co. Clare was Murtagh, the son of Donogh MacGorman. A poem by Maoelin Oge MacBrody recounts how after the MacGormans had been banished from their original possessions, they came to the country of the O'Briens and settled in the district of Ibrickan. MacBrody goes on to say that the MacGormans had been in Ibrickan for four hundred years, nourishing poets and feeding the poor. It appears that they were what in Irish legal phrase was called *Brugh Fir,* i.e. men who were obliged by their tenure to keep open houses of general hospitality for wayfarers:

> "Under the distinguished race of fair O'Briens
> This tribe of ever living fame have been
> During a period of four hundred years
> Supporting poets, and feeding the poor
> Over this fair-glebed plain of cooling breezes"
> (O'Donovan & Curry 1997, 279).

James Frost in his *History and Topography of the County of Clare* (1893) lists the references to the members of the family in the annals and records of the country:

> "In 1413, Cu-abha MacGorman died. In 1484, died Donald MacGorman of Ibrickan, one of O'Brien's servants of trust, who kept a house of general hospitality, and was the richest man in Ireland in live stock. In 1580, Melaghlin MacGorman died, and his estates of Drumellihy and Cahermurogh (Cahermurphy, parish of Kilmihil) descended to his son and heir Dermot. Mahone MacGorman, son of Dun, was the proprietor of

> Cahermurogh and other lands adjoining in 1594. [...] In 1641, Daniel and Cahir MacGorman were proprietors of Drumellihy, while Cahermurphy belonged to Daniel MacGorman the elder, Daniel MacGorman the younger, Conor MacGorman, Thomas MacGorman, Teige MacGorman, Manchan MacGorman, and Scanlan MacGorman."

Chevalier O'Gorman was the first of the family to drop the Mac and adopt the O instead. He compiled several works on genealogy and Irish history.

The Kilmurry-Ibrickan parish was one of the territories that were granted to Donough O'Brien, 4th Earl of Thomond in 1585 by Sir John Perrot, as part of the Composition of Connaught scheme. The land was surveyed barony by barony, an agreed annual rent of 10 shillings payable to the crown per quarter of inhabited land was establish while the Gaelic land customs and inheritances were abolished (in Lynch & Nugent 2008, 294).

By 1660, Co. Clare had finally accepted the New English administrative system, a process initiated by Henry VIII in 1534 (in Lynch & Nugent 2008, 79). In August 1649, Cromwell arrived in Ireland only to extend his campaign to Co. Clare in 1651. The surviving records of the English army led by Cromwell's deputy Henry Ireton state that almost a third of the county's population perished either by sword, famine or disease from 1650 to 1653 and that only 40 townlands, mostly in the barony of Bunratty, were inhabited (Lynch & Nugent 2008, 80). In 1660, the barony of Ibrickan had 64% of townlands uninhabited.

In the 19th century, the parish of Kilmurry-Ibrickan became part of the landed estate of Colonel George Wyndham, 1st Baron Leconfield (1787 – 1869). The Wyndham estate comprised one twentieth of the entire land area of the county which together with the lands in counties Limerick and Tipperary, Yorkshire, West Sussex and Cumberland made Col. Wyndham one of "great landowners of great Britain and Ireland" (Lynch & Nugent 2008, 291).

The lands of the Clare estate were situated in seven baronies, 33 civil parishes, 108 whole townlands and 19 parts of townlands with the mid-western barony of Ibrickan comprising by far the largest portion of the estate – 28%. The civil parish of Kilmurry-Ibrickan had the largest single portion of the estate, comprising approximately 17% of the estate or 7,696 acres (in Lynch & Nugent 2008, 292).

The barony of Ibrickan also had by far the largest population of the estate, and together with the second most populated barony of Clonderlaw made up half of the total population of the estate. Ibrickan also boasted second highest pre-famine population density of 42 persons per 100 acres (in Lynch & Nugent 2008:293).

In 1838, Col. Wyndham initiated a programme of assisted emigration from his Irish estates. Approximately 1,800 people were removed to Canada and Australia between 1838 and the Great Famine (in Lynch & Nugent 2008, 303). This scheme sought to relieve poverty associated with the "superabundant population", to increase the productive capacity of the land, and to reduce Col. Wyndham's financial liabilities under the Irish Poor Law (in Lynch & Nugent 2008, 305).

In addition, evictions were regular occurrence on the Wyndham estate. In the period from 1838 to 1852, up to 3,800 people were evicted (in Lynch & Nugent 2008, 329). However, in 1849 the *Illustrated London News* sent a reporter and a sketch artist to Clare to look into the infamous level of evictions and poverty in the Kilrush poor law union. Their account included some of the best known

images of the Famine – destitution, hunger, disease, mass evictions and death. However, the reports concerning the lands owed by Col. Wyndham in the parishes of Kilmurry-Ibrickan and Kilfarboy paint a strikingly different picture:

> "The face of the country appeared to have changed. It was like passing from the Catholic to the Protestant cantons of Switzerland, or rather like a dream. At once I came on neat white-washed houses and tidy gardens. [...] I had entered the domain of Colonel Windham [sic], who is not tired of his fellow-creatures and does not seek to exterminate them. Not a roofless house did I see here. [...] The whole face of the country us altered, and all the people you meet, whether men, women, or children, seem cheerful, as if they had planet of the means of subsistence" (in Lynch & Nugent 2008, 318).

3.1. Results of Field Assessment

The field assessment was undertaken on Tuesday, 18th May 2010 under adverse weather conditions. Out of sixteen recorded monuments and sites located within the study area (see Appendix 1), seven were surveyed: four enclosures/ringforts, one graveyard and two holy wells (see Plates 1-7). The surveying of the remaining nine monuments and sites was not possible due to the lack of access. All recorded sites and monument lie on low hills, predominantly in field used as pastures.

