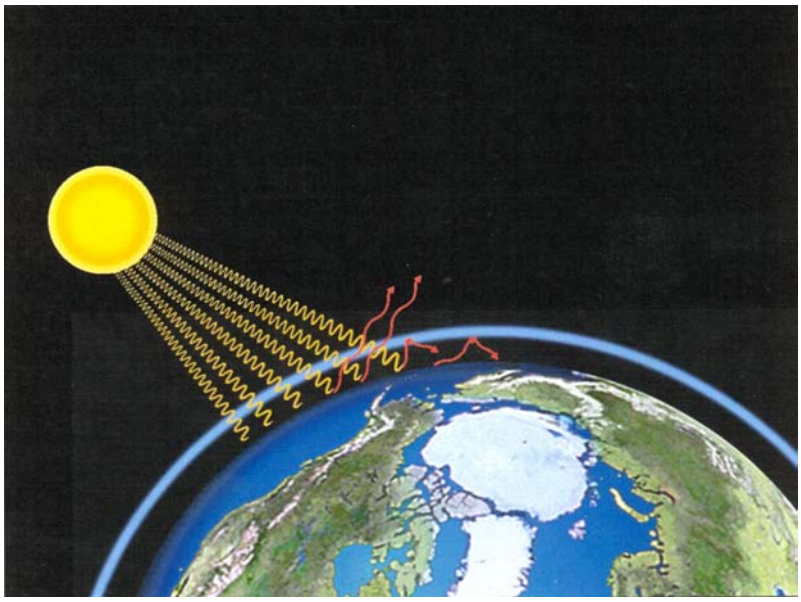
A brief summary of the science of global warming and climate change



Report prepared for an objections hearing in the
Queensland Land and Resources Tribunal

Tribunal reference numbers: AML 207/2006 and ENO 208/2006
Tenure identifier: 4761-ASA 2

Emeritus Professor Ian Lowe
AO FTSE FQA

15 January 2007

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INTRODUCTION

1. I have been asked by the Queensland Conservation Council Inc (QCC) to provide an expert report explaining what are global warming and climate change, how serious a problem are they, and how does the mining, transport and use of coal contribute to these processes? I have also been asked to consider whether the predicted total emission from this mine is likely to contribute to climate change. My letter of instructions is attached as Appendix 1.

2. The science of global warming and climate change is very complex but there is now a broad scientific consensus about much of it. The full complexity is not likely to be relevant for the Land and Resources Tribunal. I have, therefore, deliberately chosen to keep the explanations of the concepts as simple as possible in this report and not over-burden the text with copious citations and complex diagrams or graphs. I also note that Professor Ove Hoegh-Guldberg and Dr Steven Williams, two of the world's leading scientists in their fields, are addressing the likely impacts of global warming on the Great Barrier Reef and the Wet Tropics World Heritage Area, respectively. It is, therefore, not necessary for me to go into great detail about the likely severe impacts of global warming and climate change on the environment.

3. This report has been prepared in response to that request for use in an objections hearing in the Land and Resources Tribunal concerning a large open-cut coal mine. The mine is a proposed extension of the Newlands Coal Mine, Wollombi No. 2 Surface Area, at Suttor Creek approximately 129 km west of Mackay, known as the "Newlands Wollombi No. 2 Project" (the mine).

4. I am told that the proposed mine would involve 28.5 million tons (Mt) of black coal being produced over 15 years. The coal from the mine will be transported to domestic and/or export markets for electricity production (thermal or steaming coal) and/or steel production (metallurgical or coking coal).

5. I have been provided with a report by Dr Hugh Saddler, prepared for QCC, in which he calculates that the total average annual emissions from mining, transporting and using the coal produced by the mine will be 5.6 Mt CO_2-e for the 15 year life of the Project or 84.0 million tonnes of carbon dioxide equivalent (Mt CO_2-e) in total.

6. As a final introductory matter, I note that I have read and understood from the Tribunal's practice direction No. 11 of 2000 that:

   (a) I have overriding duty to assist the Tribunal on matters relevant to my area of expertise;
   (b) I am not an advocate for a party; and
   (c) my paramount duty is to the Tribunal and not to the person retaining me.

