6. Emissions and Environmental Effects

This section deals specifically with the issues of electric and magnetic fields, noise emissions, air quality, greenhouse gases, transportation, and fire risk from the proposed transmission line. The existing environmental parameters relevant to the assessment are also discussed, together with any proposed mitigation measures.

6.1 Electric and Magnetic Fields

6.1.1 Existing Environment

(1) Introduction to Electric and Magnetic Fields

A field is a concept used to describe a region where certain objects experience a force, even though not physically connected to the source of the force.

Electric fields result from the forces that electric charges exert on one another. For a given charged object, the higher the voltage, the higher the electric field. Electric fields are strongest close to their source and reduce in magnitude quickly as one moves away from the source. They are readily shielded or reduced by conducting and semi-conducting objects including buildings, trees and the human body.

Electric fields are normally measured in volts per metre or kilovolts (kV) per metre.

Magnetic fields result from the movement of electric charges (commonly known as the electric current). The higher the current, the stronger the magnetic field. When a piece of electrical equipment is switched off, there is no flow of current so there is no magnetic field. Magnetic fields also reduce in magnitude quickly as one moves away from the source but, unlike electric fields, they are not so readily shielded.

Magnetic fields are normally measured in milligauss (mG). Alternative units of measurement are gauss, teslas and microteslas (1 mG = 0.1 microtesla).

Examples of natural electric and magnetic fields (EMFs) are the earth's magnetic field, fields due to charged clouds and lightning in thunderstorms and fields associated with neuromuscular and cell activity within the body. Although these examples are all electric or magnetic fields, they are generally not identical to one another or to the common human-made EMFs, which also exist in many forms.

This discussion is confined to what are known as power frequency EMFs that result from the 50 cycles per second A.C. (alternating current) electrical system, which is used in Australia. Power frequency is in the range known as Extra-Low Frequency, so the power frequency fields are sometimes called ELF fields.

Power frequency EMFs are produced by virtually all electrical equipment and occur wherever electricity is being used, including near high voltage power lines and cables, lower voltage street distribution lines, wiring in homes and offices, toasters, computers, hair dryers, electric blankets, electric welders, electric drills and any appliance which uses electric power. They are not unique to high voltage power lines. Exposure to both electric and magnetic fields is not simply a function of living or working near a power line/cable or utility facility. Exposure depends on the myriad of sources and field strengths that are present where a person lives, works or spends time. Due to the large number of potential EMF sources in our modern industrialised society, people move from one source of EMF to another throughout their daily lives.

(2) Existing Environment

In the context of this project, the study area incorporates essentially rural and semi-rural environments. In these environments, away from dwellings, workshops, power lines and other electrical equipment, power frequency electric and magnetic fields are negligible. In the immediate vicinity of existing power lines, magnetic fields in the range of 2-20 milliGauss occur near distribution lines and 5-100 milliGauss near transmission lines. Electric fields can range from a few tens to a few thousands of volts per metre, depending on the voltage of the line.

In workshops or other similar environments away from dwellings, background fields would be negligible and the electrical equipment in use would largely determine the localised fields that would exist.

In dwellings, the background electric field would be expected to be negligible and the background magnetic field would be expected to be less than 1 milliGauss in the case of a small rural dwelling and less than 2 milliGauss in a school or shop or urban dwelling, unless high current equipment is used, as with a bakery using electric ovens for example. Higher fields would occur close to supply cables and switchboards including the meter boxes of homes and close to electrical appliances.

Background magnetic fields of tens of milliGauss are sometimes experienced in parts of urban dwellings, due primarily to the influence of electric currents that can flow in water pipes and safety earthing connections in some residential areas.

The electric fields at normal user distances from appliances are generally of the order of tens of volts per metre except for electric blankets where electric fields ranging from a few hundred to more than one thousand volts per metre have been reported. The magnetic fields in the vicinity of a selection of appliances are indicated in **Table 6.1**.

Table 6.1 - Typical magnetic field at normal user distances from Australian appliances

Appliance	Typical Magnetic Field (mG)	Typical Range (mG)
Electric Range	6	2-30
Computer	5	2-20
Television	1	0.2-2
Electric Blanket	20	5-30
Hair Dryer	25	10-70
Refrigerator	2	2-5
Toaster	3	2-10
Electric Kettle	3	2-10
Portable Fan	1	0.2-2

Note: Owing to variations in the design of electrical appliances and the ways they are used, the levels of magnetic fields can vary. The above table is based on a consistent set of measurements undertaken by power authorities in Australia using similar techniques to overseas measurements. Because of differences in appliance designs and voltages overseas, fields shown in overseas publications can differ from the above.

6.1.2 Predicted Fields Associated with the Project

(1) Introduction

All types of electrical equipment, including transmission lines, produce both electric and magnetic fields. For a transmission line, the strength of the electric field varies generally with the operating *voltage* of the line (measured in *volts*) while the magnetic field strength is related to the *current* flowing in the line (measured in *amps*). The current flowing in the line is dependent upon the load or power flow. The load varies with consumer demand. It also depends on the sources of generation that the national electricity market puts in place to respond to the demand and the transmission and distribution circuits available to deliver the electricity.

The electric and magnetic field strengths also depend on the height of the wires above the ground and their geometric arrangement as supported by the structures and the location of the observer.

The predicted electric and magnetic fields associated with the Wollar to Wellington 330 kV transmission line are shown in **Diagrams 6.1** and **6.2** and are summarised in Table 6.2 and 6.3. They have been calculated on the basis of well-established engineering principles.

The predicted fields shown in **Diagrams 6.1** and **6.2** are presented in the form of lateral profiles, showing the fields that would occur 1 m above ground level at various locations within and beyond the easement. One metre above ground is the standard height for measurements of EMF in accordance with internationally accepted standards.

(2) Basis of EMF Predictions

The electric and magnetic field predictions are based on the single circuit steel tower configuration proposed for use on the new transmission line and a range of other parameters as mentioned above.

Prediction of the electric field strength is less affected by the actual power flow or loading conditions than it is by the possible variations in system voltage. For this project the typical system voltage is 340 kV, with voltage varying from 330 kV to 362 kV.

Prediction of magnetic field strengths on the other hand requires understanding of the load in the transmission line. This load varies over time, on a daily and seasonal basis. Therefore a number of loading conditions are adopted by the electricity industry to represent the load on a transmission line for the purposes of predicting magnetic fields. The objective is to ensure that the fields so predicted can be compared to the field levels set in the applicable Australian Guidelines, as well as to the levels that are quoted as the subject of scientific studies into possible health effects of exposure to electric and magnetic fields.

The following three loading conditions have been identified for the above purposes as appropriate for the magnetic field assessment of the Wollar to Wellington transmission line:

❑ Short Term Emergency Load

This is the maximum load that is expected to occur on the transmission line. Load flow analyses of the full supporting network has confirmed that the largest load that will occur on the new line would arise following an outage of the existing 72 Line (Mt Piper to Wellington 330 kV) at a time of high import of energy from Queensland. With the Mt Piper to Wellington circuit out of service, the regional load would be carried by the new Wollar to Wellington line and the underlying 132 kV network.

❑ Infrequent High Load

This represents a conservative upper limit for long-term periodic exposure to magnetic fields. To be consistent with industry practice, the infrequent high load has been taken to be the load in the transmission line that is exceeded for not more than 15% of the time (also referred to as the 85th percentile load). From analysis of the applicable load duration curve, the 85th percentile load is approximately 80% of the maximum load with all network elements in service and representative power generation patterns.

❑ Time Weighted Average Load

This is the field strength quoted in epidemiological studies where exposure was measured, in reports by health authorities and public inquiries. It has been defined as “A weighted average of exposure measurements taken over a period of time that takes into account the time interval between measurements. When the measurements are taken with a monitor at a fixed sampling rate, the time-weighted average equals the arithmetic mean of the measurements.”