Plate 1: Ringfort (CL039-011---), Shanavogh West, looking NW

Plate 2: Ringfort (CL039-011---), entrance, Shanavogh West, looking W

Plate 3: Ringfort (CL039-011---), outer bank, Shanavogh West, looking SW

Plate 4: Ringfort (CL039-017---), Cloonlaheen West, looking SW

Plate 5: Ringfort (CL039-018---), Cloonlaheen West, looking NE

Plate 6: Graveyard (CL039-02601-), Killernan, looking W

Plate 7 Holy well (CL039-02602-), Killernan, looking W

The field assessment showed that one of the assessed ringforts (SMR, CL039-011---) is situated within 62.5m of the proposed location of wind turbine 9 (T9) and that it is possibile that ground disturbance associated with the erection of the wind turbine may affect this monument.

Although not surveyed, the planning drawing of the proposed development shows another ringfort (SMR, CL039-015---) as being located in close proximity to an access road. The construction of this road may disturb the monument, in part or in whole.

The other surveyed and non-surveyed monuments and sites will not be impacted by the proposed wind farm. However, there is a possibility that previously unrecorded archaeological material or finds may be encountered during ground disturbance associated with this development.

4. Archaeological and Architectural Significance of the Site

4.1. Discussion

Due to the relatively high density of the Recorded Monuments and Sites within the study area and its vicinity, the site of the proposed development should be recognised as a site of archaeological potential.

5. Recommended Avoidance, Remedial or Reductive Measures

5.1. Introduction

As noted above, the proposed development would impact one of the Recorded Monuments directly (CL039-015---) and one indirectly (CL039-011---). In addition to this, there is a possibility that previously unrecorded material or finds will be encountered during ground disturbance associated with this development.

In order to mitigate against the potential impact that the proposed development could have on the surviving archaeological, architectural and cultural heritage, the following measures should be considered:

5.1.1. Avoidance

The first option for mitigation is the avoidance of known or suspected archaeological sites, monuments and features by redesign of the development. We recommend that the access road directly impacting on the ringfort (CL039-015---) be relocated. Upon the submission of the new planning drawing, the impact of the proposed development will be re-assessed.

5.1.2. Archaeological monitoring

We recommend that archaeological monitoring of construction works in the proposed development be undertaken.

5.1.3. Archaeological excavation

Should any archaeological features or material be uncovered during the course of archaeological monitoring or any phase of the construction works, works will cease immediately, and the National Monuments Section of the Department of Environment, Heritage and Local Government should be informed. Time must be allowed for a suitably qualified archaeologist(s) to inspect and assess any

such material. If it is established that archaeologically significant material is present full archaeological excavation and recording will be required. Archaeological excavation is the preservation by record of archaeological remains. Adequate financial and logistical provision should be made for any such archaeological excavation, related post excavation, testing and/or conservation work and for publication of the results.

Please note that the recommendations given here are subject to the approval of The National Monuments Section of the Department of Environment, Heritage and Local Government.

References

Benett, I (ed.), 2004, *Excavation Bulletin: Excavations 2002. Summary Accounts of Archaeological Excavations in Ireland*, Wordwell, Bray

Frost, J, 1893, *The History and Topography of the County of Clare*, Sealy, Bryers & Walker, Dublin

I.T.A. Topographical and General Survey: parish of Kilmurry-Ibrickane 1942-3, facsimile of a manuscript, Clare County Library Local Studies Centre

Joyce, P W, 1995, *The Origin and History of Irish Names of Places*, in 3 volumes, De Búrca, Dublin, fascimile of the original edition published in 1869

Lewis, S, 1837, *A Topographical Dictionary of Ireland*, S Lewis, Dublin

Lynch, M & Nugent, P, 2008, *Clare: History and Society*, Geography Publications, Dublin

O'Donovan, J & Curry, E, 1997, *The Antiquities of County Clare: Ordnance Survey Letters 1839*, Clasp Press, Ennis

Rattigan, J, 2005, 'Archaeological finds from the Baronies of Moyarta, Ibrickane and Clonderlaw', *The Other Clare* **29**, 15-21

Record of Monuments and Places: Co. Clare, 1996, National Monuments Division, the National Monuments Section of the Department of Environment, Heritage and Local Government, Dublin

Ryan, P, 1969, History of Kilmurry-Ibrickane, P Ryan, Ennis

The Parliamentary Gazetteer of Ireland, 1845, A Fullerton & Co., Dublin

Westropp, T J, 1904-5, 'Antiquities Near Miltown Malbay', *Journal of the Limerick Field Club* **2(8)**, 247-256 and **3(9)**, 1-15, Clare County Library Clare Local Studies Project, Ennis

Appendix 1: Archaeological, Architectural and Cultural Heritage Features within Study Area

The recorded archaeological sites within approximately 500m of the proposed development are listed below, all noted in the Record of Monuments and Places for Co. Clare. The monuments are listed in a standard format as follows:

RMP No. Classification
Location
Description
National Grid
Ref.
Altitude'
Inv. No.
Date of Record
Description

List of recorded archaeological monuments and places:

CL031-02601- Graveyard
Killernan
10899/17522
90'
N/A
N/A
19th – 20th century graveyard. Many of the stones are the flat horizontal limestone approximately 10cm thick. The graveyard features approximately 20 mausoleums.

CL031-02602- Ritual site - Holy well
Tobermurry, Killernan
10899/17522
90'
N/A
N/A
Holy well in an immediate proximity to the Killernan graveyard dedicated to St Ernain.

CL031-027--- Ringfort - Rath
Killernan
10914/17532
90'
N/A
N/A
Not surveyed due to the lack of access.

CL031-030--- Hut site
Killernan
10973/17600
110'

N/A
N/A
Not surveyed due to the lack of access.

CL039-008---   Ringfort - Rath
Killernan
10738/17494
70'
N/A
N/A
Not surveyed due to the lack of access.

CL039-009---   Ringfort - Rath
Killernan
10738/17494
80'
N/A
N/A
Not surveyed due to the lack of access.

CL039-011---   Ringfort - Rath
Shanavogh West

10883/17465
90'
N/A
N/A
Survives in its entirety. It has two banks overgrown with gorse. The centre of the ringfort is clear and grassy. The outer bank survives up to 1.2m in height while the inner bank measures up to 3-4m at few points. The entrance of the enclosure also survives at its eastern side. The internal diameter measures 24m in the west-east direction, while the outer is 31m. The ditch is 7m wide.

CL039-012---   Holy well
Killernan

10906/17523
70'
N/A
N/A
Holy well dedicated to Virgin Mary.

