

PREFACE

This Environmental Statement (ES) has been prepared in support of a planning application for a proposed wind farm by the The Grange, Tydd St Mary's Marsh, and is situated to the south of Sutton Bridge, South Holland, Lincolnshire.

The ES is contained within three separate volumes:

- Volume I** Non Technical Summary of the detailed Environmental Impact Assessment.
- Volume II** The full Environmental Impact Assessment which contains technical and supporting information in appendices.
- Volume III** Figures and plans referred to in the text of Volume II.

A separate Planning Statement has been prepared to accompany the planning application.

The ES has been prepared by RES UK & Ireland Ltd (RES) in consultation with South Holland District Council, various statutory consultees, interest groups and in collaboration with the following specialist consultants:

Landscape Assessment LDA Design 17 Minster Precincts, Peterborough PE1 1XX	Ecology Assessment Scott Wilson 16 Priestgate Peterborough PE1 1JA	Ornithological Assessment Ecology Consulting Swallow Ridge Barn Old Cassop Durham DH6 4QB	Cultural Heritage Assessment Entec Canon Court Abbey Lawn Abbey Foregate Shrewsbury, SY2 5DE				
Hydrological Assessment SKM Alberton House St Mary's Parsonage Manchester M3 2WJ	Noise Assessment Renewable Energy Systems TEC Unit 7000 Academy Park Gower Street Glasgow, G51 1PR	Transport RES UK & Ireland Ltd Beaufort Court Egg Farm lane Kings Langley WD4 8LR	Planning Statement Cobbetts LLP Number 1 Whitehall Riverside Leeds LS1 4BN				

Copies of the full ES may be viewed during normal opening hours at the following locations:

South Holland District Council Offices, Priory Road, Spalding, Lincolnshire, PE11 2XE
Wisbech Library - 5 Ely Place, Wisbech, Cambridgeshire PE13 1EU
Long Sutton Library , Trafalgar Square, Lincolnshire PE12 9HB
Long Sutton Market House, 9 Market Street, Long Sutton, Spalding, PE12 9DD

Copies of the full ES are available from RES priced £150 each. A Loan Copy of the full ES can be supplied free of charge for limited duration. Copies of the ES are available on CD-ROM for £25. Copies of the non-technical summary are available free of charge. The non technical summary can also be viewed on the RES web page www.res-group.com with more details on the project at www.grangewindfarm.co.uk. Requests for either document should be made in writing, including payment if purchase of the full ES is required.

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Numbering of appendices follows section numbers of ES.

APPENDIX 1.1 CALCULATION OF HOMES SUPPLIED AND POLLUTION SAVED BY THE GRANGE WIND FARM

The method used to calculate homes supplied and pollution savings at the proposed Grange Wind Farm, is based on that used and supported by the BWEA as industry standard seen at <http://www.bwea.com/edu/calcs.html>

Households Supplied

To calculate the number of households whose annual electricity demand would equal the output of the proposed The Grange Wind Farm, the following equation has been used:

$$\text{Number of Households} = \frac{\text{installed capacity (kW)} \times 0.307 \times 8,760}{4,700}$$

Where:

- the installed capacity of The Grange Wind Farm is nominally 14 MW, or 14,000kW, this is 7 turbines each of 2MW capacity.
- 0.307 (i.e. 30.7%) is the mean load factor that takes into account the fluctuating nature of the wind, and various loss mechanisms (e.g. wakes and electrical transmission), based on NOABL wind speed data (<http://www.bwea.com/noabl/index.html>) which is an estimated wind speed database from the DTI.
- 8,760 is the number of hours in a year
- 4,700kWh is the average UK household electricity usage per year (Figures taken from <http://www.bwea.com/edu/calcs.html>).

$$\text{Therefore: Homes supplied} = \frac{14,000 \times 0.307 \times 8760}{4,700} = 8010$$

In Summary, The Grange Wind Farm would produce enough electricity to supply 8010 homes.

Household figures taken from: Census 2001 Neighbourhood Summary Statistics page for the South Holland District, total for households taken from Housing and Households summary section.

<http://neighbourhood.statistics.gov.uk>

In South Holland there were 32,753 occupied households in 2001.

$$\begin{aligned} \text{Percentage of households served} \\ = 100 \times (8010 / 32,753) &= 24\% \text{ of homes in South holland} \end{aligned}$$

In Summary, The Grange Wind Farm would supply the equivalent of approximately 24% of the homes in South Holland District.

Pollution Savings

Every unit (kilowatt-hour, kWh) of electricity produced by the wind displaces a unit of electricity that would otherwise have been produced by a power station burning fossil fuel.

For each unit of electricity generated by The Grange Wind Farm, savings would be made of 430g CO₂ and small amounts of other pollutants (Figures taken from BWEA, 2008).

To calculate pollutants saved by the wind farm the following equation has been used:

$$\text{Annual CO}_2 \text{ emissions reductions (in tonnes)} = (A \times 0.307 \times 8,760 \times 430) / 1,000 = 16,189$$

Where:

A is the rated capacity of the wind energy development in MW i.e. 14 MW; 0.307 (i.e. 30.7%) is the mean load factor that takes into account the fluctuating nature of the wind, and various loss mechanisms (e.g. wakes and electrical transmission) based on NOABL; 8,760 is the number of hours in a year.

The above calculations are based on conservative assumptions and computer modelling, if the calculations are based on actual measured wind speed then the resulting mean load factors would increase to 38.7%. This would mean that the potential equivalent electricity could power over 10,000 homes and save 20,408 tonnes of CO₂ per annum.

APPENDIX 3.1 SCOPING CHECKLIST

TO NOTE SOME SECTION NUMBERING HAS BEEN CHANGED FROM THE ORIGINAL CHECKLIST

ENVIRONMENTAL STATEMENT SCOPING CHECKLIST

The scope of the environmental assessment would be as follows:

SECTION 1 INTRODUCTION

The Application

The Applicants

Rationale and Need for the Project

Includes a discussion of the greenhouse gases and climate change

Energy Payback

The Renewable Energy Resource

International, EC, UK and English Policy on Renewable Energy

The Renewables Obligation

Regional Renewable Energy Resource and Regional Targets for Renewable Energy

The Environmental Impact Statement

Describes the environmental assessment process, methodology used and structure of the EIS. The significant effects approach.

Public Attitudes

Consultations - describes individuals and organisations consulted

SECTION 2 SITE SELECTION

Introduction and location of search

Identification of potential sites and their ranking

Preliminary consultation and site visits

Commitment to progression of site

Summary

SECTION 3 DESCRIPTION OF THE PROJECT

Site Description

Location, topography and landuse, designations, wind resource etc.

The Proposed Development

Site layout and design evolution, land use requirements, anemometer masts, the wind turbines, substation and control building, grid connection, main road access, on site access tracks

Construction

Construction program, site access tracks, crane outrigger pads, foundations, temporary works, cabling, substation and control building, materials and transport, pollution control measures, workforce.

Reinstatement

Site access tracks, turbine bases, other areas

Operation and Maintenance

Operational features, transport, workforce

Decommissioning

SECTION 4 LANDSCAPE AND VISUAL ASSESSMENT (This study would be undertaken by an independent consultant). A 25km study area around the wind farm will be considered. Section to consist of:

Introduction, Methodology (reference made to current best practice guidelines) **and Consultations**

Baseline Landscape character and designations would be considered.

Assessment of Effects Approximately 10 viewpoints would be selected of short, medium and long distant views from representative locations. List to be agreed with Local Planning Authority. Wirelines would be produced from each viewpoint and a photomontage produced for up to 4 of the key viewpoints. *[Please suggest a draft list of viewpoints within the scoping opinion response which the local authority wishes to see selected as viewpoints for the assessment].*

Photographs would be taken using a 50mm lens as recommended best practice by the Landscape Institute.

Mitigation Measures

Conclusion and Summary of Effects

A cumulative visual assessment will be undertaken of any existing or consented wind farms (as of the date the scoping opinion is received by RES) within the 25km study area around the proposed RES wind farm.

SECTION 5 ECOLOGICAL ASSESSMENT (FAUNA AND FLORA) (This study would be undertaken by an independent consultant). Section to consist of:

Introduction, Methodology (reference made to current best practice guidelines) **and Consultations**

Baseline

Assessment of Effects

Mitigation Measures

Conclusion and Summary of Effects

The assessment would include a breeding and wintering bird survey and phase I habitat survey. Surveys would be carried out to specifically address potential marsh harrier populations in the area using an RSPB approved ornithologist specialising in this species.

SECTION 6 CULTURAL HERITAGE ASSESSMENT (This study would be undertaken by an independent consultant). Section to consist of:

Introduction, Methodology and Consultations

Baseline

Assessment of Effects

Mitigation Measures

Conclusion and Summary of Effects

The assessment will include a desk based assessment and if considered necessary a one day walk over field visit.

SECTION 7 HYDROLOGICAL ASSESSMENT

(The hydrological assessment would be undertaken by an independent consultant). Section to consist of:

Introduction, Methodology and Consultations

Baseline

Assessment of Effects

Mitigation Measures

Conclusion and Summary of Effects

The assessment will include a desk based assessment and if considered necessary a one day walk over field visit.

SECTION 8 NOISE ASSESSMENT (undertaken by RES's own noise team)

Introduction, Methodology (reference made to British Standards, DTI Noise Working Group 1997 ETSU report and relevant PPGs etc.) **and Consultations**

Baseline environment

Impact assessment

Mitigation measures

Conclusion and Summary of Effects

Conclusions regarding the significance of the resulting effects of the operational wind farm development on the noise environment would be assessed. Taking into account current guidelines and planning conditions.

SECTION 9 TRANSPORTATION AND ACCESS

Introduction, Methodology and Consultations

Existing road conditions of the proposed site and access route - baseline

The roads which will be used for construction and operation purposes would be assessed within the EIS. The structure and strength of the route would be looked at as well as considering any alternative routes.

This would be done through site investigations to examine the route and in collaboration with the local highways authority to establish road strength and safety issues such as visibility splays.

Utilities (BT, Electric, Water, Transco) to check locations of cables/pipes etc.

Impact assessment

The number and type of construction, operation and decommissioning traffic movements would be determined. Once this is established this would be assessed against the available access routes to the proposed site

Any traffic management measures which would be required to ensure the safety of other road users would be examined.

Any road improvements, upgrading necessary would be examined and technical scale drawings would be prepared.

Driver distraction would be examined through an examination of evidence from existing wind farms in the UK.

Mitigation Measures

The preferred route would be chosen and any mitigation measures which are seen necessary by the local highways authority would be agreed.

Alternative routes to the site and on to the site would be examined and the route which minimises environmental, disturbance and technical problems would be chosen.

Conclusion and Summary

SECTION 10 ELECTROMAGNETIC INTERFERENCE

Introduction and Methodology

Consultations

With the appropriate bodies to whom electromagnetic interference may be a problem would be carried out. The possible problems which could occur would be explored such as interference with television reception, microwave communications and air traffic safeguarding.

Impact Assessment

Consultation would lead to greater knowledge of existing links and transmitters and the requirement of mitigation measures to offset any disruption. Investigation would be undertaken to examine any potential problems with interference and ways to minimise interference through site layout.

Mitigation Measures

Arrangements with the telecommunications and transmitting companies would be finalised to cover any costs necessary for any mitigation measures necessary.

Conclusion and Summary

SECTION 11 SOCIO-ECONOMIC ASSESSMENT

Introduction, Methodology and Consultations

Existing socio-economic conditions of the proposed site area - baseline

The existing socio-economic situation should be described within the environmental statement. To include nearest settlements, dwellings and population numbers.

Identify any existing public rights of way and recreational uses within and surrounding the site

Impact assessment

The economic benefits which would accrue to the local community and area both directly and indirectly would be examined. Employment created by wind energy.

Safety and Recreation: Turbine safety, RES safety procedures, Tourism and education, Public rights of way, Public safety, Risk assessment.

Mitigation Measures

Summary and Conclusion

Section 12 SUMMARY OF EFFECTS

The definition of significance according to EIA Regs. A summary table showing a summary of all environmental effects.

REFERENCES

GLOSSARY/ABBREVIATIONS

TECHNICAL APPENDICES

STRUCTURE OF THE ENVIRONMENTAL STATEMENT

The EIS would be produced in three volumes:

Volume I: Non Technical Summary - would be available free of charge to interested groups and individuals, and would be written in English and Welsh.

Volume II: Environmental Statement including technical appendices

Volume III: Figures and Photomontages

A separate Planning Policy Statement to discuss whether the wind farm is in accordance with the Development Plan and other material considerations, taking into account the findings of the EIA. This would be prepared and submitted with the ES and planning application as a separate document in support of the application.

APPENDIX 3.2 LIST OF ORGANISATIONS CONTACTED

A full list of bodies contacted to date by RES on The Grange Wind Farm proposal is as follows:

- South Holland District Council
- Lincolnshire Highways Authority
- British Broadcasting Association (BBC)
- British Telecommunications (BT) Wholesale
- Cable and Wireless
- Vodafone
- English Heritage
- Civil Aviation Authority (CAA)
- National Air Traffic Services (NATS)
- CSS Spectrum Management Services Ltd
- Defence Estates
- Environment Agency
- Natural England
- Joint Radio Company
- Lincolnshire Wildlife Trust
- National Grid Transco
- National Grid Wireless Group
- National Transcommunications Ltd (NTL)
- Lincolnshire County Council
- OFCOM
- Orange
- Channel 5
- The Royal Society for the Protection of Birds (RSPB)
- T-Mobile UK

Further organisations and individuals have been consulted directly or in more detail by the environmental consultants undertaking the various assessments for this ES and by RES directly these are detailed within the relevant sections of the ES.

Climate change matters

When RES first started developing wind farms more than 20 years ago, the issue of global warming was largely at an academic level. Now, in 2009, few people question that climate change is under way and that mankind's love of fossil fuels and the consequential rising of atmospheric CO₂ levels is a significant factor. Sir David Attenborough has summed up the feelings of many scientists: *"If you take one moment in time, you can't be sure what the trend is. Now, when we look at the graphs of rising ocean temperatures, rising carbon dioxide in the atmosphere and so on, we know that they are climbing far more steeply than can be accounted for by the natural oscillation of the weather. What people must do is to change their behaviour and their attitudes. If we do care about our grandchildren then we have to do something."*

Recently, scientists have predicted that, should global temperatures rise by just 3°C more, we could reach the point of no return. If the ice caps melt, sea levels will rise and the lives of billions of people around the world will be affected. Changing patterns of weather appear to be starting to affect the historic timings of the traditional seasons. In turn, this could affect wildlife and lead to the loss of some types of plants or animals from certain regions.

The Draft Regional Spatial Strategy for the East Midlands (2008) refers to a number of potential impacts of climate change across the region. For



example, *"The consequences of climate change are important especially in the 20% of the Region which is low lying and are safeguarded from fluvial and coastal flooding by drainage and flood defences, but also for many fragile and fragmented biodiversity habitats across the East Midlands."*

It also goes on to say that *"In general terms, climate change will alter seasonal rainfall patterns and may make it necessary to increase storage capacity or exploit new sources in order to maintain the public water supply."*

The Strategy makes it clear that wind farms have an important role to play in helping to tackle climate change: *"In establishing criteria for onshore wind energy, Local Planning Authorities should give particular consideration to.....the contribution of wind generation projects to national and international objectives on climate change."*

The UK Government has set a target to cut emissions of carbon dioxide by 80% by 2050. To achieve this, a whole range of cleaner energy

technologies will have to be developed – from onshore and offshore wind to tidal, biomass, solar and wave – as well as measures to green our transport and reduce energy demand.

The proposed wind farm at The Grange is one step towards creating a low carbon, sustainable energy supply. The UK is the windiest country in Europe and it makes sense to use this natural, clean and abundant resource.

RES has worked hard to ensure that The Grange wind farm is well designed, minimising any environmental impacts, whilst maximising the amount of clean, green energy that can be obtained from the wind. We are committed to creating important economic benefits for the local community from the project. It is important that projects like The Grange wind farm are built as soon as possible if we are to produce home grown, clean energy, make a positive contribution to the fight against climate change and reap the benefits of a shift to a low carbon economy.



THE GRANGE WIND FARM

RES
power for good

February 2009

Welcome

RES is pleased to introduce our plans for a new wind farm between Sutton Bridge and Tydd St. Mary in South Holland, Lincolnshire. The time is right to step up development of cleaner, greener energy sources. Renewable energy can reduce climate-changing pollution, provide a reliable supply of electricity to homes and businesses, create 'green collar' jobs and bring important economic benefits, both locally and nationally. As the most advanced of the new renewable energy technologies, onshore wind power has a vital role to play in meeting our needs in the next few years.

Every part of the UK is now looking at the contribution it can make to a more sustainable and secure electricity supply and The Grange Wind Farm is an exciting project that can help the region achieve its renewable energy targets.

What are we proposing?

We are applying for permission to erect 7 wind turbines on agricultural land around the Grange Farm, on Tydd St. Mary's Marsh.

Each turbine would be up to 127m high, to the tip of the blade. The layout has been designed following more than two years of comprehensive site studies aimed at reducing the visual and ecological impact of the project, whilst ensuring that the wind farm generates a substantial amount of clean, green power.

The wind farm has a potential installed capacity of 14MW. Government wind modelling data* suggests that the proposed wind farm is likely to generate enough electricity to power approximately 8,000 homes, equivalent to 24% of the annual consumption of all the houses in the South Holland District (based on 2001 UK census data). Site specific wind speed measurements have been carried out by RES which indicate that this figure could be even higher in reality.

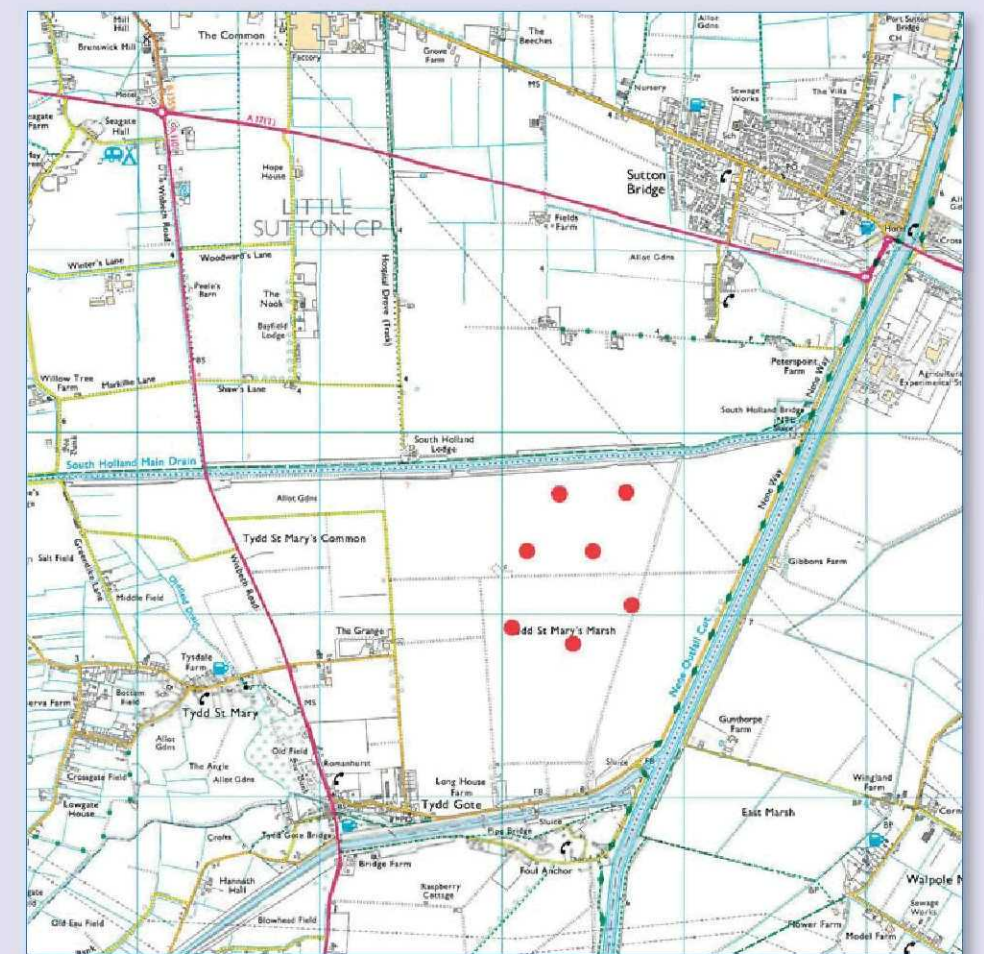
We are confident that this is a very good site for a wind farm and that our sensitively-designed project will be an asset to the area. We expect to submit a planning application in the Spring. The plan (top right) shows the layout of the proposed wind farm and the map (bottom right) shows the site location.

*The Department for Business, Environment and Regulatory Reform (DBERR) manages the NOABL database of average wind speeds for different areas of the UK. This has been used to derive the predicted capacity factor for this site on which these calculations are based.

The East Midland's renewable energy boom

The East Midlands region, in which the wind farm is situated, is aiming to have at least 155MW of installed onshore wind capacity by 2020. This is set out in the draft Regional Spatial Strategy for the East Midlands, issued for consultation in July 2008.

The Grange wind farm will make an important contribution to these targets.



"If we do care about our grandchildren then we have to DO something."

Sir David Attenborough

COME ALONG TO OUR EXHIBITIONS AND FIND OUT MORE!

We will be holding exhibitions at the following venues in March, to present the full details of our application:

Wednesday 25th March: Tydd St. Mary Village Hall, 3pm – 8pm

Thursday 26th March: Sutton Bridge Constitutional Club (New Road, Sutton Bridge), 10am – 3pm

We look forward to meeting you and explaining our plans in more detail.



For those receiving this newsletter by post, we obtained your address through a national post code database. If you do not wish to receive further information from us about this proposal, please write to us and let us know.

For further information, please contact:

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Any more questions?

We would be happy to cover any issues in more detail in forthcoming newsletters. If you would like to see anything discussed in more detail, don't hesitate to let us know.

More information about wind power can be found at the following websites:

The Sustainable Development Commission's report into wind power:
www.sd-commission.org.uk/publications.php?id=234 The British Wind Energy Association: www.bwea.com

General information about the role renewables can play in UK electricity generation:
<http://www.berr.gov.uk/energy/sources/renewables/explained/index.html>

Wind With Miller – fun stuff for kids: <http://www.windpower.org/en/kids/index.htm>

Information about renewables for your home or community:
<http://www.energysavingtrust.org.uk/Generate-your-own-energy>



Who are we?

RES is one of the world's leading independent wind energy companies and is part of the Sir Robert McAlpine Group, a British, family owned construction and engineering firm. At the time of writing, RES has successfully built over 3,500 MW of wind power capacity around the world and has developed or constructed over 10% of the UK's wind energy. From more than 25 years in the wind industry, RES has gained a high level of expertise in the technical, environmental and financial disciplines essential for the development of a successful wind farm. Our reputation for quality is second to none and we pride ourselves in being a power for good in a world facing stark energy choices.

RES is the holder of a Queen's Award for Enterprise in the Sustainable Development category, recognising RES's 'comprehensive approach to the environmental and social impact assessment prior to the commencement of every wind farm project'. We were also listed in the Sunday Times Top 25 Green Businesses in 2008.



Benefiting local people and the economy

It is our policy to ensure that each wind farm development brings tangible benefits to the local community. The usual mechanism for this is through the provision of a community fund, which is paid annually and relates to the size of the wind farm.

We are proposing a community fund of around £2,000 per installed MW, which equates to over £28,000 per year. The fund will be handed over to an independent local body to manage, such as the parish council(s) or an entirely new independent trust, to be identified through consultation with local people. We would encourage anyone with a view on how the community fund should be managed or spent to discuss this with us at any time during the planning process.

Leading by example

RES recognises that renewable energy has to go hand-in-hand with improving energy efficiency and reducing energy demand. That is why RES's award-winning UK head office is a pioneering example of a 'low carbon' office, with electricity and heat provided from its own wind turbine, solar panels, biomass grown on site and natural cooling.

The number of staff employed by RES in the UK increased from 190 to 306 during 2008, and this number is expected to continue to grow throughout 2009, despite the current economic climate.