For the Wollar to Wellington transmission line, the time-weighted average load has been calculated to be 70% of the maximum line load with all network elements in service and representative power generation patterns.

The ground clearances along a transmission line vary with the terrain, location between supporting structures, load, and conductor temperature. Accordingly, a suitably practical (and reasonably conservative) value of ground clearance needs to be selected to enable field predictions to be made.

A study of the existing Line 72 (Mt Piper to Wellington 330 kV) was undertaken to estimate the typical conductor height. A section of the conductor profile for Line 72 was used to determine a range of ground clearances and the frequency of their occurrence. The results showed that a reasonable estimate of the average clearance to ground for the 330 kV single circuit line was 14 m. With the new line in service to take a share of the load, this clearance would be increased.

This correlated well with the engineering estimate for the proposed transmission line, which considered the minimum ground clearance at the maximum design temperature (9 m), increased by the additional height provided due to the operating temperature being below the maximum design temperature and the geometry of the sag of the conductor at that operating temperature. This calculation confirmed 14 metres as a reasonably conservative estimate of average ground clearance, and therefore the appropriate clearance on which field level predictions should be based.

(3) Electric Fields

The lateral profile of the electric field was calculated for two cases, namely:

- ❑ Typical System Voltage = 340 kV with a ground clearance of 14 m, and
- ❑ System Highest Voltage = 362 kV with a ground clearance of 9 m, which gives an extreme upper limit.

The results are shown in **Diagram 6.1** below.

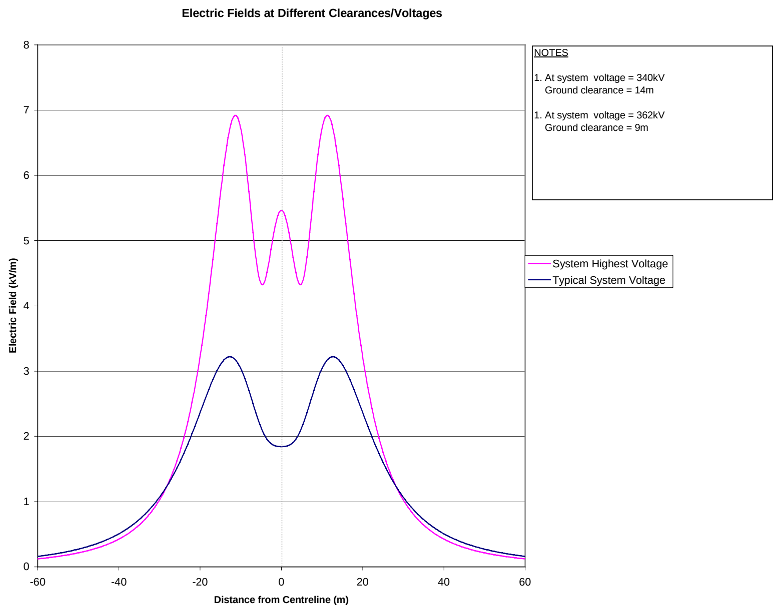

Diagram 6.1 – Lateral Profile of Electric Field

Key measures of the predicted electric fields from the above Diagram are summarised in Table 6.2 below.

Table 6.2 – Key Measures of Electric Fields

Voltage Condition	**Maximum Electric Field on easement (kV/m)**	**Electric Field at 30m easement edge (kV/m)**	**Electric Field at 60m from centreline (kV/m)**
Typical System Voltage	3.2	1.0	0.1
System Highest Voltage	6.9	1.1	0.2

(4) Magnetic Fields

The lateral profile of the magnetic field strength was calculated for the three loading conditions described above, namely:

- Short Term Emergency Load;
- Infrequent High Load; and
- Time Weighted Average Load.

The results are shown in **Diagram 6.2** below.

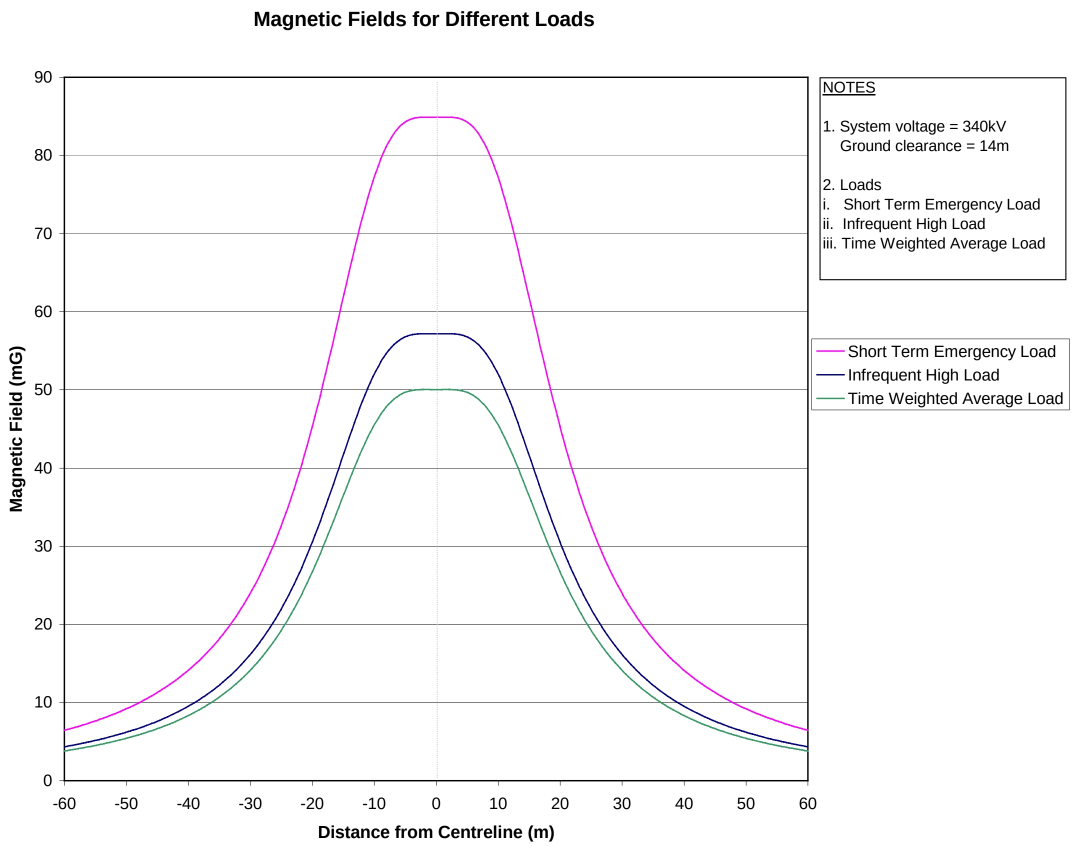

Diagram 6.2 – Lateral Profile of Magnetic Field

A full tabulation of the predicted magnetic fields from the above Diagram is provided in Table 6.3 below.