CL039-013---   Ringfort - Rath
Coor West

10930/17448
110'
N/A

N/A
Not surveyed due to the lack of access.

CL039-014--- Ringfort - Rath
Coor West

10939/17414
115’
N/A
N/A
Not surveyed due to the lack of access.

CL039-015--- Ringfort - rath
Shanavogh West

10968/17475
115’
N/A
N/A
Not surveyed due to the lack of access.

CL039-016--- Ringfort - rath
Coor West

10972/17391
110’
N/A
N/A
Not surveyed due to the lack of access.

CL039-017--- Ringfort - rath
Cloonlaheen West

11021/17307
80’
N/A
N/A
Complete enclosure survives measuring approximately 21m in diameter. Single earthen bank is visible and rises up to 1m in height. The enclosure is heavily overgrown with grass, shrubs and other low vegetation. The site does not appear to have any present use.

CL039-018--- Ringfort - rath
Cloonlaheen West
11054/17329
95’
N/A
N/A
Roughly 2/3 of the enclosure survives measuring approximately 50m in diameter. Single earthen bank

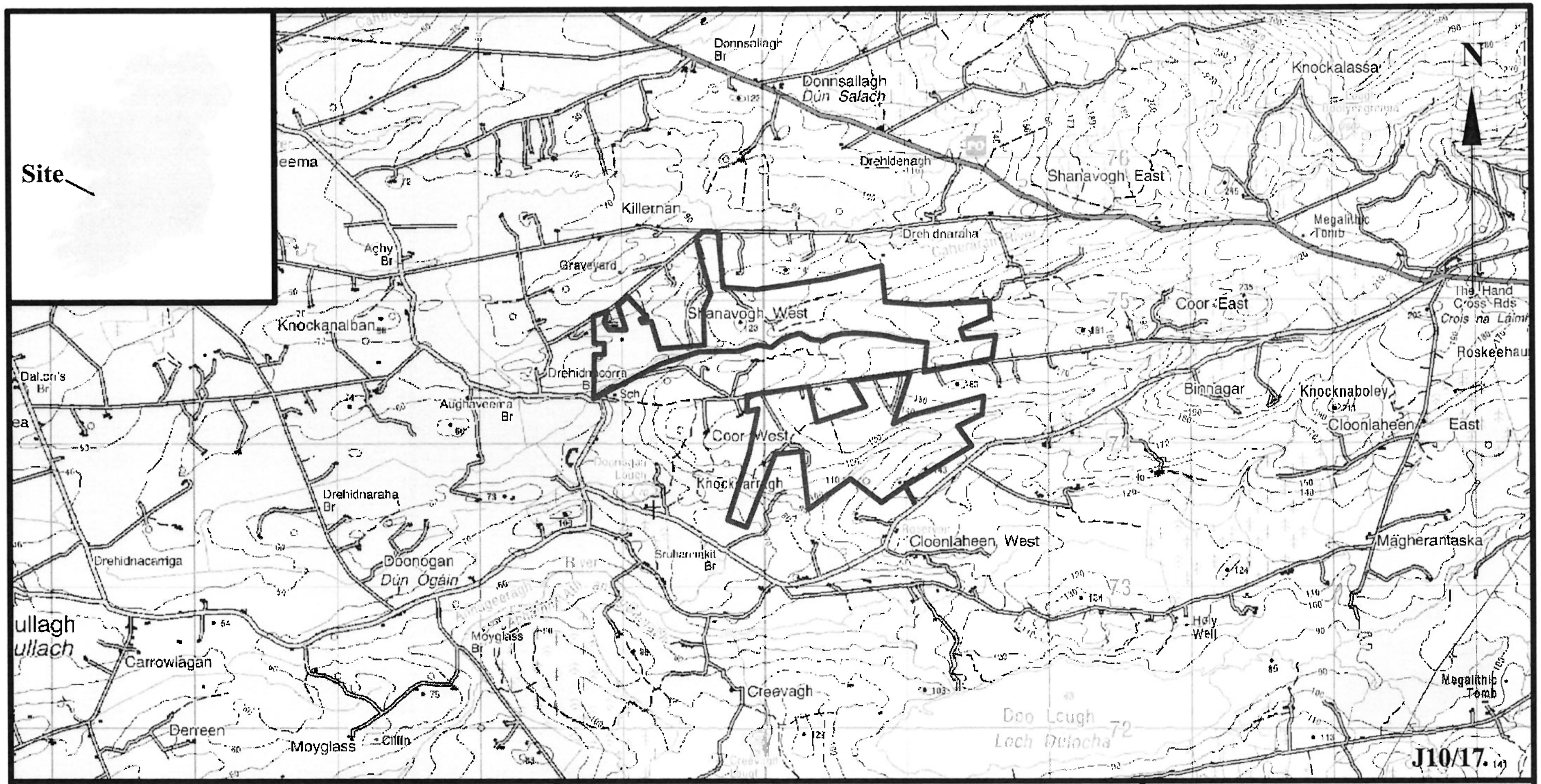
is visible from the north-easterly direction rising up to 0.5m in height. The enclosure is currently overgrown with grass and shrubs and is currently being used as a pasture.

CL039-019---		Ringfort - rath
Cloonlaheen West
11071/17377
120'
N/A
N/A
Not surveyed due to the lack of access.

Appendix 2: Previous excavations

Previously published archaeological excavations in the area from 1970 to 2005 (www.excavations.ie, Benett 2004) are summarised below.