A local landmark

As at many other wind farm sites around the UK, the project is expected to be of interest to local schools and visitors to the area. Some schools choose to follow the progress of a wind farm application as a project for their students, offering opportunities for learning about a whole range of curriculum subjects, from energy and the environment to citizenship, history and art.

For example, we have previously sponsored the energy education charity CREATE (www.create.org.uk) to work with schools around our wind farm sites to help them to reduce their energy bills. In Yorkshire, we are currently working with 3 schools who are introducing the Diploma in Engineering later this year. If your school is interested in such a project, please contact us, as our educational centre in Hertfordshire can provide educational materials.

If you're a member of a group such as the Scouts, WI, Round Table, Rotary, Probus Club, etc., or work for a local company, and would like us to come and give you a presentation on the wind farm, don't hesitate to drop us a line.

The project team



Helen Hall

is the Project Manager for The Grange wind farm proposal. She has been overseeing every aspect, coordinating the various departments of RES to ensure the site is suitable, and that all the necessary studies and assessments are carried out thoroughly. Helen also works on improving wind farm construction practices, to ensure that environmental effects are minimised, by regularly visiting RES construction sites across the UK & Ireland to monitor and make recommendations for improvements. Originally a physical geographer, a Masters in Natural Resource Management at Cranfield University led her into developing renewable energy projects. helen.hall@res-ltd.com



Amy Bambridge

Amy Bambridge is the Community Relations Manager for The Grange wind farm. Work on community environmental management projects led her into the wind industry. She handles all of the local community work and is the first point of contact for enquiries about community funds and the consultation process. amy.bambridge@res-ltd.com

Interested in a wind farm visit?

Visiting a wind farm can be useful in helping people learn more about wind energy and understanding at first hand what the project proposed for their area might be like. "We always offer local people a group visit to an operating site as a way of helping people to make informed decisions about wind farms, because there are so many false rumours in circulation. It's a particularly effective way to dispel the myth that turbines are noisy, for example," says Amy Bambridge, RES's Community Relations Manager.

If you would be interested in seeing an operating wind farm in action, please contact Amy on 01923 299328 or email amy.bambridge@res-ltd.com.

If you would like to know where the UK's wind farms are situated, please go to www.bwea.com/ukwed/ for an up-to-date map.

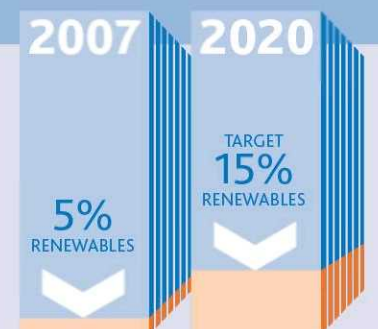
Our changing energy supply

The UK is currently undergoing a radical change in the way it generates electricity. A transition is under way from large centralised conventional generators – coal, gas, and nuclear – to smaller, more geographically dispersed renewable generation, such as wind and biomass. At the moment, the UK's electricity primarily comes from three sources: gas (50%), coal (25%) and nuclear (13%). Despite our abundant natural renewable resources, we generate just 5% of our energy from renewables. We are increasingly dependent on imported fuels, particularly gas, which is not good for our economy or our security. The government estimates that, if things don't change, we could

be dependent on imports for 75% of our primary fuel needs by 2020.

As conventional fuel resources decline, we need to make use of home-grown energy sources that will never run out. Indigenous and renewable, wind power has an important role to play in keeping the UK's lights on.

The UK has an ambitious target of producing 15% of its total energy supply from renewables by 2020. That would mean approximately 35-40% of the UK's electricity coming from renewables within 12 years, with wind power (the most mature renewable technology) providing the bulk of this total.



Why is this a good site for a wind farm

The Grange Wind Farm will harness the clean and natural power of the prevailing winds and turn it into useful energy for homes and businesses.

While Lincolnshire benefits from excellent wind speeds and good grid connections, making it an attractive place for wind farm development, there are many things to consider when finding a suitable site. As Helen Hall, the Project Manager, explains, "Choosing an appropriate site involves consideration of a range of issues. We have to ensure that the local environmental impacts of the wind farm will be absolutely minimal and take into account local planning policies, environmental designations and proximity to homes. We also have to consider technical issues such as wind speeds, land availability, a suitable grid connection close to the site and good transport access."

Environmental impact assessments are a compulsory part of the planning process for projects such as this. The detailed studies on The Grange site have been going on for over two years, and are co-ordinated by RES's in-house team of scientists, with most carried out individually by independent consultants.

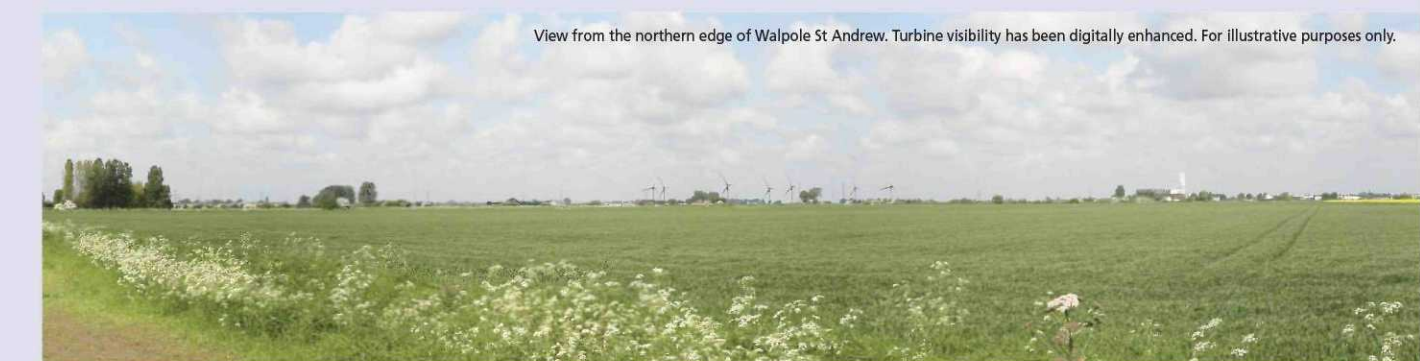
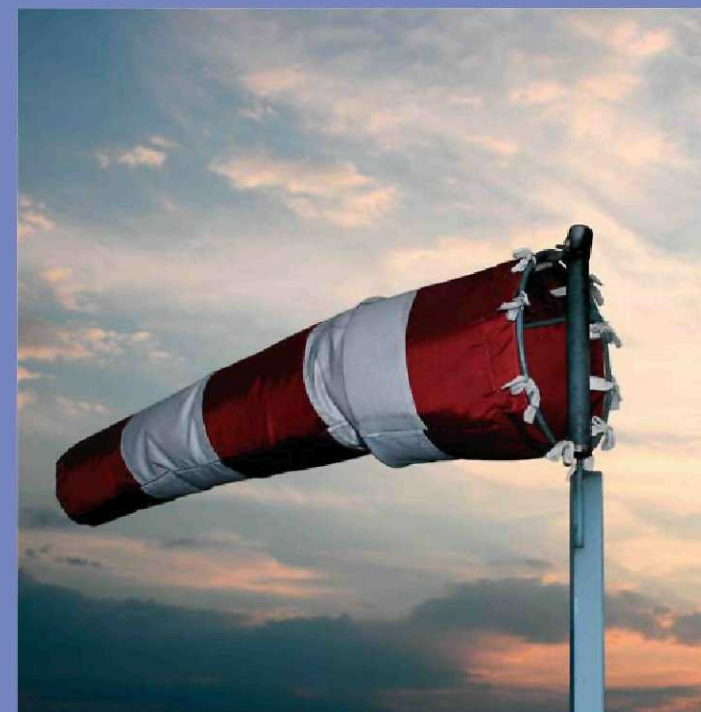
Helen further explains, "For example, we have been undertaking investigations into the hydrology around the site, looking at water flows in the area. We have also had some detailed ecological monitoring work carried out, investigating populations of bats, birds, amphibians and mammals, as well as mapping local plant life. We have also looked at the local landscape, archaeology and effect on TV reception. All of this information is helping us to design an acceptable layout of the turbines and we are confident that the site is suitable for a wind farm."

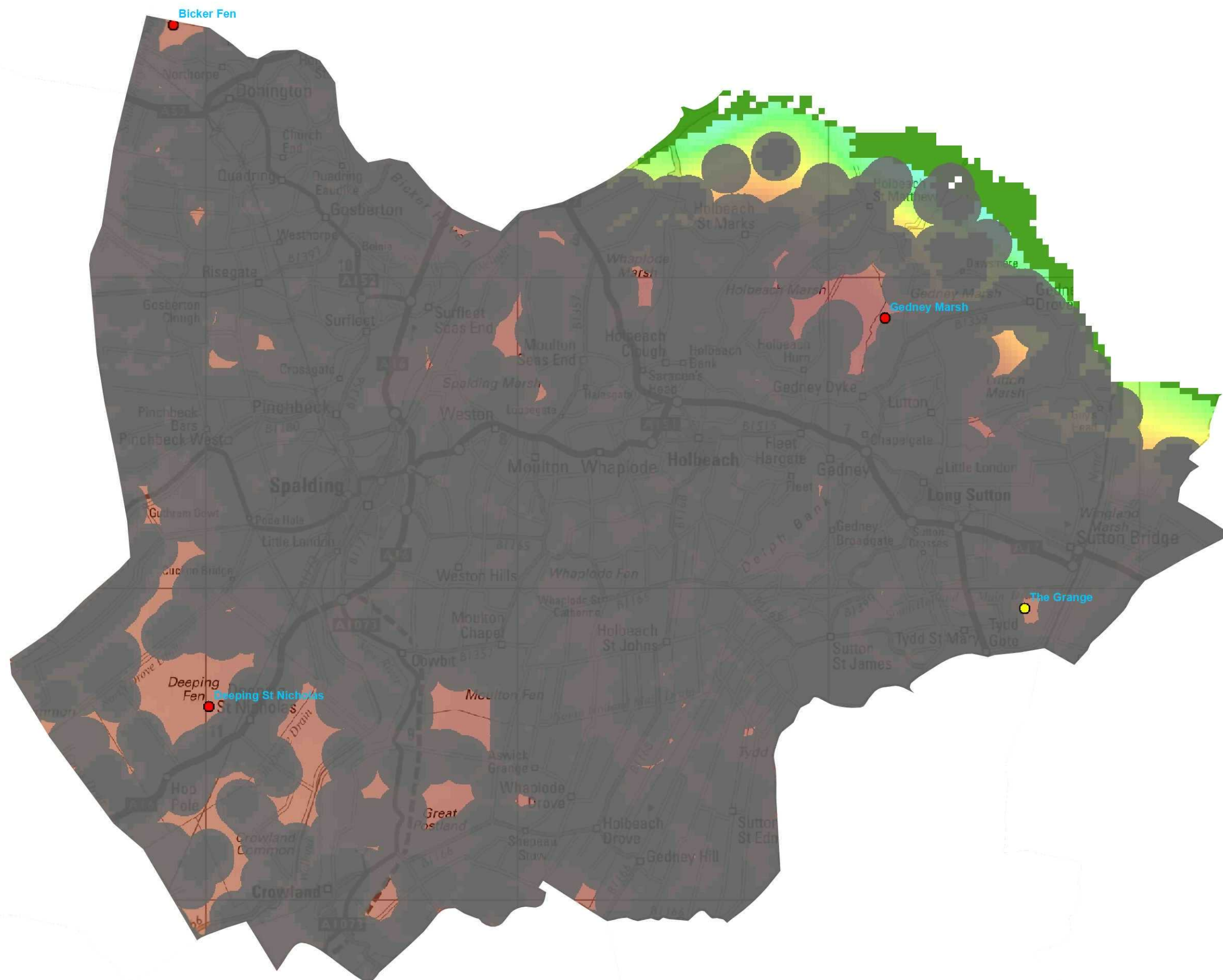
The findings from the site studies will be written up as a comprehensive Environmental Statement, which South Holland District Council will take into account when deciding whether or not to grant planning permission for the wind farm. The results will be presented at the exhibitions in March, and once the planning application has been submitted, copies will be made available locally, such as in libraries and Council offices.

Why wind?

- No polluting emissions
- Will never run out
- Helps in the fight against climate change
- Efficient and reliable
- Economically viable
- Improves our energy security
- Tried and tested technology
- Safe:
 - Quick and easy to install
 - No long-lasting legacy

Wind power works! It is the technology that can help us meet urgent short term targets on climate change and help us keep the lights on. As thousands of projects across the UK and around the world show, wind energy is already successfully generating carbon-free power and bringing jobs and economic benefits to communities.



**FIGURE A3.1**

SITE SELECTION IN SOUTH HOLLAND DISTRICT

- UK Wind Farms
- The Grange

High : 1
Low : 0

 $< 6.2 \text{ m/s}$ at 60m

800m buffer of address points

■ slope > 12deg and TV transmitters

AONB
SAC/ SPA/ Ramsar sites
Nature & RSPB Reserves
National Parks

Digital Map Data
(c) Collins Bartholomew Ltd 2009

LAYOUT DWG	N/A	T-LAYOUT NO.	N/A
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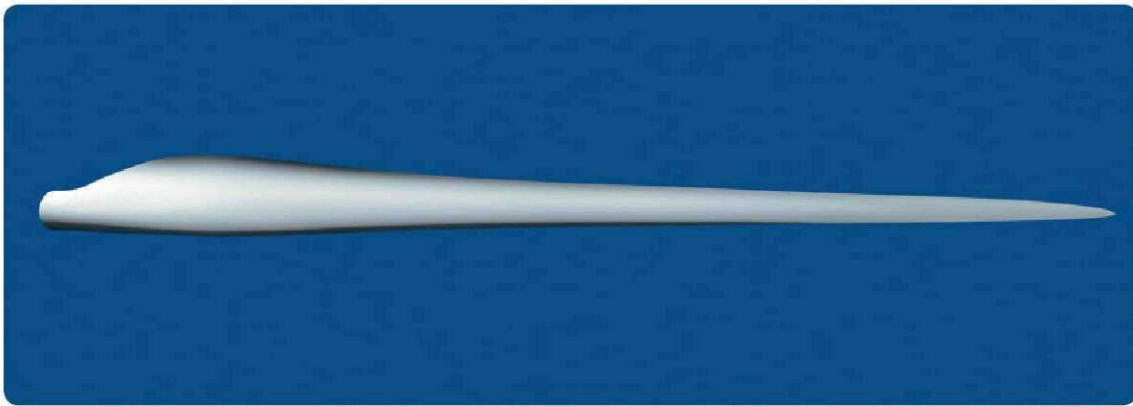
**ENVIRONMENTAL
STATEMENT 2009**

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V90-1.8 MW

V90-2.0 MW

Built on experience



Innovations in blade technology

Optimal efficiency

The OptiSpeed®* generators in the V90-1.8 MW and the V90-2.0 MW have been adapted from those in Vestas' highly successful V80 turbine. OptiSpeed® represents a significant advance in wind turbine efficiency as it allows the rotor speed to vary within a range of approximately 60 per cent in relation to nominal rpm. This means that with OptiSpeed®, the rotor speed can vary by as much as 30 per cent above and below synchronous speed. Its purpose is simple: to maximise energy output.

It does this by tapping the higher efficiency of slow and variable rotation, storing excess energy in rotational form and exploiting the full force of transient gusts. All told, OptiSpeed® boosts annual energy production.

As an added benefit, OptiSpeed® also reduces wear and tear on the gearbox, blades and tower on account of lower peak loading. Moreover, as turbine noise is a function of wind speed, the lower rotation speeds made possible by OptiSpeed® naturally reduce sound levels.

Finally, OptiSpeed® helps our V90s deliver better quality power to the grid, with rapid synchronisation, reduced harmonic distortion and less flicker.

3x44 metres of leading edge

Vestas blades have always been among the lightest on the market, and with the V90 turbines, we have once again raised the bar. The new blades feature several new light-weight materials, most notably carbon fibre for the load-bearing spars. Not only is carbon fibre lighter than the fibre glass used in previous blades, but its strength and rigidity have also made it possible to reduce the amount of material required. This means that even though our V90s have 27 per cent more swept area than our V80s, the longer blades actually weigh about the same.

The V90 blades also have a new profile that is aerodynamically superior to the previous generation. Vestas engineers developed this technologically advanced profile by optimising the relationship between the overall load impact on the turbine and the power generated annually. The fruit of their labours was an entirely new plane shape and a curved back edge.

The resulting airfoil improves energy production, while making the blade profile less sensitive to dirt on its leading edge and maintaining a favourable geometrical relationship between successive airfoil thicknesses. For the V90 turbine, this translates into an increase in output combined with a decrease in load transfers - as well as improvements on the bottom line.

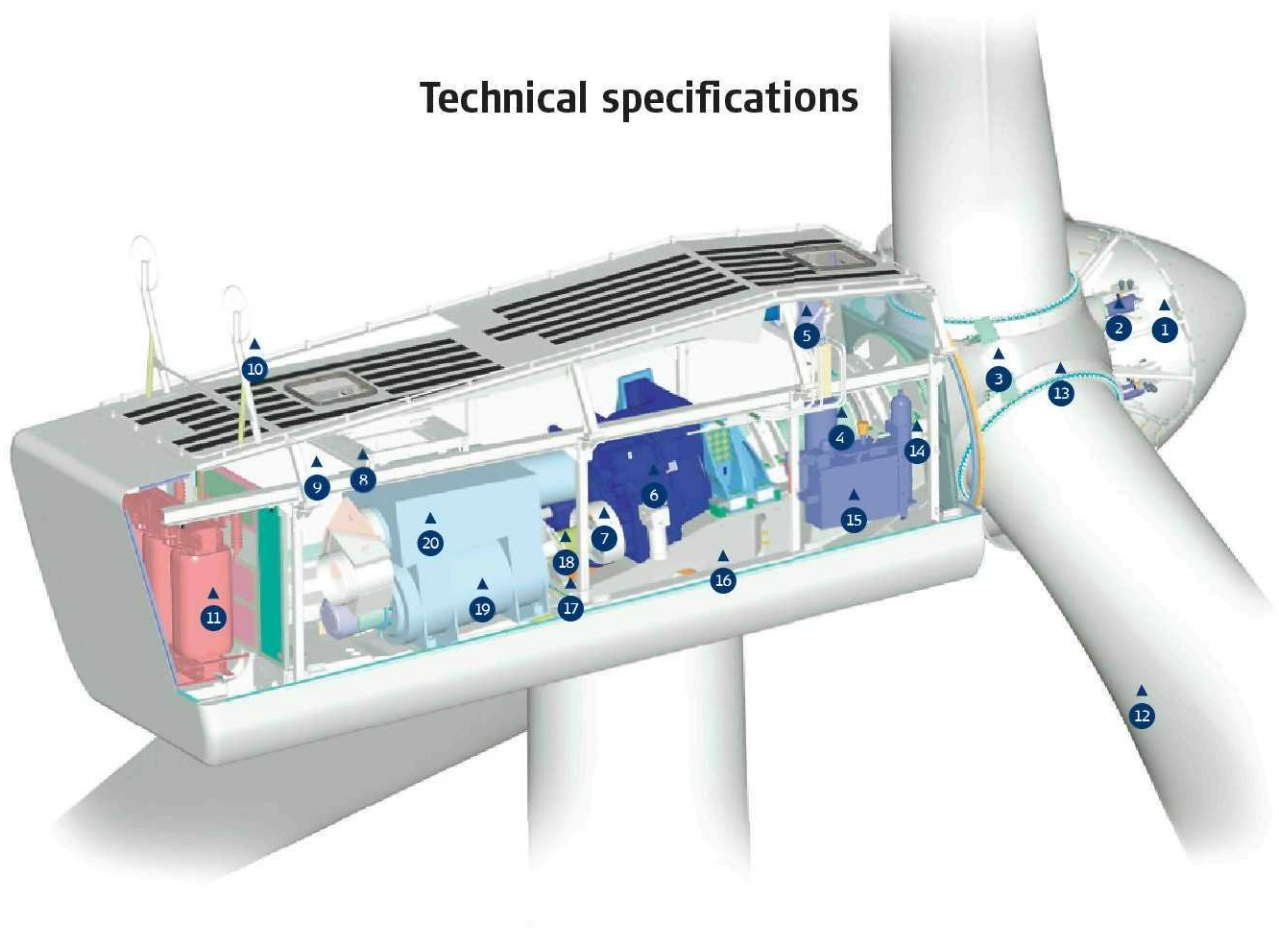
Proven Performance

Wind power plants require substantial investments, and the process can be very complex. To assist in the evaluation and purchasing process, Vestas has identified factors that are critical to wind turbine quality: energy production, power quality and sound level.

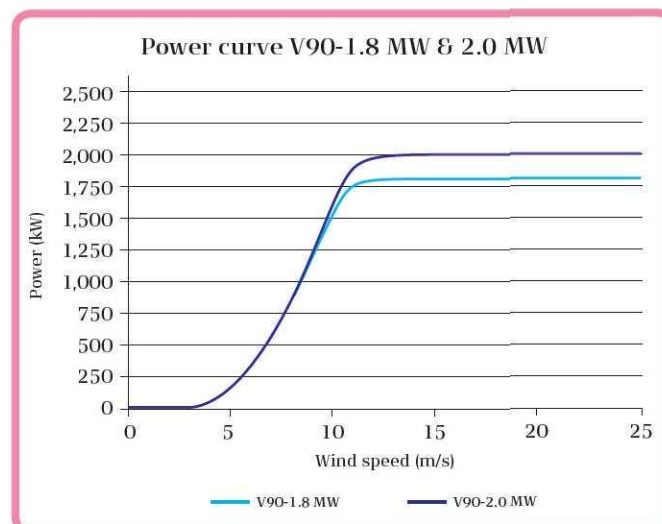
We spend months testing and documenting these performance areas for all Vestas turbines. When we are finally satisfied, we ask an independent testing organisation to verify the results - a practice we call Proven Performance. At Vestas we do not just talk about quality. We prove it.

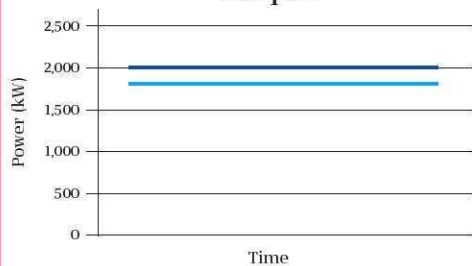
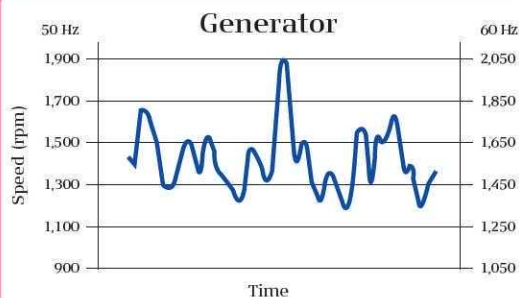
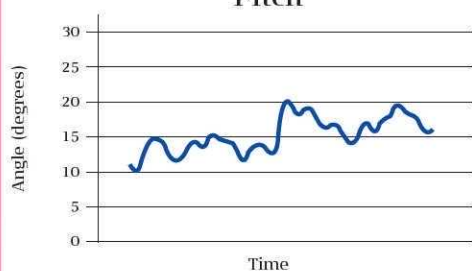
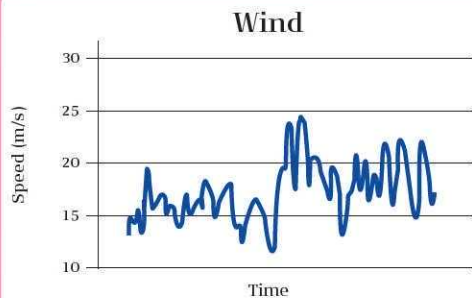
* Vestas OptiSpeed® is not available in the USA and Canada

Technical specifications



- | | | | |
|-------------------|-------------------------------------|-----------------------------|-----------------------------|
| 1 Hub controller | 6 Gearbox | 11 High voltage transformer | 16 Machine foundation |
| 2 Pitch cylinders | 7 Mechanical disc brake | 12 Blade | 17 Yaw gears |
| 3 Blade hub | 8 Service crane | 13 Blade bearing | 18 Composite disc coupling |
| 4 Main shaft | 9 VMP-Top controller with converter | 14 Rotor lock system | 19 OptiSpeed® generator |
| 5 Oil cooler | 10 Ultrasonic wind sensors | 15 Hydraulic unit | 20 Air cooler for generator |





OptiSpeed® allows the rotor speed to vary within a range of approximately 60 per cent in relation to nominal rpm. Thus with OptiSpeed®, the rotor speed can vary by as much as 30 per cent above and below synchronous speed. This minimises both unwanted fluctuations in the output to the grid supply and the loads on the vital parts of the construction.