Table 6.3 – Tabulated Prediction of Magnetic Fields

Predicted Magnetic Field at 1.0 metre Above Ground			
Distance from Centreline (m)	**Short Term Emergency Load (mG)**	**Infrequent High Load (mG)**	**Time Weighted Average Load (mG)**
0	84.9	57.2	50.1
2	84.9	57.2	50.1
4	84.7	57.0	49.9
6	83.7	56.4	49.3
8	81.1	54.6	47.8
10	77.7	52.4	45.2
12	72.1	48.5	42.5
14	65.2	43.9	38.4
16	59.3	39.0	34.1
18	52.1	34.5	29.2
20	45.4	30.6	26.7
22	39.7	26.6	23.2
24	35.3	23.7	20.5
26	30.8	20.7	18.1
28	27.0	18.2	15.9
30	24.3	16.4	14.3
35	18.3	12.3	10.5
40	14.2	9.5	8.2
45	11.3	7.6	6.6
50	9.2	6.2	5.4
55	7.7	5.2	4.5
60	6.3	4.3	3.8
65	5.5	3.7	3.2
70	4.8	3.2	2.8
75	4.2	2.8	2.4
80	3.7	2.5	2.2
85	3.2	2.2	1.9
90	<3.2	<2.2	<1.9
95	<3.2	<2.2	<1.9
100	<3.2	<2.2	<1.9

Note, as is apparent from the EMF profiles shown in **Diagrams 6.1 and 6.2** the strength of the fields falls away rapidly with distance from the transmission line, quickly reaching a level beyond the accuracy of the estimating methodology. Values in the table above at a distance of greater than 85 m from the centreline are approximate only. Effectively, long-term exposure to EMF from the transmission line will not be increased appreciably for people who live more than this distance from the power line.

6.1.3 Environmental Effects and Impact Assessment

(1) Health Concerns Associated with Electric and Magnetic Fields

Over the past twenty-five years, questions have been raised as to whether the electric and magnetic fields associated with electrical equipment may be harmful to human health. The issue of possible health risks from everyday exposure to

EMFs has not been fully resolved despite over 25 years of intensive world-wide research. There is scientific consensus that, although the existence of any health effects from EMF has not been confirmed, the possibility of such effects cannot be dismissed for some diseases of low incidence for which the statistics are weak. EMF has therefore remained an important issue of concern for some members of the community and has been carefully considered by TransGrid throughout project planning and in this EIS.

(2) Scientific Studies

The perception that adverse health effects may be associated with magnetic fields has arisen from the findings of a variety of scientific studies, which have suggested the possibility of such effects. This perception persists notwithstanding many other scientific studies, which have failed to confirm the suggested effects. This is largely due to ongoing inconsistencies of study outcomes.

The scientific studies fall into two main categories:

- epidemiological studies that have examined human populations, in their usual environment, looking for statistical associations between exposure or possible exposure to electric and magnetic fields (EMF) and various diseases (principally cancers); and

- laboratory studies where single cells, groups of cells, organs, live animals or humans have been exposed to fields under controlled conditions and tests performed to identify possible responses.

The epidemiological studies have looked for associations between estimated exposure to EMF and various health outcomes. Of these, studies relating to cancers have reported the most persistent, although not consistent, findings and have tended to generate the most widespread publicity and scientific interest. [1]

This scientific interest and publicity started with a small local study published by Wertheimer and Leeper in 1979. Many hundreds of EMF epidemiological studies have been published since that time, some of which have reported a form of statistical association between one or other type of cancer and exposure to power frequency magnetic fields. Many other studies have failed to show such an association. Where an association was observed, it was generally not strong enough to imply cause and effect, but rather constituted a clue to assist in tracking down a cause – see (3) below. The studies have examined children in residential settings and adults in both residential and occupational settings.

For an epidemiological study to provide convincing evidence of a link between exposure and a disease, it must include accurate assessments of the study subjects'

[1] It should be noted however that epidemiological studies are inherently statistical studies and their outcomes can be affected by a wide range of possible influencing factors. For example the incidence of certain cancers has a positive association with economic factors in some countries and a negative association with economic factors in others.

exposure. Ideally, the total exposure of each individual would be measured by an instrument worn during all daily activities, but this cannot be done because the design of most EMF epidemiological studies requires reconstructing exposures that have occurred in the past. Because individuals' past EMF exposure cannot be measured directly, researchers have had to estimate exposure to magnetic fields by what are called substitute or surrogate measures.

Some of the substitute or surrogate measures of field exposures that have been used in residential studies have included:

- Codings based on wiring configurations (ie wiring arrangements in terms of number and thickness of wires) in the vicinity of the subjects' residences;
- Distance of subjects' residences from the line or source;
- Spot measurements in the subjects' homes;
- Field strengths calculated from historical current loading data for nearby transmission lines; and most recently,
- Addresses on the birth certificates of children who later developed cancer, mapped against the national electricity grid.

Occupational studies have relied heavily on job titles as a surrogate. Because of the inherent uncertainty associated with the use of surrogates, some of the recent occupational studies have attempted to improve exposure assessment through measuring typical exposures for people in various job classifications, but remain unable to measure the actual exposure of the study subjects.

A survey conducted in April 2004 for EPRI (Electric Power Research Institute) provided a useful summary of the key ongoing and planned extremely low frequency (ELF) epidemiologic research worldwide. The identified epidemiologic studies were roughly half in occupational settings and half in residential settings. One third of the studies were to explore EMF exposure and childhood leukemia risk. A slight majority of respondents felt that a new study of childhood leukemia risk among more highly exposed (>3 or 4 mG) children was needed, but could not agree on the form this should take. Some suggested that investigating methodological questions (for example, exploring selection bias in existing studies) and sources of high exposure would be more productive than launching a new epidemiologic effort.

Laboratory studies have looked at reproduction, biorhythms, brain activity, heart rate, the immune system, hormonal changes, numerous aspects of cell function and a variety of cancer-related topics. The laboratory studies involving cells and tissues have reported measurable biological effects but have proven difficult to reproduce and, in any case, their significance (if any) to human health is unclear. They do however provide focal points for further research aimed at understanding how EMFs might influence health.

Cancer development is thought to involve a series of stages, first the genetic damage that initiates the process, followed by promotion and progression of initiated cells to become cancer. The cancer-related laboratory studies have investigated a range of issues covering both initiation and promotion. It is generally considered that power frequency EMFs do not cause the genetic damage which initiates cancers, but rather that, if power frequency fields influence the incidence of cancer, it could be due to their acting as promoters, either alone or in conjunction with other agents. At this stage, this area of work is inconclusive.

Other laboratory studies directed at a possible link between power frequency EMFs and cancer include work on cell proliferation, possible suppression of the immune system and the possibility that power frequency EMFs might interfere with the production of melatonin, which in turn might reduce the body's protection against cancer. Work in this area is also ongoing.

(3) Evaluating the Science

In establishing whether or not a particular agent such as EMF causes a particular disease, it is necessary to evaluate the results of both epidemiological and laboratory studies together. The strength of epidemiological studies is that they study people in their natural environment, but because epidemiology is not an experimental science, it only shows statistical associations. To establish a cause and effect relationship, it is customary for scientists to consider factors such as the:

- strength of the reported epidemiological associations;
- consistency of the findings;
- existence of a dose-response relationship, ie the incidence of the disease increasing with increasing exposure to the agent;
- biological plausibility, ie the existence of established biological mechanisms by which the agent could cause the disease; and
- support provided through laboratory evidence.

In the case of EMF, the epidemiological associations are not strong, nor are they particularly consistent. Whilst some studies have reported associations, there are numerous inconsistencies between the detailed findings of these studies. In the vast majority of the studies the 95% confidence limits on the relative risk extended to or below 1.0. Where the relative risk is 1.0 there is no difference between the risk of the disease among the cases and the risk among a matched control group.

In terms of biological plausibility, although work is ongoing and numerous theories have been advanced, there is *no established mechanism* by which power frequency EMFs could cause cancer or other adverse health effects.

Thus, after more than 25 years of research throughout the world costing hundreds of millions of dollars, the question of possible adverse health effects associated with power frequency fields is not yet resolved. However, if EMFs were a major contributor to the incidence of cancers, brain tumours, or other diseases, one would expect a clear association to have been established. There are an increasing number of high quality "negative" studies in which no association has been found. The historic trends are reflected in the findings of many independent reviews of the scientific literature.