Reference number	Excavations 2002:0204
Location	Shanavogh
Site Type	No archaeological significance
Excavation no.	02E1538 and ext.
Description	The first two phases of monitoring were carried out here. No archaeological material was recovered.
Archaeological Licensee	Christine Grant, Crossard, Killnaboy, Co. Clare



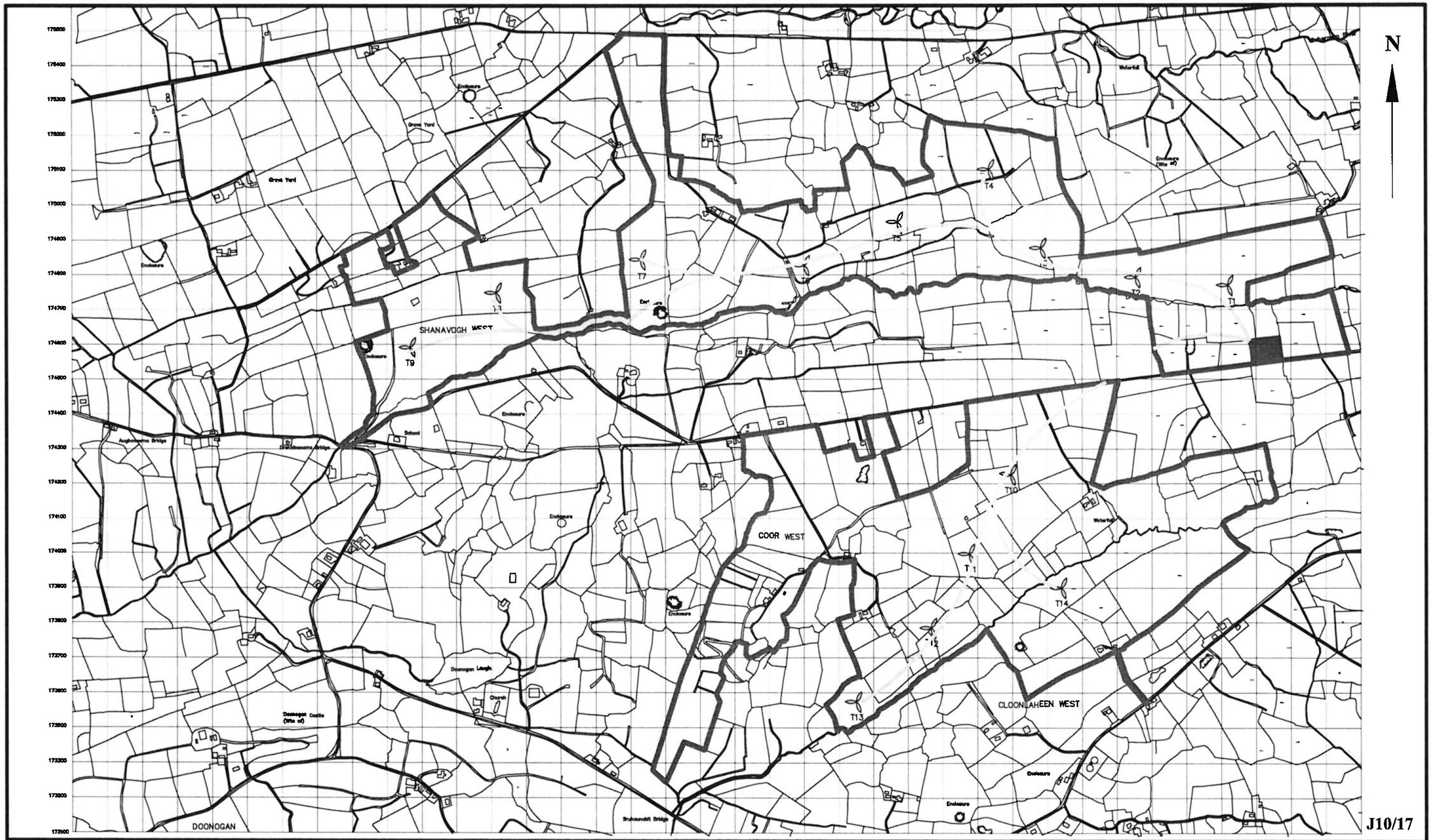
Wind Farm Project Shanavogh / Coor

Figure 1: Site location

Scale: 1:5000

Ordnance Survey Dicovery Series
Copyright OSI & Govt. of Ireland. OSI Licence: AR0049410

T V A S
I R E L A N D
L T D



J10/17

Wind Farm Project Shanavogh / Coor

Figure 2: Proposed Development

Scale: 1:1000

Based on CAD mapping supplied by client
Copyright OSI & Govt. of Ireland. OSI Licence: AR0049410

T V A S
I R E L A N D
L T D

1

APPENDIX 13

Aerial Photographic Plates of the Site & Locality

1

APPENDIX 14

Renewable Power Generation
Substation design report for proposed 13.8MW Wind Farm
at Coor, Milltown Malbay Co Clare.

Renewable Power Generation

Substation design report for proposed 13.8MW Wind Farm at Coor, Milltown Malbay Co Clare

Project No: 2121

Prepared For	INIS Environmental Consultants Ltd Edenvale Ennis County Clare Ireland
Date	**05/05/2011**

Document History		
Issue No	Description	Date
01	**Original Document Issue**	**05/05/2011**

Copy No.	Copy Issued To	**Company**
1	**Howard Williams**	**Inis Environmental**
2	**RPG (Project File)**	**RPG Ltd.**

Document Quality		Signature	**Company**
Prepared By:	**Dave McNamara**		**RPG Ltd.**
Checked By:	**Dave Eves**		**RPG Ltd.**

Table of Contents

EXECTUTIVE SUMMARY

Renewable Power Generation is an engineering consultancy providing engineering services to windfarm developers. The principles of the company have over 20 years experience in engineering, planning and project development. One of the core functions is the provision of technical, engineering and commercial and regulatory services relating to the grid connection of renewable projects.

This report details the rationale behind the design of the proposed substation at Coor Mullagh Co. Clare for the purposes of accompanying a planning application to Clare County Council for a 13.8MW windfarm.

1. Substation description

The on site substation is required to combine the electricity generated by the individual wind generators and transform the power from one voltage level to another for onward transmission to the grid. It also contains the equipment required to detect and isolate faults within the generators or site electrical equipment, control the system voltage and power flow; provide reactive power compensation; meter the electricity generation, and provide remote communications and monitoring for both the windfarm operations and the ESB.

2. Substation size and layout

Details of the substation are included in the planning drawings a copy of which has been attached to this document. It comprises a control building and compound for electrical equipment. The sub station and compound will occupy an area of 45m x 33m and will be surrounded by a 2.6m palisade fence. External to this there will be a further 45m x 17m of hardstanding and parking area which also will accommodate the biocycle unit and the 10m3 cess holding tank.