RELEVANT EXPERTISE

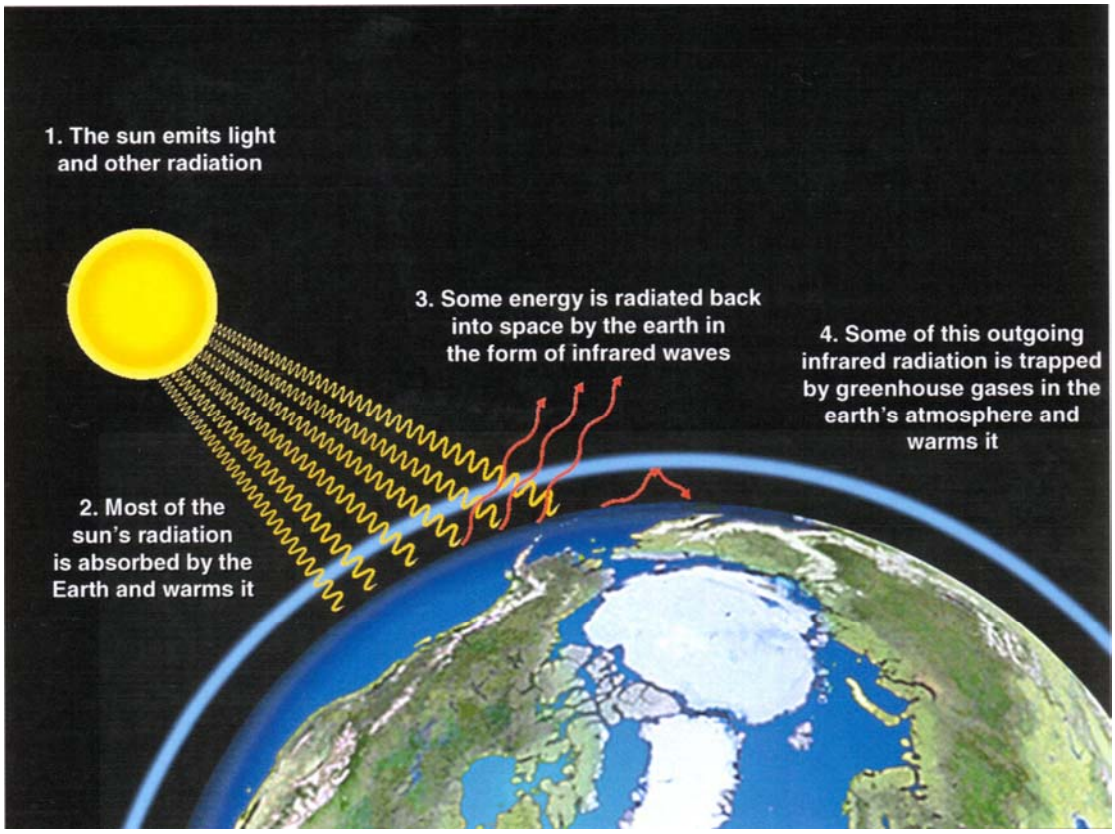
7. My brief biography is Appendix 2 to this report. In summary, I am emeritus professor of science, technology and society at Griffith University, where I was previously Head of the School of Science. I am a recognised expert on the environmental aspects of energy supply and use. As well as having chaired the

relevant committee of the national energy research body from 1983 to 1989, I have acted as a referee for the Inter-governmental Panel on Climate Change and three other global scientific reports on environmental issues. I wrote the first popular paperback book on the subject published in Australia, *Living in the Greenhouse* (1989), and recently published a follow-up book, *Living in the Hothouse* (2005). I was a member of The Australian Climate Group, which produced in 2004 the report *Climate Change Solutions for Australia*.

WHAT IS GLOBAL WARMING AND CLIMATE CHANGE?

8. We have known since the late nineteenth century that the Earth is kept warmer than it would otherwise be by the presence of trace gases in the atmosphere which trap heat. The "**greenhouse effect**" was given its name by the Swedish scientist Arrhenius in the 1890s because he recognised that it worked in the same way as the glass in a greenhouse, admitting the sunlight which warms the interior and blocking the infra-red radiation that would carry the heat away. The natural greenhouse effect is a great benefit and is the fundamental reason why the average Earth temperature, of 14°C, is about 33°C higher than the temperature on our Moon (which does not have an atmosphere). The following diagram provides a simple pictorial explanation of the greenhouse effect.

Diagram of the greenhouse effect[1]



[1] Adapted from Gore A (2006), *An Inconvenient Truth*, Bloomsbury, London.

9. Most people are familiar with one example of the greenhouse effect: the difference in temperature between a cloudy or clear night. After a hot day, a cloudless night is usually considerably cooler than a cloudy night – the difference being that the water vapour in the clouds traps the Earth's heat in and prevents it being radiated to Space. Water vapour is the major greenhouse gas in the atmosphere. This provides a simple example of the greenhouse effect that is a matter of common experience rather than complex science.

10. There are three key terms that require brief definition and explanation to clarify the concepts associated with the enhanced greenhouse effect:[2]

    (a) **Greenhouse gases** are gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. This property causes the greenhouse effect. Water vapour (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3) are the primary greenhouse gases in the earth's atmosphere. Moreover there are a number of entirely human-made greenhouse gases in the atmosphere, such as hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

    (b) **Climate change** refers to a significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. The *United Nations Framework Convention on Climate Change* (UNFCCC), in Article 1, defines climate change as, "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods". The UNFCCC thus makes a distinction between "climate change", attributable to human activities altering the atmospheric composition, and "natural climate variability", attributable to natural causes.