Rotor

Diameter:	90 m
Area swept:	6,362 m ²
Nominal revolutions:	14.9 rpm
Operational interval:	9.0-14.9 rpm
Number of blades:	3
Power regulation:	Pitch/OptiSpeed®
Air brake:	Full blade pitch by three separate hydraulic pitch cylinders.

Tower

Hub height:	80 m, 95 m, 105 m
-------------	-------------------

Operational data

	IEC IIA:	IEC IIIA/DIBt II:
Cut-in wind speed:	3.5 m/s	2.5 m/s
Nominal wind speed:	12 m/s	13 m/s
Cut-out wind speed:	25 m/s	25 m/s / 21 m/s

Generator

	IEC IIA:	IEC IIIA/DIBt II:
Type:	Asynchronous with OptiSpeed®	Asynchronous with OptiSpeed®
Nominal output:	1,800 kW	2,000 kW
Operational data:	50 Hz/60 Hz 690 V	50 Hz/60 Hz 690 V

Gearbox

Type:	Planetary/helical stages
-------	--------------------------

Control

Type:	Microprocessor-based control of all the turbine functions with the option of remote monitoring. Output regulation and optimisation via OptiSpeed® and OptiTip® pitch regulation.
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Weight

Nacelle:	68 t
Rotor:	38 t

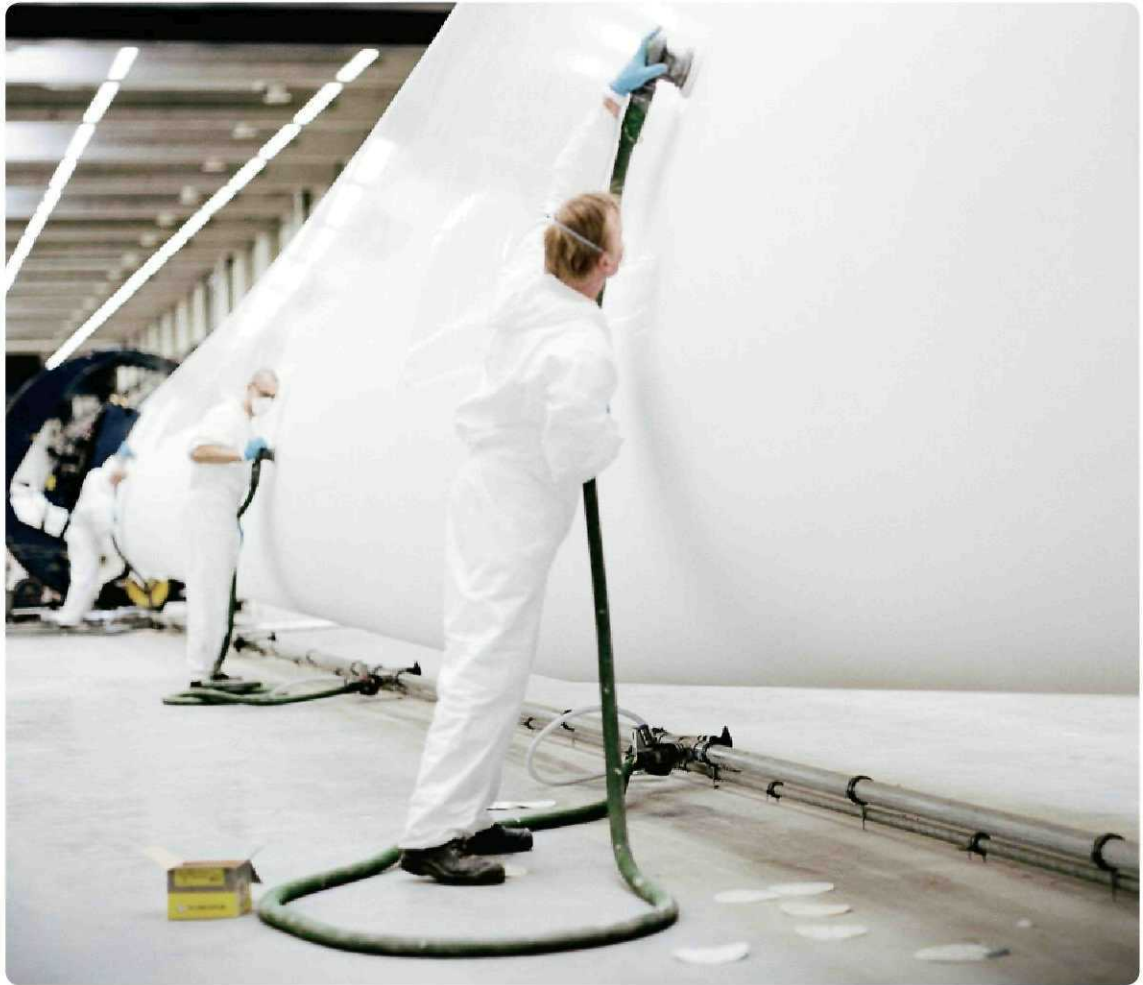
Towers:	IEC IIA	IEC IIIA	DIBt II
Hub height:			
80 m	150 t	150 t	-
95 m	200 t	-	200 t
105 m	-	-	225 t

t = metric tonnes.

DIBt towers are only approved for Germany.

All specifications subject to change without notice.

Built on experience



State-of-the-art wind turbines are not developed in a vacuum. To create the new V90-1.8 MW and V90-2.0 MW turbines for low and medium wind, we have drawn on the vast experience gained as the leading supplier of wind energy systems in the world. In particular, we applied successful design elements from our existing range of turbines.

We began with the nacelles of our tried and tested V80 wind turbines, which feature OptiSpeed® generators for maximum productivity. To these, we fitted the revolutionary new blades from our high-wind V90-3.0 MW. We then modified the components to ensure optimal harmonisation and to make the very most of the target conditions.

The resulting V90-1.8/2.0 MW turbines are optimised for sites with low turbulence and low and medium winds. These innovative wind turbines are so successful that they can actually generate 25 per cent more energy than the corresponding V80s.

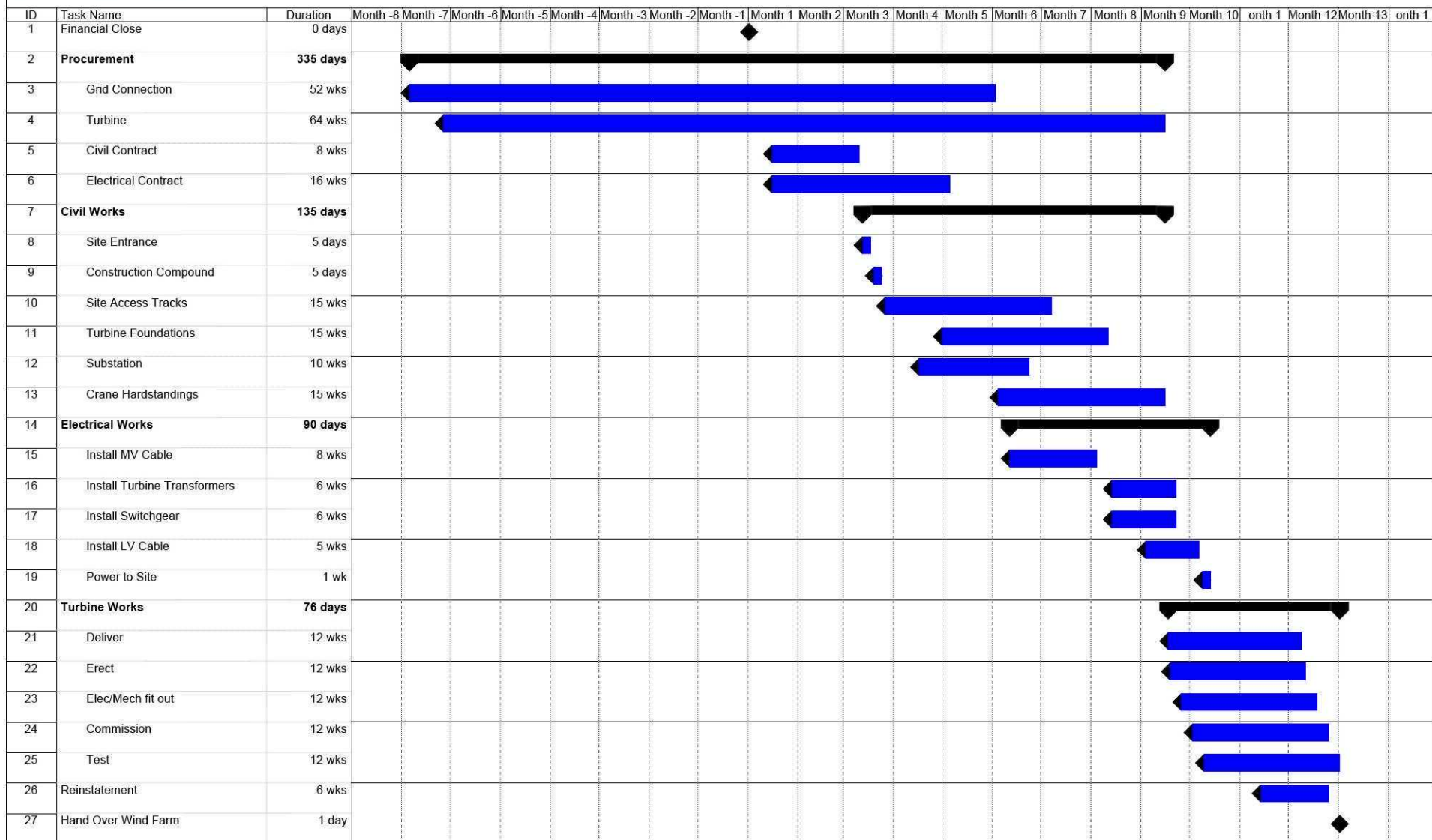
Naturally, the new integrated turbines feature innovations of their own innovations. For instance, Vestas engineers spent two years designing a more efficient and more robust gearbox. Moreover, while the 90-metre rotor weighs approximately the same as the V80 rotor, the longer blades mean higher loads, so we also reinforced the transmission and other major components of the V90.

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To see a complete list of our
sales and service units, visit
www.vestas.com



Wind Farm Construction Programme



Third Party Activities

Offsite Activity

Summary

External Milestone

Task

Milestone

External Milestone

Deadline

APPENDIX 4.3 RES Emergency Preparedness and Response and spillage Procedures

RES use an Environmental Management System (EMS) in accordance with the ISO14001 standard. The EMS identified activities that RES undertakes that may have an effect on the environment; preventative and improvement procedures have been put in place to address these activities and are used on RES construction and operational wind farm sites.

Environmental Emergency Preparedness and Response Plan

The RES Environmental Emergency Preparedness and Response Plan provides guidance to RES staff and subcontractors working on RES construction and operational wind farm sites.

The Plan details the system for the identification of, potential for, and response to, environmental accidents and emergency situations occurring on a RES construction or operational wind farm site; in order that the environmental impacts can be prevented or mitigated for.

In the event of an environmental emergency occurring on a construction or operational wind farm site, the member of RES staff or subcontractor who noticed the emergency will follow the work instruction put in place to address the situation e.g. oil spills; this will provide guidance on contacting the EA for further advice on dealing with the emergency.

Emergency Procedure in the event of a spillage

This procedure details the emergency procedure to be followed and actions to be taken in the event of an oil, fuel and chemical spill occurring on a RES wind farm construction site or an operational wind farm site.

Spill kits of appropriate form and size for the controlled substances being used are supplied on site; they are also present on any mobile refuelling bowsters on construction sites. In the event of a spill occurring on a wind farm construction or operational site trained personnel shall immediately deploy the spill kit in accordance with the manufacturer's instructions. Used spill kits and any other contaminated material e.g. rags used during the incident are disposed of in accordance with the Environmental waste management regulations, by a licensed disposal company and waste transfer certificates retained. The EA will be informed of the incident and further advice sought if required.

APPENDIX 4.4 RES ENVIRONMENTAL REQUIREMENTS FOR SUBCONTRACTORS

This document identifies environmentally safe working procedures and standards for particular operations that must be implemented by all subcontractors when working on a site managed by RES. The procedures have been developed to ensure that RES and all its subcontractors comply with Environment Agency Pollution Prevention Guidelines, and additional planning requirements set out by the Local Planning Authority and other enforcing bodies. As part of the procedure an environmental checklist has been created, which is completed on site every 2-3 weeks by the site manager. Detailed below is the scope of the procedures contained within the document, and a brief summary of what is required of the subcontractors on-site.

1.0 Existing Features

1.1 Contaminated land

Any remediation or disposal of contaminated land will only be carried out following consultation with the local environmental authority, if no work is required on the contaminated land it will be fenced off to prevent disturbance.

1.2 Underground services

Assessment of the hazards for underground services where present shall include an assessment of the environmental impact of damage during construction

1.3 Existing storage tanks

Any old containers found on site will be checked and emptied by a Licensed Waste Carrier before removal. Copy of licence certificate will be obtained and handed to RES site manager for inclusion in Project Health and Safety File.

1.4 Protection from vandalism

Vandalism, theft and tipping are common causes of pollution and the compound area should be adequately protected by fencing and locked to discourage unauthorised access. Any occurrence of tipping on the site will be reported to site management who will inform the local environmental authority and the police if necessary

2.0 Site Drainage

2.1 Surface and foul water drains

Surface water drains should carry uncontaminated rainwater only and shall be protected from ingress of silt, or any other contaminants. Wet cement and raw concrete shall never be allowed to enter any watercourse

3.0 Deliveries

3.1 Fuels and oils

Fuel and oil deliveries shall take place within the designated refuelling area only; a responsible person will supervise site deliveries to ensure that the correct amount of material is delivered to the correct tank and that the level is checked prior to refilling to avoid spillage

4.0 Storage of Fuels, Oils and Chemicals

All fuels and oils will be stored in a designated area only, including mobile bowsters when not in use. Generators permanently stationed in site compound (used for powering site cabins) will be kept in the designated refuelling area, or be banded (the bund shall be capable of containing 110% of the fuel tank's capacity) or shall have a double skinned fuel tank. Chemicals on site will be stored in accordance with their COSHH assessment and appropriate spillkit kept by subcontractor.

4.1 Security

All bowsters will be stored so as to minimise the risk of collision, run-away and vandalism. They will not be stored adjacent to watercourses. When not in use, bowsters will be securely stored in the designated refuelling area.

4.2 Marking

The contents of any tanks on site will be clearly marked. Warning notices including "No smoking" and "Close valves when not in use" shall also be displayed

4.3 Removal

No tanks or containers may be perforated or dismantled on site. A competent operator will empty all contents and residues for safe disposal elsewhere.

5.0 Waste management

5.1 Treatment and storage

All waste will be stored in designated areas that are isolated from surface drains, prior to removal from site.

Skips will be covered to prevent refuse blowing away and rainwater accumulating. They will be replaced when full and the contents disposed of in accordance with statutory requirements

5.2 Disposal

Chemical containers, used oil and filters, solvents, paints, electrical items, contaminated materials and hazardous refuse are all classified as “special waste” and, as such, will be stored in a bunded area away from watercourses and disposed of by licensed contractors in a controlled manner.

6.0 Earthworks

6.1 Dealing with silty water

Silty water can arise from excavations, exposed ground, stockpiles, wheel-washing and site roads and water containing silt will not be discharged directly into rivers, streams or surface water drains.

Wherever possible, silty water should be avoided. However, where it does occur it is vital that the silt that is held in suspension is allowed to settle out before the water reaches a watercourse.

Drainage treatments during the construction phase of a wind farm vary in cost, complexity and appropriateness. Several solutions RES may adopt for dealing with silty water are presented here:

Flat grassed area - Where the topography allows, existing grassed depressions are ideal for the natural filtration of run-off containing silt. However it is important to ensure that water issuing onto such areas is not causing erosion en route, and also that the volume of silt being deposited in the settlement area is tolerable.

Sumps - A sump dug prior to any site drainage reaching an existing watercourse will act as a settlement lagoon. The level of accumulated silt should be monitored and lowered through controlled removal (such as a sludge tanker) when necessary. Series of sumps may be necessary to deal with larger discharges.

Settlement/separation tanks - These proprietary tanks operate on the same principle as the sump. Their performance is often enhanced by the inclusion of a baffle which prevents water overshooting the settlement tank, as shown below. This baffle arrangement has the added advantage of acting as an oil separator in the event of such pollution reaching the tank. Sophisticated separators, or interceptors, which monitor the silt/oil level trapped are available. The tank size, layout and number of baffles can all be selected to identify the most appropriate arrangement.

6.2 Excavations

Where possible, water will be prevented from entering excavations. Use of cut-off ditches and well point de-watering may be necessary. Water discharged by any pumping arrangement will be dealt with according to the site drainage plan

6.3 Topsoil Stripping and Reinstatement

It is of paramount importance to minimise disturbance to flora and fauna whilst carrying out the construction works, and to ensure that disturbed habitats will regenerate quickly after completion of the works. Topsoil and vegetation (stored separately from subsoil) will be retained and reinstated over the track shoulders and all other areas of stripped ground, as soon as possible to prevent erosion and leaching.

On wet and marshy ground it may be necessary to store excavated materials on a geotextile in order to minimise disturbance to the vegetation below.

6.4 Exposed ground and stockpiles

The total quantity of exposed ground and stockpiles, and storage duration will be minimised in order to minimise generation of silt and dust. If long-term storage is required then stockpiles can be seeded or covered and silt fences constructed from a suitable geotextile. In dry weather dust suppression measures may be required.

7.0 Plant

7.1 Refuelling

Where possible, mobile plant will be refuelled in the designated area. Where plant is to be refuelled outside this area a double skinned bowser must be used and re-fuelling will take place over a drip tray. Refuelling shall always take place away from watercourses or surface drains

7.2 Maintenance

Plant and site vehicles are to be well maintained and any vehicles leaking fluids must be repaired or removed from site immediately. Any servicing operations will take place over drip trays.

8.0 Road Cleanliness

8.1 Site roads

Site Roads will be brushed or scraped as required to minimise dust and mud deposits, especially at site entrances and any watercourse crossings. If necessary during dry weather, dust suppression may be achieved by spraying water onto the site tracks to dampen down the airborne dust particulate.

8.2 Public Highways

Measures will be undertaken throughout the construction phase of the wind farm to ensure that dust and mud does not migrate onto the adjacent public highways, private roads or accesses. This may require the establishment of a wheel washing station comprising an apron onto which vehicles will drive in order to clear the wheels and undersides using a power washer. Any water used during the wheel washing process will be collected and passed through a silt trap before discharging into a soakaway. Run off water will be channelled via a silt trap into a purpose made soakaway and will not be discharged directly into watercourses.

9.0 Drip Trays

After use the drip tray will be cleaned using an appropriate absorbent material which will be disposed of in accordance with COSHH regulations. Drip trays will be regularly checked and cleaned.

10.0 Concrete

Concrete is highly alkaline and corrosive and can have a detrimental impact on watercourses. Washing-out of concrete wagons on site will not be permitted, unless in a designated sealed wash-out pit. No tools, equipment or materials will be washed in watercourses. Mortar mixing and material storage areas must be away from watercourses.

Sulphate resistant concrete shall be used where geological conditions dictate, to prevent long term corrosion of concrete (local release of alkaline compounds) due to sulphate attack.

11.0 Wildlife

Wildlife shall be protected from entering and becoming trapped in any part of the works on the site. For excavations this may mean that fences, crossings or escape routes are necessary.

APPENDIX 4.5: RES SUDS DESIGN PHILOSOPHY

Sustainable Drainage System (SUDS)

RES will appoint a SUDS Designer to undertake a detailed sustainable drainage design for the proposed wind farm site. The outline design philosophy statement presented here explains the rationale behind the SUDS proposals that have been developed for the proposed infrastructure required for the wind farm.

The main objectives of the Statement include the following:

- Propose appropriate, robust and buildable SUDS techniques for the prevention of erosion and the removal of silts from the runoff.
- Provide a sustainable drainage specification for the construction phase of the development.

Details on the timings, temporary works, and site drainage and pollution prevention measures which would be incorporated as part of the SUDS are described below.

The assessment also identifies construction and post construction maintenance requirements.

Relevant Guidance and Legislation

It is proposed that all drainage relating to the wind farm will be constructed using best practice and in conformance with the requirements of Environment Agency and other regulatory authorities. The key legislation and guidance which will be adhered to in the development of the SUDS design are defined as follows:

- EA Pollution Prevention Guidance Notes (PPGs);
 - o PPG 1 General guide to the prevention of water pollution;
 - o PPG 2 Above Ground Oil Storage Tanks;
 - o PPG 5 Works in, near or liable to affect watercourses;
 - o PPG 6 Working at construction and demolition sites;
 - o PPG 21 Pollution incident response planning.
 - o PPG23 Maintenance of structures over water
- Industry Guidance Documents
 - o CIRIA Report C502 Environmental Good Practice on Site;
 - o CIRIA 522 - Sustainable Urban Drainage Systems; Design Manual for England and Wales
 - o CIRIA Report C532 Control of Water Pollution from Construction Sites
 - o CIRIA Report C648 Control of Pollution from Linear Construction Project. Technical Guidance
 - o CIRIA Report C650 Environmental good practice on site
 - o CIRIA Report C651 Environmental good practice on site checklist
 - o CIRIA Report C609 - SUDS - hydraulic structural & water quality advice
 - o CIRIA Report C697 - The SUDS Manual
- Forestry Commission, Forests and Water, 4th Edition
- BS6031:1981 Code of Practice for Earth Works
- DEFRA Good Practice Guide for Handling Soils (MAFF 2000)
- Water Order 1999;
- The Surface Waters (Dangerous Substances) (Classification) Regulations 1998;
- The Private Water Supplies Regulations;
- UK Water Quality (Water Supply) Regulations 2001;
- Groundwater Regulations 1998
- Control of Pollution Act 1974
- UK Water Quality (Water Supply) Regulations 2000
- EC Fisheries Directive (78/659/EEC)
- Land Drainage Act 1991
- Water Framework Directive (2000/60/EC).

Design Criteria

The design criteria for the SUDS are:

- Minimise any change to the hydrology and groundwater conditions within the site. We propose the use of source control to deal with water close to where it hits the ground, rather than conveying it for long distances to large balancing ponds. Under the ethos of SUDS it is proposed, where physically possible, to replicate natural drainage in the area.
- Minimise sediment loads in the runoff, with particular attention being given to the construction phase of the project
- Maintain runoff rates and volumes at Greenfield rates for a range of storm events.
- Where appropriate, treatment facilities will be designed to offer a retention time of between 24 and 48 hours
- Incorporate additional pre-settlement ponds on internal drains, which will not only provide extra settlement capacity, but also offer better control over the transport of sediment through the site.
- Avoid high flow velocities, particularly at the entry point to the final settlement pond. Energy dissipation devices or multiple outflow structures will help avoid the re-suspension of sediment.
- The drainage system should manage problems of erosion and provide for reinstatement of vegetation along the access track.
- Ensure that the runoff discharged from the site is in compliance with Fisheries Act and EC Freshwater Fish Directive (78/659/EEC).

These design criteria can then be translated into an outline design philosophy.

SUDS Design Philosophy

In order to meet the design criteria the following philosophy has been developed.