(4) Independent Review Findings

Because of the sheer volume and complexity of the body of scientific literature on the subject, the many disciplines that are involved and the concern surrounding the issue, it is informative and beneficial to look to the findings of the various independent scientific review panels and public inquiries that have been commissioned throughout the world in recent years to review the state of EMF scientific research and, in some cases, to recommend appropriate policy responses.

These panels and inquiries generally have a role of protecting the interests and health of the public and represent an authoritative distillation of the total body of scientific knowledge on the EMF/health issue. In summary, the findings of such scientific review panels and public inquiries concur with the above findings, that it has not been established that EMFs are harmful to human health, but prudent avoidance is recommended.

A selection of findings and conclusions from some of the more significant of these reviews is set out below:

1. **Inquiry into Community Needs and High Voltage Transmission Line Development (Gibbs Inquiry – 1991)**

   Following a comprehensive inquiry in 1991, Sir Harry Gibbs, an ex-Chief Justice of the High Court of Australia, produced a report on transmission lines for the NSW Government. His overall conclusion was that:

   "It has not been established that electric fields or magnetic fields of power frequency are harmful to human health, but since there is some evidence that they may do harm, a policy of prudent avoidance is recommended." (p. 162)

2. **US National Research Council Report "Possible Health Effects of Exposure to Residential Electric and magnetic Fields" (1996)**

   This report, produced by the US National Academy of Science and which examined over 500 studies spanning 17 years of research, found that:

   "Based on a comprehensive evaluation of published studies relating to the effects of power-frequency electric and magnetic fields on cells, tissues,

and organisms (including humans), the conclusion of the committee is that the current body of evidence does not show that exposure to these fields presents a human health hazard. Specifically, no conclusive and consistent evidence shows that exposures to residential electric and magnetic fields produce cancer, adverse neurobehavioural effects, or reproductive and developmental effects." (page 1)

3. **National Institute of Environmental Health Sciences – Report to US Congress (1999)**

   US Congress mandated this report in 1992 to oversee a multi year research and communication effort with regard to EMF. In its conclusion the report states that:

   "The NIEHS believes that the probability that ELF-EMF exposure is truly a health hazard is currently small. The weak epidemiological associations and lack of laboratory support for these associations provide only marginal, scientific support that exposure to this agent is causing any degree of harm", and

   "the NIEHS believes that there is weak evidence for possible health effects from ELF-EMF exposures, and until stronger evidence changes this opinion, inexpensive and safe reductions in exposure should be encouraged." (p. 35)

4. **Report of an Advisory Group on Non-Ionising Radiation for the National Radiological Protection Board (NRPB) "ELF Electromagnetic Fields and the Risk of Cancer" (Chaired by Sir Richard Doll – 2001)**

   In its most comprehensive review of experimental and epidemiological studies published since its first report in 1992, the Advisory Group concluded that:

   "Laboratory experiments have provided no good evidence that extremely low frequency electromagnetic fields are capable of producing cancer, nor do human epidemiological studies suggest that they cause cancer in general. There is, however, some epidemiological evidence that prolonged exposure to higher levels of power frequency magnetic fields is associated with a small risk of leukaemia in children. In practice, such levels of exposure are seldom encountered by the general public in the UK. In the absence of clear evidence of a carcinogenic effect in adults, or of a plausible explanation from experiments on animals or isolated cells, the epidemiological evidence is currently not strong enough to justify a firm conclusion that such fields cause leukaemia in children. Unless, however, further research indicates that the finding is due to chance or some currently unrecognised artefact, the possibility remains that intense and prolonged exposures to magnetic fields can increase the risk of leukaemia in children" (p. 164)

5. **Annual Update 2003 of the Electromagnetic Fields Committee of the Health Council of the Netherlands (Presented January 2004)**

   In this latest and third Annual Update from the Netherlands, the Committee relevantly reported on the 2001 Report by the International Agency for Research on Cancer (IARC) and the 2002 Report by the Californian Department of Health Services (DHS).

   With reference to IARC's classification of ELF magnetic fields as *"possibly carcinogenic to humans (group 2B)"*, and suggestions that steps be taken to limit exposure, the Committee concluded "*Since the conclusion of the IARC is not different from that of the Committee, it adheres to its previously expressed view that, on the basis of the current level of knowledge, there is no reason to take such action"*. (p. 76)
   The Committee noted that IARC has placed a total of 236 agents in group 2B including for example coffee, acetaldehyde (naturally occurring in grapes and wine) and pickled vegetables.

   With reference to the DHS report, the Committee describes their approach, which was essentially based on the views of three people (all of them experts in the field of ELF electromagnetic fields), as "*interesting"*.

   The Committee *"attaches greater value to the conclusions of a group of experts with a wide range of backgrounds, such as those who drew up the NIEHS, IARC and NRPB reports, in spite of the many limitations inherent to a group-based approach of this type.* The Committee found *"no reason to revise its position regarding the risks of ELF magnetic field exposure"*. (p. 78)

6. **Review of the Scientific Evidence for Limiting Exposure to Electromagnetic Fields - 0 to 300 GHz – (Report of the NRPB – 2004)**

   Whilst the primary recommendation to arise from this review related to the adoption of the ICNIRP exposure guidelines (refer to section (5) below), other relevant statements include:

   "It is the view of NRPB that the epidemiological evidence that prolonged exposure to power frequency magnetic fields above 0.4 mT (4 mG) is associated with a small absolute raised risk of leukaemia in children (an approximate doubling of the relative risk) is, at present, an observation for which there is no sound scientific explanation." (p. 133), and

   "There is no scientific consensus that exposures to EMFs at levels below currently accepted UK or international exposure restrictions cause cancer or any other disease. However, it is the view of NRPB that the totality of the scientific data and uncertainty in knowledge and/or other relevant factors indicate that consideration should be given as to whether further precautionary measures are needed." (p. 131)

(5) Authoritative Australian Guidelines

In 1989 the (Australian) National Health and Medical Research Council (NHMRC) issued a document "Interim guidelines on limits of exposure to 50/60 Hz electric and magnetic fields (1989)". These guidelines were previously developed by the International Non-Ionising Radiation Committee of the International Radiation Protection Association (IRPA/INIRC) (which has since been replaced by the International Commission on Non Ionising Radiation Protection or ICNIRP).

In 1999 the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), a Federal Department within the Health portfolio, took over responsibility in Australia for standard setting in the non-ionising area (including EMFs) from the NHMRC. The Radiation Health Committee within ARPANSA has established a Working Group to undertake the drafting of an ELF (0 to 3,000 Hz) guideline and has also established a Consultative Group to provide a wider pool for information gathering and a forum for discussion on specific issues in support of the Working Group's objectives. Whilst this work continues, the original NHMRC guidelines remain the current applicable guidelines in Australia.

The NHMRC recommended exposure limits developed as described above are shown in Table 6.4 below.

Table 6.4 - NHMRC Limits of Exposure

Exposure Characteristics	Electric Field Strength (kV/m)	Magnetic Flux Density (Field Strength) (mG)
Occupational		
Whole working day	10	5000
Short term	30[a]	50000[b]
For limbs	-	250000
General Public		
Up to 24 hours/day[c]	5	1000
Few hours/day[d]	10	10000

Notes:
a) The duration of exposure to fields between 10 and 30 kV/m may be calculated from the formula $t \leq 80/E$, where t is the duration in hours per work day and E is the electric field strength in kV/m.
b) Maximum exposure duration is two hours per work day.
c) This restriction applies to open spaces in which members of the general public might reasonably be expected to spend a substantial part of the day such as recreational areas, meeting grounds and the like.
d) These values can be exceeded for a few minutes per day provided precautions are taken to prevent indirect coupling effects.

