Upper Hunter Holding Pty Ltd Upper Hunter Holdings Upper Hunter Holding Pty Ltd Upper Hunter Holdings, of Sunrise Town Planning, made the following submission on the project:

Mangoola Mine - Modification 6 - Extraction Rate Increase

Objects to this project

The property owners who have commissioned our report are rightly concerned about a number of
inconsistencies between their real life experiences with the impacts of the current operations of the Mangoola
Mine and the monitoring report undertaken on behalf of Mine Management.

Benbow Environmental has prepared an objective review of the documentation provided by the mine and their
experts and has found a number of environmental issues that would seem to support the concerns of the
adjoining property owners. Whilst these lie principally with noise, blasting, dust and the transport noise impact
assessment, our findings raise serious questions as to the overall rigour of the proponent's application.

- Attachment: 131062_Report_Final.pdf
- Attachment: 131062_Rep_Final_Attachments 1-2.pdf
- Attachment: 131062_Rep_Final_Attachments 4.pdf
- Attachment: 131062_Rep_Final_Attachments 5-7.pdf
- Attachment: 31062_Rep_Final_Attachments 3.pdf

SUBMISSION TO MANGOOLA MINE EA ON BEHALF OF PROPERTY OWNERS OF RIVERSLEA, WYBONG PARK, WYBONG ESTATE, DOLWENDEE AND HOLLYDENE ESTATE

Prepared for:	Upper Hunter Holding Pty Ltd Upper Hunter Holdings Pty limited-Dolwendee Upper Hunter Resources Pty Limited-Riverslea and Wybong Park United Pastoral Pty Limited -Hollydene Estate Wybong Estate Vineyard Pty Limited - Wybong Estate Wybong Estate -Wybong Winery
Prepared by:	R T Benbow, Principal Consultant Daniele Albanese, Acoustical & Environmental Engineer BENBOW ENVIRONMENTAL *North Parramatta NSW*
Report No:	131062_Rep_Final June 2013 (Released: 28 June 2013)

Benbow
ENVIRONMENTAL

Engineering a Sustainable Future for Our Environment

Head office: 13 Daking Street North Parramatta NSW 2151 AUSTRALIA
Tel: 61 2 9890 5099 Fax: 61 2 9890 5399
BE Australia: Wollongong NSW, Taree NSW, Calamvale QLD
BE Asia: Causeway Bay, Hong Kong
Email: admin@benbowenviro.com.au
Visit our website at: www.benbowenviro.com.au

EXECUTIVE SUMMARY

A submission to the proposed extension of the Xstrata Mangoola open coal mine has been prepared by Benbow Environmental for the owners of the following properties:

- Riverslea Trust -Riverslea;
- Upper Hunter Resources Pty Ltd -Wybong Park;
- Wybong Estate Vineyard; Pty Ltd
- Upper Hunter Holdings Pty Ltd -Dolwendee
- United Pastorall -Hollydene Estate.
- Wybong Estate Pty Ltd

The submission focuses on areas of Benbow Environmental's expertise – noise, blasting and air emission impacts.

Reviews of these specialist sub consultant reports being relied upon in the Environmental Assessment have been prepared.

It is recognised that the coal mining industry in NSW and specifically the Hunter Valley is of vital importance for the people of New South Wales both in providing royalties to the State Government and the massive use of infrastructure and employment that secures the financial viability of many of the community in this Region.

However, not withstanding the significance of this industry, the cumulative impacts from numerous open cut coal mines are causing significant concerns to industries and adjoining landholders. The perception amongst these greatly concerned stakeholders is that adverse environmental impacts resulting from the continued expansion of the coal mining industry are occurring which may be understated. In relation to the important neighbouring landuses being viticulture, cropping, commercial beef cattle and the Equine and Vineyards Industries it seems likely that impacts on these specific Industries may have been glossed over or even ignored completely.

An additional concern is the very real impacts the coal industry can have upon surrounding property values. The presence of an open cut mine adjoining the property of one of the clients of the report resulted in the inability of the owner to obtain mortgage financing from their bank. Upper Hunter Holdings Pty Limited has tried to sell Lot 3 DP 113745 on a number of occasions only to have each purchaser pull out due to the Banks refusing to finance the purchase due to its proximity to Mangoola Mine. This concern is not considered by the proponent in any of the reports we have been able to examine.

The property owners who have commissioned our report are rightly concerned about a number of inconsistencies between their real life experiences with the impacts of the current operations of the Mangoola Mine and the monitoring report undertaken on behalf of Mine Management. There is considerable alarm at the proposed expansion of this mine from 10,500,000 tpa to 13,500,000 tpa ROM coal and some consternation at the veracity of the specialist reports that support what is a significant 33% increase in production.

Benbow Environmental has prepared an objective review of the documentation provided by the mine and their experts and has found a number of environmental issues that would seem to support the concerns of the adjoining property owners. Whilst these lie principally with noise, blasting, dust and the transport noise impact assessment, our findings raise serious questions as to the overall rigour of the proponent's application.

In summary the following are the main areas of concern:

- Recently approved land subdivisions and new building sites have not been considered in the lists of receiver locations.
  This may have significant impact on the economic viability of the wineries, a tourism activity where additional cabins for long and short term accommodation is in place or have been approved particularly at Dolwendee, Hollydene and Wybong Estates.

- As these additional receivers have not been included in the noise, blasting and air emissions assessment, reliance may be placed on the contour plots of noise and dust rather than on the discrete receptors being included in the modelling.

  For noise specifically there usually is an important difference of 2-4dB(A) between a noise contour plot and the modelling at discrete receptors.

- One of the property owners reported that he was advised during the consultation programme that the operational noise levels were expected to <u>increase</u> as a result of the expansion in the intensification of the coal mining activities. However the findings of the noise assessment report show a significant <u>reduction</u> in operational noise levels. This inconsistency has caused the property owners to question the accuracy of the noise modelling.

It is of concern to us that in the limited timeframe available to us in which to prepare our submission we have nonetheless been able to identify 25 inconsistencies that could lead to over optimistic noise predictions. A detailed discussion of the findings of the review is included in the body of this report.

These issues all require clarification but unnecessarily complicating an objective assessment are the use of a different noise model to that model used in the earlier assessments. Compounding this is a failing to calibrate the noise model being used. Given that the mine is actually in operation this is somewhat surprising.

We further note that earlier versions of the model gave overly optimistic noise reductions due to topography; this led to corrections being made to the model with the direct result that the version used in the assessment is now outdated.

The Annual Environmental Management Plan for the period 1 January 2012 to 31 December 2012 in relation to noise in Section 3.11.1 states that attended noise monitoring is not undertaken at 71 receivers but only at those receivers agreed to with OEH (now NSW EPA) and can be '*inferred*' using a calibrated noise compliance model. In our view it is not acceptable to make an '*inference*' in these circumstances but that the results claimed should be demonstrated.

It is somewhat incongruous that the published noise monitoring data shows no exceedances, yet there were 386 complaints formally registered relating to noise. Given that noise prediction model for the mine extension was not calibrated this is a significant deficiency in the report. It is not surprising that the adjoining affected property owners disbelieve the assumptions and conclusions of the noise assessment.

Also missing is any comment on compliance with road and rail noise impacts resulting from the proposed 33% increased production.

Based on the large number of inconsistencies found and the significant failure to ensure objectivity by calibrating the noise model regardless of its origin and choice as being the "best" model to use, uncertainty has been created. This unfortunately needs to be resolved and reinforces the community's opinion that their concerns are not weighted equally due to the significance of the coal mining industry to the economy of NSW.

The blast prediction assessment also raises uncertainty due to the arguments presented to remove the condition that limits the MIC.

The assessment makes the statement that the findings "*suggest*" that this condition can be deleted. This is an inopportune expression as consents on such a major issue would need conclusive evidence rather than one with an underlying risk that it may be wrong. The facts to support the recommendation need to be based on strong findings supported by monitoring data, not merely that the findings "*suggest*" such an outcome.

One of the concerns of the property owners relating to blasting is the lack of consideration for the existence of a very old winery on one of their properties. We would have expected that at least the lower ground vibration criteria applicable to historic dwellings and structures would have been applied, yet this has been missed in the document. The property Wybong has a winery and tourist facilities present which dates back to 1965.

The winery building was an original convict sandstone gaol of mid 1800's and has been further developed in 1965 with large historic woolshed timbers for colonial Sydney and from Huon pine brought to the estate by Dr. Smith who was granted special permission to mill the Huon pine by the then head of the Legislative Council of Tasmania. This facility is being refurbished for overseas and VIP guests of the wine estate. Similarly at Hollydene Estate with origins back to the 1960s along with Wybong two of the oldest winery vineyards in the Upper Hunter.

The blast impact assessment needs to address historical buildings.

The Director General Requirements specifically requires various matters to be addressed by the proponent. Yet from the specialist reports provided we note that the following issues have been omitted.

- Assessment of transport noise relating to rail. Presumably as a result of increased production a greater number of rail movements will be required. The potential impact along the rail route especially the cumulative impact due to the intensification from the planned expansion of other coal mines in the area would have been expected as a fairly basic observation needing at least to be addressed in the report and assessed objectively to further the commitment being made to the community by this industry.

  The DGR relating to blasting stated that the impacts on <u>livestock and property</u> also needed to be considered besides the effects on people.

  Whereas the air impact assessment has given consideration to blast fumes upon <u>people</u> it has not considered the impact of oxides of nitrogen within the plume from the blast fume and health implications to the important <u>Equine and Vineyards Industry for which the Hunter Region is notable</u>.

The air emissions assessment needs to address the impacts at the subdivisions on the land holder's properties. These have not been considered and this is a flaw in an otherwise satisfactory assessment.

The land holders advise that the water tanks on three of their properties are desludged by the coal mine and sludge is removed. This practice is not mentioned in the air impact assessment report and would have been of relevance.

The levels of dust deposition may therefore be higher at these landholdings then was modelled.

Calibration of the predicted levels with measured results has not occurred and the sensitivity of the assumptions in the modelled predictions is unable to be tested.

The environmental reporting does not attempt to establish the contribution of the dust that occurs from the coal mining activities. Analyses of the dust deposited on the roofs and in the gutters of homes on the land owners properties would be able to be used to establish the proportion that is due to coal mining.

The levels of the dust deposition measured at the gauges and predicted in the model would not be expected to require desludging of these tanks used for drinking water.

The sensitivity of the predicted levels to error has not been addressed in the report.

Given the importance of dust to the community especially those engaged in sensitive agricultural activities, a sensitivity analysis would be considered essential.

We note that other air impact assessments undertaken for other coal mining intensification projects also fail in this regard.

Assessments of coal mining need to establish a higher level of transparency given the potential adverse impacts and the significance of these.

R T Benbow

R T Benbow
Principal Consultant

CONTENTS PAGE

FIGURES PAGE

ATTACHMENTS

Attachment 1: Site Plan Lot 1
Attachment 2: Site Plan Lot 2
Attachment 3: Approved Plans Lot 1
Attachment 4: Approved Plan Lot 2
Attachment 5: Plan of Subdivision
Attachment 6: Masterplan ‘Riverslea’ Denman Road, Muswellbrook
Attachment 7: Riverslea Subdivision of Lot 511 DP 854289
Attachment 8: Sub Plan 4620_001
Attachment 9: Atmospheric Environment (NO_x Emission from Blasting Operations in Open Cut Coal Mining)
Attachment 10: Dangers of Toxic Fumes from Blasting
Attachment 11: Safety Alert (Prevention and Management of Blast Fumes)

1. INTRODUCTION

This submission was prepared on behalf of adjoining property owners who believe their amenity will be adversely affected by the planned intensification of Mangoola Mine.