    (c) **Global warming** is the common term for climate change due to anthropogenic emissions of greenhouse gases leading to increased global temperatures and other climatic effects such as changes in rainfall patterns and the frequency of severe storms.

11. Since the Industrial Revolution, humans have been burning **fossil fuels** – coal, oil and gas – that were stored over the geological time of the Earth's history. Burning these fuels essentially combines the carbon within them with oxygen from the air to produce CO_2. This process has now produced a dramatic increase in the amount of CO_2 in the air. Measurements from laboratories over the last fifty years have been supplemented by assessments of polar ice cores dating back 650,000 years.[3]

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[2] I have referred to my own publications and the Australian Bureau of Meteorology (2003), *The Greenhouse Effect and Climate Change*, BOM, Canberra, for these definitions.

[3] See in particular, Petit JR, Jouzel J, Raynaud D, Barkov NI, Barnola JM, Basile I, Bender M, Chappellaz J, Davis M, Dalaygue G, Delmotte M, Kotlyakov VM, Legrand M, Lipenkov VY, Lorius C, Péplin L, Ritz C, Saltzman E, and Stievenard M, (1999) "Climate and atmosphere history of the past 420,000 years from the Vostok ice core, Antarctica" *Nature* 399: 429-436; and Siegenthaler U, Stocker

These studies show that the natural variation of CO_2 levels has been from about 180 to 280 parts per million (ppm) and that global mean temperatures are directly and closely linked to the amount of CO_2 in the atmosphere. The present level of CO_2 in the atmosphere is about 380 ppm and increasing steadily by a further 2-3 ppm each year.[4]

12. This is a simple explanation of the main concepts and processes relevant to the issues facing the Tribunal. The Earth's climate and the science of global warming and climate change is far more complex than this but it is unnecessary to go into more detail about these matters to address the issues facing the Tribunal.[5]

HOW SERIOUS A PROBLEM IS GLOBAL WARMING AND CLIMATE CHANGE?

13. The average temperature of the Earth is now warmer than at any time since human records began and it is clear that much of this increase is due to human activities releasing greenhouse gases to the atmosphere.

14. The Intergovernmental Panel on Climate Change (IPCC), the leading international body on climate change science, concluded in its Third Assessment Report (TAR) in 2001 that mean global temperatures increased by 0.6 ± 0.2°C over the 20th century primarily due to anthropogenic emissions of greenhouse gases from the combustion of fossil fuels, agriculture, and land-use changes.[6] The IPCC projected likely future temperature changes using different scenarios of emissions set out in its *Special Report on Emissions Scenarios* (SRES), with projected concentration of CO_2 in the year 2100 from 540 to 970 ppm, compared to about 280 ppm in the pre-industrial era and about 368 ppm in the year 2000. Based on these projections the IPCC concluded mean global temperatures will increase from 1990 levels by between 0.4 to 1.1°C in 2025, 0.8 to 2.6°C in 2050, and 1.4 to 5.8°C in 2100. The IPCC will deliver its Fourth Assessment Report very soon and it is expected to broadly support these projections within narrower bands of uncertainty.

15. The levels of reduction in anthropogenic greenhouse gas emissions that are required to stabilise global temperatures at less than a mean 2-3°C rise are

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TF, Monnin E, Lüthi D, Schwander J, Stauffer DR, Barnola JM, Fisher H, Masson-Delmotte V, and Jouzel J, (2005) "Stable Carbon Cycle – Climate Relationship During the Late Pleistocene" *Science* 210: 1313-1317.

[4] World Meteorological Organization (2006), *WMO Greenhouse Bulletin 2005: Atmospheric Carbon Dioxide Levels Highest on Record*, at http://www.wmo.int/web/arep/gaw/ghg/ghgbull06.html (viewed 10 January 2007).

[5] A further, reasonably simple, explanation of the science of the greenhouse effect and climate change is Australian Bureau of Meteorology (2003), *The Greenhouse Effect and Climate Change*, available at http://www.bom.gov.au/info/GreenhouseEffectAndClimateChange.pdf (viewed 10 January 2007).

[6] Intergovernmental Panel on Climate Change (IPCC) (2001), *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge. The 4th IPCC report is due for release in February 2007. See generally, the IPCC website at http://www.ipcc.ch/ (viewed 10 January 2007).

uncertain. It will probably require stabilisation of equivalent greenhouse gas concentration of 450 ppm, with further reductions after 2100.[7]

16. Australia has warmed by 0.7°C since 1910, slightly more than the increase in global average temperature. Globally, the period since 1990 has seen all of the ten hottest years since reliable instrumental records began (about 140 years ago). A range of studies collated by the IPCC all agree that the current temperatures are the highest for at least 2000 years. While there is some indirect evidence that there may have been warm periods for small regions in the northern hemisphere in the Middle Ages, all reliable studies show that the recent global and northern hemisphere average temperatures are higher than at any time in at least 2000 years.

