environmental gain

**Government of Gibraltar**

# PROPOSED NEW POWER STATION, LATHBURY BARRACKS, **GIBRALTAR**

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**ENVIRONMENTAL STATEMENT** **VOLUME 2: TECHNICAL REPORTS**

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## TECHNICAL REPORTS

# CHAPTER ONE

# AIR QUALITY

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**FIGURES (Presented in this Report)**

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| Accuracy | A measure of how well a set of data fits the true value. |
| AERMOD | Modelling tool used for dispersion processes within the atmospheric boundary layer and used for air traffic. |
| Air quality objective | Policy target generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences within a specific timescale (see also air quality standard) |
| Air quality standard | The concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on the assessment of the effects of each pollutant on human health including the effects on sensitive sub groups (see also air quality objective) |
| Annual average | The average (mean) of the concentrations measured for each pollutant for one year. Usually this is for a calendar year, but some pollutants are reported for the period April to March, known as a pollution year. This period avoids splitting the winter season between 2 years, which is useful for pollutants that have higher concentrations during the winter months |
| AQMAU | Air Quality Modelling Assessment Unit |
| BAT | Best Available Technology |
| CEMP | Construction Environmental Management Plan |
| Critical levels | Gaseous concentrations of a pollutant above which direct adverse effects on vegetation or ecosystems may occur according to present knowledge. |
| Critical loads | A quantitative estimate of an exposure to one or more pollutants below which significant effects of specific sensitive elements of the environment do not occur according to current knowledge, and where pollutants are deposited to land or water. An exceedence of a critical load is an indication of a potential for harmful effects to ecosystems. |
| Emission rate | The quantity of a pollutant released from a source over a given period of time |
| Exceedance | A period of time where the concentrations of a pollutant is greater than, or equal to, the appropriate air quality standard |
| HGV | Heavy Goods Vehicle |
| ISGS | Inter Services Generating System |

| | |
|---|---|
| Limit values | Legally binding EU standards that must not be exceeded. |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Nitrogen oxides (nitric oxide + nitrogen dioxide) |
| $PM_{10}$ | Fine particulate matter with an aerodynamic diameter of less than 10 micrometres |
| $PM_{2.5}$ | Fine particulate matter with an aerodynamic diameter of less than 2.5 micrometres |
| SCI | Site of Community Interest. A site identified for protection within the European Community's Habitats Directive |
| SCR | Selective Catalytic Reduction |
| $SO_2$ | Sulphur dioxide |
| $\mu g/m^3$ | Microgrammes per cubic metre. A measure of concentration in terms of mass per unit volume. A concentration of $1\mu g/m^3$ means that one cubic metre of air contains one microgram (millionth of a gram) of pollutant |
| Uncertainty | A measure, associated with the result of a measurement that characterizes the range of values within which the true value is expected to lie. Uncertainty is usually expressed as the range within which the true value is expected to lie with a 95% probability, where standard statistical and other procedures have been used to evaluate this figure. Uncertainty is more clearly defined than the closely related parameter 'accuracy', and has replaced it on recent European legislation |
| Validation (modelling) | Refers to the general comparison of modelled results against monitoring data carried out by model developers |
| Validation (monitoring) | Screening monitoring data by visual examination to check for spurious and unusual measurements |
| Verification (modelling) | Comparison of modelled results versus any local monitoring data at relevant locations |
| VOC | Volatile Organic Compounds |

# 1 INTRODUCTION

1.1 This chapter describes the potential air quality impacts associated with the proposed diesel power station, Lathbury Barracks, Gibraltar. It considers both operational and construction impacts.

1.2 The chapter discusses the legislative background for air quality and sets out the scope of work and methodology. It also identifies the sources of pollutant emissions, assesses the potential significant effects on air quality and describes the measures that will be employed to minimise such effects. Where measures cannot mitigate significant effects these are identified as residual effects.

1.3 The report takes into account consultation discussions held with the Environmental Agency and the Department for the Environment.

# 2 RELEVANT LEGISLATION AND GUIDANCE

## Gibraltar Development Plan

2.1 The Gibraltar Development Plan (Consultation Draft) 2007 confirms the Government's objective to ensure that proposed developments do not have a significant adverse effect on Gibraltar's air quality. Policy ENV8 of the Plan requires that:

*Planning permission will only be granted for development proposals that could potentially have a significant adverse effect on air or water quality if it can be demonstrated that, to the satisfaction of the competent authority, that appropriate mitigation measures can be implemented to minimise such effects.*

2.2 The Gibraltar Development Plan has not yet been adopted, however it is expected to be shortly and therefore relevant policies in the Consultation Draft have been referred to in this report.

## Air Quality Criteria

2.3 The significance of both existing and future air quality can be assessed with regard to the air quality objectives that have been set to protect human health and the environment.

2.4 Gibraltar has adopted a number of air quality objectives based on the Public Health (Air Quality Limit Values) Rules 2002[1] as amended by the Public Health (Air Quality Limit Values) (Amendment) Rules 2003[2] and the Public Health (Air Quality) (Ozone) Rules 2004[3]. These Air Quality Rules have transposed the European Commission (EC) limit values as set out in EC Directives 1996/62/EC[4], 1999/30/EC[5], 2000/69/EC[6] and 2002/3/EC[7]. A summary of the relevant air quality objectives for this assessment is provided in Appendix AQ-1. The objectives are consistent with the limit values defined in the Directives.

2.5 A revised EC Directive (2008/50/EC) on ambient air quality entered into force on 21 May 2008, which replaces and consolidates all of the existing directives listed above. The new Directive streamlines the existing directives; confirms the existing obligations, but introduces some flexibility in meeting these obligations under some circumstances, and introduces new controls for fine particulate matter (PM2.5). These include a limit value of 25 µg/m3 (as an annual mean) to be achieved by 2015, and an average exposure concentration obligation of 20 µg/m3 not to be exceeded at urban background locations by 2015. Urban background concentrations must be reduced by between 0% and 20% by 2020 relative to 2010 levels (measured as a three-year rolling mean), the amount of the reduction depending on the 2010 level. The new Directive will need to be transposed into Gibraltar law by May 2010.

### Health Criteria

2.6 For each pollutant there are both long-term (annual mean) and short-term (1-hour or 24-hour) objectives. These periods reflect the varying impacts on health of differing exposures to pollutants, eg temporary exposure to people adjacent to a busy road, compared with the longer-term exposure of people living in residential properties adjacent to a road.

2.7 The EC limit values for human health are fundamentally derived from air quality guidelines prepared by the World Health Organisation (WHO)[8]. Groups at special risk within the general population, such as young children, older people and those with respiratory problems, were specifically considered during the preparation of these guidelines.

### Vegetation and Ecosystem Criteria

2.8 Standards related to the potential effects of air pollution upon vegetation and ecosystems are defined by means of both critical levels (limit values) and critical loads. A *critical level* relates to the concentration of a gaseous pollutant in air (such as NOx or $SO_2$) and may be defined as a level fixed on the basis of scientific knowledge, above which direct adverse effects may occur on receptors, such as plants, trees or natural ecosystems (but excluding humans).

2.9 A *critical load* relates to the quantity of pollutant deposited (such as nitrogen) above which significant adverse effects may occur on specified sensitive habitats or species.

2.10 Whilst achievement of the critical levels is a mandatory obligation on Member States, Annex VI of Directive 1999/30/EC provides guidance on the locations of sampling points for the assessment of concentrations, and requires that these are not sited within 20 km of agglomerations (populations exceeding 250,000 people) or within 5 km of other built up areas, industrial installations or motorways. These siting criteria have been interpreted by the

Environmental Agency as representing an "exclusion zone", such that the critical levels are not applicable on Gibraltar.

2.11 Critical loads for nitrogen have been determined on an empirical basis by observation of changes to vegetation, fauna and biodiversity. In addition, field experiments and comparisons of vegetation and fauna composition are used to detect changes in the ecosystem structure.

2.12 The critical loads for all habitat types were most recently reviewed at an international workshop (the "Berne workshop") in 2005[9]. The critical load for the UNECE ecosystem category considered most applicable to the SCIs is 10 kg N/ha/yr (see the Ecology Chapter, Volume 2: Technical Reports).

2.13 It must be emphasised that exceedence of the critical load does not provide a quantitative estimate of damage to an ecosystem, but only the potential for damage to occur. In addition, exceedence of the critical load may not be manifest in terms of actual ecosystem damage, as the timescales for effects to occur may be very long (10-100 years).

# 3 SCOPE AND METHODOLOGY

## Scope

3.1 The scope of the assessment has been determined by:

- Consultations with the Environmental Agency to discuss the availability of monitoring data and the assessment methodology to be applied;
- Review of existing air quality data for the area surrounding the site; and
- Site visit and desk study to confirm the locations of receptors that may be sensitive to changes in local air quality.

3.2 The existing air quality conditions in the general vicinity of the proposed scheme are described. Predictions of air quality in the future, with and without the proposed diesel power station, are provided. The results are assessed with regard to relevant air quality criteria for the protection of human health and the environment.

3.3 Should the proposed power station be consented, then existing generating capacity on Gibraltar would be decommissioned. This includes three existing power stations:

- Ministry of Defence (MOD) Inter Service Generating Station (ISGS)
- OESCO
- Gibraltar Electricity Authority station at Waterport.

3.4 To take account of this, the contribution of these three existing power stations has been explicitly considered in the study.

3.5 Consideration has also been given to the potential impacts during construction, which focuses on dust emissions during the site works. There is also the potential for impacts to arise from the additional traffic generated by the construction work. Based on professional judgement, any impacts are considered to be of a temporary nature and restricted to the duration of the works.

### *Pollutants of Concern*

3.6 There are a range of pollutants associated with emissions from the proposed power station that have the potential to affect human health and the environment. The most significant ones are considered to be nitrogen oxides (NOx), nitrogen dioxide ($NO_2$), fine particles ($PM_{10}$ and $PM_{2.5}$) and sulphur dioxide ($SO_2$). The assessment of operational effects therefore focuses on these pollutants.

3.7 Consideration is given to both pollutant concentrations (for comparison with the objectives set out in Appendix AQ-1) and nitrogen deposition rates (for comparison with the critical load (described in paragraph 2.11). Sulphur dioxide deposition has not been quantified, as this predominantly relates to long-distance acid deposition. This is not considered important in the near-field.

3.8 The new facility would include three fuel oil storage tanks of approximately 1800 $m^3$ capacity each, located at the eastern boundary of the site. There is the potential for emissions of volatile organic compounds (VOCs) to arise from these storage tanks, potentially causing local odour problems and this has also been taken into account.

3.9 The principal pollutants of concern during construction activities are dust and fine particles arising from site works.

## Assessment Methodology

3.10 The approach used to assess the potential air quality impact of the proposed scheme has been based on standard methodologies.

### *Sensitive Locations*

3.11 Sensitive receptors are locations in the vicinity of the proposed power station that may be exposed to pollutant emissions. They include locations such as residential housing, hospitals and medical centres. They also include ecosystems that are sensitive to air pollution. In terms of the short-term criteria (1-hour mean) relevant locations may include anywhere that is open to access by the general public. Locations within the boundary of the power station site are not covered by the objectives, as the objectives do not apply to occupational exposure.

### *Impacts during Construction*

3.12 Construction activities have the potential to cause dust emissions that may impact upon residential properties and commercial operations close to the site. Sensitive ecosystems could also suffer some negative effects.

3.13 It is difficult to quantify emissions of dust from construction activities accurately and it is therefore common practice to provide a qualitative assessment of potential impacts and to focus on mitigation measures. The distance criteria set out in Table AQ3-1 have been used to assist this assessment. Table AQ3-1 defines the scale of development and assigns distance criteria within which effects might occur, assuming standard mitigation measures are in place. These distances are based on professional experience drawn from involvement with assessments of many different types of project and from discussions with practitioners in the field. They take into account the generally dry, windy climate in Gibraltar.

3.14 The construction works would also generate additional Heavy Goods Vehicle (HGV) traffic on the local roads. The additional traffic generated would vary with each phase of the works, but it is anticipated that approximately 1500 HGV movements would be required between the initial foundations work and the delivery of equipment to site for installation, a period extending over some 11-12 months. This equates to approximately 4 movements per day, averaged over a period of a year. It is thus considered highly unlikely that HGV emissions would have any significant effect and they are not considered further in this assessment.

**Table AQ3-1 Assessment Criteria for Dust from Construction Activities, with Standard Mitigation in Place**

| *Source* | | *Potential Distance for Significant Effects (Distance from source)* | | |
|---|---|---|---|---|
| *Scale* | *Description* | *Soiling* | *$PM_{10}$* * | *Vegetation effects* |
| Major | Large construction sites, with high use of haul routes | 200 m | 25 m | 25 m |
| Moderate | Moderate sized construction sites, with moderate use of haul routes | 100 m | 15 m | 15 m |
| Minor | Minor construction sites, with limited use of haul routes | 50 m | 10 m | 10 m |

**Note**

* Significance based on the 2005 objective, which allows 35 daily exceedences/year of 50 $\mu g/m^3$

### Operational Impacts – Stack Emissions

3.15 The potential impacts during operation have been assessed using a dispersion model. The predicted concentrations have then been compared with the air quality criteria described in Appendix AQ-1.

3.16 The following scenarios have been considered:

- 2006 – Current Baseline;
- 2011 – Future Baseline (2011) without the proposed power station, but with existing generating capacity;
- 2032 – Future Baseline (2032) without the proposed power station, but with existing generating capacity;
- 2011 – With Scheme (2011) with the proposed power station, but with three existing stations decommissioned; and
- 2032 – With Scheme (2032) with the proposed power station, but with three existing stations decommissioned.

3.17 As set out in subsequent sections of this Chapter, there are additional uncertainties associated with the modelling predictions provided for the existing power stations, specifically regarding the pollutant emission rates and operational parameters. Consequently, the effects of decommissioning this existing generating capacity in 2011 and 2032 has not been assessed by directly subtracting the modelled 2006 contributions from the future baseline, but has relied upon a more semi-quantitative approach.

### Modelling Methodology

3.18 Predictions of ground level pollutant concentrations arising from the existing and proposed power stations have been calculated using the AERMOD dispersion model. This is a new generation model that incorporates a state-of-the-art understanding of the dispersion processes within the atmospheric boundary layer. AERMOD is now the preferred regulatory model in the US, and is used worldwide for the assessment of industrial processes. The model also incorporates utilities to account for building downwash and terrain effects.

3.19 Within this assessment consideration has been given to relevant guidance issued by the UK Environment Agency. This includes the guidelines for air dispersion modelling reports provided in Appendix E of Horizontal Guidance Note H1[10] and guidance issued by the Air Quality Modelling and Assessment Unit (AQMAU).

3.20 The AERMOD model requires a variety of input data to be provided, covering the emission rates, conditions of release, adjacent building dimensions and orientations, and meteorological data.

*Existing Power Stations*

3.21 Information on emissions arising from the three existing power stations on Gibraltar has been derived from published air quality assessment studies.

*ISGS Power Station*

3.22 The ISGS station is located on the western side of Gibraltar. An assessment of the air quality impacts associated with its operation was provided in a report undertaken for the Defence Estates in February 2005[11].

3.23 The ISGS is located within two buildings, with 4 engine units arranged in parallel. Each unit has a separate exhaust stack that is angled at 45° from the vertical. The model input parameters assumed from the Defence Estates report are summarised in Table AQ3-2.

**Table AQ3-2 ISGS Power Station - Model Input Parameter (at 100% load)**

| *Parameter* | *Value* | |
|---|---|---|
| No. Flues | 4 | |
| Exit velocity (m/s) | 40.9 | |
| Exit temperature (°C) | 340 | |
| Flue diameter (m) | 0.5 | |
| Stack heights (m) | 1.3 m (above adjacent roof at 12.2 m) | |
| *Emissions per flue* | | |
| | Conc ($mg/Nm^3$) | Emission Rate (g/s) |
| NOx | 2050 | 8.39 |
| $PM_{10}$ | 50 | 0.2 |
| $SO_2$ | 322 | 1.43 |

*OESCO Power Station*

3.24 The OESCO station is located on the western side of Gibraltar, facing directly onto the harbour. The station consists of 7 main engines (from 1.8 to 5.1 MW capacity), discharging from 11 emission points. Emission data and load factors for 2005/06 have been obtained and used to estimate likely emissions during normal and future operations. On the basis of the data available, a 90% load factor has been used for the calculations.

3.25 The data are summarised in Table AQ3-3.

**Table AQ3-3 Summary of OESCO Power Station Emissions**

| *Stack* | *Vol flow (Nm3/sec)* | *Temp (°C)* | *Stack Diameter (m)* | *Emission Rate (g/sec)* | | |
|---|---|---|---|---|---|---|
| | | | | *NOx* | *$PM_{10}$* | *$SO_2$* |
| 1 | 10.33 | 382 | 0.71 | 6.81 | 0.21 | 0.86 |
| 2 | 8.21 | 417 | 0.71 | 4.50 | 0.30 | 0.56 |
| 3 | 10.33 | 382 | 0.71 | 6.81 | 0,21 | 0.86 |
| 4 | 11.42 | 403 | 0.71 | 10.08 | 0.13 | 0.86 |
| 5 | 10.30 | 430 | 0.71 | 7.50 | 0.30 | 0.58 |
| 6 | 10.38 | 421 | 0.71 | 6.96 | 0.32 | 0.84 |
| 7 | 11.67 | 435 | 0.71 | 7.33 | 0.40 | 0.76 |
| 8 | 10.38 | 421 | 0.71 | 6.96 | 0.32 | 0.84 |
| 9 | 11.67 | 435 | 0.71 | 7.33 | 0.40 | 0.76 |
| 10 | 13.91 | 407 | 0.61 | 13.47 | 0.12 | 0.94 |
| 11 | 13.83 | 403 | 0.61 | 13.65 | 0.10 | 0.91 |

**Note:** All stack heights assumed to be 13.5 m (1.3 m above the roof of the adjacent building).

### *Waterport Power Station*

3.26 The Gibraltar Electricity Authority power station at Waterport is located to the north west of Gibraltar. The station consists of three engines of 5.2 MW capacity. Emissions data have been obtained for 2004 for engines 1 and 3, assuming 100% operational load. The emissions data and associated release conditions are summarised in Table AQ3-4.

**Table AQ3-4 Waterport Power Station - Model Input Parameter (at 100% load)**

| *Parameter* | *Value* |
|---|---|
| No. Flues | 3 |
| Vol flow ($Nm^3/s$) | 20.4 |
| Exit temperature (°C) | 328 |
| Flue diameter (m) | 0.90 |
| Stack heights (m) | 21 m |
| *Emissions per Flue* | |
| | Emission Rate (g/s) |
| NOx | 21.24 |
| $PM_{10}$ | 0.09 |
| $SO_2$ | 0.64 |

**Note:** Emissions data calculated by averaging four "spot readings" from engines 1 and 3, which are then assumed to apply to all three engines.

*Proposed Power Station*

3.27 The proposed new power station would fully comply with European Directive 96/61/EC and local regulations covering Integrated Pollution Prevention and Control, and would operate under a permit issued by the Environmental Agency.

3.28 The proposed power station would be developed to provide increased generating capacity between 2011 and 2032. This is summarised in Table AQ3-5.

**Table AQ3-5 Summary of Projected Power Station capacity**

| *Year* | *No. 8 MW Units* | *Installed Capacity (MW)* | *Predicted Maximum Demand (MW)* | *Predicted Average Demand (MW)* | *Max No. Engines Operating* |
|---|---|---|---|---|---|
| 2011 | 9 | 72 | 45 | 26.1 | 7 |
| 2032 | 12 | 96 | 72 | 38.8 | 10 |

3.29 In 2011, the station would consist of 9 x 8 MW units, configured with 3 flues in each of the 3 main stacks. The plant would operate continuously at an output which would be determined by the load on the Gibraltar system, which is expected to vary between a maximum of 45 MW and a minimum of 16-18 MW, when the plant is commissioned in 2011. The engines would be started and stopped in order to operate them at approximately 85-95% of the rated output. For the purpose of this assessment, it is assumed that no more than 7 engines would operate simultaneously at approximately 90% load, the others providing maintenance and standby capacity. For the purpose of modelling, equivalent stack diameters have been assumed for 2 stacks with 2 flues combined, and 1 stack with 3 flues combined.

3.30 By 2032, the total installed capacity would be increased to 96 MW, with 12 x 8 MW engines configured within 4 main stacks. For the purpose of this assessment it has been assumed that no more than 10 engines would operate simultaneously at approximately 90% load, providing a peak demand of 72 MW. For the purpose of modelling, equivalent stack diameters have been assumed for 2 stacks with 2 flues combined, and 2 stacks with 3 flues combined.

3.31 For the calculation of annual average and 24-hour mean concentrations, the predicted average demand load has been applied for both 2011 and 2032.

3.32 A preferred stack height of 40 m has been considered in detail, with sensitivity tests also carried out for 30 m and 50 m stack heights.

3.33 The diesel engines would use Best Available Technology (BAT) to minimise any impact arising from pollutant emissions to air. This would include the use of low sulphur and low ash fuel to minimise emissions of sulphur dioxide and particulate matter, the use of engines with fuel injection and valve timing optimised to minimise emissions of NOx.

3.34 The station would also be equipped with selective catalytic reduction (SCR) that would achieve a NOx emissions reduction of approximately 80% in 2011, increasing to 90% by 2032, over all operational loads. A summary of the assumed emission rates and pertinent release conditions is provided in Table AQ3-6. The pollutant emission rates specified in Table AQ3-6 represent a worst-case assumption and in practice it is expected that emissions would be at least 10% lower than those stated.

**Table AQ3-6 Proposed Power Station - Model Input Parameter (90% load)**

| *Parameter* | *2011* | *2032* |
|---|---|---|
| No. Main Stacks | 3 | 4 |
| No. Flues per Stack | 2 (2 stacks), 3 (1 stack) | 2 (2stacks), 3 (2 stacks) |
| Equivalent stack diameter (m) | 1.82 | 2.23 |
| Exit temperature (°C) | 360 | 360 |
| Exit velocity (m/s) | 18 | 18 |
| Stack height (m) | 40 | 40 |
| *Assumed Emission Releases per 8 MW Unit* | | |
| *Conc (mg/Nm$^3$)* | | |
| NOx | 400 (80% SCR) | 200 (90% SCR) |
| $PM_{10}$ | 50 | 50 |
| $SO_2$ | 43.7 | 43.7 |
| *Emission Rate (g/s)* | | |
| NOx | 5.38 (80% SCR) | 2.69 (90% SCR) |
| $PM_{10}$ | 0.68 | 0.68 |
| $SO_2$ | 0.59 | 0.59 |

### *Meteorology*

3.35 The dispersion and dilution of pollutant emissions is strongly affected by the local meteorological conditions, including wind speed, direction and the degree of atmospheric turbulence. Suitable meteorological data are available from Gibraltar Airport, which is about 3.5 kilometres due north of the development site.

3.36 Hourly sequential datasets for 2003 to 2007 have been used in this study. Initial sensitivity tests confirmed that the 2006 meteorological data most consistently predicted the highest concentrations and these data were subsequently used for the detailed model runs and reporting of results. These sensitivity tests are described in Appendix AQ-2.

3.37 The meteorological data for 2006 are shown plotted in a wind rose in Figure AQ3-1. This shows that the prevailing winds are from the north-east to easterly and south-west to westerly directions.

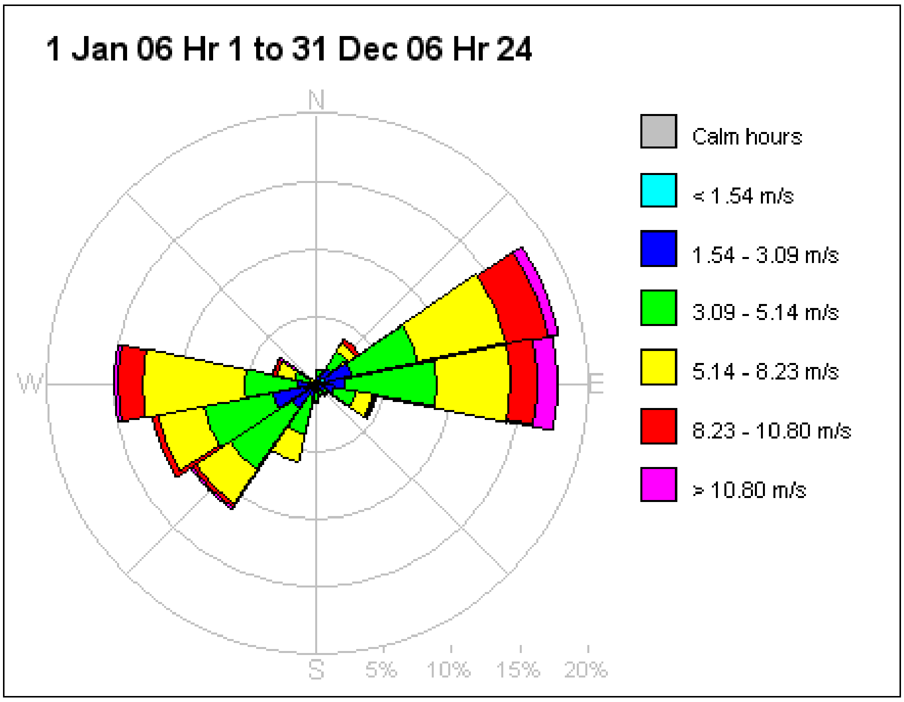
3.38 Meteorological data (wind speed and direction) are also recorded at the Bleak House monitoring station that is operated by the Environmental Agency. The wind rose for 2006 is provided in Figures AQ3-2 for comparative purposes.

3.39 There is a clear disparity between the wind patterns recorded at Gibraltar Airport and Bleak House, such that the strong easterly component shown at the Airport is diminished at Bleak House. This may be in part due to the location of Bleak House which situated at sea level below the escarpment that runs along the southern tip of Gibraltar, effectively shielding this location from easterly winds and is also due to the influence of the Rock in channelling winds (see below). Although Bleak House is closer to the development site, the meteorological data at the Airport are considered likely to be more representative of the Lathbury Barracks area.

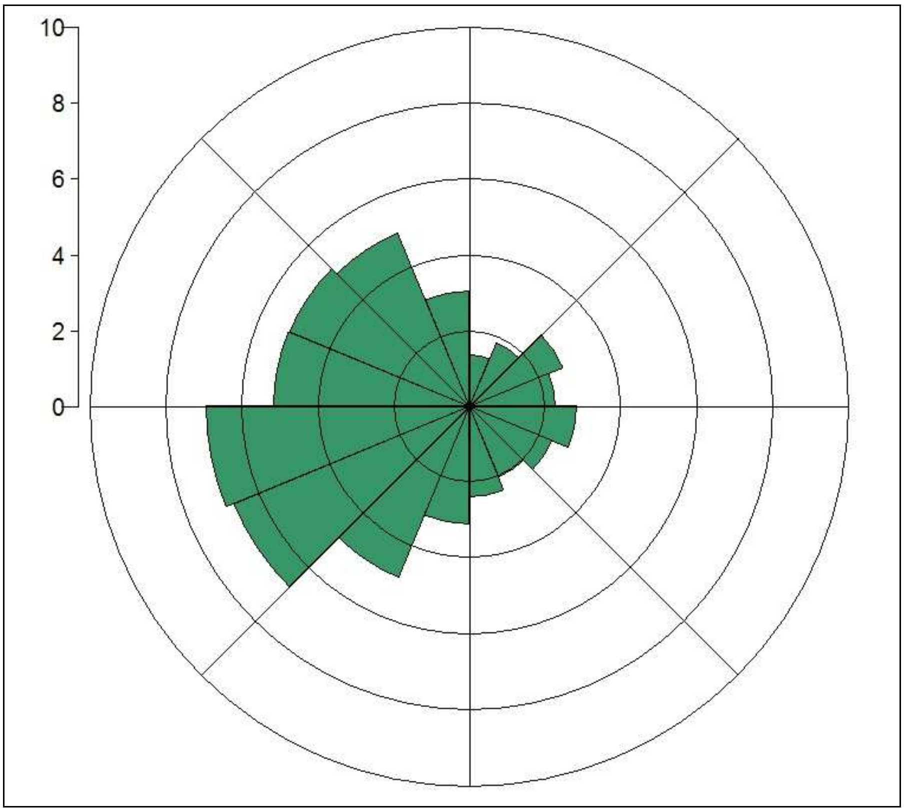
3.40 The data represented in Figure AQ3-1 show the general pattern of wind conditions in Gibraltar. An important factor to also be considered is that the area is frequently associated with strong “gap winds” known as the “Levanter” and the “Poniente”. The Lavanter describes easterly winds, while the Poniente describes the opposite. The Levanter winds can occur at any time of the year but are most common during the period May to October. During very strong easterly winds the wind field around the Rock may be severely distorted, such that the surface wind direction is changed, even becoming inverted on the downwind side. This may account for the wind direction pattern at Bleak House. A further effect is the formation of strong inversion layer at a height of several thousand feet.

3.41 In the absence of detailed wind field observations across Gibraltar, such local meteorological variations are difficult to account for within the model. However, the effect is likely to influence the geographical pattern, rather than the magnitude of ground level pollutant concentrations. The inversion layer associated with the Levanter is probably too high to have a significant effect on the plume dispersion within the near-field distances considered in this assessment.

### Figure AQ3-1: Wind rose for Gibraltar Airport 2006




### Figure AQ3-2: Wind rose for Bleak House 2006



*Terrain and tall buildings*

3.42 It is difficult to accurately represent very complex topographical features using the Gaussian dispersion models that are commonly used for this type of assessment. The AERMOD model incorporates a terrain processor (AERMAP) that allows terrain effects to be included within the model program. These are normally input to the model as USGS or OS format digital elevation files. In the absence of digital elevation files for Gibraltar, the topographical features have been manually digitised to a 100 m grid resolution.

3.43 It is also necessary to take account of elevated receptor locations within tall buildings. For the health-based receptors (see Section 4), the upper floor levels of the buildings have been represented as “flagpole receptors” within the model.

*Building Downwash*

3.44 The dispersion of the plume may also be affected by the flow of the wind across local buildings, if they are sufficiently high with respect to the stack. These so-called “building downwash effects” have been included in the model using the PRIME facility, incorporating the location and relevant dimensions of the plant and other nearby buildings. For the existing power stations this has been done using reported information and observations from satellite images. For the proposed power station, all building within 5 stack heights (if greater than two-thirds stack height) have been included based on information provided by Environmental Gain Ltd.

*Background Pollutant Contributions*

3.45 The dispersion model predicts concentrations from the emissions sources that are explicitly included in the model. It is also necessary to take account of the contribution of other sources, which represents the local background. These background contributions must be added to the process contributions.

3.46 Background concentrations of NOx, $NO_2$, $SO_2$, $PM_{10}$ and $PM_{2.5}$ have been derived from local monitoring carried out by the Environmental Agency. These data are described in Section 4. In terms of the critical loads, there are no data to describe existing nitrogen deposition rates across the SCI, and this remains unquantified.

3.47 In future years, it is expected that pollutant concentrations will decline due a range of internationally agreed measures to control emissions from both the industrial and road transport sectors. By definition, nitrogen deposition rates would also be expected to decline. In the absence of information that would allow accurate forecasts to be made, background concentrations and deposition rates in the future are considered to remain unchanged, representing a very conservative assumption.

*Model Output*

3.48 Predictions have been carried out for annual mean concentrations; in addition, the following calculations have been undertaken for comparison with the short-term objectives:

- The 19$^{th}$ highest hourly mean NOx concentration (99.8$^{th}$ percentile)
- The 36$^{th}$ highest 24-hour mean $PM_{10}$ concentration (90.4$^{th}$ percentile)
- The 25$^{th}$ highest hourly mean $SO_2$ concentration (99.7$^{th}$ percentile)
- The 4$^{th}$ highest 24-hour mean $SO_2$ concentration (99.2$^{nd}$ percentile)

3.49 Predicted annual mean concentrations have been added directly to the assumed background contribution. For the shorter-term objectives, the following approaches have been used, based on guidance provided by the UK Environment Agency[12,13]. In each case, *T* is the total calculated percentile, *q* denotes the required percentile, *S* is the source contribution, *A* is the background contribution, and *m* is the annual mean.

3.50 For nitrogen dioxide, the following approach has been applied:

$$T_q^{NO_2} = \min \{A_q^{NO_2+0_3} + 0.05S_q^{NOx}, \max [S_q^{NOx} + 2A_m^{NO_2},\ 2A_q^{NO_2} + 2S_m^{NOx}]\}$$

where, $NO_2$+$O_3$ refers to the total oxidant concentration.

3.51 The UK Environment Agency also provides similar guidance on the assessment of $PM_{10}$ concentrations, but due to the limited information in Gibraltar to describe background concentrations of $PM_{10}$, this approach has not been applied. The assessment of $PM_{10}$ is thus reliant on a semi-quantitative approach.

3.52 For sulphur dioxide, the following approach has been applied:

$$T_q = \max \{A_q + 2S_m, S_q + 2A_m\}$$

3.53 NOx emissions arising from power station stacks are predominantly in the form of nitric oxide (NO). Transformation to nitrogen dioxide ($NO_2$) takes place via chemical reactions in the atmosphere, primarily through oxidation with ozone ($O_3$). Within the plume, the rate of conversion is limited by the availability of ozone, and is thus restricted within the near field. In line with guidance issued by the UK Environment Agency, Air Quality Modelling and Assessment Unit (AQMAU), NOx:$NO_2$ conversion ratios of 35% for short-term (hourly mean) and 70% for long-term (annual and daily mean) concentrations have been applied. This is expected to represent a conservative assumption.

*Deposition*

3.54 Deposition has not been explicitly included within the dispersion model, but has been calculated from the modelled concentrations at each receptor. The effect of this is that the modelled ambient concentrations will have been slightly over-estimated as there is no allowance for loss by deposition.

3.55 Acidic pollutants (such as NOx) may be deposited via wet or dry deposition. For the purpose of this assessment, wet deposition has been ignored. Wet deposition of NOx this close to the emission source will be restricted to wash-out, or below cloud scavenging. For this to occur, rain droplets must come into contact with the gas molecules before they hit the ground. Falling raindrops displace the air around them, effectively pushing gases away. Nitrogen dioxide is relatively insoluble in water droplets, and any scavenging will be a negligible factor.

3.56 Dry deposition of nitrogen oxides to vegetation occurs mainly via uptake of nitrogen dioxide though stomata. Nitric oxide (NO) does not deposit at a significant rate[13] and has been ignored.

3.57 Dry deposition of nitrogen dioxide to the ecosystem has been calculated explicitly from the modelled annual mean concentrations, assuming a deposition velocity of 1.0 mm/second[14], derived from the EMEP Eulerian photochemistry model.

*Model Validation and Verification*

3.58 It is important to distinguish between the terms validation and verification. Model validation refers to detailed peer-reviewed studies that have been carried out by the model developer or regulatory agency. The AERMOD model has been subject to rigorous validation studies by the US Environmental Protection Agency.

3.59 Model verification generally refers to checks on the model performance that are sometimes carried out at a local level. This generally requires predicted concentrations to be compared with measured values. For point source (stack) modelling this is inherently more difficult, as often the monitoring sites do not coincide with the locations of the predicted maxima.

3.60 For the existing power stations, there is a lack of information regarding operational parameters in 2006 that would allow the predicted concentrations to be compared directly with measured data and it is only possible to draw broad comparisons between modelled and measured values. It is obviously not possible to verify the model performance for a new process in a future year. The assessment has therefore necessarily relied on the use of an appropriate and validated model, taking into account the additional uncertainties that arise.

## Operational Impacts – Fuel Storage

3.61 Three fuel storage tanks of 1800 $m^3$ capacity would be located to the east of the power station. The design of these tanks has not yet been finalised. Located with the storage tanks would be fuel transfer pumps which would transfer the diesel oil to two service tanks located at the power station. Connection points for the unloading of fuel into the storage tanks would be provided at the Dockyard area and at the East side of the Rock to enable fuel deliveries by coastal barge or by road tanker.

3.62 A qualitative assessment has been based on the expected frequency of refuelling, based on maximum operational capacity in 2032.

## Significance Criteria

### *Construction Impacts*

3.63 The assessment of impact significance is based on professional judgment (as outlined in paragraph 3.13) taking into account the sensitivity and number of receptors, the prevailing wind direction, the duration and scheduling of the works and the expected frequency of events.

*Operational Impacts*

3.64 The UK Environment Agency suggests that process source contributions are unlikely to have a significant environmental impact where the source contribution is:

- Less than 1% of the long-term criterion;
- Less than 20% of the short-term criterion.

3.65 Where potential environmental impacts are indicated, it is then recommended that account is taken of the estimated background contribution. However, this does not imply that significant effects would necessarily occur at higher process contributions.

3.66 The UK Environment Agency has also developed a series of policy documents to comply with the Habitats Directive. Appendix 6 of these documents (Further Guidance applying the Habitats Regulations to Waste Management Facilities available at www.environment-agency.gov.uk) recommend that where the background concentration currently exceeds the appropriate criterion and the process contribution is small, then a decision should be made based on local circumstances.

3.67 The following significance criteria have been applied to this assessment:

- Low significance – predicted concentrations are below relevant criteria and there will be no significant impacts;
- Medium significance – potential to exceed relevant criteria, depending on existing background concentrations. Not considered likely that significant impacts will occur; and
- High significance – predicted concentrations exceed the relevant criteria, and there are expected to be significant impacts.

## Assumptions and Limitations

3.68 In the course of preparing this air quality assessment it has been necessary to make various assumptions regarding existing and future air quality conditions, and the operations of the existing and proposed emissions sources. Wherever possible, this has been based on worst-case assumptions, such that any predicted impacts are likely to overstated.

3.69 In terms of monitoring data, there is only limited information to describe existing pollutant concentrations across the study area, particularly in the vicinity of Lathbury Barracks and within the SCIs. In addition, in the absence of suitable mechanisms to forecast background pollutant concentrations in future years, it has only been possible to assume that levels remain unchanged, although in practice they are likely to decline.

3.70 There are many components that contribute to the uncertainty of modelling predictions. For industrial point-source releases it is generally possible to quantify the emissions releases with greater accuracy than is the case for many other source types. For the proposed new power station, these emission releases have been based on information provided by the developer and are expected to represent an accurate picture of operational conditions. For the existing power stations, the emissions releases have been quantified using available published data, but there is far greater uncertainty regarding the precise operational loads and operational patterns of these units; consequently, the predicted concentrations arising from the existing power stations are subject to much greater uncertainty.

3.71 There will be additional uncertainties introduced because the model simplifies real-world processes into a series of algorithms. Where there are complex topographical features and buildings, this will introduce additional uncertainty as it is not possible to accurately represent the complex wind field patterns with Gaussian-type models.

3.72 Whilst the model has been extensively validated (as outlined in paragraphs 3.58 – 3.60), it has not been possible to undertake any detailed local verification studies and it not possible to quantify the uncertainty of the predictions beyond that normally expected for this type of study.

# 4 EXISTING CONDITIONS

## Sensitive Locations/Receptors

4.1 A total of 20 sensitive receptors representing public health exposure are described in Table AQ4-1. These locations include receptors close to the proposed power station at Lathbury Barracks (H1 to H12), and close to the existing three power stations at ISGS, OESCO and Waterport (H13 to H20). They are all expected to represent worst-case exposure. For each receptor location, where relevant, account has been taken of buildings that represent exposure at height.

**Table AQ4-1: Description of Health-Based Receptor Locations**

| *Receptor* | *Description* | *Grid Ref* | |
|---|---|---|---|
| | | *X* | *Y* |
| Receptor H1 | Clifftop House residential apartments | 288983 | 399942 |
| Receptor H2 | The Retreat Centre | 288976 | 400007 |
| Receptor H3 | Retirement Home | 289079 | 399948 |
| Receptor H4 | HM Prison | 289144 | 399921 |
| Receptor H5 | Residential properties Windmill Hill Road | 288925 | 399952 |
| Receptor H6 | The Royal Naval Hospital | 288844 | 399960 |
| Receptor H7 | The Community Catholic Centre | 289156 | 399443 |
| Receptor H8 | South View Terrace | 288450 | 400475 |
| Receptor H9 | St Joseph's School | 288480 | 400680 |
| Receptor H10 | Nuffield Pool | 288650 | 399600 |
| Receptor H11 | Public Terraces | 288700 | 399450 |
| Receptor H12 | St Christopher's School | 288820 | 399100 |
| Receptor H13 | Rosia Road (opposite petrol station) | 288470 | 400950 |
| Receptor H14 | Withams Road | 288480 | 401020 |
| Receptor H15 | Red Sands Road | 288480 | 401140 |
| Receptor H16 | Governors Meadows Estate, Rosia Road | 288430 | 401170 |
| Receptor H17 | Harbour Views | 287750 | 402970 |
| Receptor H18 | Sir William Jackson Grove | 287850 | 403045 |
| Receptor H19 | Varyl Beg Estate | 287950 | 402945 |
| Receptor H20 | New properties at Waterport | 287750 | 403190 |

4.2 Additional receptor locations have been included to represent areas of sensitive vegetation. There are two sensitive ecosystems adjacent to the proposed power station site. One lies about 200 m to the north of the site. The other lies directly south of the existing parade ground and extends approximately 500 m in length. These sites are designated as Sites of

Community Interest (SCIs). Eight specific receptors have been identified (Receptors E1 to E8), each intended to represent worst-case locations.

4.3 The health-based receptor locations are shown in Figure AQ4-1, and the ecosystem receptors shown in Figure AQ4-2.

## Existing Air Quality Conditions

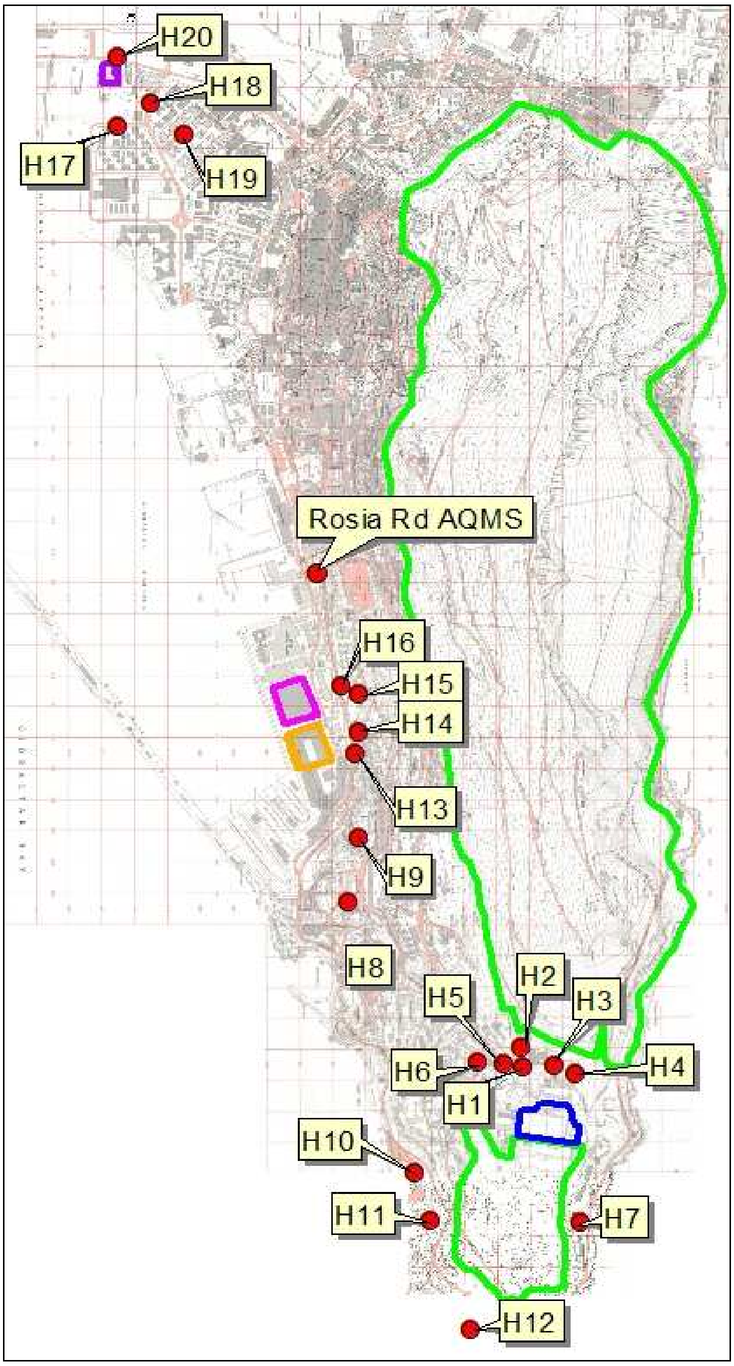
### *Air Quality Monitoring*

4.4 Information on existing air quality conditions has been derived from monitoring carried out by the Environmental Agency in Gibraltar. Two continuous monitoring stations were commissioned in February 2005, at Rosia Road and Bleak House.

4.5 Rosia Road is roadside site within the commercial centre of Gibraltar. The monitoring station is located approximately 1.8 km north-north-west of Lathbury Barracks. Bleak House is a suburban site on the south west coast of Gibraltar, approximately 470 m to the south-west of Lathbury Barracks. Pollutant concentrations measured at Bleak House are expected to be more representative of those at the proposed power station site.

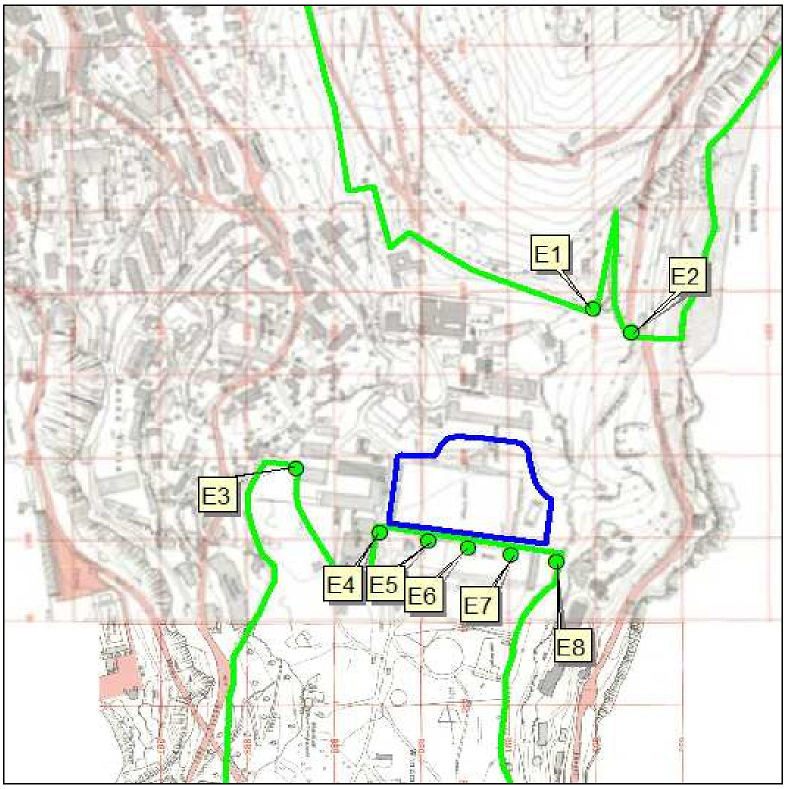
4.6 A summary of monitoring data for 2006 and 2007 is provided in Table AQ4-2. Nitrogen dioxide concentrations measured at Bleak House represent good air quality, with levels well below the health-based air quality objectives. The annual mean NOx concentration measured at this site in both 2006 and 2007 was above the annual mean objective for the protection of vegetation (30 $\mu g/m^3$). As might be expected concentrations of both nitrogen dioxide and NOx are much higher at the Rosia Road roadside monitoring station.

**Figure AQ4-1: Location of specific health-based receptors**




**Key:** Blue area – Proposed development site; Orange area – OESCO; Magenta area – ISGS; Purple area – Waterport; Green area – SCI boundary

### Figure AQ4-2: Location of specific ecosystem receptors




**Key:** Blue area – Proposed development site; Green area – SCI boundary

4.7 The Environmental Agency also operates a network of passive nitrogen dioxide diffusion tubes across Gibraltar. The 2007 data have now been fully ratified and data from relevant sites are shown summarised in Table AQ4-3. The annual mean objective was exceeded at many locations in the vicinity of Rosia Road and air quality in this part of Gibraltar is currently poor.

4.8 The network also includes a site located at Lathbury Industrial Park (approximately 90 m to the north of the application site), which recorded a 2007 annual mean concentration of 20.7 μg/m3. Concentrations of NOx are not recorded by this diffusion tube method, but if the average 2006/07 NO2:NOx ratio at Bleak House were assumed, an annual mean NOx concentration in 2007 of about 32 μg/m3 would be derived.

4.9 It is not certain to what extent the measured concentration at Lathbury Industrial Estate has been affected by local construction works and concentrations of nitrogen dioxide (and NOx) may be significantly lower to the north and south and within the SCIs. In particular, it might be expected that concentrations of both nitrogen dioxide and NOx would be lower in the more remote areas towards the Rock. Following advice from the Environmental Agency, for the purpose of this assessment it has been assumed that NOx concentrations across the SCIs are represented by that measured at Bleak House.

**Table AQ4-2: Summary of Automatic Monitoring Data in Gibraltar (µg/m$^3$). Exceedences of the objectives are highlighted in bold.**

| *Pollutant* | *Location* | | | | *Objective* |
|---|---|---|---|---|---|
| | *Rosia Road* | | *Bleak House* | | |
| | *2006* | *2007* | *2006* | *2007* | |
| *Continuous (Automatic Monitoring)*[a] | | | | | |
| ***Nitrogen dioxide*** | | | | | |
| Annual mean | **42.0** | **44.2** | 24.1 | 24.8 | 40 |
| No. hours > 200 µg/m$^3$ | 0 | 0 | 0 | 0 | 18 |
| Max 1 hour mean | 189 | 172 | 132 | 176 | - |
| 99.8$^{th}$ percentile of 1-hr means | 124 | 128 | 103 | 92 | 200 |
| ***Nitrogen oxides (NOx)*** | | | | | |
| Annual mean | **91.0** | **94.6** | **37.0** | **39.5** | 30 |
| ***Sulphur dioxide ($SO_2$)*** | | | | | |
| Annual mean | 13.1 | 13.3 | - | - | 20 |
| Max 24-hr mean | 41.0 | 42.0 | - | - | - |
| No. days > 125 µg/m$^3$ | 0 | 0 | - | - | 3 |
| Max 1-hr mean | 150 | 154 | - | - | - |
| No. hours >350 µg/m$^3$ | 0 | 0 | - | - | 24 |
| 99$^{th}$ percentile of 24-hr means | 36.0 | 39.0 | - | - | 125 |
| 99.7$^{th}$ percentile of 1-hr means | 79.5 | 80.0 | - | - | 350 |
| Semi-automatic Monitor | | | | | |
| ***$PM_{10}$*** | | | | | |
| Annual mean | 39.8 | 44.2 | - | - | 40 |
| 90$^{th}$ percentile of daily means | **55.1** | **61.0** | - | - | 50 |
| No. days > 50 µg/m$^3$ | **64** | **86** | - | - | 35 |
| Max daily mean | 92.0 | 109.0 | - | - | - |
| ***$PM_{2.5}$*** | | | | | |
| Annual mean | 18.9 | 18.5 | - | - | 25[b] |
| ***Total Oxidant ($NO_2$ + $O_3$)*** | | | | | |
| 99.8$^{th}$ percentile of 1-hr means | 149 | - | | | |

a Concentrations calculated from data taken from the Air Quality in Gibraltar website.

b Objective has not yet been included in Rules. The value stated is the concentration cap specified in the revised EC directive

**Table AQ4-3: Summary of 2007 annual mean nitrogen dioxide diffusion tube results ($\mu g/m^3$). Data have been bias adjusted and ratified. Exceedences of the objective are highlighted in bold.**

| *Location* | *$NO_2$ concentration* |
|---|---|
| Withams Road | **56.3** |
| Grosvenor Meadows | **49.3** |
| Upper Withams Entrance | **51.9** |
| Jumpers | **60.6** |
| Dockyard Road | **50.7** |
| Red Sands Road | **49.5** |
| Harbour Views | 38.3 |
| Lathbury Barracks Industrial Park | 20.7 |

### *Analysis of Air Quality Monitoring Data*

4.10 The monitoring stations at both Bleak House and Rosia Road record wind speed and direction data, and these can be used to identify potential source contributions to the measured pollutant concentrations.

4.11 Two forms of analysis are presented. A series of scatter plots have been prepared which show the relationship between each hourly measured pollutant concentration and the corresponding wind direction. These plots have been prepared for 2005-2007 for NOx and $NO_2$ at Bleak House and for NOx, $NO_2$ and $SO_2$ at Rosia Road. Plots have not been prepared for the $PM_{10}$ data, as only 24-hour mean concentrations are recorded. These scatter plots are provided in Appendix AQ-3. Pollution roses for NOx have also been prepared for both Bleak House and Rosia Road, and are shown in Figures AQ4-3 and AQ4-4.

**Figure AQ4-3: NOx pollution rose for Bleak House 2006 (scale is in μg/m$^3$ NOx as $NO_2$)**

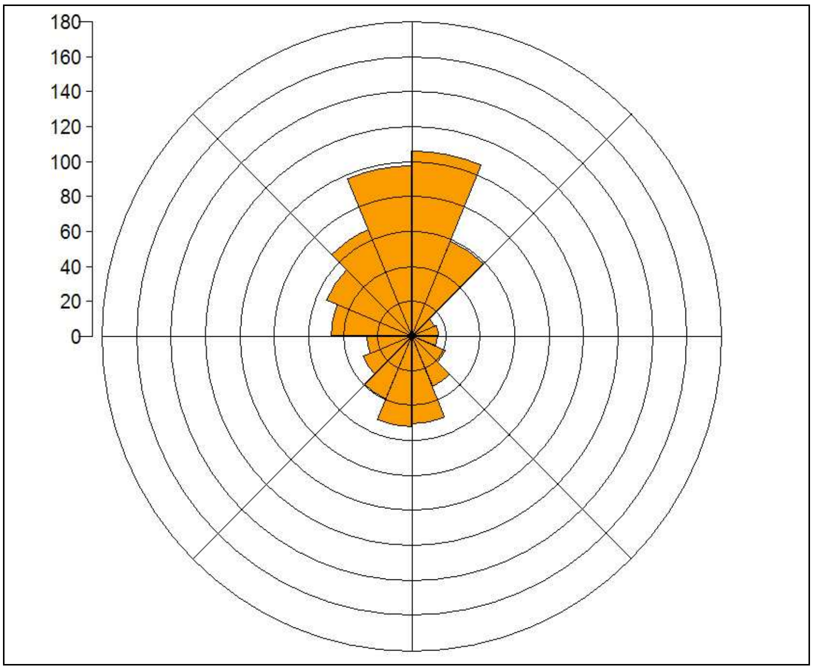
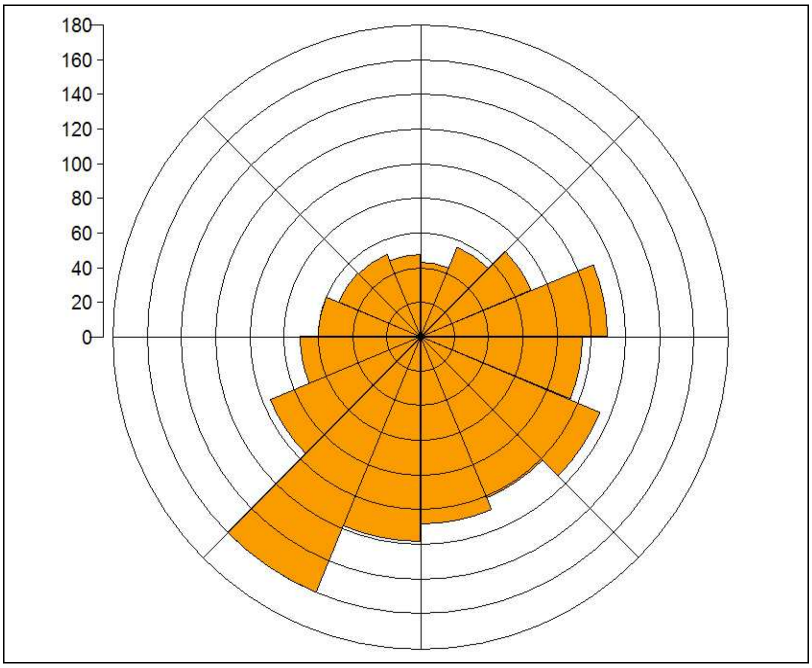



**Figure AQ4-4: NOx pollution rose for Rosia Road 2006 (scale is in μg/m$^3$ NOx as $NO_2$)**




4.12 For Bleak House, there is a strong association between high NOx and $NO_2$ concentrations with wind directions in the 340 to 20 degree sector (i.e. north-north-westerly to north-north-easterly winds). This may represent pollutant emissions arising from the commercial centre of Gibraltar, the existing power stations at OESCO and ISGS, or industrial sources on mainland Spain. There is additional uncertainty with this analysis at Bleak House, due to the local wind fields at this site (see Para 3.38)

4.13 At Rosia Road, the NOx and $NO_2$ pattern is very different, probably representing significant pollutant contributions from the OESCO and ISGS power stations to the south-west and road traffic contributions from Rosia Road to the east.

4.14 The pattern for $SO_2$ concentrations at Rosia Road is less pronounced, but there is evidence of higher concentrations associated with south-westerly winds, potentially associated with the OESCO and ISGS power stations.

### *Predicted Pollutant Concentrations – Existing Baseline*

4.15 The predicted concentrations associated with the existing power stations are shown summarised in Tables AQ4-4 and AQ4-5. The baseline year for the study is assumed to be 2006, consistent with the selected year of meteorological data. In addition to the specific health and ecosystem receptors, concentrations have also been predicted at the Rosia Road automatic monitoring station. Annual mean NOx contours are also shown in Figure AQ4-5.

4.16 A degree of caution must be applied to the interpretation of these results, As set out in previous sections of this report, the operational parameters of these power stations in 2006 was unknown, the emissions input data have been derived from a number of sources including “spot measurements”, and assumptions have had to be made regarding stack and building configurations. The actual concentrations arising from the operation of these stations may be substantially different.

4.17 Due to these uncertainties, a detailed analysis of the results was not considered appropriate, but with these caveats in mind, the following broad conclusions are drawn:

- The predicted maximum concentrations occur close to the power stations, consistent with short stacks, and significant building downwash effects;
- The maximum predicted concentrations shown in Tables AQ4-4 and AQ4-5 are reasonably consistent with the Defence Estates modelling study for ISGS (referenced earlier in this report). The maximum values predicted in this study are 2-3 times higher, but this study model has included the OESCO and Waterport stations as well as ISGS;
- The predicted NOx and $NO_2$ concentrations at Rosia Road are plausible when compared with the monitoring data, and are consistent with the analysis of the pollution roses. These results indicate that emissions from ISGS and OESCO are contributing significantly to the measured exceedences of the annual nitrogen dioxide objective at the Rosia Road monitoring station;
- The diffusion tube network operated by the Environmental Agency shows higher annual mean nitrogen dioxide concentrations along Rosia Road (see Table AQ4-3), and it likely that these exceedences are also strongly influenced by emissions from ISGS and OESCO; and
- NOx concentrations of the order of 50-150 $\mu g/m^3$ are predicted to occur at the western boundary of the SCI, extending a hundred m or so back into it (Figure AQ4.5).

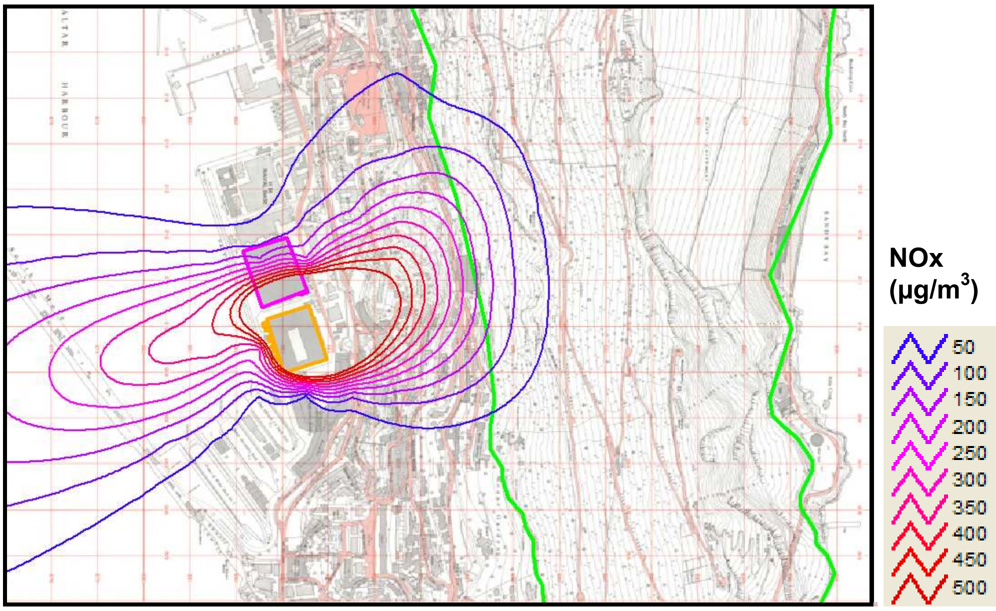
**Table AQ4-4: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location, associated with emissions from existing power stations. Predicted $NO_2$ concentrations assume 70% conversion from NOx. All concentrations expressed as μg/m$^3$.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Ground | 1.29 | 0.90 | 0.03 | 0.13 |
| H2 | Ground | 1.32 | 0.92 | 0.03 | 0.14 |
| H3 | Ground | 1.05 | 0.73 | 0.03 | 0.11 |
| H4 | Ground | 1.25 | 0.87 | 0.03 | 0.12 |
| H5 | Ground | 2.33 | 1.63 | 0.06 | 0.23 |
| H6 | Ground | 3.54 | 2.48 | 0.09 | 0.35 |
| H7 | Ground | 1.99 | 1.39 | 0.05 | 0.22 |
| H8 | Ground | 6.20 | 4.34 | 0.18 | 0.71 |
| H9 | Ground | 14.1 | 9.87 | 0.41 | 1.55 |
| H10 | Ground | 0.87 | 0.61 | 0.02 | 0.09 |
| H11 | Ground | 1.71 | 1.20 | 0.04 | 0.18 |
| H12 | Ground | 1.06 | 0.74 | 0.03 | 0.12 |
| H13 | Ground | 560 | 393 | 17.0 | 52.9 |
| H14 | Ground | 637 | 446 | 19.9 | 65.4 |
| H15 | Roof | 537 | 376 | 15.5 | 72.3 |
| H16 | Roof | 427 | 299 | 12.0 | 58.9 |
| H17 | Roof | 5.15 | 3.61 | 0.05 | 0.26 |
| H18 | Roof | 13.8 | 9.67 | 0.09 | 0.54 |
| H19 | Roof | 7.43 | 5.20 | 0.07 | 0.36 |
| H20 | Roof | 275 | 192 | 1.19 | 8.43 |
| | | | | | |
| E1 | Ground | 1.05 | 0.73 | 0.03 | 0.11 |
| E2 | Ground | 3.14 | 2.20 | 0.08 | 0.29 |
| E3 | Ground | 2.33 | 1.63 | 0.06 | 0.23 |
| E4 | Ground | 1.54 | 1.08 | 0.04 | 0.14 |
| E5 | Ground | 1.60 | 1.12 | 0.04 | 0.15 |
| E6 | Ground | 1.74 | 1.21 | 0.04 | 0.16 |
| E7 | Ground | 2.10 | 1.47 | 0.05 | 0.20 |
| E8 | Ground | 4.23 | 2.96 | 0.11 | 0.45 |
| | | | | | |
| Rosia Rd | Ground | 31.2 | 21.9 | 0.94 | 3.61 |

**Table AQ4-5: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location, associated with emissions from existing power stations. All concentrations expressed as µg/m$^3$.**

| *Receptor* | *Height* | *$NO_x$ 99.8$^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ 90$^{th}$ Percentile of 24-Hour Means* | *$SO_2$ 99.7$^{th}$ Percentile of 1-Hour Means* | *$SO_s$ 99$^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Ground | 81.5 | 6.92 | 3.43 | 0.04 |
| H2 | Ground | 93.8 | 7.95 | 3.12 | 0.04 |
| H3 | Ground | 110 | 7.72 | 2.17 | 0.04 |
| H4 | Ground | 144 | 9.63 | 3.18 | 0.04 |
| H5 | Ground | 273 | 8.54 | 5.89 | 0.06 |
| H6 | Ground | 273 | 10.3 | 12.11 | 0.10 |
| H7 | Ground | 167 | 5.11 | 3.50 | 0.10 |
| H8 | Ground | 265 | 17.4 | 15.33 | 0.24 |
| H9 | Ground | 1250 | 98.2 | 34.24 | 0.62 |
| H10 | Ground | 23.7 | 2.04 | 1.99 | 0.04 |
| H11 | Ground | 46.5 | 4.46 | 3.09 | 0.10 |
| H12 | Roof | 33.0 | 3.47 | 1.51 | 0.08 |
| H13 | Roof | 5450 | 490 | 182 | 39.5 |
| H14 | Roof | 5420 | 632 | 224 | 42.8 |
| H15 | Roof | 6740 | 866 | 294 | 39.9 |
| H16 | Roof | 5690 | 733 | 297 | 35.0 |
| H17 | Roof | 352 | 16.5 | 3.02 | 0.14 |
| H18 | Roof | 1470 | 38.4 | 10.4 | 0.24 |
| H19 | Roof | 746 | 23.6 | 5.23 | 0.19 |
| H20 | Roof | 6630 | 192 | 66.0 | 4.70 |
| | | | | | |
| Rosia Rd | Ground | 1390 | 132.4 | 28.17 | 3.57 |

**Figure AQ4-5: Predicted annual mean NOx concentrations associated with emissions from the three existing power stations at ISGS, OESCO and Waterport. No allowance for background contribution (ug/m$^3$ NOx, as $NO_2$)**




**Key:** Orange area – OESCO; Magenta area – ISGS; Green area – SCI boundary

# 5 FUTURE BASELINE (2011 AND 2032)

5.1 The baseline conditions in future years assume that the three existing power stations continue to operate as in the existing baseline year (2006), and that the proposed power station at Lathbury Barracks is not commissioned.

5.2 In reality, it is expected that background pollutant concentrations in future years would be lower than in 2006, due to a range of existing and agreed measures at the international level (within EU Directives) that will reduce emissions in future years from both the industrial and road transport sectors. To some extent these benefits may be offset by continued economic growth, but based on Europe-wide forecasts carried out to underpin the new Air Quality Directive, a substantial reduction in concentrations by 2032 is expected.

5.3 There is insufficient information available for Gibraltar to forecast any change in the background pollutant concentrations in future years and it has been assumed that these remain constant in both 2011 and 2032. This is likely to represent a worst-case assumption, particularly in 2032.

5.4 Consequently, the future baseline conditions in both 2011 and 2032 remain unchanged from the baseline 2006 position.

# 6 ASSESSMENT OF SIGNIFICANT EFFECTS

## Construction

6.1 Construction of the first phase of the power station would take about 15 months to complete. Any impacts would therefore be of a localised and temporary nature.

6.2 The greatest potential for impacts is likely to occur during the site clearance and levelling activities, when bulldozers, excavators and backhoes would be used. These activities would only take place over a period of about 3 months. There is also the potential for dust emissions during the movement of vehicles across unpaved surfaces. Dust may also be tracked out of the site onto the adjoining road network.

6.3 The proposed construction activities are judged to be a 'moderate' source of dust in terms of the criteria set out in Table AQ3-1. Assuming that standard mitigation measures are applied, there is the potential for occasional dust soiling impacts out to 100 m from the sources and the potential for occasional $PM_{10}$ and vegetation impacts out to a distance of 15 m.

6.4 Based on the distances described above, there are no residential properties that would potentially be at risk of dust-soiling impacts during the construction phase. There are however a number of properties within 15 m of roads along which construction traffic may pass. Construction traffic is expected to be infrequent, however these properties would potentially be at risk of elevated $PM_{10}$ during the proposed construction period.

6.5 To the south of the proposed power station, the boundary of the SCI effectively abuts directly onto the boundary of the development site, and professional judgement dictates that there is potential for impacts to occur out to a distance of 15 m. Although the site is exposed, any such potential impacts would be limited to occasions when work was taking place at the extreme edge of the site boundary, such as during initial site clearance, and would, by definition, be highly infrequent.

6.6 Any dust incidents would be highly dependent on the weather, requiring dry conditions and winds blowing towards a receptor. These conditions will also need to be combined with an activity creating dust. This will only be the case if there is inadequate application of standard mitigation measures.

6.7 It is concluded that the construction activities will give rise to a risk of **low adverse significant effects**. Consideration of appropriate mitigation measures is set out in Section 7 below.

### Operation

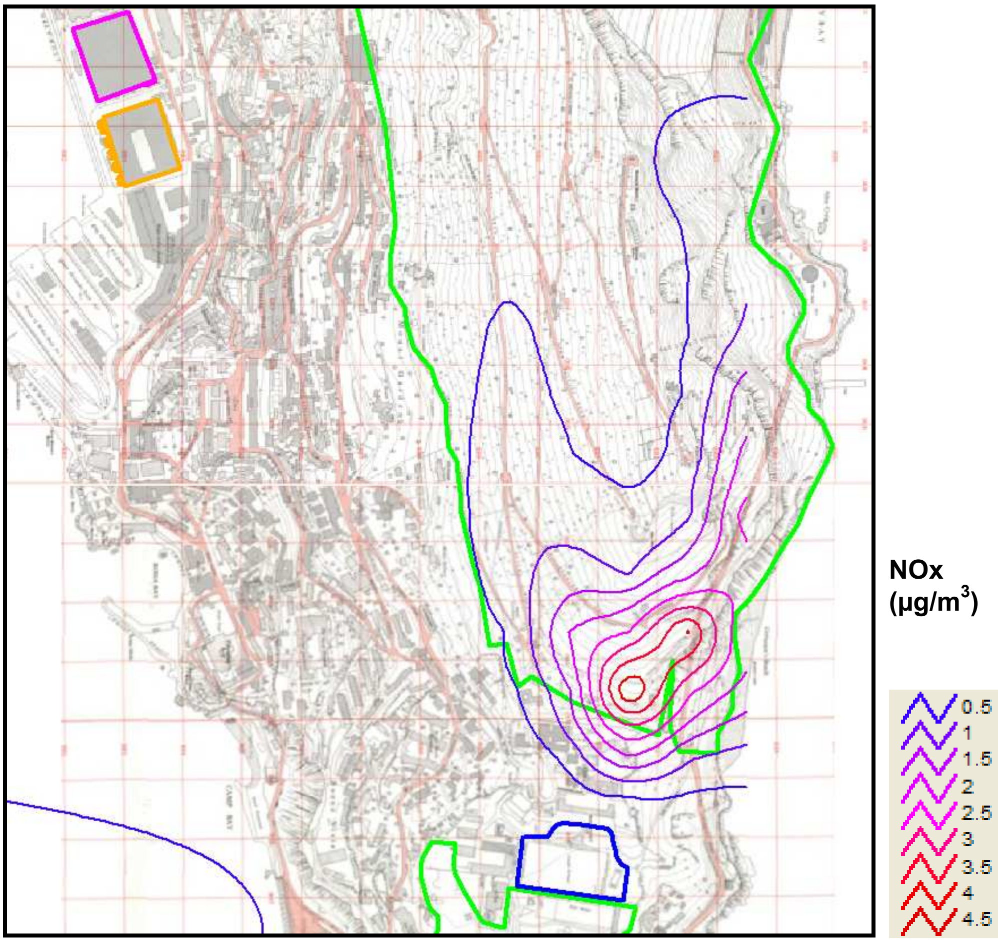
6.8 The predicted pollutant concentrations associated with emissions from the proposed power station are described in subsequent sections. The predicted concentrations in both 2011 and 2032 are compared with existing baseline concentrations derived from the monitoring data described in Section 4.

6.9 Should the new power station be granted approval, the three existing power stations would be decommissioned. In theory, it would be possible to subtract the component associated with these existing power station emissions from the measured baseline. However, as previously discussed, there is some uncertainty regarding the precise operational parameters of these existing stations. The results for the new power station in both 2011 and 2032 are thus initially presented assuming that there is no beneficial reduction in background pollutant levels associated with the decommissioning of the existing power stations, which represents a worst-case assumption. The potential reduction in background concentrations is then explored in the discussion of the results and the associated effects.

### *Stack Emissions – 2011 – pollutant concentrations*

6.10 The predicted concentrations associated with the power station emissions in 2011 are set out in Tables AQ6-1 to AQ6-2. The results are presented for the preferred 40 m stack height; corresponding results for the 30 and 50 m stack height options are provided in Appendix AQ-4. Concentration isopleths for NOx (annual mean) are also presented in Figure AQ6-1. These results are presented for the process contribution alone and do not include any contribution from the local background. In each case, the relevant averaging period for comparison with the objectives has been selected. The predictions are provided for each of the specific health-based sensitive receptor locations (Receptors H1 to H20); in each case the maximum predicted level at each receptor is shown, i.e. corresponding to ground or roof-top level. For the annual mean NOx, $NO_2$ and $SO_2$ concentrations, the predicted results are also shown for the specific ecosystem receptors (Receptors E1 to E8).

**Figure AQ6-1: Predicted annual mean NOx concentrations associated with emissions from the proposed new power stations, 2011. No allowance for background contribution (ug/m3 NOx, as $NO_2$)**




**Key:** Blue area – Proposed development site; Green area – SCI boundary

6.11 The 2011 power station emissions have been modelled assuming 7 engines operating continuously at 90% load of 56 MW maximum operating capacity, i.e. equivalent to 50.4 MW capacity. The predicted average demand in 2011 is 26.1 MW and the predicted annual mean concentrations have been adjusted accordingly. No adjustment has been applied to the 24-hour or 1-hour mean predicted concentrations, representing a worst-case assumption.

6.12 The maximum predicted concentrations of each pollutant are shown in Tables AQ6-3 and AQ6-4. These are results for relevant receptors and thus the maximum predicted concentrations at the health-based receptors (H1-H20) are considered for nitrogen dioxide, PM and sulphur dioxide and at the ecosystem receptors (E1 to E8) for NOx and sulphur dioxide. These tables show the relevant air quality criterion, the predicted process contribution, and the assumed background concentration. Where appropriate the background concentration has been added to generate a total pollutant concentration for comparison with the objective. The process contribution as a percentage of the relevant air quality objective is also provided.

6.13 It must be borne in mind that these results incorporate a number of conservative assumptions that will have overstated the impact of the proposed power station emissions, including:

- Background pollutant concentrations are expected to be lower in 2011 than in the existing year. This is due to a range of measures to reduce pollutant emissions from transport and industrial sectors and the decommissioning of three existing power stations;
- Actual emissions from the proposed power station are expected to be approximately 10% lower than those assumed for modelling.

6.14 Based on the results in Table AQ6-3, it may be concluded that the health-based objectives for nitrogen dioxide and sulphur dioxide would not be exceeded in 2011, for any of the modelled stack heights, with 80% SCR abatement. It is also concluded that the limit value for $PM_{2.5}$, which will need to be met by 2015, would also not be exceeded. On the basis of the significance criteria set out in Para 3.67, the effects of these pollutants are judged to be of **low adverse significance** as the predicted concentrations are below the relevant criteria.

6.15 It is not as straightforward to assess the impacts of $PM_{10}$ emissions, as there are no adequate data to describe background concentrations in the study area. However, the predicted contribution from the power station to $PM_{10}$ concentrations is very small, representing about a 0.3 $\mu g/m^3$ increment to the annual mean and about a 2.2 $ug/m^3$ increment to the 90th percentile of 24-hour means, with a 40 m stack. This is considered unlikely to significantly contribute to any exceedences of the objectives and the effect is also judged to be of **low adverse significance**.

6.16 Based on the results set out in Table AQ6-4, it is concluded that the objectives for sulphur dioxide would not be exceeded, and any effect is judged to be of **low adverse significance**. As discussed in previous sections, the NOx critical level for the protection of vegetation does not strictly apply in Gibraltar (30 µg/m$^3$), and on advice from the Environmental Agency, the effect is judged relative to an assumed existing NOx concentration of 40 µg/m$^3$. On this basis (with a 40 m stack), the maximum predicted increment within the SCI is just below 5 µg/m$^3$, representing 12% of the assumed background.

6.17 It is important to note that the results in Table AQ6-4 represent the point of maximum impact, in this case at Receptor E1. It can be clearly seen from Figure AQ6-1, which shows the annual mean NOx contours, the predicted concentrations are very much lower than 5 µg/m$^3$ across most of the SCI, and in fact levels are generally well below 2 µg/m$^3$.

6.18 It must also be taken into account that the proposed new power station would allow the existing power stations at ISGS, OESCO and Waterport to be decommissioned, which would reduce annual mean NOx by 1-2 µg/m$^3$ in the SCI to the north-east of Lathbury Barracks and to a much greater extent at the western boundary of the SCI close to the Dockyards. In practice the net change across most of the SCI may range from zero to a substantial reduction in annual mean NOx concentrations. In light of these considerations, the effect is judged to be of **medium adverse significance**.

**Table AQ6-1: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 26.1 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 40 m stack height, 80% SCR abatement. All concentrations expressed as µg/m$^3$, 2011.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 0.84 | 0.59 | 0.11 | 0.09 |
| H2 | Roof | 0.67 | 0.47 | 0.08 | 0.07 |
| H3 | Roof | 1.81 | 1.27 | 0.23 | 0.20 |
| H4 | Roof | 2.53 | **1.77** | **0.32** | **0.28** |
| H5 | Roof | 0.32 | 0.22 | 0.04 | 0.04 |
| H6 | Roof | 0.28 | 0.20 | 0.04 | 0.03 |
| H7 | Roof | 0.12 | 0.08 | 0.01 | 0.01 |
| H8 | Roof | 0.13 | 0.09 | 0.02 | 0.01 |
| H9 | Roof | 0.12 | 0.08 | 0.01 | 0.01 |
| H10 | Ground | 0.38 | 0.27 | 0.05 | 0.04 |
| H11 | Ground | 0.29 | 0.20 | 0.04 | 0.03 |
| H12 | Roof | 0.19 | 0.13 | 0.02 | 0.02 |
| H13 | Roof | 0.10 | 0.07 | 0.01 | 0.01 |
| H14 | Roof | 0.10 | 0.07 | 0.01 | 0.01 |
| H15 | Roof | 0.09 | 0.07 | 0.01 | 0.01 |
| H16 | Roof | 0.09 | 0.06 | 0.01 | 0.01 |
| H17 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| H18 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| H19 | Roof | 0.04 | 0.03 | <0.01 | <0.01 |
| H20 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| | | | | | |
| E1 | Ground | **4.95** | **3.47** | - | **0.54** |
| E2 | Ground | 1.26 | 0.88 | - | 0.14 |
| E3 | Ground | 0.17 | 0.12 | - | 0.02 |
| E4 | Ground | 0.06 | 0.04 | - | 0.01 |
| E5 | Ground | 0.01 | 0.01 | - | <0.01 |
| E6 | Ground | <0.01 | <0.01 | - | <0.01 |
| E7 | Ground | 0.01 | <0.01 | - | <0.01 |
| E8 | Ground | 0.02 | 0.02 | - | <0.01 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQ6-2: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 56MW maximum capacity. 40 m stack height, 80% SCR abatement. All concentrations expressed as µg/m³, 2011.**

| *Receptor* | *Height* | *$NO_x$ 99.8th Percentile of 1-Hour Means* | *$PM_{10}$ 90th Percentile of 24-Hour Means* | *$SO_2$ 99.7th Percentile of 1-Hour Means* | *$SO_2$ 99th Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | **121.4** | 0.68 | 11.7 | 2.48 |
| H2 | Roof | 94.1 | 0.49 | 9.00 | 2.07 |
| H3 | Roof | 114.8 | 1.46 | **12.0** | 3.92 |
| H4 | Roof | 95.9 | **2.17** | 9.96 | **4.27** |
| H5 | Roof | 57.9 | 0.29 | 5.85 | 0.96 |
| H6 | Roof | 43.7 | 0.21 | 4.03 | 0.75 |
| H7 | Roof | 11.8 | 0.07 | 0.98 | 0.28 |
| H8 | Roof | 17.3 | 0.10 | 1.68 | 0.28 |
| H9 | Roof | 17.4 | 0.09 | 1.58 | 0.26 |
| H10 | Ground | 23.1 | 0.30 | 2.31 | 0.51 |
| H11 | Ground | 33.4 | 0.21 | 3.27 | 0.71 |
| H12 | Roof | 33.9 | 0.12 | 3.18 | 0.57 |
| H13 | Roof | 16.4 | 0.07 | 1.30 | 0.27 |
| H14 | Roof | 14.6 | 0.07 | 1.29 | 0.28 |
| H15 | Roof | 15.4 | 0.07 | 1.20 | 0.28 |
| H16 | Roof | 13.3 | 0.06 | 1.10 | 0.25 |
| H17 | Roof | 6.20 | 0.02 | 0.51 | 0.10 |
| H18 | Roof | 7.01 | 0.02 | 0.58 | 0.10 |
| H19 | Roof | 6.93 | 0.03 | 0.59 | 0.11 |
| H20 | Roof | 6.30 | 0.02 | 0.54 | 0.09 |

Note: Maximum predicted concentration for each pollutant shown in bold.