Benbow Environmental were engaged to provide an objective review of the noise, blasting, dust and blast fume impacts from the proposed intensification.

The experience of the land owners is that adverse impacts are already occurring and these are not being evaluated to a sufficient extent to remove doubts. Certain of these doubts are reflected in clearly audible night time operations and coal and airborne dust including drinking water tanks continually being contaminated.

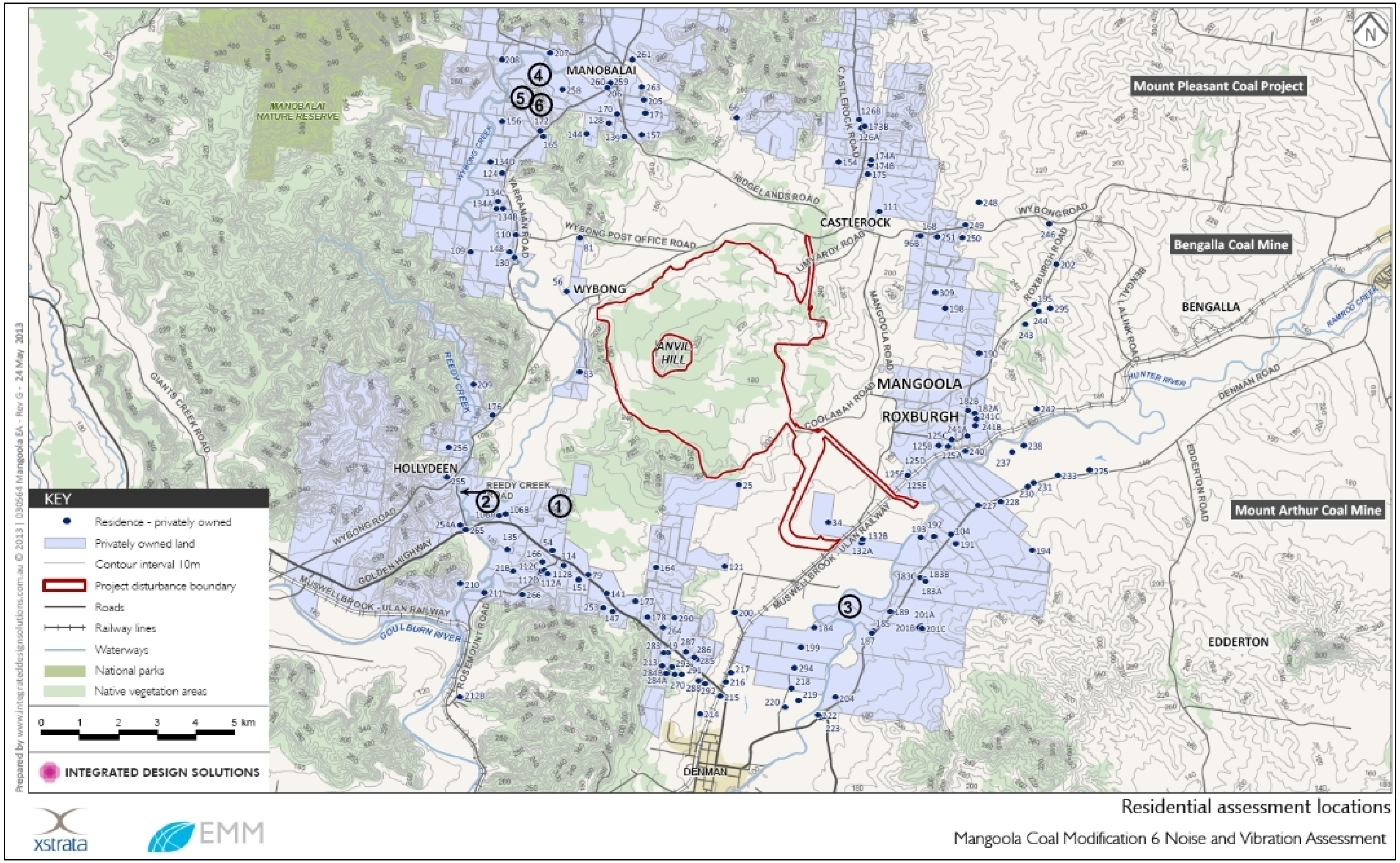
The absence of recently approved land subdivisions on the site layouts in the EA reinforce their doubts.

Refusal by a major lending authority for a first mortgage on one of their properties developed specifically for tourism reinforced their experiences that intensification of the mine would further impact on their lifestyle and value of their properties.

These many issues raised are discussed within this report.

The additional receiver locations are shown on Figure 1-1.

Figure 1-1: Location of additional Receiver



Note:

1- Upper Hunter Holdings P/L – 'Dolwendee' Lots 1,2, 3, 4
2- United Pastoral P/L – 'Hollydene Estate' Lots 5,6,7,8
3- Upper Hunter Holding Resources P/L – 'Riverslea'
4- Upper Hunter Holding Resources P/L – Wybong Park Lot 102
5- Wybong Estate (Vineyard) P/L – Wybong Estate Lot 103
6- Wybong Estate P/L – Lot 13

2. REVIEW OF THE NOISE IMPACT ASSESSMENT

This section presents the findings of the objective review undertaken of the *Mangoola Coal Project – Modification 6 Noise and Vibration Assessment* released on 22nd May 2013.

The following are the major deficiencies in the report with regard to noise:

1- Page1: No details of the proposed increase in equipment numbers are provided. On page 19 (last paragraph of section 3.1) it is stated that *"minor differences of plant and equipment quantities"* would occur.
Given that the increased production target is 33% it is an inadequate statement to justify how the increase in the annual tonnage will be achieved without a commensurate increase in plant and equipment.

2- Page 3 bullet point n.2. States that up to **150 additional employees and 90 contractors** are considered in this assessment. In section 4.8 it is stated that an additional 139 peak employee movements would result from the proposed modification. It is not clear how this number has been obtained. Moreover, it is not clear why in table 4.8 only an additional 122 light vehicles in addition to the current 152 vehicles have been considered. The increased number of employees, contractors and vehicles are in contradiction with one another.

3- Page 8, last paragraph states that no cumulative operational noise was considered in the assessment as existing industrial noise sources near Mangoola Coal with potential to contribute to cumulative noise are '*limited*'. Noise measurement should be undertaken from these other existing industrial sources in order to assess the cumulative noise impacts.

4- Page 9, first paragraph "*Schedule 3, Condition 7 of PA 06_0014 provides criteria for road traffic noise, which remains relevant to the proposed modification".*
Condition 7 of PA 06_0014 is based on the superseded EPA 'Environmental Criteria for Road Traffic Noise". *The new guideline to be considered is the NSW EPA Road Noise Policy released in March 2011.*

Table 2.2 is assumed to contain a typographical error and, in accordance with the ECRTN and RNP this would be corrected by considering the following noise descriptors.
$L_{Aeq(15hours)}$ and $L_{Aeq(9\ hours)}$ for Denman Road for daytime and night-time respectively.
$L_{Aeq(1hour)}$ for Wybong Road and Bengalla Link Road as per NSW EPA Road Noise Policy.

5- The low frequency criteria obtained from the NSW EPA INP should apply. However, if the proposed criteria apply (Norm Broner "A simple outdoor criterion for assessment of low frequency noise") this should consider the frequency range from 10Hz. As data are presented in 1 octave band centre frequency starting from 63Hz, thus the low frequency noise assessment results presented in this report could be inaccurate.

In addition, if instantaneous dB(C) Sound Pressure Level is fluctuating by at least ±5dB then a penalty of 5dB applies. This situation has not been described in the report.

6- Page 13. No explanation of the rationale for the selection of the two exceedances intervals for "management zone" and "affectation zone" is provided.

7- Page 15, second paragraph. "*Similarly, the World Health Organisation (WHO, 1999) suggest that levels **below 45 dB(A)** inside homes are unlikely to wake sleeping occupants".*

This is inaccurate as WHO states that levels **up to 45dB(A)** are acceptable but only if the number of events per night is less than 10-15. The anticipated number of such night-time events is not canvassed so there is no way of knowing what is the expectation.

8- Page 19, section 3.2, first paragraph. "*It is prudent to gain an understanding of this variation rather than relying on a single predicted noise level for one set of weather conditions as prescribed in the INP".*

We find this statement to be incorrect as the NSW EPA INP does not prescribe one set of weather conditions, but it considers two options: simple approach and detailed approach which would consider default weather conditions and site specific weather condition respectively. This is presented in Section 5 of the INP. Usually the default weather conditions provide a more conservative approach. For example when considering wind direction from source to receiver instead of specifying a wind direction.

No details of the considered weather conditions have been included in the report.

9- Page 20, second paragraph: "*This analysis results in a noise probability distribution for each receptor, which was used to establish an upper 10% noise level from the mine. This approach is consistent with the most recent previous assessment undertaken for the Modification 4 process approved in June 2012 (refer to Section 5 of Appendix C7 of the Modification 4 EA, Wilkinson Murray 2010). However for the current assessment, EMM adopted three years of hourly weather data between 2010 and 2012 as recorded by the site's northern meteorological station.*

Often a reasonable indicator of noise impact is associated with an industrial noise level present for at least 10% of the time. This is consistent with the intent of the INP".

The noise impact assessment should present results for the worst $L_{Aeq(15\ minute)}$. It is understood that the report shows the 10th percentile of the $L_{Aeq(15\ minute)}$ for different weather conditions.

This anomaly could be the underlying reason for the adjoining residents' complaints about noise as there is no verification from the weather information available.

10- Page 21, section 3.3 last paragraph. "*Other noise mitigation measures were considered and ruled out due to analysis of their reasonable and feasibleness. This included bunding on dumps and haul roads, additional restriction of operations at night time under adverse weather and trolley assist systems".*

Although '*other mitigation measures were considered and ruled out...*" there are no details provided on how the night time restriction of operations under adverse weather conditions is actually implemented.

11- Page 21, *"Sound power level data for most plant and equipment was derived from a recent noise measurement campaign at Mangoola, including data captured in 2012".* **11 out of 24 noise source data have not been obtained** from the recent measurement campaign at Mangoola. These 11 noise sources data were lifted from the previous report (Modification 4 Noise Impact Assessment (Wilkinson Murray 2010) and EMM's extensive sound power level database. No precise reference to noise data is made, there are no details on methodology and the results of the recent measurement campaign have not been provided.

12. The sound power level of Coal Rail Load Out is **10dB less** than the one considered in the previous noise assessment (Wilkinson Murray 2010). There has been no detail or explanation in regards to this major difference provided.

13. The Sound Power Level for the lighting plant is **98 dB(A**). This was **107 dB(A)** in the previous report (Wilkinson Murray 2010). No details in regard to this difference are provided.

14. Sound power level data provided in appendix B are presented in 1 octave band centre frequency from 63 Hz to 8000 Hz. It is more appropriate to consider spectrum data in 1/3 octave band centre frequency from 20Hz to 20,000Hz. This can impact on the accuracy of the noise contours especially where the topography has high vertical rests.

15. Analysis for determining the presence of tonal components has not been presented. 1 octave band spectrum data would not be suitable for this type of analysis.