While the authors of the NHMRC guidelines had regard to the epidemiological and laboratory studies concerning EMF and cancer, they considered that the available data did not provide any basis for health risk assessment useful for the development of exposure limits. Accordingly, the exposure limits contained in the guidelines are based primarily on established or predicted effects related to the flow of electric current within the body. They are not intended to "define safe limits" for possible health effects, should they exist, from fields at strengths normally encountered in the vicinity of electrical equipment.

Comparison of the limits shown in Table 6.4 with the fields shown in Tables 6.2 and 6.3, show that the fields associated with this project comply with the guidelines with substantial margins.

(6) Topical Issues

Interest in the issue of EMF varies over time depending upon developments in the research and policy setting areas. Examples of topical issues in recent times include interest in electrical *hypersensitivity* syndrome, the *contact current* hypothesis, moves to harmonise exposure guidelines internationally, the *possible carcinogen* classification of EMF, and selected recent publications purporting to relate disease incidences to proximity to power lines[2].

(7) Animals and Plants

Although not specifically raised in the context of this project, the question as to whether exposure to electric or magnetic fields has any adverse effect on flora, fauna, farm animals or plants has been raised in other contexts.

This question was addressed by the 1991 Gibbs Inquiry in which the overall conclusion was:

"No reason exists for concern as to the effect of the fields on animals or plants." (p. 162).

The issue was also addressed in a set of public information brochures published by Carnegie Mellon University in the USA in 1995. The following response was given to the question of whether power frequency fields pose significant risks to farm crops and animals:

"The answer is a simple no. There have been quite a number of studies of field crops grown in strong fields. There have also been quite a number of studies of things like meat and milk production. All of these studies show no significant effects."

"There is one aspect of electric power that can have very real implications for dairy farmers. This is the so-called stray voltage problem. When metal feeders, water troughs, or milking machines are inadequately grounded, cows can be subjected to small but perceptible electrical shocks. This can lead to changes in animal behaviour (reluctance to enter a milking stall for instance) and reductions in milk production. The problem can usually be fixed with proper grounding. The problem does not come from the direct effect of exposing the cows to fields. The only other situation that has been identified in which transmission lines can be important in agriculture is when beehives are installed directly underneath very high voltage transmission lines. Again the problem is not from exposing the

[2] Findings purporting to find positive associations tend to attract media coverage while those that find no association are often ignored in the media. This impact assessment does not address such studies as they have not yet been reviewed by expert panels and health authorities who consider all of the relevant studies.

bees to the field. Rather it comes from voltages that are induced in the hive. Effectively, the bees get shocks as they walk around and, not surprisingly, honey production can drop substantially. If a shield, such as a piece of grounded chicken wire, is installed over the hive, then the problem is eliminated and honey production returns to normal. Still, it is best not to locate beehives under transmission lines." (Part 2 p. 13)

(8) Summary of Present Position

The scientific literature on this subject is extensive, complex and inconclusive. It has been reviewed by numerous independent scientific review panels and public inquiries and there is broad consensus that:

- Adverse health effects have not been established;
- The possibility cannot be ruled out;
- There is a need for further high quality research;
- If there is a human health risk, it is likely to be a small one; and
- If power frequency magnetic fields pose a human health risk, it is unlikely to be confined exclusively to transmission lines.

In addressing the possibility of adverse health effects from fields, TransGrid relies on the findings of if review panels and public inquiries such as those described in Section (4) above.

In response to the state of scientific uncertainty, there is also broad consensus that a prudent approach should be taken to the design and siting of new transmission facilities. Such an approach is applied by TransGrid.

TransGrid's Policy in relation to the EMF issue makes the commitment to:

- Closely monitor ongoing research and reviews by scientific panels, and overseas developments;
- Continuously review policies and practices;
- Measure field strengths in and around its own installations and other places where appropriate;
- Promote employees' awareness and provide information on request to interested people; and
- Apply the principles of prudent avoidance relating to power frequency electric and magnetic fields and radio frequency electromagnetic fields when designing and locating new facilities.

(9) Prudent Avoidance Applied to this Project

A consistent component of the recommendations of all major public inquiries and review panels that have been published over the past few decades, examples of which have been discussed in Section 4 above, has been that whilst there is scientific uncertainty a precautionary approach should be taken.

Various terms have been used to cover this concept, including *precautionary, cautionary, prudence* and *prudent avoidance.* The United Nations and the European Commission are in the process of defining the term *Precautionary Principle.* In New South Wales, the major public inquiry conducted, namely the Gibbs Inquiry, recommended the adoption of a policy of "prudent avoidance" in respect of the electric and magnetic fields of power lines.

In the case of new lines, Sir Harry Gibbs indicated that:

"… it may be prudent to do whatever can be done without undue inconvenience and at modest expense to avert the possible risk". (pp.61, 62)

With regard to the Wollar to Wellington transmission line, it can be demonstrated that in designing and siting this line TransGrid has undertaken the following steps consistent with prudent avoidance.

With respect to design, TransGrid's conventional lattice towers provide the appropriate spanning performance (distance between towers) and clearance (height of conductors above ground) to keep EMF levels significantly below the relevant guidelines. Other factors considered in design included visual impact, land use, terrain, accessibility and vegetation as well as the operation and maintenance implications for the line once in service.

With respect to siting, the rationale and process for selecting the preferred corridor and arriving at the final location of the transmission line towers is discussed in detail elsewhere in this EIS. Prudent avoidance would dictate maximising the distance of the line from locations where children would spend time. The objective of the route selection process has been, in general terms, to find the location that represents the best balance of the full range of potentially competing issues. These have been grouped into the categories, engineering, environment and economic/social issues. The process has been one of continual refinement of the location for the transmission line towers so as to progressively narrow down the potential impact of the proposal whilst involving all stakeholders identified as having an interest in the above-mentioned issues.

The result has been unprecedented in transmission line projects of this size in that, prior to the finalisation of the EIS, with the co-operation of all stakeholders including landowners and environmental agencies and interest groups, TransGrid has been able to accurately determine the preferred location of all towers and the access tracks to them.

The outcome of prudent avoidance applied during the design and siting phases of this project is that no residence[3] is closer than 250 m to the transmission line and the closest school is more than 400 m away. At these distances the transmission line makes no contribution to EMF levels, refer to Table 4.2.

(10) Overall Assessment

Based on the foregoing, it has not been established that power frequency electric and magnetic fields in general have any adverse health effects, although the possibility of there being some adverse effect cannot be completely ruled out.

Several review panels and public inquiries have recommended prudent avoidance as an appropriate response to the present state of scientific uncertainty. In designing and siting the new Wollar to Wellington transmission line, TransGrid has implemented measures consistent with the concept of prudent avoidance. The electric and magnetic fields of the new line will be very low and kept to a minimum. As a result of the route selection process, the selected alignment for the transmission line is well clear of dwellings.

Based on the low levels of field exposure and the findings of the scientific reviews, it may be concluded that the new transmission line can proceed without any significant impact due to power frequency electric or magnetic fields.

(11) Further Information

There is a wealth of information available on the web concerning EMF.
Some of the key national bodies responsible for EMF include:

ARPANSA – Australian Radiation Protection and Nuclear Safety Agency
    http://www.arpansa.gov.au/issues.htm

NIEHS – US National Institute of Environmental Health Sciences
    http://www.niehs.nih.gov/emfrapid/home.htm

RPD – Radiation Protection Division of the UK Health Protection Agency (formerly the NRPB)
    http://www.hpa.org.uk/radiation/

6.2 Noise

A desktop study was carried out by Atkins Acoustics to assess construction noise and vibration associated with the construction of the proposed transmission line.