### Table AQ6-3: Impact of Process Emissions – Health Based Criteria, 2011.

| *Pollutant* | *Air Quality Criterion (µg/m³)* | *Measured as* | *Estimated Background Concentration (µg/m³)[a]* | *Stack Height (m)* | *Max. Predicted Concentration from Process (µg/m³)* | *Percentage of Criterion due to Process (%)* | *Total Concentration (Process + Background)[c]* |
|---|---|---|---|---|---|---|---|
| Nitrogen dioxide | 40 | Annual mean | 24.1 | 30 | 3.63 | 9.08% | 27.7 |
| | | | | 40 | 1.77 | 4.43% | 25.9 |
| | | | | 50 | 0.75 | 1.88% | 24.9 |
| Nitrogen dioxide | 200 | 99.8th percentile of 1-hour means | 124 | 30 | 84.7[b] | 42.4% | 161 |
| | | | | 40 | 42.5[b] | 21.2% | 155 |
| | | | | 50 | 27.8[b] | 13.9% | 128 |
| Particles $PM_{10}$ | 40 | Annual mean | N/A | 30 | 0.66 | 1.65% | N/A |
| | | | | 40 | 0.32 | 0.80% | N/A |
| | | | | 50 | 0.14 | 0.35% | N/A |
| Particles $PM_{10}$ | 50 | 90th percentile of 24-hour means | N/A | 30 | 5.00 | 10.0% | N/A |
| | | | | 40 | 2.17 | 4.34% | N/A |
| | | | | 50 | 0.94 | 1.88% | N/A |
| Particles $PM_{2.5}$ | 25 | Annual mean | 18.9 | 30 | 0.66[d] | 2.64% | 19.6 |
| | | | | 40 | 0.32[d] | 1.28% | 19.2 |
| | | | | 50 | 0.14[d] | 0.56% | 19.0 |
| Sulphur dioxide | 350 | 99.7th percentile of 1-hour means | 79.5 | 30 | 28.8 | 8.23% | 80.6 |
| | | | | 40 | 12.0 | 3.43% | 80.1 |
| | | | | 50 | 8.19 | 2.34% | 79.7 |
| Sulphur dioxide | 125 | 99th percentile of 24-hour means | 36.0 | 30 | 8.59 | 6.87% | 37.1 |
| | | | | 40 | 4.27 | 3.42% | 36.6 |
| | | | | 50 | 2.26 | 1.81% | 36.2 |

## Notes:

(a) Estimated background concentrations are based on measured values at Bleak House where available and otherwise at Rosia Road. There are no suitable data to describe $PM_{10}$ concentrations in the study area.
(b) Assumes a 35% conversion of NOx to $NO_2$
(c) Calculations based on the approach set out in Paras 3.48 to 3.51
(d) In the absence of size speciation information, it has been assumed that all PM emissions are present as both $PM_{10}$ and $PM_{2.5}$

### Table AQ6-4: Impact of Process Emissions – Ecosystem Criteria, 2011.

| *Pollutant* | *Air Quality Criterion (µg/m³)* | *Measured as* | *Estimated Background Concentration (µg/m³)* | *Stack height (m)* | *Max. predicted concentration from process (µg/m³)* | *Percentage of criterion due to process (%)* | *Total Concentration (process + background)* |
|---|---|---|---|---|---|---|---|
| Nitrogen oxides | 30[a] | Annual mean | 40.0 [a] | 30 | 6.96 | 17,4% | 47.0 |
| | | | | 40 | 4.95 | 12,4% | 45.0 |
| | | | | 50 | 3.26 | 8.15% | 43.3 |
| Sulphur dioxide | 20 | Annual/Winter mean | 13.1 | 30 | 0.76 | 3.80% | 13.9 |
| | | | | 40 | 0.54 | 2.70% | 13.6 |
| | | | | 50 | 0.36 | 1.80% | 13.5 |

## Notes:

(a) The vegetation objective (Critical Level) does not strictly apply in Gibraltar.
(b) Annual mean NOx concentrations are assumed to be 40 µg/m³, and have been used as the basis for calculating the incremental change, based on advice issued by the Environmental Agency.

### *Stack Emissions – 2011 – Nitrogen Deposition*

6.19 Nitrogen deposition rates associated with dry deposition of nitrogen dioxide, associated with the proposed power station emissions, are shown in Table AQ6-5. These deposition rates have been calculated from the predicted annual mean nitrogen dioxide concentrations at each sensitive ecological receptor location, as shown in Table AQ6-5, using the approach described in Section 3.

**Table AQ6-5: Predicted nitrogen deposition rates at each ecological receptor location. Assumed Critical Load is 10 kgN/ha/yr. 40 m stack height, 2011.**

| *Receptor* | *Height* | *Annual Mean $NO_2$ ($\mu g/m^3$)* | *N Deposition Rate (kgN/ha/yr)* | *% Increment to Critical Load* |
|---|---|---|---|---|
| E1 | Ground | 3.47 | 0.347 | 3.47% |
| E2 | Ground | 0.882 | 0.088 | 0.88% |
| E3 | Ground | 0.119 | 0.012 | 0.12% |
| E4 | Ground | 0.043 | 0.004 | 0.04% |
| E5 | Ground | 0.008 | <0.001 | <0.01% |
| E6 | Ground | 0.001 | <0.001 | <0.01% |
| E7 | Ground | 0.004 | <0.001 | <0.01% |
| E8 | Ground | 0.016 | 0.002 | 0.02% |

6.20 There are no data to describe existing nitrogen deposition rates across the SCIs and it is not known whether the critical level is currently being exceeded or not. When expressed as an incremental change to the critical level value (10 kg/N/ha/yr) the power station will cause a 3.5% change at the point of maximum impact. Incremental changes of less than 1% will occur across most of the SCI.

6.21 As with NOx concentrations, it must also be taken into account that the proposed new power station would allow the existing power stations at ISGS, OESCO and Waterport to be decommissioned. In practice the net change across most of the SCI might range from zero to a substantial reduction in nitrogen deposition. The effect of nitrogen deposition on the SCI is assessed in the ecology chapter.

### *Stack Emissions – 2032 – Pollutant Concentrations*

6.22 The predicted concentrations associated with the power station emissions in 2032 are set out in Tables AQ6-6 and AQ6-7. The results are presented for the preferred 40 m stack height: corresponding results for the 30 and 50 m stack height options are provided in Appendix AQ-4. Concentration isopleths for NOx (annual mean) are also presented in Figure AQ6-2. These results are presented for the process contribution alone and do not include any contribution from the local background. In each case, the relevant averaging period for comparison with the objectives has been selected. The predictions are provided for each of the specific health-based sensitive receptor locations (Receptors H1 to H20). For the annual mean NOx, $NO_2$ and $SO_2$ concentrations, the predicted results are also shown for the specific ecosystem receptors (Receptors E1 to E8).

6.23 The 2032 power station emissions have been modelled assuming 10 engines operating continuously at 90% load of 80 MW maximum operating capacity, i.e. equivalent to 72 MW capacity. The predicted average demand in 2032 is 38.8 MW, and the predicted annual mean concentrations have been adjusted accordingly. No adjustment has been applied to the 24-hour or 1-hour mean predicted concentrations, representing a worst-case assumption.

6.24 The maximum predicted concentrations of each pollutant are shown in Tables AQ6-8 and AQ6-9. These are results for relevant receptors and thus the maximum predicted concentrations at the health-based receptors (H1-H20) are considered for nitrogen dioxide, PM and sulphur dioxide, and at the ecosystem receptors (E1 to E8) for NOx and sulphur dioxide. These tables show the relevant air quality criterion, the predicted process contribution, and the assumed background concentration. Where appropriate the background concentration has been added to generate a total pollutant concentration for comparison with the objective. The process contribution as a percentage of the relevant air quality objective is also provided.

6.25 It must be borne in mind that these results incorporate a number of conservative assumptions that will have overstated the impact of the proposed power station emissions:

- Background pollutant concentrations are expected to be considerably lower in 2032 than in the existing year. This is due to a range of measures to reduce pollutant emissions from transport and industrial sectors, and the decommissioning of three existing power stations;
- Actual emissions from the proposed power station are expected to be approximately 10% lower than assumed for modelling.

6.26 Based on the results in Table AQ6-8, it may be concluded that the health-based objectives for nitrogen dioxide and sulphur dioxide would not be exceeded in 2032, for any of the chosen stack heights, with 90% SCR abatement. It is also concluded that the limit value for $PM_{2.5}$, which will need to be met by 2015, would also not be exceeded. On the basis of the significance criteria set out in Para 3.67, the effect of these pollutants are judged to be of **low adverse significance**.

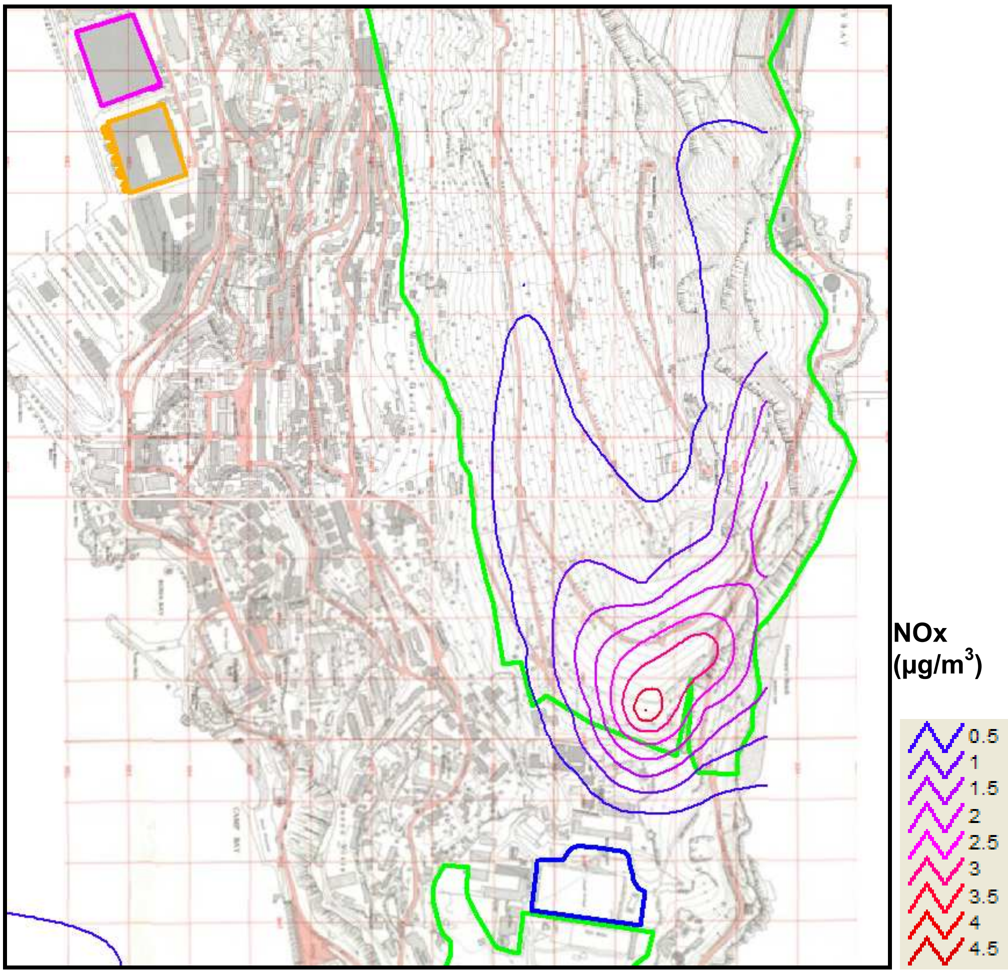
6.27 It is not as straightforward to assess the effects of $PM_{10}$ emissions, as there are no adequate data to describe background concentrations in the study area. The predicted contribution from the power station to $PM_{10}$ concentrations is very small, representing about a 0.5 μg/m$^3$ increment to the annual mean, and about a 3 ug/m$^3$ increment to the 90th percentile of 24-hour means, with a 40 m stack. This is considered unlikely to significantly contribute to any exceedences of the objectives and the effect is also judged to be of **low adverse significance**.

6.28 Based on the results set out in Table AQ6-9, it is concluded that the objectives for sulphur dioxide would not be exceeded and any effect is judged to be of **low adverse significance**. As discussed in previous sections, the NOx critical level for the protection of vegetation does not strictly apply in Gibraltar (30 μg/m$^3$) and on advice from the Environmental Agency, the effect is judged relative to an assumed existing NOx concentration of 40 μg/m$^3$. On this basis (with a 40 m stack), the maximum predicted increment within the SCI is just below 4 μg/m$^3$, representing less than10% of the assumed background.

6.29 It is important to note that the results in Table AQ6-9 represent the point of maximum impact, in this case at Receptor E1. It can be clearly seen from Figure AQ6-2, which shows the annual mean NOx contours, that the predicted concentrations are very much lower than 4 μg/m$^3$ across most of the SCI, and in fact levels are generally well below 2 μg/m$^3$.

6.30 It must also be taken into account that the proposed new power station would allow the existing power stations at ISGS, OESCO and Waterport to be decommissioned, which would reduce annual mean NOx by 1-2 μg/m$^3$ in the SCI to the north-east of Lathbury Barracks and to a much greater extent at the western boundary of the SCI close to the Dockyards. In practice the net change across most of the SCI might range from zero to a substantial reduction in annual mean NOx concentrations. In light of these considerations, the effect is judged to be of **medium adverse significance**.

**Figure AQ6-2: Predicted annual mean NOx concentrations associated with emissions from the proposed new power stations, 2032. No allowance for background contribution (ug/m$^3$ NOx, as $NO_2$)**




**Key:** Blue area – Proposed development site; Green area – SCI boundary

**Table AQ6-6: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 38.8 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 40 m stack height, 90% SCR abatement. All concentrations expressed as µg/m$^3$, 2032.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 0.67 | 0.47 | 0.17 | 0.15 |
| H2 | Roof | 0.53 | 0.37 | 0.13 | 0.12 |
| H3 | Roof | 1.60 | 1.12 | 0.41 | 0.35 |
| H4 | Roof | 1.85 | **1.29** | **0.47** | **0.41** |
| H5 | Roof | 0.23 | 0.16 | 0.06 | 0.05 |
| H6 | Roof | 0.20 | 0.14 | 0.05 | 0.04 |
| H7 | Roof | 0.09 | 0.06 | 0.02 | 0.02 |
| H8 | Roof | 0.10 | 0.07 | 0.03 | 0.02 |
| H9 | Roof | 0.10 | 0.07 | 0.02 | 0.02 |
| H10 | Ground | 0.28 | 0.20 | 0.07 | 0.06 |
| H11 | Ground | 0.22 | 0.15 | 0.06 | 0.05 |
| H12 | Roof | 0.14 | 0.10 | 0.03 | 0.03 |
| H13 | Roof | 0.08 | 0.06 | 0.02 | 0.02 |
| H14 | Roof | 0.08 | 0.06 | 0.02 | 0.02 |
| H15 | Roof | 0.08 | 0.06 | 0.02 | 0.02 |
| H16 | Roof | 0.07 | 0.05 | 0.02 | 0.02 |
| H17 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H18 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H19 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H20 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| | | | | | |
| E1 | Ground | **3.82** | **2.67** | - | **0.84** |
| E2 | Ground | 0.85 | 0.59 | - | 0.19 |
| E3 | Ground | 0.12 | 0.08 | - | 0.03 |
| E4 | Ground | 0.04 | 0.03 | - | 0.01 |
| E5 | Ground | 0.01 | <0.01 | - | <0.01 |
| E6 | Ground | <0.01 | <0.01 | - | <0.01 |
| E7 | Ground | 0.01 | 0.01 | - | <0.01 |
| E8 | Ground | 0.02 | 0.01 | - | <0.01 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQ6-7: Predicted short - term concentrations of $NO_2$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 80MW maximum capacity. Predicted $NO_2$ concentrations assume 35% conversion from NOx. 40 m stack height, 90% SCR abatement. All concentrations expressed as µg/m$^3$, 2032.**

| *Receptor* | *Height* | *$NO_2$ $99.8^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ $90^{th}$ Percentile of 24-Hour Means* | *$SO_2$ $99.7^{th}$ Percentile of 1-Hour Means* | *$SO_s$ $99^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | 81.7 | 1.02 | 16.0 | 4.02 |
| H2 | Roof | 64.8 | 0.84 | 12.4 | 3.36 |
| H3 | Roof | **88.8** | 2.61 | **18.4** | **6.28** |
| H4 | Roof | 70.7 | **3.04** | 14.7 | 6.09 |
| H5 | Roof | 42.0 | 0.32 | 7.70 | 1.30 |
| H6 | Roof | 34.2 | 0.31 | 5.74 | 1.09 |
| H7 | Roof | 8.59 | 0.10 | 1.28 | 0.42 |
| H8 | Roof | 14.4 | 0.17 | 2.60 | 0.47 |
| H9 | Roof | 14.1 | 1.02 | 2.54 | 0.44 |
| H10 | Ground | 17.1 | 0.44 | 3.31 | 0.78 |
| H11 | Ground | 26.4 | 0.31 | 5.17 | 1.08 |
| H12 | Roof | 24.3 | 0.14 | 4.43 | 0.78 |
| H13 | Roof | 11.9 | 0.11 | 2.20 | 0.45 |
| H14 | Roof | 11.6 | 0.11 | 2.07 | 0.46 |
| H15 | Roof | 10.7 | 0.11 | 1.93 | 0.43 |
| H16 | Roof | 9.80 | 0.10 | 1.78 | 0.40 |
| H17 | Roof | 5.48 | 0.04 | 0.78 | 0.15 |
| H18 | Roof | 5.48 | 0.04 | 0.84 | 0.17 |
| H19 | Roof | 5.67 | 0.04 | 0.88 | 0.19 |
| H20 | Roof | 5.08 | 0.04 | 0.80 | 0.78 |

Note: Maximum predicted concentration for each pollutant shown in bold.

### Table AQ6-8: Impact of Process Emissions – Health Based Criteria, 2032

| *Pollutant* | *Air Quality Criterion (µg/m³)* | *Measured as* | *Estimated Background Concentration (µg/m³)[a]* | *Stack Height (m)* | *Max. Predicted Concentration from Process (µg/m³)* | *Percentage of Criterion Due to Process (%)* | *Total Concentration (Process + Background)[c]* |
|---|---|---|---|---|---|---|---|
| Nitrogen dioxide | 40 | Annual mean | 24.1 | 30 | 2.32 | 5.80% | 26.4 |
| | | | | 40 | 1.29 | 3.23% | 25.4 |
| | | | | 50 | 0.80 | 2.00% | 24.9 |
| Nitrogen dioxide | 200 | 99.8th percentile of 1-hour means | 124 | 30 | 48.3[b] | 24.2% | 156 |
| | | | | 40 | 31.8[b] | 15.9% | 139 |
| | | | | 50 | 21.5[b] | 10.7% | 110 |
| Particles $PM_{10}$ | 40 | Annual mean | N/A | 30 | 0.84 | 2.10% | N/A |
| | | | | 40 | 0.47 | 1.18% | N/A |
| | | | | 50 | 0.29 | 0.73% | N/A |
| Particles $PM_{10}$ | 50 | 90th percentile of 24-hour means | N/A | 30 | 5.96 | 11.9% | N/A |
| | | | | 40 | 3.04 | 6.08% | N/A |
| | | | | 50 | 1.79 | 3.58% | N/A |
| Particles $PM_{2.5}$ | 25 | Annual mean | 18.9 | 30 | 0.84[d] | 3.36% | 19.7 |
| | | | | 40 | 0.47[d] | 1.88% | 19.4 |
| | | | | 50 | 0.29[d] | 1.16% | 19.2 |
| Sulphur dioxide | 350 | 99.7th percentile of 1-hour means | 79.5 | 30 | 25.9 | 7.41% | 80.9 |
| | | | | 40 | 18.4 | 5.25% | 80.3 |
| | | | | 50 | 12.4 | 3.55% | 80.0 |
| Sulphur dioxide | 125 | 99th percentile of 24-hour means | 36.0 | 30 | 10.6 | 8.49% | 37.5 |
| | | | | 40 | 6.28 | 5.02% | 36.8 |
| | | | | 50 | 4.30 | 3.44% | 36.5 |

## Notes:

(a) Estimated background concentrations are based on measured values at Bleak House where available and otherwise at Rosia Road. There are no suitable data to describe $PM_{10}$ concentrations in the study area.
(b) Assumes a 35% conversion of NOx to $NO_2$
(c) Calculation based on the approach set out in Paras 3.48 to 3.51
(d) In the absence of size speciation information, it has been assumed that all PM emissions are present as both $PM_{10}$ and $PM_{2.5}$

**Table AQ6-9: Impact of Process Emissions – Ecosystem Criteria, 2032**

| *Pollutant* | *Air Quality Criterion (μg/m³)* | *Measured as* | *Estimated Background Concentration (μg/m³)* | *Stack Height (m)* | *Max. Predicted Concentration from Process (μg/m³)* | *Percentage of Criterion Due to Process (%)* | *Total Concentration (Process + Background)* |
|---|---|---|---|---|---|---|---|
| Nitrogen oxides | 30[a] | Annual Mean | 40.0 [a] | 30 | 5.03 | 12.6% | 45.0 |
| | | | | 40 | 3.82 | 9.56% | 43.8 |
| | | | | 50 | 2.81 | 7.03% | 42.8 |
| Sulphur dioxide | 20 | Annual/Winter Mean | 13.1 | 30 | 1.11 | 5.55% | 14.2 |
| | | | | 40 | 0.84 | 4.20% | 13.9 |
| | | | | 50 | 0.62 | 3.10% | 13.7 |

## Notes:

a) The vegetation objective (Critical Level) does not strictly apply in Gibraltar.
(b) Annual mean NOx concentrations are assumed to be 40 μg/m³, and have been used as the basis for calculating the incremental change, based on advice issued by the Environmental Agency

### *Stack Emissions – 2032 – Nitrogen Deposition*

6.31 Nitrogen deposition rates associated with dry deposition of nitrogen dioxide, associated with the proposed power station emissions, are shown in Table AQ6-10. These deposition rates have been calculated from the predicted annual mean nitrogen dioxide concentrations at each sensitive ecological receptor location, as shown in Table AQ6-1, using the approach described in Section 3.

**Table AQ6-10: Predicted nitrogen deposition rates at each ecological receptor location. Assumed Critical Load is 10 kgN/ha/yr. 40 m stack height, 2032.**

| *Receptor* | *Height* | *Annual mean $NO_2$ ($\mu g/m^3$)* | *N deposition rate (kgN/ha/yr)* | *% Increment to Critical Load* |
|---|---|---|---|---|
| E1 | Ground | 2.67 | 0.267 | 2.67% |
| E2 | Ground | 0.59 | 0.059 | 0.59% |
| E3 | Ground | 0.08 | 0.008 | 0.08% |
| E4 | Ground | 0.03 | 0.003 | 0.03% |
| E5 | Ground | <0.01 | <0.001 | <0.01% |
| E6 | Ground | <0.01 | <0.001 | <0.01% |
| E7 | Ground | 0.01 | 0.001 | 0.01% |
| E8 | Ground | 0.01 | 0.001 | 0.01% |

6.32 There are no data to describe existing nitrogen deposition rates across the SCIs, and it is not known whether the critical level is currently being exceeded or not. When expressed as an incremental change to the critical level value (10 kg/N/ha/yr) the power station would cause a 2.7% change at the point of maximum impact. Incremental changes of less than 1% would occur across most of the SCI.

6.33 As with NOx concentrations, it must also be taken into account that the proposed new power station would allow the existing power stations at ISGS, OESCO and Waterport to be decommissioned. In practice the net change across most of the SCI might range from zero to a substantial reduction in nitrogen deposition. The effect of nitrogen deposition on the SCI is assessed in the Ecology Chapter.

### Fuel Storage

6.34 The greatest potential for VOC emissions is during the process of refuelling the Eastside storage tanks. At the maximum 72 MW load projected for 2032, the power station would consume approximately 200 tonnes of fuel per day; the capacity of the three storage tanks is thus approximately 24 days. Given the infrequency of refuelling events, and the relatively low volatility of diesel fuel, it is not considered likely that emissions of VOCs would give rise to odour problems at any of the nearby residential properties.

# 7 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

## Construction Mitigation

7.1 Measures to mitigate dust emissions will be necessary during construction and site preparation and will be based on those routinely employed as 'good practice' on construction sites. The measures to be employed will be made part of a Construction Environmental Management Plan (CEMP) and will include:

- Imposition and enforcement of a 5 mph speed limit on unpaved ground;
- Sheeting of lorries carrying dusty material on and off site;
- Early sealing of open ground with vegetation;
- Location of stockpiles of potentially dusty material as far from sensitive locations as possible;
- Regular use of a water-assisted dust sweeper on local roads if necessary, to remove any material tracked out of the site;
- Regular cleaning of paved areas on-site;
- Use of a jet-spray vehicle and wheel wash for all vehicles leaving the site;
- Use of water suppression during any demolition works; and
- Use of water suppression during any cutting of stone or concrete.

## Operational Mitigation

7.2 The proposed power station would be designed to modern standards and would operate in compliance with local regulations regarding Integrated Pollution Prevention and Control. The diesel engines would use Best Available Technology and would be equipped with fuel injection and valve timing to minimise NOx emissions. Further abatement of NOx levels in the exhaust gases would be achieved by the use of Selective Catalytic Reduction. Mitigation measures have thus already been built into the design of the facility.

7.3 In light of the uncertainties regarding existing NOx concentrations and nitrogen deposition rates, should the proposed power station be consented, it is recommended that a programme of monitoring for both NOx and nitrogen dioxide be established across the SCI, based on passive diffusion samplers. This will allow existing pollutant concentrations to be more accurately determined and will allow the future impacts associated with the decommissioning of existing power generation facilities and the operation of the new power station, to be monitored.

### Residual Significant Effects

7.4 There is no predicted exceedance of the health-based objectives associated with the operation of the proposed power station and there are no residual significant effects.

7.5 Taking into account the expected reduction in emissions associated with the decommissioning of the existing power stations, the net change in NOx concentrations and nitrogen deposition rates across much of the SCI is expected to range from zero to a substantial reduction. However, small incremental increases in both NOx and nitrogen deposition may occur across limited areas of the SCI. These changes will be quantified by the monitoring programme specified above.

# 8 CUMULATIVE IMPACTS

8.1 A new crematorium/clinical waste incinerator has started operation in June 2008 at Europa Advanced Road, which lies to the east of the Lathbury Barracks site, but at the bottom of the cliff. The potential for cumulative air quality impacts associated with emissions both from the crematorium/clinical waste incinerator and the proposed power station, is discussed in this section.

8.2 An Environmental Statement to support the planning application crematorium/clinical waste incinerator was prepared in 2006[16]. The assessment was carried out for 10, 15 and 20 m stack heights. The crematorium/clinical waste incinerator is currently being constructed with a 16 m stack.

8.3 The ES concluded that even with a 10 m stack, the crematorium/clinical waste incinerator would contribute only 0.09 $\mu g/m^3$ NOx, as an annual mean concentration, at the worst case receptor location within the SCIs. The predicted concentrations with a 16 m stack would be even lower. Any cumulative impacts upon sensitive ecosystems may therefore be discounted.

8.4 In terms of the health-related pollutants of concern in this assessment (nitrogen dioxide, sulphur dioxide and $PM_{10}$), the process contributions from the crematorium/clinical waste incinerator at the worst-case receptor (the new HM Prison) were all demonstrated to be extremely small.

8.5 Given the relative locations of the two processes and the prevailing local topography, it is highly unlikely that substantial plume interaction would occur. It is concluded that significant cumulative effects can be discounted.

# 9 REFERENCES

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3. Public Health (Air Quality) (Ozone) Rules, 2004.

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10. Environment Agency, 2002. Horizontal Guidance Note IPPC H1.

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12. Environment Agency (2006) Review of background air quality data and methods to combine these with process contributions. Report SC030174/1 SR1.

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15. Highways Agency (2007) Air Quality, Advice Note HA 207/07.

# APPENDIX AQ-1

**Air Quality Objectives in Gibraltar**

### Air quality objectives in Gibraltar

| *Pollutant* | *Objective* | *Measured as* | *To be achieved by* |
|---|---|---|---|
| Nitrogen dioxide | 40 μg/m$^3$ | Annual mean | 1 January 2010 |
| | 200 μg/m$^3$, not to be exceeded more than 18 times per year | 1 hour mean | 1 January 2010 |
| Nitrogen oxides | 30 μg/m$^3$ (1) | Annual mean | 19 July 2001 |
| Particles ($PM_{10}$) | 40 μg/m$^3$ | Annual mean | 1 January 2005 |
| | 50 μg/m$^3$, not to be exceeded more than 35 times per year | 24 hour mean | 1 January 2005 |
| Sulphur dioxide | 125 μg/m$^3$, not to be exceeded more than 3 times per year | 24 hour mean | 1 January 2005 |
| | 350 μg/m$^3$, not to be exceeded more than 24 times per year | 1 hour mean | 1 January 2005 |
| | 20 μg/m$^3$ (1) | Annual mean | 19 July 2001 |
| | 20 μg/m$^3$ (1) | Winter mean (01/10 – 31/03) | 19 July 2001 |

Note
1. These objectives are for the protection of vegetation and ecosystems

# APPENDIX AQ-2

### Sensitivity of Met Year

### Sensitivity of Met Year

AQ2.1 In order to test the model with regard to sensitivity of different meteorological years, the model was run using hourly sequential data from Gibraltar Airport for 2003 to 2007 inclusive. Predicted ground level pollutant concentrations were carried out for the proposed power station, for each of the 20 health-based and ecosystem receptors, assuming a pollutant emission rate of 1 g/second from each stack, in 2011. The results are summarised in Table AQA2-1 below.

AQ2.2 For each receptor location, the ratio between the predicted concentration in 2006 (which was selected for the detailed modelling work) and the highest predicted concentration in another met year is shown in the final column. Where the value is 100%, the highest concentrations were predicted for 2006.

AQ2.3 The results that stand out are for H10, H11, and E3, where the 2006 predictions are much lower than for an alternative year. However, in each case, it is important to note that the 2006 met data predicted higher absolute concentrations at another relevant receptor.

**Table AQA2-1 Predicted ground level pollutant concentrations at each specific receptor location, assuming a 1 g/sec emission rate release from each stack in 2011. The highest predicted concentration at each receptor is shown in bold. The ratio is that between the predicted concentration in 2006 and the highest predicted concentration in another met year**

| *Receptor* | *2003* | *2004* | *2005* | *2006* | *2007* | *Ratio* |
|---|---|---|---|---|---|---|
| H1 | 0.02467 | 0.02402 | 0.0234 | **0.04148** | 0.02345 | 100.0% |
| H2 | 0.03842 | 0.0364 | 0.03417 | **0.05978** | 0.03503 | 100.0% |
| H3 | 0.1124 | 0.10575 | 0.08557 | **0.16771** | 0.09931 | 100.0% |
| H4 | 0.07834 | 0.06946 | 0.05993 | **0.15215** | 0.06309 | 100.0% |
| H5 | 0.02263 | 0.02058 | 0.02079 | **0.03128** | 0.02241 | 100.0% |
| H6 | 0.03646 | 0.03414 | 0.03268 | **0.03138** | 0.03785 | 100.0% |
| H7 | 0.01584 | 0.01794 | **0.01871** | 0.01507 | 0.01676 | 89.9% |
| H8 | 0.03006 | 0.02343 | 0.02365 | 0.01948 | **0.03195** | 82.4% |
| H9 | **0.02069** | 0.01525 | 0.01591 | 0.01763 | 0.01963 | 85.2% |
| H10 | 0.44212 | 0.49553 | **0.52728** | 0.05852 | 0.38555 | 11.1% |
| H11 | 0.1782 | 0.17992 | **0.2119** | 0.04437 | 0.17806 | 20.9% |
| H12 | 0.02898 | 0.03003 | 0.03594 | 0.02837 | **0.03725** | 76.2% |
| E1 | 0.69298 | 0.53925 | 0.52649 | **0.7621** | 0.5835 | 100.0% |
| E2 | 0.11778 | 0.09995 | 0.10049 | **0.19386** | 0.10664 | 100.0% |
| E3 | 0.05387 | **0.06644** | 0.05556 | 0.02623 | 0.04859 | 39.5% |
| E4 | 0.01063 | **0.01456** | 0.01248 | 0.00946 | 0.01047 | 65.0% |
| E5 | 0.00164 | **0.00246** | 0.00205 | 0.00169 | 0.00213 | 68.7% |
| E6 | 0.00031 | 0.00045 | 0.0004 | **0.00025** | 0.00047 | 100.0% |
| E7 | 0.00093 | 0.00128 | 0.00131 | **0.00093** | 0.00145 | 100.0% |
| E8 | 0.00345 | 0.00465 | 0.00546 | **0.00358** | 0.00546 | 100.0% |

# APPENDIX AQ-3

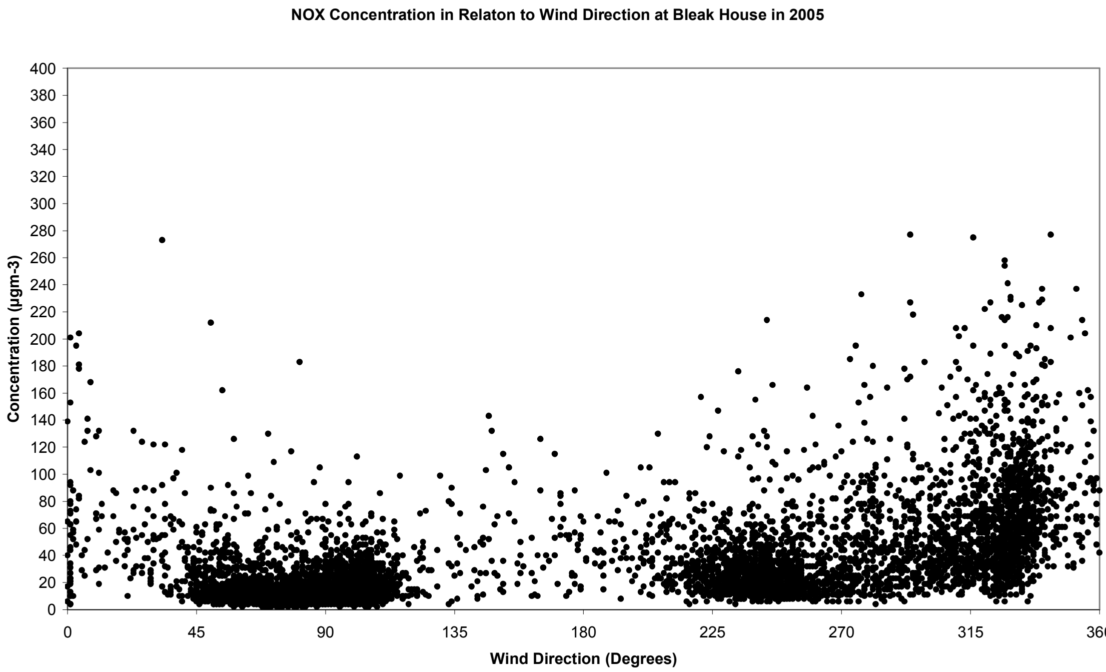
## Scatter Plots of Pollution Data at Bleak House and Rosia Road

# Scatter Plots of Pollution Data at Bleak House and Rosia Road

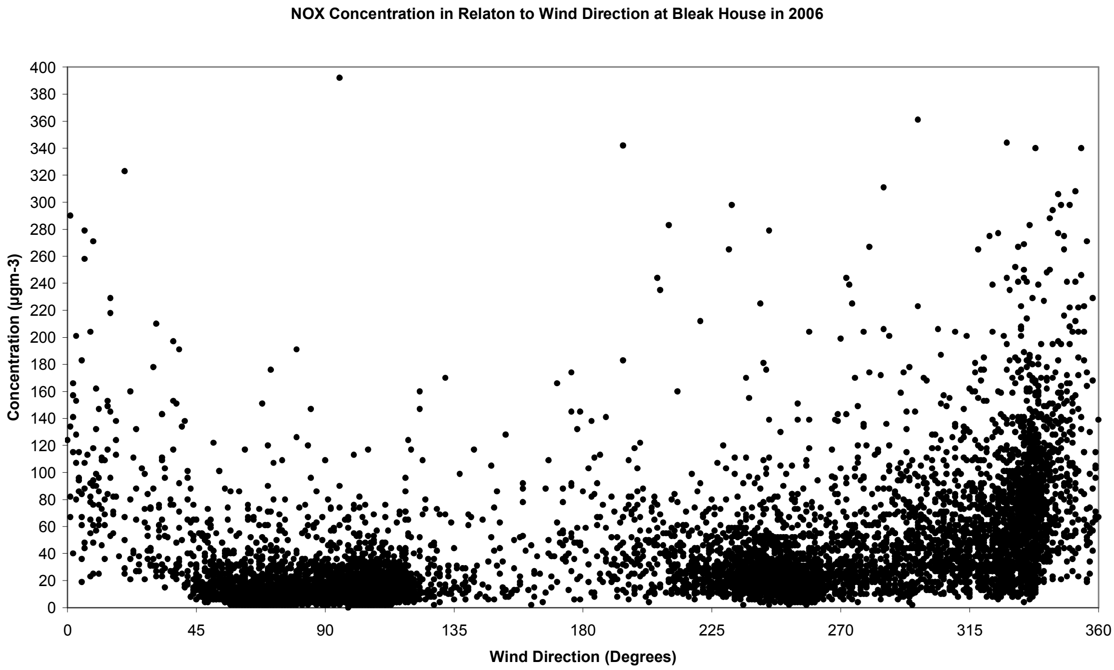
## Bleak House Data

### Nitrogen Oxides

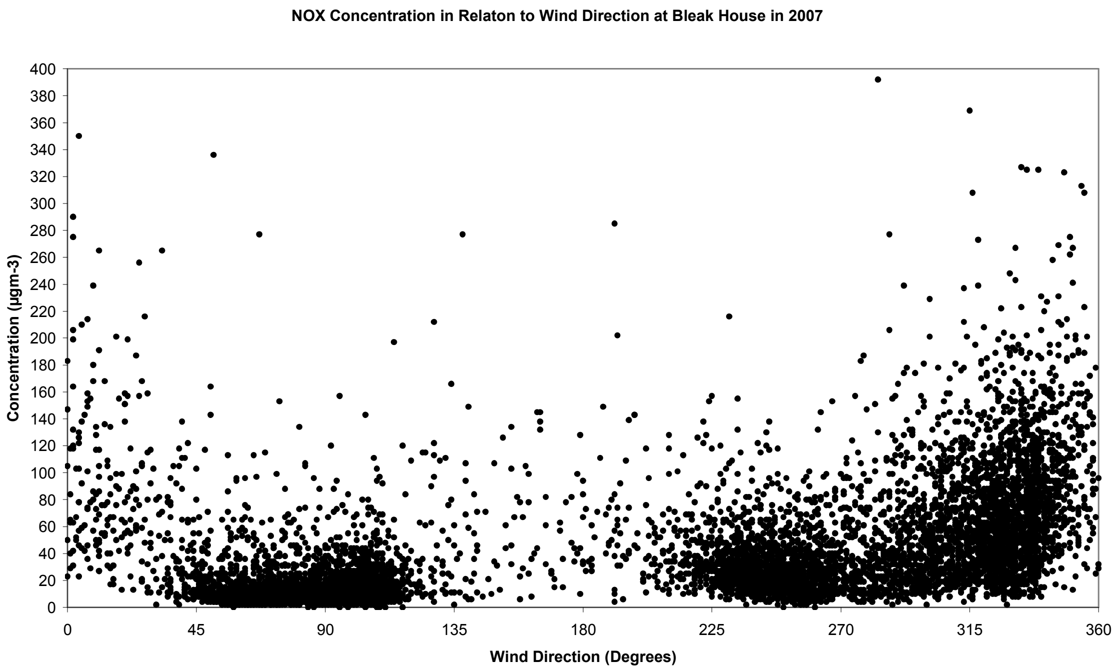
### Data for Year 2005



## Data for Year 2006

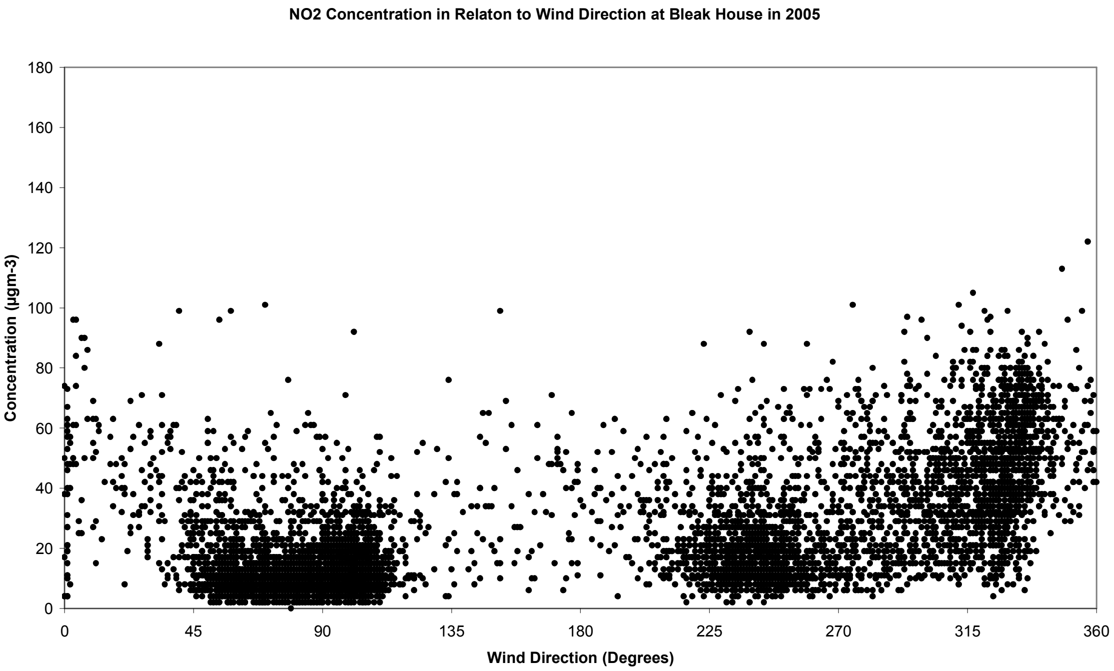



## Data for Year 2007

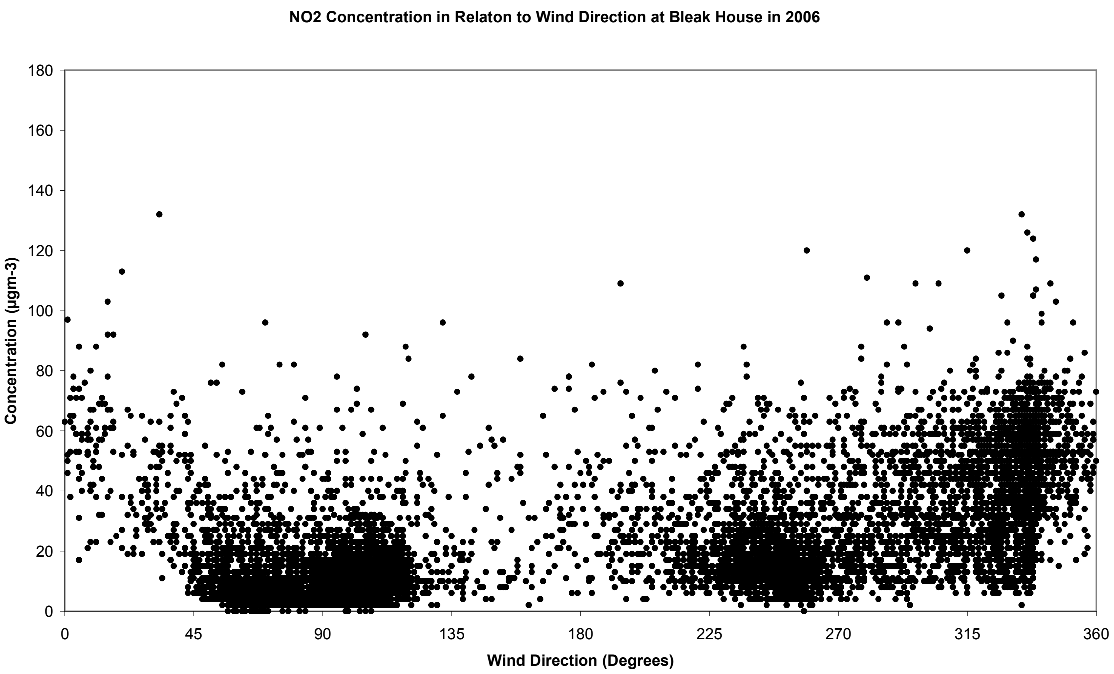


# Nitrogen Dioxide Data

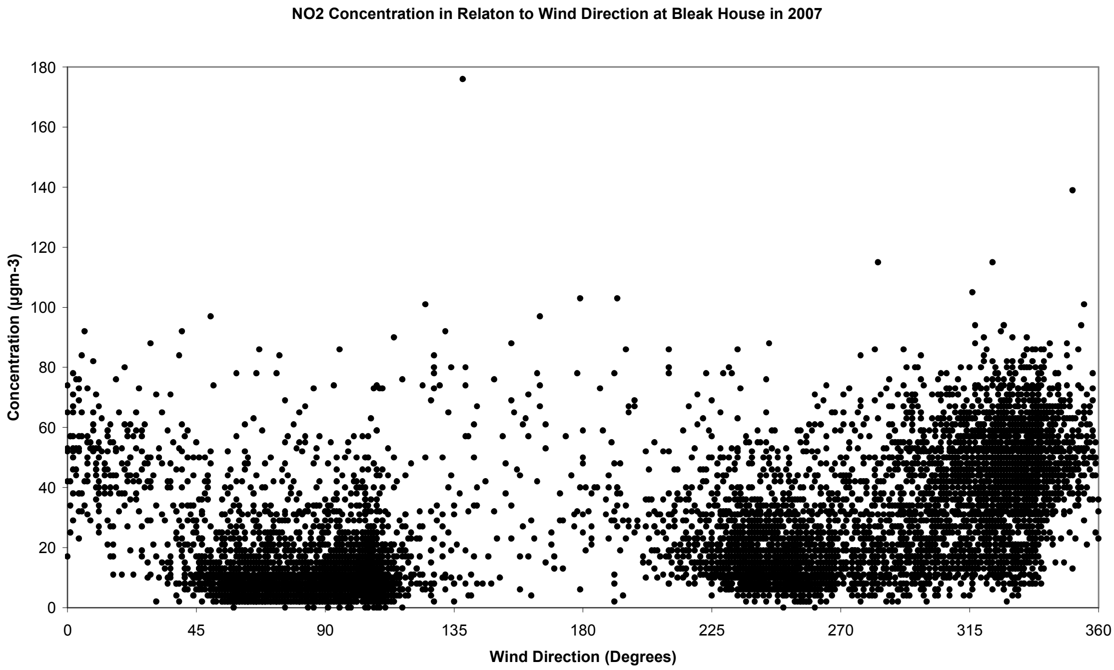
## Data for Year 2005




## Data for Year 2006



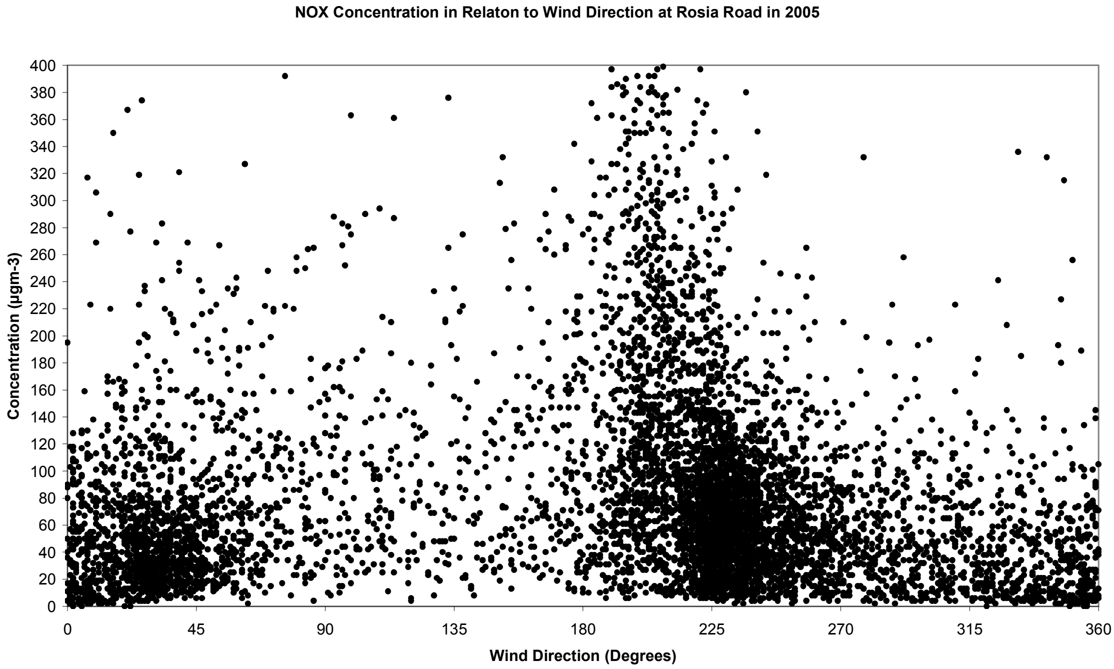
## Data for Year 2007



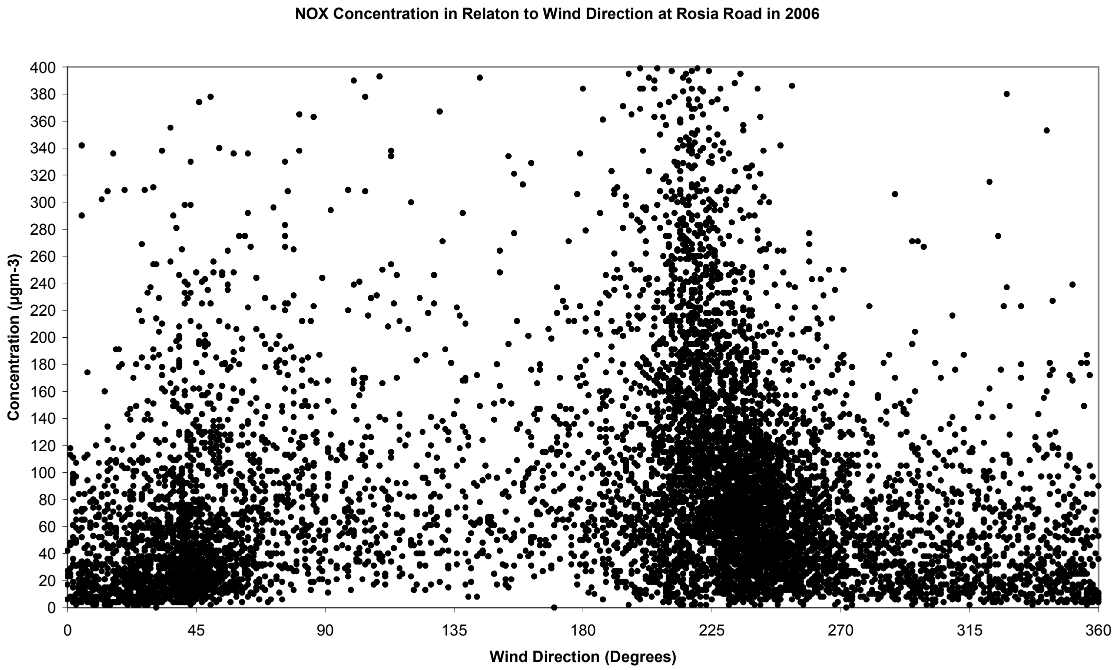
# Rosia Road Data

## Nitrogen Oxides Data

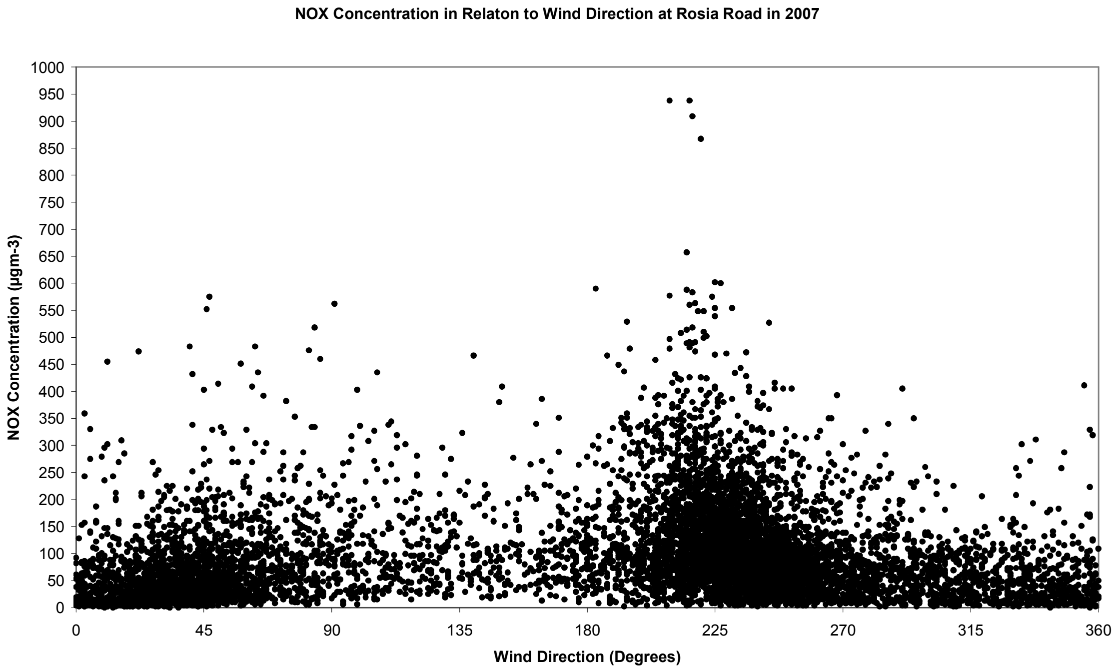
### Data for Year 2005




### Data for Year 2006

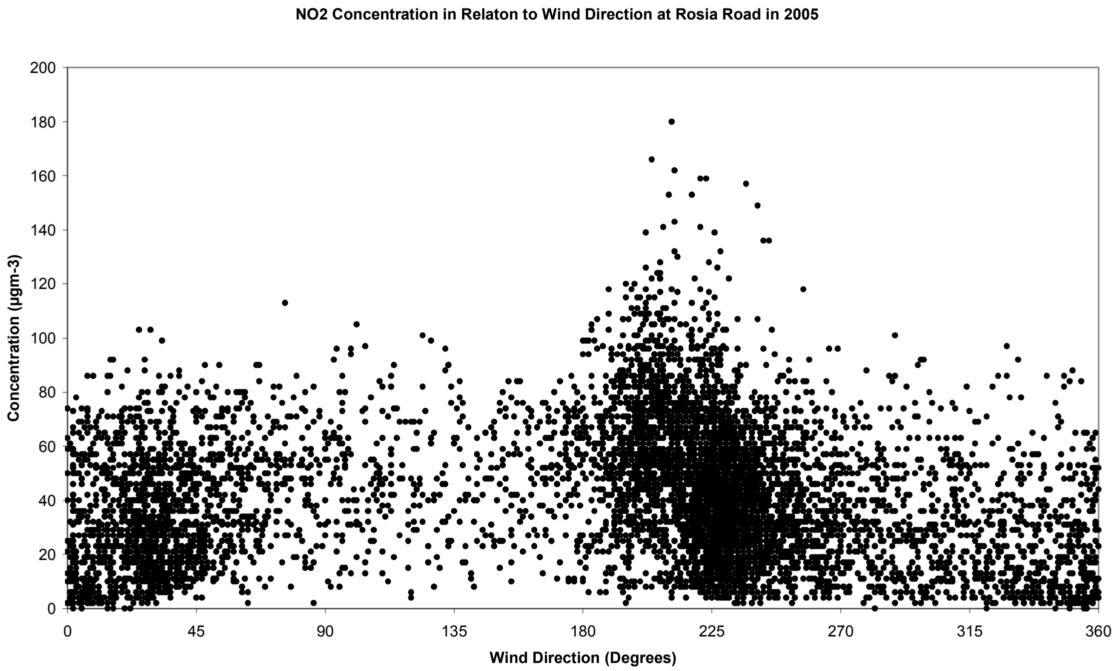


## Data for Year 2007

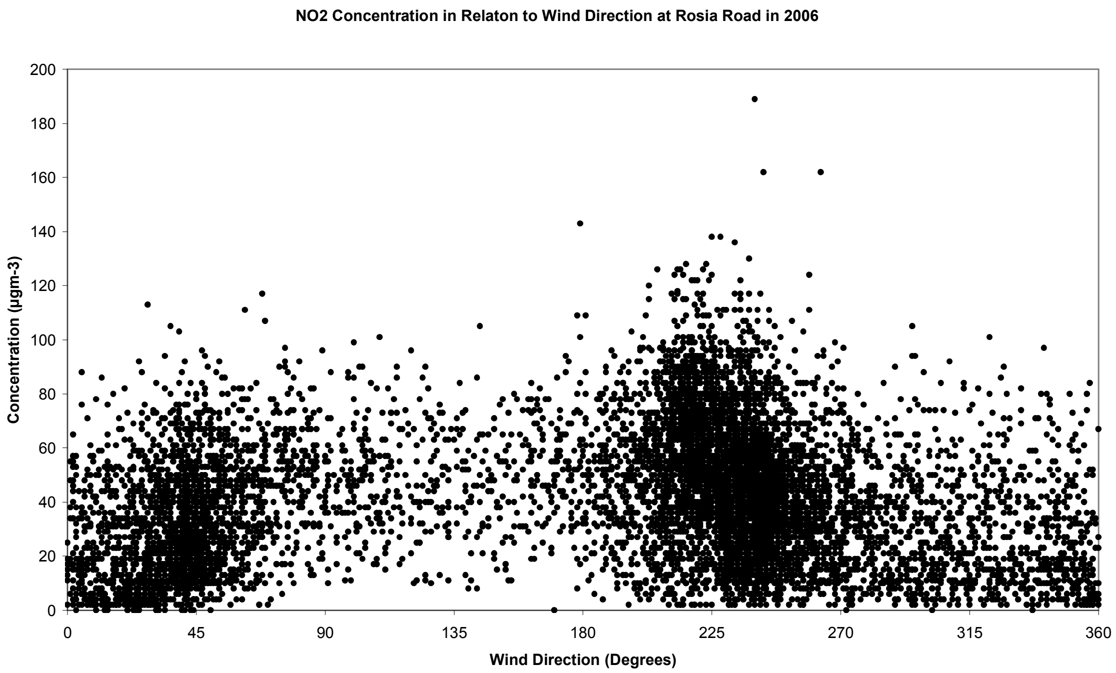


## Nitrogen Dioxide Data

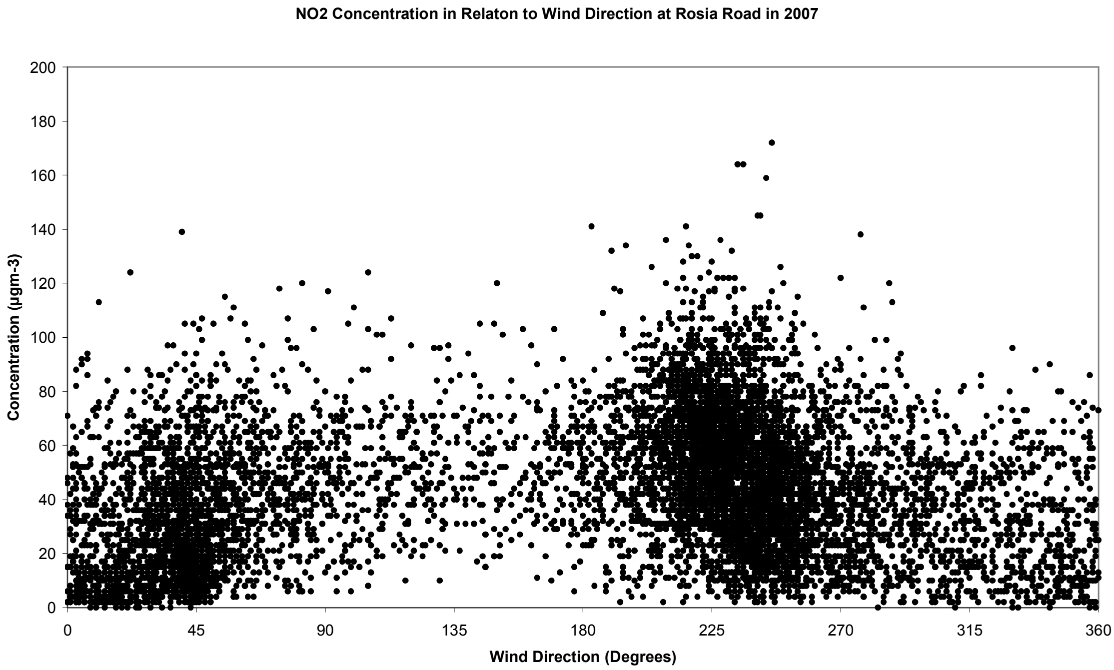
## Data for Year 2005




## Data for Year 2006

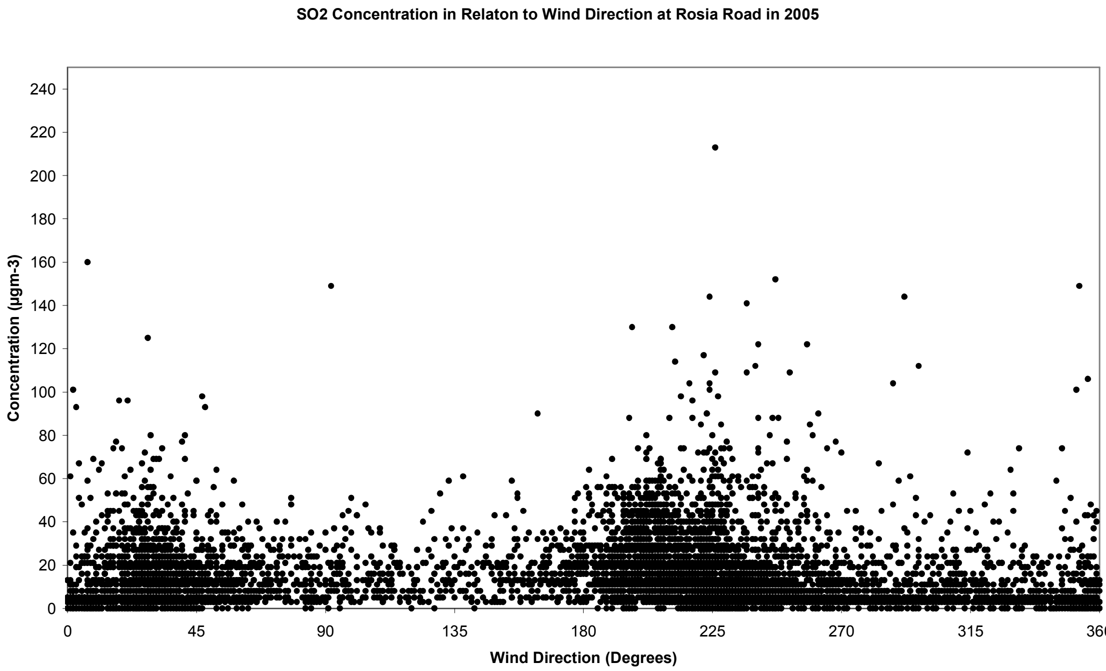


## Data for Year 2007

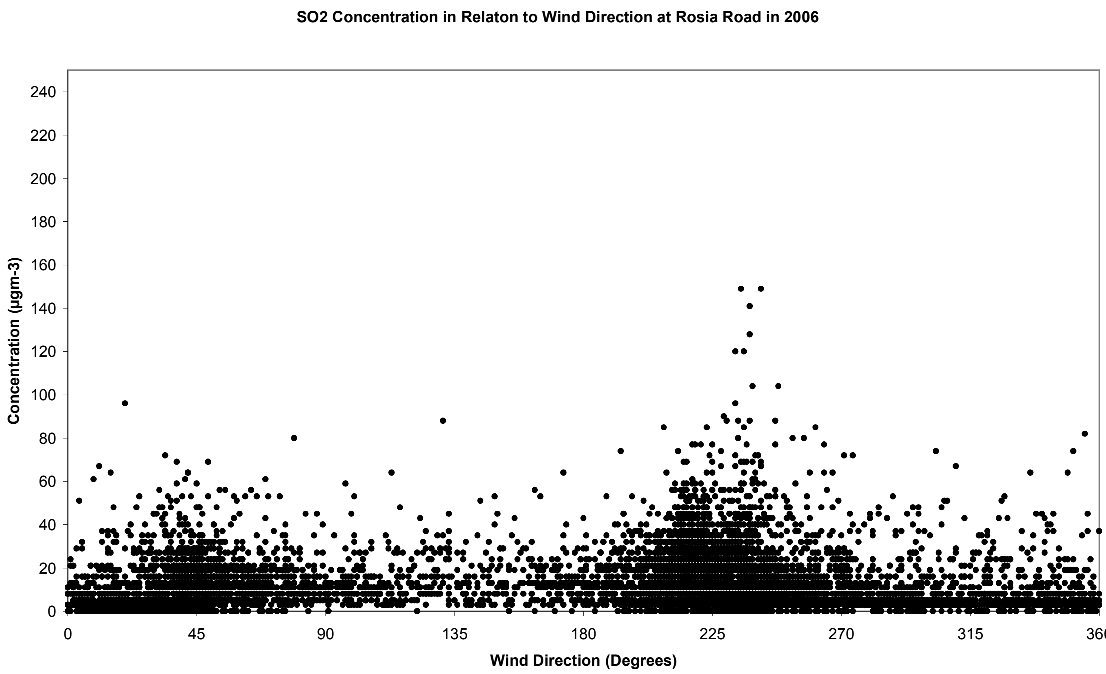


## Sulphur Dioxide Data

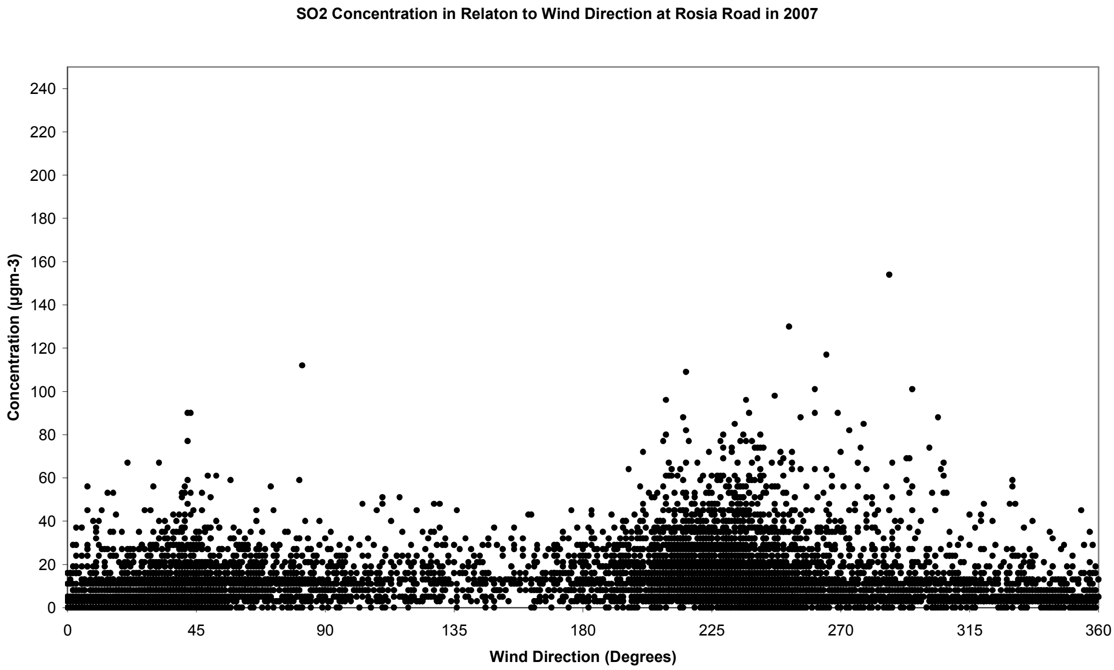
### Data for Year 2005




### Data for Year 2006



## Data for Year 2007



# APPENDIX AQ-4

## Predicted Concentrations for 30 and 50 Metre Stacks

## Predicted Concentrations for 30 and 50 Metre Stacks

**Table AQA4-1: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 26.1 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 30 m stack height, 80% SCR. All concentrations expressed as µg/m$^3$, 2011.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 1.35 | 0.95 | 0.17 | 0.15 |
| H2 | Roof | 0.95 | 0.67 | 0.12 | 0.10 |
| H3 | Roof | 2.97 | 2.08 | 0.38 | 0.33 |
| H4 | Roof | 5.19 | **3.63** | **0.66** | **0.57** |
| H5 | Roof | 0.49 | 0.34 | 0.06 | 0.05 |
| H6 | Roof | 0.40 | 0.28 | 0.05 | 0.04 |
| H7 | Roof | 0.18 | 0.12 | 0.02 | 0.02 |
| H8 | Roof | 0.14 | 0.10 | 0.02 | 0.02 |
| H9 | Roof | 0.13 | 0.09 | 0.02 | 0.01 |
| H10 | Ground | 0.54 | 0.38 | 0.07 | 0.06 |
| H11 | Ground | 0.38 | 0.26 | 0.05 | 0.04 |
| H12 | Roof | 0.23 | 0.16 | 0.03 | 0.02 |
| H13 | Roof | 0.11 | 0.08 | 0.01 | 0.01 |
| H14 | Roof | 0.11 | 0.07 | 0.01 | 0.01 |
| H15 | Roof | 0.10 | 0.07 | 0.01 | 0.01 |
| H16 | Roof | 0.09 | 0.06 | 0.01 | 0.01 |
| H17 | Roof | 0.04 | 0.02 | 0.00 | 0.00 |
| H18 | Roof | 0.04 | 0.03 | 0.00 | 0.00 |
| H19 | Roof | 0.04 | 0.03 | 0.00 | 0.00 |
| H20 | Roof | 0.03 | 0.02 | 0.00 | 0.00 |
| | | | | | |
| E1 | Ground | **6.96** | **4.87** | 0.88 | **0.76** |
| E2 | Ground | 2.67 | 1.87 | 0.34 | 0.29 |
| E3 | Ground | 0.26 | 0.18 | 0.03 | 0.03 |
| E4 | Ground | 0.10 | 0.07 | 0.01 | 0.01 |
| E5 | Ground | 0.02 | 0.02 | 0.00 | 0.00 |
| E6 | Ground | 0.00 | 0.00 | 0.00 | 0.00 |
| E7 | Ground | 0.01 | 0.01 | 0.00 | 0.00 |
| E8 | Ground | 0.04 | 0.03 | 0.01 | 0.00 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-2: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 56MW maximum capacity. 30 m stack height, 80% SCR. All concentrations expressed as µg/m$^3$, 2011.**

| *Receptor* | *Height* | *$NO_x$ 99.8$^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ 90$^{th}$ Percentile of 24-Hour Means* | *$SO_2$ 99.7$^{th}$ Percentile of 1-Hour Means* | *$SO_s$ 99$^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | 165 | 0.89 | 14.8 | 3.51 |
| H2 | Roof | 116 | 0.65 | 11.1 | 2.53 |
| H3 | Roof | 172 | 2.47 | 18.3 | 5.97 |
| H4 | Roof | **242** | **5.00** | **22.8** | **8.59** |
| H5 | Roof | 79.3 | 0.42 | 7.69 | 1.36 |
| H6 | Roof | 56.6 | 0.32 | 5.25 | 0.97 |
| H7 | Roof | 16.4 | 0.12 | 1.28 | 0.33 |
| H8 | Roof | 20.0 | 0.12 | 1.82 | 0.29 |
| H9 | Roof | 18.0 | 0.10 | 1.65 | 0.30 |
| H10 | Ground | 29.4 | 0.36 | 2.77 | 0.64 |
| H11 | Ground | 39.2 | 0.29 | 3.86 | 0.86 |
| H12 | Roof | 38.2 | 0.14 | 3.78 | 0.66 |
| H13 | Roof | 16.8 | 0.08 | 1.33 | 0.28 |
| H14 | Roof | 16.4 | 0.07 | 1.32 | 0.29 |
| H15 | Roof | 17.0 | 0.07 | 1.28 | 0.29 |
| H16 | Roof | 15.8 | 0.06 | 1.20 | 0.26 |
| H17 | Roof | 6.78 | 0.02 | 0.59 | 0.11 |
| H18 | Roof | 7.24 | 0.02 | 0.60 | 0.10 |
| H19 | Roof | 7.76 | 0.03 | 0.61 | 0.11 |
| H20 | Roof | 6.85 | 0.02 | 0.57 | 0.09 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-3: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 38.8 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 30 m stack height, 90% SCR. All concentrations expressed as μg/m$^3$, 2032.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 0.95 | 0.67 | 0.24 | 0.21 |
| H2 | Roof | 0.69 | 0.49 | 0.18 | 0.15 |
| H3 | Roof | 2.28 | 1.59 | 0.58 | 0.50 |
| H4 | Roof | 3.31 | **2.32** | **0.84** | **0.73** |
| H5 | Roof | 0.32 | 0.22 | 0.08 | 0.07 |
| H6 | Roof | 0.26 | 0.19 | 0.07 | 0.06 |
| H7 | Roof | 0.12 | 0.08 | 0.03 | 0.03 |
| H8 | Roof | 0.11 | 0.08 | 0.03 | 0.02 |
| H9 | Roof | 0.10 | 0.07 | 0.03 | 0.02 |
| H10 | Ground | 0.37 | 0.26 | 0.09 | 0.08 |
| H11 | Ground | 0.27 | 0.19 | 0.07 | 0.06 |
| H12 | Roof | 0.16 | 0.11 | 0.04 | 0.03 |
| H13 | Roof | 0.09 | 0.06 | 0.02 | 0.02 |
| H14 | Roof | 0.09 | 0.06 | 0.02 | 0.02 |
| H15 | Roof | 0.08 | 0.06 | 0.02 | 0.02 |
| H16 | Roof | 0.08 | 0.05 | 0.02 | 0.02 |
| H17 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H18 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H19 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H20 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| | | | | | |
| E1 | Ground | **5.03** | **3.52** | 1.27 | **1.11** |
| E2 | Ground | 1.55 | 1.08 | 0.39 | 0.34 |
| E3 | Ground | 0.17 | 0.12 | 0.04 | 0.04 |
| E4 | Ground | 0.06 | 0.04 | 0.02 | 0.01 |
| E5 | Ground | 0.01 | 0.01 | 0.00 | 0.00 |
| E6 | Ground | 0.00 | 0.00 | 0.00 | 0.00 |
| E7 | Ground | 0.01 | 0.01 | 0.00 | 0.00 |
| E8 | Ground | 0.03 | 0.02 | 0.01 | 0.01 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-4: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 80MW maximum capacity. 30 m stack height, 90% SCR. All concentrations expressed as µg/m$^3$, 2032.**

| *Receptor* | *Height* | *$NO_x$ 99.8$^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ 90$^{th}$ Percentile of 24-Hour Means* | *$SO_2$ 99.7$^{th}$ Percentile of 1-Hour Means* | *$SO_s$ 99$^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | 117 | 1.24 | 21.1 | 4.71 |
| H2 | Roof | 79.7 | 0.97 | 15.8 | 3.78 |
| H3 | Roof | 125 | 3.60 | **25.9** | 8.94 |
| H4 | Roof | **138** | **5.96** | 25.8 | **10.6** |
| H5 | Roof | 51.9 | 0.52 | 9.90 | 1.85 |
| H6 | Roof | 37.7 | 0.38 | 6.98 | 1.33 |
| H7 | Roof | 9.32 | 0.15 | 1.68 | 0.47 |
| H8 | Roof | 14.5 | 0.17 | 2.71 | 0.49 |
| H9 | Roof | 14.0 | 0.15 | 2.65 | 0.45 |
| H10 | Ground | 19.2 | 0.50 | 3.83 | 0.89 |
| H11 | Ground | 29.6 | 0.38 | 5.80 | 1.20 |
| H12 | Roof | 26.5 | 0.19 | 5.01 | 0.85 |
| H13 | Roof | 12.1 | 0.12 | 2.23 | 0.47 |
| H14 | Roof | 11.9 | 0.11 | 2.15 | 0.49 |
| H15 | Roof | 12.0 | 0.11 | 1.97 | 0.45 |
| H16 | Roof | 10.8 | 0.10 | 1.81 | 0.41 |
| H17 | Roof | 5.78 | 0.04 | 0.90 | 0.16 |
| H18 | Roof | 5.60 | 0.04 | 0.96 | 0.17 |
| H19 | Roof | 5.77 | 0.05 | 0.93 | 0.19 |
| H20 | Roof | 5.27 | 0.04 | 0.86 | 0.15 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-5: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 26.1 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 50 m stack height, 80% SCR. All concentrations expressed as μg/m$^3$, 2011.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 0.51 | 0.36 | 0.06 | 0.06 |
| H2 | Roof | 0.46 | 0.32 | 0.06 | 0.05 |
| H3 | Roof | 1.01 | 0.71 | 0.13 | 0.11 |
| H4 | Roof | 1.08 | **0.75** | **0.14** | **0.12** |
| H5 | Roof | 0.22 | 0.15 | 0.03 | 0.02 |
| H6 | Roof | 0.21 | 0.14 | 0.03 | 0.02 |
| H7 | Roof | 0.08 | 0.06 | 0.01 | 0.01 |
| H8 | Roof | 0.12 | 0.08 | 0.01 | 0.01 |
| H9 | Roof | 0.11 | 0.07 | 0.01 | 0.01 |
| H10 | Ground | 0.28 | 0.20 | 0.04 | 0.03 |
| H11 | Ground | 0.22 | 0.16 | 0.03 | 0.02 |
| H12 | Roof | 0.15 | 0.11 | 0.02 | 0.02 |
| H13 | Roof | 0.09 | 0.06 | 0.01 | 0.01 |
| H14 | Roof | 0.09 | 0.06 | 0.01 | 0.01 |
| H15 | Roof | 0.09 | 0.06 | 0.01 | 0.01 |
| H16 | Roof | 0.08 | 0.06 | 0.01 | 0.01 |
| H17 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| H18 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| H19 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| H20 | Roof | 0.03 | 0.02 | <0.01 | <0.01 |
| | | | | | |
| E1 | Ground | **3.26** | 2.28 | **0.41** | **0.36** |
| E2 | Ground | 0.60 | 0.42 | 0.08 | 0.07 |
| E3 | Ground | 0.12 | 0.09 | 0.02 | 0.01 |
| E4 | Ground | 0.04 | 0.03 | <0.01 | <0.01 |
| E5 | Ground | 0.01 | <0.01 | <0.01 | <0.01 |
| E6 | Ground | <0.01 | <0.01 | <0.01 | <0.01 |
| E7 | Ground | <0.01 | <0.01 | <0.01 | <0.01 |
| E8 | Ground | <0.01 | <0.01 | <0.01 | <0.01 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-6: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 56MW maximum capacity. 50 m stack height. All concentrations expressed as μg/m$^3$, 2011.**

| *Receptor* | *Height* | *$NO_x$ 99.8$^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ 90$^{th}$ Percentile of 24-Hour Means* | *$SO_2$ 99.7$^{th}$ Percentile of 1-Hour Means* | *$SO_s$ 99$^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | **79.5** | 0.45 | **8.19** | 1.79 |
| H2 | Roof | 69.8 | 0.37 | 6.77 | 1.57 |
| H3 | Roof | 67.3 | 0.88 | 7.22 | **2.26** |
| H4 | Roof | 47.3 | **0.94** | 4.90 | 1.74 |
| H5 | Roof | 43.9 | 0.18 | 3.97 | 0.67 |
| H6 | Roof | 37.5 | 0.16 | 3.55 | 0.57 |
| H7 | Roof | 9.33 | 0.06 | 0.76 | 0.18 |
| H8 | Roof | 16.2 | 0.10 | 1.57 | 0.27 |
| H9 | Roof | 16.1 | 0.09 | 1.48 | 0.25 |
| H10 | Ground | 19.9 | 0.24 | 2.02 | 0.42 |
| H11 | Ground | 26.7 | 0.16 | 2.74 | 0.60 |
| H12 | Roof | 28.7 | 0.09 | 2.53 | 0.48 |
| H13 | Roof | 13.9 | 0.07 | 1.24 | 0.24 |
| H14 | Roof | 13.9 | 0.07 | 1.20 | 0.24 |
| H15 | Roof | 14.1 | 0.06 | 1.14 | 0.23 |
| H16 | Roof | 12.6 | 0.06 | 1.07 | 0.22 |
| H17 | Roof | 6.11 | 0.02 | 0.49 | 0.09 |
| H18 | Roof | 6.02 | 0.02 | 0.50 | 0.10 |
| H19 | Roof | 6.19 | 0.02 | 0.51 | 0.11 |
| H20 | Roof | 5.95 | 0.02 | 0.47 | 0.09 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-7: Predicted annual mean concentrations of NOx, $NO_2$, $PM_{10}$ and $SO_2$ at each receptor location. Results adjusted for 38.8 MW predicted average load. Predicted $NO_2$ concentrations assume 70% conversion from NOx. 50 m stack height, 90% SCR abatement. All concentrations expressed as µg/m$^3$, 2032.**

| *Receptor* | *Height* | *NOx* | *$NO_2$* | *$PM_{10}$* | *$SO_2$* |
|---|---|---|---|---|---|
| H1 | Roof | 0.49 | 0.35 | 0.13 | 0.11 |
| H2 | Roof | 0.42 | 0.29 | 0.11 | 0.09 |
| H3 | Roof | 1.14 | **0.80** | **0.29** | **0.25** |
| H4 | Roof | 1.07 | 0.75 | 0.27 | 0.23 |
| H5 | Roof | 0.18 | 0.12 | 0.04 | 0.04 |
| H6 | Roof | 0.17 | 0.12 | 0.04 | 0.04 |
| H7 | Roof | 0.07 | 0.05 | 0.02 | 0.01 |
| H8 | Roof | 0.10 | 0.07 | 0.02 | 0.02 |
| H9 | Roof | 0.09 | 0.06 | 0.02 | 0.02 |
| H10 | Ground | 0.23 | 0.16 | 0.06 | 0.05 |
| H11 | Ground | 0.18 | 0.13 | 0.05 | 0.04 |
| H12 | Roof | 0.12 | 0.08 | 0.03 | 0.03 |
| H13 | Roof | 0.08 | 0.06 | 0.02 | 0.02 |
| H14 | Roof | 0.08 | 0.05 | 0.02 | 0.02 |
| H15 | Roof | 0.08 | 0.05 | 0.02 | 0.02 |
| H16 | Roof | 0.07 | 0.05 | 0.02 | 0.02 |
| H17 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H18 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H19 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| H20 | Roof | 0.03 | 0.02 | 0.01 | 0.01 |
| | | | | | |
| E1 | Ground | **2.81** | 1.97 | **0.71** | **0.62** |
| E2 | Ground | 0.52 | 0.36 | 0.13 | 0.11 |
| E3 | Ground | 0.09 | 0.07 | 0.02 | 0.02 |
| E4 | Ground | 0.03 | 0.02 | 0.01 | 0.01 |
| E5 | Ground | 0.00 | 0.00 | 0.00 | 0.00 |
| E6 | Ground | 0.00 | 0.00 | 0.00 | 0.00 |
| E7 | Ground | 0.01 | 0.00 | 0.00 | 0.00 |
| E8 | Ground | 0.02 | 0.01 | 0.00 | 0.00 |

Note: Maximum predicted concentration for each pollutant shown in bold.