16. In table B.1 (Appendix B) the Total dB(A) values do not match with the 'A' Weighted frequency spectrum data provided. Overall values are expected to be up to **1.8dB higher** than the ones presented based on the data provided.

17. Conveyor drives' noise data would result in an overall around 80dB(A). The table shows a Total dB(A) of 76 (per metre) (partially enclosed). This should be clarified and any partial enclosure effect should be reflected in the entire spectrum for each centre frequency band individually rather than on the overall only.

18. Some noise sources (i.e. Shovel gate banging) have been considered only when assessing the sleep disturbance and it is not clear if they are present in the modelled operational scenarios. Those noise sources are likely to contribute to increasing the overall operational noise emission from the site particularly at night.

19. Page 22, *"Table 3.1 Typical equipment sound pressure levels"* shows instead "Representative $L_{eq,15minute}$ sound power level, dB(A)". Moreover a 15 minute interval is not considered to be appropriate when describing moving vehicles (i.e. haul trucks). The glossary presented in page 4 relates the L_{eq} to a sound pressure level. Clarification on the noise descriptor is needed.

20. Page 23, table 3.2. 152 receptors are listed as privately owned, in addition, 80 receptors are listed as Mangoola owned in appendix D. This would result in a total number of receptors of **232** which would be inconsistent with the statement in page 19 which states the following: "*The effect of a representative set of meteorological conditions on the level of noise received at receptors is presented in this study. A total of **266** receptor locations (privately owned and mine owned) were used".*

    Some receptors have not been included in the study. For example the two land subdivisions present to the south west of the site identified as Lot 1 and lot 2 DP 1160936 have not been considered in this assessment. Note that a development application for two residential dwellings on the aforementioned lots has been approved in 2011.

21. Page 29, end of third paragraph states: "*To that end, those privately owned lots (vacant or otherwise) considered marginally impacted were modelled in detail by adopting additional assessment points within these lots to improve the accuracy of the presented noise contours*".

    It is not clear whether the noise contours have been obtained by reducing the grid space utilised for the calculation or adjusted by adopting additional assessment points and using an interpolation method to re-define the noise contours. The two methods could provide different results which could be in accurate.

22. Table 4.1 page 30. This table present a typographic error (dB(A)=333).
    This table should display results for both neutral and adverse weather conditions. The table does not specify under which adverse weather condition a certain noise level has been calculated.

23. Table 4.1 page 33 Note n.2: "*The evening (4 – hr) period noise levels are not shown as this period is not as statistically relevant as the day (11 – hr) or night (9 – hr) periods. However noise levels can conservatively be assumed to be the same as the night time period".*

    Noise levels have not been shown for evening time. It is a specific requirement of the NSW EPA INP to assess the noise levels for day time, evening time and night time separately.

    Moreover, considering the night time predicted noise levels to be the same as evening time it is not always conservative. In fact, as per table 4.1, for some receptors daytime noise levels are expected to be higher than the night time noise levels.

24. Page 37, first bullet point: "*all the sources (individually) pass the at-source dB(C) minus dB(A) 15 dB test, with the exception of the CHPP (based on the spectrums listed in Appendix B)".*

    Based on the data provided in Appendix B the CHPP would pass the dB(c) minus dB(A) 15 dB test.

25. Page 37, last bullet point: *"EMM can also confirm that total noise levels from the mine satisfies the lowest recommended (night time) 60 dB(C) Broner criterion at all nominated locations".*

    No results have been provided. Considering that levels up to 42-46 dB(A) could potentially result in noise level expressed in dB(C) having value greater than 60, this presents a major concern.

In addition the absence of fluctuation of SPL dB(C) of ±5dB should be demonstrated. This would potentially result in applying a 5dB penalty to the predicted noise levels.

26. *"Table 4.5 shows the implications on the total mine noise level with application of a 5 dB penalty to the CHPP at the receiver (as per the INP)."*

    It is not clear if the 5dB penalty has been applied to the overall predicted noise levels or to the CHPP noise contribution at the receivers only.

27. Page 38. "*sound power levels adopted in the current study reflect actual measured emissions captured from plant at site through regular on site surveys. These vary from the assumed emission values adopted in the assessment for Modification 4 (Wilkinson Murray, 2011), completed prior to site ‑ specific data being available. This is expected to be the main reason for differences between the two studies".*

    Reference to Modification 4 Wilkinson Murray 2011 is incorrect. It is understood that the aforementioned study is dated 2010.
    11 out of 24 noise source data were obtained from measurement of similar equipment at different sites; therefore the statement is not precise.

28. Page 39, first and second paragraph: "*Maximum noise levels at each residence were calculated under "prevailing meteorology" and reported herein".*

    "Table 4.7 summarises the highest predicted L_{max} noise levels from trucks under worst case meteorology conditions at adopted assessment locations based on typical equipment positions used for mining operations".

    It's not clear if prediction has been undertaken under **prevailing** meteorology or **worst case** meteorology conditions.

29. Page 39, end of second paragraph: reference to OEH is made. Earlier in the report this was referenced as EPA. The landowners believe minor errors such as these suggest the document was prepared in a risk.

30. Current road traffic noise levels were obtained from a previous assessment (Wilkinson Murray 2010). This is based on calculations and not on actual measurements. Current road traffic noise levels should have been measured at several residential locations and utilized in this assessment. This approach could result in a grossly inaccurate assessment of the road traffic noise generated.

31. Table 4.9. Only six receptors have been considered in the assessment. No results for private properties on Bengalla Link Road are provided. These were included in the previous assessment (Wilkinson Murray 2010).

32. Noise Model:

    We note that the March 2013 version of the Bruel & Kjaer Predictor noise model corrected an overestimation of barrier effects in ISO 9613.1/2, ISO 9613.1/2 (1/3 octave), ISO9613.1/2 Road or DAL32 models.

    If the prediction model version utilised did not include the aforementioned update and the ISO 9613.1/2 modules were adopted, then it is likely that the noise levels predicted at the residences are underestimated.

The Predicator model has seen accepted by regulatory authorities in NSW but from our understanding only after it has been calibrated for the site.

Calibration of acoustic models using observed noise levels has been practiced by Benbow Environmental over the past 15 years and provides surety to the community about the accuracy of the noise predictions. Calibration is undertaken within 100-200m of the combined activities of the site and then at reference locations where the site activities are still clearly well above background levels and not acoustically shielded.

For such a large activity as an open cut coal mine and where topography is an important noise reducing feature, further calibration reference points are chosen on the coal mine site.

The calibration of the noise model is then able to be used in undertaking a sensitivity analysis of the assumptions that are made in the model. The noise predictions are of vital importance to all parties. The absence of quantitative data to support the assumptions, makes it difficult to rely on the conclusions presented in this assessment.

The list of noise amelioration factors that are presented in the report appear impressive but have no dB(A) noise reduction levels presented. This is one of many major flaws in the assessment.

33. Section 4.9 Blasting

    No clear reference is made to any relevant document that was used to predict the overpressure and vibration associated with blasting operations as the reference quoted deals only with overpressure.

    No results are provided showing the predicted vibration and overpressure levels at the residences.

    There is a no confirmation that the prediction graphs have been calibrated. No contours are provided showing the residences potentially affected by the blasting operations.

    A sensitivity analysis of the variations in predicted overpressure and ground vibration is needed due to the significance of this issue and the land owner's heritage winery building that may potentially be affected.

The minimum offset required to achieve blast criteria would vary depending on face orientation and other factors which are not considered in this assessment.

A number of residences are expected to be affected by the blasting operations throughout the years of operation of this mine; this should be appropriately assessed taking into account also the residential locations that were not considered in the assessment.

3. AERIAL PHOTOGRAPHS

The following are the Aerial photographs of the properties involved.

Figure 3-1: Aerial Photos of Riverslea

Figure 3-2: Wybong Park Lot 102 and Wybong Estate Lot 13 and Wybong Estate (Vineyard) Lot 103

Figure 3-3: Dolwendee Lots 1 to 4

Figure 3-4: United Pastoral – Hollydene Estate

4. DUST AND BLAST FUME

The findings from the modelling of oxides nitrogen are in doubt and a further assessment is warranted.

The isopleths shown for the two conditions blasting with permissions and blasting without permissions do not show significant differences and this outcome is not explained or analysed to provide surety to the reader of the report.

The community reads these reports and these need to convey explanations as to why the findings can be relied upon.

For these two conditions i.e. blasting with permissions and blasting without permissions there is no detail provided on the weather conditions that were applied in the model.

The size of the blast fume was not indicated. The findings that the levels of NO_x would be within the site differs from the expectation if one reads the reference used in the air impact assessment report.

The reference is presented in the attachments.

The study referred to is the CSIRO study of NO_x emission from blasting operations in open cut mining. This study was undertaken in the Hunter Valley and established that '…*Numerical modelling indicated that NO_x concentrations resulting from the blast would be indistinguishable from background levels at distance greater than about 5km from the source...'*

In between the blast centre and the 5km, what happens is therefore subject to interpretation based on a number of factors and principally amongst these is the model that is used, the assumptions relating to the blast plume and meteorological conditions.

CALPUFF was not used in the CSIRO study. AFTOX was used as this was developed by the United States Air Force to assess real time toxic chemical released.

Figure 2 in the CSIRO study shows a photograph of the plume with dimensions of width 90m, depth 90m and height 150m.

The sensitivity of the findings of the model to other dimensions of the plume given that the length of the blast face may be greater than 90m and may extend over hundreds of metres need to be assessed using AFTOX or after calibration of a model such a CALPUFF with real time NO_x measurements such is the importance of this issue for all parties.

There are differences in the literature we were able to access that indicated that the average emission flux of NO_x may exceed the 0.9 kg/tonne of explosive mentioned in the CSIRO study.

Also provided in the Attachments is a study titled "*Dangers of Toxic Fumes from Blasting*" by Mainiero, Harris and Rowland III.

Figure 2 in this study shows a higher quantity of NO_x being produced when detonating ANFO. The CSIRO study also refers to the explosive as ANFO.

A further document that establishes that exposure to blast fume can cause significant health impacts is provided to hopefully achieve a balanced view point that the issue is real. This is a Safety Alert published by the Queensland Government and refers to incidents that have occurred.

At the open cut mines in Australia a direct comparison may not be possible with this data from the USA paper, but rather than ignore this lack of our current scientific knowledge a sensitivity analyses is needed to establish the range of ground level concentrations of NO_x that could occur for the following factors:

- Range of NO_x emissions rates;
- Plume size;
- Range of wind speeds and stability classes;
- Assume flat topography;
- Apply actual topography;
- Worst case ground level concentrations presented at property boundaries as well as residential receptors.

The CSIRO study indicated that a 1 ppm concentration of NO_2 would be exceeded at 3,000 m from the blast centre for Pasquil Stability Classes C-F.

The current ground level concentration limit is 0.12 ppm for one hour averaging period. Such an increase above the limit indicates why it is such a sensitive issue and one that has been personally experienced by our Principal Consultant. The outcome of exposure to concentrations above a safe level are a significant health risk as NO_2 (i.e. NO_x) exposure is toxic.

A further study has been commissioned in Queensland with the study being undertaken by SIMTARS. Until more comprehensive assessments are undertaken a separate independent assessment of the sensitivity of this issue is needed before the expansion could be approved.

Significant health risks are the concern of the community and the inadequate level of quantitative analyses just supports these concerns.

The framework of an independent assessment using sensitivity analysis is needed. It is noted that the air impact assessment presented for an intensification of Drayton South did not include blast fume.
The coal mining industry is ill advised in the way this issue is being assessed.