17. For Australia, the consequences of anthropogenic global warming and climate change have been: an increase in average temperature of 0.5°C since 1955 and 0.7°C since 1910; an increase in the frequency of very hot days; a decrease in the frequency of very cold nights; more frequent, persistent and intense droughts; more frequent heavy rainfall events; decreased winter rainfall, especially in southern Australia; sea levels increasing about 2 cm per decade; and increasingly frequent extreme events such as category five tropical cyclones, severe east coast low pressure systems and intense bushfires.[8]

18. When I wrote *Living in the Greenhouse* in 1989, it was clear that human activity was changing the composition of the atmosphere and clear that the climate was changing, but most scientists felt it was not provable that the climate change was being caused by the enhanced greenhouse effect. Since then, there has been an immense scientific effort to analyse climate change and develop sophisticated computer models which test theories about the link between greenhouse gas levels and climate. The IPCC has now released three assessments in 1990, 1996 and 2001, with the Fourth Assessment Report due to be released very soon. The IPCC is made up of hundreds of the world's most distinguished atmospheric chemists, physicists and climatologists. Its work is overseen by the United Nations and the World Meteorological Organisation. The assessments show the steady strengthening of scientific confidence that we are seeing real changes in the Earth's climate driven by human activity, principally the release of carbon dioxide and other greenhouse gases (especially methane) as a consequence of energy use.

19. We know that climate change is already imposing significant economic, social and environmental costs on Australia and the rest of the world. In the specific case of Australia, the most obvious economic costs are the impact of reduced agricultural production, the increased cost of water supply and the increasing costs of severe weather events. In terms of primary production, the 2002 drought reduced Australian agricultural output by about 30 per cent, decreasing overall GDP by 1.6 per cent and costing about 70,000 jobs. The present drought will probably have a

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[7] See generally, Houghton J (2004), *Global Warming: The Complete Briefing*, 3rd ed, Cambridge University Press, Cambridge, pp 257-261; and Pittock AB (2005), *Climate Change: Turning Up the Heat*, CSIRO Publishing, Melbourne, pp 152-155.

[8] See generally, Pittock B (ed) (2003), *Climate Change: An Australian Guide to the Science and Potential Impacts*, Australian Greenhouse Office, Canberra.

greater impact. All mainland State capitals now have water restrictions as a result of reduced rainfall and run-off to reservoirs; WA has spent $140 million on a desalination plant to augment its reduced water supply and other States are considering the same approach. In terms of natural disasters, only one of the twenty largest causes of insured losses (the Newcastle earthquake) has not been weather-related; the world's second-largest re-insurer, Swiss Re, has warned that the global cost of natural disasters could double in the next ten years, as small changes in such climate variables as temperature lead to disproportionate increases in storm intensity, drought severity, probability of flooding or risk of severe bushfires. In social terms, intensified summer heatwaves will cause more deaths from heat stress, as happened in Europe in August 2003. Rates of food poisoning and diarrhoeal disease usually increase in hotter conditions (especially in poorer rural communities), while a 2005 report supported by the Australian Medical Association and the Australian Conservation Foundation concluded that vector-borne diseases like dengue fever and Ross River virus will spread as the changing climate increases the areas suitable for the mosquitoes that carry these contagions. Finally, climate change is already having a significant impact on Australia's unique natural systems, decreasing the extent of mountain rainforests, causing coral bleaching, moving snow-lines higher with impacts for alpine species, being associated with the increased frequency of severe fire events and being linked with "thickening" of woody vegetation in savannas and bushland.

20. There is also the risk that climate change could exceed a critical threshold and cause abrupt changes. As an example of the sort of change which could occur, the average rainfall in the Perth area has reduced by about 20 per cent, but the warmer and drier conditions mean the average annual run-off into the water supply reservoirs is now only **one-third** of the figure before 1975. Evidence is emerging that the changes to the atmosphere can alter the working of such important global systems as ocean circulation patterns and the stability of polar ice sheets. The deep ocean circulation of the north Atlantic appears to be slowing now; if this were to accelerate, as some fear, it could affect both the regional climate of western Europe and the capacity of the oceans to support life. The increasing level of carbon dioxide in the air is causing more of the gas to dissolve in the oceans and measurably changing the average acidity, with potentially serious implications for shellfish and corals. There is concern that the large ice sheets of Greenland and West Antarctica could be destabilised, leading to sea level increases of several metres. The scale of these potential risks underlines the need for caution in the way we change the natural systems of the Earth.

21. The Stern report in the UK[9] and the report of the Australian Business Leaders Roundtable on Climate Change[10] both concluded that climate change is already having significant economic impacts and that these will worsen dramatically if the problem is not controlled. The IPCC estimates that global release of carbon

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[9] Stern N (2006), *Stern Review on the Economics of Climate Change*, HM Treasury, London, available at http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm (viewed 10 January 2007).