**Table AQA4-8: Predicted short - term concentrations of $NO_x$, $PM_{10}$ and $SO_2$ at each health-based receptor location. Results assume 90% load of 80MW maximum capacity. 50 m stack height, 90% SCR abatement. All concentrations expressed as µg/m$^3$, 2032.**

| *Receptor* | *Height* | *$NO_x$ 99.8$^{th}$ Percentile of 1-Hour Means* | *$PM_{10}$ 90$^{th}$ Percentile of 24-Hour Means* | *$SO_2$ 99.7$^{th}$ Percentile of 1-Hour Means* | *$SO_s$ 99$^{th}$ Percentile of 24-Hour Means* |
|---|---|---|---|---|---|
| H1 | Roof | **61.3** | 0.77 | 12.4 | 2.72 |
| H2 | Roof | 50.7 | 0.66 | 10.3 | 2.34 |
| H3 | Roof | 58.8 | **1.79** | **12.4** | **4.30** |
| H4 | Roof | 41.4 | 1.73 | 8.28 | 3.46 |
| H5 | Roof | 32.6 | 0.26 | 6.27 | 1.08 |
| H6 | Roof | 29.8 | 0.24 | 5.08 | 0.91 |
| H7 | Roof | 7.73 | 0.08 | 1.15 | 0.38 |
| H8 | Roof | 13.9 | 0.16 | 2.53 | 0.46 |
| H9 | Roof | 13.6 | 0.14 | 2.52 | 0.43 |
| H10 | Ground | 15.8 | 0.37 | 2.98 | 0.69 |
| H11 | Ground | 22.6 | 0.25 | 4.38 | 0.97 |
| H12 | Roof | 21.5 | 0.13 | 3.84 | 0.69 |
| H13 | Roof | 11.8 | 0.11 | 2.17 | 0.42 |
| H14 | Roof | 11.4 | 0.11 | 2.05 | 0.43 |
| H15 | Roof | 10.2 | 0.10 | 1.89 | 0.40 |
| H16 | Roof | 9.63 | 0.10 | 1.75 | 0.37 |
| H17 | Roof | 5.08 | 0.04 | 0.78 | 0.15 |
| H18 | Roof | 5.06 | 0.04 | 0.82 | 0.17 |
| H19 | Roof | 5.42 | 0.04 | 0.87 | 0.18 |
| H20 | Roof | 5.11 | 0.04 | 0.78 | 0.15 |

Note: Maximum predicted concentration for each pollutant shown in bold.

# APPENDIX AQ-5

**Air Quality Assessment of Stack Heights for the Proposed Lathbury Barracks Power Station**

Air Quality Consultants

# Air Quality Assessment of Stack Heights for the Proposed Lathbury Barracks Power Station

## Document Control

| Client | Engain | Principal Contact | Clare Wyllys |
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# Contents

# 1 Introduction

1.1 Air Quality Consultants Ltd has been commissioned by Environmental Gain Ltd (Engain) to carry out an assessment of stack heights for the proposed 72 MW diesel power station at Lathbury Barracks, Gibraltar. The objective of this assessment is to inform the concept design at an early stage, regarding stack height and abatement measures.

1.2 The existing air quality conditions in the general vicinity of Lathbury Barracks are described, and predictions of air quality in a future year (2011) with the proposed power station are provided. The results are assessed against the relevant air quality criteria for the protection of human health and the environment, and with regard to significance criteria for industrial emissions.

# 2 Policy Context and Assessment Criteria

## Air Quality Criteria

2.1 The significance of both existing and future air quality can be assessed against the air quality standards that have been set to protect human health and the environment.

2.2 Gibraltar has adopted a number of air quality objectives based on the Public Health (Air Quality Limit Values) Rules 2002 as amended by the Public Health (Air Quality Limit Values) (Amendment) Rules 2003 and the Public Health (Air Quality) (Ozone) Rules 2004. These Air Quality Rules have adopted into legislation the EC limit values as set out in Directives 1996/62/EC, 1999/30/EC, 2000/69/EC and 2002/3/EC. A summary of the relevant air quality objectives is provided in Table 1.

**Table 1: Air Quality Objectives in Gibraltar**

| Pollutant | Objective | Measured as | To be achieved by |
|---|---|---|---|
| **Nitrogen Dioxide** | $40\ \mu g/m^3$ | Annual mean | 1 Jan 2010 |
| | $200\ \mu g/m^3$ not to be exceeded more than 18 times a year | 1-hour mean | 1 Jan 2010 |
| **Nitrogen Oxides** | $30\ \mu g/m^3$ [(1)] | Annual mean | 19 July 2001 |
| **Fine Particles ($PM_{10}$)** [(2)] | $40\ \mu g/m^3$ | Annual mean | 1 Jan 2005 |
| | $50\ \mu g/m^3$ not to be exceeded more than 35 times a year | 24-hour mean | 1 Jan 2005 |
| **Sulphur Dioxide** | $125\ \mu g/m^3$ not to be exceeded more than 3 times a year | 24-hour mean | 1 Jan 2005 |
| | $350\ \mu g/m^3$ not to be exceeded more than 24 times a year | 1-hour mean | 1 Jan 2005 |
| | $20\ \mu g/m^3$ [(1)] | Annual mean | 19 July 2001 |
| | $20\ \mu g/m^3$ [(1)] | Winter mean (01/10-31/03) | 19 July 2001 |

[(1)] These objectives are for the protection of vegetation and ecosystems.
[(2)] Measured by the gravimetric method.

# 3 Scope and Assessment Methodology

3.1 The existing air quality conditions in the general vicinity of the power station are described. Predictions of future air quality assuming 7 different stack heights are then provided.

## Pollutants of Concern

3.2 The principal pollutants of concern for this study are nitrogen oxides (NOx), sulphur dioxide ($SO_2$) and fine particles ($PM_{10}$).

## Sensitive Receptors

3.3 Sensitive receptors are locations in the vicinity of the proposed power station that may be exposed to pollutant emissions. They include locations such as residential housing, hospitals and medical centres. They also include ecosytems that are sensitive to air pollution. In terms of the short-term criteria (1-hour mean) relevant locations may include anywhere that is open to access by the general public. Locations within the boundary of the power station are not covered by the objectives set out in Table 1, as the objectives do not apply to occupational exposure.

3.4 A total of 12 sensitive receptors representing public health exposure are described in Table 2. These locations are expected to represent worst-case exposure; pollutant concentrations arising from the power station emissions at other locations would be expected to be lower.

**Table 2: Description of Health- Based Receptor Locations**

| Receptor | Description |
|---|---|
| **Receptor H1** | Clifftop House residential apartments |
| **Receptor H2** | The Retreat Centre |
| **Receptor H3** | Retirement Home |
| **Receptor H4** | HM Prison |
| **Receptor H5** | Residential properties between Europa Road and Windmill Hill |
| **Receptor H6** | The Royal Naval Hospital |
| **Receptor H7** | The Community Catholic Centre |
| **Receptor H8** | South View Terrace |
| **Receptor H9** | St Joseph's School |
| **Receptor H10** | Nuffield Pool |
| **Receptor H11** | Public Terraces |
| **Receptor H12** | St Christopher's School |

3.5 Additional receptor locations have been included to represent areas of sensitive vegetation. There are two areas of sensitive ecosystems adjacent to the proposed power station site. One area lies about 200 metres to the north of the site. The other lies directly south of the existing parade ground and extends approximately 500 metres in length. These sites are designated as Sites of Community Interest (SCIs). Eight specific receptor locations have been identified (Receptors E1 to E8) intended to identify worst-case locations. A larger network of receptor locations has also been included across both SCIs to describe a larger spatial pattern.

3.6 A map describing the receptor locations is provided in Figure 1.

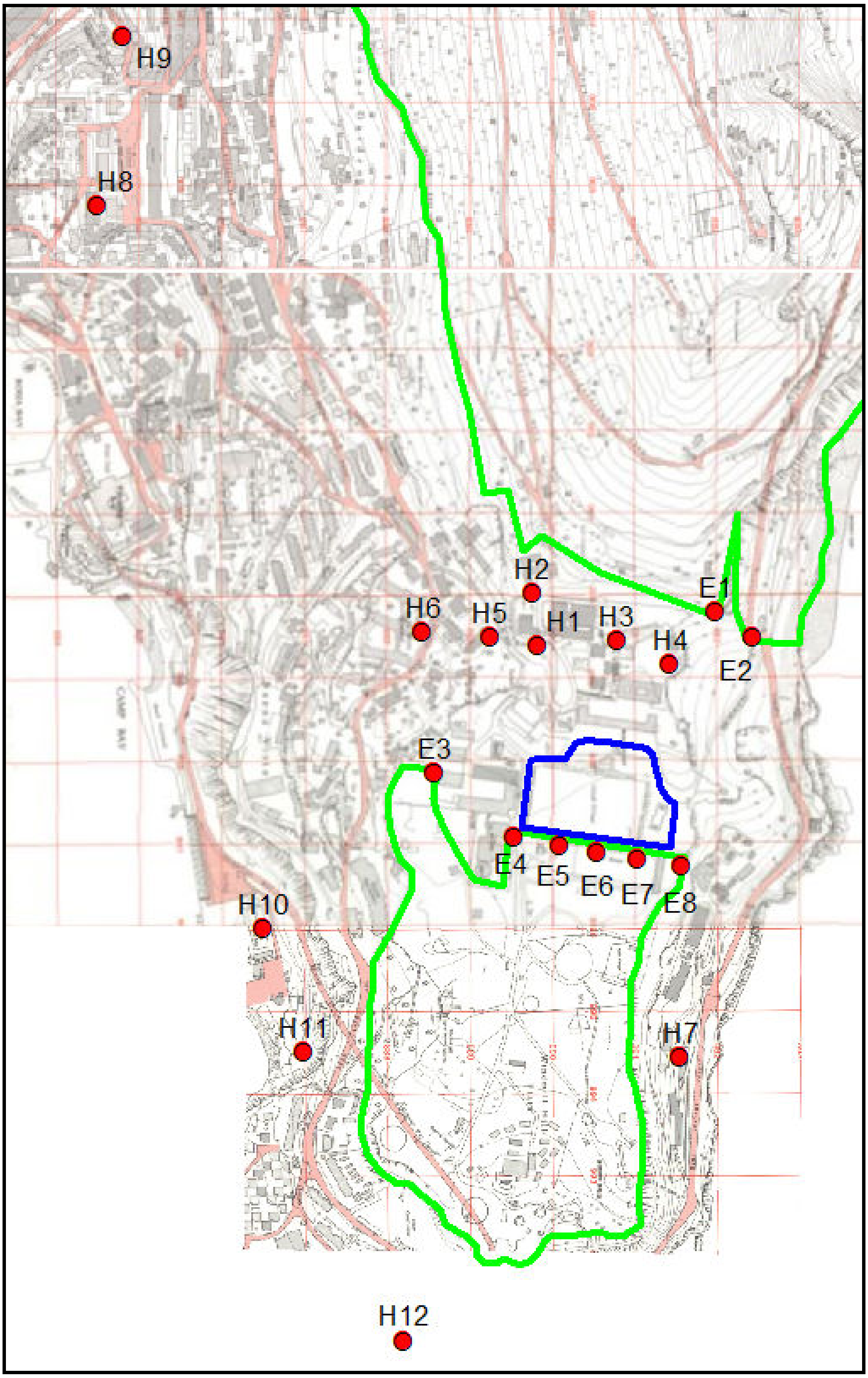



**Figure 1: Location of Sensitive Receptor Locations in Proximity of the Proposed Power Station (Site Boundary shown in Blue). The SCI Boundary is shown in Green.**

## Dispersion Modelling

3.7 Predictions of ground level pollutant concentrations arising from the power station have been calculated using the AERMOD dispersion model. This is a new generation model that incorporates a state-of-the art understanding of the dispersion processes within the atmospheric boundary layer. AERMOD is now the preferred regulatory model in the US, and is used worldwide for the assessment of industrial processes. The model also incorporates utilities to account for building downwash and terrain effects.

3.8 The model requires a variety of input data to be provided, regarding the emission rates, conditions of release, adjacent building dimensions and orientations, and meteorological data.

3.9 The scenarios to be considered were advised by Engain, and may be summarised as follows:

- Operational year of 2011, with 9 diesel units (8MW each) at full capacity (100%). Represents 72MW installed capacity.
- Stack heights of 18m, 20m, 25m, 30m, 35m, 40m and 50m.
- No SCR abatement.

3.10 This is expected to represent a very conservative assessment for 2011. The predicted average demand for 2011 is about 26MW, representing 36% of the assumed operational load. The predicted maximum demand is 45MW, representing 63% of the assumed operational load. The predicted concentrations for 2011 will thus over-estimate the impacts.

3.11 The power station would consist of 3 main stacks, with 3 flues in each stack. For the purpose of modelling, an equivalent diameter for each stack has been assumed for the 3 flues combined, in order to account for plume buoyancy effects. The emission rates, and release conditions were provided by Engain.

3.12 A summary of the assumed emission rates and pertinent release conditions is provided in Table 3.

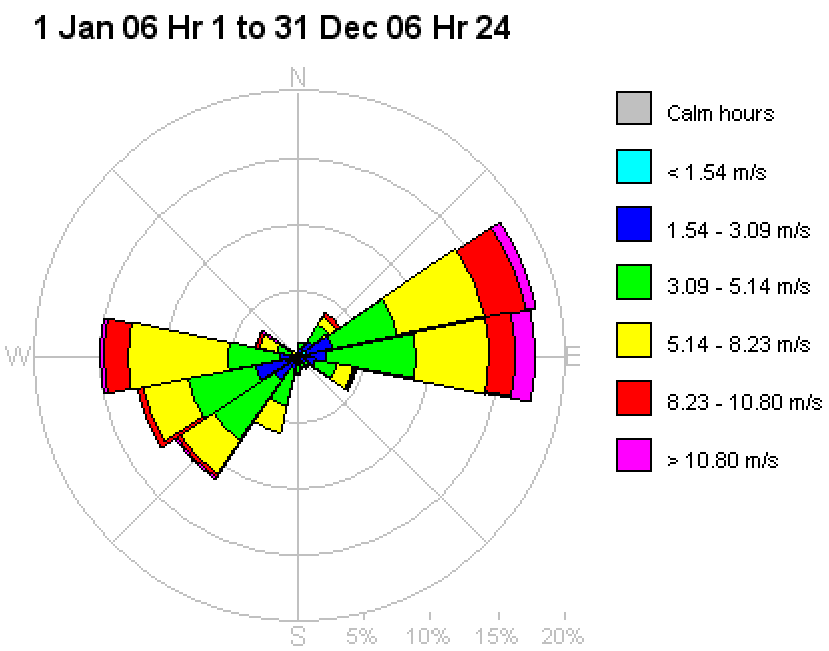
3.13 The dispersion and dilution of pollutant emissions is strongly affected by the local meteorological conditions, including wind speed, direction, and the degree of atmospheric turbulence. Suitable meteorological data are available from Gibraltar Airport which is about 3.5 kilometres due north of the development site. The hourly sequential dataset for 2006 has been used.

3.14 The meteorological data for 2006 are shown plotted in a wind rose in Figure 2. This shows that the prevailing winds are from the north-east to easterly and south-west to westerly directions.

**Table 3: Model Input Parameters and Assumptions**

| Parameter | Value | |
|---|---|---|
| No. Flues per Stack | 3 | |
| No. Stacks | 3 | |
| Equivalent Stack Diameter (m) | 2.23 | |
| Exit Temperature (ºC) | 360 | |
| Exit Velocity (m/s) | 20 | |
| Assumed Emission Releases (no SCR) per 8 MW unit | | |
| | Concentration ($mg/Nm^3$) | Emission Rate (g/s) |
| NOx | 2000 | 29.9 |
| $PM_{10}$ | 50 | 0.75 |
| $SO_2$ | 43.7 | 0.65 |

**Figure 2: Wind Rose Gibraltar Airport 2006**




3.15 The data represented in Figure 2 show the general pattern of wind conditions in Gibraltar. An important factor to also be considered is that the area is frequently associated with strong “gap winds” known as the “Levanter” and the “Poniente”. The Lavanter describes easterly winds, while the Poniente describes the opposite. The Levanter winds can occur at any time of the year but are most common during the period May to October. During very strong easterly winds the wind field around the Rock may be severely distorted, such that the surface wind direction is changed, even becoming inverted. A further effect is the formation of strong inversion layer at a height of several thousand feet.

3.16 In the absence of detailed wind field observations across Gibraltar, such local meteorological variations are difficult to account for within the model. However, the effect is likely to influence the geographical pattern, rather than the magnitude of ground level pollutant concentrations. The inversion layer associated with the Levanter is probably too high to have a significant effect of the plume dispersion within the near-field distances considered in this assessment.

3.17 It is difficult to accurately represent complex topographical features using the dispersion models that are commonly used for this type of assessment. In the absence of digitised topographic maps for Gibraltar, elevations of the specific receptor locations have been manually entered into the dispersion model. For the health-based receptors, this accounts for the elevation of the receptor with respect to the stack base, with the upper floor levels of the buildings represented as "flagpoles". For the ecosystem receptors, the ground elevations relative to the stack base have been included.

3.18 The dispersion of the plume may also be affected by the flow of the wind across local buildings if they are sufficiently high with respect to the stack. These so-called "building downwash effects" have been included in the model by incorporating the location and relevant dimensions of the plant and other nearby buildings, based on information provided by Engain. The height of the main generator building was assumed to be 13 m.

3.19 The dispersion model predicts concentrations from the emissions sources that have been explicitly included in the model. It is also necessary to take account of the contribution of other sources, which represents the local background. This is done by way of discussion, rather than by quantitative addition within the results tables.

3.20 The predictions have been carried out assuming a 1 g/sec emission rate, and then scaled as appropriate to calculate ground-level concentrations of NOx, $PM_{10}$ and $SO_2$. Predictions have been carried out for annual mean concentrations; in addition, the following calculations have been undertaken for comparison with the short-term objectives:

- The 19th highest hourly mean NOx concentration (99.8th percentile)
- The 25th highest hourly mean $SO_2$ concentration (99.7th percentile)
- The 36th highest 24-hour mean $PM_{10}$ concentration (90th percentile)
- The 4th highest 24-hour mean $SO_2$ concentration (99th percentile)

# 4 Existing Conditions

4.1 Information on existing air quality conditions has been derived from monitoring carried out by the Environmental Agency in Gibraltar. Two continuous monitoring stations were commissioned in February 2005, at Rosia Road and Bleak House.

4.2 Rosia Road is roadside site within the commercial centre of Gibraltar. The monitoring station is located approximately 1.8 kilometres north-north-west of Lathbury Barracks. Bleak House is a suburban site on the south west coast of Gibraltar, approximately 470 metres to the south-west of Lathbury Barracks. Pollutant concentrations measured at Bleak House are expected to be more representative of those at the proposed power station site.

4.3 A summary of monitoring data for 2006 and 2007 is provided in Table 4. Nitrogen dioxide concentrations measured at Bleak House represent good air quality, with levels well below the health-based air quality objectives. The annual mean NOx concentration measured at this site in both 2006 and 2007 is above the annual mean objective for the protection of vegetation (30 $\mu g/m^3$). As might be expected concentrations of both nitrogen dioxide and NOx are much higher at the Rosia Road roadside monitoring station, which is also influenced by local industrial emissions.

4.4 The Environmental Agency also operates a network of passive nitrogen dioxide diffusion tubes across Gibraltar, including a site located at Lathbury Industrial Park. The 2007 data have now been fully ratified, and show an annual mean concentration of 20.7 $\mu g/m^3$. Concentrations of NOx are not recorded by this method but if the average 2006/07 $NO_2$:NOx ratio at Bleak House were assumed, an annual mean NOx concentration in 2007 of about 32 $\mu g/m^3$ would be derived.

4.5 It is not certain to what extent the measured concentration at Lathbury Industrial Estate has been affected by local construction works, and concentrations of nitrogen dioxide (and NOx) may be significantly lower to the north and south, and within the SCIs. In particular, it might be expected that concentrations of both nitrogen dioxide and NOx would be lower in the more remote areas towards the Rock.

**Table 4: Summary of Monitoring Data in Gibraltar (µg/m³). Exceedences of the objectives are highlighted in bold.**

| Pollutant | Location | | | | Objective |
|---|---|---|---|---|---|
| | Rosia Road | | Bleak House | | |
| | 2006 | 2007 | 2006 | 2007 | |
| **Continuous (Automatic Monitoring)[b]** | | | | | |
| **Nitrogen dioxide** | | | | | |
| Annual mean | **42.0** | **44.2** | 24.1 | 24.8 | 40 |
| No. hours > 200 µg/m³ | 0 | 0 | 0 | 0 | 18 |
| Max 1 hour mean | 189 | 172 | 132 | 176 | - |
| 99.8th percentile of 1-hr means | 124 | 128 | 103 | 92 | 200 |
| **Nitrogen oxides (NOx)** | | | | | |
| Annual mean | **91.0** | **94.6** | **37.0** | **39.5** | 30 |
| **Sulphur dioxide ($SO_2$)** | | | | | |
| Annual mean | 13.1 | 13.3 | - | - | 20 |
| Max 24-hr mean | 41.0 | 42.0 | - | - | - |
| No. days > 125 µg/m³ | 0 | 0 | - | - | 3 |
| Max 1-hr mean | 150 | 154 | - | - | - |
| No. hours >350 µg/m³ | 0 | 0 | - | - | 24 |
| 99th percentile of 24-hr means | 36.0 | 39.0 | - | - | 125 |
| 99.7th percentile of 1-hr means | 79.5 | 80.0 | - | - | 350 |
| **Semi-automatic Monitor** | | | | | |
| **$PM_{10}$** | | | | | |
| Annual mean | 39.8 | **44.2** | - | - | 40 |
| 90th percentile of daily means | **55.1** | **61.0** | - | - | 50 |
| No. days > 50 µg/m³ | **64** | **86** | - | - | 35 |
| Max daily mean | 92.0 | 109.0 | - | - | - |

[b] Concentrations calculated from data taken from the Air Quality in Gibraltar website.

4.6 In the absence of any additional monitoring data, the measured annual mean $NO_x$ and $NO_2$ concentrations from Bleak House in 2006 have been used to represent background concentrations across the study area, but this is likely to represent a conservative approach.

4.7 There are no monitoring stations close to the proposed development site that describe concentrations of $PM_{10}$ and sulphur dioxide. Annual mean $PM_{10}$ concentrations were marginally below the objective at Rosia Road in 2006 and above the objective in 2007, but as noted above, this site will be strongly affected by local road traffic emissions. Concentrations of $PM_{10}$ in the vicinity of the proposed power station site would be expected to be significantly lower.

4.8 Concentrations of sulphur dioxide were below the objectives at the Rosia Road automatic monitoring station in both 2006 and 2007. It is therefore unlikely that sulphur dioxide concentrations in the vicinity of the development site will currently exceed the objectives.

# 5 Assessment

5.1 This section describes the results of the dispersion modelling exercise, and compares the predicted concentrations with the air quality objectives set out in Section 2.

5.2 The model was run assuming an emission release rate of 1 g/second. The predicted concentrations at each receptor location were then calculated by scaling the results according to the assumed emissions release rates set out in Table 3 above.

5.3 The predicted concentrations associated with the power station emissions are set out in Tables 6 to 12. These values are presented without the local background, but as described in paragraph 3.9, they assume 100% load factor at 72MW capacity. In each case, the relevant averaging period for comparison with the objectives has been selected. The predictions are provided for each of the specific health-based sensitive receptor locations (Receptors H1 to H12), and for each of the assumed stack heights. For the annual mean NOx concentrations (Table 6) the predicted concentrations are also shown for the specific ecosystem receptors (Receptors E1 to E8).

5.4 The results indicate a clear stack downwash effect at stack heights below 30 metres. Given the assumed height of the generator hall (13 metres) and the rule of thumb that the stack should be 2.5 times the height of the building, these results confirm that a stack of height of at least 30 metres is recommended.

5.5 Predicted NOx concentrations across the network of ecosystem receptors are shown in Figures 3 to 6, for the 30, 35, 40 and 50m stacks respectively. Results are not shown for stack heights below 30 m, due to the influence of building downwash described above. Each Figure shows the predicted annual mean NOx concentration at each receptor point. The results confirm that the highest NOx concentration for stack heights of 30m and above, are predicted to occur at Receptor E1.

**Table 6: Predicted Annual Mean NOx Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 18.8 | 16.6 | 11.5 | 7.0 | 5.5 | 4.4 | 2.7 |
| H1 | Roof | 32.2 | 30.1 | 25.4 | 21.0 | 17.7 | 14.5 | 9.2 |
| H2 | Ground | 14.5 | 13.1 | 9.5 | 6.6 | 5.5 | 4.6 | 3.2 |
| H2 | Roof | 20.1 | 18.6 | 15.0 | 11.9 | 10.1 | 8.5 | 5.9 |
| H3 | Ground | 76.9 | 65.1 | 36.3 | 15.8 | 11.3 | 7.9 | 3.8 |
| H3 | Roof | 86.8 | 76.2 | 48.1 | 25.0 | 19.1 | 14.3 | 7.4 |
| H4 | Ground | 239.7 | 209.1 | 120.6 | 38.3 | 26.6 | 17.9 | 7.6 |
| H4 | Roof | 263.6 | 237.2 | 159.9 | 78.8 | 60.0 | 44.5 | 22.0 |
| H5 | Ground | 7.2 | 6.5 | 4.4 | 2.4 | 2.0 | 1.6 | 1.2 |
| H5 | Roof | 10.4 | 9.3 | 6.5 | 3.8 | 3.1 | 2.5 | 1.8 |
| H6 | Roof | 8.4 | 7.8 | 5.4 | 3.2 | 2.7 | 2.3 | 1.8 |
| H7 | Roof | 2.1 | 2.0 | 1.6 | 1.3 | 1.1 | 0.9 | 0.6 |
| H8 | Ground | 1.6 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.2 |
| H9 | Ground | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.2 | 1.1 |
| H10 | Ground | 137.7 | 129.0 | 109.7 | 5.3 | 4.4 | 3.8 | 2.9 |
| H11 | Ground | 38.2 | 33.5 | 27.3 | 3.6 | 3.2 | 2.8 | 2.2 |
| H12 | Ground | 2.6 | 2.5 | 2.3 | 2.1 | 1.9 | 1.8 | 1.5 |
| | | | | | | | | |
| E1 | Ground | 188.3 | 173.4 | 132.1 | 92.0 | 82.0 | 71.8 | 51.5 |
| E2 | Ground | 155.2 | 137.7 | 86.8 | 21.3 | 14.8 | 10.4 | 5.1 |
| E3 | Ground | 88.2 | 65.8 | 37.3 | 2.8 | 2.3 | 1.9 | 1.4 |
| E4 | Ground | 560.1 | 516.2 | 372.8 | 1.0 | 0.8 | 0.6 | 0.4 |
| E5 | Ground | 496.5 | 456.4 | 321.1 | 0.3 | 0.2 | 0.1 | 0.1 |
| E6 | Ground | 13.8 | 12.6 | 8.9 | 0.1 | 0.0 | 0.0 | 0.0 |
| E7 | Ground | 9.7 | 7.8 | 4.8 | 0.2 | 0.1 | 0.1 | 0.0 |
| E8 | Ground | 35.4 | 18.3 | 12.1 | 0.4 | 0.3 | 0.3 | 0.2 |

**Table 7: Predicted 99.8th Percentile 1-Hour Mean NOx Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 1465.5 | 1181.3 | 713.2 | 497.6 | 414.9 | 358.8 | 229.8 |
| H1 | Roof | 2465.9 | 1944.2 | 1399.7 | 1227.6 | 1089.2 | 940.3 | 677.7 |
| H2 | Ground | 1050.3 | 956.2 | 584.2 | 443.5 | 389.1 | 345.5 | 264.1 |
| H2 | Roof | 1330.3 | 1164.4 | 803.0 | 702.8 | 636.3 | 580.7 | 434.8 |
| H3 | Ground | 2766.7 | 2273.4 | 1382.2 | 549.0 | 390.6 | 289.3 | 181.9 |
| H3 | Roof | 2766.9 | 2478.1 | 1636.2 | 858.0 | 664.3 | 493.7 | 272.3 |
| H4 | Ground | 4140.8 | 3694.1 | 2623.8 | 793.5 | 559.1 | 380.6 | 197.7 |
| H4 | Roof | 4568.2 | 4109.4 | 3048.3 | 1874.4 | 1337.0 | 867.3 | 455.5 |
| H5 | Ground | 639.5 | 552.2 | 305.2 | 224.2 | 196.1 | 159.4 | 122.2 |
| H5 | Roof | 988.0 | 764.6 | 426.4 | 322.8 | 273.5 | 246.6 | 174.0 |
| H6 | Roof | 753.9 | 609.9 | 358.6 | 252.0 | 239.6 | 217.8 | 176.0 |
| H7 | Roof | 74.2 | 73.6 | 67.0 | 60.0 | 56.7 | 49.4 | 41.6 |
| H8 | Ground | 101.5 | 100.0 | 99.1 | 99.9 | 99.3 | 98.0 | 88.9 |
| H9 | Ground | 102.0 | 99.7 | 96.5 | 93.8 | 93.2 | 93.9 | 90.6 |
| H10 | Ground | 2183.8 | 2075.5 | 1826.2 | 140.1 | 127.5 | 116.2 | 101.0 |
| H11 | Ground | 1628.5 | 1251.7 | 1118.6 | 197.3 | 180.0 | 169.6 | 137.3 |
| H12 | Ground | 229.8 | 220.6 | 204.2 | 186.9 | 177.5 | 164.3 | 147.6 |

**Table 8: Predicted Annual Mean $PM_{10}$ Concentrations ($\mu g/m^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 0.47 | 0.42 | 0.29 | 0.18 | 0.14 | 0.11 | 0.07 |
| H1 | Roof | 0.80 | 0.75 | 0.63 | 0.53 | 0.44 | 0.36 | 0.23 |
| H2 | Ground | 0.36 | 0.33 | 0.24 | 0.16 | 0.14 | 0.11 | 0.08 |
| H2 | Roof | 0.50 | 0.46 | 0.37 | 0.30 | 0.25 | 0.21 | 0.15 |
| H3 | Ground | 1.92 | 1.63 | 0.91 | 0.39 | 0.28 | 0.20 | 0.10 |
| H3 | Roof | 2.17 | 1.90 | 1.20 | 0.63 | 0.48 | 0.36 | 0.18 |
| H4 | Ground | 5.99 | 5.22 | 3.01 | 0.96 | 0.66 | 0.45 | 0.19 |
| H4 | Roof | 6.59 | 5.93 | 4.00 | 1.97 | 1.50 | 1.11 | 0.55 |
| H5 | Ground | 0.18 | 0.16 | 0.11 | 0.06 | 0.05 | 0.04 | 0.03 |
| H5 | Roof | 0.26 | 0.23 | 0.16 | 0.10 | 0.08 | 0.06 | 0.04 |
| H6 | Roof | 0.21 | 0.19 | 0.14 | 0.08 | 0.07 | 0.06 | 0.04 |
| H7 | Roof | 0.05 | 0.05 | 0.04 | 0.03 | 0.03 | 0.02 | 0.02 |
| H8 | Ground | 0.04 | 0.04 | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 |
| H9 | Ground | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| H10 | Ground | 3.44 | 3.22 | 2.74 | 0.13 | 0.11 | 0.09 | 0.07 |
| H11 | Ground | 0.95 | 0.84 | 0.68 | 0.09 | 0.08 | 0.07 | 0.06 |
| H12 | Ground | 0.07 | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 |

**Table 9: Predicted 90th Percentile 24-hour Mean $PM_{10}$ Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 1.02 | 0.98 | 0.76 | 0.57 | 0.50 | 0.41 | 0.24 |
| H1 | Roof | 2.00 | 1.90 | 1.61 | 1.35 | 1.15 | 0.92 | 0.68 |
| H2 | Ground | 0.87 | 0.80 | 0.64 | 0.53 | 0.44 | 0.39 | 0.27 |
| H2 | Roof | 1.19 | 1.13 | 0.93 | 0.74 | 0.65 | 0.59 | 0.49 |
| H3 | Ground | 6.65 | 5.69 | 3.16 | 1.35 | 0.96 | 0.68 | 0.36 |
| H3 | Roof | 7.93 | 6.61 | 4.02 | 2.15 | 1.65 | 1.22 | 0.67 |
| H4 | Ground | 22.85 | 19.16 | 11.19 | 3.55 | 2.39 | 1.55 | 0.63 |
| H4 | Roof | 25.39 | 21.35 | 13.63 | 7.35 | 5.58 | 4.01 | 2.03 |
| H5 | Ground | 0.41 | 0.38 | 0.31 | 0.19 | 0.17 | 0.13 | 0.09 |
| H5 | Roof | 0.60 | 0.52 | 0.43 | 0.33 | 0.27 | 0.20 | 0.14 |
| H6 | Roof | 0.55 | 0.49 | 0.36 | 0.25 | 0.19 | 0.18 | 0.13 |
| H7 | Roof | 0.15 | 0.14 | 0.12 | 0.09 | 0.07 | 0.06 | 0.04 |
| H8 | Ground | 0.13 | 0.13 | 0.13 | 0.12 | 0.11 | 0.11 | 0.11 |
| H9 | Ground | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.09 |
| H10 | Ground | 11.11 | 10.79 | 9.95 | 0.37 | 0.34 | 0.31 | 0.26 |
| H11 | Ground | 3.19 | 2.77 | 2.41 | 0.27 | 0.24 | 0.20 | 0.17 |
| H12 | Ground | 0.16 | 0.16 | 0.15 | 0.14 | 0.11 | 0.10 | 0.09 |

**Table 10: Predicted Annual Mean $SO_2$ Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 0.41 | 0.36 | 0.25 | 0.15 | 0.12 | 0.10 | 0.06 |
| H1 | Roof | 0.70 | 0.66 | 0.55 | 0.46 | 0.39 | 0.32 | 0.20 |
| H2 | Ground | 0.32 | 0.29 | 0.21 | 0.14 | 0.12 | 0.10 | 0.07 |
| H2 | Roof | 0.44 | 0.41 | 0.33 | 0.26 | 0.22 | 0.19 | 0.13 |
| H3 | Ground | 1.68 | 1.42 | 0.79 | 0.34 | 0.25 | 0.17 | 0.08 |
| H3 | Roof | 1.90 | 1.67 | 1.05 | 0.55 | 0.42 | 0.31 | 0.16 |
| H4 | Ground | 5.24 | 4.57 | 2.64 | 0.84 | 0.58 | 0.39 | 0.17 |
| H4 | Roof | 5.76 | 5.19 | 3.50 | 1.72 | 1.31 | 0.97 | 0.48 |
| H5 | Ground | 0.16 | 0.14 | 0.10 | 0.05 | 0.04 | 0.04 | 0.03 |
| H5 | Roof | 0.23 | 0.20 | 0.14 | 0.08 | 0.07 | 0.05 | 0.04 |
| H6 | Roof | 0.18 | 0.17 | 0.12 | 0.07 | 0.06 | 0.05 | 0.04 |
| H7 | Roof | 0.05 | 0.04 | 0.04 | 0.03 | 0.02 | 0.02 | 0.01 |
| H8 | Ground | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| H9 | Ground | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.02 |
| H10 | Ground | 3.01 | 2.82 | 2.40 | 0.11 | 0.10 | 0.08 | 0.06 |
| H11 | Ground | 0.83 | 0.73 | 0.60 | 0.08 | 0.07 | 0.06 | 0.05 |
| H12 | Ground | 0.06 | 0.06 | 0.05 | 0.05 | 0.04 | 0.04 | 0.03 |

**Table 11: Predicted 99.7th Percentile 1-hour Mean $SO_2$ Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 26.34 | 21.80 | 13.18 | 9.86 | 8.54 | 7.19 | 4.74 |
| H1 | Roof | 39.56 | 36.14 | 27.73 | 24.13 | 21.58 | 19.09 | 12.76 |
| H2 | Ground | 20.17 | 18.34 | 11.55 | 9.01 | 7.94 | 6.83 | 5.23 |
| H2 | Roof | 24.00 | 22.25 | 15.82 | 13.66 | 12.57 | 10.99 | 8.17 |
| H3 | Ground | 55.35 | 47.82 | 29.77 | 11.47 | 8.43 | 6.16 | 3.58 |
| H3 | Roof | 58.16 | 51.56 | 34.56 | 17.79 | 13.90 | 10.62 | 5.85 |
| H4 | Ground | 89.03 | 79.87 | 56.63 | 16.86 | 11.65 | 8.11 | 3.96 |
| H4 | Roof | 98.13 | 88.39 | 65.79 | 35.52 | 24.24 | 18.48 | 9.60 |
| H5 | Ground | 10.78 | 7.89 | 5.94 | 4.27 | 3.72 | 3.27 | 2.45 |
| H5 | Roof | 16.77 | 12.97 | 8.42 | 6.72 | 5.69 | 4.75 | 3.59 |
| H6 | Roof | 10.92 | 10.14 | 6.95 | 4.39 | 4.07 | 3.83 | 3.14 |
| H7 | Roof | 1.45 | 1.42 | 1.36 | 1.13 | 1.07 | 0.88 | 0.64 |
| H8 | Ground | 2.10 | 2.09 | 2.02 | 1.97 | 1.88 | 1.81 | 1.74 |
| H9 | Ground | 1.89 | 1.90 | 1.90 | 1.88 | 1.80 | 1.79 | 1.74 |
| H10 | Ground | 46.41 | 44.38 | 39.36 | 2.75 | 2.60 | 2.42 | 2.05 |
| H11 | Ground | 30.98 | 25.86 | 22.84 | 4.07 | 3.74 | 3.40 | 2.77 |
| H12 | Ground | 4.16 | 4.10 | 3.99 | 3.69 | 3.38 | 3.17 | 2.67 |

**Table 12: Predicted 99th Percentile 24-hour Mean $SO_2$ Concentrations (µg/m$^3$) at each Receptor Location due to the Power Station (100% load factor, 72MW capacity)**

| Receptor | Height | 18 m | 20 m | 25 m | 30 m | 35 m | 40 m | 50 m |
|---|---|---|---|---|---|---|---|---|
| H1 | Ground | 5.58 | 4.79 | 3.00 | 1.88 | 1.61 | 1.38 | 0.80 |
| H1 | Roof | 7.51 | 7.35 | 5.29 | 4.71 | 4.04 | 3.34 | 2.20 |
| H2 | Ground | 4.47 | 3.85 | 2.47 | 1.80 | 1.61 | 1.44 | 0.99 |
| H2 | Roof | 5.36 | 4.83 | 3.59 | 2.92 | 2.47 | 2.00 | 1.65 |
| H3 | Ground | 18.81 | 16.16 | 8.02 | 3.50 | 2.51 | 1.77 | 0.91 |
| H3 | Roof | 19.04 | 17.74 | 10.98 | 5.47 | 4.29 | 3.20 | 1.71 |
| H4 | Ground | 42.01 | 37.52 | 24.81 | 6.74 | 4.66 | 3.12 | 1.21 |
| H4 | Roof | 41.23 | 37.96 | 29.84 | 13.47 | 10.49 | 7.85 | 3.84 |
| H5 | Ground | 1.88 | 1.75 | 1.23 | 0.71 | 0.61 | 0.52 | 0.37 |
| H5 | Roof | 2.45 | 2.30 | 1.76 | 1.02 | 0.88 | 0.76 | 0.57 |
| H6 | Roof | 2.67 | 2.84 | 1.58 | 0.72 | 0.63 | 0.56 | 0.48 |
| H7 | Roof | 0.28 | 0.28 | 0.26 | 0.24 | 0.22 | 0.19 | 0.16 |
| H8 | Ground | 0.33 | 0.34 | 0.33 | 0.33 | 0.33 | 0.32 | 0.31 |
| H9 | Ground | 0.31 | 0.31 | 0.31 | 0.31 | 0.30 | 0.30 | 0.29 |
| H10 | Ground | 23.38 | 22.96 | 21.75 | 0.64 | 0.57 | 0.51 | 0.44 |
| H11 | Ground | 7.07 | 6.19 | 5.99 | 0.74 | 0.67 | 0.60 | 0.46 |
| H12 | Ground | 0.70 | 0.66 | 0.63 | 0.57 | 0.56 | 0.54 | 0.46 |

5.6 The UK Environment Agency (2002) suggests that process source contributions are unlikely to have a significant environmental impact where the source contribution is:

- Less than 1% of the long term criterion
- Less than 20% of the short term criterion

5.7 Where potential environmental impacts are indicated, it is then recommended that account be taken of the estimated background contribution.

5.8 The maximum predicted long-term (annual and 24-hour mean) and short-term (1-hour) concentrations of each pollutant are shown in Tables 13 and 14 respectively. These are results for relevant receptors, thus the maximum values at the health-based receptors (H1-H12) are considered for nitrogen dioxide, $PM_{10}$ and $SO_2$, and at the ecosystem receptors (E1-E8) for NOx. The focus is upon the annual mean objectives for NOx and $NO_2$, the 24-hour mean objective for $PM_{10}$, and the 1-hour mean objectives for $NO_2$ and $SO_2$, as these represent the most stringent test. These tables show the relevant air quality criteria, the predicted concentration associated with emissions from the stacks (at each assumed height), and the existing background concentration (for 2006). They also describe the process contribution as a percentage of the relevant air quality objective.

5.9 In each case, the maximum predicted concentrations for the health-based receptors are at the roof level of the HM Prison (Receptor H4). The maximum predicted annual mean NOx concentration at the ecosystem receptors is at Receptor E4 for the 18, 20, and 25 m stacks, and E1 for 30, 35, 40 and 50 m stacks.

5.10 It must be borne in mind that a number of pessimistic assumptions are included within the results presented in Tables 13 and 14. These are:

- It has been assumed that the power station is operating at full 72MW output capacity. For 2011, this is likely to over-estimate annual mean concentrations by a factor of approximately 3 times, and the short-term concentrations by a factor of about 1.5 times;

- The background NOx and $NO_2$ concentrations presented are for 2006. It is expected that background concentrations in 2011 would be slightly lower, due to improved emissions controls. The station is not expected to reach full generating capacity until around 2030, when background concentrations will have fallen even lower;

- Should the proposed power station receive consent, then three existing stations would be decommissioned. The impact of these emission reductions has not been accounted for within the assessment.

- For $NO_2$, a pessimistic assumption has been made that 100% of the NOx emitted from the stack would be converted to $NO_2$. Within the distances considered, this is highly unlikely, and a lower conversion is probably more realistic.

5.11 It is also important to remember that these predictions allow for no SCR abatement. The results presented in the Tables and the Figures are all directly scalable e.g. if the assumed NOx emission rate were reduced to 200 mg/Nm$^3$, the predicted NOx concentrations would be 10 times lower.

5.12 To take some of these pessimistic assumptions into account, and represent a more realistic picture, Tables 15 and 16 provide the same data as Tables 13 and 14, but with the following adjustments made:

- In line with guidance issued by the UK Environment Agency, Air Quality Modelling and Assessment Unit (AQMAU), NOx:$NO_2$ conversion ratios of 35% for short-term (hourly mean) and 70% for long-term (annual and daily mean) concentrations have been applied;
- To take account of the actual operational loads, the long-term means have been adjusted to 36% of the predicted values, and the short-term means to 63% (see paragraph 3.9)

5.13 Subsequent discussions of the results are based on Tables 15 and 16. As discussed above, at stack heights below about 30 metres, there is evidence of significant building downwash effects. Further consideration is only given to the 30m, 35m, 40m and 50m heights.

## Health-based Objectives

5.14 In terms of $NO_2$, the predicted concentrations significantly exceed the EA criterion cited above, even before the background is taken into account. Taking the estimated annual mean background concentration at Bleak House into account, there is “headroom” of about 16 µg/m$^3$ $NO_2$. From the results presented in Table 15, the objective would not be exceeded at the worst-case receptor location with stack heights of 35 metres and above. In terms of the 1-hour objective, it is not appropriate to add the 99.8$^{th}$ percentile background concentration to the 99.8$^{th}$ percentile process contribution, as the two events would be unlikely to occur at the same time. Assuming the background contribution were no more than twice the annual mean, the short term objective would not be exceeded at the worst-case receptor with a 50 metre stack.

5.15 In the absence of suitable background $PM_{10}$ concentrations, it is difficult to accurately interpret the results. As discussed above, the levels measured at Rosia Road are highly unlikely to represent the environs of the development site. With a stack height of 35 metres and above, the process would contribute less than 2 µg/m$^3$ to the 90$^{th}$ percentile of daily means. This is unlikely to significantly contribute to an exceedence of the objective.

5.16 Predicted concentrations of sulphur dioxide are well below the objective based on worst-case assumptions, and this pollutant is unlikely to constrain stack height considerations.

## Ecosystem Objective

5.17 The annual mean objective for the protection of sensitive vegetation (30 µg/m$^3$ NOx) is assumed to be exceeded across the whole of the SCIs based on the monitoring data available from Bleak House. As discussed in Section 4 above, this is a very pessimistic assumption, and it is confidently expected that NOx levels will be lower in the vicinity of Lathbury Barracks and within the SCIs to the north and the south, particularly within the remote areas towards the upper Rock. In the absence of other monitoring data there is no certainty that the NOx objective is widely exceeded across the SCIs, if indeed it is exceeded at all. A programme to measure $NO_2$ concentrations within the SCIs is recommended to both inform future assessments and to provide the basis for mitigation should the process be consented.

5.18 With a 50 metre stack, the predicted maximum annual mean NOx concentration would be 18.5 µg/m$^3$, representing 61.8% of the objective (30 µg/m$^3$). With 80% SCR abatement, this would be reduced to 3.7 µg/m$^3$, representing 12% of the objective. As can be seen from Figures 3 to 6, predicted NOx concentrations decline rapidly away from the area of maximum impact (which represents an area of about 400 m$^2$) and levels across much of the SCI would be considerably lower.

5.19 There are no precise criteria to determine the significance of emissions in this case. The UK Environment Agency suggests that process source contributions are unlikely to be significant where the contribution is less than 1% of the critical level, irrespective of the background levels. However, this **does not** imply that significant effects would necessarily occur at higher process contributions.

5.20 The UK Environment Agency has also defied a series of policy documents to comply with the Habitats Directive. These recommend that where the background concentration currently exceeds the appropriate criteria, and the process contribution is small, then a decision should be made based on local circumstances.

**Table 13: Impact of Process Emissions upon Long Term Air Quality (100% load factor, 72MW capacity)**

| Pollutant | Air Quality Criterion (µg/m$^3$) | Measured as | Estimated Background Concentration (µg/m$^3$) | Stack Height (m) | Predicted concentration from process (µg/m$^3$)[a] | Percentage of criterion due to process (%) |
|---|---|---|---|---|---|---|
| Nitrogen dioxide | 40 | Annual mean | 24.1 | 18 | 263.6 | 659% |
| | | | | 20 | 237.2 | 593% |
| | | | | 25 | 159.9 | 399% |
| | | | | 30 | 78.8 | 197% |
| | | | | 35 | 60.0 | 150% |
| | | | | 40 | 44.5 | 111% |
| | | | | 50 | 22.0 | 55% |
| Nitrogen oxides | 30 | Annual mean | 37.0 | 18 | 560.1 | 1867% |
| | | | | 20 | 516.2 | 1720% |
| | | | | 25 | 372.8 | 1242% |
| | | | | 30 | 92.0 | 306% |
| | | | | 35 | 82.0 | 273% |
| | | | | 40 | 71.8 | 239% |
| | | | | 50 | 51.5 | 172% |
| Particles ($PM_{10}$) | 50 | 90$^{th}$ percentile of 24-hour means | 55.1 | 18 | 25.4 | 51% |
| | | | | 20 | 21.4 | 43% |
| | | | | 25 | 13.6 | 27% |
| | | | | 30 | 7.4 | 15% |
| | | | | 35 | 5.6 | 11% |
| | | | | 40 | 4.0 | 8.0% |
| | | | | 50 | 2.0 | 4.0% |

a: Predicted concentrations for nitrogen dioxide assume 100% conversion from NOx to $NO_2$

**Table 14: Impact of Process Emissions upon Short-Term Air Quality (100% load factor, 72MW capacity)**

| Pollutant | Air Quality Criterion (µg/m$^3$) | Measured as | Estimated Background Concentration (µg/m$^3$) | Stack Height (m) | Predicted concentration from process (µg/m$^3$)[a] | Percentage of criterion due to process (%) |
|---|---|---|---|---|---|---|
| Nitrogen dioxide | 200 | 99.8$^{th}$ percentile of 1-hour means | 103 | 18 | 4568 | 2284% |
| | | | | 20 | 4109 | 2054% |
| | | | | 25 | 3048 | 1524% |
| | | | | 30 | 1874 | 937% |
| | | | | 35 | 1337 | 668% |
| | | | | 40 | 867.3 | 433% |
| | | | | 50 | 455.5 | 228% |
| Sulphur dioxide | 350 | 99.7$^{th}$ percentile of 1-hour means | 79.5 | 18 | 98.1 | 28% |
| | | | | 20 | 88.4 | 25% |
| | | | | 25 | 65.8 | 19% |
| | | | | 30 | 35.5 | 10% |
| | | | | 35 | 24.2 | 6.9% |
| | | | | 40 | 18.5 | 5.3% |
| | | | | 50 | 9.6 | 2.7% |

a: Predicted concentrations for nitrogen dioxide assume 100% conversion from NOx to $NO_2$

**Table 15: Impact of Process Emissions upon Long Term Air Quality (36% load factor, 72MW capacity)**

| Pollutant | Air Quality Criterion ($\mu g/m^3$) | Measured as | Estimated Background Concentration ($\mu g/m^3$) | Stack Height (m) | Predicted concentration from process ($\mu g/m^3$)[a] | Percentage of criterion due to process (%) |
|---|---|---|---|---|---|---|
| Nitrogen dioxide | 40 | Annual mean | 24.1 | 18 | 66.4 | 166.1% |
| | | | | 20 | 59.8 | 149.4% |
| | | | | 25 | 40.3 | 100.7% |
| | | | | 30 | 19.9 | 49.6% |
| | | | | 35 | 15.1 | 37.8% |
| | | | | 40 | 11.2 | 28.0% |
| | | | | 50 | 5.5 | 13.9% |
| Nitrogen oxides | 30 | Annual mean | 37.0 | 18 | 201.6 | 672.1% |
| | | | | 20 | 185.8 | 619.4% |
| | | | | 25 | 134.2 | 447.4% |
| | | | | 30 | 33.1 | 110.4% |
| | | | | 35 | 29.5 | 98.4% |
| | | | | 40 | 25.8 | 86.2% |
| | | | | 50 | 18.5 | 61.8% |
| Particles ($PM_{10}$) | 50 | 90th percentile of 24-hour means | 55.1 | 18 | 9.1 | 18.3% |
| | | | | 20 | 7.7 | 15.4% |
| | | | | 25 | 4.9 | 9.8% |
| | | | | 30 | 2.7 | 5.3% |
| | | | | 35 | 2.0 | 4.0% |
| | | | | 40 | 1.4 | 2.9% |
| | | | | 50 | 0.7 | 1.4% |

a: Predicted concentrations for nitrogen dioxide assume 70% conversion from NOx to $NO_2$

**Table 16: Impact of Process Emissions upon Short-Term Air Quality (63% load factor, 72MW capacity)**

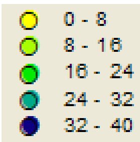
| Pollutant | Air Quality Criterion (µg/m$^3$) | Measured as | Estimated Background Concentration (µg/m$^3$) | Stack Height (m) | Predicted concentration from process (µg/m$^3$)[a] | Percentage of criterion due to process (%) |
|---|---|---|---|---|---|---|
| Nitrogen dioxide | 200 | 99.8$^{th}$ percentile of 1-hour means | 103 | 18 | 1007.2 | 503.6% |
| | | | | 20 | 906.0 | 453.0% |
| | | | | 25 | 672.1 | 336.0% |
| | | | | 30 | 413.2 | 206.6% |
| | | | | 35 | 294.8 | 147.4% |
| | | | | 40 | 191.2 | 95.6% |
| | | | | 50 | 100.4 | 50.2% |
| Sulphur dioxide | 350 | 99.7$^{th}$ percentile of 1-hour means | 79.5 | 18 | 61.8 | 17.7% |
| | | | | 20 | 55.7 | 15.9% |
| | | | | 25 | 41.5 | 11.8% |
| | | | | 30 | 22.4 | 6.4% |
| | | | | 35 | 15.2 | 4.4% |
| | | | | 40 | 11.7 | 3.3% |
| | | | | 50 | 6.0 | 1.7% |

a: Predicted concentrations for nitrogen dioxide assume 35% conversion from NOx to $NO_2$

# 6 Figures

6.1 Predicted annual mean NOx concentrations at each of the ecosystem receptors are presented in the following Figures, for stack heights of 30 m and above. A 36% load factor at 72MW capacity is assumed.

Legend: NOx Concentration (µg/m$^3$)



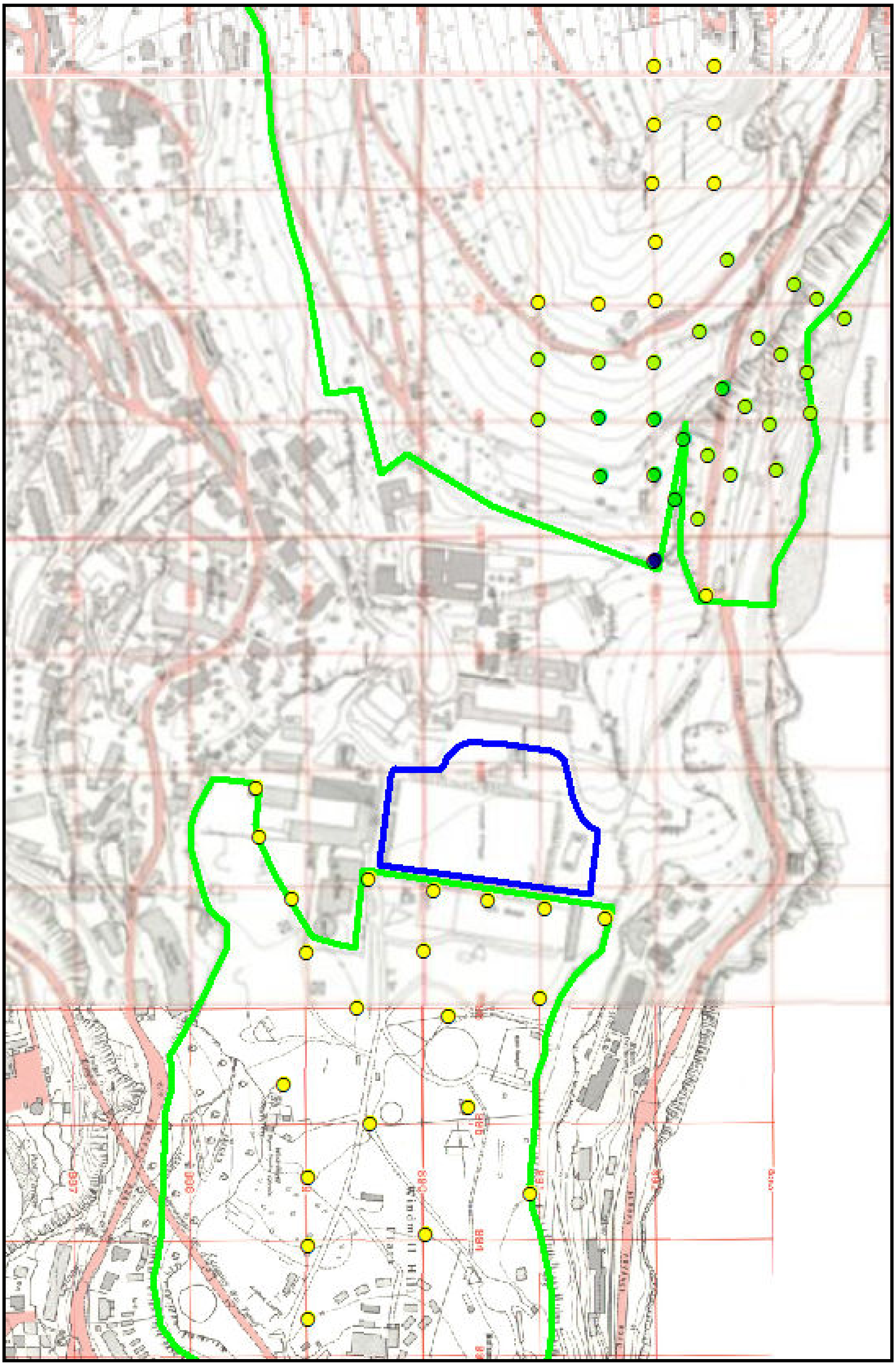


**Figure 3: Annual Mean NOx Concentrations at Ecosystem Receptors with a 30 m Stack Height (36% load factor, 72MW capacity).**

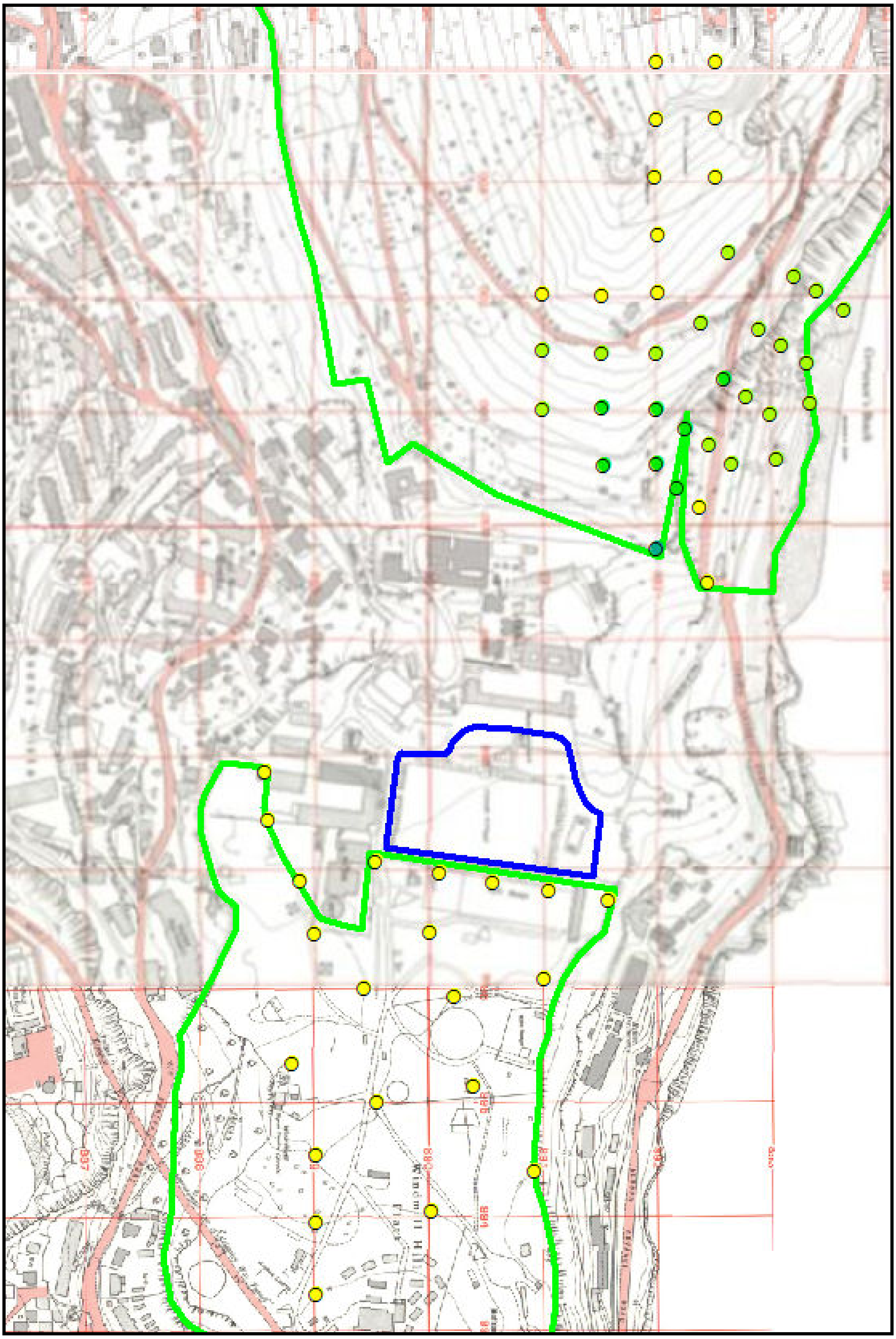


**Figure 4: Annual Mean NOx Concentrations at Ecosystem Receptors with a 35 m Stack Height (36% load factor, 72MW capacity).**

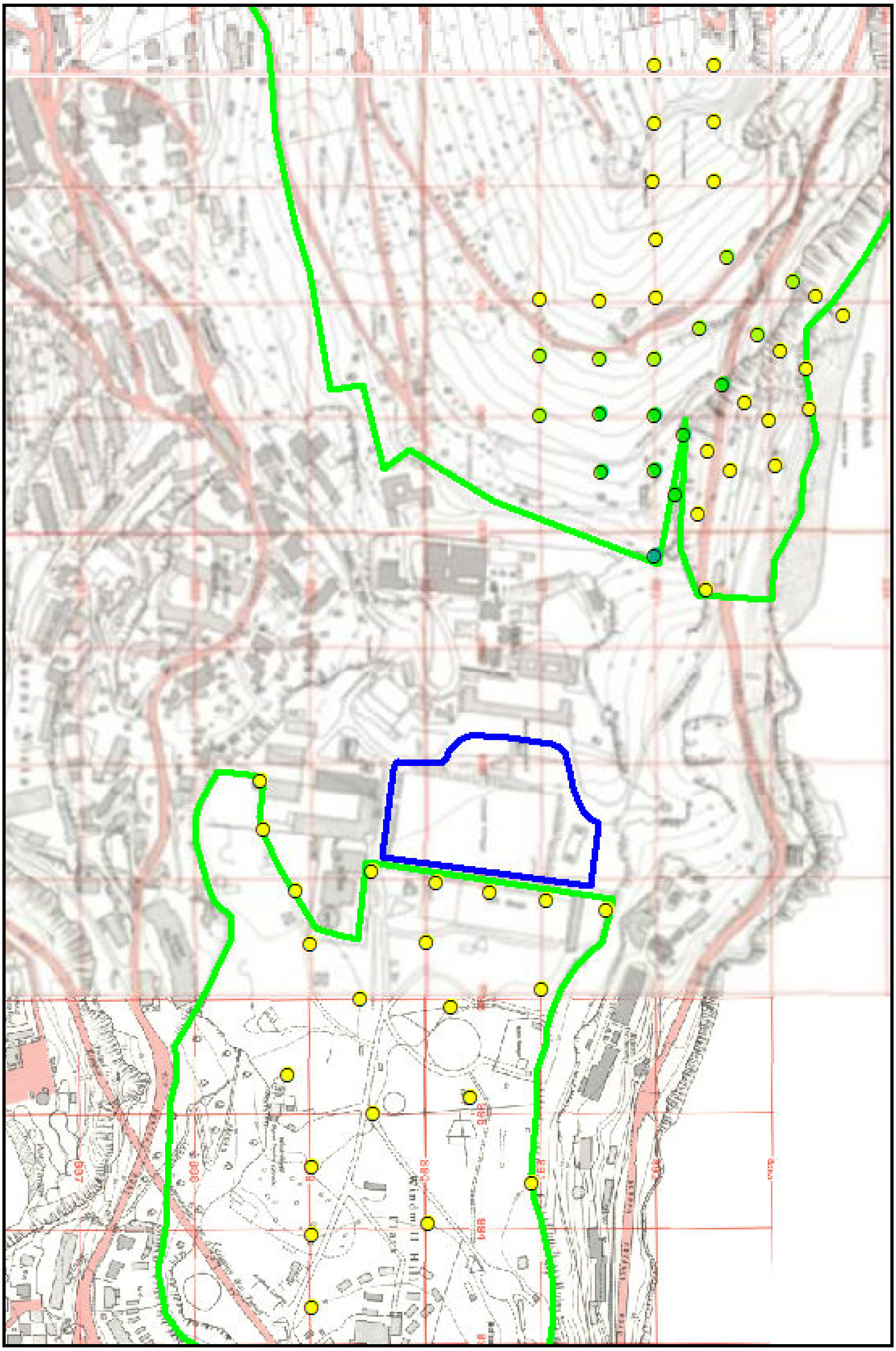


**Figure 5: Annual Mean NOx Concentrations at Ecosystem Receptors with a 40 m Stack Height (36% load factor, 72MW capacity).**

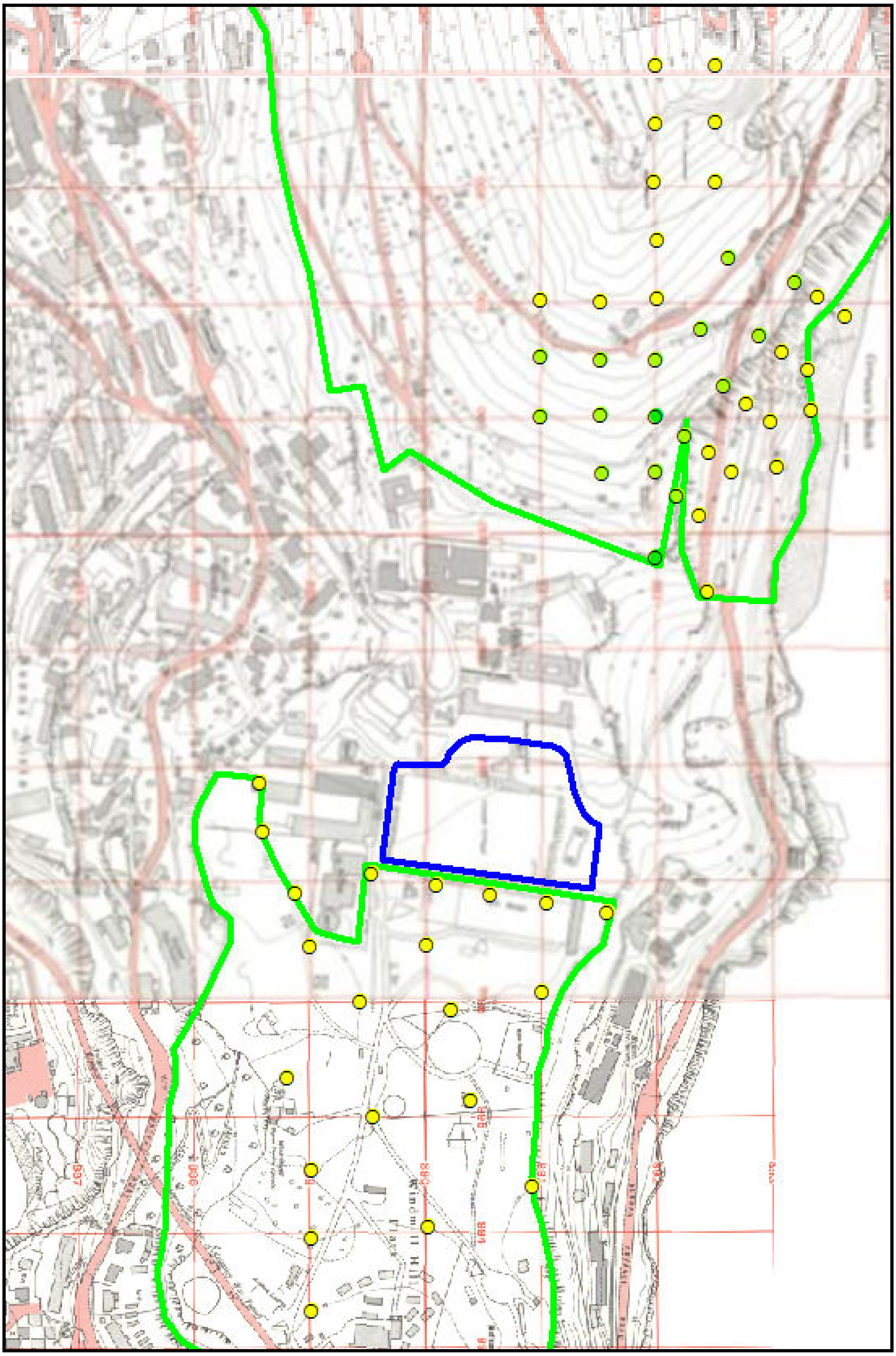


**Figure 6: Annual Mean NOx Concentrations at Ecosystem Receptors with a 50 m Stack Height (36% load factor, 72MW capacity).**

# CHAPTER TWO

# ARCHAEOLOGY AND CULTURAL HERITAGE

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| Archaeology | The study of past societies and individuals through their physical remains. |
| Built Heritage | The study of buildings and their surroundings in their wider cultural, historical and social context. |
| EIA | Environmental Impact Assessment |
| MoD | Ministry of Defence |

# 1 INTRODUCTION

1.1 This report assesses the archaeological and cultural heritage resource of the proposed diesel power station site, Lathbury Barracks, Gibraltar. It sets out the approach to the assessment, describes the archaeological and cultural heritage resource, identifies potential impacts, assesses the potential significant effects of the development proposals, identifies appropriate mitigation and assesses residual significant effects.

1.2 Consultation has been undertaken with the Heritage Division of the Government of Gibraltar and the Gibraltar Heritage Trust.

# 2 SCOPE AND METHODOLOGY

## Scope

2.1 The scope of the assessment has been informed by consultation in 2006 and 2008 with the Heritage Division of the Government of Gibraltar and the Heritage Trust. As a result, a full Environmental Impact Assessment (EIA) following appropriate guidelines, eg *Standard and Guidance for Desk-based Assessments'* issued by the Institute of Field Archaeologists[1] has been undertaken.

## Approach, Data Collection and Site Survey

2.2 Data on the known archaeological resource, including designated sites, within and in the immediate vicinity of the site has been accessed, together with historic cartographic records. Sources used to compile baseline information were as follows:

- Relevant planning information;
- Cartographic records held by the National Archives in London;
- Consultation of records held by the Heritage Division of the Government of Gibraltar and The Heritage Trust;
- A microgravity survey carried out in 2005[2];
- A geotechnical investigation carried out in 2008[3];
- The results of site walkovers undertaken on 2nd November 2005 and 2nd April 2008.

2.3 This has led to an understanding of the general archaeological and historical background of the site allowing an assessment of the impacts of the development proposals to be made.

## Assessment Methodology

2.4 The value and sensitivity of archaeological and built heritage receptors are categorised by their designation, uniqueness, extent, character, condition and associations with other features. There can be permanent effects on these receptors (eg destruction of an archaeological site) and temporary effects (eg increased visual impact on the setting of a listed building during construction). The importance of the site being potentially affected and the scale of the impact are key factors, as are the duration of impacts and the potential to mitigate against significant effects of impacts on receptors.

2.5 The approach taken to assess the significance of effect of the development proposals on receptors is shown in Table 2-1. The heritage receptors are defined as being of lesser, local and regional/national importance. Impacts on these receptors can be direct or indirect and of temporary or permanent duration and, taking this into account, the overall magnitude of impact is defined as minor or major. Impacts can sometimes be reduced through relevant mitigation. The effects of the impact are defined as low, medium or high and can be either adverse or beneficial. Adverse effects will have a negative effect on heritage receptors, whereas beneficial effects will have a positive effect.

**Table 2-1 Matrix Assessing Significance of Effect on Heritage Receptors**

| *Impact Magnitude* | *Lesser Importance* | *Local Importance* | *Regional/National Importance* |
|---|---|---|---|
| Minor | Low Effect | Low Effect | Medium or High Effect |
| Major | Low Effect | Low or Medium Effect | High Effect |

2.6 There is the risk that development may affect an unknown archaeological resource. Such a risk is inherent in archaeological assessments where information on archaeological features is often limited. Based on professional judgement the levels of risk are categorised as follows:

- Low (eg potential archaeological levels are likely to have been previously destroyed);
- Medium (eg potential archaeological levels may survive although in truncated form); and
- High (eg potential archaeological levels may survive relatively intact).

### Limitations of Study

2.7 This assessment is based upon examination of the sources listed in paragraph 2.2, the sources listed in the references section and also informal discussions with representatives from The Heritage Trust and the Heritage Division of the Government of Gibraltar. Every effort has been made to access readily-available information using these sources. However, no archaeological evaluation within the footprint of the proposed diesel power station has been carried out. There is therefore a risk of potential unknown heritage resources existing within the site. This risk has been accounted for in this report.

2.8 It is understood that at the time of writing a geophysical survey has been commissioned which may well give a clearer indication of the presence/absence of any significant underground voids which could be connected with the Genista Cave system. This chapter has been produced without knowledge of the results of this survey.

# 3 BASELINE EVALUATION

3.1 This section of the report describes the known archaeological and cultural heritage value of the site and surrounding area, and is structured as follows:

- Relevant planning legislation;
- Topography and geology; and
- Archaeological and historical background.

## Relevant Planning Legislation

3.2 Key legislation relating to heritage is the Gibraltar Heritage Trust Act 1989[4] which provides two Schedules of protection for listed buildings, structures, sites and land. Schedule 1 lists category A sites where any alteration requires authorisation from the Governor (after consulting The Heritage Trust), as long as it does not impair the integrity of the site. Schedule 2 lists category B sites where alterations require a permit from the Board of the Trust.

3.3 In addition archaeology and cultural heritage are protected under policy in the Gibraltar Development Plan Consultation Draft 2007[5]. The following policies are considered relevant to this assessment:

<u>Policy ENV21 – Archaeological Sites</u>

*There will be a general presumption against development that has a significant adverse affect on designated sites of archaeological importance. On other sites of archaeological importance permission will only be granted where the importance of the proposed development outweighs the value of the remains in question. In such circumstances adequate provision shall be required for the archaeological evaluation, investigation and recording of sites. This will normally be achieved through the use of planning conditions.*

<u>Policy Z7.9 – Parade Ground</u>

*A site is allocated for industrial use as shown on the Proposals Map. The design of any development on this site must take into account it's setting with* *particular regard to nearby historical structures and its proximity to the Upper Rock Nature Reserve.*

### Topography and Geology

3.4 Both topography and geology are important in assessing the potential of a site to contain archaeological remains. For example, both can dictate on the presence of cave shelters, suitable for prehistoric occupation.

3.5 The former Lathbury Barracks and parade ground straddle the boundary between the Main Ridge of Gibraltar and the Southern Plateau, although the parade ground appears to be south of that divide. This boundary is known as 'the Great Main Fault', which extends north-west from Hole-in-the-Wall towards the Dockyard South Gate. The Southern Plateau consists of two distinct geological and physiographic units namely Windmill Hill Flats (the northernmost plateau) which is separated from Europa Flats (the southernmost plateau) by an abrupt slope. Cliffs and steep rock slopes bound the site to the east, with more gently inclined slopes to the west[6].

3.6 The major slopes that fringe Gibraltar consist largely of breccias (deposits composed of cemented angular rock fragments) which have formed from an accumulation of Gibraltar Limestone debris falling from the cliffs above. Raised beach sands and gravels have been identified around the Rock, predominantly on the southern and eastern sides. Indeed, scree breccias and raised beach sands and gravels are present on the slope to the east of the parade ground, across which Hole-in-the-Wall Road descends towards the coast[4].

3.7 A geotechnical investigation comprising 11 boreholes and 8 trial pits was carried out in 2008[3]. This in general showed that the natural limestone (or sometimes an overlying clay or sand) was generally encountered at depths of between 0.4 m and 1.5 m below present ground level, although two others east of the parade ground encountered natural limestone at depths of 3.8 m and 5.5 m.

### *Designated Sites within the Immediate Vicinity of the Site*

3.8 The following structures are registered on the Gibraltar Heritage Trust Ordinance 1989 as Grade A listed buildings (Table 2-2).