5. CONCLUDING COMMENTS

The findings of our review are that there are a number of technical deficiencies in the proponent's consultant's reports that require clarification, and other matters that require re-evaluation of specific impacts. Various assumptions have been made that are not based upon available data but on supposition; this invariably leads to conclusions that may be proven in time to be erroneous.

Reports which include the number and type of deficiencies identified in our review demonstrate to the various affected stakeholders that they lack the rigour necessary for Authorities to make a considered merit assessment of the application.

Importantly they also indicate that, rightly or wrongly, proposals with significant economic potential will typically take precedence over the legitimate environmental concerns of the community. This may be erroneous; it is not within our brief to make judgement as to the intent of the proponent only to identify and highlight omissions in the technical reports relied upon to seek such approvals. Regretfully a flawed report serves merely to undermine the veracity of the entire application which is to no-one's benefit.

One way forward would be for the Consent Authorities to require the proponent to enter into a consultative process with the land owners to achieve a mutually agreed and satisfactory outcome. A formal report of the consultation would be provided to the Department of Planning and Infrastructure.

If further assistance is required please advise.

Daniele Albanese

Daniele Albanese
Acoustical & Environmental Engineer

R T Benbow

R T Benbow
Principal Consultant

ATTACHMENTS

Attachment 1: Site Plan Lot 1

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY

A3 SHEET

DENOTES AREAS NO ERECTION OF DWELLINGS ALLOWED

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR COUNCIL APPROVAL	17/08/11	DF

'HOLYDEEN'
UPPER UPPER HOLDINGS

RHM Consulting Engineers
Civil & Structural Consulting Engineers
Suite 6, 56 Brook Street, Muswellbrook, NSW 2333
Tel (02) 6541 3333 Fax (02) 6541 3334
Email rhmce@rhmce.com.au www.rhmce.com.au
ABN 82 153 018 800

LOT LAYOUT

CIVIL DRAWING

Designed	MP	On behalf of RHM Consulting Engineers	
Drawn	DF	Project Engineer/Director	Date
Scale	NIL	Drawing No:	Rev
Date	AUG 11	10-141 – C01	A

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated

17 NOV 2011

endorsed by

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY

A3 SHEET

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR COUNCIL APPROVAL	17/10/11	DF

'HOLYDEEN'
UPPER UPPER HOLDINGS

RHM Consulting Engineers
Civil & Structural Consulting Engineers
Suite 6, 56 Brook Street, Muswellbrook, NSW 2333
Tel (02) 6541 3333 Fax (02) 6541 3334
Email rhmce@rhmce.com.au www.rhmce.com.au
ABN 82 153 018 800

LOT LAYOUT
AREA 1

CIVIL DRAWING

On behalf of RHM Consulting Engineers

Designed MP
Drawn DF
Scale NIL
Date OCT 11

Project Engineer/Director

Date

Drawing No: 10-141 – C02

Rev A

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated

1 / NOV 2011

endorsed by

Note: For the purpose of the siting of the proposed dwelling only.
1/11/11

Attachment 2: Site Plan Lot 2

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY

A3 SHEET

DENOTES AREAS NO ERECTION OF DWELLINGS ALLOWED

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
21 DEC 2011
endorsed by

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR COUNCIL APPROVAL.	09/11/11	DF

'HOLYDEEN'
UPPER UPPER HOLDINGS

RHM Consulting Engineers
Civil & Structural Consulting Engineers
Suite 6, 56 Brook Street, Muswellbrook, NSW 2333
Tel (02) 6541 3333 Fax (02) 6541 3334
Email rhmce@rhmce.com.au www.rhmce.com.au
ABN 82 153 018 800

LOT LAYOUT

CIVIL DRAWING

Designed	MP	On behalf of RHM Consulting Engineers	
Drawn	DF	Project Engineer/Director	Date
Scale	NIL	Drawing No:	Rev
Date	NOV 11	10-141 – C03	A

DO NOT SCALE THIS DRAWING - USE FIGURED DIMENSIONS ONLY

A3 SHEET

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
21 DEC 2011
endorsed by

REV	DESCRIPTION	DATE	BY
A	ISSUED FOR COUNCIL APPROVAL	09/11/11	DF

'HOLYDEEN'
UPPER UPPER HOLDINGS

RHM Consulting Engineers
Civil & Structural Consulting Engineers
Suite 6, 56 Brook Street, Muswellbrook, NSW 2333
Tel (02) 6541 3333 Fax (02) 6541 3334
Email rhmce@rhmce.com.au www.rhmce.com.au
ABN 82 153 018 800

LOT LAYOUT
AREA 2

CIVIL DRAWING

Designed	MP	On behalf of RHM Consulting Engineers
Drawn	DF	Project Engineer/Director Date
Scale	NIL	Drawing No: Rev
Date	NOV 11	10-141 – C04 A

Attachment 4: Approved Plan Lot 2

DEVELOPMENT APPLICATION

NEW SINGLE RESIDENTIAL DWELLING

RD, HOLLYDEEN NSW 2328

LOT 2 DP 1160936

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
21 DEC 2011
endorsed by

INDICATIVE ARTIST IMPRESSION NOT TO BE REFERRED TO FOR CONSTRUCTION PURPOSES

INDICATIVE ARTIST IMPRESSION NOT TO BE REFERRED TO FOR CONSTRUCTION PURPOSES

Drawing Index

Drawing #	Drawing Name	Rev
1	COVER PAGE	A
2	SURVEY	A
3	SITE ANALYSIS	A
4	GROUND FLOOR PLAN	A
5	ROOF PLAN	A
6	ELEVATIONS	A
7	ELEVATIONS	A
8	SECTIONS	A
9	BASIX CERTIFICATE	A

LIVING GREEN DESIGNER HOMES ™

www.livinggreendesignerhomes.com.au

4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

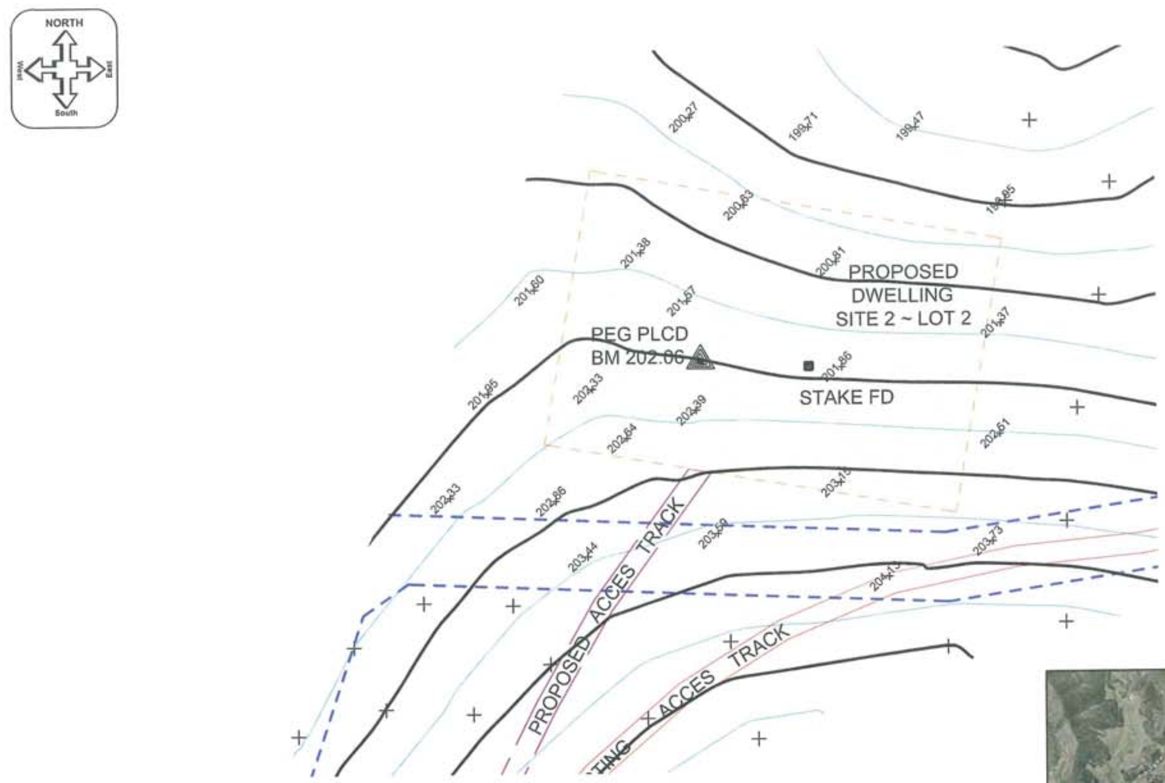
THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Number: CAR231

GreenSmart PROFESSIONAL
SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	COVER PAGE		
CAD Technician:	JJU	Scale :	1:1
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	1
File Location:	29-10-11-CAR231-DA.pln		



LOCALITY DIAGRAM

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated

2 1 DEC 2011

endorsed by

REV	DESCRIPTION	DATE	BY	CHECKED
A	CONTOUR SURVEYS AT PROPOSED NEW HOUSE SITES ON GOLDEN HIGHWAY, HOLLYDEEN	25/08/11	J.G	R.P

www.dialbeforeyoudig.com.au
DIAL 1100 BEFORE YOU DIG

BOARDMAN PEASLEY Pty Ltd.
Registered Land Surveyors
www.boardmanpeasley.net.au

RHM CONSULTING ENGINEERS P/LTD
CONTOUR SURVEYS OF PROPOSED HOUSE SITES AT HOLLYDEEN

DRAWING FILE: OVERALL_CONTOUR_PLAN.Dwg
SURVEY FILE: OVERALL_CONTOUR_PLAN.Cxx
SURVEY: J.G — DESIGNED:
DRAWN: J.G — CHECKED: R.P
DATUM: MGA / AHD
DATUM SOURCE: PM 75280 R.L 173.880m
DATE: 25-08-2011
Sheet No. 2 of 4 Sheets
Job No. S4953-2
Plan No. 001
SCALES: 1 : 750 (A3)
Revision No. A

LIVING GREEN DESIGNER HOMES
www.livinggreendesignerhomes.com.au

Revisions :

A	RELOCATE DWELLING ON SITE	30/9/2011

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Name :	New Residential Dwelling		
Drawing Title :	SURVEY		
CAD Technician:	JJU	Scale :	1:1
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	2
File Location:	26-10-11-CAR231-DA.pln		

MINE SUBSIDENCE BOARD
Development/Building Application
This approval is valid for two (2) years from today and includes any condition of approval attached.

17 NOV 2011

The approval is subject to levels & heights shown on plan being accurate & footings designed to comply with AS2870.1 or relevant Australian Standards.
For Mine Subsidence Board.