Road and hard-standing runoff will be handled by sheet flow to the side ditches or swales. The cross-fall on the road will be aligned in the downhill direction in line with the natural hydrology of the site. The slope from the road/hard-standing to the ditch will be suitably profiled to reduce the volume and rate of runoff and prevent erosion. Any vegetation used will be appropriate to the local area. Hardstandings and tracks will be constructed from aggregate and will not be surfaced, thus helping to reduce runoff volumes. This has been allowed for within the design philosophy through the utilisation of a reduced runoff coefficient of 75%, and a heavy silt loading assumed as defined by D'Arcy et al (2000), for light industrial and engineering land uses

The ditches (swales) will be primarily used to hold water temporarily and to encourage infiltration / discharge into the ground locally to where the rainfall hits the ground. This avoids concentrating large volumes of water into point discharges. This will be achieved through the provision of small check dams at approximately 40m centres along the swales. The stone used for the construction of the check dams will be 20mm 'clean' graded stone. On steeper slopes the check dams will be reinforced using larger 100mm stone placed on the downhill side of the dam to prevent washing away of the small stones. The check dams will serve dual functions, both removing and settling out silts and reducing flow velocities, therefore mitigating against the effects of erosion within the swale.

Also, swales will provide a flow route in extreme events to carry water to the existing surface water channels across the site.

Trackside drainage will empty into spillways placed at regular intervals along the channels. This method will decrease both the net dewatering of the area and the amount of additional flow entering the watercourses.

Under-track drainage will be provided with associated sumps and check dams. The under-track drainage will provide a means for flows to pass from a swale on the uphill side of the slope to the downhill side of

the slope. Where the track runs tangential to the fall of the slope the under track drainage will assist in balancing flows between the swales on either side of the access road.

Small balancing ponds will be required for the majority of turbine locations. Where practicable the number of ponds will be rationalised. The general location of the small balancing ponds should ensure that they pose minimal health and safety risk to site personnel, particularly whilst constructing the wind turbine rotors during the installation process (as this process takes place adjacent to the crane hard standing).

All swales and ponds will be kept as shallow as possible. Maximum depth of standing water will be limited to 0.5m within the ponds and 0.3m within the swales.

The use of large balancing ponds will be avoided and there will be no merit in using other methods such as filter drains or hard permeable surfacing due to the lack of infiltration capacity and high groundwater levels across the site

The level of silt in runoff during construction will be monitored and if it is excessive in any area this can be managed by providing straw bales locally around the problem areas. These will filter the runoff and trap silt.

Field drains/streams will be piped directly under the track through appropriately sized drainage pipes. Where appropriate a lateral drainage ditch will be cut along the uphill side of the track to intercept the natural runoff. This lateral drain will be drained under the track at regular intervals through correctly sized cross drains to the downhill side of the access track.

Where appropriate, a second lateral drainage ditch on the other side of the road will catch runoff from the track itself. Flows from this ditch will be treated by filtration through check dams, settlement at sumps and filtration through geotextile attached to the inlet end of the discharge pipes.

In cases where the tracks must run significantly downhill, transverse drains ('grips') will be constructed where appropriate in the surface of the tracks to divert any runoff down the road into the drainage ditch.

Where burn or stream crossings cannot be avoided, the design of the crossing, either culvert or bridge, shall be prepared in line with Environment Agency guidelines.

Appropriate site management measures will be taken to ensure that runoff from the construction site is not contaminated by fuel or lubricant spillages. Earth spillages into any existing streams will also be avoided. There will be no discharge of trade effluent, sewage effluent or contaminated drainage into any watercourse system or ditch. Any dewatering from excavations will be via surface silt traps to ensure sediment does not enter surrounding watercourses.

Silt runoff from stockpiles and excavated spoil heaps will be contained through the placement of geotextile silt fences (or straw bales) on the downhill side of the stockpile.

The proposed SUDS design provides a surface water management train that will mitigate any adverse impact on the hydrology and hydrogeology of the site and surrounding areas.

Detailed Considerations

If swale calculations show excessive flow velocity ($> 1.5\text{m/s}$) and negligible residence time ($< 10\text{mins}$) along the steeper gradients of the access road, check dams will be incorporated into the design to slow flow velocities down and prevent erosion and to enhance treatment. Check dams will still be provided along the shallower and 'flat' sections of the access road to intercept silts at source.

It is proposed that rock filled dams will be used as part of the SUDS system. The 20mm crushed rock should be locally won, and will constitute the majority of the check dams. On steeper slopes these dams will be protected from washing away with the placement of larger stone ($> 100\text{mm}$) on the downhill side of the check dam. It is noted that it may not be possible to produce sufficient volume of stone within the borrow pits of sufficient quality or grading to construct the check dams for the site. It is intended that

these dams will be relatively simple and cost effective to construct and therefore correctly specified stone may need to be imported from off site.

Geo-textile filtration dams will be utilised should the requirement arise upon the agreement of the SUDS designer and Site Engineer. These dams will only be installed at locations of the site which have been identified as particularly sensitive to silt runoff. It is noted that the dams would require regular maintenance during the construction phase and would be removed completely on completion of the construction phase where silt within the runoff has significantly reduced. The geo-textile filtration dams would be installed after a series of stone check dams.

There will be regular outflow points (spillways) from the swales throughout the SUDS system to eliminate the potential of the generation of large flows and to maintain / mimic the natural hydrological response displayed by the catchment. Spillway points would be formed by providing a notch through the embankment on the downhill slope side of the access road. Where it is not possible to form a notch, a length of polypropylene pipe will provide the means of discharge through the embankment. Where possible, these outflows will be directed away from watercourses, to increase the drainage path to the watercourse.

Figure 4.10 details the typical long section and cross sections and plan view for the stone check dams, swales and discharge points.

For the turbine hard-standings, drainage will be by swales to mini settlement ponds. These will either infiltrate the water to the ground or discharge over open vegetated areas across the site. A typical turbine base hard-standing area and associated access road will require 25m³ of storage. Typical cross section and plan views for the settlement ponds are also detailed in Figure 4.10.

RECOMMENDATIONS FOR CONSTRUCTION OF SUDS

It is highlighted that the road layout design and SUDS design have been developed to minimise and mitigate for the effects of pollution to all local watercourses. However, this does not remove all environmental responsibilities from the contractor / sub-contractors. All site personnel will be made aware of their environmental responsibilities at the site inductions and by detailed method statements/risk assessments.

This section of the report outlines the steps which should be undertaken during the construction phase of the project to ensure compliance with the relevant guidance and legislation outlined above. Site visits by the SUDS designer will be undertaken at various stages of the construction process to ensure that the proposed SUDS scheme is being constructed in line with the design.

In accordance with BS6031: 1981 Code of Practice for Earth Works, land disturbance will be kept to a minimum and disturbed areas will be stabilised as soon as possible. Soil handling will be undertaken with reference to best practice guidelines available from DEFRA in the form of the Good Practice Guide for Handling Soils (MAFF 2000). In principal, soil excavation will be undertaken during dry periods where reasonably practicable. However, it is noted that due to other factors such as bird nesting season and fish spawning season, most of the work at the site will be undertaken during autumn / winter periods and therefore working only during dry weather may not always be practicable or feasible.

Essential mitigation measures relevant to controlling erosion and runoff from construction of the SUDS are described in Environment Agency's Pollution Prevention Guidance and Special Requirements.

Working in the Vicinity of water / Buffer zones

The following recommendations apply to the general construction activities either within the watercourses or in the vicinity of watercourses.

- Ensure roads are built to the layout design and therefore remain outside the relevant buffer zones to rivers and watercourses.
- Minimise construction near streams in wet weather.
- Avoid using acidic, metal or sulphide-rich spoil from mine workings for road construction.

- Plan so that roadside drains do not discharge directly into watercourses, but rather through a buffer area of adequate width (see below).
- Keep cement and raw concrete out of watercourses.
- Runoff from excavations will NOT be pumped directly to watercourses.

Following the advice of the Forest and Water Guidelines 4th Edition (Forestry Commission 2004) the following buffer zones will be implemented for watercourses that are not sensitive in terms of fisheries, spawning areas or extraction points being located downstream.

"In terms of providing adequate protection for the aquatic zone, a width of 20 m on either side will generally suffice for larger watercourses with a channel more than 2 m wide. A minimum buffer width of 20 m should also be left along the shore of lakes and reservoirs. For small streams, practical constraints mean that the minimum buffer widths should be 10 m on either side for channels 1-2 m wide and 5 m on either side of channels up to 1 m wide (unless highlighted as being important for fish spawning when a minimum buffer width of 10 m should also apply to either side of channels less than 1 m wide)."

Where there are important fish spawning areas, fisheries or abstraction points located downstream, the stated buffer zones will be increased by a factor of two. It is noted that treatment techniques will be utilised to remove silts from all contaminated runoff prior to the discharge of flows over the open vegetated areas

Buffer zones will be designated using a drainage management plan for the site, which will be developed as part of the Construction Management Statement for the site.

Watercourse Diversions

The following procedure will be followed for the installation of any minor watercourse diversions located across the site.

- The diversion channel must be excavated leaving a plug at each end so that the existing watercourse does not breach into the diversion channel in an uncontrolled way;
- Compact the diversion channel bed, and use a geotextile layer to provide a non-erodable surface as required;
- Open the downstream plug first, allowing some water to flow back up the diversion channel;
- Then open the upstream plug;
- Place a non-erodable dam (i.e. compacted earth with a geotextile layer over the top) in the upstream part of the old channel to direct all flows into the diversion channel;
- Place a non-erodable dam in the downstream part of the old channel, preventing backflow.

Water Crossings

Recommendations have been made for the undertaking of fish surveys at all water crossing locations to establish the presence of migratory fish. For the installation of minor water crossings where it has been proven through survey that migratory fish are not present, the following procedure should be followed:

- Place a filtration check dam downstream of the proposed works.
- Provide cut-off channels at the top of the banks to divert flows away from the proposed water crossing area.
- Prepare the channel bed, and use a geotextile layer to provide a non-erodable surface.
- Put the stone surround and culvert in place.
- Backfill with specified stone materials.
- Provide erosion protection at the inlet and outlet points to the culvert.
- Provide bunds along either side of the top of the crossing to ensure that runoff does not discharge directly into the watercourse.
- Remove the infiltration check dam upon completion of construction activities and when there is no longer a risk from silt pollution.
- *It should be noted that major water crossings will be designed on a bespoke basis. Each water crossing will be sized to convey a 1 in 100 year return period flood event and designed to suit the specific requirements and constraints of its location. The details of all main water crossings and diversions will be submitted to Environment Agency to obtain all necessary consents and in general will follow the construction procedure outlined above.*

Should there be any incidents of pollution to the watercourses Environment Agency would be notified immediately. Immediate steps will be undertaken to resolve the cause of the pollution.

Swales /Access Roads

- Scheduling construction activities to minimise the area and period of time that soil will be exposed, particularly during winter periods;
- Installation of cut-off drains around the working areas to intercept uncontaminated surface runoff and divert it around and away from the works;
- Minimising the stockpiling of materials and locating essential stockpiles as far away as reasonably practicable from watercourses
- Keep drains and culverts clear of debris and maintain silt traps. Do not dump spoil within buffer areas.
- Carry out drains maintenance only in dry weather after September and consider leaving undisturbed sections or using straw bales to act as temporary sediment traps.
- Ensure that road cambers are adequate and rutting is kept to a minimum.
- Avoid erosion of embankments and, where possible, maintain a vegetation cover.
- Inspect roads, drains and silt traps for damage after intense storms and also before and after any intensive use
- Minimise using quarry dust as a surface dressing for roads.
- Geo-textile will be fixed to the inlet end of some discharge pipes to act as an additional stage in the treatment process. Geo-textile will only be fixed around the inlet of pipes where the discharge location is deemed to be sensitive or the primary treatment stages (check dams and settlement sumps) have not been fully effective.
- Where a geo-textile filter has been fixed to the inlet end of a discharge pipe, this will be checked regularly and replaced if required. Geo-textile filters will be removed at the end of the construction phase or whenever the levels of silt within the runoff have significantly reduced.

Mini-Settlement Ponds

- Installation of cut-off drains around the working areas to intercept uncontaminated surface runoff and divert it around and away from the works; surface water runoff may also be diverted around the excavation using heavy timbers or similar laid on the surface of the ground.
- Minimising the stockpiling of materials and locating essential stockpiles as far away as possible from watercourses
- Inspect mini-settlement ponds for damage after intense storms, in particular at the entry point and around the forebay area.
- Mini settlement ponds are to be in-filled and the surrounding area fully rehabilitated post construction phase. Construction waste materials such as generated silts and gabion baskets should be disposed of in an appropriate manner.

Turbine Bases and Crane Pads

- Installation of cut-off drains around the working areas to intercept uncontaminated surface runoff and divert it around and away from the works; surface water runoff may also be diverted around the excavation using heavy timbers or similar laid on the surface of the ground.
- Minimising the stockpiling of materials and locating essential stockpiles as far away as possible from watercourses
- The base of the excavation will be constructed level, and water will be gathered in a sump, and pumped at a low flow rate into either the mini-settlement pond or road swale.
- If pumping of flows to a SUDS feature is not feasible or the rate of flow is too high then flows will be collected and pumped out to the downhill side of the excavation over an area of flat land and well away from watercourses.
- If the downhill slope is steep a shallow trench will be dug parallel to contour lines, to ensure it filters into the soil layers. The trench will be in-filled with the excavated material after completion of the turbine base.
- The foundation working areas will be re-vegetated as soon as practical after construction.

Substation, Temporary Compounds

- During construction of the substation and temporary compounds, similar measures to those implemented during turbine/crane pad construction will be used to limit water ingress, sediment

erosion and concrete pollution. Particular care will be taken during the construction of infrastructure situated on peaty soils to prevent dewatering of the surrounding soils and prevent soils slumping during excavation.

- Cut-off drainage channels around compounds will direct water away from the construction site in order to prevent water entering foundation excavations or carrying sediment away from the site.

Cable Trenches

- To minimise impacts from disturbance, cables will be laid in small trenches along the side of access tracks as far as possible.
- The trenches will be dug during drier periods, if practical, and any spoil material will be temporarily placed on the uphill slope to reduce the likelihood of runoff entering the excavations.
- The electric cables will be quickly placed within the trenches and soils replaced to minimise the ingress of water into the trenches.
- Temporary silt traps will be provided in the longer trench runs and on steeper slopes.
- Swale slopes are to be correctly reinstated post infilling of the cable trench.

Proposed Road Construction

- Any runoff containing soil from construction will flow to track-side drainage channels (dug as tracks are constructed). Permanent drainage structures will be constructed as soon as is practical after the construction of a stretch of road.

GENERAL PROGRAMME FOR INSTALLATION OF SUDS / DECOMMISSIONING OF SELECTED SUDS FEATURES

Installation

Where feasible the SUDS will be constructed prior to, or at the same time as the access roads

Where work carried out to construct the swales and check dams in advance of the construction of the access road is likely to cause increased detriment or adverse environmental impacts to the hydrological processes of the site; under such circumstances the SUDS system will be constructed after the access road and interim measures such as the placement of straw bales will be employed.

Suitable prevention measures will be in place at all times to prevent the conveyance of silts to receiving water courses.

Before runoff is allowed to flow through the swales, surety must be given by the contractor that the swales are fully stabilised and will not be affected by erosion. This will prevent the erosion of the sides and the base and clogging of other parts of the system by the silt that is generated. Where there is likelihood that the swales could be affected by erosion, the base of the swale should be lined with a layer of geo-textile. Where feasible, the side slopes and base of the swale should be reinstated with vegetated sods which should be removed and stored as part of the excavation process.

Decommissioning

Some of the main treatment SUDS features are fundamental for the effective treatment of surface runoff flows during the construction phase. It is proposed that once the site has been completed and silt entrained within the runoff has been reduced to negligible levels, that some of the SUDS features will be decommissioned.

The following items have been considered as the main activities of work to be undertaken after the main construction activities for the wind farm site have been completed and all silt levels entrained within the runoff have reduced to negligible levels.

Activity - Mini settlement ponds are to be in-filled and the surrounding area fully rehabilitated post construction phase. Construction waste materials such as generated silts and gabion baskets would be disposed of in an appropriate manner.

Reason - Leaving the settlement ponds in place may pose a longer term health and safety risk to grazing livestock. Once all construction activities in the area have ceased and silt levels within the runoff have significantly reduced there should no longer be a requirement for the ponds.

Activity - Sumps along the access road are to be infilled with large open voided stone. Construction waste materials such as generated silts should be disposed of in an appropriate manner.

Reason - As with the ponds the main operation of the sumps will be during the construction phase. By infilling the sumps with large open voided stone, all health and safety issues will be removed whilst still retaining some settlement ability.

Activity - Removal of Geo-textile from inlet end of pipes. Geo-textile will be fitted to the inlet end of discharge pipes to act as an additional stage in the treatment process. Geo-textile will only be placed around the inlet of pipes where the discharge location is deemed to be sensitive or the primary treatment stages (check dams and settlement sumps) have not been fully effective. Removed sections of geo-textile and lengths of rope used to fix the geo-textile should be disposed of in an appropriate manner.

Reason - Geo-textile has a tendency to clog over time when used for this type of application. As with the ponds and sumps the main requirement will be during the construction phase. Removal will ensure that the inlet ends of discharge pipes are not blocked off, which could lead to flooding of the access roads.

Activity - Re-vegetation of foundation and crane pad working areas as soon as possible after construction of the turbine. A layer of geo-textile should be laid over these surfaces prior to the re-soiling and vegetation, to ensure that these materials can be easily removed, should it become necessary to gain access to the crane pad for maintenance purposes in the future. A sufficient area of the crane pad should be left uncovered to allow for dry access for maintenance personnel to and from the turbine and also to allow for the turning of maintenance vehicles.

Reason - To reduce the volume of runoff from the hard-standing areas around the site, the top layer of soil and vegetation can be scraped off at a later date should the crane hard standing areas be required. A layer of geo-textile will allow for suitable separation of the vegetative materials from the underlying stone sub-base.

SUDS MAINTENANCE MANUAL - RECOMMENDATIONS DURING CONSTRUCTION / POST CONSTRUCTION PHASE

Recommendations during Construction Phase

This report will serve as the primary SUDS System maintenance manual for the construction phase. As part of the working relationship the SUDS Designer will operate with RES, regular site inspections are arranged during the construction phase of the wind farm, in order for SUDS designer to validate that the SUDS specification is being adhered to by the contractor and to make additional recommendations where potential problems are identified.

In addition to the site inspections carried out by the SUDS Designer, the following construction inspections will be undertaken by the site engineer during the construction phase of the project.

- All Check dams and mini-settlement ponds to be checked at least once fortnightly via a walkover survey during the full period of construction. All excess silts to be removed and disposed of as agreed with Environment Agency. Where check dams have become full blocked with silt, they would be replaced.

Procedure for replacement of the check dam is as follows:

- Silt deposits to be removed from the upstream side of check dams.
- Removed silt to be disposed of by spreading in an area of the site where surface runoff will not convey silt deposits back to a water course.
- The existing 20mm stone check dams are to be removed and disposed of appropriately. Stone materials removed from the check dams should **not** be disposed of over vegetated areas of the site.

- Replacement check dam to be installed using 20mm stone.
- Where there are regular incidents of check dam blockage, further check dams to be installed (every 15-20m intervals) within the swales.
- Soil in the swales should not be smeared or compacted so that permeability is reduced.
- All excavations are to the required size and gradient and located in correct position.
- Ensure side slopes are correct.
- Ensure depth of excavation is correct.
- Any excavated materials should be placed in such a manner that any instability of excavated materials will not cause infilling of the swale.
- Debris (e.g. loose roots) to be removed from the base of the swale.
- If, during the course of developing the site, the Engineer uncovers a watercourse not previously evident, he should advise the local Environment Agency office immediately in order that arrangements may be made for investigation and direction in respect of any necessary measures required to deal with the watercourse. However, finding of further watercourses is viewed as unlikely, with a full hydrological survey having been carried out on the site.
- Should there be noticeable effects of erosion along the swales or at discharge points, suitable erosion protection measures such as placement of large stones or reno mattresses should be installed at the area affected.

Recommendations during construction / post construction phase

This section of the report will serve as the primary SUDS System maintenance manual for the post construction phase. It is recommended that a post construction inspection programme be implemented, with a walk over site visit to be undertaken on an ongoing 6-monthly basis (winter and summer preferably). Points to be considered during these inspections are as follows:

- *No excess silting from construction phase or post construction.* - Check dams and mini settlement ponds to be checked twice yearly on an ongoing basis. Where stone check dams have become clogged with silt, the check dam should be removed and replaced, subsequent to the removal of silt.
- Procedure for replacement of the check dam is as follows:
 - o Silt deposits to be removed from the check dams.
 - o Removed silt to be disposed of by spreading in an area of the site where surface runoff will not convey silt deposits back to a water course.
 - o The existing 20mm stone check dams are to be removed and disposed of appropriately. Stone materials removed from the check dams should **not** be disposed of over vegetated areas of the site.
 - o All new check dams to be installed using 100mm stone.
 - o Further check dams to be installed (every 15-20m intervals) within the swales along any steeper sections of the access road.
 - o *No excessive erosion or bare areas of planting.* - Should there be noticeable effects of erosion at discharge points, suitable erosion protection measures such as reno-mattress or placement of large stones (>150mm) to dissipate water energy levels should be installed at the area affected.
 - o Any materials excavated should be placed in such a manner that any instability of excavated materials will not cause further infilling of a swale or drainage feature.
 - o Inlets and outlets of cross drainage pipes are to be free from silt and debris. All litter to be removed from discharge points / outlets and inlets / outlets to be operating correctly.
 - o A maintenance record log should be maintained for all maintenance work carried out. Where problems persist on each six-monthly inspection, advice should be sought from the SUDS designer on an alternative drainage solution.

It is the long term objective of the SUDS design that the swales become fully vegetated. Should, over the course of the ongoing post construction inspection programme, it be found that over 30% of the swale along any part of its length be bare of vegetation, reseeding or planting should be considered to achieve 80-90% coverage. Vegetation of areas worst affected by lack of take up from vegetation may be assisted with the placement of an erosion control blanket or the use of bare earth as a temporary cover during the

wetter seasons. Areas should be seeded with a suitable grass mix as soon as the weather is conducive to seed germination. A suitable grass seed mix **must** be agreed with the local Environment Agency ecologist. It is noted that not all wind farm sites will be suitable for reseeding.

APPENDIX 5.1: Local Landscape Character

Cambridgeshire Landscape Guidelines, Landscape Character Area 8, Fenlands

The Cambridgeshire Landscape Guidelines identify the following landscape characteristics within the Fenlands:

- landscape of contrasts and variety with a haphazard pattern of settlement and tree cover superimposed upon the regimented and highly organised drainage patterns;
- A large open landscape combining numerous fens which can add changing visual characteristics;
- Distant views possible with scatterings of trees and individual trees which merge to produce a feeling of a more densely tree-covered horizon; and
- Isolated agricultural buildings, farmsteads and loose-knit villages are often prominent against a backdrop of a constantly changing sky where vast cloudscapes provide drama and visual delight.

Peterborough Landscape Strategy; Landscape Character Assessment for Peterborough City Council

The study identifies the area to the north east of Peterborough as within:

Landscape Character Area 4, the Peterborough Fens;

- Flat extensive and open landscape with panoramic views and large skies.
- Rectilinear field pattern reflecting the artificial drainage pattern.
- Isolated farmsteads mainly of Victorian to modern origin.
- Sparse tree cover generally limited to shelter belts/copses around farmsteads and avenues along drove roads.
- Road pattern typically rectilinear and raised above the surrounding peat fen.
- Scattered active and former mineral extraction sites.
- Settlement on the drained fen mainly of recent origin.
- Organic pattern of fields and stronger hedgerows around Thorney.

Landscape Character Area 5, the Peterborough Fen Fringe;

- Gently undulating landform slightly higher than adjacent fen.
- Evidence of former clay extraction, with clay pits now both nature reserves and a landfill site.
- Isolated farmsteads and residential properties.
- Large commercial buildings associated with the site of former brickworks.
- Some medium sized hedgerows containing a variety of species.
- Promontory of open historically cultivated land extending to the east up to the line of the Catswater Drain.