**Table 2-2 Listed Buildings Immediately Adjacent to the Boundary of the Site**

| *Grade* | *Description* |
|---|---|
| A | Devil's Bellows. Gateway from Windmill Hill Road |
| A | Hole in the Wall Gate. South end of Hole in the Wall Road leading from Windmill Hill to Europa Advance Road |
| A | Genista Cave Stone. This site is marked by a stone tablet outside the eastern entrance to QM Block at Lathbury Barracks |
| A | Two Russian Crimean Cannons presented to Gibraltar. Formerly situated by the Retrenchment Block but now removed |
| A | Hole In The Wall Battery |

## Archaeological and Historical Background

3.9 Designated and non-designated sites of heritage interest lie in close vicinity to the site. These receptors are discussed below as they inform on whether the site has the potential to contain unknown archaeological remains. These sites are considered below in chronological sequence, together with a documentary background to the site.

### *Prehistoric*

3.10 There is clear evidence of early man being present in Gibraltar from the Palaeolithic era. In addition Neanderthal occupation, dating to 31,000 years ago, has been identified at Gorham's Cave to the north of the site, making it one of the last sites in the world where these hominids survived. Indeed, at least five Neanderthal cave sites have been identified in Gibraltar along with several Neolithic (c. 5000 BC) and Bronze Age (approx 1800 to 1650 BC) sites. A 3rd century BC Carthaginian shrine has also been identified at Gorham's Cave[7].

3.11 The above sites are all of heritage importance but are unaffected by the proposed development. However, the Genista Cave complex, which contains five known caves or fissures, lies in close proximity to the site. Indeed the earliest scientific cave exploration on Gibraltar began with the Genista Caves. These caves were all accessible from Windmill Hill, and yielded rich deposits of fossil bones, including those of bear, hyena, leopard, wild cat, rhinocerous, ibex, hare and rabbit[8]. In 1862 Captain Frederick Brome, the Governor of the Military Prison, discovered a very deep cave which yielded many human and animal remains. The top cavern was blasted out for an ammunition store in 1895, during which operation the entrance to the rest of the cave is believed to have been lost. However, the general location of this cave is marked on the site of the Genista Cave Magazine on a map of 1902 (Figure AC3-1, Volume 3: Figures) and is commemorated by a Grade A listed plaque outside the entrance to the MoD Buffadero Training Ground directly west of the parade ground (Figure AC3-2, Volume 3: Figures).

*Moorish - Spanish*

3.12 There is no evidence that the Romans settled in Gibraltar, although they may have used its strategic location as an observation and trading post. Following the Romans, Vandals and Visigoths occupied Iberia from 414 to 711 AD. In 711 the Moors occupied all the principal points in the Bay and the Rock then became know as Jebal Tarik (Mountain of Tarik) from which the name Gibraltar derives. Gibraltar remained generally under Moorish control until 1303. Within this period the Muslims built fortifications in Gibraltar as well as the first town. After a brief Spanish occupation the Moors recaptured Gibraltar in 1333. However, in 1462 the Spanish eventually captured Gibraltar and Queen Isabella of Spain made Gibraltar Spanish crown property in 1501. At this time the town still only occupied the area north-west of the Rock and the rest was called La Turba Alhambra (Red Sands). However, no known archaeological sites of these dates are located within or close to the site, although Moorish Walls are shown on a map of 1757 to the north of the site (Figure AC3-3, Volume 3: Figures).

*British Rule (AD1704 – Present)*

3.13 In 1704 an Anglo-Dutch fleet conquered Gibraltar and in the following year Gibraltar was declared a 'free port' and Queen Anne appointed the first British Governor in 1707. Windmill Hill is shown on a map of 1712 as an unoccupied plateau apart from two windmills. In 1713 the Spanish signed the Treaty of Utrecht handing Gibraltar over to the British in perpetuity. The windmills are marked again on a map of 1757 as two circular structures close to a rectangular building. A D-shaped feature called Casaron del Tarrfe lies to the south of the mills (Figure AC3-3, Volume 3: Figures). However, there is no sign of any other settlement within land now occupied by the site. During the Great Siege of 1779-1783 many officers were quartered in canvas tents along what today is the parade ground (consultation response from Gibraltar Heritage Trust). In 1784 war with Spain ended after the signing of the Treaty of Versailles and in 1830 Gibraltar was declared a Colony of the British Crown.

3.14 A map of 1837 shows that the Windmill Hill Barracks had been constructed to the north of the site. Hole in the Wall is also shown, as are several tracks on the plateau (Figure AC3-4, Volume 3: Figures). Hole in the Wall Gate is likely to have been built around 1799 as a stone bearing this date has been observed near the pathway leading to Hole in The Wall Battery[9]. This map also shows a rectangular building and a reverse L-shaped building, and these may be associated with the windmills. In this regard, large limestone blocks were observed in trial pit 8 in the geotechnical investigation[3]. One of these blocks had a side which appeared to be slightly curved with cement render and paint on one side. It is possible, though not proven, that these blocks form part of the remains of one of the windmills.

## Specific Archaeological and Cultural Heritage Interests

3.15 The following interests in the immediate vicinity of the proposed diesel power station are of archaeological or cultural heritage importance. They have either been listed in the Gibraltar Heritage Trust Ordnance 1989 or highlighted during consultation.

*Devil's Bellows (Grade A listed)*

3.16 Windmill Hill Road passes through a short tunnel through the Retrenchment Block curtain wall known as 'Devil's Bellows'. This Grade A listed tunnel is some 16 m long and square in cross section, measuring 3.95 m (13 feet) wide by 3.95 m (13 feet) high. It is concrete lined throughout (Figure AC3-5, Volume 3: Figures). An inscription on the north-western side of Devil's Bellows reads *"AD1842. The roads were made and the surface levelled of this heretofore rugged hill by the voluntary labor (sic) of Her Majesty's VIIth Royal Fusiliers".*

*Hole in the Wall Gate (Grade A listed)*

3.17 From the east the Hole-in-the-Wall Road ascends to reach the site via a gap in the Retrenchment Block curtain wall. The road is around 170 m long and its overall gradient is some 1:4. The paved width is generally around 3.4 m (which corresponds to a likely construction width of 11 feet in imperial units), with a wider section of 5 m, approximately half-way along its length. The Grade A listed gap in the fortification wall is 3.4 m wide, although the narrowest point along this route is some 7 m uphill of the gate, where it reduces to around 3.1 m (Figure AC3-6, Volume 3: Figures).

*Hole in the Wall Battery (Grade A listed)*

3.18 To the east of the Retrenchment Block lies the Grade A listed Hole in the Wall Battery which was known as Emplacement R in a 19$^{th}$ century chain of gun batteries on the perimeter of Windmill Hill. It was not armed in 1863 but had a single 80-pound gun in 1885. It had been disarmed by 1956[10].

*World War II Tunnels*

3.19 In 1939 the civilian population was evacuated and Gibraltar was fortified from potential enemy attack. This included the construction of an airstrip and the building of barracks, supply depots and further excavation of miles of tunnels. Two tunnels or tunnel complexes are believed to underlie the Lathbury Barracks site, namely Poor Relation and Harley Street[6].

3.20 Poor Relation is an adit constructed in 1940, leading from Windmill Hill northwards to G.O.R tunnel and Ottawa tunnel. A rock fall where the Great Main Fault was encountered blocked the tunnel in 1957. The adit entrance is some 30 m south-south-east of the former Officers' Quarters of the Retrenchment Block although no surface feature that might confirm its position has been observed. Retrenchment Shelter, built in 1941, is reported by Rosembaum and Rose[11] to adjoin the Poor Relation tunnel and is reportedly partially collapsed.

3.21 Harley Street tunnel was constructed in 1941-2 and the original chambers were enlarged in 1956 (Figure AC3-7, Volume 3: Figures). The tunnel and associated chambers beneath the site are estimated to be approximately 50 m below the existing parade ground. The tunnel provided emergency access between the west and east sides of Gibraltar and also serves as a route for saltwater pipes, which are located in ducts in the tunnel floor. The western portal is located off Europa Road and the eastern portal is adjacent to the rear of the municipal waste incinerator on Europa Advance Road. The tunnel is some 410 m long and consists of three sections. Of the chambers leading off the main drive, Chamber 7 contains a saltwater storage tank and Chamber 8 contains a spiral staircase which gives access to Lathbury Barracks via a shaft. On the basis of its location and a surface chamber cover, its egress point is believed to be adjacent to the parade ground[6].

3.22 Other than Poor Relation and the Harley Street Tunnel and adjoining complexes and chambers, there are no known man-made tunnels beneath the parade ground and former Officers' Quarters of the Lathbury Barracks site. A complex named 'Marble Arch' was constructed in 1941 beneath Windmill Hill Road, downslope of Devil's Bellows, and extended beneath parts of the former barracks buildings but lies outside of the site. In addition, a concrete structure marking the entrance to the Parminter Place tunnel is located adjacent to the upslope side of Hole in the Wall Road, approximately 40 m from the junction with Europa Advance Road[6]. Gort's Hospital was also located west of the parade ground.

3.23 A map believed to have been annotated in the 1940's shows three octagonal structures, possibly anti-aircraft gun emplacements (Figure AC3-8, Volume 3: Figures). In this regard part of what was believed to have been an octagonal red brick structure was encountered in trial pit 5 of the geo-technical investigation which was 1.8m deep[3] and this may well form part of the remains of one of these emplacements. Further buildings are marked between these emplacements and the Military Laundry Drying Ground although their function and these may be associated with the concrete found in trial pit 2 of the geotechnical investigation[3].

3.24 The date of construction of the current parade ground and landscaping in front of the Officers' Quarters clearly post-dates World War II. It is understood that Lathbury Barracks was closed in the mid to late 1990's and many associated buildings were replaced by the Lathbury Barracks Industrial Park. The Retrenchment Block and curtain wall still survive in an excellent state of preservation. The Retrenchment Block was at the time of a site visit in April 2008, being refurbished. The parade ground is now partly used for vehicle storage.

*Retrenchment Block*

3.25 Consultation with the Heritage Division of the Government of Gibraltar in 2005 confirmed that in heritage terms the Retrenchment Block is an important site. Apart from its heritage value as a unique Victorian fortification on Gibraltar, it also adds a certain charm to the approaches to Windmill Hill with its loopholed walls for muskets.

3.26 The Retrenchment Block was proposed by Sir John Jones in 1841 as a defensive measure to counter any hostile force approaching Gibraltar from Europa Point to the south. Jones also considered providing a citadel as a central rallying point but this proved to be too expensive. The complex consists of two demi-bastions with a barrack block behind the curtain wall that joins them. There is also a continuation of the right demi-bastion and almost the whole length of the top of the wall is loopholed. It is built of local limestone, two stories high with a basement in parts with a bold plain external elevation. Internally there are equally plain bold pilasters that divide a twostorey bay with one window with an arched top on the ground floor and plain windows on the first floor[10].

3.27 A plan of 1846 shows the Retrenchment Block as proposed. An Officer's Quarters are shown to the south of the Block as a set of rectangular, circular and one six-sided building. These latter buildings could be the remains of former windmills (Figure AC3-9, Volume 3: Figures).

3.28 A further plan of c. 1861 shows the main block divided into Officers Quarters of individual rooms of equal size flanked by a Servants Quarters to the west, a Mess Room to the east and Stables to the rear (Figure AC3-10, Volume 3: Figures). A Ball Court is shown fronting part of the Retrenchment Block. To the west the curtain wall is shown with a Magazine to the rear. To the east the curtain wall continues to the cliff edge. By the Ordnance Survey map of 1902 a Military Laundry had been built in front of the western curtain wall with the Military Prison to the south. Much of the ground in front of the Officers Quarters was used as a Drying Ground by the Laundry.

### Microgravity Survey

3.29 A microgravity survey was carried out at the barracks site in September 2005[2]. This survey used techniques to scan the ground beneath the proposed power station site in order to detect any gravitational anomalies that might indicate unrecorded voids. It was capable of detecting voids of greater diameter than 3 m to a depth of below 10 m. No anomalies were detected that would indicate significant underground voids.

### Summary of Baseline Information

3.30 The baseline study has established that the site is historically significant because of its association with the following sensitive heritage receptors:

- The potential foundations of former windmills;
- Potential buried archaeological remains associated with the Genista Caves;

- Three Grade A listed buildings (Hole in the Wall Battery, Hole in the Wall Gate and Devil's Bellows);
- Tunnels and anti-aircraft gun emplacements constructed in World War II; and
- The Retrenchment Block.

# 4 POTENTIAL IMPACTS

4.1 The proposed development may have potential impacts on built heritage and archaeological receptors. These potential impacts have been classified as minor or major, can be temporary or permanent and occur either during the construction or operational phases or both. Such impacts can sometimes be reduced through relevant mitigation.

*Retrenchment Block*

4.2 Construction will not have any impact on the fabric of the Retrenchment Block which lies to the north of the site.

*Genista Caves*

4.3 A borehole investigation and microgravity survey has not detected any underground voids which may be associated with the Genista Cave Complex. It is therefore unlikely that construction will have an impact on the cave system. However, it is understood that at the time of writing a geophysical survey has been commissioned which may well give a clearer indication of any associated significant underground voids within the site.

*Listed Buildings*

4.4 There will be no physical impact upon the fabric of the Grade A listed Hole in the Wall Gate and Devil's Bellows caused by construction and operational traffic entering and leaving the site (unless through accidental damage). No physical impact is anticipated on Hole In The Wall Battery as it lies outside of the site.

*World War II Tunnels*

4.5 The World War II tunnels are believed to be too deeply buried for there to be any impact caused through construction, although there is a potential impact on a shaft leading down to Harley Street Tunnel. The precise location of this shaft is however not known and there will be no impact on the overall tunnel complex.

*Buried Archaeological Remains*

4.6 There may be a permanent impact on buried archaeological remains eg the buried foundations of $18^{th}$ century (or earlier) windmills and World War II anti aircraft emplacements, as potentially identified in the geotechnical trial pits. The full extent of this impact (minor or major) cannot at this stage be stated with certainty as no archaeological investigation has taken place which would clarify their location and state of survival. However, any surviving remains are liable to damage or destruction through construction. It is unlikely that any archaeological remains associated with the Great Siege encampment will have survived, although this cannot be stated with certainty.

4.7 Based on the findings of the geotechnical investigation there is therefore a high risk of buried archaeological remains in the form of the foundations of windmills and military anti-aircraft emplacements or structures being impacted upon during construction. However, based on current knowledge there is only a low risk of other buried archaeology being encountered.

# 5 ASSESSMENT OF SIGNIFICANT EFFECTS

5.1 This section assesses the significant effects of the development proposals on the archaeological and cultural heritage resource.

5.2 No physical impacts and therefore no significant effects are anticipated on the Retrenchment Block, Genista Cave Complex, listed buildings (excepting accidental damage through narrow access points) or the World War II tunnels.

5.3 However, there are potential significant effects caused through construction on buried archaeology in the form of the foundations of the former windmills and World War II anti-aircraft emplacements. The latter are considered to be of lesser importance in the overall context of World War II archaeology in Gibraltar. However any well preserved archaeology associated with the windmills, the presence of which gave rise to the name Windmill Flats, is considered to be of local importance.

5.4 On the basis of current evidence and considering the scope of the development proposals, there is a high risk of exposing potential archaeological sites of lesser and local importance within the area of the proposed power station. Given the lesser and local importance of this archaeology and the potential minor or major impact the overall significant effect on the archaeological resource is considered to be of potential **low adverse significance**.

# 6 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

*Mitigation*

6.1 In order to mitigate against the potential significant effects the following mitigation is proposed.

6.2 During construction an archaeological watching brief will be undertaken in order to record any remains associated with the windmills, anti-aircraft emplacements or any other archaeology that is exposed. This will ensure that any exposed archaeology is recorded prior to its destruction. Should any deposits of regional or greater importance be encountered, consultation will take place with the Heritage Division of the Government of Gibraltar in order for appropriate steps ensuring full recording or, if feasible, preservation *in situ* to be formulated.

*Residual Significant Effects*

6.3 With the implementation of these mitigation measures **no residual significant effects** are anticipated upon the potential archaeological resource and known built heritage interest of the area.

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# CHAPTER THREE

# ECOLOGY

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| BAP | Biodiversity Action Plan |
| CEH | Centre for Ecology and Hydrology |
| CEMP | Construction Environmental Management Plan |
| DoE | Department of the Environment |
| EIA | Environmental Impact Assessment |
| ES | Environmental Statement |
| EU | European Union |
| Gibraltar Nature Conservancy Council (GNCC) | Statutory body with responsibility for nature conservation in Gibraltar. Advises the Government of Gibraltar on nature conservation issues. |
| Gibraltar Nature Protection Ordinance | Legislation passed by the Government of Gibraltar and dealing with wildlife protection and nature conservation. |
| Gibraltar Ornithological and Nature History Society (GONHS) | Non-governmental organisation concerned with nature conservation in Gibraltar. Also acts as a statutory consultee to the Government of Gibraltar. |
| IEEM | Institute of Ecology and Environmental Management |
| IUCN | International Union for Conservation of Nature |
| JNCC | The Joint Nature Conservation Committee |
| MoD | Ministry of Defence |
| N | Nitrogen |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Nitrogen oxides |
| Pers comm. | Personal communication |

| | |
|---|---|
| SCI | Site of Community Importance. An area designated under the EU Habitats Directive for inclusion in the Natura 2000 network of sites receiving highest protection in recognition of their ecological value according to EU conservation priorities/objectives. |

# 1 INTRODUCTION

1.1 This chapter sets out the results of an ecological assessment of the proposed new diesel power station.

1.2 The assessment evaluates the potential impacts of the proposals on the habitats and the protected species within the proposed site and surrounding area.

1.3 This report describes the scope and methodology of the study, the significant wildlife on the site and its surroundings, the potential impacts and significant effects on wildlife from the proposals, proposed mitigation measures, and any residual significant effects following implementation of the mitigation measures.

1.4 The Gibraltar Nature Conservancy Council (GNCC), the Department for the Environment, and the Ministry of Defence (MoD) have been consulted as part of this assessment. Information has also been sought from other sources, and in particular the Gibraltar Ornithological and Natural History Society (GONHS).

# 2 SCOPE AND METHODOLOGY

## Scope

2.1 The scope of this assessment has been informed through consultation with relevant authorities and organisations in Gibraltar and the UK and through an understanding of existing ecological conditions at the proposed site and surrounding area.

2.2 During this consultation process, discussions were held with:

- Mr A Bruzon, Dr L Mesilio-Torres and Mr S Warr, Department for the Environment;
- Dr J Cortes, as a representative of the Gibraltar Nature Conservancy Council (GNCC);
- Dr D Fa, as a representative of the Heritage Division of the Government of Gibraltar; and
- Dr K Bensusan, as a representative of the Gibraltar Ornithological and Natural History Society (GONHS).

2.3 Ecological features of the site and the surrounding land that are potentially sensitive to the impacts of the scheme were identified through an ecological survey of the proposed site and surrounding area, a review of existing ecological data, and through consultation with relevant individuals and organisations within Gibraltar.

2.4 Given the potential for off-site impacts from the dispersal of air pollutants, the area of study considered in this report includes those features of ecological interest falling within the area considered in the Air Quality Chapter (Volume 2: Technical Reports). Some additional land of ecological importance around the periphery of the air quality study area was also included as a contingency. This geographical scope was confirmed with relevant authorities as at paragraph 2.2.

## Field Survey

2.5 Several field surveys were conducted in March, April and May 2008. They involved site familiarisation and examination of habitats and ecological features within the site and the surrounding area.

2.6 An initial habitat survey involved recording target notes for selected features and habitats (similar to the approach used for Phase 1 Habitat surveys

(NCC[1])). The extent of the area under consideration, difficulties of access to parts of the area (cliffs etc) and the limited time available in which to undertake the work precluded comprehensive mapping of the whole of the geographical area. Instead, an aerial photograph has been used to show the main features of the survey area. Particular protected species considered during the survey included mammals, birds, reptiles, invertebrates and plants. The potential or actual presence of any other species which may be of interest was also recorded. Photographs of the area, and any notable species, were used to assist the interpretation of the survey records.

*Desk Study and Consultation*

2.7 A desk study of existing ecological data for the site and surrounding area was conducted during 2008.

2.8 Existing ecological data was obtained from the following organisations:

- Department for the Environment (DoE);
- GNCC; and
- GOHNS.

2.9 A literature and internet search was conducted and information gathered on statutory conservation designations, the distributions and status of protected or notable species and habitats, and the potential effects of other diesel power stations on such species and habitats.

### Assessment Methodology

2.10 Within this ecological assessment the term impact is used to denote the physical attribute or change caused by the proposals. Such impacts will act upon ecological features either directly or indirectly. The impact acting upon the receptor creates an effect, and the significance of the effect is dependent upon a number of factors, but principally the magnitude of the impact and the sensitivity of the receptor.

2.11 The magnitude of an impact is often quantifiable in terms of, for example, extent of habitat loss or predicted change in feeding opportunities.

2.12 There are a variety of methodologies for determining and describing the significance of potential ecological effects of proposed activities on wildlife.

The following assessment has regard to the guidelines from the Institute of Ecology and Environmental Management (IEEM)[2].

2.13 In this assessment, the importance of identified wildlife features (receptors) within the assessment area has been determined based on the spatial level of importance (local, national, international). Where possible the determination of the level of importance has considered information on the habitat or species and ecological principles, or otherwise it has been based upon the professional experience and knowledge of the assessor in line with guidance from the organisations consulted.

2.14 A significant effect may be broadly defined as one which should be brought to the attention of those involved in the decision-making process.

2.15 Significant adverse effects occur where ecological features are subject to impacts of considerable magnitude and/or duration. Some effects will be temporary, others are permanent in nature and these are stated within the assessment.

2.16 The level of importance of the wildlife features will determine the potential significance of an impact on them. As well as the quality and sensitivity of the area or the rarity and sensitivity of the species affected being important, the scale of the impact on the habitat or species is relevant. Effects are unlikely to be significant where low value or non-sensitive ecological receptors are subject to minor or short-term impacts. Where an effect is considered to be significant, its magnitude will generally be classified as high, medium and low, with these descriptions being based on precedence or current guidance.

2.17 Table 2-1 provides a description of the terms used to define the level of significance used for this assessment.

**Table 2-1 Description of the Terms used in the Determination of Significance of Effect**

| *Term* | *Description* | *Significance* |
|---|---|---|
| Very Low | The predicted impact will be highly localised. | Not significant |
| Low | The predicted impact has significance at local level only. | Significant |
| Medium | The predicted impact has significance at a national scale. | Significant |
| High | The predicted impact has significance at an international scale. | Significant |

2.18 To determine the level of significance of an impact upon a receptor, the matrix in Table 2-2 has been used. In determining the final predicted level of significance of an effect other factors are taken into consideration. Where possible these are objective and quantifiable factors such as the time period over which the effect will occur and the reversibility of the effect. The assessment is based on existing knowledge of similar developments, knowledge of species being assessed and their ecological requirements, and an understanding of ecological systems and their interactive nature. Where any limitations in information available to ecologists affect this assessment, they have been highlighted.

**Table 2-2 Basic Matrix used to Determine the Level of Significance of Effect in this Assessment**

| *Impact* | *Quality or Rarity of Ecological Feature* | | | |
|---|---|---|---|---|
| | *International* | *National* | *Local* | *Very Low* |
| High | High | Medium | Low | Low |
| Medium | High | Medium | Low | Very Low |
| Low | Medium | Low | Very Low | Very Low |
| Negligible | Low | Very Low | Very Low | Very Low |

## Constraints and Limitations

2.19 A limited amount of time has been available in which to undertake the ecological assessment. This has, in turn, imposed limits on the amount of fieldwork and background research that it has been possible to undertake and the amount of existing baseline data that it has been possible to obtain.

Subsequently, the DoE has raised additional issues to those previously agreed just prior to submission of this ES. Every attempt has been made to appropriately assess all potentially significant ecological issues. The late inclusion of these additional issues is not considered to materially affect the outcome of the ecology assessment, especially with respect to internationally and nationally significant habitats and species.

2.20 The limited time available for original work has put greater emphasis on using existing data to best effect. But there are significant gaps in the existing data regarding several important issues that require consideration. These gaps include background nitrogen deposition rates, critical nitrogen loads for the most important vegetation types in the vicinity of the proposed diesel power station and the detailed distribution of those vegetation types, the distribution and population dynamics of some of the species that require consideration as part of the assessment, and disturbance effects on fauna. Over 100 bird species are listed on the Natura 2000 data form for Gibraltar, but detailed knowledge about their use of the area appears scant. It was therefore not possible to treat the species individually within an impact assessment matrix, as requested latterly by the DoE. However, it is considered that the qualitative assessment that has been conducted which is based on species that exemplify different characteristics meets the relevant level of assessment criteria required by institutions such as IEEM.

2.21 Safe access was not available to enter caves or a disused MoD structure (the pipe rifle range) that have the potential to be occupied by roosting bats.

2.22 Uncertainty also arises as a result of the conceptual nature of the proposals. Some elements of the project have not yet been worked up in detail.

2.23 Additionally, there is a lack of published research and information regarding nitrogen (N) impacts on Mediterranean vegetation which represents an important gap in scientific knowledge and therefore potential atmospheric deposition effects of N on Gibraltar vegetation.

2.24 The assessment has therefore considered these limitations and has proceeded on a precautionary basis, particularly given that the sensitive nature of the surrounding area as a SCI.

# 3 RELEVANT LEGISLATION

3.1 The two principal European Union Council Directives relating to nature conservation are the Habitats Directive (1992)[3] and the Birds Directive (1979)[4]. Both of these Directives are transposed into National legislation through the Nature Protection Ordinance (1991)[5] (as amended). In addition, the Ordinance provides protection to other species not specifically protected under European legislation. Part IIA of the Ordinance implements the Habitats Directive and extends the level of legal protection for European protected species occurring in Gibraltar. Schedule 5 (reproduction of Annex IV(a) of the Habitats Directive) and Schedule 7 (reproduction of Annex IV(b) of the Habitats Directive) list European protected fauna and flora respectively.

3.2 Schedule 1 of the Nature Protection Ordinance lists those species of wild animals for which legal protection is provided, making it an offence to intentionally kill, injure or take any of the listed species. Schedule 3 of the Ordinance lists endangered species for which no licence shall be issued (under section 13 of the Ordinance) which may result in the extinction of that species in Gibraltar. Schedule 2 lists all plants that are not protected and therefore plants that are not on this list are protected.

3.3 The Habitats Directive makes provision for the designation of wildlife conservation areas as SCIs

3.4 A Biodiversity Action Plan[6] (BAP) has been produced for Gibraltar and this describes the key habitats and species that require local protection or action. It also provides action plans for specific flora and fauna. The BAP has been produced by GONHS and is not a formally recognised document for policy. It has however been used for general guidance in this assessment, particularly in relation to current information on species and habitats.

3.5 The Government is responsible for reporting on the status and conservation objectives for SCIs and such information has been provided for this assessment by the Department for the Environment.

# 4 EVALUATION OF EXISTING CONDITIONS

4.1 The indicative locations of ecological features referred to in the following text are provided in Figure E4-1 (Volume 3: Figures) and referred to in square brackets below.

### General Description

4.2 The site of the proposed power station is situated towards the southern end of Gibraltar, between Windmill Hill Flats and the Upper Rock. Much of it occupies the Parade Ground which is an area of hard standing, although the eastern end is vegetated and there is vegetation around the hardstanding. The Parade Ground is at an altitude of approximately 120 m and occupies an area between the two components of the Rock of Gibraltar SCI.

4.3 Initial consultation with relevant authorities and desk study indicated that the following potentially sensitive receptors should be considered as part of the assessment:

*Rock of Gibraltar SCI*

- Vegetated sea cliffs with endemic Limonium species;
- Dunes with Euphorbia terracina;
- Malcolmietalia dune grasslands;
- Mattoral with Laurus nobilis;
- Thermo-Mediterranean pre-steppe brush, with low formations of Euphorbia close to cliffs;
- Calcareous rocky slopes with chasmophytic vegetation;
- Caves not open to the public; and
- Olea with Ceratonia forests.
- Southern Waters SCI
- Reefs (in relation to accidental spills); and
- Sea caves (in relation to accidental spills).

*Species/Species Groups*

- Bats;
- Other mammals;
- Birds (resident, wintering & migrating);

- Reptiles; and
- Invertebrates including Gibraltar funnel-web spider *Macrothele calpeiana* .

### Vegetation and Habitats

*Rock of Gibraltar SCI*

4.4 The Rock of Gibraltar SCI supports a varied range of habitats. A map showing the habitat types present within the Upper Rock Nature Reserve is shown on page 52 of the BAP[6]. The habitat types shown on that plan are 1) Mediterranean woodland with some exotics, 2) open semi-exotic woodland, 3) pseudosteppe, 4) pseudosteppe/garigue, 5) pseudosteppe/high maquis, 6) low maquis, 7) high maquis, 8) low/high maquis, 9) maquio-garigue, 10) garigue and 11) cliff. A number of noteworthy plants occur within the SCI, including Gibraltar sea lavender *Limonium emarginatum*, Gibraltar campion *Silene tomentosa*, Gibraltar saxifrage *Saxifraga globulifera*, Gibraltar thyme *Thymus wildenowii*, Gibraltar candytuft *Iberis gibraltarica* and Gibraltar chickweed *Cerastium gibraltaricum*.

4.5 The vegetation on the Rock in closest proximity to the Parade Ground is very varied and is described in Perez & Bensusan[7]. Although it was only possible to investigate a small sample, the vegetation ranged from maquis with a shade-tolerant field layer to open limestone clutter with scattered herbaceous plants.

4.6 The vegetation at [1] (Figure E4-1) includes tussocks of the grass *Stipa tenacissima* amongst which are growing scattered plants of various species including clumps of *Carthamus arborescens* and *Euphorbia squamigera*. Some small stony areas support *Anagallis arvensis*, *Asparagus albus*, *Asphodelus albus*, *Calendula suffruticosa*, *Echium creticum*, *Galactites tomentosus, Geranium purpureum, Lobularia maritima*, *Mercurialis annua*, *Oxalis pes-caprae* and *Scilla peruviana*. Slightly lower down the slope is a stand of *Opuntia ficus-indica* with scattered individuals of *Chamerops humilis*. This then grades into *Olea europaea*-dominated scrub downslope and to the west.

4.7 At [2] the vegetation comprises mixed vegetation of *Chamerops* humilis, *Genista linifolia*, *Olea europaea*, *Phlomis purpurea*, *Pistacia lentiscus*, *Prasium majus*, *Ruscus hypophyllum*, and *Vinca difformis*. Much scree is present and the vegetation of the more open parts includes *Allium ampeloprasum*, *Aristolochea baetica*, *Carthamus arborescens*, *Convolvulus althaeoides*, *Ecballium elaterium*, *Echium creticum*, *Euphorbia squamigera,* *Ferula tingitana*, *Iberis gibraltarica*, *Lobularia maritima*, *Phagnalon saxatile*, *Psoralea bituminosa*, *Sonchus tenerrimus*, *Succowia balearica*, *Teucrium lusitanicum* and *Umbilicus rupestris* (growing in crevices in the scree). To the south the vegetation grades into a grass-dominated community like that at [1] and lower down to the east the scrub becomes quite dense.

4.8 The scrub becomes denser at [3], with *Asparagus albus*, *Chamerops humilis*, *Olea europaea*, *Prasium majus*, *Ruscus hypophyllum*, *Smilax aspera*, *Tamus communis*, *Vinca difformis* and, closer to the path in a better-illuminated part, *Gladiolus communis* and *Lathyrus clymenum*. Above the path and a little to the west the vegetation opens up into garrigue and patchy maquis. Below the path the maquis becomes quite dense and becomes better developed still at [4], towards the Jewish Cemetery.

4.9 The vegetation at [5] comprises scattered maquis with *Chamerops humilis*, *Genista linifolia*, *Olea europaea* and *Pistacia lentiscus*. The more open areas are vegetated by *Allium ampeloprasum*, *Asparagus albus*, *Calendula suffruticosa*, *Carthamus arborescens*, *Clematis cirrhosa*, *Ferula tingitana*, *Oxalis pes-caprae*, *Phlomis purpurea*, *Stipa tenacissima*, and *Teucrium lusitanicum*.

4.10 The 125 m rifle range to the south of the Parade Ground [6] falls within the southern part of the SCI. It is mostly grass-dominated and lawn-like. It had been mown shortly prior to the survey. Towards the rifle butts, the ground becomes more gritty and disturbed, with scattered forbs including *Echium parviflorum*, *Geranium molle, Paronychia argentea*, *Rumex bucephalophorus*, and, occasionally, *Ecballium elaterium* and *Galactites tomentosus*.

4.11 South of the 125 m rifle range, the vegetation on Windmill Hill Flats [7] is very varied. Woody species include *Asparagus albus*, *Calicotome villosa*, *Chamerops humilis*, *Genista linifolia*, *Olea europea*, *Pistacia lentiscus* and *Spartium junceum*. A few plants of *Opuntia ficus-indica* were observed around the MoD buildings and the scrambling plant *Smilax aspera* was frequently observed twining around the woody vegetation.

4.12 In places the herbaceous vegetation is lush, with tall growths of larger dicots including *Chrysanthemum coronarium*, *Galactites tomentosus*, and other bulky species. Elsewhere the growth is lower and dominated by species such as *Lotus collinus*, sometimes overtopped by clumps of *Ferula tingitana* and *Foeniculum vulgare*. Other herbaceous species include *Allium ampeloprasum, Anagallis arvensis*, *Asphodelus albus*, *Borago officinalis*, *Carlina hispanica*, *Carprobrotus edulis* x *acinaciformis*, *Echium creticum*, *Echium parviflorum*, *Erodium chium*, *Ferula tingitana*, *Foeniculum vulgare*, *Gynandiris sisyrinchium*, *Hedyarsum coronarium*, *Lobularia maritima*, *Oxalis pes-caprae*, *Pallenis spinosa*, *Paronychia argentea*, *Phagnalon saxatile*, *Phlomis purpurea*, *Plantago lagopus*, *Raphanus raphanistrum*, *Reseda alba Scilla peruviana* and *Sonchus tenerrimus*. There are also some rather bare gravelly areas with ephemeral vegetation and rocky outcrops.

### *Southern Waters SCI*

4.13 The Southern Waters SCI supports reef and submerged or partially submerged sea cave habitats.

4.14 The most significant rocky outcrop is the Europa Reef which lies approximately southwest of Europa Point and extends from the shoreline to over 300 m. It ranges from some 2 to 10 m deep[6].

4.15 There are several other reefs including Governor's Beach Reef, Sandy Bay Reef and Eastern Beach Reef.

4.16 In addition to the natural reefs, several artificial reefs have been created from varied materials including car chassis and old vessels.

4.17 The submerged or partially submerged sea caves are distributed along a stretch of approximately 4.5 km around the southern part of Gibraltar[8].

### *Terrestrial Habitat Outside of the SCI*

4.18 The Parade Ground [8] comprises hard-standing. The vegetation immediately surrounding it on its western, northern and eastern sides comprises a mixture of native and exotic species together with what appear to be the remnants of planted vegetation associated with former flower beds. It is described by GOHNS as 'an extension of the open garigue and pseudosteppe habitat of Windmill Hill Flats'.... and is 'rich in flowering plants, with their corresponding invertebrate life'[9]. GOHNS has supplied a plant list for the area around the Parade Ground which lists 115 plant species recorded during the spring of 2008, 28 being protected by virtue of their exclusion from Schedule 2 of the Nature Protection Act and a further 3 being listed under Schedule 3 of the Act.

4.19 Along the eastern side of the Parade Ground [9], the vegetation on the bank includes dense cover of *Carprobrotus edulis* x *acinaciformis* with scattered bushes of *Tamarix parviflora* and a varied range of other species including *Allium ampeloprasum*, *Asphodelus albus, Beta vulgaris* ssp. *maritima*, *Carlina hispanica*, *Crithmum maritimum*, *Daucus carota*, *Ecballium elaterium*, *Echium creticum*, *Erodium chium*, *Foeniculum vulgare*, *Galactites tomentosus*, *Lobularia maritima*, *Oxalis pes-caprae*, *Sonchus tenerrimus* and *Urtica membranacea*.

4.20 Further to the east, the lower-lying ground [10] is gravelly and compacted with some bare areas. It appears to have been used for parking vehicles. Around the edges of this area the vegetation is more closed and lush and includes *Allium ampeloprasum*, *Dactylis glomerata*, *Daucus carota*, *Erodium chium*, *Galactites tomentosus*, *Glebionis coronaria, Lobularia maritima*, *Lotus collinus*, *Lotus edulis*, *Oxalis pes-caprae*, *Sherardia arvensis, Silene obtusifolia*, *Tetragonolobus purpureus* and *Trifolium stellatum*. The compacted area is more sparsely vegetated with plants including *Plantago coronopus* and *Plantago lagopus*.

4.21 The sloping ground to the south-east of the Retrenchment Block [11] is vegetated by scattered scrub including *Tamarix parviflora* over herbaceous vegetation of *Carprobrotus edulis* x *acinaciformis*, *Crithmum maritimum*, *Calendula incana*, *Dactylis glomerata, Echium creticum*, *Foeniculum vulgare* and *Galactites tomentosus*.

4.22 There is a greater amount of woody or shrubby vegetation and other bulky species around the northern edge of the Parade Ground [12] including *Agave americana*, *Asparagus albus*, *Atriplex halimus*, *Phoenix canariensis*, *Pistacea lentiscus*, *Spartium junceum* and *Tamarix parviflora*, with herbaceous species including *Aegilops geniculata*, *Allium ampeloprasum*, *Andryla integrifolia*, *Anthyllis tetraphylla*, *Calendula incana*, *Carlina hispanica*, *Carprobrotus edulis* x *acinaciformis*, *Convolvulus althaeoides*, *Crithmum maritimum*, *Dactylis glomerata*, *Daucus carota*, *Ecballium elaterium*, *Echium creticum*, *Erodium chium*, *Ferula tingitana*, *Foeniculum vulgare*, *Galactites tomentosus*, *Lobularia maritima*, *Lotus collinus*, *Lotus edulis Oxalis pes-caprae*, *Plantago lagopus*, *Psoralea bituminosa*, *Reseda alba* and *Sonchus tenerrimus*.

4.23 The north-western edge of the parade ground [13] is vegetated mainly by herbaceous plants including *Beta vulgaris* ssp. *maritima*, *Calendula incana*, *Convolvulus althaeoides*, *Dactylis glomerata*, *Daucus carota*, *Ecballium elaterium*, *Erodium chium*, *Ferula tingitana*, *Foeniculum vulgare*, *Galactites tomentosus*, *Hyparhennia hirta*, *Lobularia maritima*, *Lotus collinus*, *Oxalis pes-caprae*, *Psoralea bituminosa*, *Reseda alba* and *Silene obtusifolia*.

4.24 Species observed during the Environmental Gain survey from the area around the Parade Ground and protected by virtue of their exclusion from Schedule 2 of the Nature Protection Act are *Aegilops geniculata*, *Agave americana*, *Aloe maculata*, *Anacyclus radiatus, Anthyllis tetraphylla*, *Atriplex halimus*, *Echium parviflorum*, *Echium plantagineum*, *Erodium chium*, *Limonium sinuatum*, *Phoenix canariensis*, *Spartium junceum*, *Tamarix parviflora* and *Tetragonolobus purpureus*. To this list may be added *Anthemis arvensis*, *Asparagus aphyllus*, *Astragalus hamosus*, *Atractylis cancellata*, *Bromus rigidus*, *Cichorium pumilum*, *Disphyma crassifolium*, *Frankenia laevis*, *Linaria tristis*, *Mantisalca salmantica*, *Rostraria cristata*, *Sagina maritima*, *Sonchus asper* ssp. *asper* and *Tragopogon porrifolius* ssp. *porrifolius* recorded by GOHNS. In addition, *Ferula tingitana*, *Iberis gibraltarica* and *Limonium emarginatum* are protected by inclusion under Schedule 3 of the Nature Protection Act and have been recorded around the margins of the Parade Ground by GOHNS and the former also during the Environmental Gain survey.

4.25 Below the cliffs to the east of the Parade Ground [14], there are buildings and hard-standing with limited plant growth including non-natives such as *Carprobrotus edulis* x *acinaciformis* and *Aeonium arboreum* and natives including *Crithmum maritimum*, *Urtica membranacea*, *Arisarum simorrhinum* and *Smilax aspera*. More details are given in other studies[10].

### Protected/Noteworthy Species

*Bats*

4.26 The 2001 bat census conducted in UK territories for bats under the terms of the implementation of Agreement for the Conservation of Bats in Europe[11] records four species of bat in Gibraltar, which are:

- Schreiber's bat (*Miniopterus schreibersi*);
- Soprano pipistrelle (*Pipistrellus pygmaeus*);
- European free tailed bats (*Tadarida teniotis*); and
- Greater mouse-eared bat (*Myotis myotis*).

4.27 All species of bats are protected under the Gibraltar Nature Protection Ordinance and the Habitats Directive. Schreiber's bats and greater mouse-eared bats are listed for the designation of the Rock of Gibraltar SCI as they are included in the Habitats Directive Annex II.

4.28 Greater mouse-eared bats are not considered further in this report as recent monitoring data[8] indicate that this species has become extinct within Gibraltar.

4.29 No evidence of bats was recorded during the field survey and habitat suitability is considered to be poor over much of the proposed development site. However, the first three species have all been reported foraging in the vicinity of Lathbury Barracks (pers.comm. Dr K Bensusan, GONHS).

4.30 There are no known bat roosts within the proposed power station site boundary. There are two structures on site; a portacabin which is unsuitable for utilisation by bats and a shooting tunnel (pipe rifle range) which may have the potential for bats. The latter was inspected externally during May 2008 with an observation at dusk for activity/ emergence. No internal access was possible. Although not conclusive, no evidence of bats was found during this investigation.

4.31 There is now only one Schreiber's bat roost known on Gibraltar. It is located close to O'Hara's Battery and is used mainly during the months of February to April and again during October and November[12]. The roost is approximately 700 m to the north east of the site. There is also the potential that other roosts might exist within caves or tunnels in the vicinity of the Lathbury Barracks site.

4.32 The Schreiber's bat population size within Gibraltar has been estimated at between 101 and 250 individuals[8]. It is the subject of a Species Action Plan in the Gibraltar BAP. The population size has also been estimated as 20 to 40 individuals[6]. More recently, it has been reported[12] that over 300 bats were present in 2006 and 2007 although the highest number recorded in spring 2008 was around 200.

4.33 European free-tailed bats roost in cracks and crevices on rock faces and therefore roost sites are difficult to locate. No information about population size appears to be available. Pipistrelles can also utilise crevices within rock faces. These two species could potentially have roosts within the cliff faces around Windmill Hill and the southern end of Gibraltar.

*Other Mammals*

4.34 Bottle-nosed dolphin *Tursiops truncatus* are reported to occur regularly within the territorial waters of Gibraltar. It is listed on the Natura 2000 Data Form in connection with the Southern Waters SCI. The population size is estimated as a maximum of 17 animals. The BAP includes a Species Action Plan for all cetaceans. The main pressures and threats are identified as 1) professional fishing, 2) shipping and 3) pollution or human impact/activities. The current trend is stable for its range but unknown in terms of its habitat[8].

4.35 Rabbits *Oryctolagus cuniculus* are known to be using the area around Lathbury Barracks. They are mainly distributed on the Upper Rock and Windmill Hill Flats. The population trend is reported as decreasing[6]. Rabbits are the subject of a Species Action Plan in the BAP and are listed on Schedule 1 of the Nature Protection Act.

4.36 A pair of red foxes *Vulpes vulpes* ssp. *silacea* is reported to be present on Windmill Hill Flats. The species is reported to have become extinct locally in the 1980s but a reintroduction programme has been developed by GOHNS as part of the yellow-legged gull control programme. The pair on Windmill Hill Flats may represent the only pair currently on Gibraltar[9]. Red foxes are the subject of a Species Action Plan in the BAP and are listed on Schedule 1 of the Nature Protection Act.

4.37 Barbary macaques *Macaca sylvanus* occur around the Lathbury Barracks area, a pack of some 20-25 individuals being reported[12] The Gibraltar population was reported to be 248 in January 2006. Barbary macaques are the subject of a Species Action Plan in the BAP and are listed on Schedule 1 of the Nature Protection Act.

*Birds*

4.38 Gibraltar has around 310 species of bird with the majority of these being passage birds using the short crossing point from Europe to Africa across the Strait of Gibraltar. A list of ringing totals for the period 1991 to 2007 (Charles Perez, GONHS, email correspondence 09-05-08) indicates that birds of 119 species were ringed at Jews Gate observatory, comprising 50,030 birds in total. The Natura 2000 data form lists 30 Annex 1 (Council directive 79/409/EEC) bird species for Gibraltar and a further 73 non-Annex 1 species.

4.39 All bird species are protected in Gibraltar, as are their nests when in use. The rock of Gibraltar provides a temporary home for many species of migratory birds that rest and feed before continuing migration. GOHNS reports circumstantial evidence that many migrants grounded on Windmill Hill Flats gradually make their way along Lathbury up to the area of Jews Gate and further[9].

4.40 Birds recorded during the Environmental Gain survey include blackbird *Turdus merula*, spotless starling *Sturnus unicolor*, Sardinian warbler *Sylvia melanocephala*, yellow-legged gull *Larus michahellis* and Barbary partridge *Alectoris barbara*.

4.41 Little owls *Athene noctua* are reported to nest within close proximity of the site of the proposed power station in a hole in a limestone wall directly north of the site[9]. Twelve little owls were ringed at the Jews Gate observatory between 1991 and 2007. The surrounding area is also known to support house sparrows *Passer domesticus*, one or two pairs of Sardinian warblers and blue rock thrushes *Monticola solitarius*. Some migrant species from further north in Europe are reported to winter around the Parade Ground. They include robin *Erithacus rubecula*, black redstart *Phoenicurus ochruros*, common stonechat *Saxicola torquata*, common chiffchaff *Phylloscopus collybita* and white wagtail

*Motacilla alba*[9]. Black kite *Milvus migrans* has also been reported using the Windmill Hill Flats (pers. comm. Peter Jackson MoD).

4.42 Wintering bird data for several locations around Lathbury Barracks have been supplied by GOHNS. Thirty-three species have been listed. The data are summarised in Table 4-1.

**Table 4-1 Summary of Overwintering Bird Data for 2005, 2007 and 2008**

| Species | 2005 | | | | | 2007 | | | | | 2008 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | | Location | | | | | Location | | | | |
| | JG to PII | JG to PC | WH | MS | HW | JG to PII | JG to PC | WH | MS | HW | JG to PII | JG to PC | WH | MS | HW |
| European shag | | | | | 2 | | | | | | | | | | |
| Common kestrel | | | | | | | 3 | 1 | 1 | 1 | 2 | 1 | 1 | | |
| Peregrine | | | 1 | | | | | | | | | | | | |
| Booted eagle | | | | | | | 1 | | | | | | | | |
| Barbary partridge | 7 | | 4 | 2 | | 3 | | 27 | 7 | | 2 | 1 | 3 | 2 | |
| Collared dove | | | | | | 1 | | | | | | | | | |
| Feral pigeon | | | | | | 5 | | 4 | | | | | 2 | | |
| Eurasian crag martin | | | | | | | | 6 | | | | | | | |
| Meadow pipit | | | 20 | | 1 | | | 10 | | | | | 19 | | |
| White wagtail | | | | | | | | | | | | | 1 | | 1 |
| Winter wren | 9 | | 1 | 4 | 4 | 23 | 32 | 1 | 15 | 1 | 24 | 27 | | 6 | |
| European robin | 35 | | 4 | 7 | 7 | 25 | 14 | 9 | 8 | | 27 | 5 | 8 | 6 | |
| Black redstart | 30 | | | 6 | 13 | 4 | 7 | 15 | 11 | 1 | 4 | 8 | 18 | 3 | 3 |
| Common stonechat | 1 | | | | | | | 6 | | | | | 8 | | |
| Blue rock thrush | | | | 1 | 1 | | | 1 | | | | | | | |
| Common blackbird | 12 | | 8 | | 4 | 15 | 31 | 13 | 12 | | 14 | 21 | 8 | 12 | |
| Song thrush | 9 | | | | | | | 2 | | | 4 | | 1 | | |
| Cetti's warbler | | | 1 | | | | | | | | | | | | |
| Zitting cisticola | | | 1 | | | | | | | | | | | | |
| Sardinian warbler | 24 | | 17 | 7 | 3 | 23 | 23 | 17 | 23 | 1 | 21 | 21 | 16 | 6 | 1 |
| Blackcap | 17 | | | 1 | | 12 | 19 | 4 | 1 | | 7 | 18 | | 1 | |
| Common chiffchaff | | | 12 | | 11 | 4 | 13 | 17 | 1 | 4 | 15 | 9 | 19 | 5 | |

| Species | 2005 | | | | | 2007 | | | | | 2008 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Location | | | | | Location | | | | | Location | | | | |
| | JG to PII | JG to PC | WH | MS | HW | JG to PII | JG to PC | WH | MS | HW | JG to PII | JG to PC | WH | MS | HW |
| Short-toed treecreeper | 1 | | | | | | | | | | | | | | |
| Blue tit | 7 | | | | | 6 | 4 | | 1 | | 3 | 3 | | 3 | |
| Great tit | 1 | | | | | 2 | | | | | | 1 | | | |
| Common raven | | | | | | | | 1 | | | | | | | |
| Common starling | | | | | | | | | | | | | 17 | | |
| Spotless starling | | | 20 | | 26 | 1 | | 14 | | | | | 32 | | 1 |
| House sparrow | | | | | 11 | | 2 | 42 | 6 | 6 | | | 10 | | |
| Common chaffinch | 5 | | | | | 10 | 1 | 6 | 1 | | | 2 | 2 | | |
| European serin | | | 1 | | | | | | | | | | 2 | | |
| European greenfinch | 8 | | 6 | | 2 | 6 | 1 | | | | | 4 | | | |
| European goldfinch | | | | | | | | 1 | | | | | 8 | | |

Information supplied by GOHNS. Abbreviations: **JG** = Jews Gate, **WH** = Windmill Hill, **MS** = Mediterranean Steps, **HW** = Hole in the Wall.

4.43 Barbary partridge has been identified as a receptor of particular concern. The birds are reported by GONHS to be quite numerous on Windmill Hill Flats. Wintering numbers on Windmill Hill Flats have ranged between 3 and 27 on the occasions when counts have been recorded in 2005, 2007 and 2008 (see Table 4-1 above). Estimates of population numbers indicate that 15 breeding pairs of Barbary partridge are present on Windmill Hill Flats and perhaps a further 30 to 40 pairs occupy the Upper Rock[13]. Windmill Hill Flats supports a higher density population than the Upper Rock population, possibly due to the amount of more open habitat. Habitat loss has been cited as a threat within the Upper Rock Nature Reserve, arising from the loss of important firebreaks[6]. Two or three pairs of Barbary partridge use an area north of the Parade Ground for nesting and foraging. Barbary partridge are also known to use the vegetated area to the east of the Parade Ground, as they travel between Windmill Hill Flats and the Upper Rock[9].

4.44 During the site survey on $1^{st}$ April 2008 several Barbary partridges were flushed from the surrounding area both within Windmill Hill Flats and to the north of the site on the lower slopes of the Rock. Barbary partridges were also seen flying from lower ground up to the cliff top at the southern end of Windmill Hill Flats.

4.45 Barbary partridge have a large global range of 100,000 to 1,000,000 $km^2$ with a large global population and an estimated population of 15,000 to 40,000 individuals in Europe[14]. The species is classified as having the least conservation concern under the IUCN guidelines. The population of Barbary partridges in Gibraltar are believed to be introduced probably in the mid-$18^{th}$ Century. However they do represent a population on the edge of the natural distribution of Barbary partridges. The species is the subject of a Species Action Plan in the BAP.

*Reptiles*

4.46 From data provided by GOHNS[7] there are 14 native terrestrial reptile species within Gibraltar. The species are listed below, with those recorded on the Upper Rock Nature Reserve[7] to the north of the Parade Ground site being indicated by an asterisk:

- Iberian worm lizard (*Blanus cinereus* );
- Turkish gecko (*Hemidactylus turcicus*)*;
- Moorish gecko (*Tarentola mauritanica*)*;
- Bedriaga's skink (*Chalcides bedriagai*);
- Three-toed skink (*Chalcides striatus*);
- Ocellated lizard (*Timon (Lacerta) lepida*)*;
- Iberian wall lizard (*Podarcis hispanica*)*;
- Algerian sand racer (*Psammodromus algirus*);
- Horsehoe whip snake (*Coluber hippocrepis*)*;
- Southern smooth snake (*Coronella girondica*)*;
- Ladder snake (*Rhinechis scalaris*)*;
- Montpellier snake (*Malpolon monspessulanus*)*;
- False smooth snake (*Macroprotodon brevis (cucullatus*))*; and
- Grass snake (*Natrix natrix*)*.

4.47 All reptile species in Gibraltar are protected under Schedule 1 of the Nature Protection Ordinance.

4.48 Reptiles reported to occur in the Lathbury Barracks area include Iberian wall lizard, Algerian sand racer, Moorish gecko, horseshoe whip snake and ladder snake[9].

4.49 The population of ocellated lizard on Windmill Hill Flats is described as 'critically small', comprising some 5 to 10 individuals and another extremely small population is present on the Upper Rock. Horseshoe Whipsnake is described as common in vegetated areas of Gibraltar[12].

4.50 In addition, loggerhead turtle *Caretta caretta* is reported to occur regularly although casually within the entire territorial waters of Gibraltar. It is listed on the Natura 2000 Data Form in connection with the Southern Waters SCI. Numbers of animals are unknown – individuals are not always present and, when they are recorded, it is as single animals. The main pressures and threats are identified as 1) fixed location fishing, 2) shipping and 3) pollution or human impact/activities. The current trend is unknown[8].

4.51 In addition, loggerhead turtle *Caretta caretta* is reported to occur regularly although casually within the entire territorial waters of Gibraltar. It is listed on the Natura 2000 Data Form in connection with the Southern Waters SCI. Numbers of animals are unknown – individuals are not always present and, when they are recorded, it is as single animals[26]. The main pressures and threats are identified as 1) fixed location fishing, 2) shipping and 3) pollution or human impact/activities[26]. The current trend is unknown[26].

4.52 Green turtle *Chelonia mydas* is also a qualifying feature of the Southern Waters SCI. Green turtles are reported to occur occasionally in the territorial waters of Gibraltar. The population size is estimated at a maximum of five individuals. The main pressures and threats are 1) fixed location fishing, 2) shipping and 3) pollution or human impact/activities[27]. The range, population and habitat for this species is considered to be favourable[27]. The future prospects of the green turtle within the Gibraltarian straits is unknown[27].

*Invertebrates*

4.53 The Lathbury Barracks area is described as being exceptionally rich in invertebrates[9]. A list of 126 beetle taxa and 14 ant taxa has been provided by GOHNS and it is understood that more species await identification.

4.54 The presence of lentisc bushes in the Lathbury Barracks area is noted by GOHNS[9] as being significant for supporting the leaf beetle *Tituboea biguttata*.

4.55 In addition to the Gibraltar funnel web spider discussed separately below, the Lathbury barracks area is reported[9] to support three invertebrate taxa listed in the Gibraltar Nature protection Act: *Scolopendra cingulatus* (a centipede particularly common in the area), *Mantis religiosa* (praying mantis) and *Oestophora calpeiana* (a snail). Additionally, an ant species *Anochetus ghilianii* occurs from the southern perimeter of Windmill Hill Flats to Jew's Gate, and has been reported in scrub directly north of the Parade Ground. This species is found only around the Strait of Gibraltar with some isolated records from Morocco. The only Gibraltar site for Provence hairstreak *Tomares ballus* is reported to be around the Parade Ground, where 20 to 30 individuals have been recorded[12]. In addition to praying mantis, another mantid *Sphodromantis viridis* has been recorded from the Parade Ground area. Both mantids are reported to be common on the Rock[12].

4.56 Limited information has been obtained about the status of the Gibraltar funnel web spider *Macrothele calpeiana* in and around the Lathbury Barracks area, although it is said to be uncommon in this location but common in other parts of Gibraltar[12].

4.57 Perez[6] reports that the spider is well distributed around Gibraltar. It is protected under Schedule 1 of the Nature Protection Ordinance and listed under Annex II of the Habitats Directive.

4.58 Gallon[15] reports that the Gibraltar funnel web spider occurs in 'damp shady localities in southern Spain' and Perez[6] notes that it is found mainly in damp wooded areas in gardens and the Nature Reserve.

4.59 Four marine species are listed as qualifying species associated with the Southern Waters SCI. They are Mediterranean ribbed limpet *Patella* *ferruginea*, date mussel *Lithophaga lithophaga*, fan mussel *Pinna nobilis* and long-spined urchin *Centrostephanus longispinus*.

4.60 There is a species action plan for the Mediterranean ribbed limpet. The distribution of this limpet is reported as scarce along the rocky shorelines of Gibraltar[6]. The main pressures and threats to the Mediterranean ribbed limpet are identified as pollution (in particular oil pollution from oil refinery), land reclamation activities and change of current flows through development of the harbour area[6]. The population trend of this species is reported to be increasing[6]. The Mediterranean ribbed limpet is listed under Annex IV of the Habitats Directive[3].

4.61 The date mussel, fan mussel and long-spined urchin are all listed under Annex IV of the Habitats Directive[3]. It is considered that the main pressures and threats to these species will be the similar to the Mediterranean ribbed limpet.

### Summary

4.62 Evaluation of the field and desk study data has revealed that the ecological features of greatest value are the SCIs and their designating features which are protected at the European level.

4.63 Outside the SCIs, the principal ecological features are groups of protected species, notably bats (also a qualifying feature of the Rock of Gibraltar SCI), birds, reptiles and several invertebrate and plant species. The importance of Gibraltar in terms of migratory birds is particulary noted.

# 5 ASSESSMENT OF SIGNIFICANT EFFECTS

5.1 The consultation process and baseline assessment has indicated that the following potentially significant effects need to be considered as part of the assessment process:

- Fallout/pollution from air emissions (in particular from nitrogen deposition)
- Noise, disturbance and vibration;
- Habitat loss;
- Disruption to movement of fauna;
- Light pollution; and
- Pollution incidents.

5.2 The assessment of impacts upon the sensitive receptors (as agreed with the relevant authorities) has been conducted at two levels. First, a list of potential effects of the proposals is applied to the list of receptors in the form of a matrix (Table 5-1). Such effects are deemed to be potentially significant or not, based upon a consideration of the ecology of the features involved. Following this initial assessment, a more detailed analysis is presented for the potentially significant effects under a series of headings that consider each of the receptors in turn.

**Table 5-1 Tabulation of Potentially Significant Effects**

| *Feature* | *Potential Impacts* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Permanent* | | | | | *Temporary* | | |
| | *Pollution from Air Emissions* | *Habitat Loss* | *Noise, Disturbance & Vibration from Operation* | *Light Pollution from Operation* | *Disruption of Movement of Fauna* | *Pollution Incidents (Including Dust Deposition)* | *Noise, Disturbance & Vibration from Construction* | *Light Pollution from Construction* |
| *Vegetation* | PS | PS | - | - | - | PS | - | - |
| *Caves not open to the public* | - | - | (Note 1) | - | - | - | (Note 1) | - |
| *Reefs* | - | - | - | - | - | PS | - | - |
| *Submerged or partly submerged sea caves* | - | - | - | - | - | PS | - | - |
| *Bats* | (Note 2) | PS | PS | PS | PS | PS | PS | PS |
| *Other terrestrial mammals* | - | PS | - | - | PS | - | - | - |
| *Birds* | - | PS | PS | PS | PS | - | PS | PS |
| *Terrestrial reptiles* | - | PS | PS | - | PS | - | PS | - |
| *Terrestrial invertebrates* | PS | PS | - | PS | PS | - | - | - |
| *Loggerhead turtle & green turtle* | - | - | - | - | - | PS | - | - |
| *Bottle-nosed dolphin* | - | - | - | - | - | PS | - | - |
| *Marine invertebrates* | - | - | - | - | - | PS | - | - |

**Footnotes:**

**PS** denotes potentially significant, - denotes not significant.

**Note 1:** disturbance is not expected to affect caves directly but has the potential to affect Schreiber's bats using caves.  This potential effect is discussed in the following text in the paragraphs that deal with Schreiber's bat.

**Note 2:** Nitrogen deposition has the potential to affect vegetation (see discussion) which may, in turn, affect the quality of bat foraging habitat, at least for Schreiber's bat which is believed to be adversely affected by vegetation succession.

5.3 Potentially significant effects are assessed below under a series of category headings (eg 'Vegetation', 'Bats', 'Birds'). The potentially direct impacts arising from construction are considered for the period 2009-2012 (the proposed start of operations). The longer-term indirect impacts (eg N deposition on vegetation) are considered at 2034, since any such effects are likely to take a number of years before manifesting themselves.

### Vegetation and Habitats

*Pollution from Air Emissions*

5.4 The main potentially significant effect on the vegetation of the Rock of Gibraltar SCI is judged to be the possibility of change arising from the exhaust output of the power station, particularly nitrogen oxides ($NO_x$) emissions.

5.5 The following summarises the potential $NO_x$ effects, which are described in detail in Appendix EC-1 at the end of this chapter.

5.6 The effects of gaseous pollutants such as $NO_x$ on sensitive receptors can be considered in terms of both critical levels and critical loads. A critical level may be defined as a concentration of a pollutant above which direct adverse effects on the receptor may occur. A critical load relates to the quantity of pollutant deposited above which significant adverse effects on the receptor may occur.

5.7 As a general guide, an annual mean concentration of 30 $\mu g\ m^{-3}$ has been identified by the World Health Organisation as the critical level beyond which direct damage to vegetation may occur. The true critical figure will vary from species to species and it is understood that the 30 $\mu g\ m^{-3}$ has no legal basis as a critical limit in Gibraltar. But it has been used here as a precautionary guide to levels of NOx that may be harmful to vegetation.

5.8 In addition to direct damage to vegetation, N deposition from gaseous pollutants may result in effects on vegetation through various causes including changes in the competitive balance between species and facilitation of invasion by exotic species. Such causes may interact in complex and unpredictable ways.

5.9 There is considerable evidence that atmospheric N deposition has greatly increased since the start of the industrial revolution. In recent years, N deposition levels of 5-25 kg $ha^{-1}$ $year^{-1}$ have been reported for eastern North America and 50-60 kg $ha^{-1}$ $year^{-1}$ for northern Europe, and levels of up to 85 kg $ha^{-1}$ $year^{-1}$ of N have been reported from the Netherlands.

5.10 The extent to which different plant communities may be affected by atmospheric N deposition depends on many factors including the amount of N being deposited, the buffering capacity of the system, soil nutrient status and soil factors that influence the nitrification potential and nitrogen immobilisation rate.

5.11 Attempts have been made to establish critical loads for N deposition for various vegetation types, and maps have been produced to provide an indication of where such critical loads are being exceeded.

5.12 To establish the likelihood of significant effects on the vegetation of the Rock of Gibraltar SCI, it is necessary to consider the sensitivity of the vegetation to N deposition and the amount of N deposition likely to occur. Any additional deposition of N arising from the power station needs to be considered in the context of the existing and likely future levels of N deposition in order to determine, for example, whether it is likely to cause exceedance of an established or agreed critical level.

5.13 Currently there appear to be very few data regarding critical levels of N deposition on Mediterranean vegetation and several publications have identified the lack of information about nitrogen impacts on all Mediterranean vegetation types as constituting important gaps in knowledge.

5.14 Kuylenstierna *et al.*[16]provide a qualitative scale of sensitivity to N deposition for various vegetation types. Sensitivity ranges from Class 1 (least sensitive) to Class 4 (most sensitive). Much of the vegetation of the Rock of Gibraltar SCI in the region where the increase in NOx is predicted to be greatest probably falls best under the broad category of 'Mediterranean scrub' which is placed in Class 2. A direct comparison between the classes of Kuylenstierna *et al.* and other published data is not straightforward because the vegetation categories seldom coincide. But, as a rough approximation, critical loads published by the Centre for Ecology and Hydrology (CEH)[17] for other categories of vegetation within Class 2 appear typically to fall within the limits of 30-40 kg N $ha^{-1}$ $year^{-1}$ (tidal flats) down to 10-15 kg N $ha^{-1}$ $year^{-1}$ (oak and beech woodland). One of the Annex I habitats for which the Rock of Gibraltar SCI is designated is 'calcareous rocky slopes with chasmophytic vegetation'. This category is given a critical load of 10-15 kg N $ha^{-1}$ $year^{-1}$ by CEH. In the absence of better data, and as a precautionary approach a level of 10 kg N $ha^{-1}$ $year^{-1}$ is taken as being the critical level for the Rock of Gibraltar SCI vegetation as a whole.

5.15 The proposed power station is anticipated to result in increased levels of N deposition of up to approximately 0.5 kg N $ha^{-1}$ $year^{-1}$, although an increase at this level is anticipated to be localised to an area of approximately 4 hectares (approximately 2% of the SCI).

5.16 In absolute terms, and relative to 'typical' levels of N deposition in western Europe, a level of 0.5 kg $ha^{-1}$ $year^{-1}$ is quite a small amount. It is around one or two orders of magnitude below the levels of N that are typically applied in experiments designed to investigate the effects of elevated N on vegetation and less than 1% of the levels that have been reported from some European countries. But, on the other hand, N deposition of 0.5 kg $ha^{-1}$ $year^{-1}$ would represent 5% of the assumed critical load of the vegetation. There are, however, no data available to establish current levels of N deposition on the SCI, and there is therefore no way of knowing whether the vegetation is already exceeding its critical limit, whether a 5% increase would cause this limit to be exceeded or whether the vegetation would remain below its critical limit despite a 5% increase in N deposition.

5.17 Given the lack of information regarding several key questions and in the light of the preceding discussion, it remains a possibility that the predicted increase in N deposition may cause the critical level to be exceeded, at least in parts of the SCI.

5.18 The effects of any exceedance of the critical N deposition level need be considered in connection with the integrity of the SCI. The Rock of Gibraltar SCI is identified as being vulnerable to seral changes and invasive plants[18]. Some studies have linked an increase in nutrient deposition with an increased risk of invasion by alien plants and it is possible that seral changes may be facilitated by a nutrient increase.

5.19 It is evident from the issues considered above, that there is a significant element of uncertainty about the effects of the proposed power station on the Rock of Gibraltar SCI. It is by no means certain that the effect of the proposals would adversely affect the integrity of the SCI (ie the 'coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified'). Equally, however, it is not possible to rule out such an adverse effect. Guidance (eg IEEM[2]) indicates that, where there is reasonable uncertainty about an outcome, the precautionary principle applies and a potentially **significant adverse effect** is therefore assumed as a result of exceedance of the critical load.

5.20 In connection with the critical limit of NOx, the relevant authorities have advised that there are no data concerning the existing nitrogen deposition rates across the SCIs and it is not known whether the critical levels are currently being exceeded. When expressed as an incremental change to the critical level value (10 kg/N/ha/yr) the power station would cause a 3.5% (in 2012) and 2.7% (in 2034) change at the point of maximum impact. Incremental changes of less than 1% would occur across most of the SCI. It is not known whether current levels of NOx are damaging the vegetation of the SCI.

5.21 The background NOx levels will be potentially affected by the decommissioning of ISGS, OESCO, and Waterport power stations. The Air Quality Chapter (Technical Reports: Volume 2) reports that, in practice, the net change across most of the SCI resulting from this decommissioning might range from nothing to a substantial reduction in annual mean NOx concentrations.

5.22 The effect of a maximum addition of 5 µg $m^{-3}$ NOx to the existing situation is therefore unclear. Some degree of adverse effect can not be ruled out, although directly phytotoxic levels of NOx are considered likely to be very localised. Again, given the uncertainty, a potentially **medium significant adverse effect** is predicted.

*Habitat Loss*

5.23 Only vegetation outside the SCI would be affected by direct habitat loss.

5.24 The proposed power station is likely to result in the loss of approximately 0.8 ha of the vegetation around the perimeter of the Parade Ground. Some of this vegetation appears to have originally been planted and several non-native or invasive species have been recorded from the area. There is, however, a significant semi-natural element to the vegetation and it is described as being rich in flowering plants. These include 28 species protected by virtue of their omission from Schedule 2 of the Nature Protection Act and a further 3 species listed under Schedule 3. Habitat loss is therefore anticipated to result in a potentially **medium significant adverse effect** on the vegetation.

*Pollution Incidents*

5.25 The main potentially significant effect during construction is considered to be the potential for dust deposition.

5.26 The part of the Rock of Gibraltar SCI that lies closest to the site of the proposed development is the 125 m rifle range. Dust deposition is considered unlikely to result in significant effects on the rifle range vegetation because it is regularly mown and dust is therefore unlikely to build up in sufficient quantities to affect the physiological performance of the plants. Some dust accumulation on more distant and less intensively managed vegetation remains a possibility, although the levels of deposition are likely to be so low as to result in no measurable adverse effects and with good construction practices dust deposition will be kept to a minimum. No significant effect is predicted.

**Reefs and Sea Caves**

*Pollution Incidents*

5.27 Water pollution is identified as one of the main pressures affecting reefs. A potentially **medium significant adverse effect** may therefore be expected in the event of any accidental pollution incident. The risk of accidental pollution events is considered to be low with the current technology to detect and manage leaks and spillages.

### Bats

*Habitat Loss*

5.28 There is a potential for habitat loss, including a potential roost site in the underground pipe range. Vegetation around the edges of the Parade Ground will also be lost and bats have been recorded foraging in this area.

5.29 In the context of the habitats found over Windmill Hill Flats and the Upper Rock, removal of vegetation around the Parade Ground would constitute only a small percentage loss of bat foraging habitat. The implications of such a loss are, however, unknown. Much depends on the factor(s) that are currently controlling bat population sizes in Gibraltar. If, for example, population size of a bat species is low as a result of limited roosting habitat, the amount of foraging habitat may be more than sufficient to support the number of bats that are present and a minor loss of habitat may make no difference to the population size. If, however, loss of foraging habitat is responsible for limiting the population size, loss of even a small amount of habitat may result in a measurable effect on population size. There appears, however, to be insufficient information available to determine the key factors controlling bat population sizes in Gibraltar.

5.30 Given the level of uncertainty, a potentially **significant low to medium adverse effect** is predicted.

*Noise, Disturbance & Vibration from Operation*

5.31 The noise and vibration results from the technical chapter of the ES (Volume 2: Technical Reports) have shown that there are no potential significant adverse disturbance effects on humans resulting from noise and vibration after mitigation for the proposed power station. The vibration criteria are based upon damage caused to buildings not cave systems, and a detailed investigation of current research suggests there are few data on the effects of noise and vibration on bats under circumstances similar to those that would prevail during the operation of the proposed power station. Only qualitative observations can be made regarding the likelihood of effects in the following text.

5.32 Direct effects on the physical structure of the only known roost (Schreiber's bat) are considered unlikely. The cave roost is some 700 m from the location of the proposed power station. Given that the levels of noise and vibration are sufficiently low to avoid damage to buildings at a much closer distances than this, no damage to the cave structures is anticipated and no significant effect is predicted.

5.33 It is possible that other (unknown) roosts are closer to the location of the proposed power station. But levels of noise and vibration are considered to be sufficiently low to avoid structural damage to the cliffs and other known features in the rock (tunnels, crevices etc) nearby, and therefore the integrity of the structure of any unknown roosts nearby is considered unlikely to be compromised by the proposals.

5.34 The effects of the operation of the proposed power station on any bats within roosts is harder to assess. Under some circumstances, bats may undoubtedly be disturbed by human activity in various forms. On the other hand, bats of at least some species may tolerate levels of 'disturbance' that can appear quite intrusive to humans. But the effects of noise and vibration are likely to vary from species to species and no information has been obtained from the detailed investigation of current research that relates specifically to Schreiber's, soprano pipistrelle or European free-tailed bats.

5.35 Additionally, assessment of the effects of any new disturbance is likely to be complicated by the intensity, frequency and nature of existing disturbances. These are not known, although it is noted that military manouvres certainly result in intermittent noise and presumably also vibration.

5.36 Overall, it is considered unlikely that the operation of the power station would result in any significant adverse effects on Schreiber's bats occupying the only known roost, simply because the roost is considered likely to be sufficiently far away for any noise and vibration from the power station to merge into the existing background levels.

5.37 The effects that noise and vibration might have on bats in any unknown roosts are, however, impossible to predict because the effects would depend on the location of the roosts. The precautionary principle therefore has to be applied resulting in a **potential medium significant effect** of noise and vibration upon potential bat roosts.

5.38 In terms of the potential effects of noise and vibration on foraging or commuting bats, it is not possible to make an assessment. The exact frequency of noises emitted from the power station are not yet known and there is insufficient information about how such noises might interfere with foraging. It is possible, for example, that power station noise might interfere with the echolocation used by bats.

5.39 For this assessment, it is assumed that bats use the site to commute for foraging between Windmill Hill Flats and the Upper Rock.

5.40 The output noise may discourage bats from flying around the proposed power station, resulting in a potentially **significant medium adverse effect**.

*Light Pollution from Operation*

5.41 Light pollution during operation may have an effect on bats. Light pollution has been shown to affect orientation or disorientation in various animals from additional artificial light sources. Lighting of the proposed power station is unlikely to affect the Schreiber's bats emerging from the only known roost due to the positioning and distance of the roost from the power station. However, the effect on disturbance of movement remains uncertain. Adopting a precautionary approach a **low significant adverse effect** is predicted.

*Disruption of Movement of Fauna*

5.42 Any disruption of movement of fauna resulting from the power station is likely to arise by the combined effects of lighting and other forms of disturbance arising from the operation of the power station rather than from the existence of the power station building *per se*. The following reasoning therefore needs to be considered in combination with the discussion on lighting and other forms of disturbance elsewhere in this section.

5.43 It is likely that Windmill Hill Flats is used for foraging by Schreiber's and European free-tailed bats, since the habitat appears to be very suitable. Soprano pipistrelles are also known to forage in the area. The only known roost of Schreiber's bats is located close to O'Hara's Battery. Roost locations for European free-tailed bats and Soprano pipistrelles are unknown. The proposed power station would occupy land between the Schreiber's bat roost and Windmill Hill Flats and it is therefore possible that it may cause some disturbance to any commuting pathways between the roost in the tunnel and foraging grounds over Windmill Hill Flats.

5.44 Further studies are required to determine the exact use of the landscape for foraging and as a potential commuting corridor. For this assessment, it is assumed that bats do use the site to commute for foraging between Windmill Hill Flats and the Upper Rock.

5.45 In general, bats are highly mobile and acute flyers and able to avoid obstacles. However, they may be sensitive to disturbance due to human activities and disruption to movement of animals may occur through the effects of light pollution as discussed separately above. Limited research has been undertaken of the effects of disturbance on commuting routes. It is therefore hard to establish the effect that the power station may have on the bats within Gibraltar. The power station building would not cause total severance and bats could fly over or around the structure to the east or west. However the extent to which bats may be deterred from moving between roosts and existing foraging grounds by the operation of the proposed power station is not known.

5.46 In addition, it is noted that Policy Z7.10 of the 2007 Consultation Draft Gibraltar Development Plan, makes reference to maintaining the natural linkages in the Lathbury Barracks area, specifically:

> *The Commission shall seek to ensure that appropriate provision is made in future development in the Lathbury Barracks area for green corridors and green roofs to assist in maintaining the natural linkages between Windmill Hill and the Upper Rock.*

5.47 Although the policy makes no reference to any particular taxon or group of taxa, the power station would affect the implementation of Policy Z7.10.

5.48 In the absence of detailed information about the proposed lighting, the effects of other kinds of disturbance and use of the landscape around the proposed power station by bats, coupled with considerations associated with Policy Z7.10 (see also potentially significant issues associated with the prison under cumulative effects at the end of this section), a potentially **medium significant adverse effect** is assumed.

*Pollution Incidents*

5.49 Temporary effects from pollution may occur as a result of accidental fuel spill if the fuel is spilt within an underground area that is occupied by bats. No fuel lines or storage tanks are proposed in or adjacent to the only currently-known roost and an impact of this kind would therefore only occur if a new roost were discovered within one of the tunnels or the Admiralty Oil Tank Chambers where fuel pipes or fuel storage are proposed. A potentially **medium significant adverse effect** could, however, occur if this was the case and a fuel spillage occurred.

*Noise, Disturbance & Vibration from Construction*

5.50 The potential effects here will be intermittent rather than continuous. The main potential for noise, disturbance and vibration to affect bats during construction is through disturbance to roosts, since it is anticipated that the works would mostly be undertaken during daylight hours. If any bat roosts were to be encountered in caves or tunnels where fuel storage or fuel pipes were to be situated, there is the potential for disturbance to roosting bats.

5.51 The only effects on foraging or otherwise active bats away from the roost are likely to arise as a result of works undertaken during the hours of darkness.

5.52 The presence of any bat roosts in the vicinity of proposed works is unknown. Given the uncertainty, a potentially **medium significant adverse effect** is assumed. However it is important to note that a certain level of intermittent noise, disturbance and possibly vibration does already occur due to exercises undertaken on MoD land adjacent to the parade ground. Additional effects arising from the construction of the proposed power station may therefore be less significant than would otherwise be the case and would be restricted to the construction period.

5.53 The noise and vibration during construction will be carried out mainly in daylight hours and therefore should not disturb foraging bats. The only known bat roost is at such a distance from the site that no effect is anticipated to occur, for the reasons discussed above.

*Light Pollution from Construction*

5.54 Light pollution during construction may have an adverse effect on foraging bats for the same reasons as light pollution during operation, although this would only occur if there were a need to illuminate the site after dark. In the absence of detailed information about the proposed lighting and use of the landscape around the proposed power station by bats, a potentially **low significant adverse effect** is assumed.

**Other Terrestrial Mammals**

*Habitat Loss*

5.55 Occupation of habitat around the Parade Ground by other terrestrial mammals (apart from any use of such habitat as a 'green link' which is considered separately below) appears to be minimal and no significant adverse effects are therefore anticipated.

*Disruption of Movement of Fauna*

5.56 Red foxes are reported to move outside the Windmill Hill Flats area and have been recorded from scrub around the Parade Ground as well as the area around Jew's Gate[9].

5.57 Rabbit populations are known from Windmill Hill Flats and the Upper Rock. Concerns have been expressed (Dr K Bensusan, 30$^{th}$ April) that the populations may become isolated as a result of the creation of a power station at the Lathbury Barracks site. It is not known to what extent there is currently any movement between these two populations, and the extent of any impact that would arise from the power station therefore remains speculative.

5.58 In addition to the issues discussed above, there is the potential for Barbary macaques to be attracted to the site through the presence of human activity and possibly food being made available. This may also lead to conflict with vehicles and other machinery associated with the development. There is therefore the possibility of a potentially **low significant adverse effect** arising.

### Birds

*Habitat Loss*

5.59 Construction of the proposed power station would result in a loss of potential breeding habitat for some passerines and other birds, eg Sardinian warbler, Barbary partridge. The potential nesting habitat is limited within the Lathbury Barracks site due to the majority of it being hardstanding, but some suitable habitat is associated with the vegetation around the Parade Ground. It is an offence under Part II of the Nature Protection Act 1991 (3.1) to take, damage or destroy a nest of any wild bird while that bird nest is in use or being built. Damage or destruction of such nests and loss of Barbary partridge habitat would result in a **high significant adverse effect**.

*Noise, Disturbance & Vibration from Operation*

5.60 There is evidence that noise and other sources of disturbance may result in a deterioration in habitat quality for some bird species[19]. Other species may, however, be able to benefit by occupying areas that become vacated by more sensitive ones. In the present case, it is assumed that most of the species present in the area are at least moderately tolerant of disturbance owing to the vicinity of MoD operations. Given that birds occupying territories associated with the vegetation around the Parade Ground are already likely to be displaced as a result of direct habitat loss, no additional significant adverse effects arising from disturbance are anticipated.

*Light Pollution from Operation*

5.61 Birds may be attracted to sources of light, especially during bad weather conditions. Different light sources have been shown to have different effects on migratory birds. Death can occur within these migratory passerine birds through collision, exhaustion caused by prolonged fluttering around the light, or predation[20]. Different light frequencies have been proven to have different levels of associated attraction. For example, strobe lights attract fewer birds than slow flashing or constant sources[20].