As per ESB's requirements for substation design approximately half the overall compound will be fenced exclusively for their equipment.

The construction of the substation will be to ESB standards. Layout plans and elevations are included in Drawings 2121-003. The control building will occupy an area of 19 x 6m and will comprise of four rooms: a windfarm operations room, a windfarm control room, a medium voltage switch room and an ESB control room, in addition to two toilets. One of these will be for windfarm personnel use and one for ESB personnel use. The toilets will empty to a fully sealed holding tank (maximum dimensions 10m3) which will be emptied once a year by a licensed operator. As a substation is an area where only approved persons are allowed to enter all windfarm operational and control rooms will be accessible by means of external doors. This is done from a health and safety point of view thus avoiding the requirement for entry to the substation compound area to enter these rooms. The ESB control room and toilet will only be accessible through the ESB compound which will be under the sole control of ESB. This is a design requirement from ESB.

The equipment shown on plans and elevations in drawings 2121-001 and 2121-002 within the compound is typical windfarm substation outdoor air insulated high voltage equipment. The final arrangement of equipment within the compound boundary may vary depending on chosen supplier

or ESB/Eirgrid requirements. What has been shown is considered to be an accurate representation.

As the windfarm will be operated remotely the substation will be generally unmanned. The external compound will contain the high voltage switchgear, metering and protection equipment, lighting protection, earthing, and transformers. There will also be a telecommunications aerial mounted on a pole for communication with the ESB control centre. The control building will have a dark coloured pitched slate roof and the external walls will be finished in a white plaster finish. The building will be screened by the trees on the site.

All of the site wind generators will be connected to this substation by means of underground cables which will be buried within the site adjacent to the roads. A profile section of the recommended installation method for these cables is shown in drawing 2100-004. These cables will carry the electricity produced from the turbines and will be terminated in the medium voltage switch room to switchgear for isolation and protection purposes. From there the power will be transformed to high voltage for onward transmission to the grid. The control room contains the control and protection equipment to allow the windfarm generators and equipment to operate safely and efficiently to ESB and Eirgrid standards and requirements.

The windfarm operations room serves as a storage and work area for the maintenance and on site operators which carry out scheduled maintenance and operation functions throughout the life of the windfarm.

The ESB control room serves a similar purpose to the windfarm control room but it allows the ESB protection and control equipment to only be accessed by ESB personnel.

3. Substation size

The project is sized to accommodate the 13.8MW of wind turbine capacity. An application has been made to ESB and the final grid connection route and location will be at the discretion and jurisdiction of ESB, and this will be the subject of a separate planning application.

We have designed the grid substation and transformer at 38kV which is an appropriate voltage level for the project. This is the smallest and least expensive voltage level and capacity for the grid connection of 13.8MW. A 20kV connection while less expensive and having a smaller footprint on site would not be large enough in terms of cables or overhead line capacity to accommodate a project of this size.

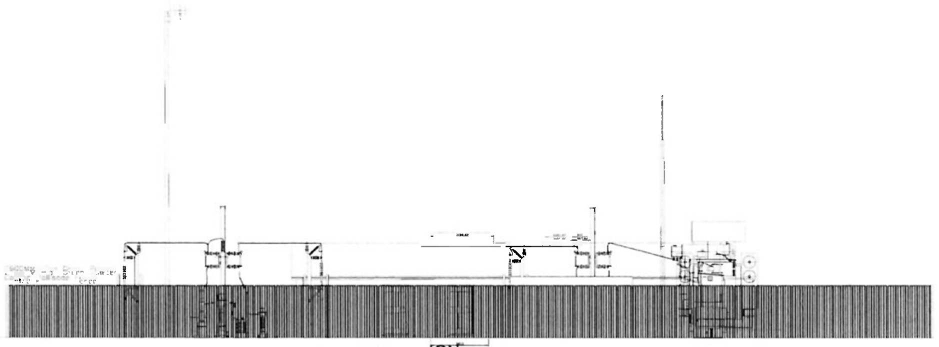
The layout chosen accommodates a looped connection to the grid. It is designed based on the latest ESB Networks contestable substation standards.

4. Potential grid connection locations

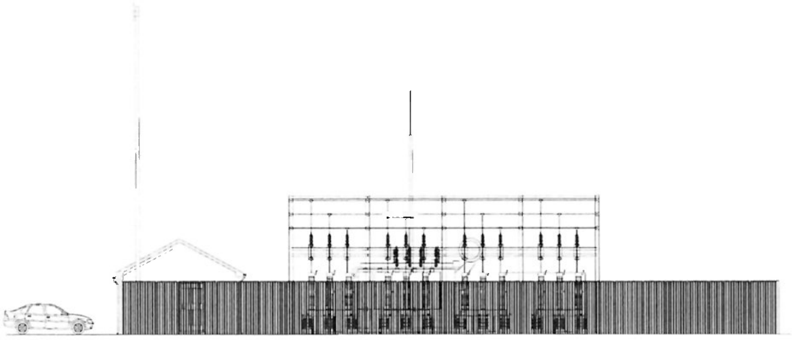
At this stage due to the fact that a grid connection offer has not been received it is not possible to say where the project will connect to the grid. That will be at the discretion of ESB and Eirgrid at the time of connection offer and will be based on the Least Cost Technically Acceptable principle to the group of projects being considered at that stage and in that Gate. While there are a number of projects currently scheduled to be connected to the Booltiagh transmission station, there are also a number of other projects in the area which are outside the Gate 3 process and these may have a bearing on the final connection location.

The final connection to the grid will be the responsibility of ESB Networks and will be the subject of a separate planning permission.