Wind Turbine Development: Landscape Assessment, Evaluation and Guidance

At a borough level, Breckland Council and King's Lynn and West Norfolk Borough Council commissioned a report entitled Wind Turbine Development: Landscape Assessment, Evaluation and Guidance (Land Use Consultants, August 2003) which identifies a number of Landscape Character Types that fall within the study area to the north east, east and south. These include 1. Open Coastal Marshes, 2. Drained Coastal Marshes, 4. The Fens - Settled Inland Marshes, 5, The Fens - Open Inland Marshes, 6. Wooded Slopes with Estate Land, 7. Farmland with Woodland and Wetland and 8. Settled Farmland with Plantations. The key characteristics of each of the landscape types are identified below:

Landscape Character Type 1. Open Coastal Marshes

- A medium scale landscape defined by extensive areas of salt marsh, shingle banks, sand dunes, brackish lagoons and reed beds marking the transition between land and sea. Although expansive and open, small details such as the winding creeks and small fishing boats reduce the sense of scale overall.
- Low lying with elevations predominantly ranging between 0 and 5m AOD.
- A flat landform - providing distant and open views across the marsh towards both the sea and inland.
- The saltmarshes are interspersed by tidal creeks and inlets that have a natural, organic form making for an irregular land cover pattern.
- Settlement is notably absent although views can be gained of the villages aligning the A149 in the adjacent Coastal Slopes landscape type.
- The coastal skyline is largely uninterrupted and smooth - giving way to wide open skies. The skyline inland from the North Sea marshes is greatly influenced by built form and the presence of woodland on the adjacent Coastal Slopes. The skyline inland from The Wash marshes is defined by the strong line of the sea defence bank.
- Views inland from The Wash marshes are restricted by the prominent sea defence bank separating the marshes from the adjacent Drained Coastal Marshes landscape type. Views inland from the North Sea marshes are defined by adjacent Coastal Slopes landscape type.
- Boat masts and posts carrying overhead wires from the main vertical elements. There are no obvious landmark features or strong points of focus.
- In some parts, the presence of people is evident on the marshes. The Wash marshes are inaccessible. Birds in flight bring a subtle source of movement but generally both areas feel calm and still.
- These are areas of immense ecological value and scenic beauty - reflected in the landscape (AONB) and biodiversity (SSSI) designations.
- Strong Sense of remoteness, tranquillity and wildness - a fluid, dynamic spectacle of sea, sand and sky.

Landscape Character Type 2. Drained Coastal Marshes

- A large scale landscape with an overwhelming sense of openness and exposure due to the simplicity of the land cover and landform.
- This area was reclaimed from the waters of The Wash and is delineated on its seaward extent by extensive sea defence walls.
- The land use is simple and repetitive - dominated by large, geometric arable fields that are intensively farmland and bordered by drainage ditches and dykes.
- Towards the east, the landscape appears less intensively farmland and there is an increase in tree cover, low gappy hedges are a feature.
- The landform is uncomplicated - flat and with an elevation range between -2m AOD and 5m AOD.
- The River Great Ouse, River Nene Outfall and River Welland cut through the landscape with significant sections canalised and embanked. A number of smaller, minor watercourses also meander through the marshes before entering The Wash.
- Views are both distant and panoramic, defined by wide open skies and a simple uninterrupted horizon often defined by the sea wall.
- There is a notable absence of vertical elements across most of the area and there are no obvious landmarks or points of focus aside from the strong visual line of the sea walls and the embanked rivers.

- Settlement and built structures are largely absent aside from the occasional isolated farmstead and the stationary caravans (and associated facilities) at Shepherd's Port and west of Heacham.
- Although greatly influenced by humans, the majority of the landscape feels both physically and perceptually remote.
- There are some localised pockets of human activity (such as at the caravan sites) but for the most part the landscape is remote, peaceful and still.
- Access is limited - major roads becoming unmade tracks lead to individual farms with Admiralty Point and Guy's Head marking the most seaward points accessible by car.
- Mixed shelterbelts, both aligning fields and field junctions, occur in some areas but are dispersed and infrequent and do not provide any degree of enclosure.
- Views into the adjacent Settled Inland Fens are for the most part uninterrupted. The rising slopes of the Wooded Slopes with Estateland to the east are apparent due to the changes in landform and land cover. From these elevated areas, to the east, there are extensive views over the Drained Coastal Marshes.

Landscape Character Type 4. The Fens - Settled Inland Marshes

- A large scale, low lying landscape offering distant, panoramic views that evoke a sense of openness. This open character is less evident where settlements, shelterbelts and orchards occur.
- Simplistic terrain characterised by a distinctly flat landform providing wide horizons. Earthworks in the form of rivers and creek embankments bring topographic change and strong, straight lines of contrast.
- An intensively farmed arable landscape comprising predominantly geometric fields divided by straight drainage channels and dykes. Field size is variable in places with small units defining settlement edges.
- Fruit orchards are a common feature with rectangular plots ordered into rows. These often channel views and where orchards occur alongside roads, views across the landscape are more restricted.
- Well served by a network of rural roads that follow an irregular path.
- The landscape appears well settled - with villages, towns, individual farms and properties generally in view. Settlement is predominantly aligning secondary roads and has a linear arrangement with villages often merging through ribbon development.
- The skyline has an inconsistent character and appears cluttered in places due to the varied heights, forms and textures of vertical elements including trees, pylons and buildings.
- Lines of pylons are dominant features slicing diagonally across the field system. The pylons and posts carrying overhead wires are frequently in view.
- Views can be gained to the edge of King's Lynn, Wisbech and Spalding
- The change to the adjacent Coastal Marshes and Open Inland Marsh landscapes is transitional and not always obvious.
- Large churches within villages are key landmark features - visible from long distances.
- The main roads - the A17 (T) and A47 (T) are busy through routes and the operation of farm machinery brings constant movement to the landscape.
- The sense of remoteness and tranquillity varies and is largely dependent on proximity to roads and settlement edges.

Landscape Character Type 5. The Fens - Open Inland Marshes

- A large scale landscape with extensive vistas and wide open skies evoking a strong sense of openness, exposure and isolation.

- The elevation of the landscape ranges between 1 m AOD to - 2m AOD resulting in a strikingly flat, low lying terrain.
- Strong geometric and linear landscape patterning defined by large scale intensive arable farming with extensive field units divided by a regular network of drainage ditches and dykes, long straight roads, large straight rivers and cut off channels.
- A largely unsettled landscape with small villages, hamlets and dispersed farmsteads with adjoining outbuildings.
- Isolated farmsteads are often surrounded by wind break trees that provide points of focus in a landscape largely devoid of landmarks or strong focal points.
- Posts carrying overhead wires are frequently in view.
- Pylons cross the landscape. These are conspicuous due to the lack of other vertical elements and form a strong contrast with the flat open horizontal plane.
- Drainage channels and dykes flanked with golden rushes and bright green grass banks draw the eye and contrast with the dark peaty spoils.
- Views into the adjoining Fens landscape - Settled Inland Marshes - are clear, however, the distinction between the landscape types is not obvious - appearing as one continuous landscape type where settlements are not in view.
- Long straight roads cut through the landscape and are important transport routes. These and the operation of large agricultural machinery bring a constant source of movement to the landscape. However, these do not dominate and the landscape, for the most part, feels empty and peaceful.
- The landscape does not feel remote because although largely unsettled, is dominated by human influences including the consistent presence of artificial drainage channels, ditches and dykes.

Landscape Character Type 6. Wooded Slopes with Estate Land

- Dominated by the presence of vast coniferous and mixed plantation woodlands and mixed estate woods but with substantial areas of land given over to arable farming, this is large scale landscape with contrasting degrees of enclosure. The small villages bring an intimate quality to the landscape.
- Elevation ranging between 10m and 30m AOD making for a gently undulating, sloping landform.
- The extent of tree cover impacts a dark, enclosed character to the landscape.
- Where the landscape is under arable cultivation, there are few vertical or divisionary elements such as hedgerows. Ditches, dykes and post and wire fencing define the field margins - offering wide open views towards the wooded areas where trees define the horizon.
- A well-managed landscape due to managed estates in the wider area and well tended villages.
- Views are restricted across much of the area due to the density of the plantations but with open views across arable land and channelled along the main roads.
- Aside from larger settlements, settlement comprises small scale villages of traditional style that are often focused around greens. Carstone is consistently used as a building material.
- The edge of King's Lynn brings an urban influence to the landscape - with views from the main A149 to modern developments and built structures.
- Within the landscape, visible built structures are generally discrete and there are few points of focus or landmark features.
- The landscape is cut by long straight roads including the main A149 (Hunstanton to King's Lynn road) that runs north - south through the entire area. These roads form the main source of movement. Away from this major road the landscape is for the most part quiet.

- Human influence is apparent and the landscape is neither physically or perceptually remote.

Landscape Character Type 7. Farmland with Woodland and Wetland

- Mixed agricultural fields, interspersed with woodland and areas of open water create a medium scale landscape with a varied sense of enclosure.
- With elevation ranging between 10m and 40m AOD, this landscape is flat to gently undulating.
- Much of the surface geology is defined by Sand and Gravel and previous and present day mineral extraction sites characterise much of the landscape. Restored workings are important for both recreation and biodiversity.
- Fields are irregular both in terms of size and shape and are bound by hedgerows that vary in terms of height, thickness and overall condition - evoking an inconsistent character.
- Settlement is concentrated on areas of higher ground and characterised by small scale villages and hamlets of a linear arrangement. To the north west, views can be gained of the urban edge of King's Lynn.
- Wooded horizons frequently characterise the skyline views. Pylons are also prominent features on the - occurring within the north and south of the landscape. Masts and posts carrying overhead wires are also frequently in view.
- The landscape has very few points of focus - churches associated with settlement are the most prominent landmark feature.
- Although some views into the landscape can be gained from adjacent character types, these are largely broken or filtered by the tree cover and landform.
- The A47 brings a clear source of movement to the landscape. However away from this transport corridor the landscape has a peaceful character.

Landscape Character Type 8. Settled Farmland with Plantations.

- Medium to large field units interspersed by area of woodland and belts that offer some degree of enclosure and impart a medium scale to the landscape.
- Elevation predominantly ranges from 10m - 30m AOD - gradually ascending inland and appearing for the most part very flat but with localised areas of gently sloping land.
- Arable crop production is the predominant land use and is defined by a variety of field margins. These are some small areas of pasture but these are limited.
- Areas of mixed woodland bring textural quantities and offer semi-enclosure in the landscape. Away from the woodland areas however, the landscape is open with distant views.
- Field margins range from ditches and dykes, hawthorn hedges, scrubby margins, and lines of poplar to areas where there are no visible boundary divisions.
- Although fields are geometric in form, due to the inconsistent nature of the field margins and the irregular location and shape of the wooded areas, the regularity of the land cover pattern is diffused.
- Scattered farm dwellings and small scale settlements of low density are dispersed throughout this landscape, connected by rural roads.
- Characteristic building materials are buff coloured brick and clay roof tiles.
- Suburban development on the edge of Downham Market (abutting the landscapes western edge) influences the character of this landscape type.
- The skyline is variable - appearing inconsistent in areas of mixed woodland and scrub, regular where views can be gained of the block plantations within the adjacent landscape, and feeling uncomplicated and open across the Fens.
- With the exception of views across and into the Fens, wooded horizons define much of the skyline.

- Landmark features include churches, located on higher ground, windmills at Fodderstone Gap and the British Sugar factory occurring within the adjacent Fens landscape type. There are, however, significant areas where there are no obvious landmarks or points of focus.
- Due to the predominantly flat landform, vertical elements from a strong contrast to the horizontal plane. In particular, lines of popular, scots pine and beech - marking field boundaries - are eye catching elements.
- A number of main routes cross through the landscape - the A10, A1122 and A134 - bringing a constant source of movement but away from these main routes the landscape is, for the most part, still and peaceful.

The Strategic Landscape Capacity Study for South Holland District Council

The Strategic Landscape Capacity Study for South Holland District Council identifies three Landscape Character types. The study has taken cognisance of the Wind Turbine Development: Landscape Assessment, Evaluation and Guidance and the National Character Context, LCA 46, The Fens in defining the landscape character within the South Holland District. Three of the four Landscape Character Types within the Landscape National Character study have been acknowledged in the study. These include:

The Settled Fens Landscape Character Type

- Predominantly flat topography, dissected by main roads, rivers, drainage channels and drainage ditches often on raised banks (1-3m).
- Primarily nucleated settlements with associated mature trees. Church spires and towers often rise above the mature vegetation to provide prominent landmark features.
- Medium to large fields with intensive market garden crops. Locally strong hedgerow elements.
- Views restricted by or foreshortened by shelterbelts and woodland or mature hedgerows.
- Visual detractors are overhead lines, electricity sub stations and power stations and urban fringe built form of light industry and glasshouse horticulture.

The Peaty Fens Landscape Character Type

- Flat topography dissected by long straight roads, rivers, drainage channels and drainage ditches, often on raised banks (1-3m).
- Predominantly linear settlement.
- Large scale, extensive views, and largely uninterrupted skyline.
- A sense of openness/exposure.
- A strong linear pattern, defined by geometric arable fields of cereal and root crops, bounded by drainage channels or drainage ditches.

The Wash Marshes Landscape Character Type

- Flat topography dissected by winding creeks, drainage channels and drainage ditches.
- Extensive open areas of salt marsh.
- Expansive views over the sea and inland.

Wide uninterrupted horizon.

- Occasional isolated farm buildings constructed primarily in brick.

Boston District Landscape Character Assessment - Desk Study

Black Fens Landscape Character Type

-
- A flat area with a strong geometric pattern and grain influenced by large water filled drains and canalised rivers.
 - Dominated by the influences of agriculture and geometric arable fields.
 - Limited built form of scattered farmsteads and horticultural greenhouses towards the boundaries with the Settled Fens.
 - A network of straight minor roads and farm tracks follow the geometric pattern of the landscape.
 - There are a few trees and a limited number of small rectangular woodland blocks.

Settled Fens Landscape Character Type

- The landscape has an organic pattern with a simple mix of relatively small scale elements.
- Frequent small historic settlements linked by winding minor roads.
- Arable farming and horticulture in irregular shaped fields with frequent glass horticulture.
- The flat landscape gives long distance views with vertical elements such as church towers and spires.

Sea Bank Fens Landscape Character Type

- The area is flat with raised sea banks which run parallel to the coastline.
- Mostly used for arable farming, geometric fields have drains around their perimeter.
- Views within the area are constrained by the sea banks but there are long views from the top of the sea banks across the Wash and the flat area of land to the north.

Wash Marshes Landscape Character Type

- Located on tidal flats where Boston district meets the Wash.
- Simple, large scale and largely unspoilt landscape which consists of a flat, open and undeveloped area of tidal salt marshes and mudflats with few man-made influences. The area is of international and national importance for nature conservation and is particularly important for the conservation of water birds.

The Grange Wind Farm



FLOOD RISK ASSESSMENT

- Final
- 4 March 2009



The Grange Wind Farm

FLOOD RISK ASSESSMENT

- Final
- 4 March 2009

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1. Introduction

SKM have been appointed by Renewable Energy Systems (RES) to perform a flood risk assessment (FRA) for a proposed wind farm at The Grange. This development is known as the Grange Wind Farm. This report outlines the results of the FRA and provides supporting documentation for a planning application for this site in accordance with Planning Policy Statement 25 (PPS25), *Development and Flood Risk*. PPS25 requires any proposed development located within or close to a flood risk area to undergo a detailed FRA.

1.1. Site Location

The site, which is shown in Figure 1 below, lies to the south of Sutton Bridge on Tydd St Mary's Marsh in the South Holland District, Lincolnshire, approximately 8 km north of Wisbech, and approximately 22 km south west of Spalding. The site is centred on grid ref: E546300, N319200.

To the north of the site is the South Holland Main Drain which flows from west to east. To the east of the site is Nene Way which is located on a flood defence bund to the Nene Outfall Cut or River Nene which lies beyond the road. The River Nene flows from the south west to north east towards the sea and is tidal at this point. To the south of the site beyond the road between Tydd Gote and Sutton Bridge is the North Level West Drain which flows from the south west to the north east towards the sea. To the west of the site is Wisbech Road (A1101).

Tydd St Mary's Marsh lies within a region where drainage is controlled by several Internal Drainage Boards (IDB). The IDBs maintain an extensive network of surface drains, sluices and pumping stations to prevent flooding of agricultural land and developed areas across the region. The site is located within the south eastern boundary of the South Holland Internal Drainage Board (SHIDB), which manages the South Level Main Drain. SHIDB have been consulted as part of the Grange Wind Farm hydrology assessment. The North Level Internal Drainage Board (NLIDB) manages the North level West Drain, which is located more than 9m away from the site. The EA manages the River Nene.



■ **Figure 1 - Site Location**



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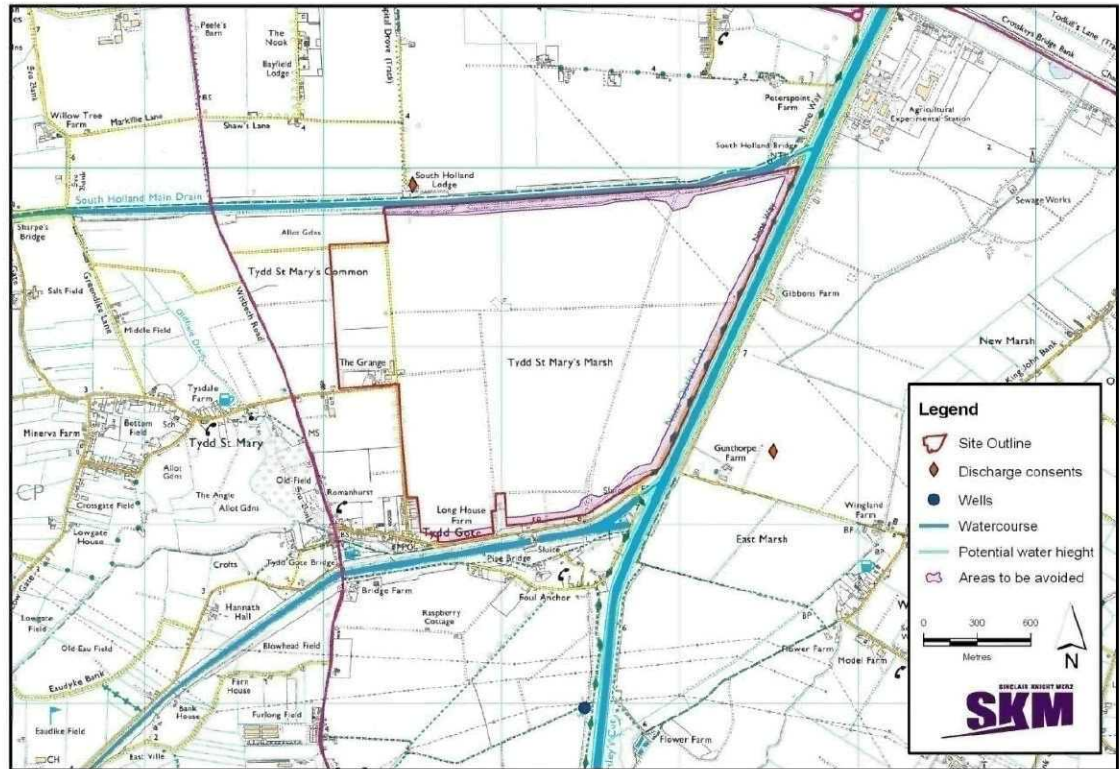
1.2. Existing Site Layout

The site occupies approximately 3.2 km² of relatively flat agricultural crop land on Tydd St Mary's Marsh. The site presently consists of a number of access tracks and fields. The current site layout is shown in Figure 2.

The site is generally bound by raised man-made banks or bunds with the level of the main site area being lower forming a flat based trough. The bunds to the north and east are associated with the South Holland Main Drain and the Nene Outfall Cut respectively. The bunds between the site boundary and Nene Outfall Cut have the Nene Way road running along the top. The south of the site is bound by raised banks or bunds with Station Road running along the top. These bunds are associated with the North level West Drain to the south of the road. Wisbech Road (A1101) to the west of the site is also raised above the site level, however, this is not parallel with any river or drain but may be raised to allow ease of crossing the river and drain network systems by bridge and for flood defences.



■ **Figure 2 - Existing Site Layout**



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1.3. Proposed Site Layout

The proposal is for a wind farm of seven three-bladed, horizontal axis wind turbines, each up to 127m maximum height to tip. The development will have associated electricity transformers, access tracks, rotor assembly pads, crane hardstandings, control building and substation compound, communications mast, and a permanent free-standing wind monitoring mast. All cabling between the turbines and the substation on the site would be underground. The point of connection for the proposal into the grid system is proposed to be at Long Sutton, subject to technical assessments. The connection would be by either underground cabling or overhead wooden poles. The precise route will be subject to a separate application by the grid provider. Onsite access tracks will exploit existing access tracks and will follow field boundaries where possible. The proposed access route for large turbine components will be from the north A1 at Newark-on-Trent along the A17 to Sutton Bridge, then along the A1101 taking the North Road as the entrance to the site.

During construction and commissioning there would be a number of temporary works including a construction compound, welfare facilities and two guyed meteorological masts up to 80 metres high (indicative hub height). During construction there will be a temporary workforce varying between 20 and 60 people over a period of 12 months.

A detailed plan of the site showing the proposed positions of the turbines, permanent meteorological masts, access tracks, crane hardstandings, control building, sub-station compound, temporary construction compound and other infrastructure are shown in Figure 3. The conclusions in this report are based on proposed plans at the time of writing.

Legend

- Meteorological Masts
- Turbines
- Access Tracks
- Temp Construction
- Sub-station Compound
- Gaspipe Cover Slab
- Crane Hardstandings
- Site Outline
- Watercourse
- Potential water height
- Areas to be avoided

0 300 600
Metres

SKM
SINGHANI KNIGHT WATZ

PAGE 4



2. PPS25 Development and Flood Risk

Planning Policy Statement 25 (PPS25), *Development and Flood Risk* was released for issue in December 2006 by the Department for Communities and Local Government. PPS25 replaces Planning Policy Guidance Note 25 (PPG25), *Development and Flood Risk*, published in 2001. PPG25 has been cancelled following this release.

The aims of PPS25 on development and flood risk are to ensure that flood risk is taken into account at all stages of the planning process to avoid inappropriate development in areas potentially at risk of flooding. The key role of the policy is to provide for positive planning to facilitate delivery of sustainable development, whilst ensuring adherence to the Government's policy on flood risk management. Avoidance, reduction and management of flood risk is achieved through the consideration and analysis of present flood risk, future flood risk, consequence of flooding and the wider implications for flood risk of developments located outside the development area.

PPS25 states that the site should initially be subject to a Sequential Test^[1] to ensure no other sites are available for the development within areas or zones of lower flood risk and that the development complies with the strategic development of the region. If the development is in line with the strategic planning for the region and no reasonably available site exists in a lower risk flood zone, the vulnerability of the proposed development can be taken into account.

Indicative floodplain mapping provided by the Environment Agency (EA) illustrates the whole site and surrounding area as having a moderate chance of flooding. The chance of flooding each year is categorised by the EA as 1.3% (1 in 75) or less, but greater than 0.5% (1 in 200). The floodplain maps are indicative only and do not take into account the provision of flood defences. The following sections make a detailed assessment of the flood risk across the site from all potential sources of inundation and provide recommendations for mitigation measures to manage these risks.

¹ PPS25 states “*The risk-based Sequential Test should be applied at all stages of planning. Its aim is to steer new development to areas at the lowest probability of flooding*”



3. Flood Risk Assessment

This section outlines the results of the FRA, which has been carried out to satisfy the requirements of PPS25.