5.62 The potential effect of lighting at night from the power station on migratory birds is only likely to affect certain species. Raptors and storks fly using thermals and therefore fly during the day. As a result, lighting is not anticipated to have a significant effect on these birds. Passerines which sometimes fly and migrate during darkness are at the highest risk of being affected by lighting. The contribution of lighting at night from the power station in context of other existing and new build developments is considered to be negligible (Landscape Character and Visual Amenity Chapter, Volume 2: Technical Reports) and no significant effects are predicted.

*Disruption of Movement of Birds*

5.63 Many passerine migrants are reported to become grounded on Windmill Hill Flats during the pre and post nuptial migrations. The potential for an effect on passerine migration from the proposed power station has been raised on account of evidence that migrants grounded on Windmill Hill Flats gradually make their way along Lathbury up to the area of Jews Gate and further[9].

5.64 It is considered very likely that the presence of a power station would result in changes in the way that some migrants use the landscape in the vicinity of Lathbury. Specifically, it is anticipated that some species may be deterred by the presence of a power station, possible examples being northern and black-eared wheatears *Oenanthe oenanthe* and *O. hispanica*, which are reported sometimes to make landfall during the night on Windmill Hill Flats and make their way up the rock during the following day. Migrant birds do, however, possess very considerable powers of flight. Even northern wheatear appears able to continuous flights of considerable distances and the race *leucorhoa* has been suspected of migrating directly across the North Atlantic some 2,500 km from Greenland to mainland Europe[25]. In the context of the overall routes followed by migrating birds and even in the context of passage across the Straights of Gibraltar, any additional obstacle posed by the presence of a power station is considered to be small. And some migrants, for example barn swallow *Hirundo rustica* and common swift *Apus apus* (both listed on the Natura 2000 data form as passing through in large numbers (1,001-10,000 and > 10,000 respectively), are highly aerial and are considered unlikely to be affected by the proposals in any significant way. Based on information currently available, the presence of a power station is therefore not anticipated to result in more than local modifications to existing movement patterns (ie modifications to movement in the Lathbury area). The significance of any effect on migrating birds is therefore considered to be **very low to low**.

5.65 Disruption of movement also has the potential to increase the isolation of Barbary partridge populations on Windmill Hill Flats and the Upper Rock.

5.66 Some bird species are more prone to habitat fragmentation than others. This can depend on whether the species prefers an edge or interior habitat, the area of the habitat required and the ability of the bird to disperse from one area to another[21]. The smaller and more isolated the habitat fragment, the greater the chance of stochastic processes (random events) causing local extinction.

5.67 There are examples of wind farms where a barrier effect might lead indirectly to population level impacts. For example, where a wind farm effectively blocks a regularly used flight line between nesting and foraging areas[22].

5.68 The proposed power station has the potential to disturb any commuting corridor that may exist between the lower slopes and Wind Mill Hill Flats for Barbary partridges. Barbary partridge adults have high mobility and have the potential to navigate around the power station. The presence of a power station, however, with the associated disturbance that would arise in connection with its operation and construction, may result in adult birds being less inclined than previously to move between Windmill Hill Flats and the Upper Rock. It is also likely to act as a barrier to young birds before they are able to fly. The implications of such effects on the Gibraltar Barbary partridge population are difficult to judge on the basis of current information. Adopting the precautionary approach, a potentially **medium significant adverse effect** is therefore assumed.

*Noise, Disturbance & Vibration from Construction*

5.69 Disturbance to breeding birds may arise as a result of noise and other activities during the construction phase. Such disturbance is likely to be more unpredictable than during the operational phase and may therefore affect some species to a greater extent than would be the case during operation. Such activities may result in the pair of little owls that currently breeds in a hole in a limestone wall abandoning their nest site, for example.

5.70 The effects of noise, disturbance and vibration from construction are therefore likely to vary according to species and to be limited. But potentially **medium**

**significant and temporary adverse effects** may occur in the case of some species including little owl.

*Light Pollution from Construction*

5.71 Light pollution will be avoided during construction, as the majority of work will be conducted during daylight hours. It is therefore predicted that there will be no significant effect from construction lighting.

*Other Combined Effects*

5.72 In addition to the issues discussed above, there is the potential for yellow-legged gulls to be attracted to the site through the presence of human activity and possibly by food being made available. There is therefore the possibility of a potentially **medium significant adverse effect** arising.

**Terrestrial Reptiles**

*Habitat Loss, Noise, Disturbance & Vibration from Operation*

5.73 The vegetation and other features around the Parade Ground are used by several reptile species. Construction of the proposed power station would result in the loss of this habitat and would result in a potentially **medium significant adverse effect** for these species.

*Disruption of Movement of Reptiles*

5.74 There is insufficient information to determine whether any of the habitat around the Lathbury Barracks Parade Ground is used as a 'green corridor' by reptile species moving between Windmill Hill Flats and the Upper Rock. And, even if it were, the importance of such a movement corridor remains unknown. Given that the horseshoe whip snake is described as being common in vegetated areas in Gibraltar, it is assumed that the populations on Windmill Hill Flats and the Upper Rock are moderate or large. Any adverse effects arising from breaching a movement corridor are therefore likely to be small and are not considered likely to threaten the viability of the population(s) on Gibraltar. A similar conclusion is likely to apply to other common reptile species.

5.75 With regard to the rarer species including ocellated lizard of which a 'critically small' population is reported from Windmill Hill Flats and another 'extremely small' population is reported from the Upper Rock[12] the effects of a power station on disruption of movement are extremely difficult to assess. The potential impacts depend crucially on the extent to which the Lathbury Barracks area currently acts as a 'green link' and there is insufficient information to determine this. Therefore as a precautionary approach a potentially **medium significant adverse effect** is predicted**.**

5.76 It is not known whether Bedriaga's skink occurs in the vicinity of the proposals, although the closest known occurrence appears to be the Eastern Sand Slopes. In common with ocellated lizard, as a precautionary approach a potentially **medium significant adverse effect** is predicted**.**

### Terrestrial Invertebrates

*Pollution from Air Emissions*

5.77 There is insufficient published information relating to invertebrate species and the effects of air quality to establish the extent of any effects arising from air pollution from the new power station. The Air Quality Chapter records low air quality changes and it is considered that N deposition will not result in significant effects to invertebrates directly.

*Habitat Loss*

5.78 The vegetation around the Parade Ground is described as rich and supporting a corresponding diversity of invertebrate life[9]. Some of the invertebrate species including the leaf beetle *Tituboea biguttata* are restricted in distribution. Habitat loss is therefore considered to result in potentially **low significant adverse effects** on such species.

*Light Pollution from Operation*

5.79 There is insufficient information to determine the extent of likely impacts on invertebrates arising from light pollution with any certainty. it is noted that light can attract some invertebrate taxa which may, as a result of being present in an unnatural concentration, form prey for other animals. Moths being attracted to artificial light and then becoming consumed by bats are probably the best-know example of this. No evidence has, however, been found that any of the more noteworthy invertebrates reported from the area are likely to be affected in this way and therefore no significant effects are anticipated.

*Disruption of Movement of Fauna*

5.80 There is the potential for the habitat around the Parade Ground to act as a movement corridor for flightless invertebrates with populations on Windmill Hill Flats and the Upper Rock. If this were the case, then loss of such a corridor may have an impact on those populations. There appears, however, to be no evidence that this actually is the case and, given the distance between the two parts of the SCI and the likely range sizes of the invertebrates, such a movement corridor is considered unlikely to play a significant role in maintaining their population sizes.

## Loggerhead Turtle, Green Turtle and Bottle-nosed Dolphin

*Pollution Incidents*

5.81 Pollution is identified as one of the main pressures affecting loggerhead turtles. A potentially **medium significant adverse effect** may therefore occur in the event of any accidental pollution incident to marine waters, since similar effects might be anticipated with the other species.

### Marine Invertebrates

*Pollution Incidents*

5.82 The marine invertebrates are considered to be potentially susceptible to the effects of pollution. A potentially **medium significant adverse effect** may therefore occur in the event of any accidental pollution incident to marine waters, The invertebrate species are sedentary and therefore are at greater risk of effects from pollution incidents in their vicinity. These species also inhabit the intertidal zones and may be affected by terrestrial pollution incidents. Mussels by their nature are filter feeders and are known to be bio-accumulators and are sensitive to pollution.

# 6 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

6.1 The following mitigation is approved and committed to by the Government of Gibraltar.

## Mitigation

*Vegetation*

6.2 Potentially the effect with the greatest significance is associated with increased levels of nitrogen and the changes in the vegetation on parts of the Rock of Gibraltar SCI that may result.

6.3 The extent to which the Rock of Gibraltar SCI may be affected by nitrogen deposition is uncertain, although it is considered possible that such deposition may encourage more rapid seral succession. One possible means of mitigating such an effect is through management. Härdtle *et al.*[23] for example, found that high intensity management measures had the potential to preserve a long-term balanced nitrogen budget in heathlands. And Wilson *et al.*[24] discuss the importance of management as part of an integrated strategy to maintain grassland species diversity under the influence of increased nitrogen deposition. Habitat management may also improve the prospects of Schreiber's bat and Barbary partridge since vegetation succession or the lack of open areas is cited as one of the main pressures on these species. More site-specific information would, however, be required before an informed judgement could be made about the suitability of such an approach to the vegetation of the Rock of Gibraltar SCI.

6.4 A programme of monitoring for both NOx and nitrogen dioxide ($NO_2$) will be established across the SCI, as reported in the Air Quality Chapter. The sample points will relate to vegetation evaluation (discussed further below). This will allow existing pollutant concentrations to be more accurately determined and will allow the future impacts associated with the decommissioning of existing power generation facilities and the operation of the new power station, to be monitored.

6.5 A thorough monitoring regime will be implemented to measure both pollution outputs from the power station and changes in the vegetation of the SCI. This monitoring approach will assist in determining the type of any management that may be appropriate as corrective action should vegetation be negatively affected by pollutants from the power station. With such mitigation in place significant effects can be reduced, however, it is possible that **significant residual effects will remain**.

6.6 The relevant authorities and the Government of Gibraltar will agree the design and implementation of a suitable survey and monitoring protocol for the SCI vegetation. Habitat quality, diversity, rarity of species and species richness will be evaluated and levels of acceptable change, following the precautionary principle, will be applied. The relevant authority will be required to conduct monitoring for Appropriate Assessment (under the Habitats Directive) of favourable conservation status of the SCI. Where results show deterioration of sensitive important vegetation and habitat types, these will be compared with emissions data and NOx and $NO_2$ monitoring data to establish cause. Should the new power station be found to be the cause, immediate corrective action will be required, which may result in altering the SCR abatement levels or changing the stack heights to reduce deposition of pollutants within the SCI. This monitoring will be essential throughout the power station life.

6.7 Habitat loss will affect the vegetation around the Parade Ground. To mitigate the effects of such habitat loss, new landscaping (Figure E7-1) incorporated into the detailed design of the power station will be planted with locally native species. The species mix, including shrub and herbaceous plants for the benefit of various species including birds, and a detailed planting plan will be agreed with relevant authorities during the detailed design. The available area for planting is approximately 0.6 ha (equating to almost 75% of the current vegetated area).

6.8 The new power station administration buildings will include ecological roofs to extend the area available for wildlife. Brown roofs in similar climates have proved more successful than planted green roofs, as brown roofs require much less maintenance and develop locally representative vegetation naturally. The ecological roofs will be developed in detail by the Contractor and in agreement with relevant authorities.

6.9 Additionally, species protected under Schedule 3 of the Nature Protection Ordinance that currently occur on site will be conserved through the collection of seeds for sowing into the newly created landscaped areas in agreement with relevant authorities.

6.10 With these mitigation measures in place it is considered unlikely that significant adverse effects of habitat loss from the site will remain.

*Reefs and Sea Caves*

6.11 Adverse effects resulting from oil spillage and other pollution events will be avoided by the adoption of a Construction Environmental Management Plan (CEMP) and a specific Oil and Chemical Spill Contingency Plan for the construction and operation of the power station. With this management in place no residual significant effects are predicted.

*Bats*

6.12 Loss of potential foraging habitat will, to some extent, be mitigated by creation of new habitat as discussed under vegetation above.

6.13 There is a low risk of additional habitat loss for bats as a result of demolition of the ex-MoD pipe rifle range. It is considered unlikely that bats occur here, however, their presence cannot be ruled out and a precautionary approach will be adopted. This will include monitoring to assess the potential to act as a roost for bats and if bats are found appropriate additional mitigation will need to be put into place. To preclude this requirement and to enhance the site bat boxes and roof spaces for bats in buildings will be incorporated into the final design of the buildings. With such mitigation in place no residual significant effects are anticipated.

6.14 Although no adverse significant effects of lighting on roosting bats during the construction and operational phases of the power station are anticipated, required safety lighting will be low-level and directional. Careful positioning and selection of lighting has the potential also to assist in minimising any disruption to bat movements that may result from the presence of the power station across possible bat flight lines.

6.15 Adverse effects caused by disturbance to bats which may be roosting in caves or tunnels where works are undertaken will be minimised by means of timing the works to avoid the period when the bats are in residence. Adverse effects resulting from fuel leakage or spillage in roost sites will be avoided by the adoption of a CEMP. The extent of **residual significant effects** is uncertain and these may remain even with mitigation.

*Other Terrestrial Mammals*

6.16 Any adverse effects caused by disruption to movement of flightless mammals will be mitigated by the inclusion of natively planted terrestrial areas (and corridors) within and around the site to adjoin the Windmill Hill Flats area with the Upper Rock area. This will additionally meet the requirements of Policy Z7.10 of the 2007 Consultation Draft Gibraltar Development Plan. No significant residual effects are therefore predicted in the long term when planting has established.

6.17 Food waste will be removed from the construction site and vehicle movements and speeds controlled to minimise conflict between Barbary macaques and humans, resulting in no predicted residual significant effects.

*Birds*

6.18 Damage to or destruction of nests will be avoided by undertaking potentially damaging works such as scrub removal outside of the breeding season.

6.19 Adverse effects of lighting during the construction and operation phases of the power station will be minimised by using low-level and directional site safety lighting. No significant residual effects are predicted.

6.20 To the extent that migrant birds and others such as Barbary partridge are dependent on a 'green link' between the two elements of the SCI, any adverse effects caused by disruption to movement will be mitigated by the inclusion of newly planted areas and green corridors within the site. No residual significant effects are therefore predicted to remain.

6.21 There is little potential to mitigate any effects of operational noise and disturbance, although measures will be adopted to provide alternative habitat for some species. The provision of alternative nest sites for species, including the little owl, will be agreed with relevant authorities. **A low residual potential significant effect is predicted**.

6.22 Food waste will be managed and removed from the construction site to minimise the potential for nuisance arising from an increase in yellow-legged gulls. No residual significant effects are predicted.

*Terrestrial Reptiles*

6.23 There is little potential to mitigate any adverse effects of direct habitat loss on reptiles around the Parade Ground, although the new habitat creation may go some way to alleviate such effects. A programme of reptile survey and translocation (if present) will be agreed with relevant authorities.

6.24 To the extent that any of the rarer reptile species may be dependent on a 'green link' between the two elements of the SCI, any adverse effects caused by disruption to movement will be mitigated by incorporating terrestrial habitat, as discussed above. No residual significant effects to reptiles are predicted.

*Terrestrial Invertebrates*

6.25 The effects of habitat loss would be mitigated as far as possible by creation of new habitat that is appropriate to the needs of notable invertebrate species, including the provision of suitable food plants where relevant (e.g. lentisc).

6.26 To the extent that any of the rarer terrestrial invertebrate species may be dependent on a 'green link' between the two elements of the SCI, any adverse effects caused by disruption to movement will be mitigated by incorporating terrestrial habitat, as discussed above. No residual significant effects to terrestrial invertebrates are predicted.

*Loggerhead Turtle, Green Turtle and Bottle-nosed Dolphin*

6.27 Adverse effects resulting from oil spillage and other pollution events will be avoided by the adoption of a detailed CEMP and oil spill contingency plan. No residual significant effects are predicted.

*Marine Invertebrates*

6.28 Adverse effects resulting from oil spillage and other pollution events will be avoided by the adoption of a detailed CEMP and oil spill contingency plan. No residual significant effects are predicted.

### Residual Effects

6.29 There is potentially a residual significant effect of change in vegetation caused by pollution from air emissions on habitats within the Rock of Gibraltar SCI which are in close proximity to the proposed power station. Although these effects may be low, and monitoring and management will help alleviate the effect, potential **residual significant effects** may still be present.

6.30 Potentially there may be a residual significant effect on the disruption of bats moving through the site due to several factors such as noise, lighting and loss of green corridor. It is not possible to say whether this will be completely alleviated by the mitigation therefore an unknown level of **residual effect remains**.

6.31 A **low residual significant effect** is also predicted for some bird species from the combined effects of the power station.

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# APPENDIX EC-1

## Assessment for Site of Community Interest (SCI)

# CONTENTS

## GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| AA | Appropriate Assessment |
| CEH | Centre for Ecology and Hydrology |
| CEMP | Construction Environmental Management Plan |
| EC | European Community |
| EMF | Electromagnetic Field |
| EU | European Union |
| Gibraltar Nature Conservancy Council (GNCC) | Statutory body with responsibility for nature conservation in Gibraltar. The GNCC advises the Government of Gibraltar on nature conservation issues. |
| Gibraltar Nature Protection Ordinance | Legislation passed by the Government of Gibraltar and dealing with wildlife protection and nature conservation. |
| Gibraltar Ornithological and Nature History Society (GONHS) | Non-Governmental Organisation concerned with nature conservation in Gibraltar. GONHS also acts as a statutory consultee to the Government of Gibraltar on such matters. |
| IEEM | Institute of Ecology and Environmental Management. |
| Pers. comm. | Personal communication |
| SAEFL | Swiss Agency for the Environment, Forests and Landscape |
| Site of Community Importance (SCI) | An area designated under the EU Habitats Directive for inclusion in the Natura 2000 network of sites receiving the highest protection in recognition of their ecological value according to EU conservation priorities/objectives. |

# 1 INTRODUCTION

1.1 The aim of this report is to assess the potential significant adverse effects of the proposed new diesel power station at Lathbury Barracks upon European protected wildlife within the Rock of Gibraltar site of Community importance (SCI) and the Southern Waters SCI. Both are European designated wildlife sites.

1.2 The report is based upon existing information provided by the Government of Gibraltar. Site visits have been conducted for familiarisation and examination of selected areas where the proposed activities are to occur.

1.3 The Government of Gibraltar has requested this report to assist the production of an Appropriate Assessment and the Department of the Environment has guided the scope of this report. Consultation has been undertaken with Gibraltar Ornithological and Natural History Society (GONHS) and Gibraltar Nature Conservancy Council (GNCC).

1.4 The potential effects have been assessed upon an agreed list of receptors. These receptors/resources are those that are likely to occur in the vicinity of the proposed new power station and are potentially affected by the development as agreed with the Department of the Environment:

### Habitats

*Rock of Gibraltar SCI (* indicates a priority habitat)*

- 1240 – Vegetated sea cliffs with endemic *Limonium* species;
- 2220 – Dunes with *Euphorbia terracina**;
- 2230 – *Malcolmietalia* dune grasslands;
- 5230 – Mattoral with *Laurus nobilis*;*
- 5320 - Thermo-Mediterranean pre-steppe brush, with low formations of *Euphorbia* close to cliffs;
- 8210 – Calcareous rocky slopes with chasmophytic vegetation;
- 8310 – Caves not open to the public; and
- 9320 – *Olea* with *Ceratonia* forests.

*Southern Waters SCI*

- 1170 – Reefs (in relation to accidental spills); and
- 8330 – Sea caves (in relation to accidental spills).

**Species**

*Rock of Gibraltar SCI*

- *Miniopterus schreibersii* - Schreiber's bat;
- *Tadaria teniotis* – European free-tailed bat;
- *Coluber hippocrepis* - Horseshoe whip snake;
- *Chaclides bedriagae* – Bedriaga's skink; and
- *Macrothele calpeiana* - Gibraltar funnel-web spider.

1.5 The latter three species are not qualifying features of the SCI, however they have been included in this assessment since they are designated under Annex IV Of the EU Habitats Directive.

*Southern Waters SCI*

- *Caretta caretta* - Loggerhead turtle;
- *Chelonia mydas* – Green turtle;
- *Tursiops truncatus* - Bottle-nosed dolphin.
- *Patella ferruginea* – Mediterranean ribbed limpet*;*
- *Lithophaga lithophaga* – Date mussel*;*
- *Pinna nobilis* – Fan mussel;
- *Centrostephanus longispinus* – Long-spined sea urchin

1.6 The assessment methodology has included the requirement from the Government of Gibraltar to use appropriate assessment (AA) guidelines produced by the EU Environment DG[1]. This guidance is non-mandatory to assist Appropriate Assessments, required under Articles 6(3) and 6(4) of the EU Habitats Directive, where a project or plan may give rise to significant effects upon a SCI.

# 2 BACKGROUND

## Relevant Legislation

2.1 The Directive on Conservation of Natural Habitats and of Wild Fauna and Flora 92/43/EEC (the "Habitats Directive") identifies and protects a pan-European network of sites with high biodiversity, against negative effects of development. Sites of Community importance form part of this "Natura 2000" network. Developments must undergo AA to assess the potential for significant adverse effects on the integrity of the sites.

2.2 The core AA requirements of the Habitats Directive are as follows:

"**Article 6(3)** Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the sites conservation objectives. In the light of the conclusions of the assessment of the implications for the site and subject to the provisions of paragraph 4, the competent national authorities shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the site concerned and, if appropriate, after having obtained the opinion of the general public.

**Article 6(4)** If, in spite of a negative assessment of the implications for the site and in the absence of alternative solutions, a plan or project must nevertheless be carried out for imperative reasons of overriding public interest, including those of social or economic nature, the Member State shall take all compensatory measures necessary to ensure that the overall coherence of Natura 2000 is protected. It shall inform the Commission of the compensatory measures adopted.

Where the site concerned, hosts a priority natural habitat type and/or a priority species the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest."

2.3 Also key is the EU Birds Directive (1979), this and the Habitats Directive is transposed into national legislation through the Nature Protection Ordinance (1991) (as amended). In addition, the Ordinance provides protection to other species not specifically protected under European legislation. Part IIA of the Ordinance implements the Habitats Directive, and extends the level of legal protection for European protected species occurring in Gibraltar. Schedule 5 (reproduction of Annex IV(a) of the Habitats Directive) and Schedule 7 (reproduction of Annex IV(b) of the Habitats Directive) list European protected fauna and flora respectively.

2.4 Schedule 1 of the Nature Protection Ordinance lists those species of wild animals for which legal protection is provided, making it an offence to intentionally kill, injure or take any of the listed species. Schedule 3 of the Ordinance lists endangered species for which no licence shall be issued (under section 13 of the Ordinance) which may result in the extinction of that species in Gibraltar. Schedule 2 lists all plants that are not protected and therefore plants that are not on this list are protected.

### Location and Characteristics

2.5 The site of the proposed power station is situated towards the southern end of Gibraltar, between Windmill Hill Flats and the Upper Rock. Much of it occupies the parade ground which is an area of hard standing. The parade ground is at an altitude of approximately 120 m and occupies an area between the two components of the Rock of Gibraltar SCI. The Southern Waters SCI surrounds the southern part of Gibraltar.

# 3 APPROACH AND METHODOLOGY

3.1 The approach to this assessment has been to:

- Agree the scope of the assessment with the Government of Gibraltar;
- Conduct site familiarisation and investigation;
- Obtain baseline ecological data and information pertaining to the SCI and other Habitats Directive features related to the Rock of Gibraltar SCI and Southern Waters SCI from the Government of Gibraltar.
- Obtain information where available on proposed and consented development proposals and activities (confirmed with the Town Planner), and identify potential impacts;
- Assess the significance of effects of the potential impacts upon the protected features;
- Provide mitigation options if required and where possible; and
- Produce a report to the Government of Gibraltar to assist decision-making.

3.2 The EU Environment DG's guidance[1] on AA methodology has been used where qualifying features of the SCI may be significantly adversely affected. Figure 3-1 (page 8) shows the approach to considering projects affecting Natura 2000 sites (taken from the EU guidance). The detailed AA methodology can be found in the EU's guidance document and is not reproduced here.

3.3 There are various methodologies for determining and describing the significance of potential ecological effects of proposed activities on wildlife. This assessment has used, amongst others, guidance from the Institute of Ecology and Environmental Management (IEEM) on ecological impact assessment and significance criteria[2]. Significance criteria have included aspects such as habitat loss, fragmentation, severance, species disturbance and changes in species composition and density. These aspects are quantified where possible or dealt with qualitatively where data are not available.

3.4 The protected feature descriptions are based on the available information. The magnitude of the identified impacts is then assessed against the sensitivity of the protected feature. The magnitude of the identified potential impacts are assessed against the sensitivity of the protected wildlife features, in order to form a judgement about the significance of the effect.

3.5 Following the EU Environment DG's guidance on AA the assessment has followed a Stage 2 Appropriate Assessment, ie where significant effects are identified, appropriate mitigation measures to avoid or reduce such effects are recommended to be included as planning conditions.

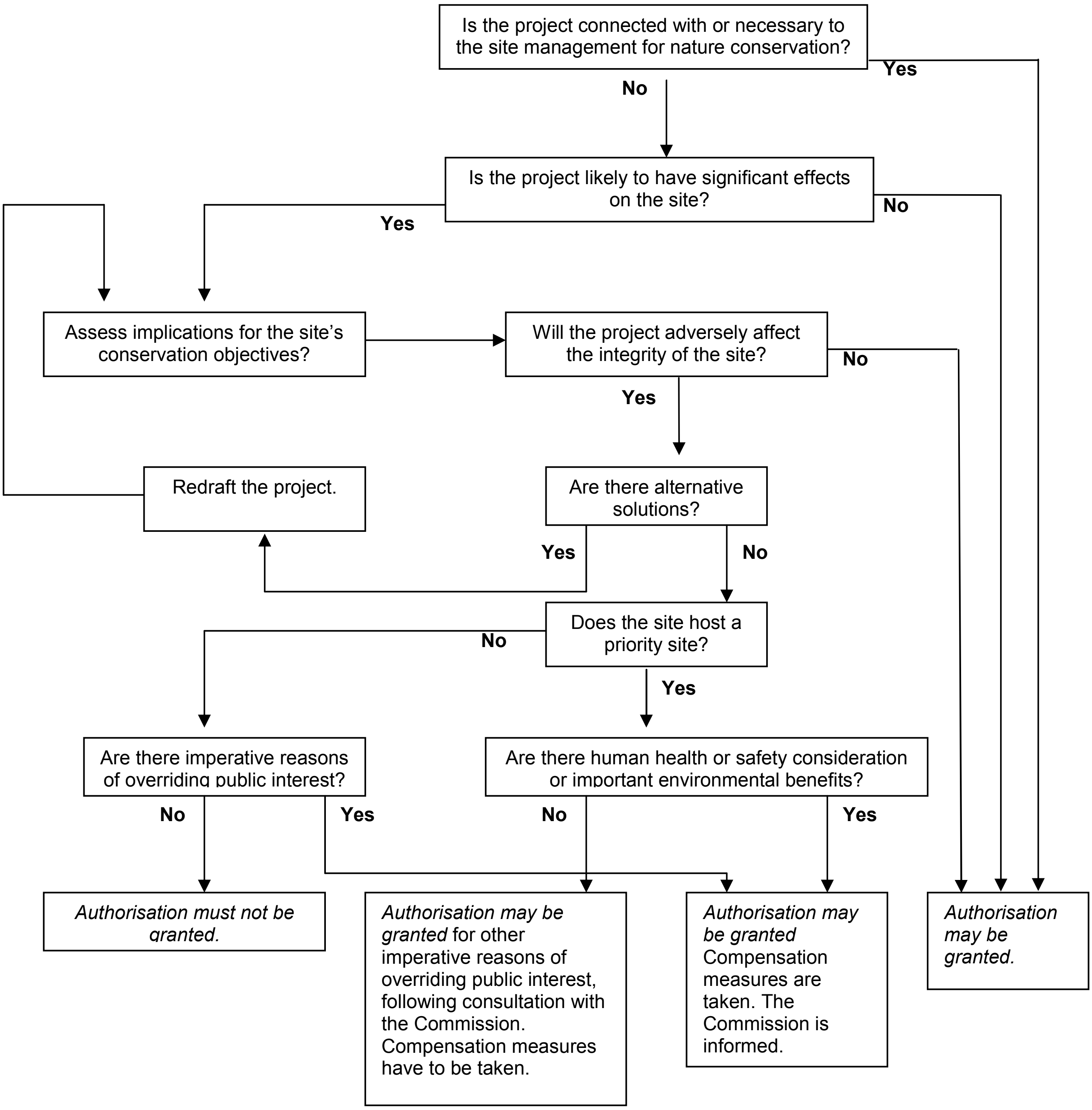
### Scope

3.6 The scope of this assessment was agreed with the Department of the Environment. The Department of the Environment consulted relevant parties including Gibraltar Ornithological and Natural History Society (GONHS), Gibraltar Nature Conservancy Council (GNCC) and the Government of Gibraltar Heritage Division.

### Limitations

- A limited amount of time has been available in which to undertake the ecological assessment. This has, in turn, imposed limits on the amount of fieldwork and background research that it has been possible to conduct and the amount of existing baseline data that it has been possible to obtain;
- The limited time available for original work has put greater emphasis on using existing data to best effect. However there are significant gaps in the existing data regarding several important issues that require consideration. These gaps include background nitrogen deposition rates, critical nitrogen loads for the most important vegetation types in the vicinity of the proposed diesel power station, the distribution and population dynamics of some of the species that require consideration as part of the assessment and disturbance effects on fauna;
- Safe access was not available to enter some of the features (eg caves or ex-MoD structures) that have the potential to be occupied by roosting bats;
- Additional uncertainty also arises as a result of the conceptual nature of the proposals. Some elements of the project have not yet been worked out in detail; and
- Vegetation in 'Assessment of Significant Effects' section is treated as a single entity because information on critical loads is not available for the individual vegetation types present on the Rock of Gibraltar SCI.

## Figure 3-1 Flow Chart of the Procedures for AA



# 4 DESCRIPTION OF PROJECTS AND POTENTIAL IMPACTS

### Summary Description of the Projects

4.1 The proposed developments and activities considered as potentially affecting the Rock of Gibraltar SCI and Southern Waters SCI are:

- Proposed new diesel power station at Lathbury Barracks Parade Ground;
- New HM Prison to the north of the Parade Ground;
- Crematorium/clinical waste incinerator at Europa Advance Road;
- Residential development area with 22 apartments and car parking at Old Junior Ranks Building West, Lathbury Barracks; and
- Nursing home with 56 beds and 21 closed care apartments at Old Junior Mess, Lathbury Barracks.

### Objectives of the Projects

4.2 None of the projects are for the management of the SCI.

### Potential Impacts – Direct Permanent (Operation) and Direct Temporary (Construction)

4.3 The proposed new power station will not cause direct impacts on the SCI since the development boundary excludes the SCI. Some potential for direct effects on bats outside the SCI has been identified. This is discussed separately in detail in the ES and summarised here.

### Potential Impacts – Indirect Permanent (Operation)

4.4 The development of the proposed new power station has the potential to cause indirect permanent impacts as set out below.

4.5 The main potentially significant effect on the habitats of the Rock of Gibraltar SCI is judged to be the possibility of change arising from the exhaust output of the power station, particularly NOx emissions.

4.6 The main potentially significant effect on the species of the Rock of Gibraltar SCI is judged to arise from disruption to movement of fauna between the two components of the SCI. Disruption of movement is also extended to include other forms of disruption including potentially adverse effects on bat foraging areas, causing bats and animals to forage elsewhere.

4.7 The main potentially significant effect on the habitats and species of the marine SCI during operation is considered to arise from the possibility of accidental pollution incidents.

### Potential Impacts – Indirect Temporary (Construction)

4.8 The main potentially significant effect on the habitats of the Rock of Gibraltar SCI during construction is considered to be the potential for dust deposition.

4.9 The main potentially significant effects on the species of the Rock of Gibraltar SCI during construction are considered to arise from disturbance and accidental pollution incidents.

### Potential Impacts – Cumulative

4.10 The potential for impacts to arise from a combination of the development proposals occurring at the same time or all together may result in cumulative impacts.

4.11 Potential cumulative impacts arising from disruption of movement to fauna may result in connection with the prison and possibly other development proposals.

# 5 EVALUATION OF IMPORTANT ECOLOGICAL FEATURES

5.1 There are two SCIs associated with Gibraltar; the Rock of Gibraltar and the Southern Waters of Gibraltar. Both are considered in more detail below.

## Important Features of the Rock of Gibraltar SCI

### *Habitats*

5.2 The habitats of the Rock of Gibraltar SCI that are to be assessed are listed in paragraph 1.4. They are discussed in terms of their conservation status and trends at the end of this section of the report.

5.3 Broad vegetation types include pseudosteppe, garigue and maquis. Some noteworthy plants are also associated with the cliffs, including the sea lavender *Limonium emarginatum*.

### *Species*

5.4 Schreiber's bat *Miniopterus schreibersi* and greater mouse-eared bat *Myotis myotis* are the two Annex II species listed on the Rock of Gibraltar SCI citation, although the latter species is now believed to be extinct in Gibraltar[3] and is not considered further here.

5.5 Additional species from the Rock of Gibraltar SCI to be considered in this report are free-tailed bat *Tadaria teniotis*, horseshoe whip snake *Coluber hippocrepis,* Bedriaga's skink *Chaclides bedraigae* and Gibraltar funnel-web spider *Macrothele calpeiana*.

### *Vulnerability*

5.6 The Natura 2000 Data Form (Version 2.1, 17/05/06) states that the Rock of Gibraltar is vulnerable to decreasing diversity due to seral changes and invasive plant species that affect mainly open ground plants, birds and bats. Three other problems are also identified: 1) feral cats and a high population of yellow-legged gulls, 2) possible pressure from urbanisation and 3) disturbance from visitor pressure.

### Important Features of the Southern Waters SCI

*Habitats*

5.7 The Southern Waters SCI supports reef and submerged or partially submerged sea cave habitats.

*Species*

5.8 Loggerhead turtle *Caretta caretta*, green turtle *Chelonia mydas*, bottle-nosed dolphin *Tursiops truncatus*, Mediterranean ribbed limpet *Patella ferruginea*, date mussel *Lithophaga lithophaga*, fan mussel *Pinna nobilis* and long-spined urchin *Centrostephanus longispinus* are the Annex II/Annex IV species listed on the Southern Waters SCI citation.

*Vulnerability*

5.9 The Natura 2000 Data Form (Version 2.1, 17/05/06) states that the Southern Waters SCI is vulnerable to disturbance, pollution from industries and illegal emissions from ships.

### Conservation Objectives for the Rock of Gibraltar SCI and the Southern Waters SCI

5.10 These are simply stated as being: 'to ensure that the status of European features pertaining to the Rock of Gibraltar SCI are maintained in a favourable condition allowing for natural change'. This description has been provided via the Department of the Environment.

### Habitat Features and Species of European Importance, Conservation Status and Underlying Trends[3]

*Rock of Gibraltar SCI*

<u>1240 – Vegetated sea cliffs of the Mediterranean coast with endemic *Limonium* spp.</u>

This habitat covers a range and surface area of 0.55 km$^2$ and is limited to a maximum altitude of approximately 150 m owing to the requirements of *Limonium*. The main pressures are identified as 1) pollution or human impacts/activities, 2) eutrophication (by gull droppings) and 3) invasive species. Threats are identified as 1) urbanised areas, human habitation, 2) mountaineering, rock climbing and speleology and 3) air pollution. The current trend is reported as stable in terms of both range and area covered.

2220 – Dunes with *Euphorbia terracina*.

5.11 This habitat covers a range of 1 km$^2$ and a surface area of 0.2 km$^2$. The main pressures are identified as invasive species. The main threat is identified as continuous urbanisation. The current trend is reported as 300% increasing in terms of range and 5% increasing in terms of area covered.

2230 – *Malcolmietalia* dune grassland.

5.12 This habitat is limited to the sand slopes on the east side of the Rock. It covers a range of 0.5 km$^2$ and a surface area of 0.25 km$^2$. The main pressures are identified as invasive species. The main threat is identified as continuous urbanisation. The current trend is reported as 100% increasing in terms of range and 50% increasing in terms of area covered.

5230 – Mattoral with *Laurus nobilis*.

5.13 This habitat is limited to small patches in the south and along the ridge of the Rock where relict vegetation is thought to have survived. It covers a range of 2 km$^2$ and a surface area of 0.08 km$^2$. The main pressures are identified as 1) air pollution and 2) interspecific floral competition. The main threats are identified as 1) urbanised areas, human habitation and 2) fire (natural). The current trend is reported as increasing in terms of range and 5% increasing in terms of area covered.

5320 – Thermo-Mediterranean pre-steppe brush, with low formations of *Euphorbia* close to cliffs

5.14 This habitat covers a range of 1 km$^2$ and a surface area of 800 m$^2$. The main pressures and threats are identified as 1) military manoeuvres and 2) vegetation succession of mattoral. The current trend is reported as stable in terms of both range and area covered.

8210 – Vegetated calcareous inland cliffs with chasmophytic vegetation

5.15 This habitat occupies the north face and east side cliffs to the end of the southern ridge of the Rock and some smaller cliffs on the western side of the Rock. It covers a range of 7 km and a surface area of 1.4 $km^2$. The main pressures are identified as eutrophication (by gull droppings). The main threats are identified as 1) mountaineering, rock climbing and speleology, 2) air pollution and 3) invasive species. No current trends are reported.

8310 – Caves not opened to the public

5.16 These are distributed throughout the Rock of Gibraltar. They cover a range of 5 $km^2$. The main pressures and threats are identified as 1) pollution, (deposition of litter and waste) 2) vandalism (including disturbance – at least one cave provides roosting habitat for Schreiber's bat) and 3) drying out. The current trends for range and area covered are reported as stable.

9320 – *Olea* with *Ceratonia* forests

5.17 This habitat occupies the western slopes. It covers a range of 3 $km^2$ and a surface area of 2.25 $km^2$. The main pressures are identified as 1) general forestry management, 2) pollution or human impacts/activities and 3) fire (natural). The main threats are identified as urbanised areas and human habitation. The current trend is reported as stable in terms of range and 10% increasing in terms of area covered.

*Miniopterus schreibersii* – Schreiber's bat

5.18 This species is reported to occupy a range of 4 $km^2$ and the population was estimated at between 101 and 250 individuals[3]. Dr K Bensusan[4] reports that over 300 bats were recorded in 2006 and 2007 although the highest number recorded in spring 2008 was around 200. The population is said to be transient, with the bats being present in their only known roost (close to O'Hara's Battery) mainly during the months of February to April and October to November[4,5]. The main pressures and threats are identified as 1) noise nuisance, 2) vandalism and 3) vegetation succession. The current trend is reported as stable although the future prospects are judged to be poor and the habitat is considered to be inadequate on account of succession.

*Tadarida teniotis* – European free-tailed bat

5.19 Little is known about the status of this species on Gibraltar. Numbers are extremely difficult to estimate because they roost disparately in crevices on cliffs[5].

*Coluber hippocrepis* – Horseshoe whip snake

5.20 This species has been reported from Windmill Hill Flats and on the Upper Rock Nature Reserve. It has been described as being common in vegetated areas of Gibraltar[4].

### *Chaclides bedriagae – Bedriaga's skink*

5.21 It is not known whether Bedriaga's skink occurs in the vicinity of the proposals, although the closest known occurrence appears to be the Eastern Sand Slopes.

*Macrothele calpeiana* – Gibraltar funnel-web spider

5.22 This species has been reported as uncommon in the Lathbury Barracks area, but common in other parts of Gibraltar[4]. It is found mainly in damp wooded areas in gardens and the Nature Reserve, occasionally in caves and buildings. Large populations are also known from the East Side. The species is not considered by relevant authorities to be under threat.

### *Southern Waters SCI*

1170 – Reefs

5.23 This habitat covers a range of 4 $km^2$ and surface area of 1.2 $km^2$. The main pressures are identified as 1) leisure fishing, 2) professional fishing, 3) nautical sports and 4) water pollution. Threats are identified as professional fishing. The current trends for range and area covered are reported as stable for natural reefs, although the overall amount of reef habitat is now larger than before, owing to the creation of several artificial reefs on the western side of the Rock.

8330 – Submerged or partly submerged sea caves

5.24 This habitat covers a range of 200 m, with a number of caves being distributed along a stretch of approximately 4.5 km. The main pressures are identified as sand and gravel extraction. Threats are identified as sea level rise due to climate change. The current trends for range and area covered are reported as stable.

*Caretta caretta* – Loggerhead turtle

5.25 This species is reported to occur regularly although casually within the entire territorial waters of Gibraltar. Numbers of animals are unknown – individuals are not always present and, when they are recorded, it is as single animals. The main pressures and threats are identified as 1) fixed location fishing, 2) shipping and 3) pollution or human impact/activities. The current trend is unknown.

### *Green turtle - Chelonia mydas*

5.26 Green turtles are reported to occur occasionally in the territorial waters of Gibraltar.

*Tursiops truncatus* – Bottle-nosed dolphin

5.27 This species is reported to occur regularly within the territorial waters of Gibraltar. The population size is estimated as a maximum of 17 animals. The main pressures and threats are identified as 1) professional fishing, 2) shipping and 3) pollution or human impact/activities. The current trend is stable for its range but unknown in terms of its habitat.

### *Marine invertebrates*

5.28 Four marine species are listed as qualifying species associated with the Southern Waters SCI. They are Mediterranean ribbed limpet *Patella ferruginea*, date mussel *Lithophaga lithophaga*, fan mussel *Pinna nobilis* and long-spined urchin *Centrostephanus longispinus*.

5.29 There is a species action plan for the Mediterranean ribbed limpet. The distribution of this limpet is reported as scarce along the rocky shorelines of

Gibraltar[6]. The main pressures and threats to the Mediterranean ribbed limpet are identified as 1) pollution (in particular oil pollution from oil refinery), 2) land reclamation activities and 3) change of current flows through development of the harbour area[6]. The population trend of this species is reported to be increasing[6]. The Mediterranean ribbed limpet is listed under Annex IV of the Habitats Directive[3].

5.30 The date mussel, fan mussel and long-spined urchin are all listed under Annex IV of the Habitats Directive[3]. It is considered that the main pressures and threats to these species will be the similar to the Mediterranean ribbed limpet.

# 6 ASSESSMENT OF SIGNIFICANT EFFECTS

6.1 The assessment of impacts upon the agreed list of receptors has been conducted at two levels. First, a list of potential effects of the proposals is applied to the list of receptors in the form of a matrix for each of the two SCIs. Such effects are deemed to be potentially significant or not, based upon a consideration of the ecology of the features involved and, particularly, having regard to the list of pressures and threats for each of the key features[3]. Air pollution, for example, has been identified as a threat to vegetated sea cliffs of the Mediterranean coast with endemic *Limonium* spp., and pollution from air emissions is therefore identified as being potentially significant in the appropriate cell of the matrix. This first level of the assessment is presented in Table 6-1 (Rock of Gibraltar SCI) and Table 6-2 (Southern Waters SCI).

6.2 Following this initial assessment, a more detailed analysis is presented for the potentially significant effects under a series of headings that consider each of the receptors in turn. In the case of Schreiber's bat (one of the qualifying features of the SCI), an extra category of 'additional issues' is added to address the potential for permanent impact on a potential roost feature outside the SCI.

6.3 Owing to a lack of detailed quantitative information on critical nitrogen loads, the Annex I habitat types for which the Rock of Gibraltar is designated are dealt with under a combined heading of 'vegetation' rather than individually by habitat type.

6.4 It has previously been suggested by the Department of the Environment (pers. comm.), that some adverse effects on the key interests of the SCI may occur as a result of electromagnetic fields (EMFs). Further to this study no significant effects are, however, anticipated as discussed below. Potential effects of EMFs are therefore not considered in the later sections of this report.

6.5 Electromagnetic field (EMF) consists of both electrical fields (caused by differences in voltage) and magnetic fields (caused by flowing currents). Electrical fields are attenuated by common materials including metals and building materials such as wood and brick, and are only a problem when dealing with air-insulated components such as overhead (bare) transmission lines and open bushings on high voltage transformers and switchgear. With insulated and screened cable, the potential difference is contained within the cable and the outside of the cable is at ground potential so there is no electrical field. In a similar way with indoor switchgear, the electrical field is contained within the equipment cabinets, enclosures and terminal boxes, so again there is no electric field to the outside.

6.6 Magnetic fields are caused by flowing current and are not attenuated by materials but can be cancelled out, eg in 3-core cables (rather than single over head conductors and single core cables). So with a system that uses 3-core cables, as in Gibraltar, the magnetic field is related to the residual (unbalanced) current in the cables, not simply the load current. The effect of increasing the voltage of the main transmission ring would in fact be to reduce the magnetic fields due to unbalanced current in the cabling by a factor of 3.

6.7 Measurements taken around substations incorporating transformers and switchgear indicate that the main areas of measurable magnetic field are associated with and local to, the incoming and outgoing cables, and the general level of magnetic field along the fenceline is virtually imperceptible from the background ambient levels.

**Table 6-1 Tabulation of Potentially Significant Effects on European Features Associated with the Rock of Gibraltar SCI or EU Protected Species.**

| *Feature* | *Indirect Effect Type* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Permanent* | | | | *Temporary* | | | |
| | *Pollution from Air Emissions* | *Noise, Disturbance & Vibration from Operation* | *Light Pollution from Operation* | *Disruption of Movement of Fauna* | *Pollution Incidents (Including Dust Deposition)* | *Noise, Disturbance & Vibration from Construction* | *Light Pollution from Construction* | *Construction Traffic* |
| *Vegetation* | PS | - | - | - | PS | - | - | - |
| *Caves not open to the public* | _ | (Note 1) | - | - | - | Note 1 | - | - |
| *Schrieber's bat* | (Note 2) | PS | PS | PS | PS | PS | PS | - |
| *European free-tailed bat* | (Note 2) | PS | PS | PS | (Note 3) | PS | PS | |
| *Horseshoe whip snake/Bedriaga's skink (Note 4)* | - | PS | - | PS | - | PS | - | PS |
| *Gibraltar funnel-web spider (Note 5)* | - | - | - | - | - | - | - | - |

**Footnotes:**

**PS:** denotes potentially significant, - denotes not significant.

**Note 1:** disturbance is not expected to affect caves directly but has the potential to affect Schreiber's bats using caves. This potential effect is discussed in the following text in the paragraphs that deal with Schreiber's bat.

**Note 2:** Nitrogen deposition has the potential to affect vegetation (see discussion) which may, in turn, affect the quality of bat foraging habitat, at least for Schreiber's bat which is believed to be adversely affected by vegetation succession.

**Note 3:** Being crevice-roosters, European free-tailed bats are not considered likely to be affected by pollution incidents since their roosts will not be in close proximity to anywhere where fuel is to be stored or transported by pipes etc.

**Note 4:** Bedriaga's skink is not known to occur in the immediate vicinity of the proposals but has been included on a precautionary basis and has been considered alongside horseshoe whip snake.

**Note 5:** No evidence of any mechanism whereby indirect significant adverse effects on this species might reasonably be expected to occur has been found during the course of preparation of this assessment report. Effects as a direct result of habitat loss outside the SCI are, however, possible. They are considered separately in the ES.

**Table 6-2 Tabulation of Potentially Significant Effects on European Features Associated with the Southern Waters SCI**

| *Feature* | *Indirect effect type* | | | | | | |
|---|---|---|---|---|---|---|---|
| | *Permanent* | | | | *Temporary* | | |
| | *Pollution from Air Emissions* | *Noise, Disturbance & Vibration from Operation* | *Light Pollution from Operation* | *Disruption of Movement of Fauna* | *Pollution Incidents* | *Noise, Disturbance & Vibration from Construction* | *Light Pollution from Construction* |
| *Reefs* | - | - | - | - | PS | - | - |
| *Submerged or partly submerged sea caves* | - | - | - | - | PS | - | - |
| *Loggerhead turtle/Green turtle* | - | - | - | - | PS | - | - |
| *Bottle-nosed dolphin* | - | - | - | - | PS | - | - |
| *Marine invertebrates* | - | - | - | - | PS | - | - |

**Footnote**:

**PS:** denotes potentially significant, - denotes not significant

## Potential Significant Effects of the Projects on European Features

*Vegetation*

Pollution from air emissions

6.8 The main potentially significant effect on the SCI is judged to be the possibility of change arising from the exhaust output of the power station, particularly NOx emissions. Air pollution is identified as one of the threats to the vegetated sea cliffs of the Mediterranean coast with endemic *Limonium* spp., for example. If vegetation change were to occur, it would be likely to take some time to manifest itself. Any potential effects at 2012 are unlikely to be large enough to be measurable and the following discussion is therefore focused on the possible situation at 2034.

6.9 The following discussion adopts a qualitative approach and begins with a consideration of broad principles before attempting to apply those to the specific details of the Rock of Gibraltar SCI.

6.10 The effects of gaseous pollutants such as NOx on sensitive receptors can be considered in terms of both critical levels and critical loads. A critical level may be defined as a concentration of a pollutant above which direct adverse effects on the receptor may occur. A critical load relates to the quantity of pollutant deposited above which significant adverse effects on the receptor may occur, often by indirect means.

6.11 As a general guide, an annual mean concentration of 30 µg $m^{-3}$ has been identified by the World Health Organisation as the critical limit beyond which direct damage to vegetation may occur. This figure has been derived experimentally, often by means of studies on crop plants. The true critical figure will vary from species to species and some groups of taxa (including lichens and bryophytes) contain species that are particularly sensitive, in part because they lack a cuticle and gas-exchange is not controlled via stomata. It is understood that the 30 µg $m^{-3}$ has no legal basis as a critical limit in Gibraltar, but it has been used here as a guide to levels of NOx that may be harmful to vegetation.

6.12 In addition to direct damage to vegetation, nitrogen deposition from gaseous pollutants may result in effects on vegetation. Potential causes underlying such effects include changes in: 1) the competitive balance between species, 2) herbivory, 3) mycorrhizal infection, 4) disease and 5) invasive species. In some cases, a spatial coincidence between high N deposition and non-native earthworm activity has also been noted[6]. Such causes may interact in complex and unpredictable ways.

6.13 There is considerable evidence that atmospheric N deposition has greatly increased since the start of the industrial revolution. A nearly ten-fold increase in the atmospheric deposition of reactive N is estimated to have occurred within the last 200 years[6]. In recent years, N deposition levels of 5-25 kg $ha^{-1}$ $year^{-1}$ have been reported for eastern North America and 50-60 kg $ha^{-1}$ $year^{-1}$ for northern Europe[7]. Some authors report even higher levels, with 85 kg $ha^{-1}$ $year^{-1}$ of N being deposited in the Netherlands (reported by Allen *et al.*[8]).

6.14 There is evidence that increased levels of nitrogen have affected vegetation or flora at large scales. In the British flora, for example, species characteristic of high nitrogen situations have increased whilst those characteristic of low nitrogen situations have declined[9] between 1930 and 1999. Atmospheric nitrogen deposition has been linked to changes in species composition within particular vegetation types. Evidence has been found that high N deposition levels are responsible for the dominance of the grass *Molinia caerulea* on ombrotrophic bogs in the Netherlands, for example[10].

6.15 The extent to which different plant communities may be affected by atmospheric N deposition depends on many factors including the amount of N being deposited, the buffering capacity of the system, soil nutrient status and soil factors that influence the nitrification potential and nitrogen immobilization rate[11].

6.16 Attempts have been made to establish critical loads for N deposition for various vegetation types (e.g.[12]) and maps have been produced to provide an indication of where such critical loads are being exceeded (e.g. [13]). Determination of critical loads may, however, be problematic. Not only may the critical nitrogen level for a particular vegetation type vary considerably depending on the levels of other nutrients such as phosphorus[e.g.14], but it may take many years for any effects to manifest themselves. Effects of N on alpine plant communities have been detected over a ten year study period that would not have been detected over the more usual two or three year studies[15], and in the longest-running ecological experiment in existence (Park Grass, Rothamstead, UK), plant communities continued to change even at the aggregate level (grasses/legumes/others) for more than 40 years[16].

6.17 To establish the likelihood of significant effects on the vegetation of the Rock of Gibraltar SCI, it is necessary to consider the sensitivity of the vegetation to N deposition and the amount of N deposition likely to occur. Any additional deposition of N arising from the power station needs to be considered in the context of the existing and likely future levels of N deposition in order to determine, for example, whether it is likely to cause exceedance of an established or agreed critical level.

6.18 Currently there appear to be very few data regarding critical levels of N deposition on Mediterranean vegetation and several publications (eg Swiss Agency for the Environment, Forest and Landscape (SAEFL)[17]) have identified the lack of information about nitrogen impacts on all Mediterranean vegetation types as constituting important gaps in knowledge (see Limitations).

6.19 Kuylenstierna *et al.*[13] provide a qualitative scale of sensitivity to nitrogen deposition for various vegetation types. Sensitivity ranges from Class 1 (least sensitive) to Class 4 (most sensitive). Much of the vegetation of the Rock of Gibraltar SCI in the region where the increase in NOx is predicted to be greatest probably falls best under the broad category of 'Mediterranean scrub' which is placed in Class 2. A direct comparison between the classes of Kuylenstierna *et al.* and other published data is not straightforward because the vegetation categories seldom coincide. But, as a rough approximation, critical loads published by Centre for Ecology and Hydrology (CEH)[18] for other categories of vegetation within Class 2 appear typically to fall within the limits of 30-40 kg N $ha^{-1}$ $year^{-1}$ (tidal flats) down to 10-15 kg N $ha^{-1}$ $year^{-1}$ (oak and beech woodland). One of the Annex I habitats for which the Rock of Gibraltar SCI is designated is 'calcareous rocky slopes with chasmophytic vegetation'.

This category is given a critical load of 10-15 kg N $ha^{-1}$ $year^{-1}$ by CEH[18]. In the absence of better data, a level of 10 kg N $ha^{-1}$ $year^{-1}$ is taken as being the critical level for the Rock of Gibraltar SCI vegetation as a whole.

6.20 The proposed power station is anticipated to result in increased levels of N deposition of up to approximately 0.5 kg N $ha^{-1}$ $year^{-1}$, although an increase at this level is anticipated to be localised to an area of approximately 4 hectares (approximately 2% of the SCI).

6.21 In absolute terms relative to 'typical' levels of N deposition in western Europe, a level of 0.5 kg $ha^{-1}$ $year^{-1}$ is quite a small amount. It is around one or two orders of magnitude below the levels of nitrogen that are typically applied in experiments designed to investigate the effects of elevated N on vegetation and less than 1% of the levels that have been reported from some European countries. On the other hand, however, N deposition of 0.5 kg $ha^{-1}$ $year^{-1}$ would represent 5% of the assumed critical load of the vegetation. There are, however, no data available to establish current levels of N deposition on the SCI, and there is therefore no way of knowing whether the vegetation is already exceeding its critical limit, whether a 5% increase would cause this limit to be exceeded or whether the vegetation would remain below its critical limit despite a 5% increase in nitrogen deposition.

6.22 Given the lack of information regarding several key questions and in the light of the preceding discussion, it remains a possibility that the predicted increase in N deposition may cause the critical level to be exceeded, at least in parts of the SCI.

6.23 The effects of any exceedance of the critical N deposition level needs to be considered in connection with the integrity of the SCI. The Rock of Gibraltar SCI is identified as being vulnerable to seral changes and invasive plants (see paragraph 5.6). Some studies have linked an increase in nutrient deposition with an increased risk of invasion by alien plants (e.g.[19, 20, 21]) and it is possible that seral changes may be facilitated by a nutrient increase. van Wijnen and Bakker[22], for example, found evidence to support the hypothesis that nitrogen is an important determinant of successional processes in salt marshes and a similar conclusion might be expected to apply to many other vegetation types since nitrogen is the limiting factor in many sensitive ecosystems[e.g.11].

6.24 It is evident from the issues considered above, that there is a significant element of uncertainty about the effects of the proposed power station on the Rock of Gibraltar SCI. It is by no means certain that the effect of the proposals would adversely affect the integrity of the SCI (ie the 'coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations of the species for which it was classified'). Equally, however, it is not possible to rule out such an adverse effect. Guidance (eg IEEM[2]) indicates that, where there is reasonable uncertainty about an outcome, the precautionary principle applies. A potentially **adverse effect** is therefore assumed.

6.25 In connection with the critical limit of NOx, the EA has advised that the existing background levels are those measured at Bleak House, i.e. 40 $\mu g\ m^{-3}$. It is predicted that the proposed power station would increase this by a maximum of 5 $\mu g\ m^{-3}$ or by some 13%. The existing NOx concentration is some 30% greater than the 30 $\mu g\ m^{-3}$ level that has been shown to be damaging to some vascular plant species under experimental conditions although there appears to be no evidence to suggest that current NOx levels are causing direct harm to the vegetation of the SCI. The effect of a maximum addition of 5 $\mu g\ m^{-3}$ NOx to the existing situation is therefore unclear. Some degree of adverse effect can not be ruled out, although directly phytotoxic levels of NOx appear likely to be very localised[7]. But, adopting the precautionary principle, a potentially **adverse effect** is assumed.

Dust deposition

6.26 The part of the Rock of Gibraltar SCI that lies closest to the site of the proposed development is the 125 metre rifle range. Dust deposition is considered unlikely to result in significant effects on the rifle range vegetation because it is regularly mown and dust is therefore unlikely to build up in sufficient quantities to affect the physiological performance of the plants. Some dust accumulation on more distant and less intensively managed vegetation remains a possibility, although the levels of deposition are likely to be so low, as to result in no measurable adverse effects and with good construction practices dust deposition will be kept to a minimum.

*Schreiber's Bat*

6.27 Noise, disturbance and vibration followed by light pollution are discussed separately below. Any effects arising from such causes are, however, considered most likely to manifest themselves through some kind of disruption to movement including flightlines and foraging. The discussion about these potential causes of disturbance is therefore drawn together under the category of 'disruption of foraging'.

<u>Noise, disturbance & vibration from operation</u>

6.28 The noise and vibration results from the technical chapter of the ES have showed that there are no significant adverse disturbance effects on humans resulting from noise and vibration after mitigation for the proposed power station. But the vibration criteria are based upon damage caused to buildings not cave systems etc, and there appear to be few data on the effects of noise and vibration on bats under circumstances similar to those that would prevail during the operation of the proposed power station. Some qualitative observations regarding the likelihood of effects are, however, made in the following text.

6.29 Direct effects on the physical structure of the only known roost are considered unlikely. The cave roost is some 700 m from the location of the proposed power station. Given that the levels of noise and vibration are sufficiently low to avoid damage to buildings at a much closer distance than this , no damage to the cave structure is anticipated.

6.30 It is possible that other (unknown) roosts are closer to the location of the proposed power station. But levels of noise and vibration are considered to be sufficiently low to avoid structural damage to the cliffs and other known features in the rock (tunnels etc) nearby, and therefore the integrity of the structure of any unknown roosts nearby is considered unlikely to be compromised by the proposals.

6.31 The effects of the operation of the proposed power station on any bats within roosts is harder to assess. Under some circumstances, bats may undoubtedly be disturbed by human activity in various forms. On the other hand, bats of at least some species may tolerate levels of 'disturbance' that can appear quite intrusive to humans. Examples of the latter include maternity roosts and hibernation sites of brown long-eared *Plecotus auritus*, greater horseshoe *Rhinolophus ferrumequinum* and lesser horseshoe *R. hipposideros* bats in close proximity to busy railway lines where passing trains result in very obvious noise and vibration (pers. obs.). But the effects of noise and vibration are likely to vary from species to species and no information has been obtained that relates specifically to Schreiber's bats.

6.32 Additionally, assessment of the effects of any new disturbance is likely to be complicated by the intensity, frequency and nature of existing disturbances. These are not known, although it is noted that military manouvres certainly result in intermittent noise and presumably also vibration.

6.33 Overall, it is considered unlikely that the operation of the power station would result in any significant adverse effects on Schreiber's bats occupying the only known roost, simply because the roost is probably sufficiently far away for any noise and vibration from the power station to merge into the existing background levels. The effects that noise and vibration might have on any unknown roosts are, however, impossible to predict because the effects would depend on the location of the roosts.

6.34 In terms of the potential effects of noise and vibration on foraging bats, it is not possible to make an assessment. The exact frequency of noises emitted from the power station are not yet known and there is insufficient information about how such noises might interfere with foraging. It is possible, for example, that power station noise might interfere with the echolocation used by bats. Potentially, noise and vibration might discourage Schreiber's bats from flying in the vicinity of the power station.

<u>Light pollution from operation</u>

6.35 Light pollution during operation could have an effect on Schreiber's bats. Light pollution from artificial light sources has been proved to increase orientation or disorientation in various animals. Lighting at night can attract and repulse fauna. This can affect foraging, reproduction, communication and other critical behaviours[23]. Artificial light can disrupt interspecific interactions evolved in natural patterns of light and dark with potentially serious implications for community ecology[23]. Light pollution may therefore have an effect via disruption of foraging as discussed below.

6.36 Bats have been shown to be disturbed by artificial light sources which can affect the timing of emergence from roost[24]. However less is known about the effect of lighting at night on foraging paths, and lighting can have a positive effect by providing clusters of insects for feeding. Lighting of the proposed power station is unlikely to affect the Schreiber's bats emerging from the only known roost due to the positioning and distance of roost from the power station. However, the effect on disturbance of movement remains uncertain.

Disruption of movement

6.37 It is likely that Windmill Hill Flats is used for foraging by Schreiber's bats, since the habitat appears to be very suitable. The only known roost of this species is located close to O'Hara's Battery. The proposed power station would occupy land between these two locations and it is therefore possible that it may cause some disturbance to any commuting pathways between the roost in the tunnel and foraging grounds over Windmill Hill Flats. It is understood that Schreiber's bats have been detected foraging above the Lathbury Barracks Parade Ground. Further studies are required to determine the exact use of the landscape for foraging and as a potential commuting corridor. For this assessment, it is assumed that bats do use the site to commute for foraging between Wind Mill Hill Flats and the Upper Rock.

6.38 In general, bats are highly mobile and acute flyers and able to avoid obstacles. However they are potentially sensitive to disturbance due to human activities and disruption to movement of animals may occur through the effects of light pollution and other causes of disturbance as discussed above. Limited research has been undertaken of the effects of disturbance of commuting routes. It is therefore hard to establish the effect that the power station may have on the bats within Gibraltar. The power station would not cause total severance and bats could fly over or around the structure to the east or west. However the extent to which bats may be deterred from moving between roosts and foraging grounds by the proposed power station is not known. In the absence of the additional effects of noise, vibration, disturbance and light pollution (ie considered purely as an inert physical structure), effects of the power station on bats would probably be minor. But these additional potential effects need to be considered as a group in order to assess the likelihood of an effect.

6.39 In addition, it is noted that Policy Z7.10 of the 2007 Consultation Draft Gibraltar Development Plan, makes reference to maintaining the natural linkages in the Lathbury Barracks area, specifically:

> *The Commission shall seek to ensure that appropriate provision is made in future development in the Lathbury Barracks area for green corridors and green roofs to assist in maintaining the natural linkages between Windmill Hill and the Upper Rock.*

6.40 Although the policy makes no reference to any particular taxon or group of taxa, the power station as currently proposed would hinder the implementation of Policy Z7.10.

6.41 In the absence of detailed information about the proposed lighting, the effects of other kinds of disturbance and use of the landscape around the proposed power station by bats, coupled with considerations associated with Policy Z7.10 (see also potentially significant issues associated with the prison under cumulative effects at the end of this section), a potentially **adverse effect** is assumed.

Pollution incidents

6.42 Temporary effects from pollution may occur as a result of accidental fuel spill if the fuel is spilt within an underground area that is occupied by Schreiber's bats. No fuel lines or storage tanks are proposed in or adjacent to the only currently-known roost and an impact of this kind would therefore only occur if a new roost were discovered within one of the tunnels or the Admiralty Oil Tank Chambers where fuel pipes or fuel storage are proposed. A potentially

**adverse effect** could, however, occur if this was the case and a fuel spillage occurred.

Noise, disturbance & vibration from construction

6.43 The potential effects here will be intermittent rather than continuous. The main potential for noise, disturbance and vibration to affect bats during construction is through disturbance to roosts, since it is anticipated that the works would mostly be undertaken during daylight hours. If any bat roosts were to be encountered in caves or tunnels where fuel storage or fuel pipes were to be situated, there is the potential for disturbance to roosting bats.

6.44 The only effects on foraging or otherwise active bats away from the roost are likely to arise as a result of works undertaken during the hours of darkness.

6.45 The presence of any bat roosts in the vicinity of proposed works is unknown. Given the uncertainty, a potentially **adverse effect** is assumed. However it is important to note that a certain level of intermittent noise, disturbance and possibly vibration does already occur due to exercises undertaken on MoD land adjacent to the parade ground. Additional effects arising from the construction of the proposed power station may therefore be less significant than would otherwise be the case ..

6.46 The noise and vibration during construction will be carried out in daylight hours and therefore should not disturb foraging Schreiber‘s bats. The known Schreiber’s bat roost is at such a distance from the site that no effect is anticipated to occur, for the reasons discussed above.

Light pollution from construction

6.47 Light pollution during construction may have an adverse effect on foraging Schreiber's bats for the same reasons as light pollution during operation, although this would only occur if there were a need to illuminate the site after dark. In the absence of detailed information about the proposed lighting and use of the landscape around the proposed power station by bats, a potentially **adverse effect** is assumed.

Additional issues

6.48 The proposed development would result in the destruction of the Pipe Range, an underground shooting range at the eastern end of the parade ground outside the SCI. It was not possible to examine this structure internally and the presence of a bat roost within it can not be ruled out, although there is equally no reason to suppose that a roost is present. If a roost were, however, to be present in that location, a potentially **adverse effect** could arise since Schreiber's bats are not only protected but are also a qualifying feature of the SCI and loss of a roost, even outside the SCI, might affect its integrity.

### *European Free-Tailed Bat*

Noise, disturbance & vibration from operation

6.49 The considerations associated with this category of potentially disturbing factors are similar to those discussed under Schreiber's bat above.

Light pollution from operation

6.50 The considerations associated with this category of potentially disturbing factors are similar to those discussed under Schreiber's bat above.

Disruption of movement of fauna

6.51 Any disruption of movement arising from the power station is likely to arise by the combined effects of lighting and other forms of disturbance rather than the existence of a power station *per se*. Such potential disruption is discussed under Schreiber's bat above and also below under cumulative effects. For the reasons given in the discussion relating to Schreiber's bat, an **adverse effect** is assumed.

Noise, disturbance & vibration from construction

6.52 Minor noise, disturbance and vibration effects are possible as discussed under Schreiber's bat above.

Light pollution from construction

6.53 A potentially **adverse effect** is assumed, for the same reasons as discussed under Schreiber's bat above.

*Horseshoe Whipsnake/Bedriaga's Skink*

Disruption of movement of fauna

6.54 There is insufficient information to determine whether any of the habitats around Lathbury Barracks parade ground are used as a movement corridor by either species between Windmill Hill Flats and the Upper Rock, and, even if they were, the importance of such a movement corridor remains unknown. Given that the horseshoe whip snake is described as being common in vegetated areas in Gibraltar, it is assumed that the populations on Windmill Hill Flats and the Upper Rock are large. Any adverse effects arising from breaching a movement corridor are therefore likely to be small and are not considered likely to threaten the viability of the population(s) on Gibraltar. But, as noted above in the context of Schreiber's bat, Policy Z7.10 of the 2007 Consultation Draft Gibraltar Development Plan emphasises the need for green corridors to maintain natural linkages between these two parts of the SCI. Bedriaga's skink is reported to occur on the Eastern Sand Slopes. Although no information has been found to suggest that the Lathbury area provides an important movement corridor for this species, maintenance of habitat links between the two parts of the SCI remains desirable both as a precaution and for the Policy reason cited above.

Noise, disturbance & vibration from operation

6.55 It is predicted that the effects of noise and vibration are likely to be minor because there is little suitable habitat immediately around the proposed power station and, in any event, any animals here are presumably habituated to disturbance from military manoeuvres.

Noise, disturbance vibration and traffic from construction

6.56 See noise, disturbance & vibration from operation.

6.57 Potentially, these species may have an increased chance of fatality due to traffic for construction. However they are highly mobile and the predicted increase in traffic is low so no significant effect is expected.

*Reefs*

Pollution incidents

6.58 Water pollution is identified as one of the main pressures affecting reefs. The transportation of fuel by sea and storage of fuel within barges present a risk of accidental fuel spillage. A potentially **adverse effect** is expected in the event of any accidental pollution incident.

*Submerged or Partly Submerged Sea Caves*

Pollution incidents

6.59 Although water pollution is not identified as one of the main pressures affecting submerged or partially submerged sea caves, any fuel spillage does have the potential at least to affect partially submerged caves. A potentially **adverse effect** is expected in the event of any accidental pollution incident.

*Loggerhead Turtle/Green Turtle*

Pollution incidents

6.60 Pollution is identified as one of the main pressures affecting loggerhead turtles. A potentially **adverse effect** is expected in the event of any accidental pollution incident in the case of both species.

*Bottle-nosed Dolphin*

Pollution incidents

6.61 Pollution is identified as one of the main pressures affecting bottle-nosed dolphin. A potentially **adverse effect** is expected in the event of any accidental pollution incident.

*Marine Invertebrates*

Pollution incidents

6.62 The marine invertebrates are considered to be potentially susceptible to the effects of pollution. A potentially **adverse effect** may therefore occur in the event of any accidental pollution incident to marine waters,

*Cumulative Effects*

6.63 There is the potential for several cumulative effects, arising both from different aspects of the proposed power station and also in combination with other projects. Insufficient information is available to consider such effects fully but a brief discussion is presented below.

*Vegetation*

6.64 Air pollution is considered to be a potentially significant issue affecting the vegetation of the SCI. Predicted changes in background levels of pollution are unknown but have the potential to affect the significance of any effects arising from the proposed power station. A general reduction in background levels may act to lessen any effects of the proposed power station.

*Bats*

6.65 The potential has been identified for the proposed power station to disrupt movement of bats between the two parts of the terrestrial SCI, particularly as a result of lighting and other forms of disturbance including noise and vibration. It is, however, not possible to be certain about such potential effects owing to a lack of detailed information about bat movements. But, even if such information were known, the situation is likely to be complicated by the presence of a prison since it is likely to be illuminated in which case it might act to disrupt existing patterns of movement quite independently of any effects arising from the proposed power station. There is too great a degree of uncertainty to establish the likely cumulative effects of these two developments.

6.66 Any effects of disturbance during construction may have to be considered alongside other construction work occurring in the vicinity at the same time.

Any cumulative effects would depend upon the programming of the different projects and this is currently unknown.

6.67 There is the potential for a reduction in quality of bat foraging habitat to be exacerbated by nutrient deposition which may encourage the successional process. If this were the case, the reduction of foraging quality would further add to any adverse effects on bat movement that may occur between Windmill Hill Flats and the Upper Rock.

# 7 RECOMMENDATIONS

7.1 This section discusses mitigation (using avoidance where possible) to minimise adverse effects on the two SCIs and other features considered in this report. Although theses are recommendations, where mitigation has been approved and committed to by the Government of Gibraltar this is clearly stated. Mitigation will require the involvement of relevant authorities and agreement of specific measures to achieve the protection of the European protected species and habitats that may potentially be affected by the power station. Further field survey and evaluation is required to obtain a clearer understanding of the conservation status of the qualifying features of the SCIs.

### Mitigation of Potentially Significant Effects

7.2 There are potentially significant effects arising from the proposed power station and cumulative effects of other specified projects. These are:

- Adverse effects on the different vegetation types arising especially from increased air pollution;
- Disruption of bat movements both during construction and operation;
- Disturbance of bats in roosts;
- Effects of fuel spill in locations where Schreiber's bats are roosting; and
- Effects of fuel spill on reefs, sea caves, loggerhead turtle and bottle-nosed dolphin.

7.3 In addition, although the potential for disruption of movement of horseshoe whip snake is judged to be minor, Policy Z7.10 of the 2007 Consultation Draft Gibraltar Development Plan emphasises the need for green corridors to maintain natural linkages between these two parts of the SCI. So, irrespective of any effects on the horseshoe whip snake, construction of the proposed power station would have an adverse effect on the implementation of this policy.

7.4 The following mitigation measures will be adopted by the Government of Gibraltar, They have the potential to overcome some of these potentially adverse effects, although there remains a significant level of uncertainty owing to the limited amount of background data available and the limited amount of available information on the success of some of the techniques. Mitigation is discussed below, taking each of the points in turn.

*Effects on Vegetation Arising from Air Pollution*

7.5 The extent to which the Rock of Gibraltar SCI may be affected by nitrogen deposition is uncertain, although it is considered possible that such deposition may encourage more rapid seral succession. One possible means of mitigating such an effect is through management. Härdtle *et al.*[25], for example, found that high intensity management measures had the potential to preserve a long-term balanced nitrogen budget in heathlands. And Wilson *et al.*[12] discuss the importance of management as part of an integrated strategy to maintain grassland species diversity under the influence of increased nitrogen deposition. Habitat management will improve the prospects of Schreiber's bat since vegetation succession is cited as one of the main pressures on the species. More site-specific information will, however, be required before an informed judgement can be made about the suitability of such an approach to the vegetation of the Rock of Gibraltar SCI, owing to the complexity of the issues and potential interactions involved.

7.6 A thorough monitoring plan will be implemented that will measure both pollution outputs from the power station and changes in the vegetation of the SCI. This monitoring will assist in determining the type of any management or corrective action that may be appropriate. The design and implementation of the monitoring and corrective action regime will be dependent upon the outcome of various decision-making processes (including EIA certification) and the detailed design. The Government of Gibraltar takes responsibility with relevant authorities in the ownership and implementation of the monitoring and correction action plan.

*Disruption of Bat Movements during Construction and Operation*

7.7 Disruption of bat movements during construction will be minimised by adopting a CEMP that includes specific measures to avoid the need for illumination at night by the appropriate timing of operations. If some lighting is required throughout the construction period for safety purposes, it will be ensured that such lighting is kept to minimum acceptable levels and is directional to minimise disturbance.

7.8 During the operational phase, effects on bat movements cwill be minimised by keeping lighting to the minimum acceptable level and by using directional lighting. The details of the lighting will be determined following survey work to establish bat flightlines and activity patterns.

*Disturbance of Bats in Roosts*

7.9 Disturbance will be minimised by undertaking a full survey of potential roost features within the area likely to be affected by noise, vibration and other disturbances (eg fitting fuel pipes in tunnels). Then, as far as is possible, by timing operations in such a way that disturbance effects are minimised.

*Effects of Fuel Spill in Places where Schreiber's Bats are Roosting*

7.10 Adverse effects resulting from fuel leakage or spillage in roost sites will be avoided by the adoption of a CEMP.

*Effects of Fuel Spill on Reefs, Sea Caves, Loggerhead Turtle and Bottle-nosed Dolphin*

7.11 Adverse effects resulting from oil spillage and other pollution events will be avoided by the adoption of a CEMP and a specific Oil and Chemical Spill Contingency Plan for the construction and operation of the power station.

7.12 There are numerous uncertainties involved in establishing the likely effects of the proposals, particularly on the terrestrial SCI. The likely success of some of the mitigation measures is also uncertain, since it depends on some measure of the effects. It is therefore not possible to be certain that the proposed power station will not affect the integrity of the Rock of Gibraltar SCI. Specifically, the issues which are associated with the greatest levels of uncertainty are considered to be:

- The extent of air pollution effects on vegetation, especially given 1) the lack of information on baseline and predicted future conditions in the absence of the power station, 2) the lack of information about critical levels of N deposition for the different vegetation types, 3) uncertainty about the extent of combined effects, and 4) uncertainty about the extent to which management may compensate for any changes to the vegetation arising from increased nutrient deposition.
- The extent of any disruption of bat movements during construction and, more particularly, operation, especially given 1) incomplete knowledge about roost locations and a lack of information about how bats currently use the landscape, 2) uncertainties associated with other developments in the vicinity and how they might affect existing bat movements in the absence of the power station, and 3) uncertainty about whether there is sufficient flexibility in the lighting arrangements to mitigate any adverse effects.

7.13 Given that the other potential effects identified in this report are likely to be short-term and will largely or completely be avoided through good construction management, additional adverse effects on the SCIs arising from these other potential effects are not considered likely to further affect the integrity of the Rock of Gibraltar SCI or the Southern Waters SCI.

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# CHAPTER FOUR

# LAND CONTAMINATION

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| aDIV | Adjusted DIVs, where the DIV has been adjusted to reflect the clay and organic carbon content of the soil. Both these parameters can affect the behaviour of chemicals in the soil. |
| BH | Borehole |
| Borehole | A technique of obtaining information of the sub-surface conditions by drilling a typically 150 mm to 200 mm diameter hole |
| CEMP | Construction Environmental Management Plan |
| CIRIA | Construction Industry Research and Information Association |
| COC | Chemical of Concern. Potential contaminants which have the potential to cause harm |
| CS | Characteristic Situation |
| DIV | Dutch Intervention Values. Calculated concentrations of various chemicals. Concentrations of chemicals below their relevant DIV are assumed to pose no significant risk. |
| EA | Environmental Agency (Gibraltar) |
| EIA | Environmental Impact Assessment |
| Geotechnical | An area of civil engineering concerned with geological materials, earth structures and foundations |
| Hazard | Anything that can cause harm to a receptor |
| HSE | Health Safety and Environment |
| Hydrogeological | Branch of geology that is concerned with the occurrence, distribution and effect of ground water |
| Made Ground | Fill materials which have been placed for the purpose of ground raising, levelling and improvement etc |
| mbgl | meters below ground level |
| MoD | Ministry of Defence |
| PAHs | Poly Aromatic Hydrocarbons |

| | |
|---|---|
| PCB | Polychlorinated Biphenyls |
| Pollutant Linkage | Source-pathway-receptor linkage conceptualisation used for risk assessment purposes |
| Risk | The likelihood that a receptor will be harmed by any perceived hazard |
| STV | Soil Target Value |
| Threshold Value | Value of contaminant concentration, above which further assessment of risks posed to receptors and/or mitigation is required |
| TPH | Total Petroleum Hydrocarbons |
| Trial Pit | The excavation of a pit/trench typically using a machine excavator |

# 1 INTRODUCTION

1.1 This chapter discusses the soils and geology present beneath the site and assesses the potential effects of the proposals with regards to any contamination present in the location of the proposed power station which is situated towards the southern end of Gibraltar historically used as a parade ground for Lathbury Barracks. The chapter also considers the potential effects of the proposed fuel storage facility and the fuel supply pipes to the site.

1.2 An evaluation of the importance of the geology, soil resource and the levels of contamination are presented. An assessment of the potential for the construction of the proposed power station to expose unacceptable levels of contamination is discussed, together with appropriate mitigation measures and any residual significant effects.

1.3 In Gibraltar, the Environmental Agency (EA) is responsible for protecting the environment (air, land and water) and regulates discharges to controlled waters, disposal and management of waste, and major industrial processes. The EA, Department for the Environment and the Ministry of Defence (MoD) have been consulted as part of this assessment.

1.4 The contamination identified to be present beneath the site and detailed within this chapter will be fully addressed and appropriately remediated as part of the detailed design process by the Contractor as the site is redeveloped. An appropriate level of investigation for the purposes of EIA has been carried out to adequately characterise the soil conditions that underlie the site and to characterise the level and extent of contamination present. Although unexpected areas of contamination may always be encountered during redevelopment of historical sites, the characterisation of the site is sufficient to provide confidence that such occurrences, should they arise, can be adequately and appropriately dealt with.

1.5 The findings and opinions in this report are based upon information derived from a variety of sources, including third party site investigation. The accuracy or completeness of any information derived from third party sources cannot be accounted for in this assessment.

# 2 SCOPE AND METHODOLOGY

## Scope

2.1 A scoping assessment was undertaken indicating the potential effects of the development proposals with respect to contaminated soil. The scope of the EIA has been influenced by the historical and current land use of the site, the future redevelopment proposals and from consultation with relevant Authorities in Gibraltar. Consultation for matters relating to contamination was conducted with:

- Environmental Agency (EA) for Gibraltar;
- Department for the Environment; and
- MoD.

2.2 The scoping exercise indicated that there could potentially be contaminated soil present which may have an effect on receptors as a result of the proposed development. Therefore, as part of this EIA, a land contamination assessment has been undertaken to determine potential impacts and effects during construction and operation of the proposed development. The scoping exercise identified a potential risk of contaminated sand blowing onto the site from the adjacent firing range, however during the site visit in April 2008 it was established that the firing range uses rubber rather than sand and therefore the evaluation of this contamination source has been removed from the scope.