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated

2 DEC 2011

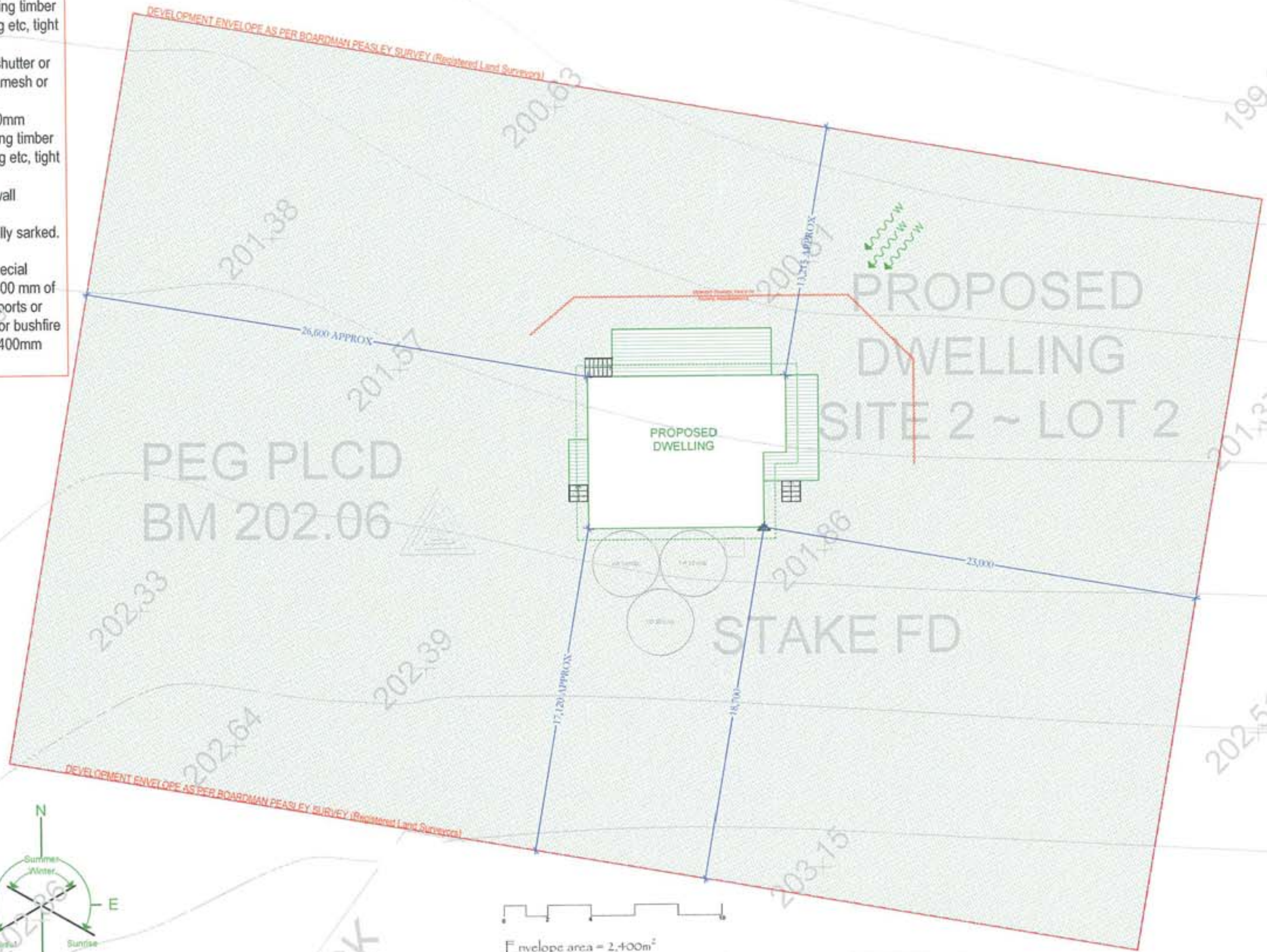
endorsed by

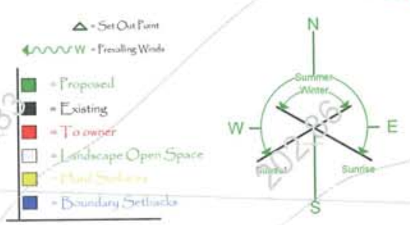
BUSHFIRE REQUIREMENTS:

All constuction to comply with BAL 12.5 in accordance with AS3959-2009 & 'PBP'.

Sub Floor - No special construction requirements.
Floors - No special construction requirements.
External Walls - External walls-Parts less than 400mm above ground or decks etc to be of non combustible material6mm fibre cement clad or Bushfire resistant/naturally fire resistant timber.
External Windows - Protected by bushfire shutter, completely screened with steel bronze or aluminium mesh or mm grade A safety glass, non combustible or 35mm solid timber for 400mm above threshold , metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
External Doors - Protected by bushfire shutter or screened with steel bronze or aluminium mesh or glazed with 5mm toughened glass, non combustible or 35mm solid timber for 400mm above threshold, metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
Roofs - Non combustible covering roof/wall junction sealed openings fitted with non combustible ember guards. Roof to be fully sarked.

Decks - Enclosed sub floor space, no special requirement for materials except within 400 mm of ground. No special requirements for supports or framing. Decking to be non combustible or bushfire resistant within 300mm horizontally and 400mm vertically from a glazed element.





Envelope area = 2,400m²
Proposed Landscaped area = 2,320m²
Landscape Open Space = 96.6%

LIVING GREEN
DESIGNER HOMES

www.livinggreendesignerhomes.com.au

4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.
FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.
THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.
THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.
LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Number: CAR231

GreenSmart
SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	SITE ANALYSIS		
CAD Technician:	JJU	Scale :	1:250
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	3
File Location:	25-10-11-CAR231-DA.pln		

PROPOSED

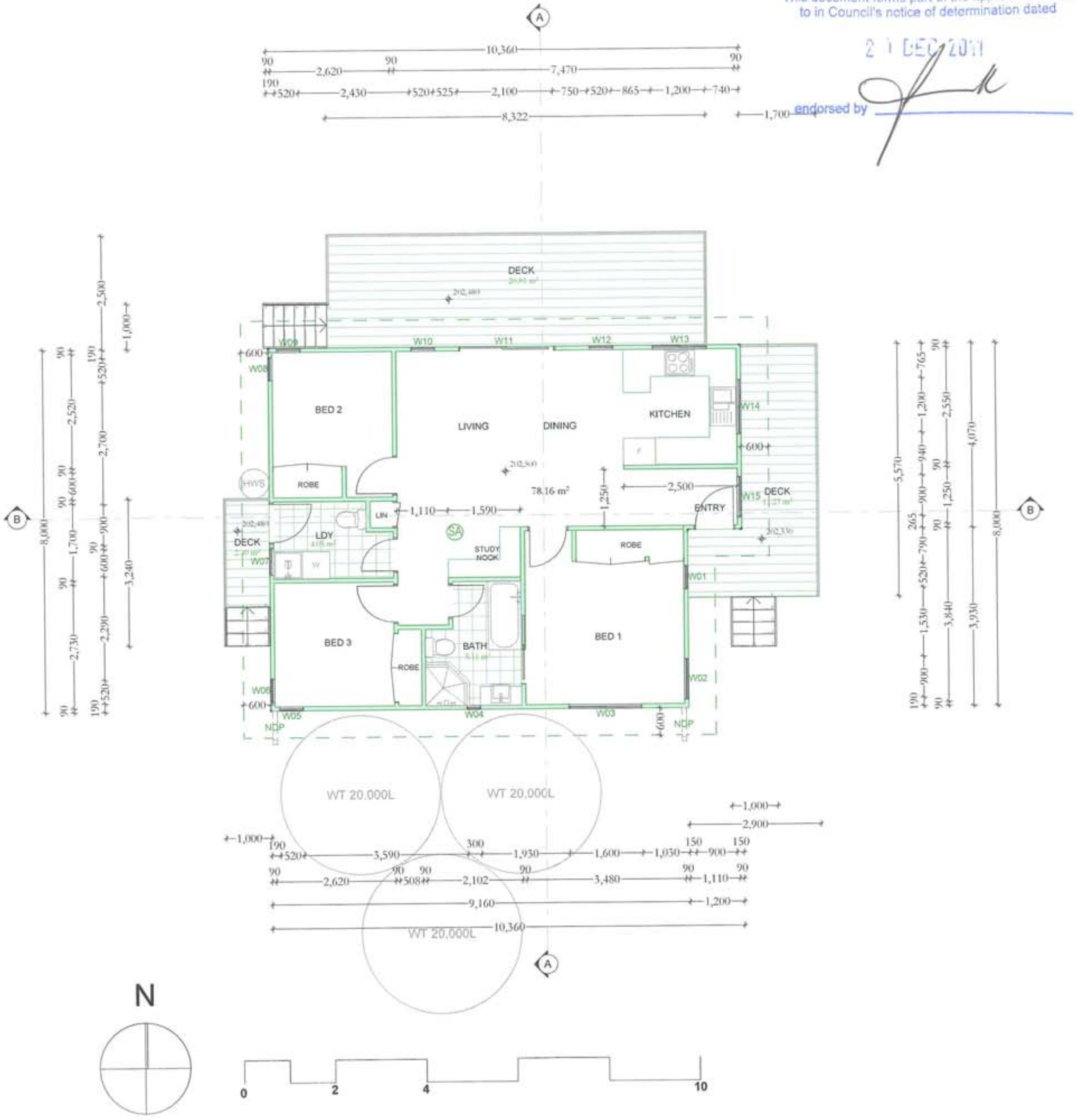
- -External walls - 90mm Timber Framed
- -External Cladding - Lightweight Cladding
- -Internal walls - 90mm Timber Framed
- -Floor Structure - Timber Bearers & Joists
- -Windows - Aluminium Framed
- -Roof Structure - Timber Framed
- -Roof Covering - Colorbond Roof Sheeting
- -NDP = New Downpipe
- -HWS = Hot Water System
- SA - Smoke Alarm

BUSHFIRE REQUIREMENTS:

All constuction to comply with BAL 12.5 in accordance with AS3959-2009 & 'PBP'.

Sub Floor - No special construction requirements.
Floors - No special construction requirements.
External Walls - External walls-Parts less than 400mm above ground or decks etc to be of non combustible material6mm fibre cement clad or Bushfire resistant/naturally fire resistant timber.
External Windows - Protected by bushfire shutter, completely screened with steel bronze or aluminium mesh or mm grade A safety glass, non combustible or 35mm solid timber for 400mm above threshold , metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
External Doors - Protected by bushfire shutter or screened with steel bronze or aluminium mesh or glazed with 5mm toughened glass, non combustible or 35mm solid timber for 400mm above threshold, metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
Roofs - Non combustible covering roof/wall junction sealed openings fitted with non combustible ember guards. Roof to be fully sarked.
Decks - Enclosed sub floor space, no special requirement for materials except within 400 mm of ground. No special requirements for supports or framing. Decking to be non combustible or bushfire resistant within 300mm horizontally and 400mm vertically from a glazed element.