[10] Australian Business Leaders Roundtable on Climate Change (2006), *The Business Case for Early Action*, available at http://www.businessroundtable.com.au/ (viewed 10 January 2007).

dioxide needs to be reduced by at least 60 per cent to stabilise the atmospheric concentrations and thus stop the enhancement of the natural greenhouse effect.

HOW WOULD THE MINING, TRANSPORT AND USE OF COAL FROM THE MINE CONTRIBUTE TO GLOBAL WARMING AND CLIMATE CHANGE?

22. Dr Saddler calculates in his report that the total average annual emissions from mining, transporting and using the coal produced by the mine would be 5.6 Mt CO_2-e for the 15 year life of the mine or 84.0 Mt CO_2-e in total.[11]

23. An initial point to understand in assessing the contribution that these emissions will make to climate change and global warming is that greenhouse gas emissions are additive, i.e. any emissions add to the amount of greenhouse gases already in the atmosphere.[12] While different greenhouse gases persist in the atmosphere for different lengths of time, CO_2 remains in the atmosphere for around 50-200 years. As a consequence of this, CO_2 emitted into the atmosphere from the mine could influence the atmospheric concentrations of CO_2 for up to two centuries. It is not possible to link these emissions to any particular impact on a specific part of the environment in Queensland, Australia or globally, other than to contribute to greenhouse gases in the atmosphere and thereby contribute to global warming and climate change. The impacts of greenhouse gas emissions from this mine should, therefore, be understood as contributing to the cumulative impacts of global warming and climate change.

24. In assessing the contribution of the emissions from the proposed mine, it is important to understand that geological structures now trap the carbon contained in the coal, so that the carbon is completely isolated from the atmosphere and will not contribute to global warming or climate change in its current form. It would, therefore, be wrong to say that "the mining of this coal will not make any difference to global warming because if this mine does not proceed the coal will just come from another mine somewhere in the World". It is true that there is a large amount of coal in the World and that the coal could be supplied from another mine.[13] However, that reasoning ignores the fact that coal is a finite resource, so the mining and use of the coal from this mine will release to the

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[11] Note that "carbon dioxide equivalents" (CO_2-e), is a standard for measuring the effect of different greenhouse gases. One CO_2-e is equal to the amount of greenhouse gas that has the effect of 1 kilogram CO_2 emitted. The emission of 1 kilogram of N_2O equals 310 CO_2-e and the emission of 1 kilogram of CH_4 equals 21 CO_2-e. The major greenhouse gas emitted from the use of coal is CO_2 itself, which is equal to CO_2-e by definition but the standard term is used here because mining coal also releases other greenhouse gases, especially methane.

[12] In the past 200 years, more than 2.3 trillion tons of CO_2 have been released into the atmosphere due to human activities relating to fossil fuel consumption and land-use changes: Baumert KA, Herzog T, and Pershing J (2005), *Navigating the Numbers: Greenhouse Gas Data and International Climate Policy*, World Resources Institute, available at http://www.wri.org/climate/pubs_description.cfm?pid=4093 (viewed 11 January 2007), p 4.

[13] Globally, coal reserves are significantly larger than other fuels. At current prices and consumption rates, present reserves of coal will not be depleted until the year 2168. Total global coal consumption, production, and reserves in 2004 are 2,778, 2,732, and 448,464 million tons of oil equivalent, respectively: Baumert, Herzog, and Pershing, n 12, pp 43 and 44.

atmosphere fossil carbon that would otherwise be trapped in the ground. Such reasoning also ignores the growing recognition that reasonable and practicable measures should be required to avoid, reduce or offset the greenhouse gas emissions from all human activities, including the proposed mine. Global warming and climate change are massive problems for society that, ultimately, need to be addressed through action at the level of individual projects such as this proposed mine.

25. As the emissions of greenhouse gases from the mine will add to the amount of greenhouse gases already in the atmosphere, they need to be considered in the context of national and global emissions. Dr Saddler notes that the most recent available data on Australia's national direct greenhouse gas emissions were set out by the Australian Greenhouse Office in the *National Greenhouse Gas Inventory 2004*. The AGO found Australia's direct greenhouse gas emissions in 2003-04 were as follows:

Sector	**Emissions (Mt CO_2-e)**
Energy	387.5
Stationary Energy	279.9
Transport	76.2
Fugitive Emissions	31.0
Industrial Processes	29.8
Agriculture	93.1
Land Use, Land Use Change and Forestry	35.5
Waste	19.1
Australia's Net Emissions	564.7

26. Dr Saddler also notes that global greenhouse gas emissions in 2000 (excluding emissions from land use, land use change and forestry) are estimated to have been nearly 34 Gigatonnes of CO_2 equivalents (Gt CO_2-e).[14]

27. To put the potential release of CO_2 from the proposed mine extension into context, the lifetime emissions from the proposed mine extension would be about one quarter of the national figure for a year, more than the total annual emissions of the entire transport sector, or about 0.24 per cent of the current annual global release of greenhouse gases.