2.3 The technical scope of the site investigation covered groundwater, ground gas and soil contamination. It should be noted that this assessment considers ground gas and contaminated soil only. No ground water was encountered during the intrusive survey works so this has not been considered further.

## Data Collection

2.4 A desk based assessment of available information was undertaken from which an initial conceptual model was developed.

2.5 In addition, a site investigation in accordance with the contaminated land code of practice[1] was undertaken to provide information on existing contaminated land.

2.6 Baseline information has been obtained from the following:

- Published maps and guides;
- Site visit photographs; and
- Site investigation data.

2.7 Following the desk study stage, the area of the proposed new power station has been investigated to establish the geological, hydrogeological and geotechnical conditions via intrusive ground investigation[2].

2.8 Eleven boreholes were drilled using continuous rotary coring to a maximum depth of 13.4 metres below ground level. One of these boreholes was located off the proposed power station site, near the bottom of the Hole in the Wall Road along which the parade ground is accessed. This was drilled to provide geotechnical information for the potential underpinning of the retaining wall in order to allow heavy loads to use the access road.

2.9 Eight trial pits were machine dug to a maximum depth of 2.7 m. Soil samples were collected from the trial pits in order to characterise the soil and its content. A total of six soil samples from the trial pit locations were analysed for a range of potential contaminants. No groundwater was encountered during the intrusive works.

2.10 A soil gas survey was also undertaken utilising one of the boreholes.

2.11 The location of the sample points are presented on Figure LC2-1 (Volume 3: Figures). In the absence of specific areas of known risk identified by the historical site usage data, the distribution of the investigation positions has been designed to provide a general characterisation of the area.

### *Sampling Techniques and Testing Strategy*

2.12 The locations of exploratory boreholes and trial pits were guided by the conceptual model and were chosen to provide a general coverage across the site.

2.13 The purpose of chemical sampling was to assess the condition of the soils at the site that would be affected by the proposed development. Soil samples were taken and analysed for a range of chemical determinants to provide a broad analytical suite with which to assess the sites chemical characteristics.

A range of geological horizons were sampled including made ground and top soil.

2.14 Boreholes and trial pits were utilised in order to produce a depth profile of on-site geology and ground conditions, and for environmental purposes soil sampling and gas monitoring.

2.15 Samples for laboratory testing were submitted to a laboratory appropriately accredited to undertake the analysis chosen. This laboratory was ALcontrol Laboratories based in Barcelona, Spain.

2.16 The laboratory soil testing suite was chosen to provide a screening of the likely contaminants on site, including heavy metals, cyanide, volatile aromatics, phenols, nitro-phenols, polycyclic aromatic hydrocarbons (PAHs), halogenated hydrocarbons, pesticides, and total petroleum hydrocarbons (TPH). If field evidence of suspected contamination had been observed, extra samples would have been taken for testing, in the case of this investigation no additional issues were identified.

## Assessment Methodology

*Soils*

2.17 An initial 'Tier 1' risk assessment using Soil Target Values (STVs) has been used that compares results for concentrations of chemicals of concern (COC) in soils against conservative threshold values for those chemicals. This level of assessment assumes that there is no significant risk where the thresholds are not exceeded.

2.18 The STVs are derived from sources accepted within the current approach to assessing contaminated land in Gibraltar, in the absence of specific STVs for Gibraltar. This approach has been agreed with the Department for the Environment.

2.19 The STVs used herein are the Dutch Intervention Values[3] (DIVs) as presented in Appendix LC-1. DIVs are based on a standard soil containing 10% organic matter and 25% clay fraction. The DIVs used during this study have been adjusted to reflect known site-specific conditions using the 1.37% organic matter content and 12.43% clay content derived from the analysis undertaken as part of this study.

2.20 Based on the above conservative assumptions used, if chemical concentrations on site exceed generic thresholds appropriate for the intended end use of the site, site specific quantitative risk assessment and remediation may be necessary. Similarly, if concentrations were below the thresholds, the site would be considered to be suitable for the proposed use.

*Soil Gas*

2.21 Assessment of soil borne gas is based on guidance given by the Construction Industry Research and Information Association (CIRIA, 2006)[4]. The guidance indicates the requirement to take into account borehole gas volume flow rates in addition to gas concentrations. The guidance characterises sites from Characteristic Situation 1 i.e. CS1 (typical source being natural soils with low organic content) to CS6 (typical source being a recent landfill site). Based on the characteristic situations, typical scopes of protection measures are also given.

*Risk*

2.22 Contamination is assessed in terms of the risk of an identified occurrence of contamination (source) affecting a receptor via an exposure pathway, to form a complete source-pathway-receptor pollutant linkage. A source is defined as contamination by COCs having the potential to cause significant harm to humans (receptor), or the environment (receptor). Where the linkage is complete and assessment indicates potential for significant harm to a receptor, there is considered to be a significant pollutant linkage, sometimes referred to in regulatory guidance as a plausible, or relevant pollutant linkage. If any one of the three elements is absent, there is not considered to be such a pollutant linkage.

2.23 The source/pathway/receptor approach forms the basis of both the assessment of risk and the design of necessary remediation measures. Remediation techniques can remove the source, cut the pathway, or remove a receptor by controlling the end use of the site.

2.24 Receptors for the proposed power station include:

- On-site workers including ground workers during development;
- Future site maintenance and ground workers post development;

- Future site workers and visitors;
- Controlled waters;
- Fauna and flora;
- Buildings, below ground structures, services and building foundations; and
- Landscaping plants.

*Significant Effects*

2.25 The assessment of significant effects has been carried out using several factors, including the location of any hazards relative to the ground surface, the sensitivity of receptors, the ability to mitigate and/or remediate against the potential hazard and the magnitude of any potential impact. Using these factors, each effect is assigned a risk evaluation of not significant, low, medium or high and once complete, an overall risk evaluation of not significant, low, medium or high is made. The criteria used to assess the significance of each risk of an effect are presented in the Table 2-1.

**Table 2-1 Criteria and Levels of Significant Effect**

| *Significance* | *Criteria* |
|---|---|
| High | Major adverse effects would be important considerations for both the site and surrounding area including sensitive receptors. Mitigation and/or remedial measures may not be fully successful due to the magnitude of such an event. |
| Medium | Moderate adverse effects would be important on a site wide basis and may affect key decisions for the development. Mitigation and/or remediation would wholly or partly ameliorate the identified effect. |
| Low | Slight adverse effects are relevant on a small scale. These effects are likely to be generally reduced or removed using appropriate mitigation/remediation techniques. |
| Not Significant | Effects are assigned this level of significance if they are nil, imperceptible or negligible. |

### Assumptions and Limitations

2.26 Conclusions are based on the findings of the investigation. Fieldwork consisted of discrete sampling across the site where access was available to assess the character and degree of contamination. Conditions of the intervening ground may be different from the tested locations.

2.27 Limited gas monitoring has been undertaken following the installation of monitoring wells as part of the site investigation and monitoring is ongoing at the time of conducting this EIA.

2.28 If future work discovers ground conditions that vary significantly from the presented findings, the conclusions should be reviewed in the context of the new information. Moreover, ground conditions may change with time.

2.29 Findings were assessed in the context of DIVs and methodology current at the time of the reporting. Assessment was based on a proposed planned development and should be reviewed if plans are changed. Dutch standards were used in the absence of specific standards for Gibraltar.

# 3 EXISTING CONDITIONS

## Geological Baseline

3.1 The geological conditions encountered were as anticipated from the known geology of the area which comprises of soil and fill material overlying limestone at depth.

3.2 The vertical geological profile is consistent throughout the site and is summarised below.

## Current Baseline – Parade Ground

*Soil*

3.3 The soils over the proposed power station area comprised a varied fill material with a very heterogeneous consistency. Generally, it was composed of sandy clay with pieces of gravel of variable lithology, along with pieces of pottery, pipes and drums. This soil/fill horizon was typically between 1.2 and 1.7 m thick; the exceptions to this were on the eastern side of the site where it reached 5.5 m thick (BH1) and in the middle of the site where it was only 0.6 m thick and bedrock is essentially at the surface.

*Clays*

3.4 The fill material is underlain by clayey sand, sandy gravely clay and limestone cobbles, which varied in thickness across the site from 0.3 m to over 7.9 m (in BH1 where the base of the clay was not reached before the borehole was terminated).

*Solid Geology*

3.5 The basal level encountered by the intrusive investigation comprised the limestone bedrock of this part of Gibraltar. The upper part is weathered and comprises a breccia formed from limestone gravels and cobbles. The limestone is present at a variety of depths on the site, from BH8 where it is present almost at the surface to at least 7.9 m depth (BH1). With the exception of BH1 all boreholes terminated in this formation.

*Soil Contamination Results*

3.6 No visual or olfactory field observations of contamination were noted on the field logs for the borehole or trial pit locations or in the six made ground or shallow soils samples collected during the intrusive investigation.

3.7 The test results obtained from the investigations are presented in Appendix LC-1. Soil contaminant concentrations were noted to exceed the adjusted Dutch Intervention Values (aDIV) relevant to the planned development for a range of contaminants including metals, polycyclic aromatic hydrocarbons and phenols. Each group of soil contaminants is addressed separately below.

3.8 Seventeen metals were tested for at six of the sampling locations. The only contaminant for which the aDIV was exceeded was arsenic (aDIV=38.92 mg/kg) that was elevated in four of the samples from TP1-TP3, and TP6. The maximum arsenic concentration was 120 mg/kg which was recorded in TP1. The trial pits were all located in the northeast part of the site. No source of these elevated concentrations has been identified. The maximum concentration is above that reported for the maximum for uncontaminated soils (80 mg/kg) in the Upper Rock Nature Reserve[5], while the other three samples are below this, indicating that this may be naturally occurring.

3.9 Phenol was detected at one of the six samples analysed. The phenol detected, which was below the aDIV, was present in TP6 located in the northwest corner of the site. Phenol is considered not to be of concern due to the low concentrations and isolated occurances.

3.10 PAHs were detected at low concentrations in each soil sample. Concentrations detected were generally low and did not exceed STVs. However, the aDIV of 40 mg/kg was exceeded in TP5 (1.5 mgbl) where the highest concentration 77.8 mg/kg (Sum of 10 PAH) was recorded.

3.11 Alkyl benzenes compounds were detected at low concentrations in made ground TP5 1.5 mbgl. Alkyl benzenes are not considered to be of concern due to the low concentrations and isolated occurrences.

3.12 Hydrocarbons were detected at low concentrations in four of the sampling locations in the shallow soils and made ground. Concentrations recorded did not exceed the aDIV of 1000 mg/kg for total mineral oils. The maximum concentration were recorded the shallow made ground in TP8 at 0.6 mbgl in the aromatic fraction $C_{21}$-C35 at 440 mg/kg. This is likely to be associated with the phenol detected at this location.

3.13 No polychlorinated biphenyls (PCBs), volatile organic compounds, chlorobenzenes, chlorophenols, pesticides, herbicides, or phthalates have been detected above the laboratory analytical limit in any samples tested.

3.14 A screen for asbestos fibres was undertaken and no asbestos fibres were detected within any of the soil samples tested.

3.15 The presence of PAHs, aromatic hydrocarbons and alkylbenzenes may be indicative of the presence of discrete areas of asphalt/tarmac within the made ground across the site. As such, low concentrations of these contaminants are considered likely to present across the site.

*Groundwater*

3.16 No groundwater has been encountered during the intrusive investigation. This corresponds with known hydrogeology of the area.

*Soil Gas*

3.17 Gas monitoring was conducted in BH4 using a Multirae PGM 50/54 monitor on four dates in March and April 2008. The ground gas monitoring was undertaken to assess whether such gas, which may migrate through permeable strata, fissures or fractures and build up within confined spaces and buildings, was present on the site.

3.18 The results from the monitoring recorded oxygen to be in the range 20.3-20.9%. Carbon dioxide was low in the range 180-860 ppm, and methane was detected at 1% during only one sampling event.

3.19 The results obtained to date from the ground gas monitoring currently indicate that little or no methane was present on site and that carbon dioxide concentrations were below 1%. Based on these results it is considered that ground gas is unlikely to be an issue at the site.

### Current Baseline – Eastside Tanks

3.20 The Eastside Tanks comprise six concrete lined caverns and associated tunnels which were excavated in to the solid limestone bedrock. Three of these caverns excavated in 1906 contain water tanks (the "Admiralty Water Storage Tanks") and three excavated in 1925-26 contain fuel tanks. The connecting tunnels in the area date from 1898-9, 1940 and 1943.

3.21 As well as the inspection of the tanks as part of the current EIA, they were the subject of a Phase 1 (i.e. baseline appraisal) in 1998[6]. The assessment of potential contamination associated with these tanks draws on both of these sources.

3.22 Each of the fuel tanks consists of a concrete tank and access chamber, and can contain approximately 10,000 $m^3$. As the tanks are built into the caverns there is no secondary containment. Based on the 1998 Phase 1 report, it is understood that the volume was checked with an automatic levelling system, accurate to 1 mm and that the tanks were cleaned every three years when any sludge was removed. At the time of the site visit in April 2008 it was noted that the tanks still contained sludge. This sludge will be removed and the tanks cleaned as part of the detailed design works.

3.23 No intrusive investigation has been undertaken around these tanks, as this is not practicable. However the potential refurbishment of these tanks for the proposed power stations fuel supply, may involve the removal of some of the existing structures and their replacement with modern tanks with secondary containment. This refurbishment will enable tanks to be assessed for potential contamination and appropriate remedial action taken if required. The Contractor will provide a detailed approach as part of the Construction Environmental Management Plan (CEMP).

3.24 The Eastside Tanks may be connected to the proposed power station site by pipelines running through tunnels between the two sites. In addition the supply pipelines from the docks will run through existing pipeline tunnels. The management plan for the installation of these pipelines will incorporate the removal of any redundant pipes and remediation of contamination in the tunnels, if any is encountered.

# 4 FUTURE BASELINE

## Parade Ground

4.1 The proposed development constitutes a material change in use of the site from a parade ground to a power station.

4.2 During construction it is possible that the potential contaminants in the made ground may become exposed and possibly released in the form of dust or as a liquid. This could have an impact on any construction workers and possibly a number of future occupiers of the site as well as off-site receptors, such as local workers or fauna and flora.

4.3 During construction, procedures will be put in place to avoid spillages of fuels and oils. However, if such an event should occur then it may have an impact on the ground, elevating the contaminant concentration within.

4.4 Drainage from vehicle parking areas on the site should pass through suitable petrol/oil interceptors before being discharged. If these interceptors are well maintained and kept in good condition then any oil/petrol spillages will not form a future contamination issue.

4.5 Fuel and chemical storage areas will be constructed with suitable secondary containment and leak detection so as to prevent any spills from entering the environment and impacting the underlying soils and ultimately the groundwater within the limestone bedrock.

## Eastside Tanks

4.6 Fuel and chemical storage areas will be constructed with suitable secondary containment and leak detection so as to prevent any spills from entering the environment and impacting the underlying bedrock and ultimately the groundwater within the limestone bedrock. The possible refurbishment of the Eastside Tanks will include covering the tanks with an epoxy lining, and installing a new concrete floor. The fuel supply for the power station will be stored in ten 300 $m^3$ steel tanks constructed with secondary containment which will be sized to suit 110% of the largest tank or 25% of the total volume, whichever is largest.

4.7 The existing Eastside Tanks pump room is proposed to be stripped out and new smaller capacity pumps for transfer to the power station installed. An unloading bay which is to be built alongside the roadway near the tanks will be provided with appropriate containment and drainage will be via an oil interceptor. This unloading bay will be used in the event of a problem with shipping or unloading from barges in the port, when emergency supply may need to be provided by road tankers.

4.8 The pipelines linking the Eastside Tanks with the power station and the docks will be fitted with suitable leak detection which will provide a means of detecting leak in different parts of the fuel supply network.

# 5 POTENTIAL IMPACTS

## During Construction – Parade Ground

5.1 Elevated concentrations of arsenic in excess of the aDIV were measured in made ground at four of the six sampling locations. Site workers during the earthworks on the site are potentially at risk by ingestion of the affected soils.

5.2 Further unsuspected contaminated ground could be discovered during intrusive works, potentially exposing site workers to unacceptable levels of contamination.

5.3 Dust from the construction works could provide a health hazard to site workers, impact the local fauna and flora (for example the Upper Rock Nature Reserve) or cause a nuisance.

5.4 Although minimal concentrations of methane were detected from one sampling location, there remains the possibility that higher concentrations may exist. Ground gases may migrate through permeable strata, fissures or fractures and may build up within confined spaces. Although there has been no reported issue with ground gas, any underground structures may be vulnerable to the build up of underground gases and thus pose a risk to site workers.

5.5 The scoping study did not identify any risks from ordnance and although it is unlikely that the parade ground was used for the storage or testing of ordnance there is a low risk of encountering unexploded ordnance which could present a risk to site workers.

5.6 Contamination risks may result from accidental chemical releases and surface water runoff during construction.

## During Construction – Eastside Tanks

5.7 Further unsuspected contaminated ground could be discovered during redevelopment works in the Eastside Tanks, potentially exposing site workers to unacceptable levels of contamination.

5.8 Vapours from the sludge remaining in the tanks could provide a health hazard to site workers, or cause a nuisance.

5.9 Ground gases may migrate through permeable strata, fissures or fractures and may build up within confined spaces. Although there has been no reported issue with ground gas in the Eastside Tanks, any underground structures may be vulnerable to the build up of underground gases and thus pose a risk to site workers.

5.10 Contamination risks may result from accidental chemical releases and surface water runoff during construction.

### Operation Risk Assessment – Parade Ground

5.11 It is considered unlikely that ground gases will build up to dangerous concentrations within any underground structures as the design will require these to be properly ventilated in any event.

5.12 The concentrations of contaminants of concern recorded during this investigation are considered likely to relate to made ground (i.e. material imported or moved to raise and flatten the area) at the site. As such any risks will be mitigated by the use of personal protective equipment as per the Health & Safety Plan for the future construction works. During normal operations the majority of the area will be sealed or landscaped and the risk of exposure is minimal.

5.13 In areas of chemical storage/transport there is a risk of the accidental release of products through leakages and spillages.

### Operation Risk Assessment – Eastside Tanks

5.14 It is considered unlikely that ground gases or vapours from the fuel tanks will build up to dangerous concentrations within the underground tanks and pipeline tunnels, as the design will require these to be properly ventilated in any event.

5.15 The fuel and chemical storage and transport present a potential risk through the accidental release of products through leakages and spillages.

# 6 ASSESSMENT OF SIGNIFICANT EFFECTS

6.1 This section discusses the assessment and significance of effects arising from the potential impacts. It takes into account the source, pathway and receptor in describing any associated risks and the final assessment is based on the significance criteria as detailed in Table 2-1.

### Parade Ground

6.2 Table 6-1 identifies the potential significant effects from contamination arising from the construction of the parade ground, and Table 6-2 identifies the significant effects from the operational phase of the proposed power station.

**Table 6-1 Assessment of Significance – Development Phase**

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| Contamination – risks to human health | Limited areas of ground impacted by contamination have been identified at a depth of approximately 1.5 m. Further contaminated ground could be discovered during development. This gives rise to potential risks to site workers during any excavation or earth moving works. The risk pathway is via contact/inhalation/ingestion during construction | Low |
| Dust on local fauna and flora | Dust could be generated during construction that could mobilise contamination which could impact site works, off-site people and fauna and flora (eg Upper Rock Nature Reserve) this is considered further in the air quality and ecology chapters of this study. | Low |
| Ground Gas | It is unlikely that ground gases will build up to dangerous concentrations within any subsurface structures formed during construction. | Low |
| Unexploded Ordnance | The scoping study did not identify any risks from ordnance and although it is unlikely that the parade ground was used for the storage or testing of ordnance there is a low risk of encountering unexploded ordnance. Risks from unexpected finds will be addressed in the contractors HSE plans | Low |

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| Accidental chemical releases | There is a risk associated with the release of chemicals during the construction phase. This could impact the surrounding soils. | Low |

**Table 6-2 Assessment of Significance – Operational Phase**

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| Contamination – risks to human health | Limited areas of ground impacted by contamination have been identified at a depth of approximately 1.5 m. This gives rise to potential risks to site workers during operation through vapour inhalation. | Low |
| Ground Gas | It is unlikely that ground gases will build up during development to dangerous concentrations within the tanks and pipeline tunnels. | Low |
| Accidental chemical releases | There is a risk associated with the release of chemicals during the operation phase. This could impact the surrounding soils. | Low |

## Eastside Tanks

6.3 Table 6-3 identifies the potential significant effects from contamination arising from the construction of the proposals for the Eastside Tanks and associated pipelines. Table 6-4 identifies the potential significant effects during the operational phase of the proposed power station.

**Table 6-3 Assessment of Significance – Development Phase**

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| Contamination – risks to human health | There are sludges remaining in the tanks which present potential risks to site workers during their removal and cleaning of the tanks. The risk pathway is via contact/inhalation/ingestion. | Low |
| Ground Gas | It is unlikely that ground gases will build up during refurbishment to dangerous concentrations within | Low |

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| | the Eastside Tanks or pipeline tunnels. | |
| Accidental chemical releases | There is a risk associated with the release of chemicals during the refurbishment. | Low |

**Table 6-4 Assessment of Significance – Development Phase**

| *Identified Impact* | *Explanation* | *Significance* |
|---|---|---|
| Ground Gas | It is unlikely that ground gases will build up during operation of the proposed power station to dangerous concentrations within the Eastside Tanks or pipeline tunnels. | Low |
| Accidental chemical releases | There is a risk associated with the release of chemicals during the operational phase of the proposed power station. | Low |

# 7 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

7.1 Mitigation measures are provided to sever the source – pathway – receptor pollutant linkage. The following describes appropriate mitigation to minimise the risk of contamination to people, places and the environment including fauna and flora, soil quality and groundwater. These mitigation measures will be in place through a Construction Environmental Management Plan (CEMP) and Operational Environment Management Plan to protect both the construction workers and users of the site. With these in place there are expected to be no residual significant effects from contaminated land during construction and operation of the proposed new power station and the associated infrastructure (access roads, fuel tanks and pipelines).

### Mitigation Measures – Construction Phase

7.2 Many of the potential contamination risks will be rendered insignificant by performing the construction in accordance with an appropriately designed CEMP. If contaminated ground is encountered during construction works, this will be addressed in accordance with the CEMP such that the risks to site workers and the environment is minimised and any contamination is remediated. During the construction all personnel will use appropriate personal protective equipment.

7.3 Dust suppression techniques will be employed to minimise dust impacts and nuisance whether contamination is encountered or not.

7.4 The Contractor will consult with the relevant Authorities to agree methods to safely manage and/ or dispose of the contaminated material. These measures (if required) will mitigate the risk and result in **no residual significant effects**. All contaminated material moved offsite will be through an appropriately licensed waste contractor and disposed of to a suitably licensed facility.

7.5 Secondary containment and leak detection will be provided for any fuel and chemical storage, to minimise the potential for a spill to impact the environment.

7.6 Suitably managed onsite activities including bunding of chemical storage areas, spill response plans, providing appropriate workforce training and covering of spoil, will minimise the potential for a spill to occur and also enable any spills to be controlled and remediated effectively.

7.7 The control of storm water run-off will be through the use of appropriate sediment controls such as settlement areas and covering of any contaminated areas. This will prevent storm water washing sediment (with or without contamination) off the area into local drains and the surrounding environment.

7.8 The investigation comprised sampling at specific locations and intervening ground conditions may differ. Any visual or olfactory evidence of contamination observed during future ground works will be brought to the attention of an environmental specialist to ensure that the risks to receptors (including site workers) can be appropriately assessed.

### Mitigation Measures – Operational Phase

7.9 By incorporating mitigation measures in the development design the potential contamination risks will be rendered insignificant. In particular, hard surfacing for around and under the power station will mitigate the pollutant linkages via dermal contact and soil/dust inhalation. Future maintenance or excavations on the operational site will be undertaken through a CEMP which will serve to minimise potential risks to site workers and the environment.

7.10 It is unlikely that ground gases will build up during operation to dangerous concentrations within any subsurface structures as the design will incorporate appropriate ventilation of these areas. Such mitigation, if required, will result in no residual significant effects.

### Residual Significant Effects

7.11 Through implementing an appropriate CEMP and incorporating suitable design criteria into the development, the development is **not predicted to have any residual significant effects**. Developing Operational Environmental Management Plans for the site based on the CEMP will manage the environment at the site, in a manner that is protective of site workers and the environment.

# 8 REFERENCES

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# APPENDIX LC-1

## Chemical Analysis – Soil Laboratory Results

## Chemical Analysis – Soil Laboratory Results

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **dry weight** | **wt.-%** | **87.9** | **87.9** | **89.8** | **96.9** | **92.1** | **88.4** | |
| T.O.C. | **% of DM** | **0.9** | **2.0** | **0.6** | **1.5** | **1.7** | **1.5** | |
| PARTICLE SIZE | | | | | | | | |
| **lutum (soil)** | **% of DM** | **17** | **12** | **16** | **12** | **3.6** | **14** | |
| pH (KCl) | **-** | **8.6** | **8.0** | **8.1** | **8.8** | **8.4** | **8.0** | |
| Temperature for pH | **ºC** | **21.5** | **21.3** | **21.8** | **20.9** | **20.9** | **21.3** | |
| *METALS* | | | | | | | | |
| **Antimony** | **mg/kgdm** | **<1** | **<1** | **<1** | **<1** | **<1** | **<1** | 15 |
| **Arsenic** | **mg/kgdm** | **120** | **69** | **70** | **36** | **18** | **51** | 38.92 |
| **Barium** | **mg/kgdm** | **85** | **330** | **260** | **130** | **170** | **220** | 371.57 |
| **Beryllium** | **mg/kgdm** | **<1** | **<1** | **<1** | **<1** | **<1** | **<1** | 18.87 |
| **Cadmium** | **mg/kgdm** | **1.2** | **<1** | **<1** | **1.1** | **<1** | **<1** | 7.88 |
| **Chromium** | **mg/kgdm** | **13** | **28** | **20** | **32** | **22** | **28** | 284.47 |
| **Cobalt** | **mg/kgdm** | **12** | **18** | **11** | **10** | **6.8** | **8.8** | 146.14 |
| **Boron** | **mg/kgdm** | **<25** | **<25** | **<25** | **<25** | **<25** | **<25** | nv |
| **Copper** | **mg/kgdm** | **32** | **34** | **36** | **29** | **53** | **31** | 122.87 |
| **mercury** | **mg/kgdm** | **1.5** | **<1** | **<1** | **<1** | **<1** | **<1** | 8.099 |
| **Lead** | **mg/kgdm** | **47** | **80** | **51** | **59** | **120** | **95** | 397.81 |
| **Molybdenum** | **mg/kgdm** | **3.2** | **2.3** | **1.9** | **<1** | **<1** | **<1** | 200 |
| **Nickel** | **mg/kgdm** | **31** | **38** | **27** | **31** | **24** | **29** | 134.58 |
| **Tin** | **mg/kgdm** | **1.5** | **5.4** | **4.1** | **3.5** | **3.6** | **9.5** | 542.75 |
| **Vanadium** | **mg/kgdm** | **23** | **32** | **33** | **42** | **24** | **49** | 160.21 |
| **Zinc** | **mg/kgdm** | **54** | **84** | **73** | **200** | **100** | **96** | 459.49 |
| **Selenium** | **mg/kgdm** | **<1** | **<1** | **<1** | **<1** | **<1** | **<1** | 100 |
| *INORGANIC COMPOUNDS* | | | | | | | | |
| **Cyanide (free)** | **mg/kgdm** | **<1** | **<1** | **<1** | **<1** | **<1** | **<1** | 20 |
| *VOLATILE AROMATICS* | | | | | | | | |
| **Benzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.2 |
| **Ethylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 10 |
| **Naphthalene** | **µg/kgdm** | **31** | **<20** | **<20** | **11000** | **49** | **<20** | * |
| **O – Xylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 5 |
| **p/m – Xylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **26** | **<20** | **<20** | 5 |
| **Styrene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 20 |
| **Toluene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 26 |
| *PHENOLS* | | | | | | | | |
| **2,4+2,5-dimethylphenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **100** | **<100** | **<100** | |
| **2-methylphenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **3+4-methylphenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **240** | |
| **Phenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **240** | 8 |
| *NITRO FENOL* | | | | | | | | |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **2-nitrophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4-nitrophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| *POLYCYCLIC AROMATIC HYDROCARBONS* | | | | | | | | |
| **Naphthalene** | **µg/kgdm** | **31** | **<20** | **<20** | **11000** | **49** | **<20** | * |
| **Anthracene** | **µg/kgdm** | **<100** | **730** | **<100** | **12000** | **1200** | **1600** | * |
| **Phenanthrene** | **µg/kgdm** | **<100** | **2600** | **130** | **21000** | **3000** | **2700** | * |
| **Fluoranthene** | **µg/kgdm** | **120** | **4700** | **310** | **18000** | **7900** | **4200** | * |
| **Benzo (a) anthracene** | **µg/kgdm** | **<100** | **1100** | **170** | **2900** | **1100** | **700** | * |
| **Chrysene** | **µg/kgdm** | **<100** | **1800** | **160** | **3700** | **1700** | **850** | * |
| **Benzo (a) pyrene** | **µg/kgdm** | **<100** | **1800** | **180** | **3500** | **2200** | **1200** | * |
| **Benzo (ghi) perylene** | **µg/kgdm** | **<100** | **1300** | **140** | **1100** | **1700** | **1200** | * |
| **Benzo (k) fluoranthene** | **µg/kgdm** | **<100** | **1200** | **160** | **1900** | **1200** | **570** | * |
| **Indeno (1,2,3-cd) pyrene** | **µg/kgdm** | **<100** | **1200** | **140** | **2700** | **2500** | **1200** | * |
| **acenaphthylene** | **µg/kgdm** | **<100** | **<100** | **<100** | **1100** | **<100** | **<100** | |
| **Acenaphthene** | **µg/kgdm** | **<100** | **160** | **<100** | **1500** | **330** | **130** | |
| **Fluorene** | **µg/kgdm** | **<100** | **210** | **<100** | **6300** | **130** | **200** | |
| **Pyrene** | **µg/kgdm** | **110** | **4100** | **290** | **12000** | **6700** | **3900** | |
| **Benzo (b) fluoranthene** | **µg/kgdm** | **<100** | **1200** | **160** | **2400** | **840** | **880** | |
| **Dibenzo (a, h) anthracene** | **µg/kgdm** | **<100** | **720** | **<100** | **2000** | **1800** | **750** | |
| **Sum of 10 PAH*** | **mg/kg** | **0.151** | **16.43** | **1.39** | **77.8** | **22.549** | **14.22** | 40 |
| *HALOGENATED HYDROCARBONS* | | | | | | | | |
| **1,1,1,2-tetrachloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,1,1-trichloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 3 |
| **1,1,2,2-tetrachloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,1,2-trichloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **dibromochloromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **dichlorodifluoromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,1-dichloropropene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,2,3-trichloropropane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.4 |
| **1,2-dibromoethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,2-dichloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.8 |
| **1,2-dichloropropane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,3-dichloropropane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **2,2-dichloropropane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **2-chlorotoluene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **4-chlorotoluene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Bromobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **bromochloromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **bromodichloromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Chloroethane** | **µg/kgdm** | **<50** | **<50** | **<50** | **<50** | **<50** | **<50** | |
| **chloromethane** | **µg/kgdm** | **<50** | **<50** | **<50** | **<50** | **<50** | **<50** | |
| **Chloroform** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **cis-1,2-dichloroethylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.2 |
| **cis-1,3-dichloropropene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **dibromomethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **dichloromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 2 |
| **hexachloroethane** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **tetrachloroethylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.8 |
| **tetrachloromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.2 |
| **trans-1,2-dichloroethylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **trans-1,3-dichloropropene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **trichloroethylene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **trichlorofluoromethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Vinylchloride** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.02 |
| **1,1-dichloroethane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 3 |
| **1,1-dichloroethene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | 0.06 |
| **Bromoform** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **bromomethane** | **µg/kgdm** | **<50** | **<50** | **<50** | **<50** | **<50** | **<50** | |
| **1,2-dibromo-3-chloropropane** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| *CHLOROBENZENES* | | | | | | | | |
| **1,2,3-trichlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,2,4-trichlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,2-dichlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,3-dichlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,4-dichlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **chlorobenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **hexachlorobenzene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Sum of Chlorobenzenes** | **mg/kg** | | | | | | | 6 |
| *ALKYLBENZENES* | | | | | | | | |
| **4-Isopropyltoluene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **isopropylbenzene (cumene)** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **n-butylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **sec-butylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **tert-butylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,3,5-trimethylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **43** | **<20** | **<20** | |
| **propylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **1,2,4-trimethylbenzene** | **µg/kgdm** | **<20** | **<20** | **<20** | **72** | **<20** | **<20** | |
| *CHLOROPHENOLS* | | | | | | | | |
| **2,4,5-trichlorophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4,6-trichlorophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4+2,5-dichlorophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2-chlorophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4-chloro-3-methylphenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **pentachlorophenol** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Sum of Chlorophenols** | | | | | | | | 2 |
| *POLYCHLORINATED BIPHENYLS* | | | | | | | | |
| **PCB 101** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 118** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 138** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 153** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 180** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 28** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **PCB 52** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Sum of 7 congeners** | **Mg/kg** | | | | | | | 0.2 |
| *CHLOROPESTICIDES* | | | | | | | | |
| **Aldrin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Alfa-endosulfan** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Alfa-HCH** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Beta-endosulfan** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Beta-HCH** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **chlorothalonil** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **cis-chlordane** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **heptachlorepoxide** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Dieldrin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 0.8 |
| **endosulphan sulphate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 0.8 |
| **Endrin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **gamma-HCH** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Heptachlor** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **hexachlorobutadiene** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Isodrin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<20** | **<100** | |
| **2,4-methoxychlor** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4-DDD** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4-DDE** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4-DDT** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4,4-DDD** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4,4-DDE** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4,4-DDT** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 0.8 |
| **Quintozene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Tecnazene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Telodrin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **trans-chlordane** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Triallate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4,4-methoxychlor** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| *PHOSPHOR PESTICIDES* | | | | | | | | |
| **azinphos-ethyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **azinphos-methyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **carbophenothion** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **chlorfenvinphos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **chlorpyriphos-ethyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **chloropyriphos-methyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Diazinon** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Dichlorvos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Dimethoate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Disulphoton** | **µg/kgdm** | **<100** | **320** | **<100** | **910** | **510** | **<100** | |
| **Ethion** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Etrimphos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Fenitrothion** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Fenthion** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Phosalone** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Malathion** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Mevinphos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **parathion-ethyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **parathion-methyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **pirimiphos-methyl** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **propetamphos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Triazophos** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| *N - PESTICIDES* | | | | | | | | |
| **Ametryn** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Atraton** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Atrazine** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 1.2 |
| **Prometryn** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Prometon** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Propazine** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Simazine** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Simetryn** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Terbutryn** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Terbuthylazine** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Triadimephon** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Trifluralin** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| *PHTHALATES* | | | | | | | | |
| **butylbenzylphtalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **bis(2-ethylhexyl)phthalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **diethylphthalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **dimethylphtalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **di-n-butylphtalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **di-n-octylphthalate** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Sum of phtalate** | **mg/kg** | | | | | | | 12 |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| *MINERAL OIL* | | | | | | | | |
| **Total oil C10-C40** | **mg/kgdm** | **<50** | **<50** | **<50** | **<50** | **300** | **130** | 1000 |
| **Aromatic fraction >C6-C7** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aromatic fraction >C7-C8** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aromatic fraction >C8-C10** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aromatic fraction >C10-C12** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aromatic fraction >C12-C16** | **mg/kgdm** | **<20** | **<20** | **<20** | **21** | **<20** | **<20** | |
| **Aromatic fraction >C16-C21** | **mg/kgdm** | **<20** | **<20** | **30** | **66** | **21** | **<20** | |
| **Aromatic fraction >C21-C35** | **mg/kgdm** | **<20** | **<20** | **30** | **130** | **440** | **43** | |
| **Aliphatic fraction >C5-C6** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aliphatic fraction >C6-C8** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aliphatic fraction >C8-C10** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aliphatic fraction >C10-C12** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aliphatic fraction >C12-C16** | **mg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **Aliphatic fraction >C16-C35** | **mg/kgdm** | **<20** | **<20** | **<20** | **23** | **270** | **23** | |
| **mineral oils (C6-10)** | **mg/kgdm** | **<10** | **<10** | **<10** | **<10** | **<10** | **<10** | |
| **fraction C10-C12** | **mg/kgdm** | **<5** | **<5** | **<5** | **<5** | **13** | **<5** | |
| **fraction C12 - C16** | **mg/kgdm** | **<5** | **<5** | **<5** | **<5** | **6.0** | **5.5** | |
| **fraction C16-C21** | **mg/kgdm** | **<5** | **<5** | **<5** | **<5** | **13** | **12** | |
| **fraction C21-C40** | **mg/kgdm** | **<5** | **<5** | **<5** | **<5** | **270** | **110** | |
| **mineral oils (C6-40)** | **mg/kgdm** | **<50** | **<50** | **<50** | **<50** | **300** | **130** | |
| *SEVERAL CHEMICAL ANALYSIS* | | | | | | | | |
| **Sulphur (total)** | **mg/kgdm** | **140** | **290** | **320** | **770** | **460** | **250** | |
| **Sulphate** | **mg/kgdm** | **<20** | **38** | **170** | **400** | **210** | **<20** | |
| *SEVERAL ORGANIC COMPOUNDS* | | | | | | | | |
| **permethrin-1** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Permethrin-2** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,4-dinitrotoluene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2,6-dinitrotoluene** | **µg/kgdm** | **<100** | **<100** | **<100** | **120** | **<100** | **120** | |
| **2-chloronaphthalene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **2-methylnaphthalene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **1400** | |
| **4-bromophenylphenylether** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **4-chlorophenylphenylether** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Azobenzene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **bis(2-chloroethoxy)methane** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **bis(2-chloroethyl)ether** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Carbazole** | **µg/kgdm** | **<100** | **220** | **<100** | **<100** | **340** | **1200** | |
| **Dibenzofuran** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **320** | **2100** | |

| *Location* | | *TP-1* | *TP-2* | *TP-3* | *TP-5* | *TP-8* | *TP-6* | *Dutch Intervention Values ADJUSTED mg/kg* |
|---|---|---|---|---|---|---|---|---|
| *Depth (m)* | | *-0.80* | *-1.50* | *-1.30* | *-1.50* | *-0.60* | *-1.00* | |
| **hexachlorocylcopentadiene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Isophorone** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **Nitrobenzene** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| **methyl tertiary butyl ether** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| **carbon disulphide** | **µg/kgdm** | **<20** | **<20** | **<20** | **<20** | **<20** | **<20** | |
| *AMINO-LIKE COMPOUNDS* | | | | | | | | |
| **3+4-chloroaniline** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 10 |
| **2-nitroaniline** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 10 |
| **3-nitroaniline** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 2 |
| **4-nitroaniline** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | 6 |
| **n-nitrosodi-n-propylamine** | **µg/kgdm** | **<100** | **<100** | **<100** | **<100** | **<100** | **<100** | |
| *ASBESTOS* | | | | | | | | |
| **Chrysotile** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Amosyte** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Crocidolyte** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Anthophylyte** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Tremolyte** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Actinolite** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |
| **Degree of attachment** | **-** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | **n.a.** | |

**Notes:**

Ref: Dutch Intervention Values: February 2000

Values have been adjusted using 1.37% organic matter content and 12.43% clay content as per chemical laboratory analytical results. The unadjusted DIVs are based on a standard soil that contains 10% organic matter and 25% clay fraction.

Shaded numbers indicate the concentration exceeds the adjusted Dutch Intervention Value

# CHAPTER FIVE

# LANDSCAPE CHARACTER AND VISUAL AMENITY

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| CEMP | Construction Environmental Management Plan |
| IEMA | Institute of Environmental Management and Assessment |
| Landscape | The appearance of the land made up of combinations of various forms, colours and textures that create a specific identity to a place. |
| Landscape Character Area | The distinct and recognisable pattern of elements that occurs consistently in a particular type of landscape, and how people perceive this. It can reflect particular combinations of geology, landform, soils, vegetation, land use and human settlement. It creates the particular sense of place of different areas of the landscape. |
| MoD | Ministry of Defence |
| Receptor | A physical landscape resource, special interest or viewer group that will experience an effect. |
| Visual Impacts | A type of landscape impact. They relate solely to changes in a variable view of the landscape and the effects of those changes on people and properties. |
| SCI | Site of Community Interest |

# 1 INTRODUCTION

1.1 This chapter assesses the likely landscape and visual impact of the proposed diesel power station at Lathbury Barracks in Gibraltar.

1.2 Landscape character and visual amenity are separate but related issues. Landscape character impacts are changes in the character and quality of the landscape as a result of the proposed development. Visual impacts are changes in the available views of the landscape and the effects of those changes on viewers.

1.3 This chapter describes the methodology of the assessment, evaluates landscape character, describes the extent of views from the surrounding areas into the site, assesses the potential effects of the proposed power station development upon the visual receptors, identifies mitigation where required and assesses any residual effects.

1.4 Consultation has been undertaken with the Town Planner, Ministry for the Environment and the Government's Heritage Division to inform this assessment. Additional reference has been made to available information including mapping, local plans and policies, aerial photographs, and Gibraltar's Development Plan (Consultation Draft) 2007[1].

# 2 SCOPE AND METHODOLOGY

2.1 This assessment is based on guidance in Guidelines for Landscape and Visual Impact Assessment by the Institute of Environmental Management and Assessment (IEMA) and The Landscape Institute (2002)[1].

## Scope

2.2 The initial scoping exercise identified potential visual effects from the proposed development. Consequently a full assessment of potential impacts has been undertaken.

2.3 The technical scope of this assessment considers the visual amenity of the site and the surrounding area and identifies potentially sensitive visual receptors and the approximate visibility of the development. Potential effects have been addressed for both construction and operation phases.

2.4 The geographical scope of the study area has been influenced by the sensitivity of receptors within a distance of approximately 1 km of the proposed diesel power station. Longer distances have been included where appropriate.

## Data Collection

2.5 The assessment was carried out in April 2008 and consisted of baseline studies of the site, its context and the development proposals. The information has been collected by desktop studies and by site surveys. The likely impact of the development proposals on the landscape and the likely visual impact has been assessed. The predicted impacts of development during construction works and in operation have been assessed separately. Additional mitigation measures have been considered and possible residual impacts described.

2.6 Local character assessment has been carried out by site assessment. Visual impact has been assessed by the initial identification of outward views from within the site and from the study of maps for likely viewpoints into the site. These viewpoints have been visited and visibility checked by an experienced landscape architect.

### Relevant Planning Legislation

2.7 The development of the proposals has considered adopted planning policy from the existing Gibraltar Development Plan (1991)[2]. Policy ENV1 requires that all development projects take account of the need to protect the environment.

2.8 The site falls within Zone 9 South District within the planning policy zones of the Development Plan. No reference is made to power needs. Policies relating to Zone 9 include:

- Z13 - retention of existing land use pattern within the south district which is predominantly residential and important open areas;
- Policy Z15 - the general open nature of Europa Point will be retained. Buildings, which are well designed and in suitable locations, may be acceptable if they can be individually justified; and
- Policy Z16 – land uses which are not appropriate within residential or industrial areas can be located at the Governor's Cottage.

2.9 The proposed diesel power station has been considered under potential future planning policy from the consultation draft Gibraltar Development Plan 2007[3]. This plan has developed the policy in the 1991 plan further and has undergone Strategic Environmental Assessment (SEA) required as part of the planning process. The plan provides detailed and indicative information and a clear policy structure to work within. It is important to note that this plan has not yet been formally adopted and may be subject to change.

- Policy UW1 – New Utility Services – all new proposals should pay careful attention to their design and location in order to minimise possible adverse effects on the environment.

2.10 It states within the development plan that the Waterport Power Station is nearing its maximum capacity and with additional developments it is expected that generating capacity will need to be increased. There is some limited scope to expand the existing station at its present site, however the extra capacity that could be accommodated would be limited and the close proximity to existing and proposed residential areas is less than ideal.

2.11 The site falls within Zone 7 – Europa of the consultation draft Gibraltar Development Plan 2007.

- Policy Z7.9 – Parade Ground – A site is allocated for industrial use. The design of any development on this site must take into account it's setting with particular regard to nearby historical structures and it's proximity to the Upper Rock Nature Reserve..
- Policy Z7.10 – Lathbury – Natural Linkages –The commission shall seek to ensure that appropriate provision is made in future development in the Lathbury Barracks area for green corridors and green roofs to assist in maintaining the natural linkages between Windmill Hill and the Upper Rock.

## Assessment Methodology

### *Landscape Assessment*

2.12 Assessment of landscape, including urban landscape or townscape, is based primarily on character and sensitivity. Landscape character refers to the different features between landscapes/townscapes that make them distinct and recognisable. The quality of the character depends on a number of factors including the condition of the landscape and its value based on either national or local criteria. Sensitivity is the ability of the landscape/townscape to accommodate change without detrimental effect on the character.

2.13 For the purposes of the baseline study a three-part scale of high, medium and low quality has been used:

- A high quality landscape has valued features that are significant in the context of the surrounding area, with distinctive components and structure. These landscapes/townscapes are considered to be of particular importance to conserve and may be particularly sensitive to change in general;
- A medium quality landscape has features that are distinctive to the local area with some recognisable and consistent structure; and
- A low quality landscape has no distinctive features or character and is often in a poor condition.

2.14 The quality of the landscape and its ability to accommodate the type of change associated with the development will determine its sensitivity. For example, a change associated with the development that would have a major effect on the quality of that landscape is considered to have a high sensitivity. Conversely a landscape of low sensitivity would be affected in a minor way and would be more able to accommodate change.

2.15 The proposed development has the potential to affect the landscape fabric of the site itself and also the quality/character of the site and the surrounding areas. To determine the significance of the effect, consideration is given to the sensitivity of the landscape and to the magnitude of change. The scale or magnitude of change is determined by the extent of the alteration to key features, the distance from the proposed development, the extent to which the proposals would be visible, the presence of other built structures and the duration of operations.

2.16 In accordance with the relevant guidelines[1], the overall impact on the landscape is summarised below in Table 2-1, using the standard seven point scale (slight, moderate or substantial, beneficial or adverse and neutral). To allow suitable comparison with other technical assessments in this ES, this scale has been interpreted to low, medium and high significant effects. This does not change the outcome of this assessment.

**Table 2-1 Impact Criteria - Landscape**

| *Scale* | *Degree of Effect* |
|---|---|
| High adverse or beneficial effect | Where the scheme would result in a significant deterioration (or improvement) to the existing landscape |
| Medium adverse or beneficial effect | Where the scheme would result in a noticeable deterioration (or improvement) to the existing landscape |
| Low adverse or beneficial effect | Where the scheme would result in a barely perceptible deterioration (or improvement) to the existing landscape |
| Neutral | No discernable deterioration (or improvement) to the existing landscape. |

### *Visual Assessment*

2.17 The visual assessment considers the visual amenity of the site and the surrounding area, and identifies potentially sensitive visual receptors and the approximate visibility of the proposed development.

2.18 The sensitivity of the visual receptors and views will be dependent on the receptor type and frequency of use, the speed at which the view would be gained, the landscape designation of the viewpoint, the quality of the intervening landscape and the scale of the landscape and the context of the view. The most sensitive receptors may include users of public footpaths and residential properties with views affected by the proposed development. For the purposes of this baseline study, the sensitivity of the viewpoint has been classed as high, medium or low.

*Assessment of Significance*

2.19 The significance of the resulting visual effect is the degree to which the nature and appearance of the proposals would affect the character and quality of the existing view. It is therefore a result of the magnitude of change and the degree of sensitivity of the view to change. Magnitude is determined by the distance from the proposed development, extent to which the proposals would be visible and extent within the overall view, presence of other built structures and duration of operations. In accordance with the relevant guidelines[2] the significance criteria for visual effects are summarised and defined as follows in Table 2-2.

**Table 2-2 Significance Criteria – Visual Impact**

| *Significance* | *Criteria* |
|---|---|
| High | Where effects are adverse, the proposals create dominating changes to views from sensitive receptor types or major changes to views from very sensitive receptor types that would cause deterioration in view. Where beneficial, the proposals change the nature of the view creating a marked improvement. |
| Medium | Where effects are adverse, the proposals create distinct changes to views from sensitive receptor types that would cause some deterioration in view. Where beneficial, the proposals form an immediately apparent feature in a less sensitive view, such that it affects and improves the overall view. |
| Low | Where effects are adverse, the proposals create major changes to views from receptors of low to medium sensitivity or small changes to views from very sensitive receptor types that would cause limited deterioration in view. Where beneficial, proposals create small changes to sensitive views or a recognisable new element within a view of low sensitivity, such that there is some localised improvement. |
| Negligible | Negligible or no discernible change. |

### Approach to Mitigation

2.20 Opportunities to reduce and remedy or compensate for adverse significant visual effects for construction and operation have been identified where practicable and appropriate.

### Assumptions and Limitations of Study

2.21 The assessment has been carried out using currently available information on the power station proposals. Not all potential view points were visited due to security considerations and a full inspection from the sea was not possible due to bad weather. Private properties were also not visited. As a result, impacts to these viewpoints have been estimated based upon professional judgement and experience of similar developments.

# 3 EXISTING CONDITIONS

## The Existing Site

3.1 The preferred site of the new power station is the parade ground area forming part of Lathbury Barracks on Windmill Hill Flats at the south end of Gibraltar.

3.2 The Windmill Hill Flats plateau has an average elevation of 120 m above sea level. The plateau is surrounded to the east, west and south by steep cliffs dropping down to lower terraces and the sea, and to the north by steep slopes rising to the Upper Rock.

3.3 There are no significant trees or high vegetation on the plateau. Areas not paved or built over, however, have a rich vegetation of low scrub resulting in the area being designated as a site of Community importance (SCI). This is described in more detail in the Ecology Chapter (Volume 2: Technical Reports).

3.4 The south part of Windmill Hill Flats is the secure MoD Buffadero Military Training Area comprising active shooting ranges, various buildings and structures, communication equipment, roads and hard standing, and a variety of obsolete gun emplacements and other installations. This area also includes an active signals station.

3.5 The north part of the Windmill Hill Plateau including the Parade Ground is not secured and is not in active military use. It has a variety of land uses including industrial and residential. The parade ground is currently in use as a storage area for new cars and general (unofficial) public use. Immediately to the north of the parade ground, the Retrenchment Block is an historic 19th century military building currently being restored for commercial and community uses. On the northeast side of the Retrenchment Block a high modern residential block is currently under construction. .Also to the north west is a commercial satellite earth station incorporating a transceiver dish. Immediately to the north, a new HM Prison is under construction. Further to the north the land rises steeply to the Upper Rock Nature Reserve and becomes more vegetated.

### Landscape, Townscape or Heritage Designations

3.6 The majority of Windmill Hill Flats south of the parade ground is designated as a SCI mainly because of its botanical interest (refer to the Ecology Chapter for more detail). However, the parade ground itself is not designated. The Upper Rock from approximately Jew's Gate northwards is also part of The Rock SCI.

3.7 There are several listed buildings or structures in the vicinity of the site (refer to the Archaeology and Built Heritage Chapter, Volume 2: Technical Reports, for a detailed description). These are the Hole in the Wall Gate and the Hole in the Wall Battery, both close to the north east corner of the site, and Devil's Bellows to the northwest. The Retrenchment Block is not listed but recognised by the Heritage Division of the Government of Gibraltar as a unique Victorian fortification.

### Landscape Character

3.8 Landscape character areas differ in their range of landscape features and the patterns these create and consequently in their ability to accommodate different types of development. Some areas may be particularly sensitive and others more resilient. Some landscapes may present opportunities for landscape improvement that will help with the eventual integration of the development with the surrounding landscape.

3.9 In the area surrounding the parade ground the mixture of land uses including light industry, commercial and construction, uncoordinated buildings and structures of different scales, obsolete military installations and lack of unifying elements such as trees, results in an overall low landscape quality. There are several historic buildings and structures in the vicinity. The character of the local area is considered to be of low quality and has low sensitivity to change. However, in a wider perspective, the whole of Gibraltar is a distinctive, iconic topographical form and the Windmill Hill Flats is an important part of this topography. In this wider context the contribution of the Windmill Hill Flats to the overall iconic character of the Rock is considered to be important and of high quality with low to medium sensitivity to change.

## Visibility

*Overview*

3.10 As much of the area around the site has restricted access there will be few local receptors except for some residents of the new residential developments in the vicinity and workers and visitors to the various military and commercial establishments. Views into the site from below the plateau are completely screened by the surrounding cliffs (Figure LV3-1 and LV3-2). From the Upper Rock some views of the site are possible but most are screened by topography and vegetation. From the sea, the edge of the plateau can be seen but there are no views into the site due to the low angle of view.

## Key Viewpoints

3.11 The locations of the following key viewpoints are shown on Figure LV3–1 and the photographs on Figures LV3-3 to LV3-5. The following assessment sets out their sensitivity categorised as high, medium, low or negligible.

*Viewpoint 1: Europa Point (Approximately 900 m from the Site)*

3.12 This is an important tourist destination in Gibraltar. The edge of the plateau can be seen but none of the existing buildings at Lathbury are visible. The sensitivity of this viewpoint is classed as high.

*Viewpoint 2: Jew's Gate (Approximately 360 m from the Site)*

3.13 This is one of the main entrances to the Upper Rock and an important stop on the tourist circuit. The site is clearly visible but the view is dominated by large buildings in the foreground and the mixture of other buildings and structures on the plateau. The sensitivity of this viewpoint is classed as medium/low.

*Viewpoint 3: Mediterranean Steps Path (Approximately 350 m from the Site)*

3.14 The Mediterranean Steps Path is a well used footpath running between Jew's Gate and the highest point of The Rock at O'Hara's Battery. It is an extremely attractive rural path allowing panoramic views over the Mediterranean and the Straits of Gibraltar to Africa. From this viewpoint the site is clearly visible. The sensitivity of this viewpoint is classed as high. Although the site is visible from several points along this path, of which viewpoint 3 is typical, for most of the route the site is screened by topography and vegetation and is not visible.

*Viewpoint 4: Hole in the Wall Battery (Approximately 100 m from the Site)*

3.15 The Battery and adjacent Hole in the Wall Gate are listed historic structures. However, this viewpoint is not easily accessible and not normally visited. The site is clearly visible but the view is degraded by disparate military buildings and structures. The sensitivity of this site is classed as medium.

*Viewpoint 5: Off Camp Bay (Approximately 1 km from the Site)*

3.16 This viewpoint is approximately 500 m offshore which is representative of a zone used by pleasure boats. The edge of the plateau and the higher parts of some of the buildings and structures in Lathbury Barracks are visible. Mainly due to screening by topography and distance the sensitivity of this viewpoint is classed as **low**.

*Viewpoint 6: Gibraltar Bay (Approximately 2 km from the Site)*

3.17 This viewpoint was chosen as it approximates to the location offshore where cruise ships pick up their pilots for the final approach to Gibraltar. It is considered that this location is representative of the various views of the site which might be seen by cruise ship passengers. From this position the edge of the plateau can be seen but due to the distance it is difficult to see any detail of buildings. The sensitivity of this viewpoint (and from cruise ships generally) is classed as **low**.

*Views from Residential and Other Viewpoints*

3.18 There are several housing and other developments to the north of the site from which views from the upper storeys will be possible. It was not possible to access these private properties. The sensitivity of these viewpoints will vary but in some cases they are likely to be **high**.

*Night Views*

3.19 Night views from the Upper Rock were not assessed as this area is closed to the public at night. From other viewpoints existing street and other lighting on Lathbury and in the built up areas fringing the base of the plateau dominate the view.

# 4 ASSESSMENT OF SIGNIFICANT EFFECTS

## Construction Phase

4.1 This section assesses the potential significance of effects of the proposed power station on landscape quality and visual amenity.

4.2 The main activities during the construction period will be site preparation and the construction of the power station components. All of the main generating components will be prefabricated for site assembly and transported to site by road. There will therefore be a rise in the amount of heavy traffic in the area. The total estimated construction period is 24 months although 6 months of this is for commissioning and testing. All of the construction impacts will be temporary,

*Landscape Character*

4.3 Overall it is considered that the magnitude of change during construction on the existing local landscape character will be low to medium and the significance low to medium adverse. Due to the low sensitivity of the site the construction works will **not have a significant effect** on the existing local landscape character. In the wider context of the whole west end of the Rock it is also considered that the magnitude of change will be low and the works will **not have a significant effect.**

## Visual Amenity

*Viewpoint 1: Europa Point*

4.4 All of the construction work will be hidden by topography. The magnitude of change and significance of effect are therefore **negligible**.

*Viewpoint 2: Jew's Gate*

4.5 The construction works will be clearly visible but in the context of other buildings and activity. The magnitude of change is considered to be medium and the significance of effect is considered to be **medium adverse**.

*Viewpoint 3: Mediterranean Steps Path*

4.6 The construction works will be clearly visible. The magnitude of change is considered to be high and the significance of effect is considered to be **high adverse**. Note that this viewpoint is not representative of the whole route of the path.

*Viewpoint 4: Hole in the Wall Battery*

4.7 The construction works will be clearly visible. The magnitude of change is considered to be high and the significance of effect **high adverse**.

*Viewpoint 5: Off Camp Bay*

4.8 Some construction work will be visible from this viewpoint but the effect will be minimised by distance. The magnitude of change is considered to be low and the significance of effect is considered to be **low adverse**.

*Viewpoint 6: Gibraltar Bay*

4.9 Some construction work will be visible from this viewpoint but the effect will be greatly minimised by distance. The magnitude of change is considered to be low and the significance of effect is considered to be **low adverse**.

*Residential and Other Viewpoints*

4.10 The visual impact of construction on the other viewpoints and receptors previously described will vary depending on proximity and will result in a magnitude of change and significance of effect that varies from **negligible to high adverse.**

*Night Views*

4.11 During construction the magnitude of change and significance of effect is considered to be **negligible**.

### Operational Phase

*Landscape Character*

4.12 As previously described in section 3 of this chapter, the existing local landscape character is unexceptional and capable of absorbing change. The proposed power station buildings and structures will relate to other large buildings in the area and to the existing character of the area. It is considered that the magnitude of change will be medium and the significance of effect is considered to be **medium adverse**. In the wider context of the whole west end of the Rock it is considered that the magnitude of change will be low and the works will **have low adverse effect.**

*Visual Amenity*

*Overview*

4.13 The power station will be most visible in short views from the immediate vicinity but in this area there are few receptors. It will be visible from some important visitor view points on the Upper Rock and from the sea but only at considerable distance. Only the top of the stacks will be visible from viewpoints on the land below the plateau such as the Europa area and Buena Vista. Overall the magnitude of change is considered to be low and the significance **low adverse**.

*Viewpoint 1: Europa Point*

4.14 The line of view from this location (shown on the section in Figure LV3-2) demonstrates that only the top of the stacks will be visible from this location. Therefore the proposed development will result in **negligible** significant effects.

*Viewpoint 2: Jew's Gate*

4.15 The proposed power station will be clearly visible from this location although in the context of other large buildings. The magnitude of change is considered to be medium and the significance of effect **medium adverse**.

*Viewpoint 3: Mediterranean Steps Path*

4.16 The proposed power station will be clearly visible from this viewpoint (although as noted in section 3 most views along this path are screened). The magnitude of change is considered to be high and the significance of effect **high adverse**.

*Viewpoint 4: Hole in the Wall Battery*

4.17 The proposed power station will be clearly visible as it is so close but will be seen in the context of other buildings and structures in the area. The magnitude of change is considered to be high and the significance of effect **medium adverse.**

*Viewpoint 5: Off Camp Bay*

4.18 The upper parts of some buildings and structures, and the proposed power station chimneys will be visible but at considerable distance. The magnitude of change is considered to be low and the significance of effect **low adverse**.

*Viewpoint 6: Gibraltar Bay*

4.19 As for viewpoint 5 the upper parts of some buildings and structures, and the chimneys will be potentially visible from this viewpoint but the effect will be greatly minimised by distance, resulting in **negligible** significant effects.

*Residential and Other Viewpoints*

4.20 As previously noted the sensitivity of these viewpoints will vary. The magnitude of change and significance of effect will also vary but are considered to range from **negligible to high adverse**.

*Night Views*

4.21 It is considered that any additional lighting will merge with existing lighting at Lathbury and the surrounding areas below the plateau. Therefore the magnitude of change is considered to be low and the significance of effect **negligible**.

# 5 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

5.1 The proposed power station is an industrial facility sited among a mix of uses in an area zoned for this industrial type of use. Care has already been taken in the choice of a site that is very well screened from many receptors.

## Mitigation

### *Construction*

5.2 During the construction phase the temporary adverse visual effects will be mitigated as far as reasonably possible by robust and attractive hoarding where appropriate, by control of construction vehicle movements, prevention of dust and control of lighting at night which will be directional. Working at night will not be permitted or will be minimised and work or security lighting will be controlled to light only the work site and avoid light spillage and light pollution outside the site or to the sky. These measures will be made part of the Construction Environmental Management Plan (CEMP).

### *Operation*

5.3 During the detailed design process, care will be taken with the quality of the design of the power station to provide a neat and well ordered facility using good quality materials and finishes. As the few clear views of the facility will be from the Upper Rock it will be seen mainly against the background of the Lathbury military and industrial area (Figure LV3-4 Viewpoint 3). Colours therefore should be generally recessive i.e. buffs or light greys to fit with this landscape background.

5.4 The site and its perimeter will include landscaping with native plant species, including annuals, perennials, shrubs and trees appropriate to the connecting vegetated areas, where there is available space. Provision will be included in the parameters of the detailed design. The Ecology Chapter (Volume 3: Technical Reports) provides further details of planting.

5.5 Operational controls to minimise the production of a visible plume from the chimneys will be implemented (described further in the Air Quality Chapter, Volume 2: Technical Reports).

### Residual Significant Effects

5.6 The foregoing landscape and visual assessment shows that there will be very few viewpoints from where the power station will be clearly visible apart from very close views in the Lathbury area and from some viewpoints on the Upper Rock. The stacks will just be visible from Europa Point. The site location is considered capable of absorbing such land use change. The mitigation measures described above are considered to be appropriate and adequate for this type of industrial facility in such a setting and it is anticipated that overall there will be no residual significant landscape character or visual amenity effects apart from some views from the Mediterranean Steps Path, the view from Jew's Gate and some residences (eg the new nursing home) which may experience residual significant visual effects even after mitigation has been included as part of the design.

# 6 REFERENCES

1. Institute of Environmental Management and Assessment and The Landscape Institute, 2002. Guidelines for Landscape and Visual Impact Assessment, 2nd Edition.
2. Government of Gibraltar Department of Trade and Industry, 1991. The Gibraltar Development Plan, 1991.
3. Government of Gibraltar Department of Trade and Industry, 2007. The Gibraltar Development Plan Consultation Draft, 2007.

# CHAPTER SIX

# LAND USE

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| CEMP | Construction Environment Management Plan |
| DMRB | Design Manual for Roads and Bridges (UK) |
| EFW | Energy for Waste |
| IEEM | Institute of Ecology and Environmental Management |
| IEMA | Institute of Environmental Management and Assessment |
| MoD | Ministry of Defence |
| SCI | Site of Community Importance |

# 1 INTRODUCTION

1.1 This chapter describes the existing land uses around the proposed diesel power station. Potential effects are assessed by comparison to existing conditions.

1.2 The assessment has included site visits and information gathering through consultation and desk studies. The study focuses on land within a radius of approximately 1 km of the proposed diesel power station.

1.3 Consultation and information gathering has been undertaken with relevant Authorities. A full list of the sources consulted is provided in the Consultation Log, (Main Report: Volume 1). Information has been obtained from consultation with various organisations, including departments of the Government of Gibraltar and the Ministry of Defence (MoD).

1.4 This chapter describes the methodology of the assessment, evaluates the current land use, assesses the potential effects of the development proposals upon land use, identifies appropriate mitigation where required and assesses any residual effects. Cross-reference to other technical assessments of this Environmental Statement, including Ecology (Volume 2: Technical Reports) has been made where required.

# 2 SCOPE AND METHODOLOGY

## Scope

2.1 The initial scoping exercise identified potential effects upon land use from the proposed development. Consequently a full assessment of potential impacts has been undertaken.

2.2 The technical scope of this assessment has included existing land uses within and adjacent to the proposed power station. Potential significant effects have been addressed for construction and operational phases.

2.3 The geographical scope of the study area has been influenced by the sensitivity of receptors within a radius of approximately 1 km of the proposed power station.

2.4 The effects of Electromagnetic Fields (EMF) have been scoped out of the assessment as the existing practice and design of Gibraltar's distribution system results in no electrical field, and the proposed new distribution system would do the same. Since the electrical field is contained within the equipment, the increase in voltage from 11 to 33 kV would have no impact on the situation.

## Assessment Methodology

2.5 There is no specific land use assessment methodology available. The general guidelines provided by the Institute of Environmental Assessment (IEMA)[3] have been used and the assessment principles given in the Design Manual for Roads and Bridges (DMRB) Volume II Part 6 (Land Use) have been adopted where relevant.

2.6 The desk study has included a review of:

- The Gibraltar Development Plan 1991[1] and Consultation Draft 2007;[2]
- Aerial and ground photographs; and
- Base mapping of Gibraltar.

2.7 Land use for the purpose of this assessment is defined as the use and management of any land directly or indirectly affected by the proposed development.

2.8 Whilst there are no published 'standard' criteria for land use assessments, threshold levels for potential significant effects have been developed based upon practical experience and guidance from such bodies as the Institute of Ecology and Environmental Assessment (IEEM) and the IEMA. Significance is seen as an interaction of both the sensitivity of the potential receptor (eg international, national, regional, local importance) and the magnitude and scale of change.

2.9 The assessment has been carried out as a three stage process using the criteria as outlined in Tables 2-1 to 2-3.

**Table 2-1 Criteria to Assess Sensitivity of Receptor**

| *Sensitivity* | *Criteria* |
|---|---|
| High | Areas of land use of national or international importance eg designated sites and neighbouring land uses, highly sensitive to the type of development proposed. |
| Medium | Areas of land of local importance, especially neighbouring land highly sensitive to the type of development proposed. |
| Low | Land uses of greater than local importance, although not particularly sensitive to type of development proposed. |
| None | Areas of land of no more than very local significance or not sensitive to the type of development proposed. |

**Table 2-2 Criteria to Assess Magnitude and Scale of Change on Land Use**

| *Magnitude* | *Criteria* |
|---|---|
| High | Existing land use will be unable to continue as a direct or indirect consequence of the development or a beneficial new land use that could not otherwise occur will be facilitated. |
| Medium | Where existing land use can continue but changes in land take, extent, profitability, enjoyment, etc is likely to be noticed by the user. |
| Low | Small changes not materially affecting the continuation of existing use. |
| None | No predicted change. |

**Table 2-3 Assessment of Significance of Potential Effects on Land Use**

| *Significance* | *Criteria* |
|---|---|
| High | A land use of at least national importance which will be unable to continue or facilitated as a direct result of the development process. |
| Medium | A noticeable change in locally significant land use, which may be unable to continue; or a small change in nationally important land use. |
| Low | Small changes with no more than local effects. |
| None | Change will be negligible and/or land use not sensitive to this type of development process. |

### *Approach to Mitigation*

2.10 Opportunities to reduce and remedy or compensate for adverse significant effects on land use and infrastructure resources have been identified where practicable and appropriate.

# 3 BASELINE CONDITIONS

3.1 The primary study area comprises land defined by the permanent and temporary land take for the scheme. The study also identifies sensitive land uses extending a further 1 km from the proposed site, to place the primary land uses within their local context. Land use definitions have been developed as shown in Table 3-1 below.

**Table 3-1 Land Use Definitions**

| *Land Use* | *Definition* |
|---|---|
| Industrial/Commercial | Land used for the pursuit of industrial and commercial work/interest |
| Residential Property | Land used for residential purposes |
| Military | Land occupied or used by the MoD |
| Leisure/Tourism | Land used for tourism and recreational purposes |
| Other Uses | Site of Community interest (SCI) |

## Land Use

### *Industrial/Commercial*

3.2 The parade ground is currently used as storage compound for vehicles for general public use. Lathbury Industrial Park is located to the north of the site, and has a mix of light industrial and commercial businesses.

3.3 Directly east of the site is a cliff, where the land height immediately drops by approximately 60 m to the industrial area at Europa Advance Road. This area includes a new crematorium and clinical waste incinerator in construction and an extant quarry which is currently used as a temporary refuse storage area. An Energy for Waste (EFW) plant is also situated in this area, however, it is not operational.

### *Residential Property*

3.4 Residential areas in the vicinity of the site include properties on Windmill Hill Road and Europa Road. There are also properties at Buena Vista to the west, and Europa Flats to the south west of the site, however, these properties will not be directly influenced by the proposed power station as they are separated from the site by a steep cliff.

*Military*

3.5 There is MoD land adjacent to the south of the proposed new power station at the Buffadero Battery Training Ground.

*Leisure/Tourism*

3.6 The parade ground is classed under this definition as well as commercial, as it is also used as an open space by the general public eg for dog walking and skateboarding.

3.7 The Retrenchment Block (approximately 90 m north of the site perimeter) is currently being refurbished and redeveloped. Under Policy Z7.6 of the Gibraltar Development Plan, the Retrenchment Block will be used for recreational and leisure purposes.

3.8 The Retreat Centre is located to the north of the site and is used for some overnight stays.

3.9 Jew's Gate is to the north of the site off Windmill Hill Road and is the entrance to the Upper Rock Nature Reserve. The Mediterranean Steps are used recreationally as a walk up to the Rock and are situated to the north of the site.

*Other Uses*

3.10 Land directly east of the parade ground which will be used for the proposed power station is ex-MoD land. It has developed some flowering plants and is a useful wildlife corridor (this is discussed further in the Ecology Chapter, Volume 2: Technical Reports). The land is not accessible to the public. There is also an old piped rifle range situated on the land which is also ex-MoD and is not accessible.

3.11 Windmill Hill Flats adjacent to the south of the proposed power station site is designated as a SCI. The Upper Rock Nature Reserve to the north of the site is also designated as a SCI. This is described in the Ecology Chapter.

### Future Baseline

3.12 At the time of this assessment the following future developments have been identified:

- Clifftop House Luxury Apartments (completion scheduled August 2008);
- Prison (completion scheduled January 2009); and
- Retirement Home (no completion date available).

# 4 ASSESSMENT OF SIGNIFICANT EFFECTS

4.1 This section assesses the potential significance of effects of the proposed development on land use.

*Construction*

4.2 The main site construction compound will be located within the site perimeter as a result of space constraints. It will either be located on the grass patch to the east of the tarmac of the parade ground where the urea tanks will eventually be located, or to the north of the site where the administration block will eventually be located. The significance of the effect of the site construction compound upon other land uses is considered to be **none**.

4.3 It is anticipated that secondary construction compounds will be located further from the site, where large components of engines will be temporarily stored for short periods. Contractors will assess any such temporary storage sites for environmental impacts within their provisions under the CEMP. They will have a duty to limit environmental effects such as noise, general disturbance, vibration, traffic, air quality, ecology, fragmentation of land and general pollution under various EU Directives and Gibraltar laws protecting the environment. The temporary land required for these offsite construction compounds may cause a low impact to existing land uses, which may lead to a temporary **low adverse significant effect**.

*Operation*

4.4 The Parade Ground is owned by the MoD and is currently used as a storage area for a vehicle company under MoD consent. The Parade Ground is also currently used by the general public for general recreational activities. This is not an official designation and therefore under this assessment there is a **low adverse significant effect** to current land use.

4.5 There will not be any other changes to land use, including those adjacent to the site, as a result of the proposed power station.

# 5 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

## Mitigation

5.1 Mitigation of the effects from construction will be made, primarily, through the development of a Construction Environmental Management Plan (CEMP) and ensuring that the offsite construction compound does not fragment existing land uses nor affect any future developments on that land.

## Residual Significant Effects

5.2 It is not possible to mitigate the permanent change in land use. This will therefore result in a permanent **low adverse significant residual effect.**

# 6 REFERENCES

1. Government of Gibraltar Department of Trade and Industry, 1991. Government of Gibraltar Development plan 1991.

2. Government of Gibraltar Department of Trade and Industry, 2007. Government of Gibraltar Development plan Consultation Draft 2007.

3. Institute of Environmental Management and Assessment, 2004. Guidelines for Environmental Impact Assessment.

4. Highways Agency, 1994. Design Manual for Roads and Bridges.

# CHAPTER SEVEN

# NOISE AND VIBRATION

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| Ambient Noise Level | The ambient noise level is the equivalent continuous 'A' weighted sound pressure level ($L_{Aeq,T}$) (see below). It takes account of both the number and level of noise events. |
| A-weighting, dB(A) | The sensitivity of the ear is frequency dependent. Sound level meters are fitted with a weighting network which approximates to this response and allows sound levels to be expressed as an overall single figure value, in dB(A). |
| Background Noise Level | Statistical noise indices are also used to describe the noise environment. The $L_{A90}$ is the 'A'-weighted sound pressure level exceeded for 90 percent of the measurement period, and is referred to as the background noise level, as noise rarely drops below this level. |
| Baseline Noise Level | In this study, where the term baseline noise level is referred to, it is the equivalent continuous 'A' weighted sound pressure level, ($L_{Aeq,T}$) (see below) not including either construction noise or the operation of the power station. |
| BS | British Standard |
| CRTN | Calculation of Road Traffic Noise |
| Decibel, dB | The unit used to describe the magnitude of sound is the decibel (dB) and the quantity measured is the sound pressure level. The decibel scale is logarithmic and it ascribes equal values to proportional changes in sound pressure, which is a characteristic of the ear. Use of a logarithmic scale has the added advantage that it compresses the very wide range of sound pressures to which the ear may typically be exposed to a more manageable range of numbers. The threshold of hearing occurs at approximately 0 dB (which corresponds to a reference sound pressure of $2x10^{-5}$ pascals) and the threshold of pain is around 120 dB.<br>The sound energy radiated by a source can also be expressed in decibels. The sound power is a measure of the total sound energy radiated by a source per second, in watts. The sound power level, $L_w$ is expressed in decibels, referenced to $10^{-12}$ watts. |
| EU | European Union |
| Frequency, Hz | Frequency is analogous to musical pitch. It depends upon the rate of vibration of the air molecules which transmit the sound and is measured as the number of cycles per second or Hertz (Hz). The human ear is sensitive to sound in the range 20 Hz to 20,000 Hz (20 kHz). |
| $L_{Aeq,T}$ | Where noise levels vary with time, it is necessary to express the results of a measurement over a period of time in statistical terms. The most widely applicable unit is the equivalent continuous A-weighted sound pressure level ($L_{Aeq,T}$). It is an energy average and is defined as the level of a notional sound which (over a defined period of time, T) would deliver the same A-weighted sound energy as the actual fluctuating sound.<br>T is the reference time period which for the operational noise assessment is 30 mins, and for construction noise is 12 hours. |

| | |
|---|---|
| | Where no reference time period is specified for a noise level, the unit is presented as $L_{Aeq}$. |
| mm/s | Millimetres per second |
| NEC | Noise Exposure Category |
| NoiseMap | Industry-standard environmental noise modelling software. |
| PPG | Planning Policy Guidance (UK) |
| p.p.v. | Peak particle velocity. Relating to vibration, this is the maximum value of particle velocity obtained during a given interval. |
| RNH | Royal Naval Hospital |
| VDV | Vibration dose value. Relating to vibration, this is a measure of exposure to vibration, taking into account both level and duration. |
| MoD | Ministry of Defence |
| PPG | Planning Policy Guidance (UK) |
| p.p.v. | Peak particle velocity. Relating to vibration, this is the maximum value of particle velocity obtained during a given interval. |
| TRL | Transport Research Laboratory |
| WHO | World Health Organisation |

# 1 INTRODUCTION

1.1 This chapter presents an assessment of the potential significant noise and vibration effects arising from the proposed diesel power station (as described in the Environmental Statement; Main Report; Volume I).

1.2 The assessment is primarily concerned with the effects of noise and vibration on people living and working within the environs of the power station. Normal practice has been followed in that the assessment of both construction and operation has been made at nearby noise and vibration sensitive receptors including residential dwellings, community facilities and places of work.

1.3 In matters relating to environmental noise and vibration, Gibraltar makes use of the current best practice in the UK as set out in British Standards and planning policy guidelines. The noise and vibration study has followed that protocol and a schedule of the relevant Standards, Legislation and Planning guidance is set out in Section 2 of this chapter.

1.4 The scope of the study and a detailed description of the methods by which noise and vibration have been calculated and assessed are contained in Section 3 of this chapter. This Section also sets out the procedures used for the noise survey carried out, including a description of monitoring locations. A summary of the results of the survey is contained in Section 4, whilst a description of future baseline noise levels used for the purposes of the noise assessment is given in Section 5. The results of noise and vibration calculations at receptors, and assessments of the effects are detailed in Section 6. The mitigation of significant effects is dealt with in Section 7.

# 2 PLANNING CONTEXT

2.1 This section provides a summary of the relevant legislation and planning policy from European Union (EU) and Gibraltar legislation, and UK policy and guidance in the absence of specific Gibraltar policy. The following legislation and policy has been used to assist in setting noise and vibration criteria for the proposed development, Section 3 of this chapter (Scope and Methodology) provides details of these guidance thresholds.

## EU and Gibraltar Legislation

*Environmental (Assessment and Management of Noise) Regulations 2006*

2.2 The Environmental Assessment and Management of Noise Regulations (2006)[1] transposes Directive 2002/49/EC[2] relating to the assessment and management of environmental noise into the law of Gibraltar. This Directive covers the process of strategic noise mapping and resulting action plans for Gibraltar.

## Gibraltar Planning Policies

*The Gibraltar Development Plan 1991*

2.3 The Gibraltar Development Plan[3], prepared by the Government of Gibraltar Department of Trade and Industry and released in 1991, sets out the Government's development plan and associated policies for Gibraltar in line with the British Development Plan system.

*The Gibraltar Development Plan (Consultation Draft) 2007*

2.4 The Gibraltar Development Plan (Consultation Draft)[4], prepared by the Government of Gibraltar Department of Trade and Industry, sets out the Government's development plan and associated policies for Gibraltar in line with the British Development Plan system. It has not yet been formally adopted. The plan does not contain any specific items relating to environmental noise.

## UK Planning Policies

*Planning Policy Guidance 24*

2.5 Current guidance given in Planning Policy Guidance (PPG 24) Planning and Noise[5], which has been in force since September 1994, deals mainly with new housing development in relation to existing noise generating development.

## British Standards

2.6 The British Standards Institute sets defined standards established by consensus and approved by a recognised institution. For the assessment of effects of noise and vibration from the proposed diesel power station, the following British Standards (BS) have been used:

- BS 5228 (1997)[6] Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control;
- BS 4142 (1997)[7] Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas;
- BS 6472 (1992)[8] Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz);
- BS 8233 (1999)[9] Sound Insulation and Noise Reduction for Buildings-Code of Practice: and
- BS 7385 Part 2. (1993)[10] Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings.

# 3 SCOPE AND METHODOLOGY

## Scope

3.1 The scope of this study includes the assessment of the effects of:

- Noise from power station construction activities carried out on the Lathbury Barracks site;
- Noise from construction road traffic accessing the Lathbury Barracks site; and
- Vibration from construction activities carried out at the Lathbury Barracks site.

3.2 The scope of the study also includes the assessment of the effects of:

- Noise caused by operation of the power station;
- Noise from road traffic accessing the power station site; and
- Vibration caused by operation of the power station.

3.3 The study has considered the potential effects of noise from these sources on noise sensitive receptors in the environs of the Lathbury Barracks site and at noise sensitive receptors adjacent to site access roads. The study has also considered the potential effect of vibration from these sources at the nearest vibration sensitive receptors to the power station.

3.4 The construction study has been made for the years 2009 to 2011. The operational assessment has been made for the opening year of the power station (2011) and the year when it is first expected to run at full capacity (2032).