- Proposed
- To owner/Excluded
- Existing
- Boundary Setbacks



MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
2 1 DEC 2011
endorsed by

LIVING GREEN DESIGNER HOMES

www.livinggreendesignerhomes.com.au

4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Number: CAR231

GreenSmart STYLE & SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	GROUND FLOOR PLAN		
CAD Technician:	JJU	Scale :	1:100
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	4
File Location:	25-10-11-CAR231-DA.pln		

PROPOSED

-External walls - 90mm Timber Framed

-External Cladding - Lightweight Cladding

-Internal walls - 90mm Timber Framed

-Floor Structure - Timber Bearers & Joists

-Windows - Aluminium Framed

-Roof Structure - Timber Framed

-Roof Covering - Colorbond Roof Sheeting

-NDP = New Downpipe

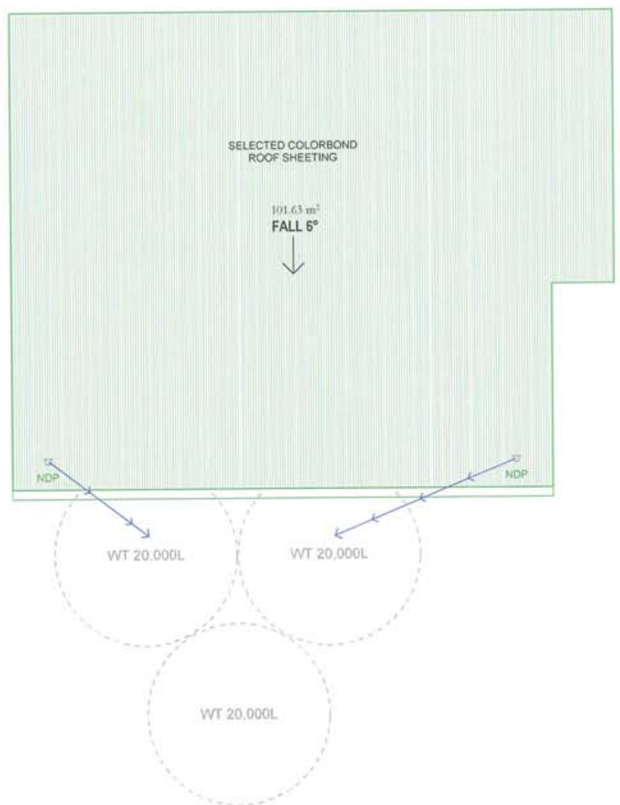
-HWS = Hot Water System

SA - Smoke Alarm

BUSHFIRE REQUIREMENTS:

All constuction to comply with BAL 12.5 in accordance with AS3959-2009 & 'PBP'.

Sub Floor - No special construction requirements.
Floors - No special construction requirements.
External Walls - External walls-Parts less than 400mm above ground or decks etc to be of non combustible material6mm fibre cement clad or Bushfire resistant/naturally fire resistant timber.
External Windows - Protected by bushfire shutter, completely screened with steel bronze or aluminium mesh or mm grade A safety glass, non combustible or 35mm solid timber for 400mm above threshold , metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
External Doors - Protected by bushfire shutter or screened with steel bronze or aluminium mesh or glazed with 5mm toughened glass, non combustible or 35mm solid timber for 400mm above threshold, metal or bushfire resisting timber framed for 400mm above ground, decking etc, tight fitting with weather strips at base.
Roofs - Non combustible covering roof/wall junction sealed openings fitted with non combustible ember guards. Roof to be fully sarked.
Decks - Enclosed sub floor space, no special requirement for materials except within 400 mm of ground. No special requirements for supports or framing. Decking to be non combustible or bushfire resistant within 300mm horizontally and 400mm vertically from a glazed element.



MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
21 DEC 2011
endorsed by

LIVING GREEN DESIGNER HOMES™
www.livinggreendesignerhomes.com.au
4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

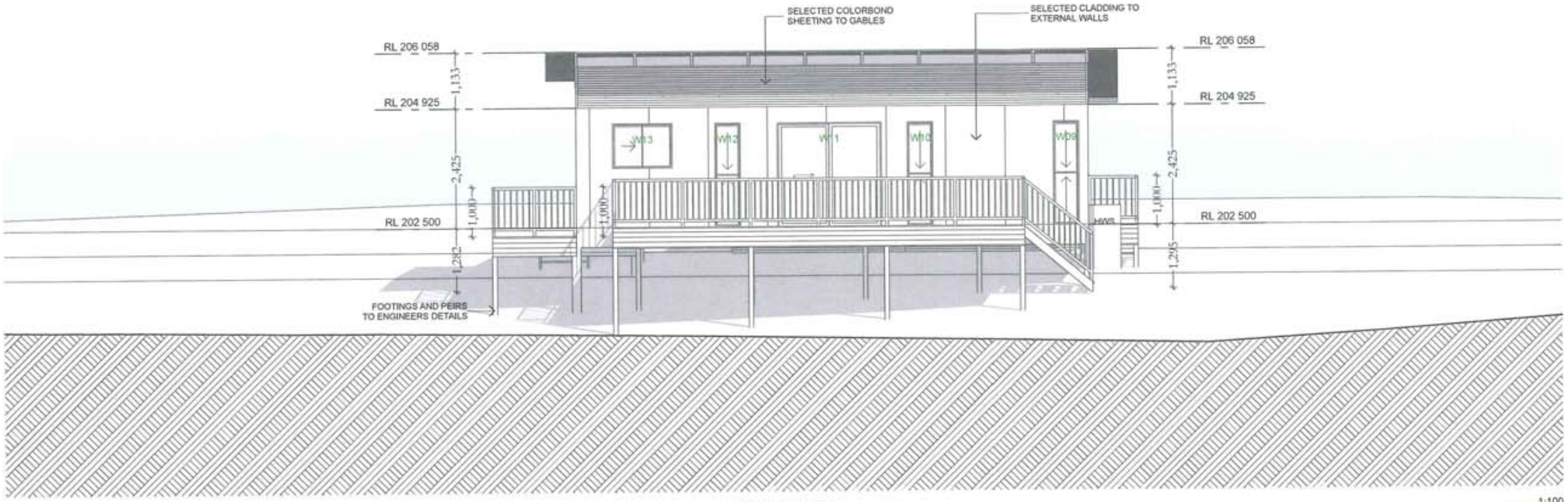
THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

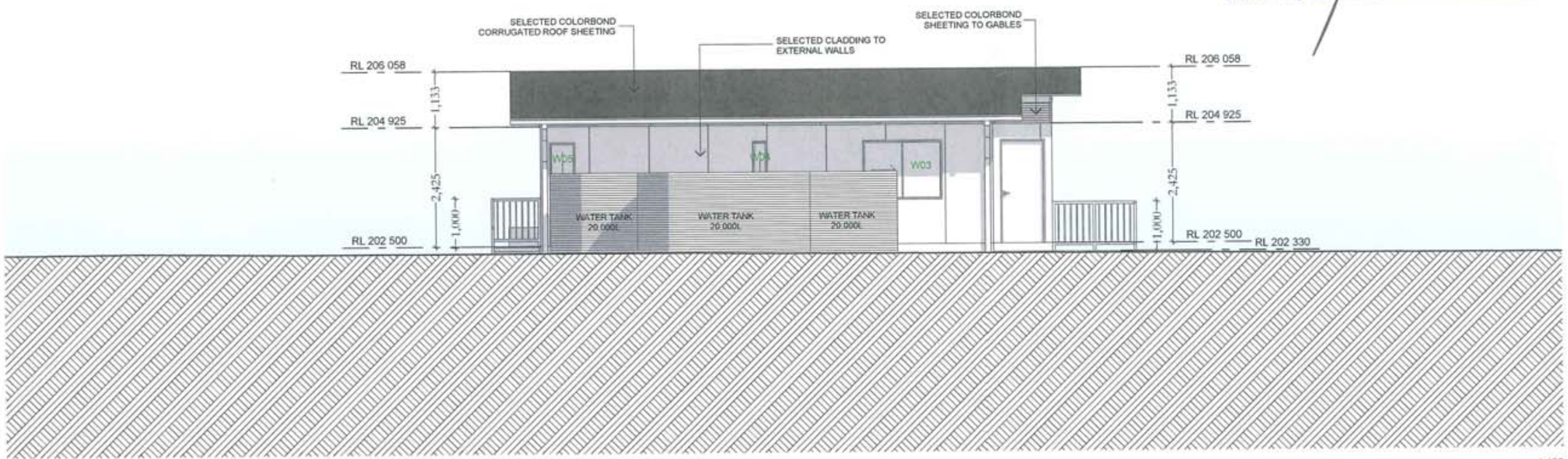
Project Number: CAR231

GreenSmart PROFESSIONAL
STYLE & SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	ROOF PLAN		
CAD Technician:	JJU	Scale :	1:100
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	5
File Location:	26-10-11-CAR231-DA.pln		



1 NORTH ELEVATION 1:100



2 SOUTH ELEVATION 1:100

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
21 DEC 2011
endorsed by

LIVING GREEN DESIGNER HOMES™
www.livinggreendesignerhomes.com.au
4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

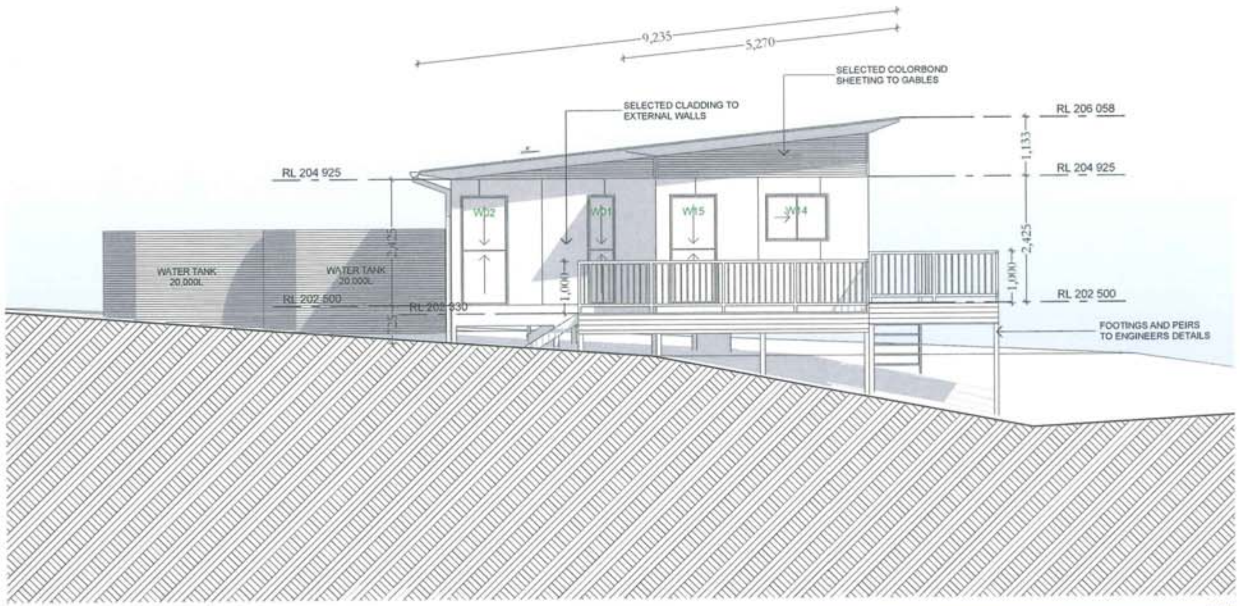
THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Number: CAR231

GreenSmart SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	ELEVATIONS		
CAD Technician:	JJU	Scale :	1:100
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	6
File Location:	25-10-11-CAR231-DA.pln		



1 EAST ELEVATION 1:100

2 WEST ELEVATION 1:100

... SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
2 DEC 2011
endorsed by

LIVING GREEN DESIGNER HOMES ™

www.livinggreendesignerhomes.com.au
4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