28. The IPCC data show that about 40 per cent of the carbon from fossil fuels released each year comes from coal, about 40 per cent from oil and about 20 per cent from gas. Since some of the oil is used to transport coal, the IPCC figure of about 10,000 Mt, or 10 Gt, of CO_2 released each year from the burning of coal should be

[14] World Resources Institute, Climate Analysis Indicators Tool (CAIT) Version 4.0. http://www.wri.org/climate/ (accessed 19 December 2006). 1 Gt equals 1,000 Mt.

seen as a conservative estimate that does not include the associated transport emissions. Because coal contains more carbon and less hydrogen than oil or gas, it produces proportionately more CO_2 per unit energy. In round figures, gas produces about 60 per cent of the CO_2 per unit energy of coal, while petroleum fuels produce about 80 per cent. Burning coal to generate electricity is extremely inefficient, so that coal-fired electricity releases about five times as much CO_2 per unit energy as burning gas.

29. The global problem of climate change stems from compounding of all the local decisions to burn fossil fuels and release carbon dioxide. Australia, like other OECD countries, agreed at the Kyoto conference to curb our greenhouse gas emissions, though we have since joined the USA in refusing to ratify the treaty. The consensus at Kyoto was that the global problem requires a global solution, to which all countries must contribute. Apart from the USA and China, every country accounts for a small fraction of the global greenhouse pollution, but all will have to play a role in reducing the burden on the atmosphere.

30. The Stern report in the UK and the report of the Australian Business Leaders Roundtable on Climate Change both concluded that the most effective way to slow down the release of greenhouse gases is to build a clear price signal into our economic system. There are two obvious mechanisms to achieve this. Either the government sets a carbon tax and uses the proceeds to offset emissions, or we establish the principle that those who release carbon dioxide are responsible for offsetting their own emissions. There will be legal and political difficulties in applying new conditions retrospectively to existing commercial activities. So the most obvious solution is to apply stringent conditions to any large project that would release significant amounts of carbon dioxide or methane, making the project greenhouse-neutral.

CLEAN COAL AND GEO-SEQUESTRATION

31. There is a strong emphasis at the present time in the Australian and Queensland Governments and the coal industry on "clean coal" and geo-sequestration (basically, capturing and pumping greenhouse gas emissions underground rather than emitting them to the atmosphere).[15] The Xstrata group of companies, of which the main proponent of the mine is part, is the world's largest exporter of thermal coal. It notes on its website that:[16]

> Xstrata Coal recognises that coal is also a carbon liability and that climate change is a real international and community issue. Furthermore, the company believes that emission reductions resulting from the use of coal are required and achievable within a sustainable development framework.
>
> Through its approach to climate change, Xstrata Coal:
>
> - acknowledges that any action taken to address climate change has a delay, so planning for the future is needed now;

[15] See generally, Metz, B., O.Davidson, H. C. de Coninck, M. Loos, and L.A. Meyer (eds) (2005) *IPCC special report on Carbon Dioxide Capture and Storage*, prepared by working group III of the IPCC, Cambridge University Press, Cambridge. Available at www.ipcc.ch (viewed 11 January 2007).
[16] http://www.xstrata.com/reports/doc/x_hsec_climate_change_2004.pdf (viewed 12 January 2007).

- is committed to playing a part in identifying and implementing solutions to the challenge of climate change;
- recognises that the future will be a "carbon-constrained world";
- is working together with governments, researchers and industry in Australia through the COAL21 programme to develop a portfolio of options for reducing greenhouse gas emissions from the use of coal in electricity generation;
- collaborates in research and development programmes and provides both technical and financial support to dedicated Cooperative Research Centres focused on near zero emission technologies;
- supports additional research into CO_2 capture and storage;
- assesses its products for utilisation in new, near-zero emission future technologies, such as gasification;
- has developed a close working relationship with the power generation industry to help expand the implementation of higher efficiency, low emission power plants;
- strives continually for the more efficient use of energy and reduction of greenhouse gas emissions at its operations;
- looks to collaborate with its customers, both domestic and international, towards the sustainable use of coal through new power generation technologies;
- seeks to enter into joint ventures with power generation companies in capturing and using methane to generate electricity, thereby preventing further greenhouse gas emissions from its operations; and
- monitors and explores opportunities for the use of emission reduction mechanisms proposed in the Kyoto Protocol.

Xstrata Coal plans to spend in excess of US$9 million over the next five years on research into clean coal technology, methane utilisation, and carbon sequestration.