[3] This excludes certain houses on the land owned by Ulan and Wilpinjong Coal companies where the alignment has been negotiated with the coal companies. In one case it has been agreed to remove a house in the Wilpinjong mine development area, as it would lie partly in the proposed transmission line easement.

The report is contained in full in Appendix C, Volume 2. The main aims of the noise and vibration assessment were:

- identify sensitive land uses in the area that could be affected by construction noise and vibration impacts;
- estimate background noise levels likely to prevail within the study area;
- predict noise and vibration emission levels from various construction activities at representative reference distances;
- assess potential construction noise and vibration impacts;
- recommend conceptual controls and procedures to minimise potential noise and vibration impacts during construction; and
- report on the results and findings of the assessment.

6.2.1 Existing Conditions

Considering the extent of the proposed transmission line route and study area consisting predominantly of rural areas with minimal human activity Atkins Acoustics has not monitored the existing noise environment prevailing in the study area.

In the absence of noise monitoring, the assessment has adopted the minimum background RBL noise level of 30dB(A) in accordance with Section 3.1.2 of the Department of Environment and Conservation, Industrial Noise Policy (INP). This is a conservative approach, particularly with respect to the Ulan residential area given the anticipated higher background noise levels resulting from road traffic, rail traffic and mining activities.

6.2.2 Noise Assessment Criteria

The Department of Environment and Conservation (DEC) recommends goals for the assessment of construction noise in the Environmental Noise Control Manual (ENCM) and “Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration” have been adopted in this assessment.

6.2.2.1 Construction Noise

The ENCM assessment guidelines and goals for short, medium and long-term daytime construction activities are as follows:

(i) Short Term Construction Periods - for construction periods of less than 4 weeks, the DEC recommends that the $L_{A10,15min}$ noise level from construction activities should not exceed the rating background noise level (RBL) by more than 20 dB(A).

(ii) Medium Term Construction Periods - for construction periods extending from 4 to 26 weeks, the DEC recommends that the $L_{A10,15min}$ noise level from construction activities should not exceed the RBL by more than 10 dB(A).

(iii) Long Term Construction Periods - for construction periods longer than 26 weeks, the DEC recommends that the $L_{A10,15min}$ construction noise should not exceed the RBL by more than 5 dB(A).

For evening and night-time activities, the DEC normally accepts that the $L_{A10,15min}$ construction noise should not exceed the background noise level by more than 5 dB(A) between 6.00 pm and 10.00 pm, and not exceed the background level between 10.00 pm and 7.00 am. Albeit under normal work scheduling, evening and night construction operations is not proposed.

In setting these goals the DEC recognises that there is limited opportunity to reduce noise from construction plant and activities, and that the goals are not always satisfied.

Considering the adopted RBL of 30 dB(A), the assessment goals recommended for evaluating daytime construction activities are summarised in Table 6.5 below.

For assessment purposes the construction noise is assessed at a residential boundary or 30 m from a residential dwelling, if the boundary is more than 30 m from the dwelling.

Table 6.5 - Construction Noise Goals (Day) dB(A) ref: 20 × 10^{-6} Pa

Reference Location	**Sound Pressure Level dB(A)**			
	Adopted RBL	**Noise Assessment Goals (LA10,15min)**		
	Day	Short Term	Medium Term	Long Term
Any Residential Receiver	30	50	40	35

6.2.2.2 Ground Vibration

The effect of vibration on humans and structures is normally considered and evaluated in terms of annoyance and structural damage.

- ❑ Annoyance - for assessing human exposure to vibration, the ENCM recommends goals in terms of potential disturbance to the occupants of buildings. In accordance with the DEC goals, Table 6.6 presents a summary of vibration levels recommended for the project. For assessment purposes, the vibration is measured on the floor or within the building structure.

Table 6.6: Vibration Limits (Human Annoyance) Velocity (vertical axis 1 Hz – 80 Hz)

Description	Time	Continuous Vibration mm/sec	Intermittent Vibration mm/sec
Residential	Day	0.2-0.6	8-12

- Perception - for comparison and evaluation of vibration in terms of human response, Table 6.7 presents a summary of levels referenced to degrees of perception and potential reactions.

Table 6.7 - Human Perception of Vibration Ref: German Standard DIN 4150 (1986)

Vibration Levels mm/sec	Likely Perception
0.15	Perception Threshold
0.35	Barely Noticeable
1.0	Noticeable
2.2	Easily Noticeable
6.0	Strongly Noticeable
14.0	Very Strongly Noticeable

Structural Damage - the response of a building structure to ground-borne vibration is affected by the type of foundation, ground condition, building construction and state of repair of the building. The British Standard BS7385 (1993) provides limits above which the risk of vibration-induced damage to structures is minimal. Table 6.8 presents a summary of the structural damage vibration limits specified in the British Standard BS7385. For assessment purposes the vibration is measured on any component of the building structure.

<table>
<tr><th colspan="3">Table 6.8 - Structural Damage Goals Ref: British Standard BS7385 (1993)</th></tr>
<tr><th rowspan="2">Type of Building</th><th colspan="2">Peak Component Particle Velocity at Foundation (mm/sec)</th></tr>
<tr><th>4Hz to 15Hz</th><th>≥ 15Hz</th></tr>
<tr><td>1. Reinforced or framed structures, industrial and heavy commercial buildings</td><td>50mm/s</td><td>50mm/s</td></tr>
<tr><td rowspan="2">2. Un-reinforced or light-framed structures, residential or light commercial type buildings</td><td>15mm/s at 4Hz increasing to 20mm/s at 15Hz</td><td>20mm/s at 15Hz increasing to 50mm/s at 15Hz and above</td></tr>
<tr><td colspan="2">A maximum displacement of 0.6mm (zero to peak) not to be exceeded at frequencies below 4Hz for Building Type 2.</td></tr>
</table>

Notes

1 The vibration levels recommended in Table 6.6 provide minimal risk of vibration-induced damage to structures. The risk of damage tends towards zero at 12.5mm/s peak component particle velocity.
2 Minor and major damage to structures are possible at vibration magnitudes greater than twice and four times the values in Table 6.6 respectively.
3 Values in Table 6.6 relate predominantly to transient vibration which does not give rise to resonant responses to structures and low-rise buildings. Where dynamic loading caused by continuous vibration which gives rise to dynamic magnification due to resonance, then the values in Table 6.6 may need to be reduced by up to 50%.
4 Important structures such historical buildings which are difficult to repair may require special consideration on a case-by-case basis and should not necessarily be assumed to be more sensitive unless structurally unsound.
5 Damage to buildings may arise indirectly from vibration in certain ground conditions where vibration is sufficient to cause soil compaction

6.2.2.3 Blast Assessment Goals

Guidelines documented in the DEC "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" have been used to establish goals for assessing blast air-blast overpressure and ground vibration.

As site specific blast laws have not been established, the following conservative blast assessment parameters have been adopted for predicting and assessing blast impacts.

- Air-blast Overpressure - The DEC recommends a level 115 dBLin for the assessment of air-blast overpressure at residential dwellings and commercial premises. The DEC normally allows this level to be exceeded by up to 5% of the total blasts over a period of 12 months, with a maximum limit of 120 dBLin.

- Ground Vibration - The DEC ground vibration goal for residential and commercial premises is 5 mm/sec (peak particle velocity). The DEC normally allows this level to be exceeded by up to 5% of the total number of blasts over a period of 12 months with a maximum limit of 10 mm/s.

- Blast Project Assessment Goals - From the DEC recommendations, Table 6.9 provides a summary of the recommended blast assessment goals.