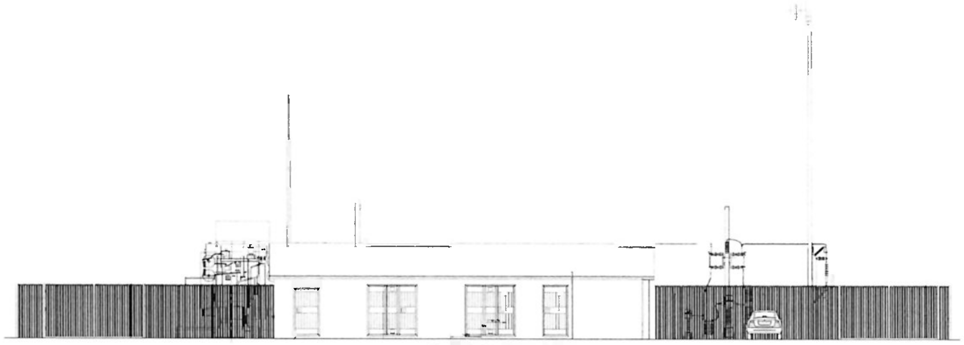
APPENDIX A – Substation compound Plan Drawing 2121-002



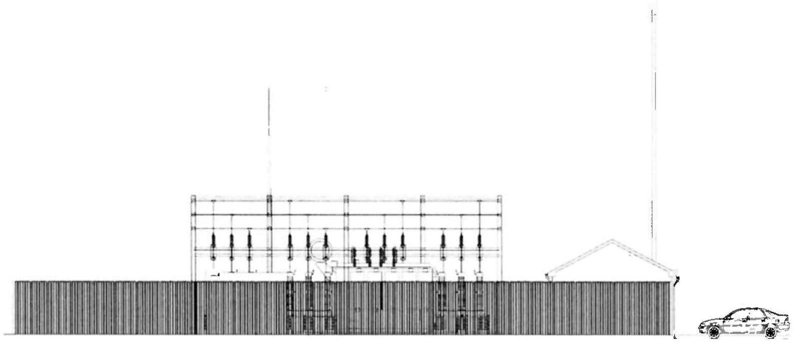
WEST ELEVATION (View C-C)



SOUTH ELEVATION (View D-D)



EAST ELEVATION (View A-A)



NORTH ELEVATION (View B-B)

TYPICAL WIND FARM SUBSTATION COMPOUND LAYOUT FOR INFORMATION PURPOSES ONLY. ARRANGEMENT OF EQUIPMENT WITHIN COMPOUND MAY VARY DEPENDING ON FINAL DESIGN AND [illegible] REQUIREMENTS

NOTES:

1.)

REFERENCE DRAWINGS

N/A

REV	DESCRIPTION	BY	DATE	CHKD	APPRD
ORIG	ORIGINAL	DE	24/04/1	DMcN	DMcN

[illegible] Power Generation
Synergy Centre
Institute Of Technology
Tallaght
Dublin 24
www.[illegible]
Tel +353[illegible]
Fax +353[illegible]

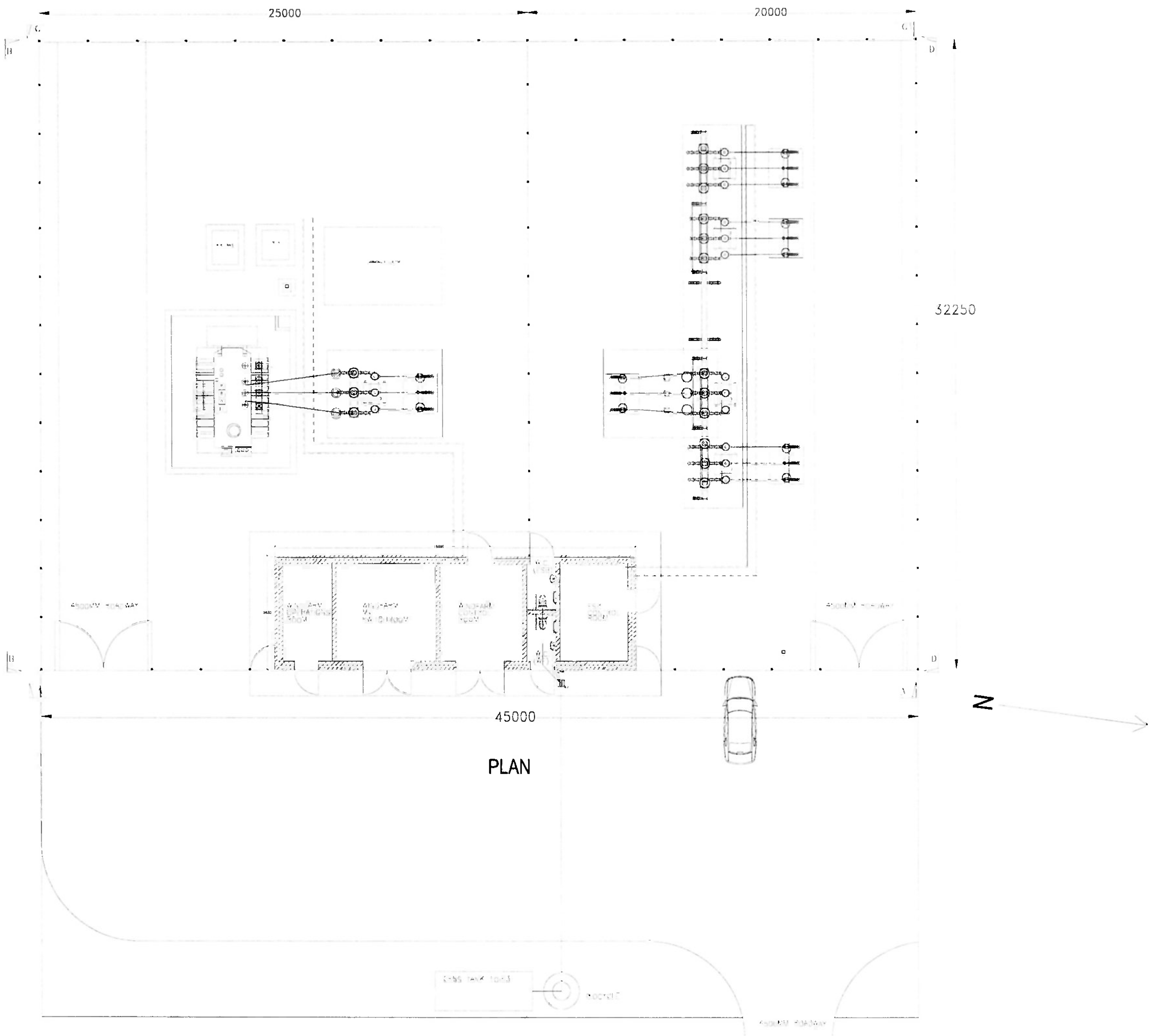
SCALE 25
ORIGINAL DRAWING SIZE A1

TITLE
Coor WF Substation Compound Elevation

CLIENT
Inis Environmental Ltd

DWG No
REV. 0

APPENDIX B – Substation compound Elevation Drawing 2121-002



NOTES:

1)

REFERENCE DRAWINGS
N/A

REV	DESCRIPTION	BY	DATE	CHKD	APPRD
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Renewable Power Generation
Synergy Centre
Institute Of Technology
Tallaght
Dublin 24
www.r-p-g.ie
tel +35314301841
Fax +35314430680

SCALE
1:200

ORIGINAL DRAWING SIZE
A1

TITLE
COBR WF SUBSTATION COMPOUND PLAN

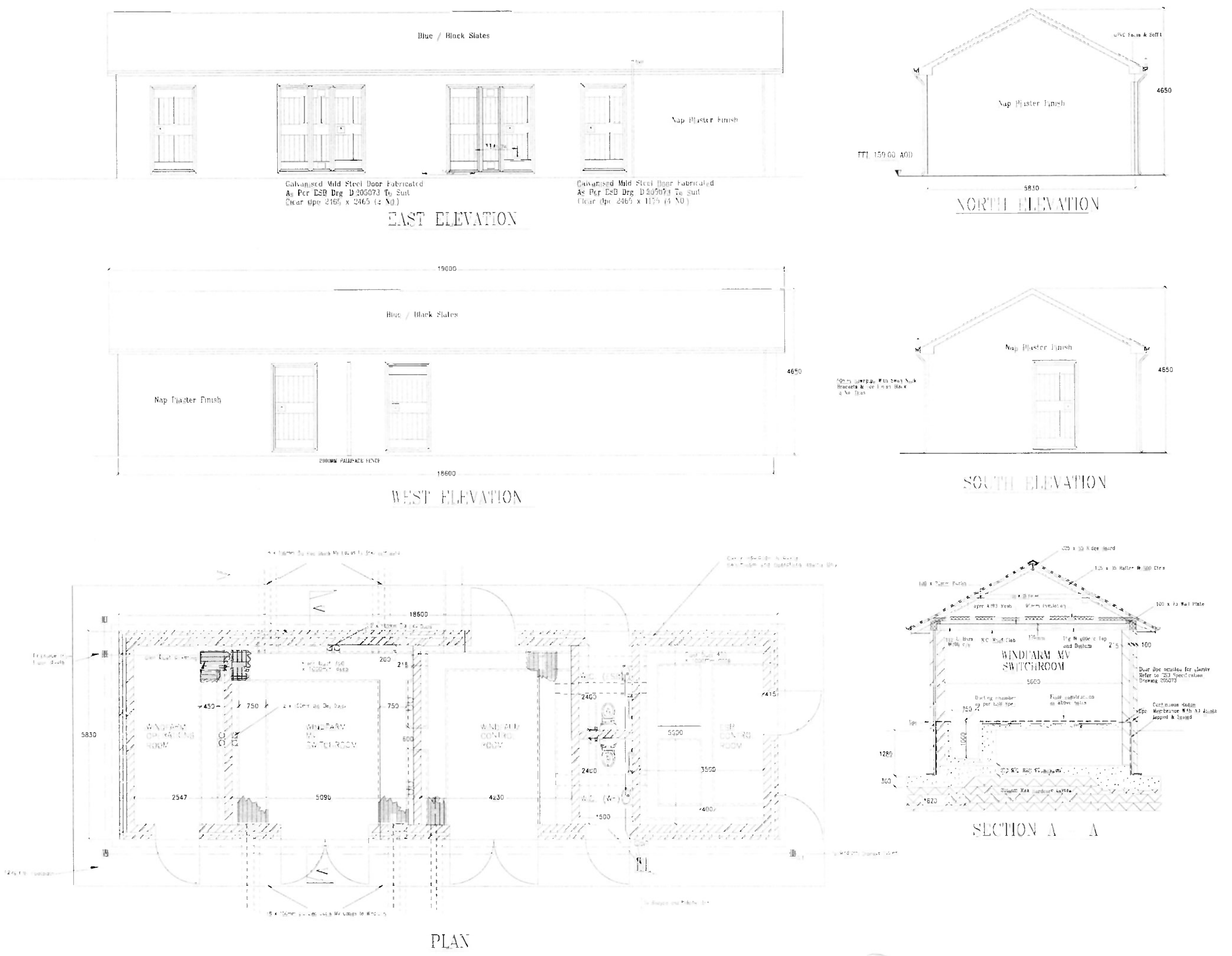
CLIENT
IMS ENVIRONMENTAL LTD

DWG NO

REV.
0

THIS DRAW… …ENTIAL INFORMATION. ANY
UNAUTHORIS… …R ADAPTION IS FORBIDDEN

APPENDIX C – Substation Control room detailed drawing 2121-002



NOTES:

1.)

REFERENCE DRAWINGS
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REV	DESCRIPTION	BY	DATE	CHKD	APPRD
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Renewable Power Generation
Synergy Centre
Institute Of Technology
Tallaght
Dublin 24

SCALE 50	ORIGINAL DRAWING SIZE A1

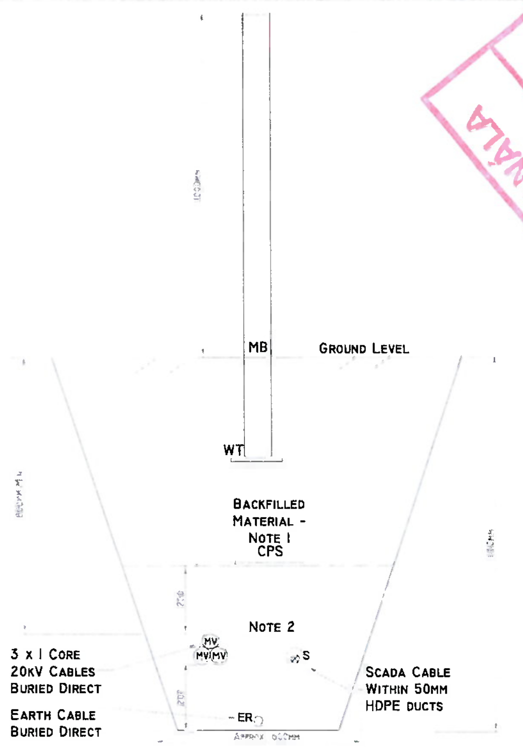
TITLE
Cobb WF Substation Building detail