32. There are many ways in which the use of coal can be made more efficient, thereby reducing overall emissions, but the potential for commercial, industrial-scale CO_2 storage underground (carbon or geo-sequestration) is currently a matter of speculation. While CO_2 has been injected into declining oil fields for more than 30 years to increase oil recovery and the technology for capturing of CO_2 is already commercially available for large CO_2 emitters, such as power stations, storage of CO_2, is a relatively untried concept. At this time, no power station anywhere in the world operates with a full carbon capture and storage system.

33. The research that is currently being conducted on geo-sequestration is not expected to produce viable, commercial applications for at least 15 years. Even on the most optimistic view, there would then be major economic and practical issues of retro-fitting existing power stations and other coal burning facilities to capture CO_2 emissions and pump them underground. The potential for geo-sequestration also depends upon locating suitable geological formations into which the gas or liquid form of the emissions can be injected with complete confidence that the carbon would not escape. This is certainly problematic, and very probably costly.

34. Based on currently available technology it can be assumed that none of the CO_2 emissions from the use of the coal from this mine will be captured and stored underground. Consequently, it should be assumed for the purposes of assessing the potential impacts of the mine that all of the greenhouse gas emissions from the mining, transport and use of the coal will be emitted to the atmosphere and contribute to global warming and climate change.

APPENDIX 1 – LETTER OF INSTRUCTIONS

ENVIRONMENTAL DEFENDERS OFFICE (QLD) INC.

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9 January 2007

Emeritus Prof. Ian Lowe
School of Science
Griffith University
Nathan Qld 4111

Via e-mail: I.Lowe@griffith.edu.au

Dear Ian

Queensland Conservation Council Inc ats Xstrata Coal Queensland Pty Ltd & Ors

Objection to Mining Lease Application for Newlands Coal Mine Expansion

We act for the Queensland Conservation Council Inc ("QCC") in relation to an application lodged by Xstrata Coal Queensland Pty Ltd for a coal mine expansion at Newlands Coal Mine. QCC will argue, in the Land & Resources Tribunal, that the coal mine expansion should not be approved without imposing conditions to avoid, reduce or offset the greenhouse gas emissions from the mining, transport and use of the coal.

Background

Xstrata Coal Queensland Pty Ltd ("Xstrata") and its joint venturers[1] have applied for a mining lease under the *Mineral Resources Act* 1989 (Qld) ("MRA") and an environmental authority (mining lease) under the *Environmental Protection Act* 1994 (Qld) ("EP Act") for an open cut coal mine (ML 4761). The applications are for an additional surface area for extension of the Newlands Coal Mine, Wollombi No 2 Surface Area, at Suttor Creek approximately 129 km west of Mackay, known as the Newlands Wollombi No. 2 Project ("the Newlands Coal Mine Expansion").

The mine will produce up to 2.5 million tonnes per annum ("Mtpa") of run of mine ("ROM") black coal for a nominal annual average of 1.9 Mtpa product coal over a 15 year mine life, or 28.5 Mt of coal in total.

The coal from the mine will be transported to domestic and/or export markets for electricity production (thermal or steaming coal) and/or steel production (metallurgical or coking coal).

Subject to finalising his report, Dr Hugh Saddler calculates the greenhouse gas emissions from the mining, transport and use of the 28.5 Mt of coal from the mine for electricity production or

[1] Itochu Coal Resources Australia Pty Ltd, ICRA NCA Pty Ltd, and Sumisho Coal Australia Pty Ltd.

steel production will be approximately 81 – 85.5 Mt of carbon dioxide equivalent ("Mt CO2–e"). The majority of the greenhouse emissions from these projects will occur overseas when the coal is used.

Expert evidence

The key evidentiary issues QCC will address in expert evidence are:

1. What is global warming and climate change, how serious a problem is it, and how does the mining, transport and use of coal contribute to these processes?
2. The likely greenhouse gas emissions from the mining, transport and use of the 28.5Mt of coal from the mine (possibly just by using the Australian Greenhouse Office Workbook).
3. The contribution that the likely greenhouse gas emissions from the mining, transport and use of the coal from the mine will make to climate change and potential impacts of this.
4. The reasonable and practicable means to avoid, reduce or offset the likely greenhouse gas emissions from the mining, transport and use of the coal from the mine, including the costs of these measures being imposed.
5. The likely impacts of climate change on the Queensland economy.

We would very much value your assistance as an expert for QCC to address issue 1. In your report, please also consider whether, in your opinion, the 81 – 85.5 Mt of carbon dioxide equivalent predicted total emissions from this mine can or is likely to contribute to climate change.

Documents

We attached electronically copies of the following documents:

1. The Land and Resources Tribunal Guidelines for expert witnesses (Practice Direction No 11 of 2000)

2. The objection dated 7 November 2006 lodged by QCC

3. Further and better particulars filed by QCC

4. Extracts from the EIS for the Newlands Coal Mine dated December 2005, as follows:
   i. Executive Summary – pages ES-1 to ES-9
   v. Greenhouse Gas Inventory – page6-16 to 6-17

5. *Factual and Legal context of the QCC objection in the Queensland Land & Resources Tribunal to the Newlands Coal Mine Expansion* prepared by Chris McGrath, barrister.