## Assessment Methodology

### *Construction Noise*

<u>Calculation Method</u>

3.5 Noise levels resulting from construction activities on the Lathbury Barracks site have been calculated at noise sensitive receptors adjacent to the site using industry standard computer based modelling software, NoiseMap. The model option embodying the method set out in the British Standard BS5228 Part 1, Noise and Vibration Control on Construction and Open Sites[6] has been used for construction noise calculations.

3.6 The method takes into account the following factors that affect the propagation of noise between the site and each receptor, including:

- The reduction in noise levels (attenuation with distance) that will occur between the source and the receptor as a result of geometrical spreading. ie as the noise spreads out from the source it affects a wider area, but its intensity reduces;
- The reduction in noise levels which will occur if the sound crosses 'soft' ground, often referred to as ground attenuation; and
- The reduction in noise levels resulting from the positioning of barriers between the source and receptors. A barrier may take the form of, for example, a building, a wall, or in areas of complex topography the ground itself. This last factor is of considerable importance at the Lathbury Barracks site, where at some nearby receptors, the cliffs and walls on the boundary of the barracks provide acoustic screening of noise from the proposed site of the power station. Therefore, in order to ensure the best possible level of accuracy, detailed 3-D topographical information has been included in the model.

3.7 In the calculation of the noise generated on the site itself the model takes into account factors including:

- The number and type of plant used on the site;
- The sound power emission of individual plant;
- The source height of individual plant;
- The proportion of time that the plant is working, often referred to as the ‘on time’; and
- The location of the plant on the site.

3.8 In Figure NV3-1 (Volume 3: Figures) the locations for which noise calculations have been made are illustrated with a red square accompanied by a receptor number, which is used as the referencing system in the presentation and discussion of results.

Construction Assumptions

3.9 The numbers and types of plant utilised by the contractor will be dependant on the construction methods and sequence that will be decided by the contractor. However the schedule below represents the best current estimate and has been used as the basis of noise calculations. The work has been considered to comprise seven phases which are as follows:

- Phase 1: Site clearance and earthworks: Requiring 1 bulldozer, 1 excavator, 1 front end loader and 4 dump trucks;
- Phase 2: Construction of foundations: Requiring 1 excavator, 1 dump truck and 1 back hoe;
- Phase 3: Backfilling around foundations: Requiring 1 front end loader, 1 dump truck and 1 back hoe;
- Phase 4: Laying services: Requiring1 backhoe, 1 excavator and 2 dump truck;
- Phase 5: Erection of generating plant and equipment: the main generators will be brought in on a low-loader and jacked and skidded into position. A crane may be used for lifting the engine/generator onto the combined underbase. Other equipment will be erected on site using mobile cranes;
- Phase 6: Building generator hall: Requiring two 50 tonne mobile cranes, 1 flat truck for moving steelwork, 1 telescopic handler or yard crane for lighter steelwork; and
- Phase 7: Road works: Requiring 1 front end loader, 1 dump truck, 1 grader and 1 vibrating roller.

3.10 In order to give a worst case assessment, construction noise calculations have been made for the period during which plant are working nearest to receptors ie along the north west section of the site. In this study it has been assumed that construction will be carried out during normal working hours (08:00-18:00).

Assessment Criteria: Residential Buildings

3.11 The potential effect of construction noise has been assessed at residential properties on the basis of the time of day of the activity, the noise level and the proposed duration of the construction works. A noise impact is considered to exist where noise from construction activities gives rise to an increase in ambient noise levels of greater than or equal to 3 dB.

**Table 3-1: Construction Noise Impact: Description of Noise Change**

| *Increase in Noise Level (dB)* | *Semantic Description* |
|---|---|
| <3 | Not significant |
| 3-5 | Low |
| 5-10 | Medium |
| 10< | High |

3.12 Noise impact has been described using the semantic scale in Table 3-1, however account has also been taken of the absolute level of construction noise in comparison to the noise levels set below in Table 3-2. These are guideline noise levels set out in the Department of the Environment Advisory Leaflet 72 Noise Control on Building Sites[11] and are commonly used as limits for construction noise in major UK infrastructure projects. For a noise impact of high to be considered to occur at a dwelling during the day, evening or night time period then in addition the noise change in Table 3-1, construction noise levels must also be equal to or greater than the value given in Table 3-2 for the relevant period.

**Table 3-2: Construction Noise Limits: Dwellings**

| *Construction Period* | *Noise Level dB $L_{Aeq,T}$* |
|---|---|
| Daytime (07:00-18:00) | 75 |
| Evening (18:00-23:00) | 65 |
| Night (23:00-07:00) | 55 |

3.13 Baseline noise levels were measured at two locations that were considered to represent groups of properties at potential risk of noise effects arising from the power station, namely the old Naval Hospital Building (receptor no. 27), and the Retreat Centre (receptor no. 1). Noise assessments have been carried out at these positions by comparing this baseline noise level, corrected to take account of potential changes between the year of the noise survey (2005) and the years of construction (2009 to 2011), with the ambient noise level which would occur during each phase of construction. The ambient noise level is the total noise level including construction noise and existing noise sources.

3.14 Noise levels at the Retreat Centre have been considered to be representative of those at the new luxury flats and the proposed retirement home. Assessments have been carried out at these locations by comparison of construction noise levels with 2009 to 2011 baseline noise levels at the Retreat Centre.

3.15 The identification of potential significant effects at dwellings arising from construction noise has taken account of the severity of noise impact, its duration and the number of people potentially affected.

Assessment Criteria: Non-Residential Buildings

3.16 Construction noise impacts at non-residential noise sensitive facilities have been assessed using criteria that take into account their specific usage. At the

Lathbury Barracks site the nearby non-residential buildings (eg Firing Range office (receptor no. 6) are used as offices and therefore criteria have been chosen which reflect the affect of noise on office spaces. Suitable criteria are contained in the British Standard BS 8233 (1999) Sound Insulation and Noise Reduction for Buildings- Code of Practice[9]. BS 8233 recommends an internal noise level of 50 dB LAeq,T as a reasonable design level for offices and this level has therefore been used as a criterion in the assessment. That is, noise levels above this level will interfere with activities normally carried out within an office, with effects including speech interference and loss of reasonable conditions for study and work.

3.17 The significance of potential noise effects has then taken into account the severity of noise effects, the duration and the utility of the resource.

Construction Road Traffic Noise

3.18 Changes in noise levels at dwellings adjacent to site access roads arising from changes in traffic during construction of the power station will be calculated using the traffic flow relationships set out in the Calculation of Road Traffic Noise (CRTN)[12].

### *Operational Noise*

Calculation Method

3.19 The noise model described above, NoiseMap, has also been used to calculate noise levels resulting from the operation of the power station at noise sensitive receptors adjacent to the site.

3.20 The method takes into account the following factors that affect the propagation of noise between the power station and each receptor, including:

- The reduction in noise levels that will occur between the noise sources at the power station and the receptor as a result of geometrical spreading;
- The reduction in noise levels which will occur if the sound crosses 'soft' ground, often referred to as ground attenuation;
- The increase in noise levels at a receptor due to façade correction; and
- The reduction in noise levels, as a function of frequency, resulting from the positioning of barriers in the form of buildings, walls, or topography, between the source and receptors.

3.21 In the calculation of the noise emission from the power station itself the model takes into account factors including:

- The sound power emission of individual sources including options for mitigation eg engine exhaust and silencers;
- The number of sources;
- The source height; and
- The location of each source on the site.

3.22 The numbering system used to identify receptors is identical to that used in the construction noise calculations and the locations of receptors are shown In Figure NV3-1 (Volume 3: Figures).

3.23 It was stated earlier that the model allows accurate representation of the effects of topography, which is an important consideration at the Lathbury Barracks site, where at some nearby receptors, the cliffs and walls on the boundary of the barracks will provide acoustic screening of noise from the power station.

3.24 The attenuation will certainly be apparent during westerly wind direction (Poniente) and during still atmospheric conditions (0-5 m/s), however for the period during which the wind is blowing in an easterly wind direction (Levante), refraction effects arising from wind shear may reduce the effect of topographical screening. Therefore additional noise calculations and assessment have been made without the effects of topographical screening.

*Design and Operating Assumptions*

3.25 Noise levels have been calculated with the power station operating at three different capacities, corresponding to the day (07:00-19:00hrs), evening (19:00-23:00hrs) and night time (23:00-07:00hrs) periods. The assumptions with respect to numbers of engines running during these periods are presented in Table 3-3. To give a worst-case assessment, it has been assumed that the generators nearest the west of the site are operating.

**Table 3-3: Number of Generators Assumed Operational during Day, Evening and Night time Periods**

| | *Number of Generators Running* | | |
|---|---|---|---|
| *Year* | *Day* | *Evening* | *Night* |
| *2011* | 6 | 5 | 3 |
| *2032* | 10 | 9 | 6 |

3.26 The noise calculations include noise from the exhaust stacks, radiator/fans and engine inlets. It has been assumed that in the first year of operation (2011) there will be three exhaust stacks and three radiator units. Each exhaust stack will contain three discrete flues, one per engine. It has been assumed for the noise calculations that the height of the stacks will be 30 m above ground level and incorporate a high performance combined reactive/absorptive silencer. However the stack height has since been increased to 40 m. This will cause changes in the calculated noise levels presented in the report however it will not materially affect the findings of the study in terms of the significance of effects. This is because receptors most potentially at risk of effect are already in line of sight of the top of the stacks and hence increasing the height of the stack does not lead to any reduction of the mitigation that might otherwise be gained through barrier or ground effects.

3.27 The radiator units have been assumed to be at a height of approximately 5 m above ground level with fans mounted above via transition pieces. It has been assumed that inlet/outlet noise from the fan/radiator units will be reduced using absorptive silencers. Each engine will have a silenced air inlet located on the south face of the generator hall at a height of approximately 2 m above ground level. The source sound power levels and silencer attenuation data on which these calculations are based are shown in Appendix NV-1.

3.28 In 2032 an additional stack and radiator unit will be operating at the western end of the generator hall, serving three further engines, with three additional air inlets.

3.29 The generator hall will be constructed to a height of 10 m to the eaves and 13 m to the apex with a double-pitched roof running east-west. It has been assumed that noise emissions from the hall will be controlled through detailed design of the building structure and ventilation equipment; such that levels will be 10 dB below the combined noise from external sources.

*Assessment Criteria: Operational Noise*

3.30 The impact of operational noise from the power station on dwellings has been assessed using criteria based on the British Standard BS4142, Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas[7], which describes noise effects in terms of likelihood of complaint. In circumstances where the rated noise level from the power station exceeds the background noise level at a nearby dwelling by 10 dB the Standard states that complaints are likely. A difference of +5 dB between the rated noise level and the background noise level is of marginal significance, whilst a difference of -10 dB would indicate that complaints are unlikely. The rated noise level is the calculated continuous equivalent sound pressure level taken over the relevant period, with a rating of 5 dB added if the noise source is considered to contain tonal components. In the case of noise from the power station the dominant noise sources, the engine and the radiator/cooling fans, both contain tonal components and the rating penalty has therefore been applied.

**Table 3-4: Semantic Description of Operational Noise Impacts: Dwellings**

| *Semantic Description* | *Difference Between Rated Noise Level and Background Noise Level* |
|---|---|
| Not significant | <5 dB |
| Low | 5 - 7.5 dB |
| Medium | 7.5 - 10 dB |
| High | 10< dB |

3.31 The degree of noise impact has been described in this study using the semantic scale in Table 3-4. However, the application of the semantic scale has also taken into account absolute ambient noise levels during power station operation.

3.32 For a noise impact of high to be considered to occur in a day, evening or night time period, then in addition to the required difference between the rating level and background noise level, the future ambient noise level during that period should exceed a façade level of 58, 53 or 48 dB for day time, evening or night time periods respectively. These day and night time levels correspond to the free-field day and night time noise levels contained in PPG 24[5] which define Noise Exposure Category (NEC) A for mixed noise sources. For an area in which noise levels meet NEC A, PPG 24 states that noise does not need to be a determining factor in granting planning permissions. Whilst the function of PPG 24 is primarily to assist decision making relating to the granting of permissions to build new dwellings, the noise limits within it are also a useful guide to the assessment of noise levels in the environs of existing dwellings, notwithstanding the guidance provided by BS 4142[7].

3.33 Background noise levels were measured at two locations that were considered to represent groups of properties at potential risk of noise effect from the power station, namely the old Naval Hospital Building (receptor no. 27, Figure NV3-1, Volume 3: Figures), and the Retreat Centre (receptor no. 1, Figure NV3-1, Volume 3: Figures). Noise assessments have been carried out at these positions by comparing predicted noise levels from the power station with the results of the noise monitoring, corrected to take account of potential changes between the year of the noise survey (2005) and the years of assessment (2011 and 2032). Noise levels at the Retreat Centre have been considered to be representative of those at the new luxury flats and the proposed retirement home, and assessments have been carried out at these locations by comparison of predicted operational noise levels with future noise levels at the Retreat Centre. Whilst calculated noise levels from operation of the power station have been presented at all floors of receptors, assessments have been made at ground floor locations ie at a height representative of that at which background noise levels have been measured.

3.34 The significance of noise effects on dwellings has been assessed taking into account the severity of noise impact and number of people potentially affected.

*Assessment Criteria: Non-Residential Buildings*

3.35 At non-residential receptors the potential impact of noise from operation of the power station has been assessed on an individual basis taking into account the usage of the receptor. At the Lathbury Barracks site the nearby non-residential buildings are used as offices and therefore criteria have been chosen which reflect the affect of noise on office spaces. This reflects the approach taken in the assessment of construction noise. Appropriate criteria are contained in the British Standard BS 8233 (1999) Sound Insulation and Noise Reduction for Buildings- Code of Practice[9]. BS 8233 recommends an internal noise level of 50 dB LAeq,T as a reasonable design level for offices and this level has therefore been used as a criterion in the assessment. That is, noise levels above this level are considered to interfere with activities normally carried out within an office, with effects including speech interference and loss of reasonable conditions for study and work.

3.36 The significance of the potential operation noise effects has taken into account the severity of the effects and the utility of the resource.

*Road Traffic Noise*

3.37 An accurate calculation of additional road traffic noise arising from the operation of the power station is outside the scope of this study. However the potential change in day time (18hr) noise level at façades of noise sensitive receptors immediately adjacent to the road used to access the site has been estimated using the traffic flow correction factor in CRTN[12]. A potential noise impact is considered to occur where the additional traffic resulting from the development ie vehicles accessing the power station is calculated to give an increase in noise level of greater than or equal to 3 dB.

3.38 Road traffic flow data for Europa Road and Windmill Hill is unfortunately limited to sample traffic counts made during noise monitoring in 2005, as reported in Section 4 of this chapter. Additional road traffic flows occurring between 2005 and 2011 on Windmill Hill will result from developments including the prison, the luxury flats and the retirement home. The additional two way traffic flows for these have been assumed as 60, 40 and 20 vehicles per day respectively. The two way day time flow for the power station has been assumed to be 60 vehicles. It has been assumed that there will be no increase in road traffic associated with the power station between 2011 and 2032.

*Vibration Calculation and Assessment Methodologies: Operation and Construction*

3.39 Levels of vibration resulting from operation of the power station have been calculated at the nearest receptor based on measurements of vibration taken on foundation adjacent to diesel engines of similar design to those proposed at Lathbury Barracks. In the calculation it has been assumed that the foundations of both the generator hall and nearby receptor are both well coupled to the underlying rock, and that, as a worst case, the attenuation of vibration will be inversely proportional to distance. Again, as a worst case, it has been assumed that nearby receptors have suspended floors.

3.40 Vibration resulting from construction activities has been calculated using the method set out in BS 5228 Part 4[6]. Specific activities that have been considered in the study include bored piling and road construction (vibratory roller) as these result in higher levels of vibration than other construction activities. Piling source terms have been taken from the Standard, whilst those for the vibratory roller have been taken from Transport Research Laboratory (TRL) measured data[13].

3.41 The potential effect of vibration arising from operation or construction of the power station on the structure of nearby vibration sensitive receptors has been assessed using criteria set out in BS 7385: Part 2: 1993[10]. The Standard prescribes vibration guide values for un-reinforced or light framed structures, residential or light commercial buildings (see Table 3-5 below) at and above which building damage could occur, including cosmetic damage or minor/major damage to the structure of the building.

**Table 3-5: Transient Vibration Guide Values for Building Damage**

| *Extent of Building Damage* | *Semantic Description* | *Peak Component Particle Velocity (mm/s) and Frequency* | |
|---|---|---|---|
| | | *4 Hz to15 Hz* | *15 Hz <* |
| *Cosmetic Damage* | Low | 15 at 4 Hz increasing to 20 at 15 Hz | 20 at 15 Hz increasing to 50 at 40Hz and above |
| *Minor Damage to Structure* | Medium | 30 at Hz increasing to 40 at 15 Hz | 40 at 15 Hz increasing to 100 at 40Hz and above |
| *Major Damage to Structure* | High | 60 at 4 Hz increasing to 80 at 15 Hz | 80 at 15 Hz increasing to 50 at 40Hz and above |

3.42 The potential effect of vibration arising from operation or construction of the power station on persons living or working within nearby receptors has been assessed using criteria set out in BS 6472 (1992) Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz)[8]. The Standard rates the potential effects of vibration in terms of the probability of adverse comment from occupants. The dose values set out in the Standard and the corresponding semantic descriptions used in this study are set out below in Table 3-6 below.

**Table 3-6: Vibration Dose Values ($ms^{-1.75}$) Above which Various Degrees of Adverse Comment may be Expected in Residential Buildings and Offices (BS 6472)**

| | *Vibration Dose Values ($ms^{-1.75}$) and Semantic Description* | | |
|---|---|---|---|
| | *Low* | *Medium* | *High* |
| *Probability of Adverse Comment* | *Low Probability of Adverse Comment* | *Adverse Comment Possible* | *Adverse Comment Probable* |
| Residential buildings (16hr day) | 0.2 - 0.4 | 0.4 - 0.8 | 0.8 - 1.6 |
| Residential buildings (8 hr night) | 0.13 | 0.26 | 0.51 |
| Office buildings (16 hr day) | 0.4 | 0.8 | 1.6 |

## Noise Monitoring

3.43 Noise monitoring was carried out between 17th – 21st November 2005 at the Europa Retreat Centre and the Royal Naval Hospital (RNH). The position of the noise monitoring sites corresponds to the receptor locations on the façade of these buildings, as shown in Figure NV3-1, Volume 3: Figures. At the Retreat Centre (receptor number 1, Figure NV3-1, Volume 3: Figures) the microphone was positioned at a height of 1.2 m above ground level, at the façade of the building adjacent to the entrance. At the RNH (receptor number 27, Figure NV3-1, Volume 3: Figures) the microphone was positioned on the façade on the first floor of block E, overlooking Europa Road. Noise levels were logged at half hourly intervals in the following descriptors: $L_{Aeq}$, $L_{Amax,F}$, $L_{Amin}$, $L_{A1}$, $L_{A10}$, $L_{A50}$ and $L_{A90}$. Equipment was calibrated before and on completion of the measurements at each location and a record was made of prevailing weather conditions and noise sources contributing to ambient levels.

3.44 Noise monitoring for the purposes of an assessment using BS4142[7] is normally carried out using a free-field microphone position, that is, a microphone positioned beyond the influence of reflecting surfaces. Façade positions were used at both monitoring locations in this survey because potential free field locations adjacent to the buildings were unsuitable. However to make allowance for this, operational noise from the power station has been calculated to give noise levels at the façades of receptors, in contrast to the results of construction noise calculations, which are presented in the form of free-field noise levels.

3.45 Details of the instrumentation used for the survey are set out in Appendix NV-2. Wind speed measurements were made when necessary during the survey to check that speed adjacent to the microphones remained below 5 m/s.

# 4 EXISTING CONDITIONS

4.1 A noise survey was carried out in 2005 to determine baseline noise levels using the approach set out in Section 3 of this chapter. Weather conditions during the monitoring period were as follows:

- Thursday 17th November: Sunny with a light westerly breeze. Daytime Temperature c.22° C. Atmospheric pressure1018mb;
- Friday 18th November: Periods of rain, some heavy, with a light westerly breeze Temperature c.17° C. Atmospheric pressure 1020mb;
- Saturday 19th November: Overcast with a strong easterly wind. Daytime temperature c.17° C. Atmospheric pressure 1021mb;
- Sunday 20th November: Overcast with a strong easterly wind. Daytime temperature c.17° C. Atmospheric pressure 1021mb; and
- Monday 21st November: Overcast with a strong easterly wind. Daytime temperature c.17° C. Atmospheric pressure 1021mb.

## Results of Noise monitoring

4.2 Detailed results of the noise monitoring at the Retreat Centre (receptor no. 1, Figure NV3-1, Volume 3: Figures) are shown in Appendix NV-3, whilst the minimum background noise level and average $L_{Aeq}$ for day, evening and night time periods are shown below in Table 4-1. Noise sources contributing to the ambient noise levels at the Centre included cars arriving and leaving the Centre, aircraft (both military and civil), seabirds, coaches and cars on Windmill Hill Road. A sample traffic count between 15:35 and 17:35 gave two-way traffic flows of c. 15 vehicles per hour. The Centre was in use between Friday and Sunday. The edge of the cliff and the building structure screen this site from the nearby construction works and traffic on Europa Road.

**Table 4-1: Background and Ambient Noise Levels at Retreat Centre (Receptor no 1)**

| | *Day* | *Evening* | *Night* |
|---|---|---|---|
| *Minimum $L_{90}$ (dB) yr 2005* | 33.7 | 31.4 | 26.6 |
| *Average $L_{Aeq,T}$ (dB) yr 2005* | 55.0 | 54.6 | 42.9 |

4.3 Ambient noise levels at the Royal Naval Hospital (receptor no. 27, Figure NV3-1, Volume 3: Figures) are also present in Appendix NV-3, whilst the minimum background noise level and average $L_{Aeq}$ for day, evening and night time periods are shown below in Table 4-2 below. Noise levels are dominated by road traffic on Europa Road, which a sample traffic count between 12:35 and

13:05 on 17th November, gave a traffic flow of c.330 vehicles per hour (two way). Other noise sources during the survey included the construction of a new house on the opposite side of Europa Road, and military and civil aircraft flying overhead. The rooms adjacent to the monitoring location (i.e. bar) were not in use during the period of the survey.

**Table 4-2: Background and Ambient Noise Levels at Royal Naval Hospital Block E (receptor no 27)**

| | *Day* | *Evening* | *Night* |
|---|---|---|---|
| *Minimum $L_{90}$ (dB) yr 2005* | 40.3 | 39.3 | 37.4 |
| *Average $L_{Aeq,T}$ (dB) yr 2005* | 62.7 | 58.2 | 55.2 |

# 5 FUTURE BASELINE

5.1 Baseline noise levels in the environs of Lathbury Barracks are highly likely to increase between 2005 and 2011 due new developments adjacent to the site including a new prison (receptor no. 5, Figure NV3-1, Volume 3: Figures) , a retirement home (receptor no. 4, Figure NV3-1, Volume 3: Figures) and luxury flats (receptor no 2, Figure NV3-1, Volume 3: Figures). Potential sources would include noise from heating and ventilation equipment and road traffic noise from vehicles using Windmill Hill Road. Noise from the clinical waste incinerator and the crematorium would be unlikely to influence future baseline noise levels.

5.2 Further away from the site, for example at the new flats in the old Royal Naval Hospital building (receptor no. 18, Figure NV3-1, Volume 3: Figures), noise levels are likely to increase as a result of increased road traffic on Europa Road.

5.3 Increases in baseline noise levels are likely to continue between 2011 and 2032, the year when the power station is schedule to reach full operating capacity. However there is insufficient information regarding either predicted increases in road traffic flows or potential new noise sources adjacent to the power station from which to gauge the size of the increase. In order to achieve a balance between a worst case yet realistic assessment, a conservative approach has been taken in which an increase of 1 dB in both $L_{Aeq}$ and $L_{90}$ noise indices has been assumed to occur for both between 2005-2009 and 2009-2032. In terms of the change in $L_{Aeq}$, a 1 dB increase is roughly equivalent to a 25% increase in road traffic flows. It has been assumed for the purposes of the construction noise assessment that there is no change in baseline noise levels between the start of the construction in 2009 and completion in 2011. Future minimum background noise levels and average $L_{Aeq}$ for day, evening and night time periods for the Retreat Centre (receptor no 1, Figure NV3-1, Volume 3: Figures) and the Royal Naval Hospital (receptor no 27, Figure NV3-1, Volume 3: Figures) are shown below in Tables 5-1 and 5-2 respectively.

**Table 5-1: Future Background and Ambient Noise Levels at Retreat Centre (Receptor no. 1)**

| | *Day* | *Evening* | *Night* |
|---|---|---|---|
| *Minimum $L_{90}$ (dB) yrs 2009 to 2011* | 34.7 | 32.4 | 27.6 |
| *Minimum $L_{90}$ (dB) yr 2032* | 35.7 | 33.4 | 28.6 |
| *Average $L_{Aeq,T}$ (dB) yrs 2009 to 2011* | 56.0 | 55.6 | 43.9 |
| *Average $L_{Aeq,T}$ (dB) yr 2032* | 57.0 | 56.6 | 44.9 |

**Table 5-2: Future Background and Ambient Noise Levels at Royal Naval Hospital Block E (Receptor no. 27)**

| | *Day* | *Evening* | *Night* |
|---|---|---|---|
| *Minimum $L_{90}$ (dB) yrs 2009 to 2011* | 41.3 | 40.3 | 38.4 |
| *Minimum $L_{90}$ (dB) yr 2032* | 42.3 | 41.3 | 39.4 |
| *Average $L_{Aeq,T}$ (dB) yrs 2009 to 2011* | 63.7 | 59.2 | 56.2 |
| *Average $L_{Aeq,T}$ (dB) yr 2032* | 64.7 | 60.2 | 57.2 |

# 6 ASSESSMENT OF SIGNIFICANT EFFECTS

6.1 This section sets out the assessment of potential noise and vibration effects arising from the construction and operation of the power station at nearby receptors.

### Construction Phase

6.2 The results of construction noise calculations at nearby receptors for seven phases of the construction programme are presented in Table 6-1. A key to the construction activities in each phase is presented at the foot of the Table.

*Construction Noise Assessment: Residential Receptors*

6.3 The results of day time construction noise assessments at selected dwellings are shown in Tables 6-2 to 6-5. In each Table, the figures in row 1 are the ground floor noise levels at the receptor for separate phases of the construction, taken from Table 6-1. Row 2 is the future 2009 to 2011 daytime baseline noise level, and row 3 is the resulting change in noise level. Finally row 4 gives a semantic description of the noise impact taking into account the noise change and the construction noise level.

**Table 6-1 Construction Noise Levels at Noise Sensitive Receptors**

| *Rec. No.* | *Floor* | *Address* | *Calculated Noise Level per Construction Phase :dB $L_{Aeq,T}$* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
| 1 | 1 | The Retreat Centre | 56.0 | 48.3 | 43.6 | 47.8 | 46.2 | 42.5 | 49.7 |
| 1 | 2 | The Retreat Centre | 56.4 | 48.7 | 44.0 | 48.3 | 46.7 | 42.9 | 51.1 |
| 1 | 3 | The Retreat Centre | 57.1 | 49.9 | 45.2 | 49.4 | 47.8 | 44.1 | 52.1 |
| 2 | 1 | Proposed Luxury flats | 62.1 | 58.7 | 56.7 | 59.4 | 54.4 | 50.2 | 60.5 |
| 2 | 2 | Proposed Luxury flats | 62.6 | 58.8 | 56.8 | 59.5 | 54.5 | 50.4 | 60.4 |
| 2 | 3 | Proposed Luxury flats | 62.9 | 58.7 | 56.7 | 59.5 | 54.6 | 50.4 | 60.4 |
| 3 | 1 | Retrenchment Block | 69.7 | 63.5 | 61.3 | 64.4 | 59.5 | 55.3 | 67.3 |
| 4 | 1 | Proposed Retirement Home | 53.2 | 49.8 | 48.4 | 51.6 | 44.0 | 40.0 | 52.8 |
| 4 | 2 | Proposed Retirement Home | 54.9 | 51.1 | 49.9 | 53.2 | 44.8 | 41.0 | 53.5 |
| 4 | 3 | Proposed Retirement Home | 56.9 | 52.2 | 51.0 | 54.7 | 45.8 | 42.0 | 54.6 |
| 5 | 1 | Proposed prison | 55.5 | 48.3 | 47.6 | 52.1 | 39.9 | 36.1 | 51.0 |
| 5 | 2 | Proposed prison | 60.0 | 52.4 | 52.0 | 56.4 | 41.7 | 38.3 | 54.6 |
| 5 | 3 | Proposed prison | 60.9 | 53.6 | 53.1 | 57.4 | 43.9 | 40.3 | 56.1 |
| 6 | 1 | Firing Range Office | 75.7 | 72.5 | 71.4 | 74.9 | 66.1 | 61.9 | 80.3 |
| 7 | 1 | Rx Sta | 69.7 | 64.6 | 63.3 | 67.9 | 58.9 | 54.7 | 68.6 |
| 7 | 2 | Rx Sta | 69.7 | 64.6 | 63.3 | 67.9 | 58.9 | 54.7 | 69.0 |
| 8 | 1 | Highcliffe House | 33.6 | 29.1 | 27.2 | 30.0 | 24.9 | 20.7 | 30.8 |
| 8 | 2 | Highcliffe House | 34.7 | 30.3 | 28.3 | 31.2 | 26.1 | 22.0 | 31.9 |
| 8 | 3 | Highcliffe House | 36.1 | 31.7 | 29.7 | 32.6 | 27.5 | 23.3 | 33.3 |
| 8 | 4 | Highcliffe House | 37.7 | 33.4 | 31.4 | 34.3 | 29.1 | 25.0 | 34.9 |

| Rec. No. | Floor | Address | Calculated Noise Level per Construction Phase :dB $L_{Aeq,T}$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 5 | Highcliffe House | 39.8 | 35.5 | 33.5 | 36.4 | 31.3 | 27.1 | 37.1 |
| 8 | 6 | Highcliffe House | 42.7 | 38.4 | 36.5 | 39.4 | 34.2 | 30.0 | 40.2 |
| 8 | 7 | Highcliffe House | 45.8 | 41.2 | 39.2 | 42.1 | 36.9 | 32.8 | 42.8 |
| 9 | 1 | Highcliffe House | 41.2 | 36.3 | 34.4 | 38.1 | 31.8 | 27.6 | 40.0 |
| 9 | 2 | Highcliffe House | 42.0 | 37.1 | 35.3 | 39.0 | 32.6 | 28.5 | 40.8 |
| 9 | 3 | Highcliffe House | 42.9 | 38.0 | 36.2 | 39.9 | 33.4 | 29.3 | 41.7 |
| 9 | 4 | Highcliffe House | 43.8 | 38.8 | 37.0 | 40.8 | 34.2 | 30.1 | 42.7 |
| 9 | 5 | Highcliffe House | 44.7 | 39.8 | 38.0 | 41.8 | 35.0 | 31.0 | 43.7 |
| 9 | 6 | Highcliffe House | 45.7 | 40.7 | 38.9 | 42.9 | 35.9 | 31.9 | 44.8 |
| 10 | 1 | Flats | 41.2 | 37.4 | 36.0 | 38.8 | 31.5 | 27.5 | 39.8 |
| 10 | 2 | Flats | 41.9 | 38.1 | 36.8 | 39.6 | 32.2 | 28.1 | 40.5 |
| 10 | 3 | Flats | 42.6 | 38.8 | 37.6 | 40.4 | 32.9 | 28.8 | 41.3 |
| 11 | 1 | No. 13 Sunset Close | 48.0 | 43.2 | 41.3 | 44.4 | 38.7 | 34.7 | 47.0 |
| 11 | 2 | No. 13 Sunset Close | 48.9 | 44.3 | 42.4 | 45.6 | 39.7 | 35.7 | 48.0 |
| 12 | 1 | No. 6 Sunset Close | 46.7 | 42.3 | 40.4 | 42.8 | 37.8 | 33.8 | 45.8 |
| 12 | 2 | No. 6 Sunset Close | 47.5 | 43.2 | 41.3 | 43.7 | 38.6 | 34.6 | 46.8 |
| 13 | 1 | No 1 Sunset Close | 45.4 | 40.2 | 38.9 | 41.6 | 34.2 | 30.0 | 46.0 |
| 13 | 2 | No 1 Sunset Close | 46.1 | 41.0 | 39.7 | 42.4 | 35.1 | 30.9 | 46.6 |
| 14 | 1 | 47C Europa Rd | 40.0 | 35.7 | 33.7 | 36.4 | 31.4 | 27.3 | 36.3 |
| 14 | 2 | 47C Europa Rd | 40.9 | 36.6 | 34.5 | 37.3 | 32.4 | 28.3 | 37.2 |
| 15 | 1 | 51B Europa Rd | 34.5 | 30.2 | 28.2 | 31.0 | 26.0 | 21.8 | 31.9 |
| 16 | 1 | 47 Europa Rd | 41.1 | 36.9 | 34.9 | 37.8 | 32.7 | 28.6 | 38.0 |
| 16 | 2 | 47 Europa Rd | 41.9 | 37.8 | 35.8 | 38.7 | 33.5 | 29.4 | 38.8 |
| 17 | 1 | 52 Europa Rd | 36.3 | 32.1 | 30.2 | 33.1 | 27.7 | 23.6 | 33.8 |
| 17 | 2 | 52 Europa Rd | 37.1 | 32.7 | 30.8 | 33.8 | 28.4 | 24.2 | 34.5 |
| 18 | 1 | Orchid House | 41.1 | 37.4 | 35.5 | 38.4 | 33.1 | 29.0 | 38.6 |
| 18 | 2 | Orchid House | 41.9 | 38.2 | 36.3 | 39.2 | 33.8 | 29.8 | 39.3 |
| 18 | 3 | Orchid House | 42.7 | 39.0 | 37.1 | 40.1 | 34.6 | 30.6 | 40.1 |
| 18 | 4 | Orchid House | 43.5 | 39.9 | 38.0 | 41.0 | 35.5 | 31.4 | 41.0 |
| 19 | 1 | Royal Naval Hospital: Block B | 40.6 | 36.1 | 34.0 | 36.8 | 31.8 | 27.8 | 37.0 |
| 19 | 2 | Royal Naval Hospital: Block B | 41.4 | 36.9 | 34.9 | 37.7 | 32.6 | 28.6 | 37.8 |
| 19 | 3 | Royal Naval Hospital: Block B | 42.3 | 37.8 | 35.8 | 38.6 | 33.6 | 29.5 | 38.7 |
| 19 | 4 | Royal Naval Hospital: Block B | 43.3 | 38.7 | 36.7 | 39.6 | 34.5 | 30.4 | 39.6 |
| 20 | 1 | Royal Naval Hospital: Block C | 39.1 | 34.7 | 32.7 | 35.6 | 30.4 | 26.3 | 36.6 |
| 20 | 2 | Royal Naval Hospital: Block C | 40.1 | 35.6 | 33.6 | 36.5 | 31.3 | 27.2 | 37.5 |
| 20 | 3 | Royal Naval Hospital: Block C | 41.1 | 36.6 | 34.6 | 37.5 | 32.3 | 28.2 | 38.6 |
| 20 | 4 | Royal Naval Hospital: Block C | 42.1 | 37.6 | 35.7 | 38.6 | 33.3 | 29.2 | 39.6 |
| 21 | 1 | Royal Naval Hospital: Block D | 38.6 | 34.4 | 32.8 | 35.8 | 29.4 | 25.3 | 36.7 |
| 21 | 2 | Royal Naval Hospital: Block D | 39.5 | 35.3 | 33.6 | 36.7 | 30.3 | 26.2 | 37.5 |
| 21 | 3 | Royal Naval Hospital: Block D | 40.4 | 36.1 | 34.5 | 37.5 | 31.2 | 27.1 | 38.4 |
| 22 | 1 | 49 Europa Rd | 39.2 | 34.9 | 32.9 | 35.6 | 30.7 | 26.6 | 36.2 |
| 22 | 2 | 49 Europa Rd | 40.4 | 36.1 | 34.1 | 36.8 | 32.0 | 27.8 | 37.3 |
| 23 | 1 | Europa Pass Battery | 36.5 | 31.7 | 30.1 | 33.9 | 26.6 | 22.5 | 35.4 |
| 23 | 2 | Europa Pass Battery | 37.5 | 32.7 | 31.2 | 35.0 | 27.7 | 23.5 | 36.5 |
| 23 | 3 | Europa Pass Battery | 38.7 | 33.9 | 32.4 | 36.1 | 28.9 | 24.7 | 37.6 |
| 24 | 1 | Newbuild House | 36.7 | 32.5 | 30.6 | 33.5 | 28.2 | 24.1 | 34.4 |
| 24 | 2 | Newbuild House | 37.6 | 33.4 | 31.5 | 34.4 | 29.1 | 24.9 | 35.2 |
| 25 | 1 | 29 Sunset Close | 45.7 | 42.8 | 40.9 | 44.1 | 38.3 | 34.3 | 41.4 |
| 25 | 2 | 29 Sunset Close | 46.6 | 43.8 | 41.9 | 45.1 | 39.3 | 35.3 | 44.1 |

| Rec. No. | Floor | Address | Calculated Noise Level per Construction Phase :dB $L_{Aeq,T}$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 25 | 3 | 29 Sunset Close | 47.6 | 44.9 | 43.0 | 46.2 | 40.3 | 36.3 | 45.3 |
| 25 | 4 | 29 Sunset Close | 48.7 | 46.0 | 44.2 | 47.5 | 41.3 | 37.3 | 46.5 |
| 26 | 1 | 24 Sunset Close | 46.3 | 41.4 | 39.4 | 42.6 | 37.1 | 33.0 | 40.6 |
| 26 | 2 | 24 Sunset Close | 47.2 | 42.6 | 40.8 | 44.1 | 37.9 | 33.9 | 41.6 |
| 26 | 4 | 24 Sunset Close | 47.9 | 43.4 | 41.6 | 45.0 | 38.7 | 34.7 | 42.8 |
| 27 | 1 | Royal Naval Hospital: E Block | 39.4 | 34.9 | 33.0 | 36.1 | 30.5 | 26.4 | 36.9 |
| 27 | 2 | Royal Naval Hospital: E Block | 40.1 | 35.7 | 33.8 | 36.8 | 31.2 | 27.1 | 37.7 |
| 27 | 3 | Royal Naval Hospital: E Block | 40.9 | 36.4 | 34.5 | 37.6 | 31.9 | 27.8 | 38.4 |

**Key to Construction Phases**

Phase 1: Site clearance
Phase 2: Foundations
Phase 3: Backfill foundations
Phase 4: Laying services
Phase 5: Lifting in generator plant
Phase 6: Building generator hall
Phase 7: Road building

**Table 6-2: Construction Noise Assessment at the Retreat Centre (Receptor Number 1)**

| Construction Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Construction noise level (dB) | 56.0 | 48.3 | 43.6 | 47.8 | 46.2 | 42.5 | 49.7 |
| Daytime noise level (dB) | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| Noise change (dB) | 3.0 | 0.7 | 0.2 | 0.6 | 0.4 | 0.2 | 0.9 |
| Description of noise impact | low | not sig | not sig | not sig | not sig | not sig | not sig |

6.4 During phase 1 (site clearance) of construction, daytime working would give rise to a low noise impact at the Retreat Centre, though noise levels would remain substantially below the construction noise limits in Table 3-2. Activities during the remaining phases of the construction programme would not cause noise impacts. The effect on people staying at the Retreat Centre is considered to be **not significant**.

**Table 6-3: Construction Noise Assessment at the Luxury Flats, Old Junior Ranks Building (Receptor Number 2)**

| Construction Phase | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Construction noise level (dB) | 62.1 | 58.7 | 56.7 | 59.4 | 54.4 | 50.2 | 60.5 |
| Daytime noise level (dB) | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| Noise change (dB) | 7.1 | 4.6 | 3.4 | 5.0 | 2.3 | 1.0 | 5.8 |
| Description of noise impact | medium | low | low | low | not sig | not sig | medium |

6.5 At the at the residential development on the site of the Old Junior Ranks building (receptor no. 2, Figure NV3-1, Volume 3: Figures) (Table 6-3) phases 1 and 7 of construction would give rise to medium noise impacts during daytime working, whilst low noise impacts would occur during phases 2-4. Activities during the remaining phases of the construction programme would not cause noise impact. During all phases of construction, noise levels remain substantially below the construction noise limits set out in Table 3-2. This effect on the 22 residents living at the development is considered **not significant**.

**Table 6-4: Construction Noise Assessment at the Retirement Home, Old Junior Mess (Receptor Number 4)**

| *Construction Phase* | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
|---|---|---|---|---|---|---|---|
| *Construction noise level (dB)* | 53.2 | 49.8 | 48.4 | 51.6 | 44.0 | 40.0 | 52.8 |
| *Daytime noise level (dB)* | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 | 56.0 |
| *Noise change (dB)* | 1.8 | 0.9 | 0.7 | 1.3 | 0.3 | 0.1 | 1.7 |
| *Description of noise impact* | not sig | not sig | not sig | not sig | not sig | not sig | not sig |

6.6 Construction of the power station would not give rise to any noise impact at the proposed retirement home on the site of the Old Junior Mess (receptor no. 4, Figure NV3-1, Volume 3: Figures) (Table 6-4), and consequently the effect on the 77 people in care at the home or upon those working there is considered **not significant**.

6.7 Noise impacts at the proposed prison (receptor no. 5, Figure NV3-1, Volume 3: Figures) would be almost identical to those reported in Table 6-4 for the Retirement home, as both buildings occupy similar positions in terms of elevation and distance from the power station. For the purposes of this study the prison has been considered as a residential building and the effect on occupants is considered **not significant**.

**Table 6-5: Construction Noise Assessment at Orchid House Old Royal Naval Hospital (Receptor Number 18)**

| *Construction Phase* | *1* | *2* | *3* | *4* | *5* | *6* | *7* |
|---|---|---|---|---|---|---|---|
| *Construction noise level (dB)* | 41.1 | 37.4 | 35.5 | 38.4 | 33.1 | 29.0 | 38.6 |
| *Daytime noise level (dB)* | 63.7 | 63.7 | 63.7 | 63.7 | 63.7 | 63.7 | 63.7 |
| *Noise change (dB)* | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| *Description of noise impact* | not sig | not sig | not sig | not sig | not sig | not sig | not sig |

6.8 At Orchid House (receptor no. 18, Figure NV3-1, Volume 3: Figures), the new flats on the site of the Old Naval Hospital Building (Table 6-5), the combination of higher baseline noise levels and lower construction noise levels (as a result of topographical screening) means that there are no noise impacts and the effects on the occupants are considered **not significant**. This assessment will apply equally to all residential flats on the ground floor of the Old Naval Hospital Building.

*Construction Noise Assessment: Non- Residential Receptors*

6.9 The nearest non residential receptor is the Firing Range office (receptor no. 6, Figure NV3-1, Volume 3: Figures) where during phase 1 external free field noise levels will be 75.1 dB. The resulting internal noise level in office areas with windows overlooking the site would be approximately 53.1 dB and this would exceed the reasonable design level for offices suggested in BS 8233[9]. This internal noise level would also be exceeded during phases 2, 4 and 7. Taking into account the combined duration of these phases, this is a **significant effect** on the usage of the building as an office.

6.10 Internal noise levels within the remaining non-residential buildings adjacent to the site, including the Rx Station (receptor no. 7, Figure NV3-1, Volume 3: Figures) and the Retrenchment Block (receptor no. 3, Figure NV3-1, Volume 3: Figures), resulting from construction noise will be below 50 dB during all phases of construction and their usage as offices will not be affected. Effects on other non-residential buildings are considered **not significant**.

*Construction Road Traffic Noise*

6.11 It is proposed that the Hole in the Wall Road will be widened to accommodate heavy vehicles prior to the start of the construction programme and that this road will be used by outsised construction traffic to access the site at Lathbury Barracks. There are no noise sensitive receptors alongside the Hole in the Wall Road. Therefore the uses of this route will avoid negative effects from construction road traffic noise, and the effect is considered **not significant.**

6.12 Normal construction traffic will travel to the site via the residential areas alongside Europa Road to the west of the site and the areas alongside Windmill Hill Road, however although the specific level of construction traffic is unknown, it is anticipated that approximately 1500 HGV movements will be required between the initial foundations work and the delivery of equipment to site for installation, a period extending over some 11-12 months. This equates to approximately 4 movements per day, averaged over a period of a year, and the effect on residential receptors is considered **not significant**.

*Construction Vibration Assessment: Residential Receptors*

6.13 The nearest residential building is the proposed retirement home (receptor no. 4, Figure NV3-1, Volume 3: Figures) approximately 175 m from the foundation of the power station. Given this degree of separation, there would be **no vibration effects** arising from the construction activities on the site either on the structure of the building or in terms of potential adverse response of the residents. Other residential receptors in the environs of the power station are further away than the retirement home and there would therefore be **no significant construction vibration effects** at any residential receptors.

*Construction Vibration Assessment: Non- Residential Receptors*

6.14 During the piling of foundations, carried out using a bored piling technique, levels of vibration at the foundation of the nearby Firing Range Office (receptor no. 6, Figure NV3-1, Volume 3: Figures) would be 0.09 mm/s (p.p.v.) at which there would be no likelihood of cosmetic damage to the building. Within the building, assuming a worst case of 10 hours of piling with 50% on time, the daytime calculated vibration dose value of 0.1 $ms^{-1.75}$ is below the level at which there would be a low probability of adverse comment.

6.15 During the levelling of the road using a vibrating roller, levels of vibration at the foundation of the of the Firing Range Office would reach 0.4 mm/s (p.p.v) at which there would be no likelihood of cosmetic damage to the building. Within the building, assuming two hours of operation at the nearest point of the road the daytime calculated vibration dose value of 0.36 $ms^{-1.75}$ is below the level at which there would be a low probability of adverse comment.

6.16 The Firing Range Office is the nearest of the buildings to the site of the power station and the new access road. Levels of vibration are attenuated with increased distance away from the source and it therefore follows that there will **not be significant vibration effects** at the remaining non-residential buildings around the site.

## Operational Phase

### *Operational Noise*

6.17 Calculated façade noise levels at noise sensitive receptors resulting from the operation of the power station are shown in Table 6-6 below. Column 1 contains the receptor number, which corresponds to a location in Figure NV3-1, Volume 3: Figures. Column 2 indicates the floor of each building (ground floor = 1), with the address given in Column 2. Noise levels at each receptor are presented in the remaining columns for the years 2011 and 2032, for the day, evening and night time periods.

**Table 6-6: Power Station Operational Noise Levels**

| *Rec. No.* | *Floor* | *Address* | *Calculated Noise Levels dB $L_{Aeq,T}$* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | *Day 07:00-19:00* | | *Evening 19:00-23:00* | | *Night 23:00-07:00* | |
| | | | *2011* | *2032* | *2011* | *2032* | *2011* | *2032* |
| 1 | 1 | The Retreat Centre | 35.8 | 38.2 | 35.1 | 37.7 | 33.0 | 36.2 |
| 1 | 2 | The Retreat Centre | 35.8 | 38.2 | 35.2 | 37.8 | 33.0 | 36.2 |
| 1 | 3 | The Retreat Centre | 35.9 | 38.3 | 35.2 | 37.8 | 33.1 | 36.2 |
| 2 | 1 | Proposed Luxury flats | 38.4 | 40.8 | 37.7 | 40.4 | 35.6 | 38.8 |
| 2 | 2 | Proposed Luxury flats | 38.4 | 40.8 | 37.7 | 40.4 | 35.6 | 38.8 |
| 2 | 3 | Proposed Luxury flats | 38.4 | 40.8 | 37.7 | 40.4 | 35.6 | 38.9 |
| 3 | 1 | Retrenchment Block | 44.4 | 46.3 | 43.6 | 45.8 | 41.2 | 43.8 |
| 4 | 1 | Proposed Retirement Home | 36.5 | 39.3 | 35.8 | 39.0 | 33.7 | 37.6 |
| 4 | 2 | Proposed Retirement Home | 38.2 | 40.5 | 37.5 | 40.0 | 35.3 | 38.4 |
| 4 | 3 | Proposed Retirement Home | 38.3 | 40.5 | 37.5 | 40.1 | 35.4 | 38.4 |
| 5 | 1 | Proposed prison | 37.5 | 39.7 | 36.7 | 39.1 | 34.4 | 37.3 |
| 5 | 2 | Proposed prison | 37.5 | 39.7 | 36.8 | 39.2 | 34.4 | 37.3 |
| 5 | 3 | Proposed prison | 37.5 | 39.7 | 36.8 | 39.2 | 34.5 | 37.3 |
| 6 | 1 | Firing Range Office | 49.3 | 53.8 | 48.9 | 53.7 | 47.6 | 53.1 |
| 7 | 1 | Rx Sta | 46.5 | 49.7 | 46.1 | 49.4 | 44.4 | 48.4 |
| 7 | 2 | Rx Sta | 46.6 | 49.7 | 46.2 | 49.4 | 44.5 | 48.4 |
| 8 | 1 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.7 |
| 8 | 2 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.7 |
| 8 | 3 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.7 |
| 8 | 4 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.7 |
| 8 | 5 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.7 |
| 8 | 6 | Highcliffe House | 22.0 | 24.8 | 21.7 | 24.1 | 19.4 | 22.8 |
| 8 | 7 | Highcliffe House | 22.8 | 25.7 | 22.5 | 25.0 | 20.2 | 23.7 |
| 9 | 1 | Highcliffe House | 21.1 | 24.0 | 20.8 | 23.3 | 18.5 | 21.9 |
| 9 | 2 | Highcliffe House | 21.4 | 24.3 | 21.1 | 23.7 | 18.8 | 22.3 |
| 9 | 3 | Highcliffe House | 21.8 | 24.8 | 21.5 | 24.2 | 19.2 | 22.9 |
| 9 | 4 | Highcliffe House | 22.4 | 25.5 | 22.0 | 24.9 | 19.8 | 23.7 |
| 9 | 5 | Highcliffe House | 23.6 | 26.8 | 23.1 | 26.3 | 21.1 | 25.2 |
| 9 | 6 | Highcliffe House | 25.4 | 28.7 | 24.9 | 28.3 | 23.0 | 27.3 |
| 10 | 1 | Flats | 20.8 | 25.2 | 20.4 | 24.8 | 18.2 | 23.9 |
| 10 | 2 | Flats | 21.2 | 26.5 | 20.8 | 26.2 | 18.6 | 25.5 |

| Rec. No. | Floor | Address | Calculated Noise Levels dB $L_{Aeq,T}$ | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Day 07:00-19:00 | | Evening 19:00-23:00 | | Night 23:00-07:00 | |
| | | | 2011 | 2032 | 2011 | 2032 | 2011 | 2032 |
| 10 | 3 | Flats | 21.7 | 27.7 | 21.3 | 27.4 | 19.2 | 26.9 |
| 11 | 1 | No. 13 Sunset Close | 36.3 | 38.7 | 35.6 | 38.3 | 33.4 | 36.7 |
| 11 | 2 | No. 13 Sunset Close | 36.4 | 38.8 | 35.7 | 38.5 | 33.6 | 37.0 |
| 12 | 1 | No. 6 Sunset Close | 35.2 | 37.7 | 34.5 | 37.3 | 32.4 | 35.7 |
| 12 | 2 | No. 6 Sunset Close | 35.3 | 37.7 | 34.5 | 37.3 | 32.4 | 35.8 |
| 13 | 1 | No 1 Sunset Close | 34.0 | 36.4 | 33.2 | 36.0 | 31.1 | 34.4 |
| 13 | 2 | No 1 Sunset Close | 34.0 | 36.4 | 33.2 | 36.0 | 31.1 | 34.4 |
| 14 | 1 | 47C Europa Rd | 21.3 | 24.2 | 21.1 | 23.5 | 18.8 | 22.2 |
| 14 | 2 | 47C Europa Rd | 21.4 | 24.3 | 21.2 | 23.7 | 18.9 | 22.3 |
| 15 | 1 | 51B Europa Rd | 22.0 | 25.0 | 21.8 | 24.3 | 19.6 | 23.0 |
| 16 | 1 | 47 Europa Rd | 21.1 | 24.1 | 20.9 | 23.5 | 18.7 | 22.2 |
| 16 | 2 | 47 Europa Rd | 21.4 | 24.4 | 21.1 | 23.8 | 19.0 | 22.6 |
| 17 | 1 | 52 Europa Rd | 20.9 | 23.8 | 20.6 | 23.1 | 18.4 | 21.8 |
| 17 | 2 | 52 Europa Rd | 20.9 | 23.8 | 20.6 | 23.2 | 18.4 | 21.9 |
| 18 | 1 | Orchid House | 21.4 | 25.0 | 21.1 | 24.6 | 19.6 | 23.9 |
| 18 | 2 | Orchid House | 22.7 | 26.7 | 22.5 | 26.4 | 21.4 | 25.9 |
| 18 | 3 | Orchid House | 24.5 | 28.2 | 24.3 | 28.0 | 23.5 | 27.6 |
| 18 | 4 | Orchid House | 25.8 | 30.7 | 25.6 | 30.6 | 24.9 | 30.3 |
| 19 | 1 | Royal Naval Hospital: Block B | 20.6 | 23.4 | 20.3 | 22.8 | 18.1 | 21.4 |
| 19 | 2 | Royal Naval Hospital: Block B | 21.0 | 23.8 | 20.7 | 23.2 | 18.5 | 21.9 |
| 19 | 3 | Royal Naval Hospital: Block B | 21.6 | 24.4 | 21.3 | 23.9 | 19.2 | 22.6 |
| 19 | 4 | Royal Naval Hospital: Block B | 22.9 | 25.7 | 22.5 | 25.3 | 20.6 | 24.1 |
| 20 | 1 | Royal Naval Hospital: Block C | 20.4 | 23.3 | 20.1 | 22.6 | 17.8 | 21.3 |
| 20 | 2 | Royal Naval Hospital: Block C | 20.6 | 23.4 | 20.3 | 22.8 | 18.0 | 21.5 |
| 20 | 3 | Royal Naval Hospital: Block C | 20.8 | 23.7 | 20.5 | 23.0 | 18.2 | 21.7 |
| 20 | 4 | Royal Naval Hospital: Block C | 21.1 | 24.1 | 20.8 | 23.5 | 18.6 | 22.2 |
| 21 | 1 | Royal Naval Hospital: Block D | 20.1 | 23.1 | 19.8 | 22.4 | 17.5 | 21.1 |
| 21 | 2 | Royal Naval Hospital: Block D | 20.2 | 23.2 | 19.9 | 22.6 | 17.7 | 21.4 |
| 21 | 3 | Royal Naval Hospital: Block D | 20.4 | 23.5 | 20.1 | 22.9 | 17.9 | 21.7 |
| 22 | 1 | 49 Europa Rd | 22.9 | 25.8 | 22.6 | 25.1 | 20.4 | 23.8 |
| 22 | 2 | 49 Europa Rd | 22.9 | 25.8 | 22.6 | 25.2 | 20.4 | 23.9 |
| 23 | 1 | Europa Pass Battery | 21.2 | 24.1 | 20.9 | 23.4 | 18.6 | 22.1 |
| 23 | 2 | Europa Pass Battery | 21.2 | 24.1 | 20.9 | 23.4 | 18.6 | 22.1 |
| 23 | 3 | Europa Pass Battery | 21.2 | 24.1 | 20.9 | 23.4 | 18.6 | 22.1 |
| 24 | 1 | Newbuild House | 22.0 | 25.0 | 21.8 | 24.4 | 19.6 | 23.1 |
| 24 | 2 | Newbuild House | 22.0 | 25.0 | 21.8 | 24.4 | 19.6 | 23.1 |
| 25 | 1 | 29 Sunset Close | 33.2 | 36.5 | 33.2 | 36.4 | 33.1 | 36.4 |
| 25 | 2 | 29 Sunset Close | 33.2 | 36.5 | 33.2 | 36.5 | 33.1 | 36.4 |
| 25 | 3 | 29 Sunset Close | 33.2 | 36.5 | 33.2 | 36.5 | 33.1 | 36.5 |
| 25 | 4 | 29 Sunset Close | 33.3 | 36.6 | 33.2 | 36.6 | 33.2 | 36.5 |
| 26 | 1 | 24 Sunset Close | 26.7 | 28.0 | 25.9 | 27.8 | 22.9 | 25.3 |
| 26 | 2 | 24 Sunset Close | 31.5 | 32.5 | 30.5 | 32.5 | 27.1 | 29.4 |
| 26 | 4 | 24 Sunset Close | 34.5 | 36.4 | 33.8 | 36.3 | 31.7 | 34.7 |
| 27 | 1 | Royal Naval Hospital: E Block | 19.6 | 22.6 | 19.3 | 22.0 | 17.1 | 20.7 |
| 27 | 2 | Royal Naval Hospital: E Block | 19.9 | 22.9 | 19.6 | 22.4 | 17.4 | 21.2 |
| 27 | 3 | Royal Naval Hospital: E Block | 20.3 | 23.5 | 20.0 | 23.0 | 17.9 | 21.9 |

*Operational Noise Assessment: Residential Receptors*

6.18 The results of noise assessments at selected dwellings for the day, evening and night time periods for the years 2011 and 2032 are shown in Tables 6-7 to 6-10 below. In each table, the figures in row 1 are the calculated operational noise levels from the power station at ground floor level of the receptor taken from Table 6-6. Row 2 is the rated noise level, which corresponds to the noise level from row 1 plus a 5 dB rating penalty to allow for potential tonal components in noise from the power station. Row 3 gives the projected future background noise levels ($L_{90}$) and row 4 is the difference between this and the rating level, with a positive number indicating that the rated level is greater than the background noise level. A difference of +10 dB indicates that complaints would be likely from residents living at the receptor, whilst a difference of +5 dB is of marginal significance. Row 4 gives the projected baseline noise level, which is the equivalent continuous noise level not taking account of the operation of the power station. Row 5, the ambient noise level is the total noise level which will accompany operation of the power station, that is the logarithmic sum of the existing noise (row 6) and the calculated level of noise from the power station (row 1). Finally row 7 gives the semantic description of the noise impact taking into account the noise rating using BS 4142[7], and the ambient noise level resulting from operation of the power station.

**Table 6-7: Operational Noise Assessment at the Retreat Centre (Receptor Number 1)**

| | *Day 07:00-19:00* | | *Evening 19:00-23:00* | | *Night 23:00-07:00* | |
|---|---|---|---|---|---|---|
| *Year* | *2011* | *2032* | *2011* | *2032* | *2011* | *2032* |
| *Calculated Noise Level $L_{Aeq,T}$ (dB)* | 35.8 | 38.2 | 35.1 | 37.7 | 33 | 36.2 |
| *Rated Noise Level (dB)* | 40.8 | 43.2 | 40.1 | 42.7 | 38 | 41.2 |
| *Background Noise Level $L_{90}$ (dB)* | 34.7 | 35.7 | 32.4 | 33.4 | 27.6 | 28.6 |
| *Difference (dB)* | 6.1 | 7.5 | 7.7 | 9.3 | 10.4 | 12.6 |
| *Baseline Noise Level $L_{Aeq,T}$ (dB)* | 56.0 | 57.0 | 55.6 | 56.6 | 43.9 | 44.9 |
| *Ambient Noise Level $L_{Aeq,T}$ (dB)* | 56.0 | 57.0 | 55.6 | 56.7 | 44.2 | 45.4 |
| *Description of Noise impact* | Low | Low | Medium | Medium | Medium | Medium |

6.19 In the year 2011 noise from the operation of the power station at the Retreat Centre (receptor no. 1, Figure NV3-1, Volume 3: Figures)(Table 6.7) would give rise to a low noise impact during the day, and a medium impact during the evening. Although there is a greater likelihood of complaint during the night time period, ambient levels will not be sufficiently high to cause sleep disturbance and the impact is still considered to be medium. In 2032 noise levels from the power station are calculated to be approximately 2-3 dB higher than in 2011 with a resulting greater likelihood of complaint. This would be considered to be a **significant adverse effect** on people staying at the Retreat Centre.

**Table 6-8: Operational Noise Assessment at the Luxury Flats, Old Junior Ranks Building (Receptor Number 2)**

| | *Day 07:00-19:00* | | *Evening 19:00-23:00* | | *Night 23:00-07:00* | |
|---|---|---|---|---|---|---|
| *Year* | *2011* | *2032* | *2011* | *2032* | *2011* | *2032* |
| *Calculated Noise Level $L_{Aeq,T}$ (dB)* | 38.4 | 40.8 | 37.7 | 40.4 | 35.6 | 38.8 |
| *Rated Noise Level (dB)* | 43.4 | 45.8 | 42.7 | 45.4 | 40.6 | 43.8 |
| *Background Noise Level $L_{90}$ (dB)* | 34.7 | 35.7 | 32.4 | 33.4 | 27.6 | 28.6 |
| *Difference (dB)* | 8.7 | 10.1 | 10.3 | 12 | 13 | 15.2 |
| *Baseline Noise Level $L_{Aeq,T}$ (dB)* | 56.0 | 57.0 | 55.6 | 56.6 | 43.9 | 44.9 |
| *Ambient Noise Level $L_{Aeq,T}$ (dB)* | 56.1 | 57.1 | 55.7 | 56.7 | 44.5 | 45.8 |
| *Description of Noise impact* | Medium | Medium | High | High | Medium | Medium |

6.20 In the year 2011 noise from the operation of the power station at the residential development on the site of the Old Junior Ranks building (receptor no. 2, Figure NV3-1, Volume 3: Figures) (Table 6-8) would give rise to a medium noise impact during the day and a high impact during the evening. Although there is a greater likelihood of complaint during the night time period, ambient levels will not be sufficiently high to cause sleep disturbance and the impact is considered to be medium. In 2032 noise levels from the power station are calculated to be approximately 2-3 dB higher than in 2011 with a resulting greater likelihood of complaint. This would be considered to be a **significant adverse effect** on the 22 residents living at the development.

**Table 6-9: Operational Noise Assessment at the Retirement Home, Old Junior Mess (Receptor Number 4)**

| | *Day 07:00-19:00* | | *Evening 19:00-23:00* | | *Night 23:00-07:00* | |
|---|---|---|---|---|---|---|
| *Year* | *2011* | *2032* | *2011* | *2032* | *2011* | *2032* |
| *Calculated Noise Level $L_{Aeq,T}$ (dB)* | 36.5 | 39.3 | 35.8 | 39 | 33.7 | 37.6 |
| *Rated Noise Level (dB)* | 41.5 | 44.3 | 40.8 | 44 | 38.7 | 42.6 |
| *Background Noise Level $L_{90}$ (dB)* | 34.7 | 35.7 | 32.4 | 33.4 | 27.6 | 28.6 |
| *Difference (dB)* | 6.8 | 8.6 | 8.4 | 10.6 | 11.1 | 14 |
| *Baseline Noise Level $L_{Aeq,T}$ (dB)* | 56.0 | 57.0 | 55.6 | 56.6 | 43.9 | 44.9 |
| *Ambient Noise Level $L_{Aeq,T}$ (dB)* | 56.0 | 57.0 | 55.7 | 56.7 | 44.3 | 45.6 |
| *Description of Noise impact* | Low | Medium | Medium | High | Medium | Medium |

6.21 In the year 2011 noise from the operation of the power station at the proposed retirement home on the site of the Old Junior Mess (receptor no. 4, Figure NV3-1, Volume 3: Figures) (Table 6-9) would give rise to a low noise impact during the day and a medium impact during the evening. In 2032 noise levels from the power station are calculated to be approximately 2-3 dB higher than in 2011 with a resulting greater likelihood of complaint, with for example the scale of noise impact during the evening period rising to high. Although there is a greater likelihood of complaint during the night time period, ambient levels will not be sufficiently high to cause sleep disturbance, even given the additional acoustic standards required of a retirement home, and the night time impact is considered to be medium. Nonetheless, noise from the operation of the power station would be considered to be a **significant adverse effect** on the 77 people in care at the home and upon those working there.

6.22 Noise impacts at the proposed prison (receptor no. 5, Figure NV3-1, Volume 3: Figures) would be almost identical to those reported in Table 6-9 for the Retirement home, as both buildings occupy similar positions in terms of elevation and distance from the power station. For the purposes of this study the prison has been considered as a residential building and therefore noise from the operation of the power station would be considered to be a **significant adverse effect** on the prisoners and their over-seers.

**Table 6-10: Operational Noise Assessment at Orchid House, Old Royal Naval Hospital (Receptor Number 18)**

| | *Day 07:00-19:00* | | *Evening 19:00-23:00* | | *Night 23:00-07:00* | |
|---|---|---|---|---|---|---|
| *Year* | *2011* | *2032* | *2011* | *2032* | *2011* | *2032* |
| *Calculated Noise Level $L_{Aeq,T}$ (dB)* | 21.4 | 25 | 21.1 | 24.6 | 19.6 | 23.9 |
| *Rated Noise Level (dB)* | 26.4 | 30 | 26.1 | 29.6 | 24.6 | 28.9 |
| *Background Noise Level $L_{90}$ (dB)* | 41.3 | 42.3 | 40.3 | 41.3 | 38.4 | 39.4 |
| *Difference (dB)* | -14.9 | -12.3 | -14.2 | -11.7 | -13.8 | -10.5 |
| *Baseline Noise Level $L_{Aeq,T}$ (dB)* | 63.7 | 64.7 | 59.2 | 60.2 | 56.2 | 57.2 |
| *Ambient Noise Level $L_{Aeq,T}$ (dB)* | 63.7 | 64.7 | 59.2 | 60.2 | 56.2 | 57.2 |
| *Description of Noise impact* | Not sig. | Not sig. | Not sig. | Not sig. | Not sig. | Not sig. |

6.23 The operation of the power station at Orchid House (receptor no 18, Figure NV3-1, Volume 3: Figures), the new flats on the site of the Old Naval Hospital Building (Table 6-10) would not give rise to any significant noise impact at any time of the day, evening or night, during 2011 or 2032. The reduced noise impact at this location is a result of the combination of higher background noise levels and lower noise level from the power station caused by topographical screening affects. This assessment will apply equally to all residential flats on the ground floor of the Old Naval Hospital Building.

**Table 6-11: Operational Noise Assessment at Royal Naval Hospital Block E (Receptor Number 27) assuming no topographical screening**

| | *Evening 19:00-23:00* |
|---|---|
| *Year* | *2032* |
| *Calculated Noise Level $L_{Aeq,T}$ (dB)* | 38.5 |
| *Rated Noise Level (dB)* | 43.5 |
| *Background Noise Level $L_{90}$ (dB)* | 41.3 |
| *Difference (dB)* | 2.2 |
| *Baseline Noise Level $L_{Aeq,T}$ (dB)* | 60.2 |
| *Ambient Noise Level $L_{Aeq,T}$ (dB)* | 60.2 |
| *Description of Noise impact* | Not sig. |

6.24 In Section 3 of this chapter, it was reported that the effect of topographical screening of noise from the power station might lessen during an easterly wind direction. Table 6-11 presents a noise assessment at the Ground Floor of Block E (receptor no 27, Figure NV3-1, Volume 3: Figures), Old Royal Naval Hospital, for the evening period, assuming the absence of topographical screening that would be provided by the cliffs and buildings surrounding the site of the power station. Whilst calculated noise levels are approximately 19 dB higher, there is still **no significant noise effect** at this location.

*Operational Noise Assessment: Non Residential Receptors*

6.25 The most potentially affected non residential receptor is the Firing Range Office (receptor no. 6, Figure NV3-1, Volume 3: Figures) at which the calculated façade noise level is 53.7 dB for daytime in 2032. The resulting internal noise levels would be below the limit of 40 dB which is specified in BS8233[9] as a design aim for a 'good' office environment. Therefore there will be **no significant noise effect** on the Firing Range office or the other non residential buildings adjacent to the site of the power station.

*Road Traffic Noise*

6.26 Increased road traffic flows on Windmill Hill Road in 2011 accompanying the opening year of operation of the power station would give rise to a noise increase at noise sensitive receptors of less than 1 dB. This would not be considered to be a significant noise impact at these receptors and there are no noise effects. The corresponding change in road traffic flows on Europa Road is proportionally much smaller and the resulting change in noise level would be negligible. The situation is not considered to change appreciably when the power station runs at full capacity in 2032.

6.27 In conclusion there are **no significant effects** likely to arise from a change in road traffic noise on access roads to Lathbury Barracks as a result of operation of the power station.

*Potential Cumulative Noise Effects*

6.28 The operation of the power station at Lathbury barracks in 2032 will allow the decommissioning of existing power stations including the station at Waterport, the OESCO power station and the MOD's ISGS power station. The effect of decommissioning of the existing power stations is outside the scope of this project, however these stations lie adjacent to residential areas and it is highly likely that the reduced noise levels which will accompany the cessation of their operation will constitute **significant beneficial effects** for those living in these areas.

*Operational Vibration: Residential Receptors*

6.29 The nearest residential building is the proposed retirement home (receptor no 4, Figure NV3-1, Volume 3: Figures) which is a distance of approximately 175 m from the foundation of the power station. Given this considerable separation, there would be **no vibration effects** arising from the operation of the power station either on the structure of the building or in terms of potential adverse response of the residents. Other residential receptors in the environs of the power station are further away than the retirement home and there would therefore be **no operational vibration effects** at any residential receptors.

*Operational Vibration: Non- Residential Receptors*

6.30 Vibration arising from operation of the power station will give rise to a vibration dose value of 0.008 $ms^{-1.75}$ on the ground floor of the Firing Range Office (receptor no 6, Figure NV3-1, Volume 3: Figures). This is substantially below the level at which there would be a probability of adverse comment from users of the building and it is therefore considered that there will be **no vibration effects**. The Firing Range office is the nearest of the buildings to the site of the power station and the new access road. Levels of vibration are attenuated with increased distance away from the source and it therefore follows that there will be **no vibration effects** at the remaining non-residential buildings around the site.

# 7 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

## Mitigation

### *Construction*

7.1 During the construction of the power station and the access road, noise levels within the Firing Range office will have an adverse effect on its use as an office. Mitigation in the form of temporary hoardings of c. 2.5 m in height on the western boundary of the site would reduce noise levels sufficiently that the use of the building as an office would not be affected during the construction period.

### *Operation*

7.2 The assessment of the operation of the proposed power station at Lathbury barracks has identified significant negative noise effects at residential buildings adjacent to the site. The dominant noise sources identified during noise modelling at the power station are the exhaust stacks and by incorporating silencers offering increased attenuation as part of the detail design process it will be possible to reduce noise levels to mitigate the noise effects at residential buildings. The improvements to the exhaust silencers must be accompanied by careful attention to acoustic design of the structure of the generator hall, its ventilation and to any other external noise generating plant.

7.3 In order that noise from the power station should not exceed the background noise level by 5 dB or more at nearby noise sensitive receptors a reduction in overall noise emissions from the power station of c. 10 dB from the figures used during the noise modelling will need to be achieved when compared to the noise levels set out in this report.

7.4 As part of the design process it will also be necessary to augment the noise monitoring reported in this study both in terms of spatial scope and duration, in order to provide a more comprehensive and current baseline to support the design of noise control systems.

### Residual Significant Effects

7.5 Provided that best practice is adopted for acoustic design of the power station and that the construction methods assumed within this study are adhered to, there will be **no residual significant effects** arising from construction or operation of the power station in 2011 or 2032.

# 8 REFERENCES

1. Government of Gibraltar – Environmental (Assessment and Management of Noise) Regulations 2006 (L.N. 2006/121).

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3. Government of Gibraltar Department of Trade and Industry, The Gibraltar Development Plan. 1991 (Amendments to the Final Draft).

4. Government of Gibraltar Department of Trade and Industry, The Gibraltar Development Plan. Consultation Draft 2007.

5. Planning Policy Guidance (PPG) 24: Planning and Noise. The Office of The Deputy Prime Minister (ODPM) 2006.

6. BS 5228 Noise and vibration control on construction and open sites. Code of practice for basic information and procedures for noise and vibration control. April 1997.

7. BS 4142. (1997) Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas.

8. BS 6472 (1992) Guide to Evaluation of Human Exposure to Vibration in Buildings (1Hz to 80Hz).

9. BS 8233 (1999) Sound Insulation and Noise Reduction for Buildings- Code of Practice.

10. BS 7385 Part 2. (1993) Evaluation and measurement for vibration in buildings. Guide for measurement of vibrations and evaluation of their effects on buildings.

11. Department of the Environment Advisory Leaflet 72 Noise Control on Building Sites.

12. Calculation of Road Traffic Noise, Department of Transport, HMSO 1988.

13. Groundborne Vibration Caused by Mechanised Construction Works. TRL Report No. 429. Hiller and Crabb. 2000.

# APPENDIX NV-1

## Power Station Noise Emission Data and Comments from Design Team

## Power Station Noise Emission Data and Comments from Design Team

*Power Station Sound Power Levels (dB re 10 $^{-12}$ W)*
(brackets refer to comments in footnotes)

*Engine mechanical noise, unsilenced sound power level, 1m from engine outline (1)*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| LwA | 74.6 | 93.9 | 101.4 | 106.2 | 116.6 | 119.6 | 117.0 | 118.2 | 114.7 |

*Exhaust gas at 90 degrees and 1 m distance to outlet gas flow, unsilenced sound power level (2)*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| LwA | 113.0 | 110.7 | 114.4 | 115.6 | 118.7 | 119.7 | 117.0 | 106.6 | 98.4 |

*Engine air intake noise, unsilenced sound power level at 1m from intake filter (3)*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| LwA | 61.6 | 83.8 | 97.9 | 108.4 | 116.8 | 120.0 | 127.2 | 137.0 | 132.1 |

*Radiators unsilenced sound power level at 1 m from periphery (4)*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| LwA | 94.0 | 94.0 | 100.0 | 99.0 | 99.0 | 97.0 | 96.0 | 92.0 | 83.0 |

*Ventilation unit, unsilenced sound power level at 1m from intake (5)*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| LwA | 60.1 | 75.7 | 79.0 | 88.6 | 85.5 | 82.0 | 81.6 | 66.7 | 54.6 |

*Typical transmission loss (attenuation) figures:-*

*Building wall transmission loss*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| TL (dB) | - | 24.5 | 27.6 | 31.5 | 34.4 | 31.0 | 43.9 | 56.7 | - |

*Exhaust gas silencer attenuation*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| TL (dB) | 14.0 | 24.0 | 37.0 | 34.0 | 39.0 | 47.0 | 34.0 | 25.0 | 21.0 |

*Air intake silencer attenuation*

| Hz | 31.5 | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|---|
| TL (dB) | 3.0 | 5.0 | 11.0 | 19.0 | 31.0 | 43.0 | 45.0 | 41.0 | 36.0 |

*Exhaust gas silencer attenuation: high performance option*

| Hz | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| TL (dB) | 36.0 | 45.0 | 51.0 | 50.0 | 49.0 | 45.0 | 43.0 | 37.0 | 24.0 |

## Foot notes to noise emission data

*Typical diesel engine source data*

This data is for 'standard' equipment not designed with any particular noise target in mind. Silencers and building walls can be designed to give higher levels of attenuation if necessary.

Comments:-

*Engine mechanical noise (1)*

Typical engine mechanical noise levels attached.

Building skin – 100 mm mineral wool with sheet steel cladding either side.

*Engine exhaust (2)*

At top of stack and at 90 deg to exhaust flow and 1 m distance - assume 30 m above local ground level. Directivity should be taken into account. Normally the exhaust discharges vertically upwards.

Should probably use combined reactive/absorbtion type silencer or two separate silencers per engine

*Engine intake (3)*

At filters 2 m above ground level

Silencer insertion loss typically 35 dB. Air inlet filter typically approx 5 dB reduction.

*Radiators (4)*

At around 3 m above ground level

Typically 90 dB'a' but can get low noise designs down to about 75 dB'a' by use of slower speed fans, louvres etc. May need to construct a barrier wall between radiators and nearest receptors.

*Openings (5)*

One ventilation inlet opening at each end of each engine. With plenum box and splitters plus weather louvres. Approximately 3 m above ground level. Engine hall ridge vent will require some form of attenuation, especially bearing in mind housing uphill to the North. It may be worth making this directional (i.e. opening towards the south).