Table 6.9 - Assessment Goals for Blasting

Assessment Location	**Air-blast Overpressure dBLin**		**Ground Vibration PPV mm/s**	
	Recommended	**Maximum Allowable**	**Recommended**	**Maximum Allowable**
Residential/Commercial Buildings	115	120	5	10

For assessment purposes for blast overpressure, the DEC recommends measurement at any sensitive receiver at least 3.5 m from a building or structure, and ground vibration measured at any point which is located at least the longest dimension of the foundations of a building or structure away from such building or structure.

6.2.3 Noise Emissions and Impacts

6.2.3.1 Construction Equipment Noise Emission Levels

For the assessment of noise emanating from the envisaged construction activities, the following plant noise levels (Table 6.10) have been considered in the noise modelling for typical construction scenarios.

Table 6.10 - Typical Plant and Equipment dB(A) re: 20×10^{-6} Pa

Item	Plant Description	Number of Items	Sound Pressure Level LA10 @ 7m
Access Track Construction			
Dozer	Tracked	1	90
Water Cart		1	80
		Total	90
Vegetation Clearing			
Timber Shredder	Truck mounted	1	90
Excavator	Kato 750	1	82
Chainsaw		1	85
		Total	92
Structure Foundations			
Excavator	Kato 750	1	82
Drill Rig	truck mounted	1	87
		Total	88
Concrete Vibrators		1	80
Drill Rig	truck mounted	1	87
		Total	88
Crane	Truck mounted	1	80
Compressor	1000 CFM	1	77
Welders		2	75
		Total	83
Conductor and Earthwire Erection			
Crane	Truck mounted	1	80
Winch		2	66
Generator	Diesel	1	76

Table 6.10 - Typical Plant and Equipment dB(A) re: 20×10^{-6} Pa

Item	Plant Description	Number of Items	Sound Pressure Level LA10 @ 7m
Braking Device		2	66
		Total	82
Batching Plant			
Batching Plant		1	85

6.2.3.2 Construction Equipment Vibration Emission Levels

During the excavation and construction activities associated with access tracks and preparation of some platforms, it will be necessary to use plant and equipment that will generate ground vibration. To evaluate the likely effects of the construction activities, the following vibration levels (Table 6.11) have been considered.

Table 6.11 - Typical Plant Vibration Levels mm/s

Plant Description	Vibration Levels mm/sec		
	@ 5m	@ 20m	@ 40m
Rock-breaker (large)	5	0.5	0.3
Truck	1	0.05	0.02

6.2.3.3 Construction Noise Impact Assessment

A summary of the predicted construction noise levels for various stages of construction at reference distances are presented in Table 6.12. The calculation assume all plant referenced in Table 6.10 operating simultaneously and takes no account of potential shielding from topography or ground absorption, accordingly the expected levels at distances greater than 100 m are expected to be lower.

Table 6.12 - Predicted Noise Levels from Construction Activities L_{A10} dB(A) re: 20×10^{-6} Pa

Construction Activity	Distance from Construction Activity (m)						
	25m	50m	100m	200m	400m	800m	1600m
Access Track Construction	79	73	67	61	55	49	43
Vegetation Clearing	81	75	69	63	57	51	46
Structure Foundations - excavation -concrete pouring	77 77	71 71	65 65	59 59	53 53	47 47	41 41
Structure Erection	72	66	60	54	42	36	30

Conductor and Earthwire Erection	71	65	59	53	47	41	35
Batching Plant	74	67	61	56	50	44	38

The predicted noise levels for the access track construction and vegetation clearing activities exceed the DEC short-term assessment goal (50 dB(A)) at residential properties within 800 m of the construction activities. It is envisaged that such activities would be short term (1-3 days) and hours of activities modified to minimise disturbance. With respect to structure foundations, noise exceedances are predicted for residential properties within approximately 600 m of the activities. For other construction activities, the predicted noise levels show compliance for residential properties at distances of 300 m or greater. It is noted, (refer Table 4.2) that only six residences are located closer than 300 m.

6.2.3.4 Construction Vibration Impact Assessment

The main source of ground vibration that has been identified in this assessment is associated with rock breakers. Ground vibration from breakers could range up to 0.5 mm/sec at a distance of 20 m, and would be below 0.3 mm/sec at 40 m. The predicted ground vibration levels at these distances satisfy the recommended assessment goals, and are expected to be acceptable from both human disturbance and structural damage points of view.

6.2.3.5 Blast Impact Assessment

Confined blasting may be required along the proposed route to remove potential rock outcrops and excavate footings. Blast holes will be drilled and filled with an explosive charge and detonated with the aid of primers and detonators. Impacts associated with blasting normally relate to air blast overpressure and ground vibration.

The predicted MIC's in Table 6.13 are based on the DEC 115 dBLin goal.

Table 6.13 - Predicted Air-blast Overpressure MIC's

Receiver	Distance metres	Lower MIC range kg.
Residential/Commercial	200	<5
	400	<40
	600	<60
	800	<140
	1000	140
	1200	>140

The results in Table 6.13 show that the DEC air-blast overpressure goal (115 dBLin) can be satisfied with the employment of controlled MIC's. As a precautionary measure, it is recommended that initial blasts be undertaken at not less than 200 m from sensitive receiver locations and MIC's limited to no more than <5kg. The initial blasts will be monitored and blast site laws developed from the recorded data. The data will be compiled to confirm maximum charge weights and compliance with the DEC air-blast overpressure limits. The site data will be used to establish site blast laws and optimise further blasts.

Table 6.14 presents the range of calculated MIC's required to satisfy the 5 mm/sec vibration limits.

Table 6.14 - Predicted Ground Vibration (Average Rock Conditions) MIC's 6.3.2(a) Assessment

Receiver	Distance (m)	Lower MIC range kg.
Residential/Commercial	200	<2
	400	<20
	600	<60
	800	<80
	1000	<120
	1200	<140

The results summarised in Table 6.14 show that the DEC ground vibration goal (5 mm/sec) can be satisfied with the employment of controlled MIC's. It is recommended that the MIC's for the initial blasts be undertaken at not less than 200 m from sensitive receiver locations and limited to no more than 2 kg. The initial blasts will be monitored to confirm maximum charge weights to ensure compliance with the DEC ground vibration limits and optimise future blasts.

6.2.4 Noise Controls and Safeguards

A Construction Environmental Management Plan (CEMP) has been prepared to ensure that mitigation strategies are employed at sensitive receptor sites. The CEMP is contained in the Project Environmental Management Plan at the end of this document, and in summary will include:

- plant and equipment will be selected where practical on acoustic performance;
- noise certification of all site plant and equipment prior to commencing site work and regular monitoring to ensure equipment noise emission levels do not deteriorate due to poor maintenance;
- work practices to minimise potential noise and vibration impacts;
- a monitoring program to ensure that construction noise and vibration emissions are controlled and that the best available and economical practices are being implemented;
- noise and vibration monitoring will be conducted in response to community complaints and at the request of the DEC. Reports of investigations will be provided to the DEC upon request;

- a site noise and vibration training and awareness program for all staff and contractors engaged during construction;

- the establishment of procedures to address any noise and vibration complaints received from the public during the construction period; and

- liaison with affected property owners.

6.3 Air Quality

The only potential impact on air quality resulting from the proposed transmission line development is during the construction phase. Under normal operating conditions it is not expected that there will be any impact on air quality.

6.3.1 Emissions and Impacts

Air quality concerns during the construction phase of the development include dust through the excavation for structure erection, and exhaust emissions from machinery and equipment. As with farm machinery, exhaust emissions from construction equipment are likely to include nitrogen oxides, carbon monoxide, sulfur oxides, hydrocarbons and total suspended particulates.