Timeframe

There is a very tight timetable for the proceedings as follows:

1. Experts' affidavits are to be filed by **15 December 2006**;
2. Experts within similar field of expertise are to confer by **18 January 2007** with a view to resolving or narrowing any matters upon which they disagree;
3. Experts within similar field of expertise are to file and joint report by **22 January 2007** setting out the matters upon which they agree and any matters upon which they disagree, and the reasons for any disagreement;
4. The matter is set down for hearing in the Land and Resources Tribunal over three days commencing **31 January 2007**.

It may well be that the other parties will not rely on evidence from experts within your area of expertise and there will be no need for a joint meeting or joint report. At this stage, we do not know whether you will be required for cross-examination. As you will be in South Australia, we will seek leave for you to appear at the hearing by telephone.

Your duty to the Tribunal

We emphasise that, in accordance with the attached guideline for expert witnesses:

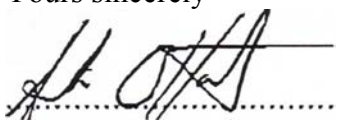
- You have overriding duty to assist the Tribunal on matters relevant to your area of expertise;
- You are not an advocate for QCC; and
- Your paramount duty is to the Tribunal and not to QCC.

We also emphasise that neither QCC nor its lawyers seek to influence your views in any way and we ask for your independent opinion to assist the Tribunal. Consequently, please note that any statements of fact or opinion in this letter of instructions, the above documents, or anything given or said to you by QCC or its lawyers relevant to the issues in your report do not constrain you in any way and are not intended to influence your views. We ask you to form your own opinion about the relevant facts and circumstances for the purposes of your report.

On behalf of the EDO and QCC, thank you very much for generously agreeing to act at such short notice. QCC have undertaken fundraising to pay for the experts in this matter. Please provide an estimate of your fees if at this stage, your believe your fees are likely to be greater than $3,000.

If you have any queries, please do not hesitate to contact me on (07) 3289 7991.

Yours sincerely



Anita O'Hart
Solicitor
Environmental Defenders Office (Qld) Inc

APPENDIX 2

BRIEF BIOGRAPHY: PROFESSOR IAN LOWE AO FTSE FQA

Professor Ian Lowe is an emeritus professor at Griffith University, where he was previously Head of the School of Science. He holds a Bachelor of Science with Honours in physics from the University of New South Wales, a D.Phil. from the University of York (UK) and was recently awarded a D.Univ. by Griffith University.

Professor Lowe is an internationally recognised expert on environmental issues, energy, science, technology and futures. He has held senior advisory roles for all three levels of government and consulted extensively for companies and peak organisations in the private sector. He is President of the Australian Conservation Foundation.

Professor Lowe was made an Officer of the Order of Australia in 2001 for services to science and technology, especially in the area of environmental studies. In 2002, he was awarded a Centenary medal for contributions to environmental science and won the Eureka Prize for promotion of science. He has also received the Prime Minister's Environment Award for Outstanding Individual Achievement and the Queensland Premiers Millennium Award for Excellence in Science.

Professor Lowe is a member of the Environmental Health Council, the Radiation Health and Safety Advisory Council and the National Commission for UNESCO. He chairs the Queensland Government task force implementing the reform of science education and the Brisbane City Council task force on climate change and energy, and is also deputy chair of the Queensland Sustainable Energy Innovation Group, which advises the state government on energy innovations. He chaired the advisory council that produced in 1996 the first national report on the state of the environment. He was a member of the National Energy Research, Development and Demonstration Council from 1983 to 1989, chairing its standing committee on economic, social and environmental issues, and directed the Commission for the Future in 1988.

Professor Lowe has been a referee for the Inter-governmental Panel on Climate Change, the scientific body set up by the United Nations to advise on climate change. He attended the Geneva and Kyoto conferences of the parties to the Framework Convention on Climate Change, and was a member of the Australian delegation to the 1999 UNESCO World Conference on Science. He was on the steering group for the UNEP project Global Environmental Outlook and an invited participant in the 2000 and 2003 workshops on Sustainability Science. He acted as a referee for both the International Geosphere-Biosphere Program's 2004 report, "Global Change and the Earth System", and the UN's Millennium Assessment Report, released in 2005.

Professor Lowe has made countless contributions to newspapers, radio, television and periodicals and gave the ABC's Boyer lectures in 1991. He is a member of the board of Major Brisbane Festivals Ltd and was a member of the organising group for the 2006 Earth Dialogues in Brisbane. He has been an advisor for the three Ideas Festivals held in Brisbane and is Vice-President of the Queensland Academy of the Arts and Sciences.