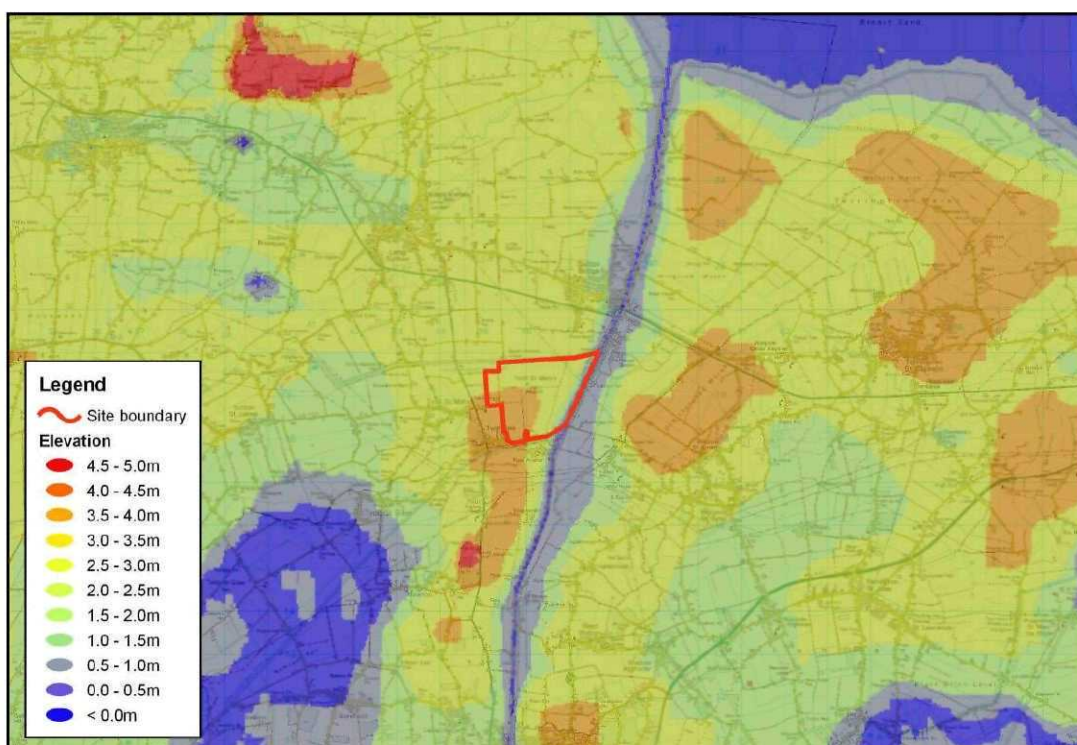
3.1. Location Plan

Please refer to Figure 1 and Figure 2.

3.2. Site Topography

The site occupies approximately 3.2 km² of relatively flat ground on Tydd St Mary's Marsh. The site is generally bound by raised man-made banks or bunds with the level of the site within being lower. The bunds to the north and east are associated with the South Holland Main Drain and the Nene Outfall Cut respectively. The Nene Way road runs along the top of the Nene Outfall Cut embankment. The south of the site is bound by raised banks or bunds with Station Road running along the top and is close to Wisbech Road (A1101) to the west. Ground elevation across the site generally varies from 1m to 4m Above Ordnance Datum (AOD) with levels up to approximately 7m AOD where bunding has been introduced for flood defence purposes. The site forms part of a much wider region of low and flat ground where levels are consistently below 4m AOD. Figure 4 details general topography across the proposed wind farm site. Photographs of the site are contained in Appendix A.

■ Figure 4 - Site Topography



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3.3. Existing Flood Defence Measures

3.3.1. Tidal

To the east of the site is Nene Way located on a flood defence bund to the Nene Outfall Cut or River Nene which lies beyond the road. The River Nene flows from the south west to north east towards the sea and is tidal at this point. The catchment of the River Nene extends from as far away as Northhampton. The lowest gauging point on the River Nene is at Orton (approximately 100km upstream from the site) where the river has a catchment area of approximately 1634 km².

The river channel running alongside the site is approximately 30 to 40m wide and water level was observed to be approximately 5 to 6m below the level of the road during the site inspection. To the north east of the site, the Cross Keys Bridge crosses the River Nene adjacent to Sutton Bridge. The tidal defences along the River Nene consist of earth embankments, which are in good condition and provide protection against a flood event with a 0.67% chance of occurring in any year (1 in 150). The defences along the River are maintained by the EA, and it is anticipated that this level of service will be maintained throughout the life of the wind farm through regular inspection and maintenance.

3.3.2. Fluvial

South Holland Main Drain

To the north of the site is the South Holland Main Drain which flows from west to east. This is a large drain with a catchment of approximately 200 km² extending from as far as Cowbit near Spalding to the west of the site. The drain is approximately 20m in width with terraced banks approximately 3.5 to 4.5m in depth from the site level to the water level. Additional flood defences in the form of approximately 2.5m high sand bunds are adjacent to the majority of the South Holland Main Drain. The bunds are absent in the north western corner of the site. Communication from the EA indicated that the defences along South Holland Main Drain provide protection against a flood event with a 1% chance of occurring in any year (1 in 100). It is anticipated that this level of service will be maintained throughout the life of the wind farm through regular monitoring and maintenance.

The water level and flow of the South Holland Main Drain is controlled by a sluice to the north east of the site before the confluence of with Nene Outfall Cut. What appears to be a decommissioned sluice is located just to the south of the South Holland Main Drain sluice, between South Holland Main Drain and the River Nene. The active sluice manages water levels within South Holland Main Drain for land drainage and flood defence purposes. Operation of the sluice gates are managed by SHIDB. Water levels are maintained at +0.30m AOD during summer months and +0.00m AOD during winter months. However, these levels may be exceeded during high flow or tide locked periods.



North Level West Drain

To the south of the site beyond the road between Tydd Gote and Sutton Bridge is the North Level West Drain. The North Level West Drain flows from the south west to the north east towards the sea and has a catchment size of approximately 210 km². This is a similar size river to South Holland Main Drain being approximately 20 m wide with banks at approximately 2.5m in height from surface water level. Between North Level West Drain and the road is a small bund at between 0.3 to 1.2m in height. Communication from the EA indicated that the bunds along North level West Drain provide protection against a flood event with a 1% chance of occurring in any year. It is anticipated that this level of service will be maintained throughout the life of the wind farm through regular monitoring and maintenance.

To the south west of the site the A1101 crosses the North Level West Drain near Tydd Gote. To the south of the site a concrete pipe bridge, carrying water, crosses the North Level West Drain at a height below the top of the river banks. Further downstream of the North Level West Drain is a large sluice complex and the NLIDB Tydd Pumping Station. The NLIDB confirmed that the North Level Drain was far enough away from the development to be affected by any construction or operation activity.

The North Level Main Drain forks before reaching the River Nene, with the southern fork blocked before reaching the River Nene. The access road for the village of Foul Anchor crosses the two branches of the drain at this point. On the northern fork of the North Level Main Drain there is a sluice gate upstream of the confluence with the River Nene. This sluice gate is used to withhold water within the North Level Main Drain for land drainage and flood defence purposes.

3.4. Potential Sources of Flooding

The main risk to the proposed site is considered to be from fluvial and tidal flooding. The possibility of flooding from other sources such as groundwater is assessed below but considered unlikely.

3.4.1. Tidal

In 2002, South Holland District Council (SHDC) undertook a Strategic Flood Risk Assessment (SFRA), to fulfil their obligations to the Department of Transport, as a Local Authority and under the requirements of PPG25. The aim of the assessment was to produce mapping assigning land in accordance with PPG25 Flood Zones 2 and 3a to 3c. In making the assessment, it was taken that a breach failure could occur in the defence fronting the tidal River Nene during the 0.5% (1 in 200 year) tidal event. EA consultation confirmed that the tidal defences along the River Nene provide protection against a flood event with a 0.67% chance of occurring in any year (1 in 150). The tidal flood levels at Wisbech that correspond to the 1 in 100 year and 1 in 200 year tidal event are 5.66 and 5.78m above Ordnance Datum Newlyn (ODN), respectively.

Based on the information collected from the EA and SHIDB relating to flooding in the area and considering the findings of the SFRA, it would appear that the main risk of tidal flooding is from



breaching of defences along the tidal reach of the River Nene. Such an event would affect the whole site and land surrounding the site. Assumptions would have to be made regarding the potential level of floodwater that could occur over the proposed site.

Due to the flat nature of the site, a significant tidal flood event or breach of tidal defences has the potential to inundate a large proportion, if not all, of the site. The flooding would extend to a wider area beyond the site, although resultant flood depths would be shallow. Any such flood would not significantly impact on the proposed wind farm development.

3.4.2. Fluvial

Several IDB across the region maintain an extensive network of surface drains, sluices and pumping stations to prevent flooding of agricultural land and developed areas.

The site is located within the south eastern boundary of the SHIDB region, which manages the South Level Main Drain. SHIDB aim to reduce the risk to people and the developed and natural environment from flooding and coastal erosion by encouraging the provision of technically, environmentally and economically sound and sustainable defence measures. SHIDB's policy is to seek to maintain a general standard capable of providing flood protection to agricultural land and developed areas of 1 in 20 and 1 in 100 years respectively. Consultation with the EA confirmed that the South Level Main Drain provides protection against a 1 in 100 year flood event.

The North Level Internal Drainage Board (NLIDB) manages the North Level West Drain, which is located more than 9m away from the site. The EA also confirmed that the North Level Drain provides protection against a 1 in 100 year flood event.

Again due to the flat nature of the site, a significant fluvial flood event or breach of fluvial defences has the potential to inundate a large proportion, if not all, of the site. The flooding would extend to a wider area beyond the site, although resultant flood depths would be shallow. Any such flood would not significantly impact on the proposed wind farm development.

3.4.3. Surface Water

Average annual rainfall for the site is approximately 560mm based on data obtained from the Flood Estimation Handbook (CEH, 1999). This indicates that the site has a particularly dry environment for the UK and therefore runoff rates from the site are unlikely to be high. Due to the low elevation of the site and surrounding area there is a chance that the site experiences long periods of dry conditions. In addition, the site and surrounding areas are serviced by an extensive network of surface drains, sluices and pumping stations to prevent flooding. This indicates that overland flow is unlikely to present a high flood risk to any development of the site.

In addition, the proposed wind farm development will have minimal physical impact on the site and construction of any hardstanding areas will be designed such that drainage will mimic existing runoff regimes. Surface water runoff will not present a flood risk to the proposed wind farm development.



3.4.4. Groundwater

The Hydrogeological Map of England and Wales (Institute of Geological Sciences, 1977) indicates that the Ampthill Clays are considered to be concealed aquifers with limited or local potential, and that there may be regions without significant groundwater. These may provide limited supplies of uncertain water quality within sands and gravels, with the risk of saline intrusion in the coastal areas, which would include those close to the tidal Nene at this site.

The Groundwater Vulnerability Map of England (Environment Agency, 1998) illustrates the vulnerability of groundwater to contamination based on the properties of the rocks, soils and volumes of groundwater abstracted. It indicates the presence of strata with generally low permeability that does not contain groundwater in exploitable quantities, though in places it may be sufficient for private water supplies. The underlying strata are therefore classified as being non-aquifer status.

The EA does not have any data regarding groundwater levels in the Tydd Gote area and describes there to be no groundwater sites within 20km of the site. However, groundwater levels are expected to be close to the surface, closely related to the level of water in the surrounding ditches. It is therefore likely that the groundwater levels will vary between summer and winter, in response to the management of water levels in these ditches.

A British Geological Survey (BGS) borehole log within the site boundary has been acquired to provide additional information on the ground conditions. The borehole struck groundwater at 9.50m below ground level (bgl). The resting groundwater level was recorded to be 3.63m bgl. On undertaking pumping tests at 5.67 l/s the ground water level decreased to 12.61m bgl. The groundwater level almost recovered to resting ground water levels within an hour of stopping pumping. This information indicates that the water table has the potential to be relatively shallow and that any excavation is likely to require pumping of water to a holding sump.

Evidence from these ground investigation indicates that groundwater will not present a flood risk to development of the site.

3.5. Site Visit

An SKM hydrologist undertook a site walkover inspection on 3rd May 2006 to identify the following:

- local hydrological conditions;
- hydraulic controls affecting overland flow;
- likely risk of flooding;
- presence and nature of any flood defences; and
- evidence of recent flooding (silt or deposition).



Dry and sunny conditions were experienced during the site visit. Photographs from the site walkover are contained in Appendix A.

The site investigation did not identify any evidence of recent or historical flooding within the site.

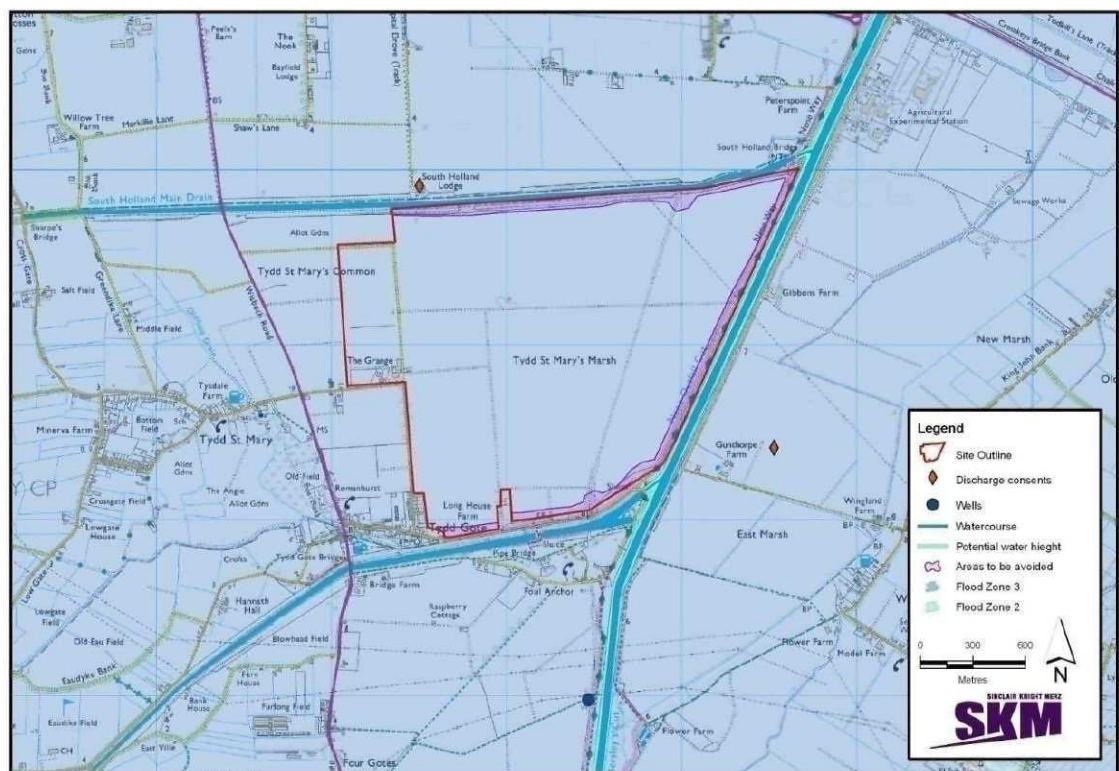
At the time of visiting there was little water within the River Nene. The tidal defences along the River Nene, which consist of earth embankments, were observed to be in good condition. The EA inspect the defences regularly to ensure that any potential defects are identified and addressed early.

During the visit, both the South Holland Main Drain and North Level Main Drain sluices were shut. The surface water drains and their associated sluices, pumping stations and fluvial defences all appeared to be in good condition and free from excessive vegetation growth.

3.6. Plan Indicating Flood Risk

Figure 5 below details the indicative flood mapping provided by the EA. Indicative floodplain mapping provided by the EA illustrates the whole site and surrounding area as having a moderate chance of flooding. The chance of flooding each year is categorised by the EA as 1.3% (1 in 75) or less, but greater than 0.5% (1 in 200). The floodplain maps are indicative only and do not take into account the provision of flood defences.

■ Figure 5 - Indicative Environment Agency Floodplain Mapping





3.7. Hydraulic Structures

The site itself has few drainage systems. What once may have been small drainage ditches are now overgrown with trees and form field boundaries to the site. There are no surface water bodies within the site boundary.

Beyond the bunds bounding the north, east and south sides of the site are rivers or drain systems. These are all of low gradient and relatively slow flowing. A system of sluice gates controls the flow and level of the drains that outfall into the River Nene. This managed drainage system is in place because the River Nene is tidal and levels at high tide are often above surrounding land and ditch levels. The sluice gates are managed by a combination of the SHIDB and NLIDB.

Apart from the extensive network of surface drains, sluices and pumping stations throughout the area, no other hydraulic structures were noted within the site boundary.

3.8. Flood Probability

As discussed in Section 3.4, the main risk to the proposed site is considered to be from fluvial and tidal flooding. Consultation with the EA facilitated an assessment of flood probability for each of these flood sources.

- Both the South Level Main Drain and the North level Drain have the capacity to accommodate a 1% probability fluvial flood event; and
- The tidal defences along the River Nene have the capacity to accommodate a 0.67% probability tidal flood event.

3.9. Assessment of Rate at Which Flooding Might Occur

Tidal and fluvial flood defences serving the site will protect the proposed wind farm from 0.67% probability tidal and 1% probability fluvial events, respectively. The site is not considered to be at an unacceptable risk of flooding. Any residual flooding is expected to be confined to widespread waterlogging of low-lying land, with extensive areas of shallow ponding. As the site is provided some protection through flood defences, the only way a flood of the site could occur is through a storm event greater than 0.67% tidal and 1% fluvial, or if a breach of the defences or embankments were to occur. Rate and extent of flooding during such a failure would be determined by the nature and location of the failure. The speed and depth of flood water would reduce further away from the breach or overtopping.

3.10. Assessment of Surface Water Management

Surface water management systems will be designed to mimic existing surface runoff regimes and will ultimately discharge to ground or local discharge channels. Design of the systems will also give due consideration to options incorporating Sustainable Drainage Systems (SuDS), such as swales or infiltration devices.

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3.11. Flood Displacement

Development of the proposed wind farm will have negligible impact on the flood displacement capacity of the current indicative flood plain.

3.12. Impact on Fluvial and Coastal Morphology

The proposed wind farm will not result in any impact on fluvial or coastal morphology. The site is located within a managed floodplain area with highly engineered and well maintained channels which are unlikely to change as a result of occasional inundation.

3.13. Adjustments for Climate Change

When assessing the flood risk to any potential development site, consideration must be made of any potential for change to that risk throughout the life of the development. The life of a wind farm is currently considered to be 25 years. Indicative floodplain mapping provided by the EA makes no consideration for climate change.

Provision for future climate change is given in a table of recommended contingency allowances for increased runoff in Appendix B of PPS25. These climate change allowances represent the current view of Defra following extensive national and international research, based on the best information and predictive modelling techniques currently available.

3.13.1. Sea Level Increases

The tidal defences along the River Nene have the capacity to accommodate a 0.67% probability tidal flood event. The tidal flood level at Wisbech that correspond to the 1 in 150 year tidal event is approximately 5.73m above ODN. Using data contained in Table B.1 of PPS 25 it is anticipated that sea levels will increase by approximately 145mm over the life of the development.

3.13.2. Increased Rainfall Runoff

PPS25 advises provision to be made for predicted changes to UK climate in future years. Current scenarios indicate an overall increase in the number of rain-days and average rainfall intensity, with wetter winters and drier summers. Policy recommendations for future rainfall conditions state that an increase of 10% be considered for peak rainfall intensity.

3.14. Mitigation Measures

Taking into consideration the potential for flooding at the Grange proposed wind farm site, the following issues should be considered during planning stages of the development:

- Construction/maintenance equipment transportation issues – Additional watercourse crossings may be required dependent on an assessment of existing transport infrastructure. Any such structures would require further detailed assessment as to their potential impacts on flood risk and restriction to overland floodplain flows.
- Wind farm design – Design considerations for the wind farm should include the use of suitable water resistant building materials and the positioning of all electrical controls and sensitive



power generation equipment above surrounding ground levels. SKM currently recommend that equipment be raised by 600mm above adjacent ground levels, however adoption of this mitigation measure had not been confirmed by the EA at the time of reporting. Previous wind farm sites developed on low lying land, where flood defences comprise of raised defences have required a topple zone to prevent a falling turbine from breaching the flood defences. Consultation has been undertaken with the EA, NLIDB and SHDB to confirm if this is required for this site. It has been confirmed that a topple zone is not required but a statutory buffer zone is required from the upper edge of the watercourse or main drain to the nearest part of the wind turbine (be it the turbine blade tip or the extent of the foundation pad). Turbines should be located a minimum of 9m from flood defences as per the EA requirements.

- Site drainage – Site drainage provisions for wind farm infrastructure will be based on ensuring that existing runoff patterns are not altered. The development of the turbines and their bases will not significantly disrupt local drainage patterns as the concrete bases will be covered in soil and vegetation allowing for natural attenuation of rainfall. The only other change to the site will be the development of roads, and these will quickly shed runoff to vegetated areas allowing infiltration and natural attenuation of runoff.
- Health and Safety – The developed site may need to be accessed during flood conditions, particularly as any inundation would be likely to be present on site for some time. Safe site access and egress policy would need to be drafted, including emergency evacuation procedures and access to turbines or substation infrastructure during flood conditions.
- Loss of floodplain – The proposed site is not considered to be part of a functional floodplain but does form part of a wider area of low-lying land where flood waters would disperse if flood defences were to be breached or were to fail. Structural development on the site is likely to be limited to turbine masts and substation infrastructure which will have a very small footprint area. It is considered that the impact on floodplain storage from such a development would be minimal/negligible.

These recommendations are based on the following guidance:

- PPS25: Development and Flood Risk documentation;
- Consultation with the Environment Agency;
- Interim Code of Practice for Sustainable Drainage Systems, (National SUDS Working Group, 2004);
- Environment Agency website (www.environment-agency.gov.uk); and
- Preparing for Floods documentation (Department for Transport and Local Government Regions).

3.15. Assessment of Residual Flood Risk

This assessment has highlighted known and likely sources of flooding for the proposed Grange Wind Farm. Consultation from the EA confirmed that the tidal and fluvial flood defences serving the site will protect the proposed wind farm from 0.67% probability tidal and 1% probability fluvial



events, respectively. It is anticipated that this level of service will be maintained throughout the life of the wind farm through regular inspection and maintenance.

As the site is provided some protection through flood defences, the only way a flood of the site could occur is through a storm event greater than 0.67% tidal and 1% fluvial, or if a breach of the defences or embankments were to occur. Failure of this infrastructure is considered to be highly unlikely or negligible.

Any residual flooding is expected to be confined to widespread waterlogging of low-lying land, with extensive areas of shallow ponding. Rate and extent of flooding during such a failure would be determined by the nature and location of the failure. The speed and depth of flood water would reduce further away from the breach or overtopping.



4. Summary

SKM have been appointed by RES to perform a FRA for a proposed wind farm at The Grange. This development is known as the Grange Wind Farm. This report outlines the results of the FRA and provides supporting documentation for a planning application for this site in accordance with Planning Policy Statement 25 (PPS25), *Development and Flood Risk*.

The site occupies approximately 3.2 km² of relatively flat agricultural crop land on Tydd St Mary's Marsh. Ground elevation across the site generally varies from 1m to 4m AOD with levels up to approximately 7m AOD where bunding, associated with the South Holland Main Drain, North Level West Drain and the River Nene, has been introduced for tidal and fluvial flood defence purposes. Consultation from the EA confirmed that the tidal and fluvial flood defences serving the site will protect the proposed wind farm from 0.67% probability tidal and 1% probability fluvial events, respectively. It is anticipated that this level of service will be maintained throughout the life of the wind farm through regular inspection and maintenance.

Indicative floodplain mapping provided by the EA illustrates the whole site and surrounding area as having a moderate chance of flooding. The chance of flooding each year is categorised by the EA as 1.3% (1 in 75) or less, but greater than 0.5% (1 in 200).

The main risk to the proposed site is considered to be from fluvial and tidal flooding. As the site is provided some protection through flood defences, the only way a flood of the site could occur is through a storm event greater than 0.67% tidal and 1% fluvial, or if a breach of the defences or embankments were to occur. Failure of this infrastructure is considered to be highly unlikely or negligible. The possibility of flooding from other sources such as groundwater is considered unlikely.

Mitigation recommendations for the site include:

- using suitable water resistant building materials and the positioning of all electrical controls and sensitive power generation equipment with a freeboard of around 600mm above existing ground levels;
- locating turbines a minimum of 9m from flood defences as per the EA requirements;
- ensuring site drainage provisions for wind farm infrastructure do not alter existing runoff regimes; and
- implementing a safe site access and egress policy, including emergency evacuation procedure and access to turbines or substation infrastructure during flood conditions.