Principal air quality impacts during operation and maintenance of the transmission line will be limited to dust and vehicle emissions during the periodic maintenance checks or emergency repairs.

Corona discharges may cause the production of small amounts of ozone through the ionisation of air near the conductors. Ozone generated by this source would not add measurably to the background levels produced by solar radiation, wind and thunderstorms, even in unpolluted atmospheres. As ozone is a very unstable gas it rapidly decomposes into oxygen compounds with no harmful effects.

6.3.2 Air Quality Safeguards

Dust controls are based on general management principles and involve a common sense approach. These include minimising activities that can cause nuisance dust, particularly in windy conditions when working near residences or land owner work areas. Management practices involve reducing vehicle or equipment speed in windy conditions when traversing dirt tracks or open paddocks.

All vehicles used on the line will be fitted with approved exhaust systems to maintain vehicle exhaust emissions within accepted standards. Drill rigs and auger type equipment shall be fitted with standard dust shields. Watering of construction sites and access tracks during construction as required will be the main method of mitigating impacts from fugitive dust.

6.4 Greenhouse Gases

While TransGrid does not generate significant quantities of greenhouse gases as part of its operations, TransGrid supports the minimisation of emissions generated by the electricity transmission and distribution industry as a whole. Where improvements in the efficiency of the transmission network are identified these are pursued.

The construction of the Wollar – Wellington 330 kV transmission line will substantially reduce energy transmission losses in delivering power to the Central West of NSW.

6.5 Transportation Impacts

6.5.1 Existing Traffic Network and Flows

There is an extensive network of roads in the region consisting of roads with national, state and local significance. The RTA fund and maintain State roads in the area which include the Mitchell Highway (State Highway No.7), Castlereagh Highway (State Highway No.18) and the Golden Highway (State Highway No.27). Numerous smaller sealed and dirt roads link up these main highways providing access through the area.

There are numerous local roads in the region. These are fully maintained and funded by local councils. Council roads consist of both sealed and gravel sections. They have variable widths ranging from three to seven metres, plus shoulders.

Available traffic data for major roads in the region are shown in **Table 6.15.** Traffic volumes show a steady increase through the years along these major roads with an increase in population densities in the western region.

Table 6.15 - Traffic Volumes in the Region

Road	1992 AADT*	1996 AADT	1999 AADT	2002 AADT
Mitchell Hwy (immediately north Wellington)	5751	5723	6674	7154
Castlereagh Hwy (west of Rouse St)	1281	1331	1316	1467
Golden Hwy (west of Castlereagh Hwy)	1155		1140	1686

* Average annual daily traffic — Source: RTA AADT figures

6.5.2 Expected Traffic Generation

During the construction period, the vehicles likely to be used are as follows:

- 1-2 long trucks for pole delivery;
- 1-2 non-articulated flat bed trucks;
- 1-2 concrete trucks;
- 1-2 trucks for the drill rig;
- 1-2 cranes;
- 1-2 bulldozer/grader/backhoe; and
- 5-10 passenger vehicles.

For the stringing operations two heavier brake and winch trucks and one truck delivering conductor wire, earthwire, and temporary anchor blocks will need access to specific sites every 5-10 km along the route.

The major impacts on most properties associated with the construction traffic will occur over a period of 2-3 days during the erection of the structures. Additional occasional visits will occur for a period of approximately 6 weeks until the line is strung.

These vehicles will either be already located within the region, being owned by local contractors used during construction, or will enter the region via the Castlereagh Highway or Mitchell Highway before following the smaller network of regional and local roads to the construction sites. A worst case scenario of 10 vehicles per day is anticipated at any one location along the transmission line.

6.5.3 Transportation Impacts

Construction Impacts

At any one time, construction traffic is expected to be in the order of 10 vehicles per day. Construction traffic will include long loads carried on flat top trucks.

Table 6.16 - Austroad Traffic Service Assessment Criteria for Rural Roads

Road Stereotype	Quality of Traffic Service		
	Poor (vpd)	Fair (vpd)	Good (vpd)
Unsealed			
Natural Surface	over 100	61 to 100	up to 60
Formed	over 100	61 to 100	up to 60
Gravel one lane (up to 4.5 m)	over 100	61 to 100	up to 60
Gravel two lane (up to 4.5 m)	over 150	61 to 150	up to 60
Sealed Undivided			
One lane (up to 4.5 m)	over 300	151 to 300	up to 150
Narrow two lane (4.6 to 6.4 m)	over 4 000	1 001 to 4 000	up to 1 000
Wide two lane (6.5 to 9.1 m)	over 6 000	4 001 to 6 000	up to 4 000

Three lane (9.2 to 11.6 m)	over 10 000	6 001 to 10 000	up to 6 000
Four lane (over 11.6 m)	over 15 000	10 001 to 15 000	up to 10 000
Divided			
Four lane (up to 9.1 m x 2)	over 30 000	15 001 to 30 000	up to 15 000

vpd = vehicles per day

Where construction works are undertaken in close proximity to residential areas, there may be a temporary impact on the local residential amenity of the area due to increased traffic noise, however, such impacts will be very limited in duration. Construction traffic will only be a minor portion of the total traffic in the area over the period of construction and inconvenience will be limited to one or two days in any location. The worst case scenario of 20 vehicles generated during any one day represents less than 0.3% of the traffic flow on the Mitchell Highway, 1.3% on the Castlereagh Highway, 1.2% on the Golden Highway, and will therefore have no significant impact on the regional road network. Any impacts will be minor in nature and short term in duration.

While the majority of the local roads are sealed two lane roads, others are sealed one lane or unsealed one or two lane roads. The particular impacts of construction traffic on the roads will depend on the road design and alignment.

Trucking of construction materials will occur during daylight hours, generally between 7 am and 6 pm, Monday to Saturday. Given the low volume of trucking associated with the construction of the line, the impacts of traffic and transportation on the roads will not be significant.

Long loads may require lead and/or chase vehicles to warn local traffic as appropriate. The roads in the area are not particularly steep or winding and therefore the long loads are not regarded as a particular transportation issue.

Operational Impacts

During the operation of the line, few vehicles will access the line on a regular basis. The only access required will be associated with maintenance and will involve one or two vehicles on an irregular basis.

Vehicles associated with the ongoing maintenance of the 132 kV transmission line will have a negligible impact on the existing local road network being restricted to 2-3 vehicles per year. Traffic movements will be restricted to electricity line personnel inspecting and maintaining the line.

During the construction phase of the project, there will be an increase in traffic density with the movement of heavy vehicles transporting equipment and materials in and out of the construction sites. However, these impacts will be short in duration, and the overall impact is considered to be non significant.

6.5.4 Transport Controls and Safeguards

All vehicles used in the construction, operation and maintenance of the line will comply with all state and local regulations, licensing and load limits. Drivers will abide by road rules at all times and conduct their business in a professional and courteous manner.

Given that a number of roads that will be required for access are dirt or gravel, these roads will be avoided wherever possible during heavy rainfall or extended periods of wet weather where damage may be caused by the passage of heavy vehicles.

6.6 Fire Risk

TransGrid currently carries out its operations under a "Bush Fire Risk Management Plan". The following procedures are implemented during all activities undertaken by TransGrid personnel and contractors, and will be employed on the Wollar to Wellington 330 kV transmission line:

- Strictly no smoking on easements;
- Bushfire risk areas are identified;
- During bushfire seasons, entry and escape routes along the easements are identified;
- Land managers and owners are identified of entry and exit to land;
- Use of petrol vehicles is restricted on easements to established/cleared access tracks;
- Fire retardant species are used where possible to revegetate corridors;
- Fuel loads are minimised through lopping or clearing of vegetation; and
- Fire extinguishers are carried in all vehicles used on the easement.