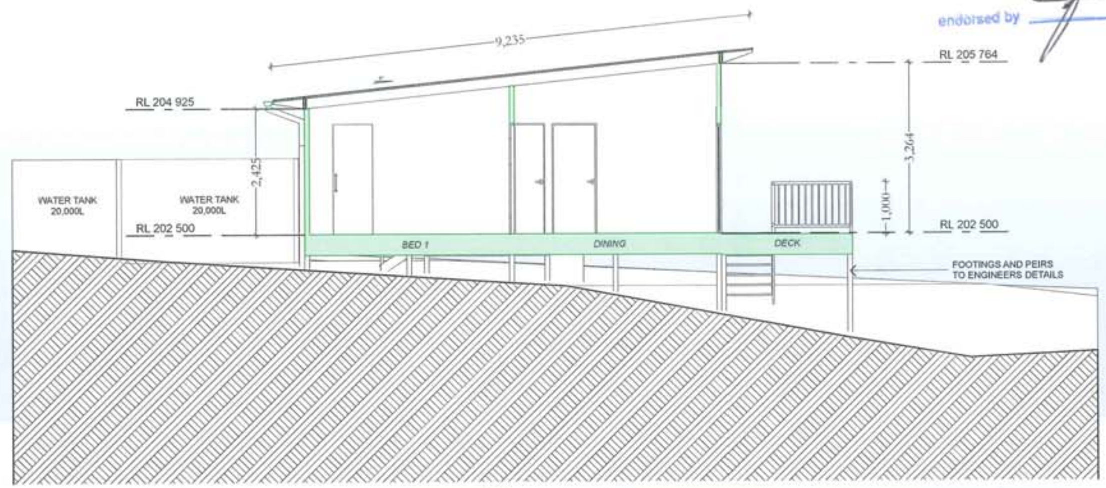
THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

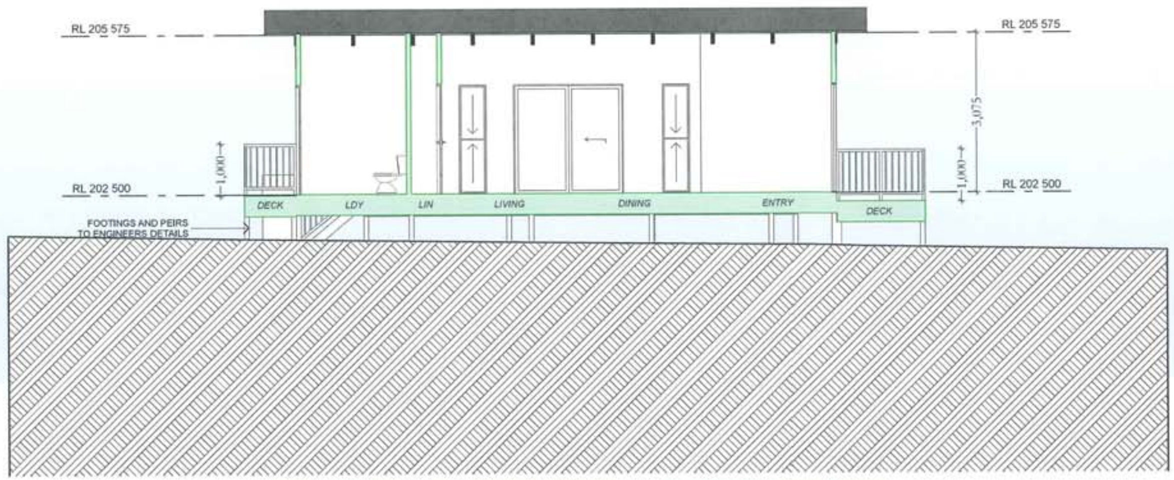
Project Number: CAR231

GreenSmart
... SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	ELEVATIONS		
CAD Technician:	JJU	Scale :	1:100
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	7
File Location:	26-10-11-CAR231-DA.pln		



1 A-A 1:100



2 B-B 1:100

... SHIRE COUNCIL
... part of the approval referred to in Council's notice of determination dated
2 DEC 2011
endorsed by

LIVING GREEN DESIGNER HOMES ™

www.livinggreendesignerhomes.com.au

4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

Project Number: CAR231

GreenSmart PROFESSIONAL ... SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	SECTIONS		
CAD Technician:	JJU	Scale :	1:100
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	8
File Location:	26-10-11-CAR231-DA.pln		

BASIX Certificate

Building Sustainability Index www.basix.nsw.gov.au

Single Dwelling

Certificate number: 402290S

This certificate confirms that the proposed development will meet the NSW government's requirements for sustainability, if it is built in accordance with the commitments set out below. Terms used in this certificate, or in the commitments, have the meaning given by the document entitled "BASIX Definitions" dated 29/06/2009 published by the Department of Planning. This document is available at www.basix.nsw.gov.au

Director-General
Date of issue: Monday, 07 November 2011
To be valid, this certificate must be lodged within 3 months of the date of issue.

NSW Planning & Infrastructure

Project summary		
Project name	Hollydeen Lot 2	
Street address	TBC Merriwa Road Hollydeen 2328	
Local Government Area	Muswellbrook Shire Council	
Plan type and plan number	deposited 1160936	
Lot no.	2	
Section no.	-	
Project type	separate dwelling house	
No. of bedrooms	3	
Project score		
Water	✓ 51	Target 40
Thermal Comfort	✓ Pass	Target Pass
Energy	✓ 94	Target 35

Certificate Prepared by (please complete before submitting to Council or PCA)
Name / Company Name: Living Green Designer Homes Pty Ltd
ABN (if applicable): 41002265492

Description of project

Project address	
Project name	Hollydeen Lot 2
Street address	TBC Merriwa Road Hollydeen 2328
Local Government Area	Muswellbrook Shire Council
Plan type and plan number	Deposited Plan 1160936
Lot no.	2
Section no.	0
Project type	
Project type	separate dwelling house
No. of bedrooms	3
Site details	
Site area (m²)	67616
Roof area (m²)	102
Conditioned floor area (m2)	69
Unconditioned floor area (m2)	9
Total area of garden and lawn (m2)	200

Assessor details and thermal loads		
Assessor number	n/a	
Certificate number	n/a	
Climate zone	n/a	
Area adjusted cooling load (MJ/m².year)	n/a	
Area adjusted heating load (MJ/m².year)	n/a	
Other		
none	n/a	
Project score		
Water	✓ 51	Target 40
Thermal Comfort	✓ Pass	Target Pass
Energy	✓ 94	Target 35

Schedule of BASIX commitments

The commitments set out below regulate how the proposed development is to be carried out. It is a condition of any development consent granted, or complying development certificate issued, for the proposed development, that BASIX commitments be complied with.

Water Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Fixtures			
The applicant must install showerheads with a minimum rating of 3 star (> 6 but <= 7.5 L/min) in all showers in the development.		✓	✓
The applicant must install a toilet flushing system with a minimum rating of 4 star in each toilet in the development.		✓	✓
The applicant must install taps with a minimum rating of 3 star in the kitchen in the development.		✓	
The applicant must install basin taps with a minimum rating of 3 star in each bathroom in the development.		✓	
Alternative water			
Rainwater tank			
The applicant must install a rainwater tank of at least 40000 litres on the site. This rainwater tank must meet, and be installed in accordance with, the requirements of all applicable regulatory authorities.	✓	✓	✓
The applicant must configure the rainwater tank to collect rain runoff from at least 102 square metres of the roof area of the development (excluding the area of the roof which drains to any stormwater tank or private dam).		✓	✓
The applicant must connect the rainwater tank to:			
• all toilets in the development		✓	✓
• the cold water tap that supplies each clothes washer in the development		✓	✓
• at least one outdoor tap in the development (Note: NSW Health does not recommend that rainwater be used for human consumption in areas with potable water supply.)		✓	✓
• all hot water systems in the development		✓	✓
• all indoor cold water taps (not including taps that supply clothes washers) in the development		✓	✓

Thermal Comfort Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Floor, walls and ceiling/roof			
The applicant must construct the floor(s), walls, and ceiling/roof of the dwelling in accordance with the specifications listed in the table below.	✓	✓	✓

Construction	Additional insulation required (R-Value)	Other specifications
floor - suspended floor above open subfloor, framed	1.3 (or 2 including construction) (down)	
external wall - framed (weatherboard, fibre cement, metal clad)	1.80 (or 2.20 including construction)	
ceiling and roof - raked ceiling / pitched or skillion roof, framed	ceiling: 2.3 (up), roof: thermocellular reflective	framed; light (solar absorptance < 0.475)

Note	Insulation specified in this Certificate must be installed in accordance with Part 3.12.1.1 of the Building Code of Australia.

Thermal Comfort Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Windows, glazed doors and skylights			
The applicant must install the windows, glazed doors and shading devices described in the table below, in accordance with the specifications listed in the table. Relevant overshadowing specifications must be satisfied for each window and glazed door.	✓	✓	✓
The dwelling may have 1 skylight (<0.7 square metres) and up to 2 windows/glazed doors (<0.7 square metres) which are not listed in the table.	✓	✓	✓
The following requirements must also be satisfied in relation to each window and glazed door:	✓	✓	✓
• Except where the glass is 'single clear' or 'single toned', each window and glazed door must have a U-value no greater than that listed and a Solar Heat Gain Coefficient (SHGC) +/-10% of that listed. Total system U-values and SHGC must be calculated in accordance with National Fenestration Rating Council (NFRC) conditions.			✓
• The leading edge of each eave, pergola, verandah, balcony or awning must be no more than 500 millimetres above the head of the window or glazed door, except that a projection greater than 500 mm and up to 1500 mm above the head must be twice the value in the table.	✓	✓	✓
• Pergolas with polycarbonate roof or similar translucent material must have a shading coefficient of less than 0.35.		✓	✓
• Unless they have adjustable shading, pergolas must have fixed battens parallel to the window or glazed door above which they are situated, unless the pergola also shades a perpendicular window. The spacing between battens must not be more than 50 mm.		✓	✓

Window/glazed door no.	Orientation	Maximum area (square metres)	Type	Shading	Overshadowing
W1	E	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W2	E	1.89	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W3	S	1.92	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W4	S	0.63	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W5	S	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W6	W	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W7	W	0.54	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W8	W	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W9	N	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W10	N	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W11	N	4.41	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W12	N	1.09	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W13	N	1.08	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W14	E	1.08	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed
W15	E	1.89	improved aluminium, single clear (U-value:6.44, SHGC:0.75)	eave/verandah/pergola/balcony 451-600 mm	not overshadowed

Energy Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
Hot water			
The applicant must install the following hot water system in the development, or a system with a higher energy rating: solar (gas boosted).	✓	✓	✓
Cooling system			
The applicant must install the following cooling system, or a system with a higher energy rating, in at least 1 living area: ceiling fans; Energy rating: n/a		✓	✓
The applicant must install the following cooling system, or a system with a higher energy rating, in at least 1 bedroom: ceiling fans; Energy rating: n/a		✓	✓
Heating system			
The living areas must not incorporate any heating system, or any ducting which is designed to accommodate a heating system.		✓	✓
The bedrooms must not incorporate any heating system, or any ducting which is designed to accommodate a heating system.		✓	✓
Ventilation			
The applicant must install the following exhaust systems in the development:			
At least 1 Bathroom: no mechanical ventilation (ie. natural); Operation control: n/a		✓	✓
Kitchen: individual fan, not ducted; Operation control: manual switch on/off		✓	✓
Laundry: individual fan, not ducted; Operation control: manual switch on/off		✓	✓
Artificial lighting			
The applicant must ensure that the "primary type of artificial lighting" is fluorescent or light emitting diode (LED) lighting in each of the following rooms, and where the word "dedicated" appears, the fittings for those lights must only be capable of accepting fluorescent or light emitting diode (LED) lamps:			
• at least 3 of the bedrooms / study;		✓	✓
• at least 2 of the living / dining rooms;		✓	✓
• the kitchen;		✓	✓
• all bathrooms/toilets;		✓	✓

Energy Commitments	Show on DA plans	Show on CC/CDC plans & specs	Certifier check
• the laundry;		✓	✓
• all hallways;		✓	✓
Natural lighting			
The applicant must install a window and/or skylight in the kitchen of the dwelling for natural lighting.	✓	✓	✓
The applicant must install a window and/or skylight in 2 bathroom(s)/toilet(s) in the development for natural lighting.	✓	✓	✓
Alternative energy			
The applicant must install a photovoltaic system with the capacity to generate at least 3 peak kilowatts of electricity as part of the development. The applicant must connect this system to the development's electrical system.	✓	✓	✓
Other			
The applicant must install a gas cooktop & gas oven in the kitchen of the dwelling.		✓	
The applicant must install a fixed outdoor clothes drying line as part of the development.		✓	

Legend
In these commitments, "applicant" means the person carrying out the development.
Commitments identified with a ✓ in the "Show on DA plans" column must be shown on the plans accompanying the development application for the proposed development (if a development application is to be lodged for the proposed development).
Commitments identified with a ✓ in the "Show on CC/CDC plans and specs" column must be shown in the plans and specifications accompanying the application for a construction certificate / complying development certificate for the proposed development.
Commitments identified with a ✓ in the "Certifier check" column must be certified by a certifying authority as having been fulfilled, before a final occupation certificate(either interim or final) for the development may be issued.