# APPENDIX NV-2

## Noise Monitoring Equipment

## Noise Monitoring Equipment

Rion NL32 Type 1 Sound level meter: Ser. No. 01020279
Microphone: UC-53A Ser. No. 103386
Pre-amplifier: NH-21 Ser. No. 05511

Rion NL31 Type 1 Sound level meter: Ser. No. 00520623
Microphone: UC-53A Ser. No. 100487
Pre-amplifier: NH-21 Ser. No. 04388

Castle GA607 Acoustic Calibrator Type 1 Ser. No. 036661

# APPENDIX NV-3

## Retreat Centre

## Retreat Centre

| Start Time | LAeq (dB) | LAE (dB) | LAmax (dB) | LAmin (dB) | LA01 (dB) | LA10 (dB) | LA50 (dB) | LA90 (dB) | LA99 (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 17/11/2005 10:00 | 60.0 | 92.6 | 82.1 | 32.7 | 73.3 | 61.1 | 45.0 | 38.2 | 35.0 |
| 17/11/2005 10:30 | 52.9 | 85.5 | 87.5 | 33.6 | 63.0 | 51.4 | 41.3 | 37.5 | 35.4 |
| 17/11/2005 11:00 | 54.3 | 86.8 | 83.2 | 32.3 | 67.2 | 51.4 | 40.0 | 36.5 | 34.4 |
| 17/11/2005 11:30 | 57.5 | 90.0 | 90.8 | 31.3 | 66.7 | 53.6 | 42.1 | 36.0 | 33.3 |
| 17/11/2005 12:00 | 47.1 | 79.6 | 71.0 | 31.6 | 58.9 | 47.0 | 39.9 | 34.7 | 33.2 |
| 17/11/2005 12:30 | 51.7 | 84.3 | 73.9 | 31.7 | 64.1 | 54.2 | 43.1 | 36.5 | 33.7 |
| 17/11/2005 13:00 | 47.9 | 80.4 | 75.7 | 33.2 | 57.7 | 50.2 | 42.2 | 37.2 | 35.4 |
| 17/11/2005 13:30 | 62.0 | 94.5 | 84.9 | 34.4 | 76.3 | 56.4 | 42.2 | 38.3 | 35.9 |
| 17/11/2005 14:00 | 55.8 | 88.4 | 82.1 | 33.3 | 70.7 | 49.4 | 38.2 | 35.7 | 34.6 |
| 17/11/2005 14:30 | 53.2 | 85.8 | 84.0 | 33.6 | 66.9 | 47.5 | 38.9 | 36.0 | 34.7 |
| 17/11/2005 15:00 | 50.2 | 82.8 | 78.4 | 33.2 | 62.8 | 50.5 | 39.4 | 35.8 | 34.4 |
| 17/11/2005 15:30 | 68.2 | 100.8 | 102.5 | 34.1 | 67.2 | 52.4 | 40.5 | 37.1 | 35.3 |
| 17/11/2005 16:00 | 63.3 | 95.9 | 88.0 | 34.6 | 77.7 | 52.6 | 39.7 | 36.6 | 35.6 |
| 17/11/2005 16:30 | 48.7 | 81.3 | 75.8 | 35.4 | 58.7 | 50.4 | 41.8 | 38.1 | 36.9 |
| 17/11/2005 17:00 | 52.0 | 84.6 | 80.2 | 37.0 | 62.9 | 51.3 | 44.8 | 40.8 | 38.7 |
| 17/11/2005 17:30 | 66.0 | 98.6 | 90.5 | 37.3 | 78.7 | 67.2 | 50.3 | 41.5 | 39.5 |
| 17/11/2005 18:00 | 53.0 | 85.5 | 78.7 | 36.9 | 62.4 | 56.0 | 47.4 | 41.0 | 38.8 |
| 17/11/2005 18:30 | 49.4 | 81.9 | 78.7 | 35.5 | 58.7 | 52.0 | 43.7 | 39.2 | 37.1 |
| 17/11/2005 19:00 | 64.1 | 96.7 | 84.8 | 40.3 | 75.7 | 66.8 | 57.6 | 48.6 | 43.2 |
| 17/11/2005 19:30 | 69.7 | 102.2 | 101.9 | 45.8 | 79.1 | 71.0 | 62.7 | 55.9 | 51.3 |
| 17/11/2005 20:00 | 52.6 | 85.2 | 83.4 | 34.3 | 64.2 | 52.6 | 40.9 | 38.1 | 36.6 |
| 17/11/2005 20:30 | 43.1 | 75.7 | 75.6 | 35.0 | 50.1 | 43.4 | 39.3 | 37.3 | 36.2 |
| 17/11/2005 21:00 | 50.9 | 83.5 | 80.2 | 33.0 | 58.1 | 50.1 | 40.3 | 36.8 | 34.9 |
| 17/11/2005 21:30 | 41.9 | 74.4 | 63.4 | 33.6 | 51.8 | 41.4 | 38.7 | 36.8 | 35.3 |
| 17/11/2005 22:00 | 38.4 | 71.0 | 60.4 | 30.3 | 46.8 | 39.9 | 36.2 | 33.9 | 32.1 |
| 17/11/2005 22:30 | 46.9 | 79.4 | 84.4 | 30.0 | 55.9 | 46.3 | 34.3 | 32.2 | 31.1 |
| 17/11/2005 23:00 | 40.5 | 73.1 | 59.4 | 29.7 | 51.9 | 42.9 | 36.1 | 32.8 | 31.2 |
| 17/11/2005 23:30 | 40.2 | 72.8 | 72.9 | 30.4 | 50.1 | 39.2 | 35.3 | 33.3 | 31.9 |
| 18/11/2005 00:00 | 38.0 | 70.5 | 60.4 | 28.7 | 50.3 | 37.9 | 34.1 | 31.4 | 30.1 |
| 18/11/2005 00:30 | 37.8 | 70.4 | 60.0 | 29.0 | 48.0 | 40.1 | 33.9 | 31.5 | 30.3 |
| 18/11/2005 01:00 | 32.7 | 65.3 | 52.2 | 27.9 | 38.8 | 34.4 | 31.7 | 30.1 | 29.2 |
| 18/11/2005 01:30 | 34.9 | 67.5 | 51.3 | 27.8 | 41.7 | 37.5 | 33.6 | 30.2 | 29.0 |
| 18/11/2005 02:00 | 35.5 | 68.0 | 54.4 | 29.5 | 40.2 | 37.4 | 34.7 | 32.2 | 30.9 |
| 18/11/2005 02:30 | 31.7 | 64.2 | 49.2 | 26.7 | 36.7 | 33.7 | 30.8 | 29.1 | 28.2 |
| 18/11/2005 03:00 | 31.4 | 63.9 | 52.2 | 27.6 | 37.7 | 31.9 | 30.6 | 29.5 | 28.8 |
| 18/11/2005 03:30 | 33.4 | 66.0 | 51.8 | 27.3 | 38.0 | 35.2 | 33.0 | 30.2 | 28.8 |
| 18/11/2005 04:00 | 34.3 | 66.9 | 53.7 | 29.8 | 39.0 | 35.7 | 33.7 | 32.0 | 31.0 |
| 18/11/2005 04:30 | 33.3 | 65.8 | 54.8 | 28.8 | 38.6 | 34.5 | 32.7 | 31.3 | 30.1 |
| 18/11/2005 05:00 | 39.3 | 71.8 | 66.0 | 28.1 | 51.1 | 37.4 | 32.3 | 30.4 | 29.4 |
| 18/11/2005 05:30 | 35.7 | 68.3 | 57.3 | 28.2 | 47.0 | 36.0 | 31.8 | 30.1 | 29.2 |
| 18/11/2005 06:00 | 39.0 | 71.6 | 63.4 | 29.3 | 49.8 | 40.0 | 35.4 | 32.7 | 30.8 |
| 18/11/2005 06:30 | 38.3 | 70.8 | 61.3 | 29.9 | 46.1 | 39.8 | 35.5 | 32.9 | 31.4 |
| 18/11/2005 07:00 | 39.9 | 72.5 | 63.7 | 30.2 | 50.7 | 40.8 | 36.3 | 33.7 | 31.9 |
| 18/11/2005 07:30 | 46.1 | 78.7 | 68.7 | 32.5 | 56.7 | 48.6 | 41.8 | 36.7 | 34.6 |
| 18/11/2005 08:00 | 50.2 | 82.7 | 77.2 | 36.7 | 60.0 | 52.9 | 44.2 | 40.5 | 38.4 |
| 18/11/2005 08:30 | 45.5 | 78.1 | 64.2 | 36.2 | 56.5 | 47.3 | 42.5 | 40.1 | 38.3 |
| 18/11/2005 09:00 | 61.2 | 93.8 | 87.2 | 36.6 | 74.7 | 56.9 | 44.0 | 41.2 | 38.8 |
| 18/11/2005 09:30 | 47.0 | 79.6 | 66.1 | 37.0 | 58.2 | 48.6 | 43.1 | 40.2 | 38.6 |
| 18/11/2005 10:00 | 49.7 | 82.2 | 73.4 | 34.5 | 62.7 | 47.5 | 40.9 | 37.6 | 36.1 |
| 18/11/2005 10:30 | 48.8 | 81.3 | 68.5 | 35.4 | 61.7 | 50.3 | 42.1 | 38.6 | 36.6 |
| 18/11/2005 11:00 | 52.2 | 84.8 | 88.9 | 36.4 | 62.7 | 51.2 | 44.0 | 40.1 | 38.0 |
| 18/11/2005 11:30 | 52.3 | 84.9 | 76.0 | 33.6 | 65.5 | 52.1 | 43.5 | 37.4 | 35.5 |

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 18/11/2005 12:00 | 47.4 | 79.9 | 67.5 | 34.7 | 57.4 | 51.1 | 42.5 | 37.8 | 36.3 |
| 18/11/2005 12:30 | 63.5 | 96.1 | 84.0 | 35.5 | 78.4 | 58.8 | 45.7 | 40.3 | 37.8 |
| 18/11/2005 13:00 | 48.4 | 81.0 | 68.9 | 34.7 | 60.3 | 50.8 | 41.8 | 37.8 | 36.0 |
| 18/11/2005 13:30 | 49.1 | 81.7 | 69.9 | 33.3 | 61.1 | 51.3 | 42.7 | 38.0 | 35.9 |
| 18/11/2005 14:00 | 50.7 | 83.3 | 71.5 | 35.2 | 61.9 | 53.3 | 45.7 | 38.9 | 37.0 |
| 18/11/2005 14:30 | 49.0 | 81.6 | 76.5 | 33.2 | 58.9 | 51.0 | 41.1 | 37.0 | 35.1 |
| 18/11/2005 15:00 | 49.6 | 82.1 | 70.2 | 34.0 | 62.6 | 52.3 | 40.3 | 36.6 | 35.4 |
| 18/11/2005 15:30 | 46.3 | 78.9 | 68.1 | 33.7 | 57.5 | 48.4 | 39.6 | 36.3 | 35.0 |
| 18/11/2005 16:00 | 49.6 | 82.1 | 76.5 | 33.1 | 60.1 | 49.5 | 41.7 | 37.8 | 35.8 |
| 18/11/2005 16:30 | 48.5 | 81.1 | 67.7 | 33.3 | 60.4 | 50.3 | 42.1 | 37.3 | 34.9 |
| 18/11/2005 17:00 | 46.0 | 78.5 | 62.9 | 34.0 | 56.3 | 49.3 | 41.4 | 37.8 | 36.0 |
| 18/11/2005 17:30 | 50.7 | 83.2 | 67.8 | 33.2 | 60.9 | 53.7 | 47.2 | 41.0 | 37.6 |
| 18/11/2005 18:00 | 48.6 | 81.1 | 77.4 | 35.1 | 58.5 | 51.6 | 43.7 | 39.5 | 37.4 |
| 18/11/2005 18:30 | 52.7 | 85.2 | 74.9 | 32.6 | 67.2 | 49.4 | 40.5 | 36.2 | 34.8 |
| 18/11/2005 19:00 | 50.0 | 82.6 | 83.5 | 32.7 | 57.2 | 44.2 | 37.2 | 34.8 | 33.8 |
| 18/11/2005 19:30 | 42.9 | 75.4 | 69.5 | 32.3 | 53.3 | 44.3 | 38.6 | 34.6 | 33.6 |
| 18/11/2005 20:00 | 44.1 | 76.7 | 66.9 | 33.4 | 52.4 | 46.6 | 41.7 | 37.6 | 35.1 |
| 18/11/2005 20:30 | 42.5 | 75.1 | 62.5 | 32.7 | 52.1 | 45.4 | 39.2 | 35.3 | 33.9 |
| 18/11/2005 21:00 | 43.0 | 75.5 | 60.1 | 31.8 | 51.6 | 46.3 | 40.3 | 35.9 | 33.5 |
| 18/11/2005 21:30 | 42.4 | 75.0 | 61.8 | 30.5 | 51.8 | 45.0 | 39.6 | 36.0 | 33.5 |
| 18/11/2005 22:00 | 40.9 | 73.5 | 61.6 | 29.5 | 51.2 | 43.4 | 37.3 | 32.1 | 30.8 |
| 18/11/2005 22:30 | 35.2 | 67.7 | 54.4 | 29.1 | 43.1 | 37.5 | 33.6 | 31.4 | 30.2 |
| 18/11/2005 23:00 | 45.7 | 78.3 | 71.8 | 29.2 | 59.1 | 44.2 | 35.1 | 31.5 | 30.4 |
| 18/11/2005 23:30 | 42.0 | 74.5 | 65.9 | 30.6 | 53.9 | 42.9 | 36.7 | 33.3 | 31.9 |
| 19/11/2005 00:00 | 38.1 | 70.6 | 61.5 | 28.6 | 46.8 | 39.3 | 33.9 | 31.3 | 29.9 |
| 19/11/2005 00:30 | 37.0 | 69.6 | 59.8 | 28.2 | 49.2 | 36.9 | 31.7 | 30.1 | 29.3 |
| 19/11/2005 01:00 | 34.3 | 66.8 | 52.3 | 29.3 | 41.7 | 35.9 | 32.9 | 31.3 | 30.4 |
| 19/11/2005 01:30 | 39.8 | 72.3 | 65.4 | 28.2 | 50.7 | 39.3 | 33.0 | 30.5 | 29.6 |
| 19/11/2005 02:00 | 36.0 | 68.6 | 58.8 | 27.1 | 46.9 | 38.5 | 31.7 | 29.6 | 28.5 |
| 19/11/2005 02:30 | 35.4 | 67.9 | 56.9 | 27.1 | 46.3 | 35.6 | 31.8 | 29.8 | 28.8 |
| 19/11/2005 03:00 | 33.9 | 66.4 | 51.0 | 27.6 | 42.1 | 35.8 | 32.2 | 30.2 | 29.0 |
| 19/11/2005 03:30 | 38.9 | 71.4 | 65.1 | 27.4 | 49.2 | 39.6 | 33.6 | 30.0 | 28.8 |
| 19/11/2005 04:00 | 33.5 | 66.1 | 51.9 | 24.2 | 43.4 | 36.9 | 29.4 | 26.6 | 25.6 |
| 19/11/2005 04:30 | 33.3 | 65.9 | 55.2 | 25.7 | 42.3 | 35.6 | 30.2 | 27.7 | 26.6 |
| 19/11/2005 05:00 | 34.7 | 67.3 | 58.1 | 25.9 | 43.9 | 36.6 | 31.7 | 28.6 | 27.1 |
| 19/11/2005 05:30 | 37.9 | 70.5 | 59.6 | 28.3 | 48.4 | 41.3 | 32.9 | 30.6 | 29.6 |
| 19/11/2005 06:00 | 38.8 | 71.4 | 60.7 | 28.9 | 49.3 | 41.2 | 34.9 | 31.3 | 30.2 |
| 19/11/2005 06:30 | 37.7 | 70.3 | 54.9 | 30.1 | 45.8 | 40.4 | 35.8 | 33.1 | 31.9 |
| 19/11/2005 07:00 | 49.0 | 81.6 | 74.5 | 30.7 | 61.0 | 48.5 | 42.8 | 36.5 | 33.2 |
| 19/11/2005 07:30 | 50.6 | 83.2 | 73.1 | 36.1 | 59.8 | 51.8 | 48.0 | 43.8 | 40.4 |
| 19/11/2005 08:00 | 52.1 | 84.7 | 73.4 | 35.0 | 62.9 | 55.1 | 47.6 | 43.1 | 40.5 |
| 19/11/2005 08:30 | 48.4 | 81.0 | 70.6 | 36.9 | 56.0 | 50.8 | 46.6 | 42.1 | 39.0 |
| 19/11/2005 09:00 | 52.5 | 85.1 | 71.3 | 40.8 | 62.9 | 54.7 | 49.5 | 45.5 | 43.2 |
| 19/11/2005 09:30 | 53.7 | 86.3 | 74.4 | 35.4 | 65.2 | 57.1 | 46.3 | 41.4 | 38.3 |
| 19/11/2005 10:00 | 55.0 | 87.5 | 89.2 | 36.6 | 65.0 | 51.8 | 47.3 | 43.0 | 40.0 |
| 19/11/2005 10:30 | 53.1 | 85.7 | 75.9 | 35.5 | 66.8 | 52.8 | 45.0 | 39.1 | 37.4 |
| 19/11/2005 11:00 | 50.3 | 82.8 | 72.6 | 35.8 | 62.0 | 51.0 | 44.1 | 40.0 | 37.7 |
| 19/11/2005 11:30 | 48.5 | 81.1 | 68.4 | 35.3 | 58.8 | 51.0 | 44.3 | 39.7 | 37.1 |
| 19/11/2005 12:00 | 47.1 | 79.6 | 65.9 | 36.3 | 56.6 | 49.8 | 44.1 | 40.0 | 38.0 |
| 19/11/2005 12:30 | 48.3 | 80.9 | 71.3 | 34.6 | 59.1 | 48.9 | 41.9 | 37.9 | 35.9 |
| 19/11/2005 13:00 | 46.1 | 78.7 | 72.0 | 34.2 | 57.7 | 46.9 | 40.0 | 36.7 | 35.5 |
| 19/11/2005 13:30 | 48.3 | 80.9 | 70.6 | 34.0 | 58.0 | 51.3 | 42.6 | 37.4 | 35.5 |
| 19/11/2005 14:00 | 47.7 | 80.2 | 63.0 | 33.9 | 58.6 | 51.0 | 42.7 | 37.3 | 35.2 |
| 19/11/2005 14:30 | 48.2 | 80.8 | 71.2 | 35.3 | 58.1 | 50.1 | 42.3 | 38.8 | 37.0 |

| Start Time | LAeq (dB) | LAE (dB) | LAmax (dB) | LAmin (dB) | LA01 (dB) | LA10 (dB) | LA50 (dB) | LA90 (dB) | LA99 (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 19/11/2005 15:00 | 50.0 | 82.6 | 73.0 | 37.5 | 59.4 | 51.6 | 45.4 | 41.6 | 39.4 |
| 19/11/2005 15:30 | 47.1 | 79.7 | 71.7 | 34.4 | 56.7 | 49.3 | 44.1 | 39.5 | 36.4 |
| 19/11/2005 16:00 | 48.3 | 80.8 | 64.9 | 34.4 | 59.9 | 51.2 | 43.2 | 38.5 | 36.4 |
| 19/11/2005 16:30 | 46.6 | 79.2 | 65.7 | 34.3 | 57.1 | 48.8 | 42.5 | 38.4 | 36.0 |
| 19/11/2005 17:00 | 49.8 | 82.3 | 71.0 | 34.5 | 59.1 | 52.7 | 45.9 | 40.3 | 37.2 |
| 19/11/2005 17:30 | 59.1 | 91.7 | 95.5 | 37.6 | 60.6 | 53.8 | 47.9 | 43.9 | 40.8 |
| 19/11/2005 18:00 | 48.1 | 80.7 | 70.5 | 37.0 | 58.3 | 50.2 | 44.6 | 40.9 | 38.8 |
| 19/11/2005 18:30 | 47.5 | 80.1 | 64.5 | 36.1 | 56.9 | 50.3 | 44.8 | 40.2 | 37.6 |
| 19/11/2005 19:00 | 49.2 | 81.7 | 76.3 | 35.4 | 59.8 | 51.4 | 43.6 | 38.9 | 36.7 |
| 19/11/2005 19:30 | 54.5 | 87.0 | 80.2 | 34.7 | 67.9 | 53.1 | 42.5 | 37.2 | 35.8 |
| 19/11/2005 20:00 | 41.7 | 74.2 | 58.8 | 34.5 | 51.0 | 44.0 | 39.0 | 36.7 | 35.7 |
| 19/11/2005 20:30 | 43.9 | 76.4 | 65.7 | 35.2 | 53.8 | 46.3 | 40.2 | 37.6 | 36.4 |
| 19/11/2005 21:00 | 43.3 | 75.8 | 63.6 | 35.2 | 52.3 | 46.6 | 39.9 | 37.1 | 36.1 |
| 19/11/2005 21:30 | 47.6 | 80.1 | 72.2 | 36.0 | 60.4 | 45.7 | 40.5 | 38.4 | 37.1 |
| 19/11/2005 22:00 | 43.7 | 76.3 | 63.0 | 35.2 | 52.8 | 45.8 | 41.2 | 38.6 | 36.7 |
| 19/11/2005 22:30 | 40.9 | 73.4 | 59.4 | 34.5 | 52.4 | 41.4 | 38.0 | 36.6 | 35.7 |
| 19/11/2005 23:00 | 41.5 | 74.1 | 60.6 | 36.1 | 49.4 | 43.7 | 39.7 | 38.0 | 37.2 |
| 19/11/2005 23:30 | 42.6 | 75.2 | 64.2 | 36.3 | 51.4 | 44.8 | 40.0 | 38.2 | 37.2 |
| 20/11/2005 00:00 | 63.0 | 95.5 | 101.3 | 36.7 | 55.5 | 46.8 | 41.0 | 39.0 | 38.0 |
| 20/11/2005 00:30 | 47.3 | 79.8 | 77.5 | 38.4 | 57.0 | 48.0 | 42.6 | 40.5 | 39.4 |
| 20/11/2005 01:00 | 44.9 | 77.5 | 61.0 | 37.6 | 54.8 | 47.6 | 41.8 | 39.7 | 38.6 |
| 20/11/2005 01:30 | 45.4 | 78.0 | 70.5 | 38.1 | 54.6 | 48.2 | 42.2 | 40.2 | 39.1 |
| 20/11/2005 02:00 | 47.0 | 79.5 | 66.0 | 39.4 | 57.0 | 48.6 | 43.8 | 41.8 | 40.6 |
| 20/11/2005 02:30 | 46.4 | 79.0 | 66.3 | 40.4 | 55.5 | 48.0 | 44.5 | 42.4 | 41.3 |
| 20/11/2005 03:00 | 47.4 | 80.0 | 66.6 | 41.5 | 55.8 | 49.3 | 45.5 | 43.7 | 42.7 |
| 20/11/2005 03:30 | 48.0 | 80.6 | 68.1 | 42.0 | 55.9 | 48.9 | 45.7 | 44.0 | 43.1 |
| 20/11/2005 04:00 | 49.7 | 82.3 | 70.0 | 42.3 | 58.3 | 51.8 | 47.1 | 45.1 | 44.0 |
| 20/11/2005 04:30 | 49.5 | 82.0 | 66.0 | 43.7 | 57.7 | 51.6 | 47.8 | 45.7 | 44.5 |
| 20/11/2005 05:00 | 55.8 | 88.4 | 84.7 | 43.3 | 68.2 | 52.6 | 47.5 | 45.4 | 44.3 |
| 20/11/2005 05:30 | 48.5 | 81.1 | 72.5 | 40.7 | 57.1 | 49.9 | 46.0 | 43.5 | 42.1 |
| 20/11/2005 06:00 | 48.8 | 81.3 | 68.2 | 40.0 | 59.0 | 50.9 | 45.5 | 43.0 | 41.4 |
| 20/11/2005 06:30 | 48.8 | 81.3 | 70.1 | 40.9 | 58.5 | 50.7 | 46.0 | 43.8 | 42.3 |
| 20/11/2005 07:00 | 51.8 | 84.4 | 73.2 | 42.2 | 61.8 | 54.5 | 48.2 | 45.4 | 43.8 |
| 20/11/2005 07:30 | 51.8 | 84.3 | 74.9 | 44.5 | 62.1 | 53.7 | 48.8 | 46.7 | 45.6 |
| 20/11/2005 08:00 | 50.3 | 82.8 | 69.3 | 42.9 | 59.3 | 52.8 | 47.8 | 45.7 | 44.3 |
| 20/11/2005 08:30 | 50.0 | 82.5 | 65.9 | 42.8 | 60.3 | 51.6 | 47.4 | 45.3 | 44.0 |
| 20/11/2005 09:00 | 49.3 | 81.8 | 63.9 | 43.1 | 57.8 | 51.4 | 47.4 | 45.4 | 44.2 |
| 20/11/2005 09:30 | 50.6 | 83.2 | 70.2 | 43.1 | 58.9 | 53.0 | 48.5 | 45.9 | 44.5 |
| 20/11/2005 10:00 | 51.6 | 84.2 | 76.6 | 44.3 | 61.0 | 53.7 | 48.6 | 46.5 | 45.4 |
| 20/11/2005 10:30 | 50.8 | 83.4 | 68.2 | 42.4 | 59.8 | 53.3 | 48.4 | 46.3 | 45.0 |
| 20/11/2005 11:00 | 50.5 | 83.0 | 68.2 | 42.9 | 59.7 | 52.8 | 48.0 | 45.5 | 44.3 |
| 20/11/2005 11:30 | 52.5 | 85.1 | 76.6 | 42.4 | 63.4 | 54.6 | 48.4 | 45.7 | 44.4 |
| 20/11/2005 12:00 | 50.1 | 82.6 | 70.8 | 41.9 | 60.3 | 52.1 | 47.0 | 44.6 | 43.2 |
| 20/11/2005 12:30 | 49.0 | 81.6 | 67.4 | 40.3 | 57.5 | 51.7 | 46.4 | 44.1 | 42.4 |
| 20/11/2005 13:00 | 52.3 | 84.9 | 70.7 | 41.1 | 64.2 | 53.9 | 46.5 | 43.8 | 42.3 |
| 20/11/2005 13:30 | 49.4 | 82.0 | 71.1 | 39.3 | 59.6 | 52.8 | 45.2 | 42.7 | 41.4 |
| 20/11/2005 14:00 | 50.1 | 82.6 | 72.4 | 41.2 | 58.7 | 53.2 | 46.6 | 43.9 | 42.6 |
| 20/11/2005 14:30 | 50.5 | 83.1 | 70.7 | 40.6 | 60.9 | 52.7 | 46.5 | 43.8 | 42.1 |
| 20/11/2005 15:00 | 52.6 | 85.1 | 70.5 | 42.1 | 64.2 | 54.5 | 48.2 | 45.4 | 43.8 |
| 20/11/2005 15:30 | 55.0 | 87.5 | 85.4 | 42.1 | 63.7 | 56.0 | 47.5 | 44.8 | 43.5 |
| 20/11/2005 16:00 | 55.7 | 88.2 | 82.8 | 41.5 | 63.0 | 52.3 | 46.7 | 44.5 | 43.2 |
| 20/11/2005 16:30 | 51.2 | 83.8 | 73.8 | 42.0 | 60.6 | 53.6 | 47.8 | 44.7 | 43.4 |
| 20/11/2005 17:00 | 65.0 | 97.6 | 97.2 | 42.1 | 65.1 | 55.7 | 49.1 | 45.3 | 43.5 |
| 20/11/2005 17:30 | 53.8 | 86.3 | 84.2 | 42.8 | 62.2 | 55.0 | 48.3 | 45.5 | 44.2 |

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 20/11/2005 18:00 | 52.5 | 85.1 | 71.8 | 42.0 | 62.4 | 55.3 | 48.7 | 45.1 | 43.6 |
| 20/11/2005 18:30 | 53.9 | 86.5 | 84.6 | 42.3 | 62.5 | 54.7 | 47.1 | 44.5 | 43.4 |
| 20/11/2005 19:00 | 54.8 | 87.4 | 82.0 | 43.3 | 64.9 | 57.0 | 48.6 | 45.5 | 44.2 |
| 20/11/2005 19:30 | 59.8 | 92.4 | 89.5 | 43.1 | 70.2 | 62.1 | 52.4 | 46.7 | 44.8 |
| 20/11/2005 20:00 | 64.6 | 97.1 | 91.9 | 45.4 | 72.4 | 67.1 | 63.7 | 51.0 | 47.5 |
| 20/11/2005 20:30 | 68.7 | 101.3 | 95.4 | 45.6 | 81.2 | 66.3 | 56.2 | 50.0 | 47.5 |
| 20/11/2005 21:00 | 59.8 | 92.4 | 79.3 | 47.1 | 69.7 | 63.2 | 55.8 | 50.4 | 48.4 |
| 20/11/2005 21:30 | 61.4 | 94.0 | 78.8 | 48.5 | 69.5 | 64.8 | 59.1 | 54.1 | 51.0 |
| 20/11/2005 22:00 | 61.7 | 94.2 | 80.2 | 48.7 | 69.6 | 65.1 | 59.4 | 54.2 | 51.0 |
| 20/11/2005 22:30 | 59.4 | 91.9 | 75.9 | 47.2 | 68.0 | 62.8 | 56.6 | 51.4 | 48.8 |
| 20/11/2005 23:00 | 57.4 | 90.0 | 88.4 | 46.3 | 66.5 | 60.1 | 53.7 | 49.7 | 48.1 |
| 20/11/2005 23:30 | 55.4 | 88.0 | 76.9 | 46.2 | 64.9 | 57.9 | 52.5 | 49.4 | 47.7 |
| 21/11/2005 00:00 | 52.8 | 85.4 | 76.1 | 45.0 | 63.6 | 54.5 | 49.9 | 47.8 | 46.6 |
| 21/11/2005 00:30 | 50.8 | 83.4 | 68.9 | 43.0 | 59.8 | 52.9 | 48.0 | 45.7 | 44.3 |
| 21/11/2005 01:00 | 48.3 | 80.9 | 69.6 | 41.6 | 57.2 | 51.1 | 45.8 | 43.8 | 42.6 |
| 21/11/2005 01:30 | 48.6 | 81.1 | 67.0 | 40.6 | 57.7 | 51.0 | 45.3 | 43.2 | 42.1 |
| 21/11/2005 02:00 | 49.8 | 82.4 | 67.1 | 41.5 | 59.8 | 52.9 | 46.1 | 43.7 | 42.6 |
| 21/11/2005 02:30 | 49.9 | 82.5 | 71.2 | 41.8 | 60.0 | 51.8 | 46.5 | 44.3 | 43.2 |
| 21/11/2005 03:00 | 48.6 | 81.2 | 79.3 | 40.6 | 57.3 | 49.9 | 45.6 | 43.5 | 42.0 |
| 21/11/2005 03:30 | 50.4 | 82.9 | 77.0 | 42.4 | 59.8 | 51.9 | 46.3 | 44.5 | 43.3 |
| 21/11/2005 04:00 | 50.2 | 82.8 | 72.2 | 41.1 | 59.9 | 52.0 | 45.9 | 43.9 | 42.6 |
| 21/11/2005 04:30 | 49.7 | 82.3 | 71.0 | 41.8 | 59.9 | 51.6 | 46.8 | 44.3 | 43.2 |
| 21/11/2005 05:00 | 47.4 | 80.0 | 63.5 | 40.7 | 56.7 | 50.1 | 44.7 | 42.9 | 41.9 |
| 21/11/2005 05:30 | 47.1 | 79.6 | 66.4 | 40.0 | 56.8 | 49.2 | 44.3 | 42.4 | 41.2 |
| 21/11/2005 06:00 | 47.6 | 80.2 | 66.7 | 40.8 | 56.9 | 50.2 | 44.7 | 42.7 | 41.8 |
| 21/11/2005 06:30 | 46.9 | 79.5 | 64.9 | 39.2 | 57.3 | 49.3 | 43.7 | 41.7 | 40.4 |
| 21/11/2005 07:00 | 47.4 | 79.9 | 64.6 | 39.3 | 57.8 | 49.8 | 44.1 | 41.7 | 40.4 |
| 21/11/2005 07:30 | 51.2 | 83.8 | 82.6 | 40.2 | 59.8 | 52.5 | 47.4 | 44.4 | 42.2 |
| 21/11/2005 08:00 | 52.6 | 85.1 | 78.6 | 41.1 | 63.3 | 52.7 | 46.9 | 44.2 | 42.6 |
| 21/11/2005 08:30 | 50.2 | 82.7 | 69.5 | 40.7 | 61.0 | 52.6 | 46.5 | 43.6 | 42.0 |
| 21/11/2005 09:00 | 51.7 | 84.2 | 72.5 | 39.7 | 61.7 | 54.5 | 48.0 | 44.0 | 41.9 |
| 21/11/2005 09:30 | 48.0 | 80.5 | 73.1 | 39.7 | 56.0 | 50.2 | 45.2 | 42.3 | 41.0 |
| 21/11/2005 10:00 | 53.8 | 86.3 | 78.5 | 38.4 | 65.6 | 53.4 | 45.9 | 42.3 | 40.4 |
| 21/11/2005 10:30 | 49.2 | 81.7 | 71.1 | 36.6 | 60.4 | 49.2 | 43.3 | 40.2 | 38.6 |
| 21/11/2005 11:00 | 54.8 | 87.3 | 89.2 | 36.7 | 64.1 | 52.0 | 44.2 | 40.4 | 38.4 |
| 21/11/2005 11:30 | 59.6 | 92.2 | 83.5 | 36.6 | 73.2 | 58.1 | 46.6 | 41.8 | 39.2 |
| 21/11/2005 12:00 | 52.5 | 85.0 | 82.5 | 36.2 | 63.6 | 50.7 | 44.7 | 40.2 | 37.9 |
| 21/11/2005 12:30 | 58.6 | 91.2 | 85.3 | 36.8 | 72.1 | 56.3 | 43.5 | 39.4 | 38.1 |
| 21/11/2005 13:00 | 57.4 | 90.0 | 84.8 | 37.0 | 71.5 | 52.3 | 43.2 | 40.3 | 38.4 |
| 21/11/2005 13:30 | 50.7 | 83.2 | 74.4 | 39.4 | 64.1 | 50.4 | 43.9 | 41.7 | 40.7 |
| 21/11/2005 14:00 | 48.8 | 81.4 | 76.6 | 34.8 | 61.2 | 47.8 | 41.8 | 39.4 | 37.2 |
| 21/11/2005 14:30 | 47.1 | 79.7 | 79.8 | 34.4 | 56.5 | 47.3 | 39.8 | 37.1 | 35.8 |
| 21/11/2005 15:00 | 42.1 | 74.6 | 61.8 | 33.9 | 53.3 | 43.0 | 38.4 | 36.2 | 35.1 |
| 21/11/2005 15:30 | 44.7 | 77.3 | 65.6 | 33.5 | 56.2 | 46.6 | 39.8 | 36.9 | 35.3 |
| 21/11/2005 16:00 | 47.9 | 76.8 | 74.8 | 34.5 | 58.7 | 49.7 | 39.6 | 36.9 | 35.5 |

## Results of Noise Monitoring: Royal Naval Hospital: E Block

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 17/11/2005 12:05 | 61.5 | 94.1 | 77.1 | 45.4 | 72.7 | 64.8 | 56.1 | 50.7 | 47.6 |
| 17/11/2005 12:35 | 59.8 | 92.4 | 80.3 | 45.7 | 70.0 | 62.7 | 55.0 | 49.8 | 47.3 |
| 17/11/2005 13:05 | 65.7 | 98.3 | 90.2 | 40.5 | 79.0 | 67.0 | 57.6 | 45.1 | 42.1 |
| 17/11/2005 13:35 | 59.2 | 91.8 | 76.1 | 42.7 | 69.9 | 62.5 | 54.4 | 46.1 | 44.2 |
| 17/11/2005 14:05 | 62.2 | 94.8 | 84.1 | 42.1 | 75.1 | 64.0 | 56.0 | 46.4 | 43.5 |
| 17/11/2005 14:35 | 61.2 | 93.8 | 82.9 | 42.1 | 71.6 | 64.0 | 55.5 | 47.0 | 44.0 |
| 17/11/2005 15:05 | 60.8 | 93.4 | 78.0 | 47.3 | 70.9 | 64.1 | 56.8 | 51.1 | 49.1 |
| 17/11/2005 15:35 | 61.1 | 93.7 | 83.1 | 47.7 | 71.7 | 63.4 | 57.4 | 51.6 | 49.4 |
| 17/11/2005 16:05 | 65.7 | 98.3 | 89.2 | 42.8 | 79.0 | 65.3 | 57.1 | 49.8 | 45.9 |
| 17/11/2005 16:35 | 62.0 | 94.6 | 82.9 | 43.1 | 73.6 | 64.3 | 57.4 | 49.0 | 45.1 |
| 17/11/2005 17:05 | 73.6 | 106.2 | 98.7 | 41.8 | 86.9 | 65.0 | 57.9 | 46.8 | 43.2 |
| 17/11/2005 17:35 | 59.0 | 91.6 | 74.1 | 41.4 | 67.8 | 62.6 | 56.2 | 47.6 | 43.7 |
| 17/11/2005 18:05 | 60.4 | 93.0 | 77.6 | 40.9 | 70.5 | 63.1 | 57.3 | 48.7 | 44.1 |
| 17/11/2005 18:35 | 61.1 | 93.7 | 82.7 | 39.9 | 71.7 | 63.3 | 55.4 | 44.8 | 41.0 |
| 17/11/2005 19:05 | 60.0 | 92.6 | 76.3 | 40.4 | 72.0 | 62.9 | 54.1 | 44.4 | 41.7 |
| 17/11/2005 19:35 | 59.9 | 92.5 | 84.4 | 39.3 | 71.0 | 61.2 | 53.3 | 42.9 | 40.5 |
| 17/11/2005 20:05 | 58.7 | 91.3 | 79.5 | 38.9 | 69.0 | 62.3 | 52.0 | 42.4 | 40.3 |
| 17/11/2005 20:35 | 56.9 | 89.5 | 75.9 | 39.8 | 68.0 | 60.3 | 50.6 | 42.8 | 40.7 |
| 17/11/2005 21:05 | 56.1 | 88.7 | 76.5 | 38.6 | 67.2 | 59.3 | 48.6 | 40.8 | 39.4 |
| 17/11/2005 21:35 | 57.1 | 89.7 | 77.1 | 39.3 | 69.0 | 60.3 | 47.2 | 41.9 | 40.8 |
| 17/11/2005 22:05 | 58.9 | 91.5 | 81.9 | 39.1 | 71.1 | 60.9 | 50.1 | 42.5 | 40.1 |
| 17/11/2005 22:35 | 54.9 | 87.5 | 80.4 | 38.5 | 65.7 | 58.0 | 43.3 | 40.0 | 39.3 |
| 17/11/2005 23:05 | 61.3 | 93.9 | 86.6 | 38.6 | 74.7 | 60.4 | 46.8 | 40.6 | 39.6 |
| 17/11/2005 23:35 | 58.2 | 90.8 | 81.1 | 38.2 | 71.5 | 59.8 | 44.1 | 40.2 | 39.3 |
| 18/11/2005 00:05 | 52.3 | 84.9 | 70.0 | 38.4 | 63.9 | 56.7 | 43.1 | 39.8 | 39.2 |
| 18/11/2005 00:35 | 57.4 | 90.0 | 82.9 | 38.1 | 71.9 | 56.8 | 42.8 | 39.6 | 38.8 |
| 18/11/2005 01:05 | 49.7 | 82.3 | 74.5 | 37.6 | 61.7 | 49.1 | 42.1 | 39.0 | 38.4 |
| 18/11/2005 01:35 | 51.2 | 83.8 | 76.4 | 37.4 | 63.9 | 50.4 | 41.5 | 39.2 | 38.2 |
| 18/11/2005 02:05 | 44.5 | 77.1 | 65.4 | 37.5 | 57.2 | 43.2 | 40.3 | 39.0 | 38.3 |
| 18/11/2005 02:35 | 47.2 | 79.8 | 71.5 | 37.5 | 60.4 | 42.9 | 39.5 | 38.6 | 38.1 |
| 18/11/2005 03:05 | 45.7 | 78.3 | 65.3 | 37.4 | 58.7 | 43.4 | 40.2 | 38.5 | 38.0 |
| 18/11/2005 03:35 | 44.7 | 77.3 | 62.6 | 38.0 | 58.2 | 43.3 | 40.1 | 39.2 | 38.7 |
| 18/11/2005 04:05 | 44.3 | 76.9 | 65.0 | 38.1 | 56.9 | 43.6 | 40.8 | 39.4 | 38.9 |
| 18/11/2005 04:35 | 49.5 | 82.1 | 69.9 | 38.7 | 62.9 | 46.8 | 41.3 | 40.1 | 39.5 |
| 18/11/2005 05:05 | 44.9 | 77.5 | 62.8 | 37.6 | 57.7 | 44.2 | 40.4 | 38.9 | 38.3 |
| 18/11/2005 05:35 | 51.7 | 84.3 | 72.7 | 37.2 | 66.2 | 47.9 | 41.0 | 39.0 | 38.2 |
| 18/11/2005 06:05 | 51.4 | 84.0 | 71.0 | 38.0 | 65.2 | 50.1 | 42.7 | 39.5 | 38.8 |
| 18/11/2005 06:35 | 58.1 | 90.7 | 77.8 | 38.7 | 71.4 | 59.0 | 44.1 | 40.7 | 39.7 |
| 18/11/2005 07:05 | 57.1 | 89.7 | 74.5 | 39.2 | 68.4 | 61.2 | 47.9 | 42.0 | 40.3 |
| 18/11/2005 07:35 | 61.8 | 94.4 | 75.6 | 42.6 | 71.4 | 65.8 | 58.0 | 49.6 | 45.2 |
| 18/11/2005 08:05 | 60.8 | 93.4 | 76.8 | 41.9 | 70.1 | 64.4 | 57.7 | 49.3 | 45.2 |
| 18/11/2005 08:35 | 68.0 | 100.6 | 84.6 | 53.0 | 75.4 | 71.9 | 63.7 | 55.8 | 54.0 |
| 18/11/2005 09:05 | 68.2 | 100.8 | 92.2 | 46.2 | 80.6 | 68.3 | 60.4 | 55.5 | 48.3 |
| 18/11/2005 09:35 | 61.9 | 94.5 | 80.0 | 48.7 | 71.5 | 64.6 | 59.4 | 53.8 | 50.2 |
| 18/11/2005 10:05 | 59.2 | 91.8 | 77.2 | 48.4 | 68.4 | 62.4 | 56.2 | 50.5 | 49.3 |

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 18/11/2005 10:35 | 63.7 | 96.3 | 89.4 | 50.5 | 71.4 | 66.9 | 60.5 | 54.0 | 52.1 |
| 18/11/2005 11:05 | 66.6 | 99.2 | 85.0 | 47.1 | 75.4 | 71.7 | 61.0 | 52.1 | 49.1 |
| 18/11/2005 11:35 | 61.2 | 93.8 | 76.8 | 41.6 | 72.1 | 64.4 | 56.1 | 47.9 | 44.0 |
| 18/11/2005 12:05 | 67.6 | 100.2 | 89.3 | 43.0 | 81.8 | 65.8 | 56.9 | 48.4 | 45.2 |
| 18/11/2005 12:35 | 61.7 | 94.3 | 81.6 | 41.8 | 73.1 | 64.3 | 55.5 | 46.5 | 44.1 |
| 18/11/2005 13:05 | 59.7 | 92.3 | 81.5 | 41.0 | 69.8 | 63.0 | 54.8 | 45.8 | 42.6 |
| 18/11/2005 13:35 | 58.9 | 91.5 | 73.6 | 42.7 | 68.1 | 62.9 | 55.1 | 46.0 | 43.9 |
| 18/11/2005 14:05 | 60.3 | 92.9 | 76.8 | 43.0 | 69.5 | 63.9 | 56.6 | 47.7 | 44.5 |
| 18/11/2005 14:35 | 59.7 | 92.3 | 77.4 | 41.1 | 70.2 | 62.7 | 56.0 | 46.6 | 43.5 |
| 18/11/2005 15:05 | 60.0 | 92.6 | 75.4 | 41.6 | 70.2 | 63.2 | 56.4 | 47.7 | 43.8 |
| 18/11/2005 15:35 | 58.8 | 91.4 | 76.2 | 39.9 | 69.4 | 62.1 | 54.9 | 45.0 | 41.9 |
| 18/11/2005 16:05 | 60.6 | 93.2 | 80.7 | 40.4 | 71.5 | 63.5 | 55.3 | 45.9 | 42.0 |
| 18/11/2005 16:35 | 59.0 | 91.6 | 79.6 | 39.7 | 68.8 | 62.0 | 53.4 | 44.1 | 41.0 |
| 18/11/2005 17:05 | 60.2 | 92.8 | 80.7 | 39.7 | 71.8 | 62.4 | 55.2 | 45.6 | 41.8 |
| 18/11/2005 17:35 | 60.9 | 93.5 | 81.0 | 41.1 | 71.8 | 63.4 | 56.3 | 47.2 | 43.1 |
| 18/11/2005 18:05 | 59.4 | 92.0 | 74.3 | 39.8 | 68.3 | 63.2 | 56.3 | 46.5 | 41.3 |
| 18/11/2005 18:35 | 60.0 | 92.6 | 83.0 | 39.2 | 69.8 | 62.5 | 55.2 | 44.5 | 41.0 |
| 18/11/2005 19:05 | 59.3 | 91.9 | 81.0 | 39.9 | 70.3 | 62.1 | 53.1 | 43.8 | 41.5 |
| 18/11/2005 19:35 | 57.3 | 89.9 | 77.6 | 37.6 | 66.8 | 60.8 | 53.1 | 41.2 | 39.1 |
| 18/11/2005 20:05 | 58.8 | 91.4 | 81.0 | 37.7 | 68.7 | 61.7 | 52.1 | 40.8 | 38.9 |
| 18/11/2005 20:35 | 59.1 | 91.7 | 83.7 | 37.2 | 69.3 | 61.1 | 50.3 | 42.7 | 38.5 |
| 18/11/2005 21:05 | 55.4 | 88.0 | 75.2 | 37.0 | 64.8 | 59.5 | 49.5 | 41.3 | 38.5 |
| 18/11/2005 21:35 | 56.2 | 88.8 | 73.8 | 37.3 | 66.8 | 60.1 | 49.8 | 42.5 | 38.8 |
| 18/11/2005 22:05 | 56.5 | 89.1 | 77.7 | 37.8 | 68.4 | 59.6 | 45.2 | 39.3 | 38.5 |
| 18/11/2005 22:35 | 58.4 | 91.0 | 81.1 | 37.6 | 69.9 | 60.2 | 49.3 | 40.8 | 39.0 |
| 18/11/2005 23:05 | 58.7 | 91.3 | 85.6 | 37.6 | 69.5 | 60.7 | 50.2 | 42.0 | 39.1 |
| 18/11/2005 23:35 | 57.3 | 89.9 | 75.8 | 38.4 | 69.0 | 60.5 | 51.5 | 46.1 | 40.8 |
| 19/11/2005 00:05 | 57.9 | 90.5 | 79.9 | 38.0 | 67.9 | 59.7 | 50.5 | 44.7 | 40.5 |
| 19/11/2005 00:35 | 56.2 | 88.8 | 76.5 | 40.2 | 64.9 | 59.6 | 52.7 | 46.7 | 43.0 |
| 19/11/2005 01:05 | 55.2 | 87.8 | 77.6 | 39.7 | 64.4 | 58.8 | 50.3 | 45.2 | 41.2 |
| 19/11/2005 01:35 | 56.9 | 89.5 | 77.8 | 41.1 | 68.0 | 59.4 | 52.6 | 47.4 | 43.8 |
| 19/11/2005 02:05 | 54.0 | 86.6 | 71.7 | 39.2 | 62.9 | 57.7 | 50.4 | 46.3 | 43.1 |
| 19/11/2005 02:35 | 56.8 | 89.4 | 77.5 | 39.2 | 67.7 | 58.2 | 51.9 | 47.7 | 42.1 |
| 19/11/2005 03:05 | 52.6 | 85.2 | 74.5 | 38.0 | 62.9 | 56.1 | 46.2 | 42.2 | 39.3 |
| 19/11/2005 03:35 | 56.4 | 89.0 | 82.7 | 37.7 | 67.3 | 58.7 | 45.9 | 41.5 | 39.5 |
| 19/11/2005 04:05 | 54.3 | 86.9 | 77.1 | 37.0 | 65.2 | 56.7 | 47.2 | 42.5 | 39.2 |
| 19/11/2005 04:35 | 57.2 | 89.8 | 82.1 | 36.0 | 69.4 | 57.7 | 45.2 | 37.4 | 36.7 |
| 19/11/2005 05:05 | 51.7 | 84.3 | 76.7 | 35.6 | 62.2 | 50.9 | 41.4 | 37.4 | 36.5 |
| 19/11/2005 05:35 | 51.7 | 84.3 | 73.7 | 36.1 | 64.9 | 52.4 | 41.4 | 37.6 | 36.9 |
| 19/11/2005 06:05 | 52.9 | 85.5 | 71.7 | 36.1 | 65.8 | 55.6 | 42.3 | 38.1 | 37.3 |
| 19/11/2005 06:35 | 56.3 | 88.9 | 74.0 | 36.9 | 69.7 | 57.7 | 43.1 | 38.7 | 37.8 |
| 19/11/2005 07:05 | 55.4 | 88.0 | 80.6 | 37.4 | 67.8 | 57.7 | 45.9 | 40.3 | 38.8 |
| 19/11/2005 07:35 | 57.6 | 90.2 | 83.3 | 39.2 | 69.2 | 60.1 | 48.2 | 43.6 | 41.2 |
| 19/11/2005 08:05 | 55.4 | 88.0 | 72.6 | 39.8 | 66.3 | 59.4 | 47.9 | 43.5 | 41.6 |
| 19/11/2005 08:35 | 56.5 | 89.1 | 77.3 | 40.4 | 68.5 | 59.7 | 49.4 | 44.8 | 42.6 |
| 19/11/2005 09:05 | 57.8 | 90.4 | 77.6 | 40.8 | 68.4 | 61.3 | 52.5 | 45.1 | 42.4 |
| 19/11/2005 09:35 | 57.8 | 90.4 | 76.2 | 39.6 | 68.1 | 61.5 | 52.4 | 44.2 | 41.3 |

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 19/11/2005 10:05 | 56.6 | 89.2 | 84.2 | 41.1 | 65.6 | 60.6 | 50.0 | 44.4 | 42.6 |
| 19/11/2005 10:35 | 59.5 | 92.1 | 84.9 | 40.1 | 68.4 | 62.1 | 52.1 | 45.0 | 42.8 |
| 19/11/2005 11:05 | 57.5 | 90.1 | 74.4 | 39.7 | 67.6 | 61.4 | 51.4 | 44.0 | 41.6 |
| 19/11/2005 11:35 | 59.5 | 92.1 | 77.8 | 39.3 | 71.3 | 62.1 | 53.2 | 44.0 | 41.2 |
| 19/11/2005 12:05 | 62.3 | 94.9 | 81.7 | 38.9 | 74.8 | 64.5 | 53.2 | 44.0 | 40.9 |
| 19/11/2005 12:35 | 61.6 | 94.2 | 84.7 | 39.6 | 73.9 | 62.8 | 51.2 | 43.5 | 40.8 |
| 19/11/2005 13:05 | 59.6 | 92.2 | 78.4 | 38.0 | 71.9 | 62.4 | 53.1 | 43.9 | 39.0 |
| 19/11/2005 13:35 | 56.9 | 89.5 | 74.3 | 39.5 | 66.9 | 60.6 | 52.0 | 45.0 | 40.8 |
| 19/11/2005 14:05 | 57.7 | 90.3 | 73.7 | 40.2 | 68.0 | 61.3 | 53.0 | 44.8 | 41.8 |
| 19/11/2005 14:35 | 57.4 | 90.0 | 76.4 | 40.0 | 67.3 | 61.1 | 52.2 | 43.6 | 41.3 |
| 19/11/2005 15:05 | 59.0 | 91.6 | 79.7 | 40.5 | 68.9 | 62.2 | 55.0 | 47.2 | 42.4 |
| 19/11/2005 15:35 | 58.3 | 90.9 | 77.1 | 41.4 | 67.5 | 61.8 | 55.1 | 45.9 | 43.1 |
| 19/11/2005 16:05 | 58.7 | 91.3 | 78.8 | 41.5 | 67.5 | 62.1 | 55.6 | 46.9 | 43.7 |
| 19/11/2005 16:35 | 59.7 | 92.3 | 80.7 | 40.5 | 69.7 | 62.3 | 55.4 | 46.2 | 42.5 |
| 19/11/2005 17:05 | 59.7 | 92.3 | 76.2 | 40.2 | 69.4 | 63.3 | 56.1 | 47.2 | 42.5 |
| 19/11/2005 17:35 | 59.3 | 91.9 | 82.1 | 42.4 | 68.6 | 62.1 | 55.0 | 47.8 | 44.9 |
| 19/11/2005 18:05 | 64.4 | 97.0 | 88.9 | 40.2 | 74.1 | 61.5 | 53.7 | 45.0 | 42.0 |
| 19/11/2005 18:35 | 60.2 | 92.8 | 82.5 | 39.5 | 72.2 | 62.7 | 54.4 | 46.1 | 41.5 |
| 19/11/2005 19:05 | 59.8 | 92.4 | 79.7 | 39.0 | 71.1 | 61.9 | 54.4 | 45.9 | 42.2 |
| 19/11/2005 19:35 | 58.4 | 91.0 | 78.8 | 41.3 | 69.1 | 61.8 | 53.0 | 45.9 | 43.0 |
| 19/11/2005 20:05 | 59.6 | 92.2 | 89.6 | 39.4 | 69.4 | 61.5 | 51.2 | 44.5 | 40.4 |
| 19/11/2005 20:35 | 59.1 | 91.7 | 82.7 | 38.4 | 69.8 | 61.4 | 51.8 | 43.9 | 40.1 |
| 19/11/2005 21:05 | 53.9 | 86.5 | 72.6 | 38.7 | 64.7 | 58.0 | 45.9 | 41.5 | 40.0 |
| 19/11/2005 21:35 | 54.0 | 86.6 | 74.9 | 37.9 | 64.9 | 57.8 | 46.9 | 41.7 | 39.1 |
| 19/11/2005 22:05 | 56.6 | 89.2 | 75.6 | 37.9 | 68.0 | 60.2 | 47.6 | 41.6 | 39.0 |
| 19/11/2005 22:35 | 61.0 | 93.6 | 91.3 | 38.3 | 66.4 | 59.3 | 48.6 | 43.0 | 40.0 |
| 19/11/2005 23:05 | 57.3 | 89.9 | 78.2 | 38.5 | 69.5 | 60.2 | 50.3 | 42.6 | 39.9 |
| 19/11/2005 23:35 | 57.6 | 90.2 | 84.5 | 38.7 | 66.6 | 58.9 | 49.2 | 42.6 | 39.7 |
| 20/11/2005 00:05 | 54.6 | 87.2 | 73.1 | 38.7 | 64.5 | 58.7 | 48.5 | 42.0 | 39.7 |
| 20/11/2005 00:35 | 55.1 | 87.7 | 76.5 | 39.7 | 64.4 | 58.0 | 49.5 | 43.6 | 41.0 |
| 20/11/2005 01:05 | 55.5 | 88.1 | 77.3 | 38.9 | 66.9 | 58.1 | 48.9 | 42.8 | 40.6 |
| 20/11/2005 01:35 | 53.6 | 86.2 | 74.3 | 38.9 | 64.0 | 57.1 | 47.4 | 42.4 | 40.0 |
| 20/11/2005 02:05 | 58.0 | 90.6 | 84.1 | 39.6 | 67.9 | 59.2 | 50.0 | 43.6 | 40.8 |
| 20/11/2005 02:35 | 56.5 | 89.1 | 84.4 | 40.2 | 65.1 | 58.0 | 49.1 | 44.0 | 41.4 |
| 20/11/2005 03:05 | 53.6 | 86.2 | 78.5 | 41.4 | 63.2 | 56.6 | 47.7 | 44.2 | 42.3 |
| 20/11/2005 03:35 | 56.5 | 89.1 | 85.5 | 41.0 | 64.6 | 56.6 | 47.9 | 43.7 | 42.2 |
| 20/11/2005 04:05 | 55.6 | 88.2 | 74.6 | 42.6 | 65.2 | 59.1 | 51.3 | 46.0 | 44.0 |
| 20/11/2005 04:35 | 59.2 | 91.8 | 84.5 | 43.3 | 70.1 | 59.9 | 52.8 | 47.6 | 44.8 |
| 20/11/2005 05:05 | 54.3 | 86.9 | 72.3 | 42.9 | 63.9 | 57.5 | 50.3 | 46.3 | 44.4 |
| 20/11/2005 05:35 | 53.2 | 85.8 | 72.4 | 40.9 | 62.2 | 56.6 | 49.8 | 45.2 | 43.0 |
| 20/11/2005 06:05 | 53.5 | 86.1 | 69.0 | 42.2 | 63.1 | 57.5 | 49.4 | 44.8 | 43.1 |
| 20/11/2005 06:35 | 52.7 | 85.3 | 67.2 | 42.2 | 60.8 | 56.0 | 50.7 | 46.0 | 43.5 |
| 20/11/2005 07:05 | 56.2 | 88.8 | 69.4 | 43.6 | 64.9 | 60.1 | 53.0 | 47.7 | 45.0 |
| 20/11/2005 07:35 | 56.5 | 89.1 | 75.5 | 42.9 | 66.8 | 60.0 | 52.4 | 47.1 | 44.7 |
| 20/11/2005 08:05 | 54.9 | 87.5 | 78.4 | 42.4 | 65.2 | 58.2 | 49.2 | 45.2 | 43.6 |
| 20/11/2005 08:35 | 55.0 | 87.6 | 69.6 | 42.7 | 64.9 | 59.1 | 50.6 | 45.3 | 43.8 |
| 20/11/2005 09:05 | 55.6 | 88.2 | 73.7 | 41.8 | 65.1 | 59.5 | 51.0 | 45.4 | 43.1 |

| *Start Time* | *LAeq (dB)* | *LAE (dB)* | *LAmax (dB)* | *LAmin (dB)* | *LA01 (dB)* | *LA10 (dB)* | *LA50 (dB)* | *LA90 (dB)* | *LA99 (dB)* |
|---|---|---|---|---|---|---|---|---|---|
| 20/11/2005 09:35 | 56.1 | 88.7 | 70.3 | 42.5 | 65.5 | 60.3 | 51.5 | 45.9 | 43.7 |
| 20/11/2005 10:05 | 56.8 | 89.4 | 73.5 | 43.3 | 65.2 | 61.0 | 53.3 | 46.8 | 44.8 |
| 20/11/2005 10:35 | 57.2 | 89.8 | 68.6 | 44.1 | 65.0 | 61.4 | 54.1 | 47.3 | 45.4 |
| 20/11/2005 11:05 | 56.9 | 89.5 | 80.8 | 41.4 | 65.5 | 60.0 | 52.3 | 45.8 | 42.9 |
| 20/11/2005 11:35 | 57.7 | 90.3 | 73.0 | 42.5 | 65.9 | 61.6 | 54.8 | 47.4 | 44.1 |
| 20/11/2005 12:05 | 61.6 | 94.2 | 90.1 | 41.2 | 68.2 | 62.4 | 55.6 | 47.0 | 43.7 |
| 20/11/2005 12:35 | 57.1 | 89.7 | 77.6 | 41.4 | 64.7 | 60.9 | 54.0 | 46.7 | 42.8 |
| 20/11/2005 13:05 | 58.5 | 91.1 | 78.3 | 42.1 | 67.8 | 61.6 | 55.6 | 48.0 | 45.2 |
| 20/11/2005 13:35 | 60.7 | 93.3 | 86.7 | 42.7 | 68.1 | 61.6 | 54.1 | 45.9 | 44.1 |
| 20/11/2005 14:05 | 57.3 | 89.9 | 77.3 | 40.5 | 66.3 | 60.8 | 53.1 | 45.9 | 42.9 |
| 20/11/2005 14:35 | 58.8 | 91.4 | 76.3 | 42.9 | 69.5 | 61.8 | 54.8 | 47.1 | 44.7 |
| 20/11/2005 15:05 | 60.8 | 93.4 | 84.7 | 42.3 | 70.6 | 62.5 | 55.7 | 47.5 | 43.7 |
| 20/11/2005 15:35 | 62.1 | 94.7 | 86.6 | 41.9 | 70.0 | 62.4 | 55.5 | 47.3 | 44.1 |
| 20/11/2005 16:05 | 61.4 | 94.0 | 87.6 | 42.4 | 68.7 | 62.1 | 55.6 | 47.4 | 44.3 |
| 20/11/2005 16:35 | 60.1 | 92.7 | 82.7 | 44.5 | 67.7 | 62.8 | 57.1 | 49.5 | 46.0 |
| 20/11/2005 17:05 | 59.9 | 92.5 | 78.5 | 43.6 | 68.2 | 63.2 | 57.4 | 50.5 | 46.4 |
| 20/11/2005 17:35 | 60.4 | 93.0 | 81.6 | 44.3 | 69.7 | 63.3 | 57.2 | 50.0 | 46.7 |
| 20/11/2005 18:05 | 60.0 | 92.6 | 78.8 | 43.5 | 70.0 | 62.5 | 56.5 | 48.1 | 45.4 |
| 20/11/2005 18:35 | 60.1 | 92.7 | 81.6 | 43.7 | 68.6 | 62.9 | 57.3 | 49.9 | 45.6 |
| 20/11/2005 19:05 | 61.2 | 93.8 | 85.5 | 43.0 | 71.5 | 62.4 | 56.8 | 49.4 | 44.8 |
| 20/11/2005 19:35 | 57.9 | 90.5 | 75.7 | 43.2 | 66.8 | 61.2 | 54.8 | 47.0 | 44.7 |
| 20/11/2005 20:05 | 56.2 | 88.8 | 73.7 | 44.0 | 65.8 | 59.9 | 51.7 | 46.3 | 44.9 |
| 20/11/2005 20:35 | 58.1 | 90.7 | 83.1 | 44.6 | 66.5 | 60.8 | 52.1 | 46.8 | 45.6 |
| 20/11/2005 21:05 | 56.7 | 89.3 | 77.5 | 44.7 | 67.0 | 59.4 | 50.4 | 46.8 | 45.5 |
| 20/11/2005 21:35 | 57.4 | 90.0 | 78.4 | 45.6 | 69.1 | 59.6 | 50.5 | 47.5 | 46.5 |
| 20/11/2005 22:05 | 54.7 | 87.3 | 72.6 | 44.4 | 64.0 | 59.0 | 49.7 | 46.9 | 45.6 |
| 20/11/2005 22:35 | 56.5 | 89.1 | 75.9 | 44.1 | 68.6 | 58.8 | 50.2 | 47.3 | 45.9 |
| 20/11/2005 23:05 | 54.6 | 87.2 | 69.8 | 44.6 | 63.9 | 58.4 | 50.2 | 47.0 | 45.9 |
| 20/11/2005 23:35 | 57.7 | 90.3 | 78.3 | 44.8 | 66.2 | 61.2 | 53.1 | 47.3 | 45.6 |
| 21/11/2005 00:05 | 59.1 | 91.7 | 76.5 | 43.9 | 67.6 | 62.6 | 56.0 | 49.1 | 45.3 |
| 21/11/2005 00:35 | 57.3 | 89.9 | 77.0 | 43.6 | 65.8 | 60.7 | 54.0 | 47.6 | 44.9 |
| 21/11/2005 01:05 | 54.3 | 86.9 | 73.9 | 41.9 | 63.5 | 57.7 | 51.3 | 45.6 | 43.7 |
| 21/11/2005 01:35 | 52.0 | 84.6 | 65.3 | 39.8 | 60.5 | 55.7 | 49.1 | 44.1 | 41.6 |
| 21/11/2005 02:05 | 53.9 | 86.5 | 72.1 | 41.6 | 62.8 | 57.0 | 50.9 | 44.6 | 42.5 |
| 21/11/2005 02:35 | 52.5 | 85.1 | 70.3 | 40.8 | 62.0 | 56.0 | 48.7 | 44.8 | 42.6 |
| 21/11/2005 03:05 | 50.3 | 82.9 | 71.6 | 40.9 | 59.4 | 52.8 | 47.0 | 43.5 | 42.0 |
| 21/11/2005 03:35 | 50.4 | 83.0 | 63.5 | 40.8 | 59.3 | 53.6 | 47.5 | 43.7 | 42.1 |
| 21/11/2005 04:05 | 50.4 | 83.0 | 64.1 | 40.6 | 59.5 | 54.1 | 47.0 | 43.4 | 42.0 |
| 21/11/2005 04:35 | 52.4 | 85.0 | 74.5 | 40.2 | 59.8 | 53.5 | 47.0 | 43.4 | 41.8 |
| 21/11/2005 05:05 | 54.8 | 87.4 | 82.6 | 39.5 | 61.2 | 51.7 | 45.7 | 42.6 | 41.1 |
| 21/11/2005 05:35 | 55.6 | 88.2 | 73.4 | 39.5 | 69.1 | 56.4 | 47.4 | 43.2 | 41.2 |
| 21/11/2005 06:05 | 55.4 | 88.0 | 74.8 | 39.7 | 68.3 | 56.6 | 48.8 | 43.8 | 41.6 |
| 21/11/2005 06:35 | 55.7 | 88.3 | 74.0 | 39.4 | 68.1 | 58.5 | 47.5 | 43.0 | 40.7 |
| 21/11/2005 07:05 | 58.1 | 90.7 | 75.0 | 40.8 | 69.1 | 61.8 | 51.6 | 44.4 | 42.0 |
| 21/11/2005 07:35 | 61.6 | 94.2 | 77.5 | 43.8 | 71.5 | 64.3 | 58.7 | 51.6 | 47.4 |
| 21/11/2005 08:05 | 61.8 | 94.4 | 78.3 | 44.6 | 71.9 | 65.2 | 58.2 | 50.9 | 47.5 |
| 21/11/2005 08:35 | 64.7 | 97.3 | 77.1 | 50.1 | 73.4 | 69.7 | 61.1 | 56.0 | 52.0 |

| Start Time | LAeq (dB) | LAE (dB) | LAmax (dB) | LAmin (dB) | LA01 (dB) | LA10 (dB) | LA50 (dB) | LA90 (dB) | LA99 (dB) |
|---|---|---|---|---|---|---|---|---|---|
| 21/11/2005 09:05 | 63.6 | 96.2 | 77.6 | 54.2 | 70.9 | 66.0 | 62.3 | 59.1 | 57.1 |
| 21/11/2005 09:35 | 62.2 | 94.8 | 77.9 | 51.0 | 72.5 | 64.6 | 59.5 | 53.8 | 51.9 |
| 21/11/2005 10:05 | 60.5 | 93.1 | 83.0 | 48.5 | 69.5 | 63.1 | 56.9 | 51.8 | 50.2 |
| 21/11/2005 10:35 | 62.5 | 95.1 | 80.9 | 49.1 | 74.7 | 64.6 | 57.9 | 52.1 | 50.5 |
| 21/11/2005 11:05 | 72.9 | 105.5 | 86.0 | 57.7 | 81.2 | 76.4 | 71.6 | 60.7 | 59.0 |
| 21/11/2005 11:35 | 64.7 | 97.3 | 86.3 | 51.6 | 73.7 | 66.5 | 63.0 | 57.6 | 52.8 |
| 21/11/2005 12:05 | 62.9 | 95.5 | 77.7 | 50.8 | 72.6 | 65.9 | 60.4 | 53.8 | 52.1 |
| 21/11/2005 12:35 | 67.2 | 99.8 | 81.7 | 44.7 | 75.3 | 71.8 | 61.4 | 54.9 | 46.4 |
| 21/11/2005 13:05 | 61.1 | 93.7 | 81.1 | 42.2 | 73.1 | 63.3 | 55.7 | 46.9 | 44.0 |
| 21/11/2005 13:35 | 59.5 | 92.1 | 76.5 | 41.4 | 69.7 | 63.0 | 55.3 | 47.2 | 43.7 |
| 21/11/2005 14:05 | 59.8 | 92.4 | 76.2 | 40.7 | 70.0 | 63.3 | 55.6 | 46.4 | 42.3 |
| 21/11/2005 14:35 | 60.3 | 92.9 | 78.2 | 39.9 | 70.4 | 63.6 | 56.4 | 50.5 | 42.2 |
| 21/11/2005 15:05 | 69.1 | 101.7 | 83.8 | 51.6 | 74.6 | 72.7 | 67.8 | 57.2 | 53.3 |
| 21/11/2005 15:35 | 73.1 | 105.7 | 90.8 | 55.8 | 80.6 | 76.8 | 71.1 | 60.9 | 57.4 |
| 21/11/2005 16:05 | 71.9 | 102.7 | 84.0 | 55.0 | 78.9 | 75.7 | 70.0 | 58.3 | 56.4 |

# CHAPTER EIGHT

# SOCIO ECONOMIC

# CONTENTS

# GLOSSARY AND ABBREVIATIONS

| | |
|---|---|
| CEMP | Construction Environmental Management Plan |
| DMRB | Design Manual for Roads and Bridges (UK) |
| EIA | Environmental Impact Assessment |
| ES | Environmental Statement |
| FTE | Full Time Equivalent |
| GDP | Gross Domestic Product |
| MoD | Ministry of Defence |
| $PM_{10}$ | Fine particulate matter with an aerodynamic diameter of less that 10 micrometers |
| $PM_{2.5}$ | Fine particulate matter with an aerodynamic diameter of less that 2.5 micrometers |
| UKOT | United Kingdom Overseas Territory |

# 1 INTRODUCTION

1.1 This chapter summarises an assessment of various positive and negative effects on people. It considers the issues that are likely to be most important in bringing about economic and social change to the area surrounding the proposed new power station.

# 2 SCOPE AND METHODOLOGY

## Scope

2.1 A scoping assessment of the proposed new diesel power station at Lathbury Barracks upon socio economic issues has been undertaken, which found that there was the potential for significant socio economic effects on people and has therefore been included in the full Environmental Impact Assessment (EIA). The scoping exercise identified the following:

- The combined potential effects of primary impacts (Air Quality, Noise, and Visual Amenity) upon residential and community facilities and general amenity;
- Tourism makes up a large percentage of the Gibraltar economy and it is important to assess whether the construction and operation of the proposed new power station will have any impact upon tourism;
- The proposed new power station will create new jobs during construction, which will be assessed in this study. However once operational, there will be no significant change to the present employment situation and therefore operational employment impacts have been scoped out of this study;
- The proposed new power station will not influence Gibraltar's demographic (eg the proposed new power station will not lead to any in-migration, and will therefore not increase demand for housing or services such as hospitals or schools). As a result, impacts on housing and services have been scoped out of this study; and
- There will be no permanent or temporary displacement of residents from their homes or land take from residential properties, therefore associated effects have been scoped out of this study.

## Relevant Guidance

2.2 Reference has been made in this assessment to the Institute of Environmental Management and Assessment Guidelines[1].

### *Gibraltar Development Plan (Consultation Draft) 2007*

2.3 Gibraltar's planning regime addresses employment, tourism and other socio economic issues in the Gibraltar Development Plan (Consultation Draft) 2007[2]. This consultation draft significantly updates the 1991 Gibraltar Development Plan[3], and although not yet formally adopted, the document provides a good indication of future planning policies.

2.4 The prime economic objective in the consultation draft Gibraltar Development Plan 2007 is to attain self-sufficiency by making best use of land, labour and capital resources. There are four specific policies relating to economic development and tourism which are relevant to this study:

- **Policy E1 Economic Development**

  Development proposals that will maintain, strengthen and diversify Gibraltar's economic base shall be encouraged.

- **Policy T2 Protection of Tourist Attractions**

  Permission will not normally be granted for development proposals that will have a serious detrimental affect on recognised tourist attractions.

- **Policy Z7.6 Retrenchment Block**

  The Retrenchment Block as defined on the proposals map is allocated for recreational use and leisure.

- **Policy Z7.9 Parade Ground**

  A site is allocated for industrial use as shown on the proposals map. The design of any development on this site must take into account its setting with particular regard to nearby historical structures and its proximity to the Upper Rock Nature Reserve.

## Assessment Methodology

2.5 The consideration of socio economic effects has used the following methodology:

- Site visits;
- Review of published information;
- Review of other technical chapters in this Environmental Statement (ES) relating to this study (namely Air Quality, Noise and Vibration and Visual Amenity and Landscape Character).
- Collation of baseline information;
- Consideration of potential impacts and significant effects;
- Identification of appropriate mitigation; and
- Assessment of key community, employment and tourism issues and their likely significance for the development of the site.

### *Construction Employment*

2.6 Studies on similar developments in the UK, such as the English Partnerships Best Practice research[4], advise that one construction job year is created per £52,000 of capital investment in a scheme (at 2001 costs), or approximately

£55,000 at 2008 prices. Construction employee years can be converted to permanent Full Time Equivalent (FTE) jobs using the standard ratio of ten years of construction employment per one FTE job, an estimate derived from experience of construction projects in the UK.

*Changes in Amenity*

2.7 General amenity refers to people's enjoyment of their surroundings, and can be affected by air quality, noise nuisance, road traffic and visual impacts.

2.8 Although these issues are addressed in detail elsewhere in this Environmental Statement (ES) (Volume 2: Technical Reports), the overall effects on general amenity are relevant to the local community and have been assessed in this chapter using the criteria outlined below in paragraph 2.13. This is generally a qualitative assessment and follows guidelines set out in the IEMA Guidelines[1].

*Tourism*

2.9 Data on tourism was collated using a number of sources including the Government of Gibraltar Information Services website[5] and information from the Gibraltar Statistics Office[6].

2.10 Effects on tourism were assessed using the qualitative assessment criteria outlined in paragraph 2.13 below.

### Assessment of Significance

2.11 The potential socio economic impacts of the proposed new power station and its effects have been assessed by identifying all potentially significant direct, indirect, cumulative, positive and negative effects, during both the construction and the operation phases.

2.12 There are no technical significance criteria relating to socio economic assessment other than those that relate to specific impacts on human population (eg air quality, noise, and visual amenity). The significance of socio economic effects is therefore considered in the context of their overall effect on the immediate surroundings and the wider neighbourhood. Significance has been determined through a combination of the probable magnitude, reversibility, mitigatability, directionality and likelihood. The following categories are used to describe the overall significance of the effect:

- **Negligible**: Effect is insubstantial and does not require the management of negative effects;
- **Low**: Effect is of little importance, but may require the management of negative effects;
- **Medium**: Effect is important, management will be required to reduce negative effects to acceptable levels; and
- **High**: Effect is of great importance, negative effects could render development options or project unacceptable if they cannot be reduced to acceptable levels, management of the effect will be essential.

### Approach to Mitigation

2.13 Opportunities to reduce and remedy or compensate for adverse significant socio economic effects for construction and operation have been identified where practicable and appropriate.

### Limitations of Study

2.14 This study has relied principally upon secondary rather than primary data. Its findings are therefore dependent to some extent on the quality, validity, reliability and scope of work undertaken by others. Where possible, however, the methodology underpinning secondary data was reviewed and found to be satisfactory.

# 3 EXISTING CONDITIONS

## Overview

3.1 Gibraltar is a UK Overseas Territory (UKOT) with a population of 27,967 (July 2007 estimate[7]) and a land area of 6.5 $km^2$. Gibraltar shares a 1.2 km land frontier with Spain.

3.2 Economically, Gibraltar is a strong and self-sufficient country, benefiting from an extensive shipping trade, offshore banking, and tourism, each of which contribute to 25%-30% of Gross Domestic Product (GDP)[6]. In 2005, Gibraltar had a GDP per capita of £20,831[8].

3.3 Gibraltar is one of the most densely populated territories in the world, with approximately 11,187 people per square mile (4,303/$km^2$). The growing demand for space is being increasingly met by land reclamation, which covers approximately one tenth of Gibraltar's land area.

3.4 The three existing power stations in Gibraltar are due to be decommissioned (as explained in Volume 1: Main Report) and without further power generation facilities in Gibraltar, in the absence of the proposed new power station, there would be no power supply in Gibraltar, having an adverse impact on the economy and well-being of the Gibraltarian population.

3.5 The three existing power stations are intended to be decommissioned as their engines have, or are rapidly reaching, the end of their operational lives and due to environmental concerns arising from the operation of the generators, which are old and are in close proximity to populated areas. Delays to the planned retirement of these older and less efficient plant could not be sustained for long and would result in greater emissions to the environment due to their inherent inefficiency.

3.6 Importation of power from neighbouring countries is not possible as Gibraltar's geographic and political setting means that it has to be self-reliant in providing its own energy. Any source of energy needs to be reliable and sustained. There is no 'grid' or network system to provide a consistent back-up power supply.

3.7 In addition to the need to close down the existing power stations due to their age and condition, there are also several proposed large scale developments in Gibraltar from which energy demand is calculated to outstrip current supply. Based on known planned developments, the electrical load in Gibraltar is calculated to rise to 45 MW by 2010 and 72 MW by 2032.

### The Existing Site

3.8 The proposed new power station site is at Lathbury Barracks parade ground in Gibraltar. Since being returned to the Government of Gibraltar by the Ministry of Defence (MoD), the parade ground has been used as a storage area for a vehicle company. The site is also used for unofficial recreational purposes as an open area by the general public eg for dog walking and skateboarding.

3.9 Land uses around the site are a mix of light mixed industrial, MoD and residential. The site is adjacent to the Buffadero Battery MoD Training Ground to the south and west (and associated buildings) and light mixed industrial use at Lathbury Industrial Park to the north. The Retrenchment Block (approximately 90 m north of the site perimeter) is currently being refurbished and redeveloped. Under Policy Z7.6 of the Gibraltar Development Plan 2007, the Retrenchment Block will be used for recreational and leisure purposes. There are residential properties to the north and northwest on Windmill Hill Road. To the immediate east of the site is a cliff, where the land height immediately drops by approximately 60 m to the industrial area at Europa Advance Road, which contains the crematorium and clinical waste incinerator and a temporary refuse storage area.

3.10 Particular community receptors of note around the site of the proposed power station include:

*Residential*

- Properties on Windmill Hill Road;
- Clifftop House residential apartments (under construction);
- HM Prison (under construction);
- Retirement home (under construction);
- Royal Naval Hospital; and
- Properties in the Bleak House and Rosia Bay areas.

*Recreation and Tourism*

- Users of the Mediterranean Steps Path;
- Retreat Centre;
- Nuffield Pool;
- Community Catholic Centre;
- Public terraces;
- Users of the Retrenchment Block once it has been redeveloped; and
- The parade ground.

*Schools*

- St. Joseph's School; and
- St. Christopher's School.

### Employment

3.11 The 2001 Census indicates that there have been significant shifts in employment patterns over the last 20 years in Gibraltar, with decline in the construction industry, a rise in shipbuilding and repairs, decline in public administration and defence and increases in education. Gibraltar's economy is now firmly based upon the financial sector, retail, tourism and shipping.

3.12 In October 2006 there were 18,485 employee jobs in Gibraltar, with the highest numbers in wholesale and retail trade (2,747), public administration and defence (2,214), construction (2,124) and real estate and business activities (2,059)[8].

3.13 Gibraltarian nationals make up 10,346 of the total employee jobs, with the remaining 8,139 employees made up of mostly British, Spanish and Moroccan nationalities[9]. There are 4,963 frontier workers who are normally resident in Spain but who work in Gibraltar and these people will cross the frontier daily to get to and from work[9].

### Tourism

3.14 Tourism is central to Gibraltar's economy and over 8 million people visited in 2006[10], most of whom were day visitors who crossed the frontier with Spain. Flights to and from London Gatwick, London Luton, Madrid and Malta (seasonal) operate from Gibraltar airport. Flights to and from Manchester are anticipated to commence in the near future. Tourists also visit Gibraltar by cruise ships docking near the North Mole and by coach from Spain.

3.15 Many daily cross border visitors come into Gibraltar to shop. These visitors contribute much to the economy. Tourism draws upon a wide range of sectors, including hotels, restaurants, wholesale, transport, communications and financial services[10].

3.16 Tourists spent over £210 million in Gibraltar in 2006[11], which translates to a high number of direct FTE jobs. In 2006, tourism supported jobs translated to 1,853 direct FTE jobs, but when indirect and induced employment opportunities is considered, this leads to 3,498 jobs supported by tourist spending[11].

3.17 The Government of Gibraltar's policy is to promote tourism, especially to markets outside the traditional market of the UK. Gibraltar offers a number of attractions, including The Rock, beaches, marinas, the Moorish Castle, Barbary Macaques, shopping, diving, the Ibrahim-al-Ibrahim Mosque, St. Michael's Cave, colonial architecture and military history including the Great Seige Tunnels and 100 ton gun.

3.18 There is limited accommodation and attractions for tourists and visitors in the immediate vicinity of the proposed new power station at Lathbury Barracks. However, tourists will be able to view the site from the Upper Rock Nature Reserve and the Mediterranean Path and Steps.

3.19 Europa Point, to the south east of the proposed power station is cited as a major tourist destination, included in most tourist itineraries and is a largely open area dominated by the Trinity Lighthouse, providing magnificent views of the North African coastline. The area has historic significance as well, with defensive walls and batteries situated along the cliff top and the site of Nun's Well nearby[2]. Policy Z7.1 of the draft Gibraltar Development Plan 2007 outlines methods of environmental improvement of the area for residential and tourism benefit and the area has been designated by the Government for an important programme of beautification.

# 4 ASSESSMENT OF SIGNIFICANT EFFECTS

## Construction

### *Employment*

4.1 The scale of construction employment will be a function of the size and type of construction expenditure, which is dependant upon the overall value of the construction project; the extent to which materials, services and equipment can be and are likely to be sourced locally or further afield and the extent to which construction labour is sourced locally or further afield.

4.2 It is assumed construction costs for the proposed new power station will be in the region of approximately £85 million (completed by 2010). Based on the English Partnerships ratio, it is estimated that approximately 1,546 gross person years of employment will be generated. Using a standard ratio of 10 person years of construction work being equivalent to one permanent job in the economy, this is equivalent to some 155 FTE jobs.

4.3 Construction employment is relatively mobile and it is not particularly meaningful to consider its impact at a local level, as it has not been established at this conceptual stage of the project where the Contractor will source employment from (eg Gibraltar, UK or Spain). If employment was sourced at an international level, the effect on Gibraltar would be **low adverse** to negligible due to pressure on local resources and the local community caused by an influx of construction workers. Although there is currently a surplus of jobs available in Gibraltar, reflected by the number of transfrontier and foreign employees in Gibraltar, if employment was sourced locally the effect would be **beneficial.**

### *Local Amenity*

4.4 During construction, communities immediately surrounding the proposed new power station would experience ‘shadow effects’ from a combination of air pollution, noise and visual changes. Construction of the proposed new power station is predicted to have a localised and **temporary medium adverse significant effect** upon local amenity.

*Tourism*

4.5 Tourists visiting the area surrounding the site will experience the combined effects of noise, air quality and visual effects by the construction works. The area immediately surrounding the site does not have any major tourist destinations or tourist accommodation, however views from the Upper Rock and Mediterranean Path and Steps and distant views from cruise ships will be affected by the construction works. It is not anticipated that tourist journey times by road will be affected by the construction works. These combined factors are likely to result in a **temporary low adverse significant effect** on Gibraltar's tourism industry.

**Operation**

*Local Amenity*

4.6 During operation, communities immediately surrounding the proposed new power station may experience 'shadow effects' from a combination of air, noise, and visual changes. It is not anticipated that there will be significant changes in traffic flow. The combination of 'shadow effects' on local amenity are considered to be of **low adverse significance**.

*Tourism*

4.7 Once operational there will be **no significant adverse effects** on Gibraltar's tourism industry.

# 5 MITIGATION AND RESIDUAL SIGNIFICANT EFFECTS

## Mitigation

### *Construction*

5.1 Construction workers will be resourced locally wherever possible, in order to reduce pressure on local resources by an influx of workers and to contribute to the Gibraltarian economy.

5.2 Mitigation specific to the shadow effects on local amenity caused by air quality, noise and vibration, traffic and visual impacts are described in detail in the relevant chapters of this ES (Volume 2: Technical Reports). A Construction Environmental Management Plan (CEMP) will be adopted and implemented to manage the construction activities for each of these potential effects.

### *Operation*

5.3 Mitigation specific to the shadow effects on local amenity caused by air quality, noise and vibration, traffic and visual impacts are outlined in detail in the relevant chapters of this ES (Volume 2: Technical Reports).

## Residual Significant Effects

5.4 There will be **no residual significant effects** on socio economics during construction or operation of the proposed power station.

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