Any residual flooding is expected to be confined to widespread waterlogging of low-lying land, with extensive areas of shallow ponding. Rate and extent of flooding during a failure would be determined by the nature and location of the failure. The speed and depth of flood water would reduce further away from the breach or overtopping.

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5. References

1. Planning Policy Statement 25 (PPS25): *Development and Flood Risk*, Communities and Local Government, 2006
2. *Development and Flood Risk: A Practice Guide Companion to PPS25 'Living Draft'*, A Consultation Paper, Communities and Local Government, Feb 2007
3. Planning and Policy Guidance note 25 (PPG 25): *Development and Flood Risk*, Office of the Deputy Prime Minister, 2001



Appendix A Walkover Inspection Photographs



Facing East, along the existing access track onto the site from Wisbech Road.



Facing west along the South Level Main Drain.

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Facing east, view of the South Level Main Drain to the north west of the site where bunds are absent.



Facing south across the main area of the site proposed for the wind farm infrastructure.



Facing East along the South Level Main Drain, the photo shows the cross section of the flood defence bunds.



Facing south east along the North Level West Drain.



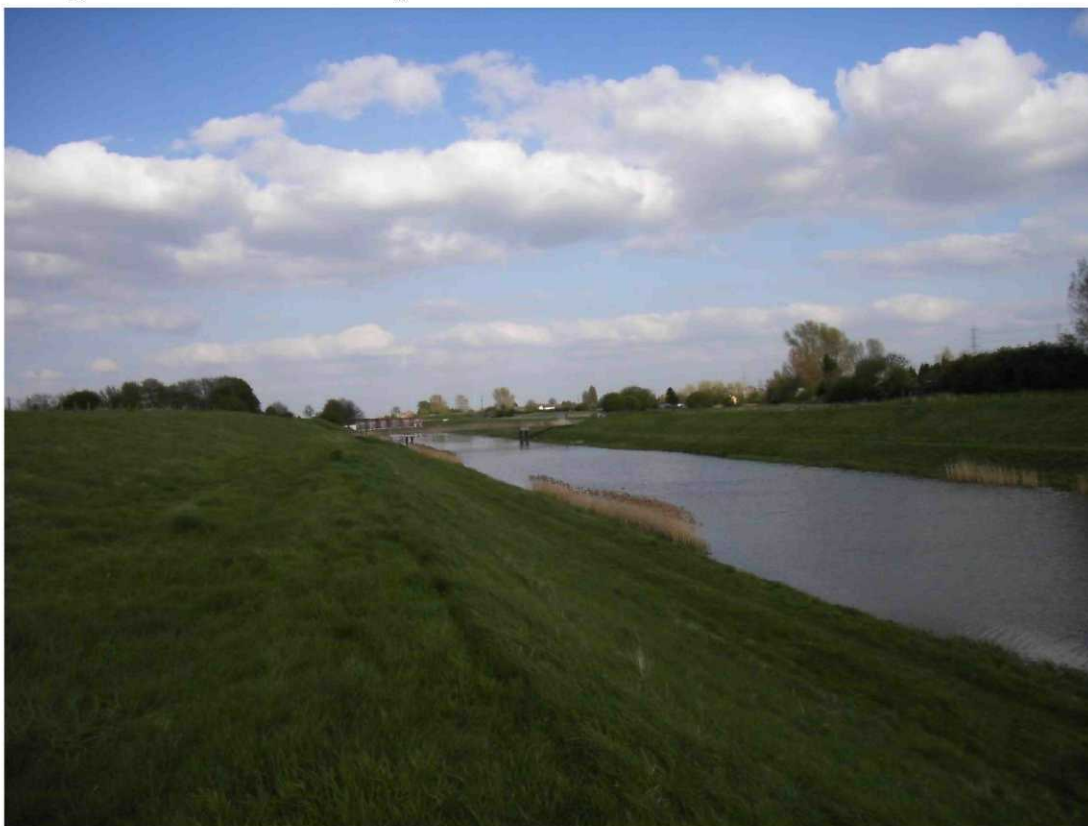
Facing west, along the North Level West Drain.



Facing south west toward a tree lined field boundary.



Facing east towards the Nene Way road.



Photograph of the North Level IDB pumping station and the sluice complex. Facing south east.



Photograph of the North Level IDB pumping station and the sluice complex. Facing south east.



Photograph of the North Level IDB pumping station and the sluice complex. Facing south east.



Photograph of the North Level IDB pumping station and the sluice complex.





Photograph of the North Level IDB pumping station and the sluice complex.



Photograph of the North Level IDB pumping station and the sluice complex. Facing south west.



Facing east, towards sign on side of the Nene Outfall.



Facing north east, the confluence of the North Level West Drain with the Nene Outfall.



Sluice gates at the confluence of the River Nene and North Level West Drain. Facing south west.



Road bridge over the South Level Main Drain confluence with the Nene Outfall.



Sluice gate on the South Holland Main Drain before the confluence with Nene Outfall Cut. Facing south west.



River Nene from the road bridge at the confluence with South Holland Main Drain. Facing south.



Facing north along the Nene way highway and the Nene Outfall Cut.



Appendix B Correspondence



Lucy Parker
Sinclair Knight Merz
OneSixty
160 Dundee Street
Edinburgh
EH11 1DQ

SKM anthony hunts	
16 FEB 2009	EKBL
	SIGNED
JOB No.	SECTION

Your ref:

Our ref:

CCN/2009/20648

Date:

12 February 2009

Dear Ms Parker

ENVIRONMENTAL INFORMATION: Grange Proposed Wind Farm Site

Thank you for your enquiry dated 12 November 2008. Following internal consultation, we are now able to provide a response to your enquiry as follows.

Flood Map

A copy of the Flood Map for your area of interest is enclosed. The Flood Map provides information on flooding from rivers and the sea only, and does not include flooding from other sources such as sewer or overland flooding. It also has information on flood defences and the areas benefiting from those flood defences.

Historic Flood Map

A copy of the Historic Flood Map for your area is enclosed. This shows the extent of previous recorded flooding in your area, notably January 1978. It is possible that other flooding may have occurred that we do not have records for, and other organisations, such as the Local Authority or Internal Drainage Boards, may have records.

Fluvial Defence Information

The drainage channels in your area are maintained by the South Holland Internal Drainage Board. Our records show that South Level Main Drain (towards the North of your site) and North Level Drain (towards the South of your site) provide protection against a flood event with a 1% chance of occurring in any year (1 in 100).

For further information about the drainage channels, including information on sluices, please contact the South Holland Internal Drainage Board (tel: 01553 669500).

Tidal Flood Levels

Please find attached available **tidal** flood levels as requested. These levels have an assessment date of 2006, which should be used in any consideration of future increases due to climate change. The levels are in metres above Ordnance Datum Newlyn (mODN) and are valid for 12 months from the date of issue.

Tidal Defence Information

The defences protecting this site from the Tidal River Nene consist of earth embankments, which are in a good condition and provide protection against a flood event with a 0.67% chance of occurring in any year (1 in 150). We inspect these defences regularly to ensure that any potential defects are identified early.

Waterside House, Waterside North, Lincoln, LN2 5HA.
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk



Requirements of Planning Policy Statement Document 25 (PPS25)

As this information has been requested for a Flood Risk Assessment (FRA) you should be aware that by supplying the information we have not made any assessment of the suitability or otherwise of any proposed development at this site from a flood risk perspective.

Planning Policy Statement 25 (PPS25) 'Development and flood risk' requires Local Planning Authorities to apply a risk-based 'sequential test' with the aim of steering development to Flood Zone 1 wherever possible. We strongly recommend that you contact the Local Planning Authority to ascertain the likely outcome of a sequential test for this site before committing monies to a detailed flood risk assessment.

PPS25 requires the FRA to demonstrate that proposals are "safe" throughout the lifetime of the development, which may require calculation of flood depths and velocities on the site. You will be required to demonstrate how this can be achieved and justify your approach within the FRA.

Groundwater

We have no groundwater monitoring within 20km of this site.

All information is provided subject to the attached licence (Licence C), which allows simple use of the data, i.e. straight forward copying and use "as is" without modification.

I hope the above provides clarification. Should you have any further queries or if I can be of any further assistance, please do not hesitate to contact this office again.

Yours sincerely



CLAIRE DOVEY (Miss)
External Relations Officer



FLOOD MAP

-  Main River
-  Raised Defences
-  Areas Benefiting from Defences
-  Flood Storage Areas
-  Area at Risk of Flooding from Rivers or The Sea
-  Extreme Flood Outline

Dark blue shows the area that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5% (1 in 200) or greater chance of happening each year.

- or from a river by a flood that has a 1% (1 in 100) or greater chance of happening each year.

Light blue shows the additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1% (1 in 1000) chance of occurring each year.

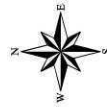
These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

Floodline
0845 988 1188
ENVIRONMENT AGENCY

Environment Agency
Anglian Region Northern Area
Waterside House
Waterside North
Lincoln
LN2 5HA

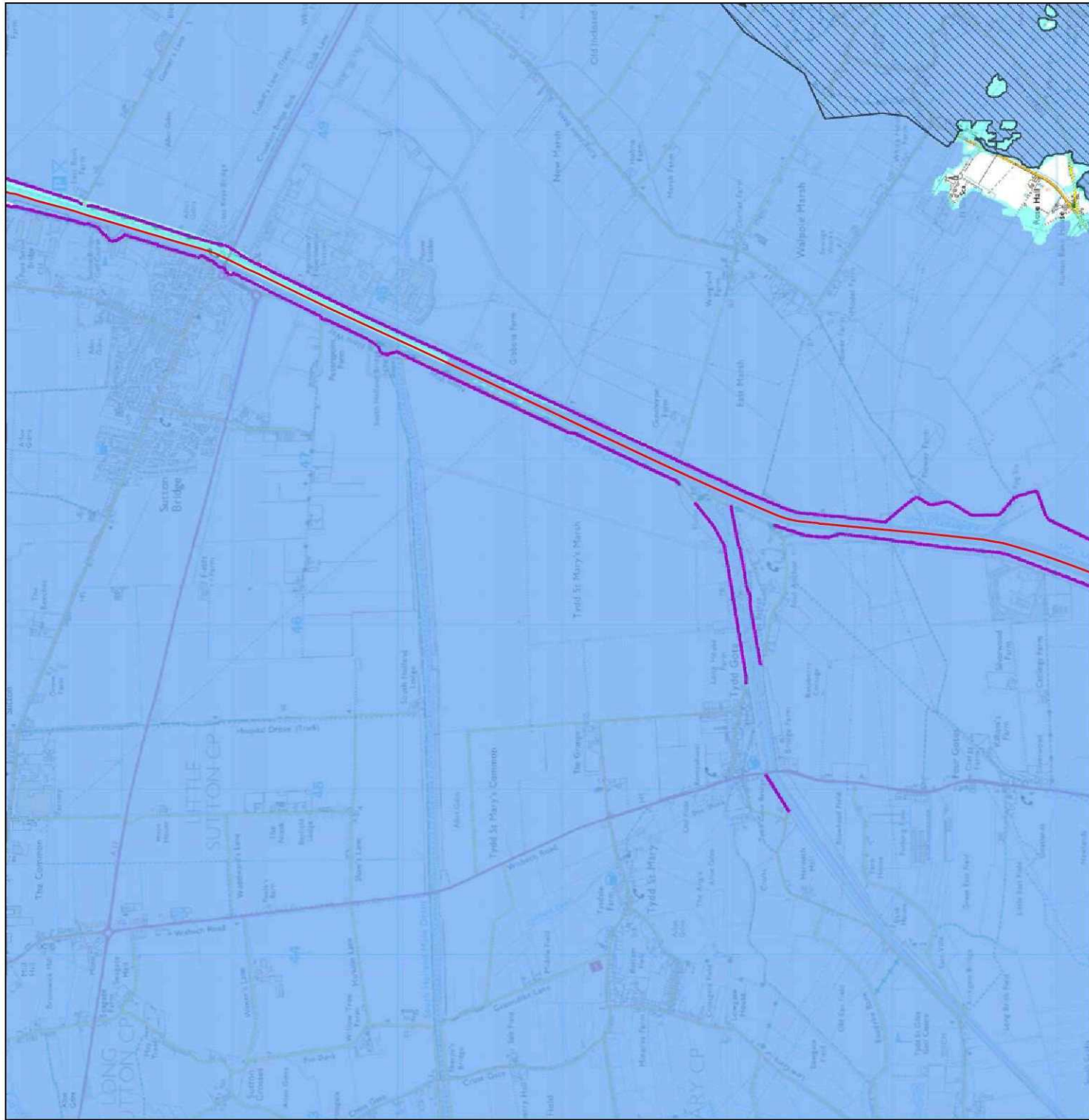
Tel : 08708 506506

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Environment Agency, 100026380, 2009.



Scale: 1:24,000

Produced by the Flood Risk Mapping and Data
Management Team, Lincoln. January 2009.





Historic Flood Extent

Legend

— Main River

January 1978 on the Tidal River Nene

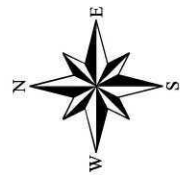
Floodline
0845 988 1188
ENVIRONMENT AGENCY



Environment Agency
Anglian Region Northern Area
Waterside House
Waterside North
Lincoln
LN2 5HA

Tel : 08708 506506

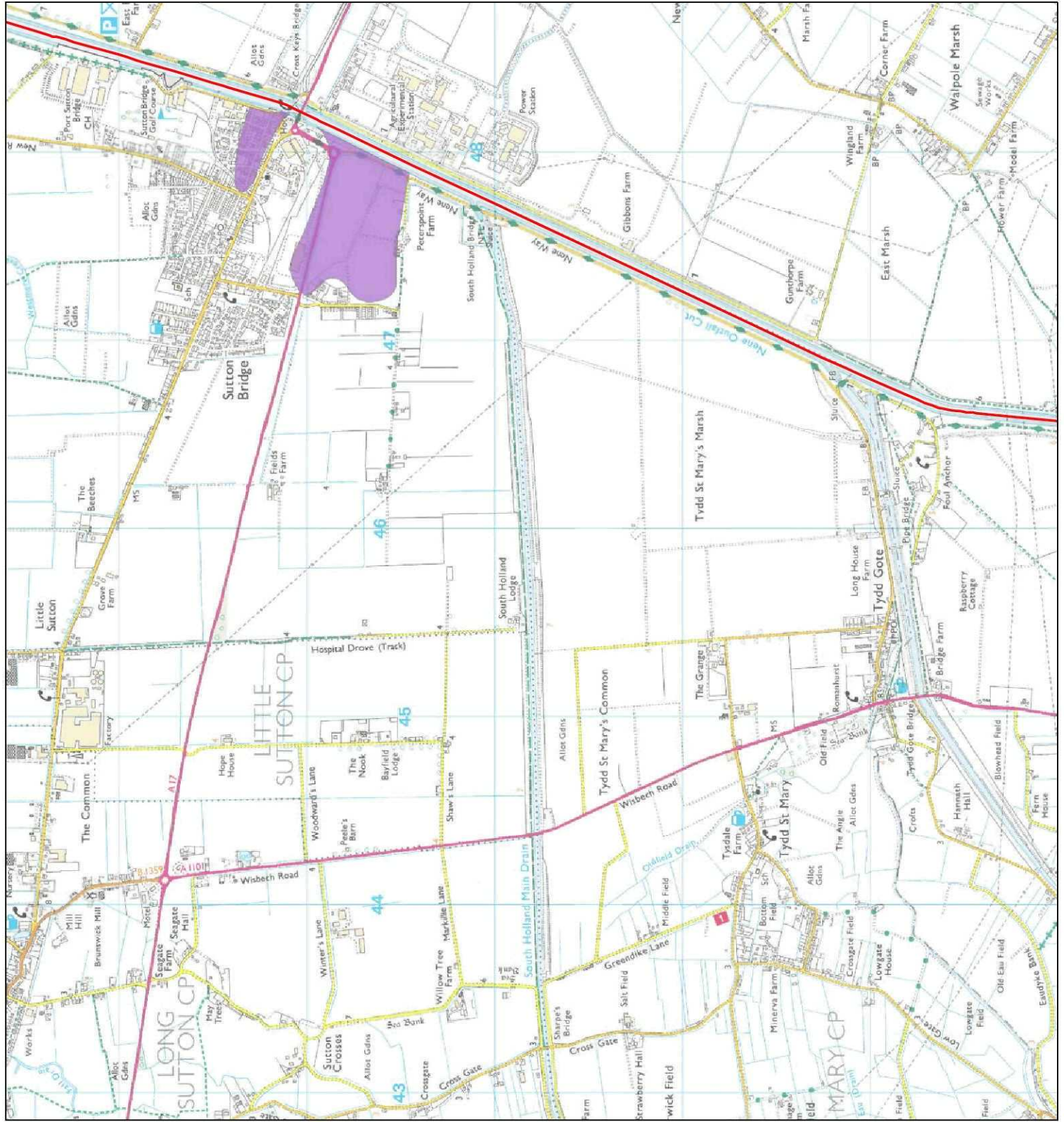
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Environment Agency, 100026380, 2008.

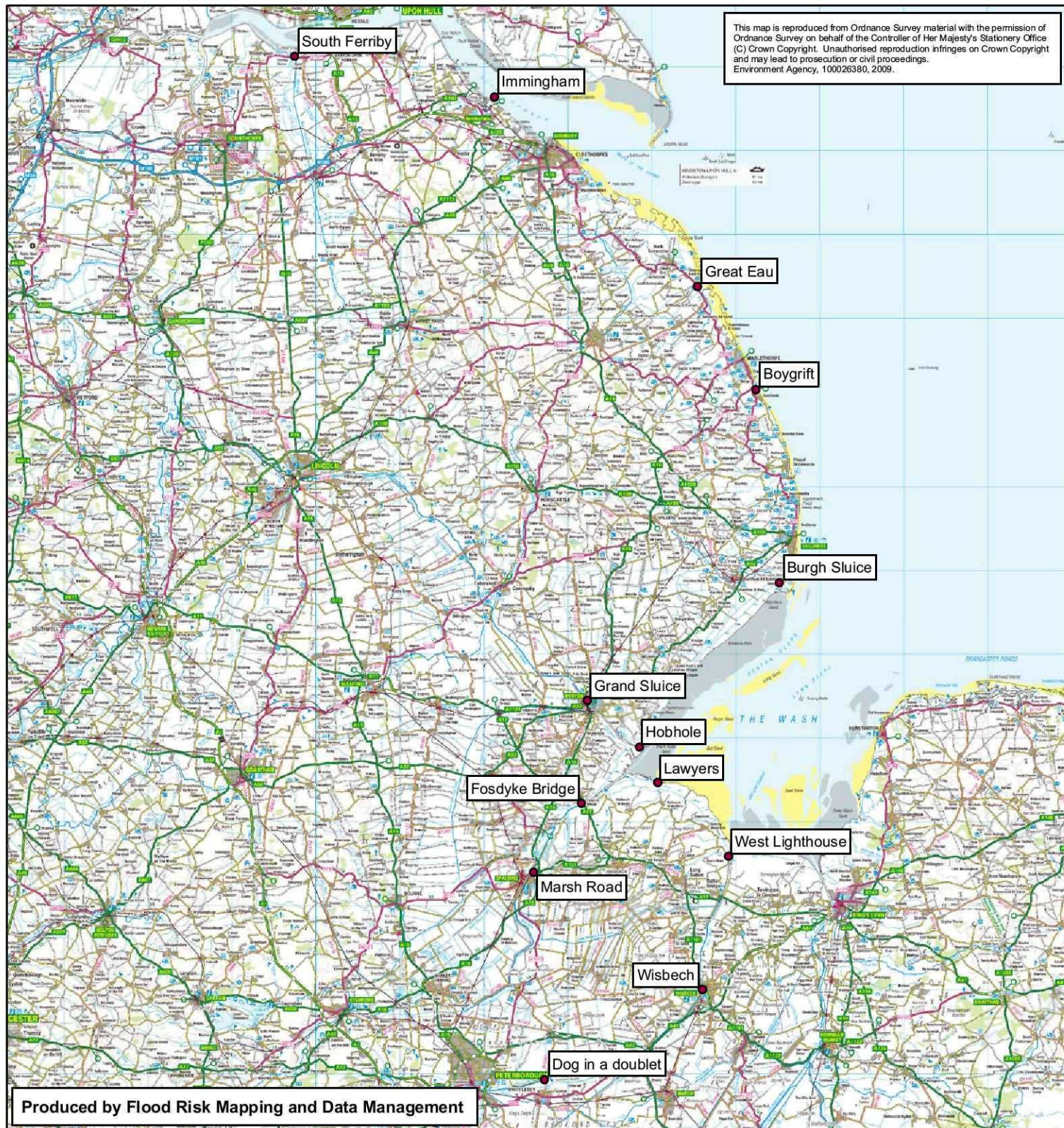


Scale: 1:20,000

January 2009

Produced by the Flood Risk Mapping
and Data Management Team, Lincoln.





Levels (mODN) - based on 2006 tidal analysis

Site	Easting	Northing	T1 Yr	T10 Yr	T25 Yr	T50 Yr	T100 Yr	T200 Yr	T500 Yr	T1000 Yr
South Ferriby	497500	421200	4.90	5.29	5.45	5.56	5.68	5.80	5.96	6.07
Immingham	521300	416400	4.10	4.49	4.65	4.76	4.88	5.05	5.16	5.34
Great Eau	545500	393800	3.80	4.19	4.34	4.46	4.57	4.69	4.84	4.96
Boygriff	552500	381500	3.84	4.24	4.41	4.53	4.65	4.77	4.93	5.05
Burgh Sluice	555300	358500	4.26	4.45	4.63	4.76	4.90	5.03	5.21	5.34
Hobhole	538600	338900	4.82	5.30	5.49	5.64	5.78	5.93	6.12	6.27
Lawyers	540800	334700	4.84	5.32	5.51	5.66	5.80	5.95	6.14	6.29
West Lighthouse	549200	325900	4.88	5.37	5.57	5.71	5.86	6.01	6.21	6.35
Grand Sluice	532400	344500	4.88	5.33	5.51	5.65	5.78	5.93	-	-
Fosdyke Bridge	531700	332200	4.91	5.38	5.56	5.71	5.85	5.99	-	-
Marsh Road	526000	324000	5.04	5.44	5.6	5.73	5.85	5.98	-	-
Wisbech	546100	310000	4.83	5.25	5.41	5.53	5.66	5.78	-	-
Dog in a doublet	527300	299300	3.67	4.00	4.13	4.22	4.32	4.42	-	-

APPENDIX 9.2 Sequential Flood Test

Information relating to sequential and exception tests set out in PPS25: Development and Flood Risk

A sequential approach to determining the suitability of land for development in flood risk areas is set out in PPS 25. The sequential test aims to ensure preference is given to land within flood zone 1 in priority to land within flood zones 2 and 3 when considering sites for the same type of development. It also seeks to take into account the flood vulnerability of proposals when locating development within flood zones 2 and 3.

If the sequential test concludes that the development cannot be located in zones of lower flood risk due wider sustainability objectives it is possible that any flood risk may be adequately managed so that the development is still feasible. PPS25 proposes an exception test to assess this.

The following paragraphs apply the sequential and exception tests to the proposal for the Grange Wind Farm.

Sequential Test

The application site lies in an area falling within flood zone 3 for the purposes of PPS25 as it forms part of a floodplain associated with the South Holland Drain and the Nene River.

The processes undertaken by the developer to identify potential sites for wind farm development are set out in detail at section 3 of the Environmental Statement. These concluded that the application site formed one of the best potential sites in the East Midland Region for a wind farm location taking into account environmental, technical, and economic constraints.

Consequently, PPS25 indicates that the development will be acceptable in flood risk terms if the exception test can be satisfied.

Exception Test

A wind farm development is classified as an electricity generating station and is therefore essential infrastructure for the purposes of PPS25. Development of essential infrastructure is acceptable in flood zone 3 following an acceptable sequential test if the exception test can be satisfied.