CLIENT
IHS Environmental Ltd

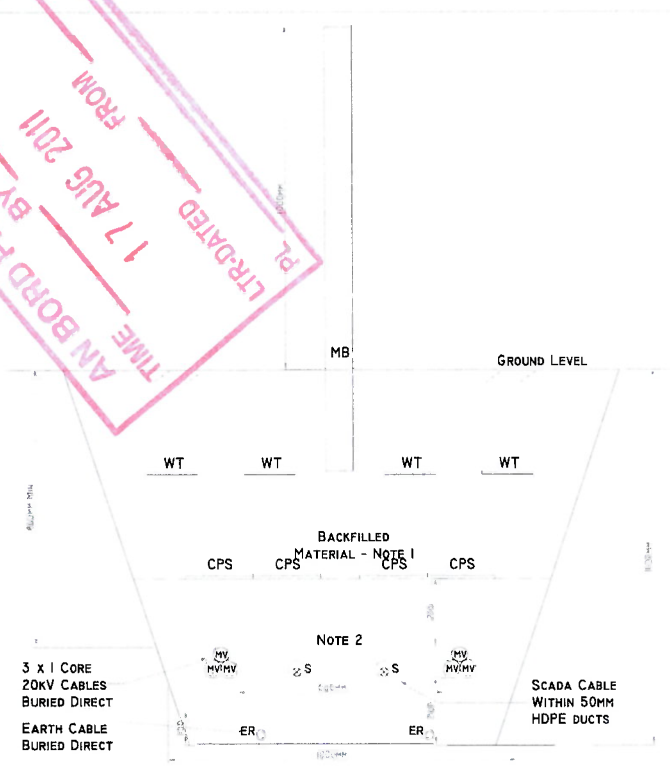
DWG No
2

REV
0

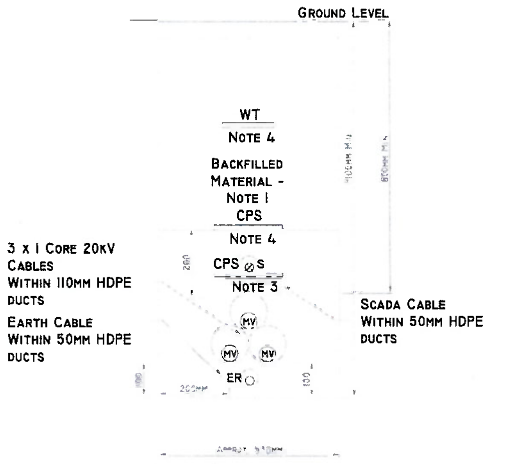
APPENDIX d – Windfarm Cable trench and duct profiles 2100-004



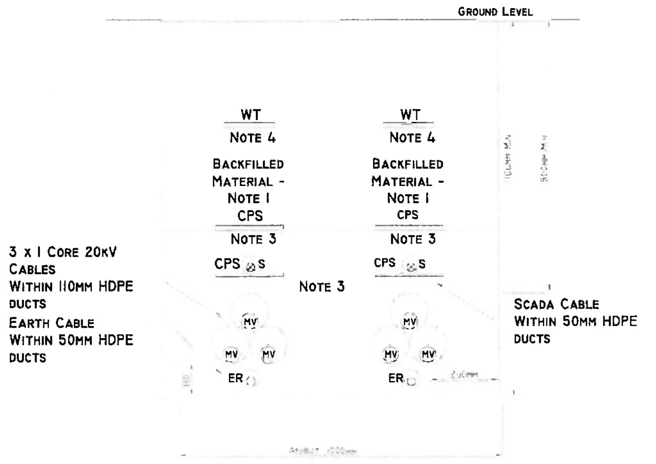
Typical Trench Profile No.1
(1 No. MV Cable Circuit, SCADA & Earth Sharing The Same Trench)



Typical Trench Profile No.2
(2 No. MV Cable Circuits, SCADA & Earth Sharing The Same Trench)



Typical Road Crossing Profile No.1
(1 No. MV Cable Circuit, SCADA & Earth Ducted)



Typical Road Crossing Profile No.2
(2 No. MV Cable Circuit, SCADA & Earth Ducted)

Notes:

1.)

1.Back Fill With Selected "As Dug" Materials With Large Or Sharp Stones Removed.

2.Cables To Be Directly Buried In Thermally Stable Material Sand Installed In 50mm Layers And Compacted To Maintain Trench Profiles. Where appropriate ground conditions prevail (eg cable laying in peat or sandy soils), the requirements for sand bedding and cover may be omitted at the engineers discretion. Due care will be required to ensure that all trench bedding is free from stones, tree roots or other debris which could damage the cables.

3.As per above but may be replaced by CBM4 (CL1039)

4. The cable route will be marked by a series of posts of approximately 1 metre height. These posts shall be located at changes of direction of the cable, and such that the adjacent posts in either direction (both up and down the route) would be visible from each post location.

5.Dimensions Are Minimum Sizes Only.

6.Cable Sizes Are Indicative Only.

Legend

WT	Warning Tape
MB	Marker Board
CPS	Cable Protection Strip
MV	MV Cables (Single Core In Trefoil)
S	SCADA Cable (Fibre Optic)
ER	Copper Earth Cable (Direct buried unless stated)

Reference Drawings
N/A

Rev	Description	By	Date	Chkd	Apprd
ORIG	Original	DMcN	05/05/11	DE	DE

Renewable Power Generation
Synergy Centre
Institute Of Technology
Tallaght
Dublin 24
www.r-p-g.ie
tel.+35314361841
Fax +35314430669

Scale
N.T.S.

Original Drawing Size:
A3

Title:
Coor WF Typical Cable Trench Detail

Client:
INIS Environmental

Dwg No.:
2121-004

Rev:
Original