Paragraph D9 of PPS 25 sets out 3 limbs to the exception test:

- (a) it must be demonstrated that the development provides wider sustainability benefits to the community that outweigh flood risk
- (b) the development should be on developable previously-developed land or, if it is not on previously developed land, that there are no reasonable alternative sites on developable previously-developed land; and
- (c) a FRA must demonstrate that the development will be safe, without increasing flood risk, and, where possible, will reduce flood risk overall.

The Planning Statement and Environmental Statement sets out the sustainability benefits of the Proposal. In summary, the development would provide sufficient electricity for 8,000 homes, equivalent to 24% of the total annual consumption of the houses in the South Holland District. It would also contribute a significant proportion towards the achievement of targets set out in Policy 41 the East Midlands Regional Spatial Strategy to 2021 installed renewable energy targets, and towards central Government targets for reductions in carbon dioxide emissions by 2020. When viewed in the context of the extent of any flood risk identified in the FRA it is considered that the sustainability benefits of the proposal significantly outweigh that risk.

The steps taken by to identify potential sites are highlighted above. The site represents one of the best available for this type of development in the region and it is not considered that there are alternatives with the same resource available on previously-developed land.

Finally, the FRA and Chapter 9 of the ES indicate that effect of the development on flood plain storage and transmission will be negligible. The FRA states that development of wind farm infrastructure will be designed such that existing runoff regimes are maintained and that any drainage infrastructure serving the access roads or turbine bases should seek to mimic the existing runoff regime. The FRA currently recommends sensitive equipment to be positioned 600mm above adjacent ground levels, however this mitigation measure was still to be confirmed by the Environment Agency at the time of reporting. This mitigation will be incorporated into the design of the wind farm.

In conclusion it is believed that the sequential and exception tests set out in PPS 25 can be satisfied in relation to the proposed development.

APPENDIX 10.1: Methodology for Calculating Standardised Wind Speed

The basis of the ETSU-R-97 methodology recommended for assessment of wind farms is to compare predicted noise levels (due to turbine emissions) with background noise levels over a range of wind speeds. In order to derive appropriate noise limits the ETSU-R-97 guidance requires the correlation of background noise survey data with 10 m height wind speed data which, it states, may be derived from wind speed measurements at other heights.

However, acoustic emission measurements on wind turbines are generally undertaken following national, or international, standards which specify that the turbine noise emission should be reported as a function of a 'standardised' wind speed at 10m height. In practice this translates as extrapolation of wind speed at hub height¹ down to 10m height, using a specified, and fixed, wind shear model.

Whilst there are good reasons for this approach, for example it allows developers to compare noise emission data from different makes and models of wind turbine, it does create potential problems. If, for example, the wind shear on a site where the turbines are to be deployed differs from the assumed values/model, the result is that, for a given 'standard' wind speed at 10 m height, the hub height wind speed may be very different. The consequence is that the turbine generates a different amount of power, and emits a different level of sound power, than might be expected from the standardised wind speed alone.

Two options are available in order to reconcile potential anomalies:

1. The turbine sound power levels are re-calculated taking due consideration of site-specific wind shear
2. The noise limits are derived with reference to the same wind speed as the turbine noise levels

In this assessment RES have chosen to apply the second option. To do this, the following methodology is employed to those wind speeds measured on-site concurrently with the background noise survey:

(1) Wind Speeds are Calculated for Hub Height

During the background noise survey campaign concurrent wind speed was measured at 44.9m and 57.5m heights. For each ten minute period the wind shear exponent has been derived:

$$\alpha = \frac{\ln \frac{v_{57.5}}{v_{44.9}}}{\ln \frac{h_{57.5}}{h_{44.9}}} \quad (\text{B.1})$$

Where: α = wind shear exponent

$v_{57.5}$ = 57.5m height wind speed at site

$v_{44.9}$ = 44.9m height wind speed at site

$h_{57.5}$ = 57.5m

$h_{44.9}$ = 44.9m

The hub height (80m) wind speed may be calculated from the mean wind speed measured at the upper anemometer and the calculated wind shear exponent:

¹ Wind speed at hub height may be derived from the resultant power output using warranted power curves or from measured hub height wind speed.

$$v_{hub} = v_{57.5} \left(\frac{h_{hub}}{h_{57.5}} \right)^{\alpha} \quad (B.2)$$

where: $v_{57.5}$ = 57.5m height wind speed at site

v_{hub} = wind speed at turbine hub

$h_{57.5}$ = 57.5m

h_{hub} = turbine hub height, 80m

α = calculated wind shear exponent from measured site data (between 44.9 & 57.5m heights)

(2) "Standardised" 10m Wind Speeds are Calculated

As described, wind turbine noise reports contain sound power level data for the turbine as a function of the 'standardised' wind speed at 10 m height. As defined in the international standard IEC 61400-11, this 'standardised' wind speed is calculated from the height at which wind speed is actually measured according to the following formula:

$$v_s = v_z \left[\frac{\ln \frac{z_{ref}}{z_{0ref}} \ln \frac{H}{z_0}}{\ln \frac{H}{z_{0ref}} \ln \frac{z}{z_0}} \right] \quad (B.3)$$

Where:

v_s is the standardised wind speed

v_z is the wind speed measured at anemometer height z (here, the derived hub height wind speed from Step 1)

z_{0ref} is the reference roughness length (0.05m)

z_0 is the roughness length

H is the rotor centre height, 80m

z_{ref} is the reference height, 10m

z is the anemometer height - the height of the derived hub height wind speed, 80m

Therefore, to derive the standardised 10m wind speed from the hub height wind speed (from step 1) the equation may be simplified to:

$$v_s = v_z \left[\frac{\ln \frac{10}{0.05}}{\ln \frac{80}{0.05}} \right] \quad (B.4)$$

(3) Correlation of "Standardised" 10m Wind Speeds with Background Noise Data

As described in Section 2.6 in the main report.

APPENDIX 10.2: Ground Type Used for Propagation Modelling

Effect & Definition of Ground Types

The International Standard noise propagation model, ISO 9613 Part 2 'Acoustics - Attenuation of sound during propagation outdoors- Part 2: General Method of calculation', which has been used to generate the noise predictions presented in this report, describes a detailed method for determining the attenuation of noise due to the effect of ground absorption.

As detailed in section 7.3 of the standard, such *"attenuation is mainly the result of sound reflected by the ground surface interfering with the sound propagating directly from source to receiver."*

"The downward-curving propagation path (downwind) ensures that this attenuation is determined primarily by the ground surfaces near the source and near the receiver. This method of calculating the ground effect is applicable only to ground which is approximately flat, either horizontally or with constant slope. Three distinct regions for ground attenuation are specified:

- a) *the source region, stretching over a distance from the source towards the receiver of $30h_s$, with a maximum distance of d_p (h_s is the source height and d_p the distance from source to receiver, as projected in the ground plane);*
- b) *the receiver region, stretching over a distance from the receiver back towards the sources of $30 h_r$, with a maximum distance of d_p (h_r is the receiver height);*
- c) *a middle region, stretching over the distance between the source and receiver regions..."*

"According to this scheme, the ground attenuation does not decrease with the size of the middle region, but is mostly dependent on the properties of source and receiver regions.

The acoustical properties of each ground region are taken into account through a ground factor, G. Three categories of reflecting surface are specified, as follows.

- a) **Hard ground**, which includes paving, water, ice, concrete and all other ground surfaces having a low porosity. Tamped ground, for example, as often occurs around industrial sites, can be considered hard. For hard ground, $G = 0$.
- b) **Porous Ground**, which includes ground covered by grass, trees or other vegetation, and all other ground surfaces suitable for the growth of vegetation, such as farming land. For porous ground, $G=1$.
- c) **Mixed Ground**: if the surface consists of both hard and porous ground, then G takes on values ranging from 0 to 1, the value being the fraction of the region that is porous."

Choice of Ground Type at The Grange

At The Grange, which has 'flat', open terrain, as required by the standard, predictions have been made using a ground type, G, of 'mixed'. A value of 0.5 has been adopted, representing ground which is 50 % hard and 50 % porous, or midway between hard and soft ground.

As discussed above, the regions that need to be considered in the choice of G are the source region ($30 h_s$) and receiver region ($30 h_r$).

For the source region, the source height is the hub height of the turbines, 80 m, as detailed in section 2.1, so that the source region would be of the order 2400 m. However, in each case this is greater than the distance from the source to the receiver (d_p), so the source region is equal to d_p . At The Grange, this distance is almost entirely given over to farming land, apart from a minor road to the east and drains to the

north and east, indicating that a porous ground type ($G=1$) is appropriate. However, as each turbine will have a small area of concrete foundations around its base, extending 1 - 2 m outwards (approximately 0.25 % of the source region), the very conservative assumption of a 50 % hard/50 % porous ground type, i.e. $G=0.5$, has been made.

For the receiver region, the receiver height is the modelled height of the observer, in this case 4 m, as detailed in section 2.4.2, so that the receiver region is of the order 120 m. At The Grange, this distance is entirely given over to farming land, indicating that a porous ground type ($G=1$) is appropriate. However, as some properties may have an area of hard standing, or patio, extending perhaps 5 - 10 m from the receiver (approximately 8 % of the receiver region), the very conservative assumption of a 50 % hard/50 % porous ground type, i.e. $G=0.5$, has been made.

Note that:

- **conditions approximating totally solid ground ($G=0$) would be unlikely to occur in practice except under high pressure, freezing conditions when wind speed would be very low**
- **the assumption of a receiver height of 4 m reduces the effects of local ground conditions in any case, resulting in higher predicted noise levels than would occur for a standard 1.2 m receiver height**

APPENDIX 10.3: Photos

Photo 1 Noise Apparatus at H2 – The Grange Farmhouse



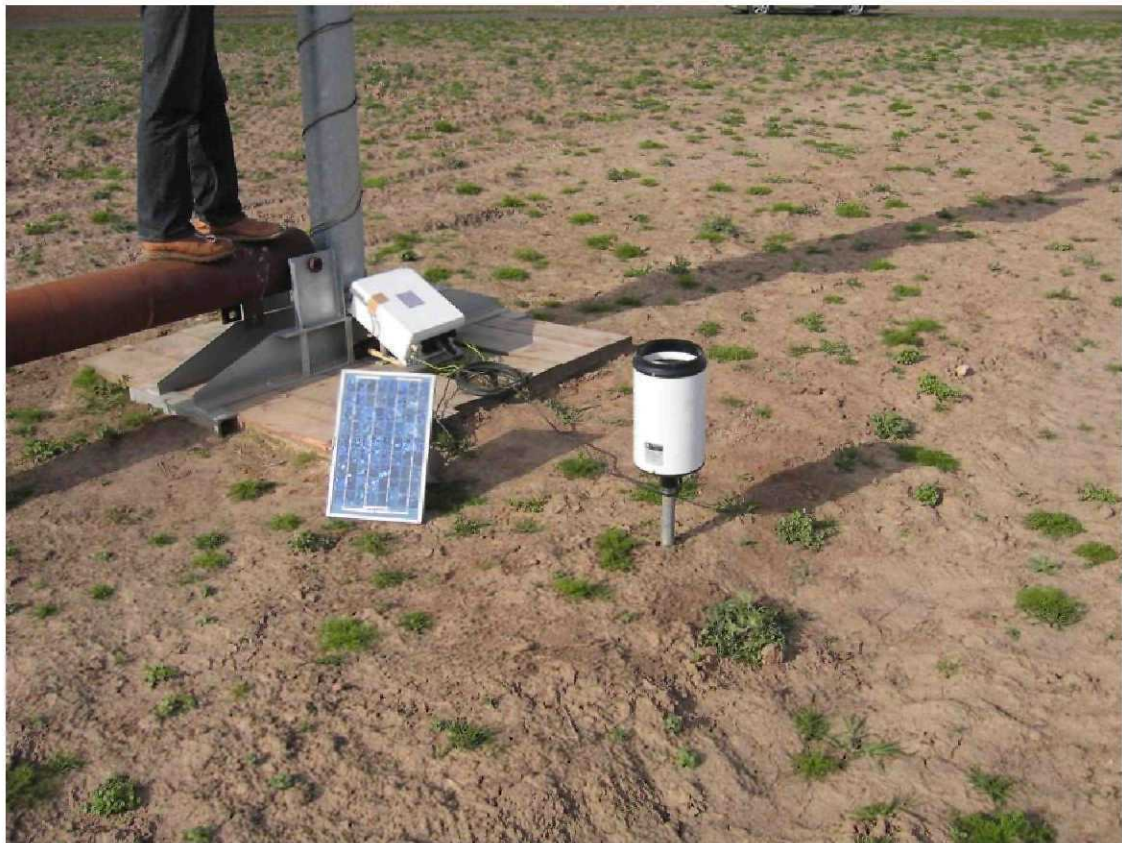
Photo 2 Noise Apparatus at H4 – Gunthorpe Farm



Photo 3 Noise Apparatus at H21 – Chestnut Farm Nursery



Photo 4 Rain Sensor at Met Mast



APPENDIX 10.4 *Quality Control of Background Noise Data*

Removal of Extraneous Noise Affected Data

Prior to any analysis being carried out on the data collected during the background noise survey the data has been inspected in order that instances of unexpected 'peaks' can be removed – these may be been caused by infrequent human activities, for example the periodic or intermittent operation of farm machinery.

Periods of measured background noise data thought to be affected by extraneous, i.e. non-typical, noise sources are generally identified by means of inference. In practice this means close inspection of the measured background noise data and comparison with concurrent data measured at nearby locations. All such non-typical data are removed prior to analysis.

Whilst this 'extraneous' data may actually be real, in practice it tends to bias any trends lines upwards, so that its removal is adopted as a conservative measure.

Removal of Rainfall Affected Data

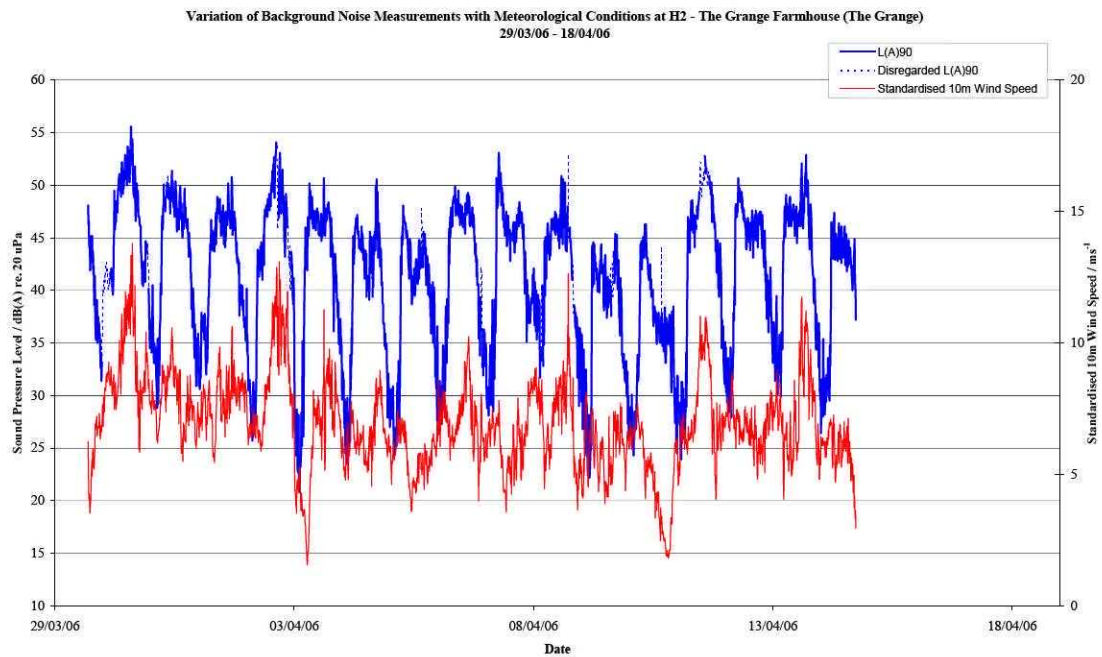
A more systematic approach is adopted to remove rainfall affected data from the record and, to assist in the detection of rainfall, a Young Tipping Bucket type Rain Gauge was deployed at site to record 10 minute rainfall data.

The rainfall data assists in the identification of acoustic data that must be excised from the record prior to further analysis.

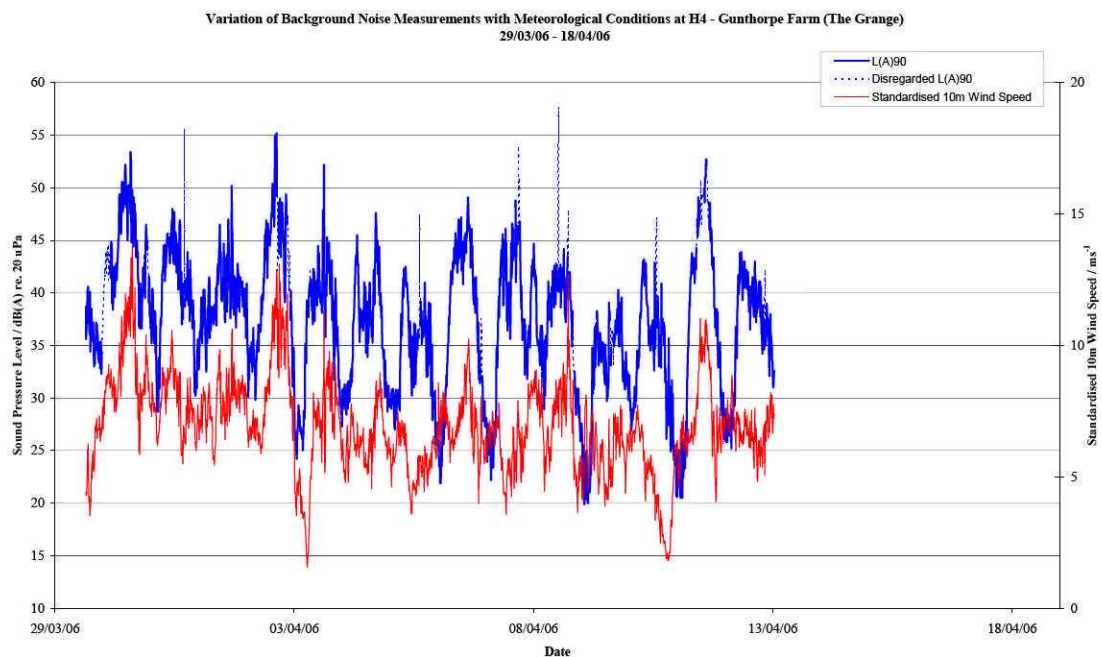
Resulting Quality Controlled Background Noise Data

Illustrations of the acoustic data removed and the acoustical data used are provided below at each of the 3 background noise measurement location.

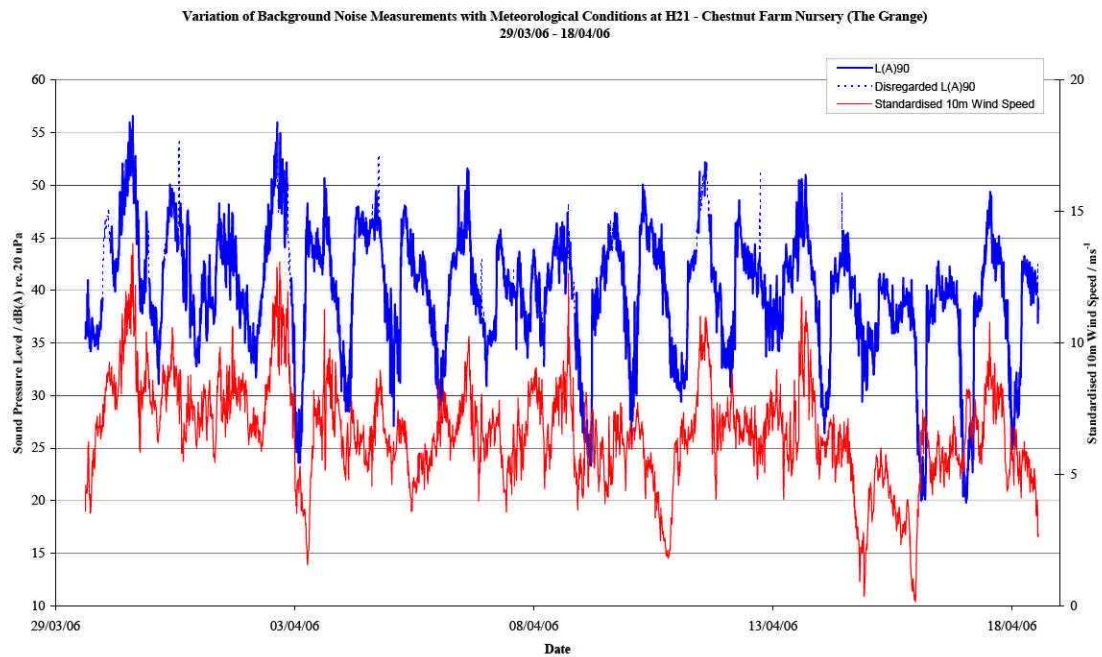
Background Noise Data at H2 – The Grange Farmhouse (The Grange): Pre and Post Quality Control



Background Noise Data at H4 – Gunthorpe Farm (The Grange): Pre and Post Quality Control



Background Noise Data at H21 – Chestnut Farm Nursery (The Grange): Pre and Post Quality Control



Glossary

Broadband Noise

Noise which covers a wide range of frequencies (e.g. from 10 Hz to 5 kHz).

dB(A) or decibel (A-weighted)

The human ear loses sensitivity at both high (>6 kHz) and low (<400 Hz) frequencies. The ear will attenuate noise at these lower and higher frequencies. dB(A) is an international weighted scale of sound levels or noise providing a good correlation with subjective impressions by individuals in most cases, of loudness and sense of annoyance by applying a correction to noise levels in each frequency band (octave band or third octave band). This correction is called A-weighting, and the corrected level is the A-weighted sound pressure level, denoted dB(A).

Frequency

The pitch of a sound in Hz or kHz. See Hz.

Hz

Sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other (in cycles per second, or Hertz (Hz)).

L_{eq}

The equivalent continuous noise level is a notional steady noise level, which over a given time, would provide the same energy as the intermittent noise. Noise standards often specify the length of time over which noise should be measured.

L₉₀

Sound pressure level exceeded for 90% of the time for any given time interval. For example, L_{(A)90, 10min} means the A-weighted level that is exceeded for 90% of a ten minute interval. This indicates the noise levels during quieter periods, or the background noise level. It represents the lower estimate of the prevailing noise level, and is useful for excluding the effects of, for example, aircraft or dogs barking on background noise levels.

L_w

Sound power level is the acoustic power (W) radiated from a sound source. This power is essentially independent of the surroundings, while the sound pressure depends on the surroundings (reflecting surfaces) and distance to the receiver.

Noise Emission

The noise energy emitted by a source (e.g. a wind turbine). Noise immission: the sound pressure level detected at a given location (e.g. nearest dwelling).

Octave Band

Range of frequencies between one frequency ($f_0 \cdot 2^{-1/2}$) and a second frequency $f_0 \cdot 2^{+1/2}$. The quoted centre frequency of the octave band is f_0 .

Sound Frequency

Refers to how quickly the air vibrates, or how close the sound waves are to each other (in Hertz). Frequency is subjectively felt as the pitch of the sound. The lowest frequency audible to humans is 18 Hz and the highest is 18,000 Hz. The human ear is most sensitive to the 1 kHz, 2 kHz and 4 kHz octaves and much less sensitive at the lower audible frequencies.

Spectrum

Description of the sound pressure level of a source as a function of frequency.

Third Octave Band

The range of frequencies between one frequency $f_0 \cdot 2^{-1/6}$ and a second frequency equal to $(f_0 \cdot 2^{+1/6})$. The quoted centre frequency of the third octave band is f_0 .

Tonal Noise

Noise which covers a very restricted range of frequencies (e.g. a range of ≤ 20 Hz). This noise is more annoying than broadband

APPENDIX 12.1: EMI CONSULTEES

Consultee	Response
Ofcom	Potential BT link 10/11/2008
Anglian Water	Potential to affect links 13/11/2008
Joint Radio Company	No objection 13/11/2008
Orange	No objection 27/11/2008
Vodafone	No objection 14/11/2008
BT Wholesale	No objection 24/11/2008