LIVING GREEN DESIGNER HOMES™

www.livinggreendesignerhomes.com.au

4 Bula Place Bensville N.S.W 2251
Phone: 61 (02) 43682889
Fax: 61 (02) 43683379
Email: enquire@lgdh.com.au

Revisions :

MUSWELLBROOK SHIRE COUNCIL
This document forms part of the approval referred to in Council's notice of determination dated
2 1 DEC 2011
endorsed by

Client Name :	WILLIAMS
Client Address :	Lot 2, DP 1160936 Merriwa Rd, Hollydeen NSW 2328
Client No. :	CAR231

ALL CONSTRUCTION WORKS TO BE IN ACCORDANCE WITH RELEVANT AUSTRALIAN STANDARDS & BCA.

FIGURED DIMENSIONS TO BE TAKEN IN PREFERENCE TO SCALING.

THESE PLANS ARE TO BE READ IN CONJUNCTION WITH THE BASIX CERTIFICATE REPORT AND ITS REQUIREMENTS.

THE DEVELOPMENT IS TO MAINTAIN EROSION SEDIMENTATION CONTROL.

LANDSCAPING TO BE IN ACCORDANCE WITH BASIX REQUIREMENTS.

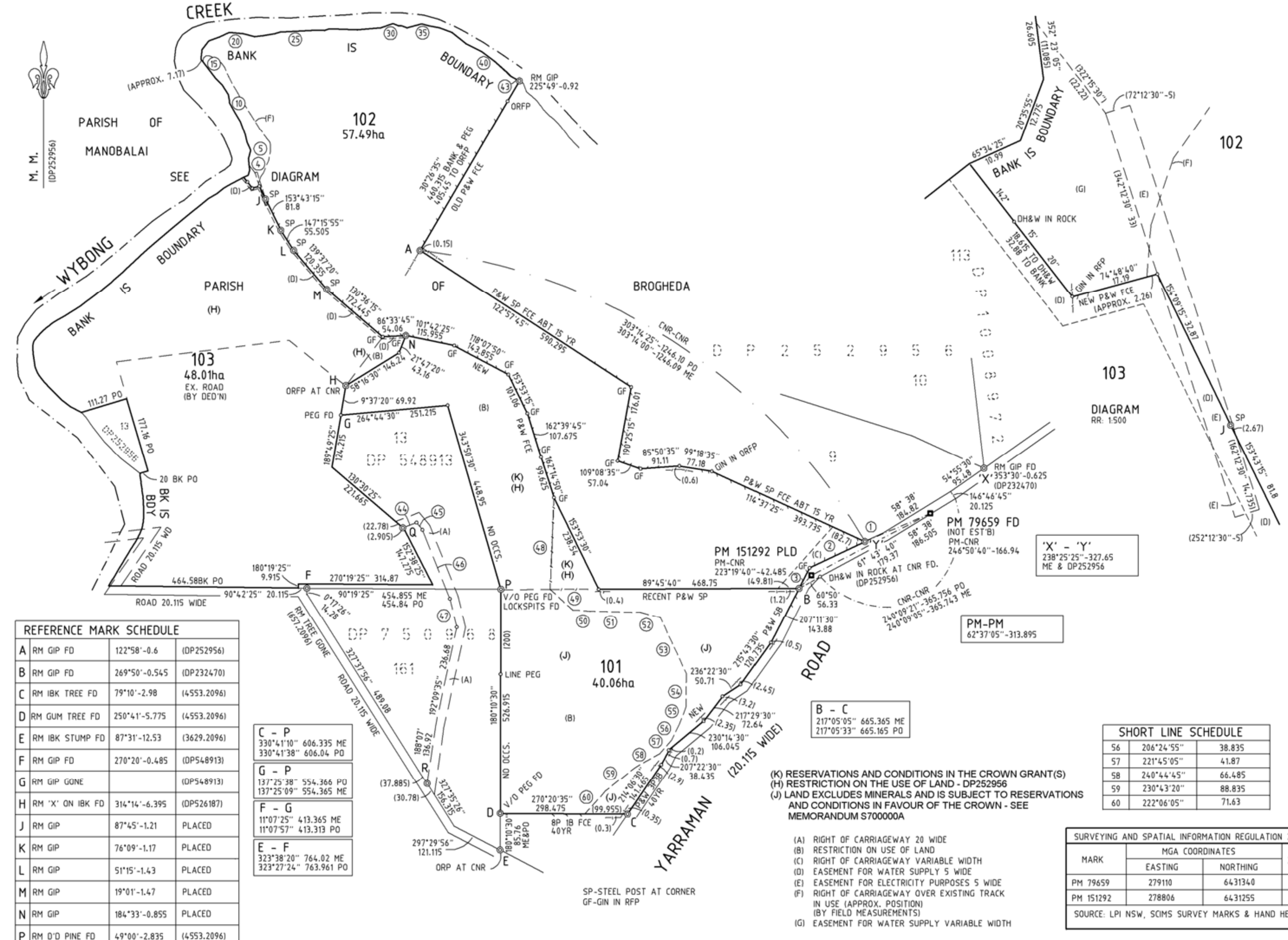
Project Number: CAR231

GreenSmart PROFESSIONAL SUSTAINABILITY

Project Name :	New Residential Dwelling		
Drawing Title :	BASIX CERTIFICATE		
CAD Technician:	JJU	Scale :	1:2
Status :	DA	Revision :	-
Plot Date :	Tuesday, 8 November 2011	Drawing No. :	9
File Location:	26-10-11-CAR231-DA.pln		

Attachment 5: Plan of Subdivision

WARNING: CREASING OR FOLDING WILL LEAD TO REJECTION



	C – P
330°41'10"	606.335 ME
330°41'38"	606.04 PO

	G – P
137°25'38"	554.366 PO
137°25'09"	554.365 ME

	F – G
11°07'25"	413.365 ME
11°07'57"	413.313 PO

	E – F
323°38'20"	764.02 ME
323°27'24"	763.961 PO

	B – C
217°05'05"	665.365 ME
217°05'33"	665.165 PO

'X' – 'Y'
238°25'25"–327.65
ME & DP252956

PM–PM
62°37'05"–313.895

REFERENCE MARK SCHEDULE

A	RM GIP FD	122°58'–0.6	(DP252956)
B	RM GIP FD	269°50'–0.545	(DP232470)
C	RM IBK TREE FD	79°10'–2.98	(4553.2096)
D	RM GUM TREE FD	250°41'–5.775	(4553.2096)
E	RM IBK STUMP FD	87°31'–12.53	(3629.2096)
F	RM GIP FD	270°20'–0.485	(DP548913)
G	RM GIP GONE		(DP548913)
H	RM 'X' ON IBK FD	314°14'–6.395	(DP526187)
J	RM GIP	87°45'–1.21	PLACED
K	RM GIP	76°09'–1.17	PLACED
L	RM GIP	51°15'–1.43	PLACED
M	RM GIP	19°01'–1.47	PLACED
N	RM GIP	184°33'–0.855	PLACED
P	RM D'D PINE FD	49°00'–2.835	(4553.2096)
Q	RM GIP	100°29'–1.23	PLACED
R	RM GIP	14°53'–1.115	PLACED
Y	RM GIP FD	294°20'–0.725	(DP252956)

(K) RESERVATIONS AND CONDITIONS IN THE CROWN GRANT(S)
(H) RESTRICTION ON THE USE OF LAND - DP252956
(J) LAND EXCLUDES MINERALS AND IS SUBJECT TO RESERVATIONS AND CONDITIONS IN FAVOUR OF THE CROWN - SEE MEMORANDUM S700000A

(A) RIGHT OF CARRIAGEWAY 20 WIDE
(B) RESTRICTION ON USE OF LAND
(C) RIGHT OF CARRIAGEWAY VARIABLE WIDTH
(D) EASEMENT FOR WATER SUPPLY 5 WIDE
(E) EASEMENT FOR ELECTRICITY PURPOSES 5 WIDE
(F) RIGHT OF CARRIAGEWAY OVER EXISTING TRACK IN USE (APPROX. POSITION) (BY FIELD MEASUREMENTS)
(G) EASEMENT FOR WATER SUPPLY VARIABLE WIDTH

SHORT LINE SCHEDULE

No.	BEARING	DISTANCE
1	64°36'20"	47.81
2	244°35'30"	143.68
3	207°09'	53.915
4	352°23'05"	26.605
5	15°27'50"	21.1
6	335°32'10"	20.005
7	345°49'10"	19.025
8	339°50'45"	32.98
9	328°42'55"	25.06
10	330°50'25"	25.225
11	355°41'20"	7.17
12	348°33'30"	12.845
13	327°25'50"	25.095
14	316°44'15"	25.655
15	322°00'20"	53.78
16	5°30'10"	21.93
17	38°21'40"	26.35
18	70°12'35"	27.105
19	64°14'40"	24.64
20	94°31'30"	33.425
21	104°27'20"	27.505
22	85°09'10"	19.395
23	80°02'10"	28.365
24	71°11'20"	12.56
25	86°56'25"	73.16
26	91°09'05"	31.655
27	67°25'30"	11.73
28	92°13'45"	65.805
29	85°01'40"	55.51
30	71°53'15"	30.235
31	111°18'00"	13.835
32	88°22'45"	7.46
33	111°49'50"	13.22
34	75°23'10"	35.44
35	104°51'40"	18.31
36	100°41'15"	24.82
37	109°56'55"	30.99
38	128°20'30"	42.045
39	117°18'00"	41.28
40	126°24'05"	38.34
41	131°52'00"	34.175
42	133°24'00"	17.92
43	117°31'15"	21.55
44	69°07'05"	34.28
45	140°39'50"	22.055
46	158°14'30"	173.4
47	166°38'45"	69.525
48	182°20'10"	214.855
49	132°31'50"	71.29
50	94°17'15"	41.975
51	91°12'35"	117.545
52	105°15'45"	47.925
53	155°12'30"	146.165
54	180°45'55"	77.93
55	201°48'20"	46.14

SHORT LINE SCHEDULE

56	206°24'55"	38.835
57	221°45'05"	41.87
58	240°44'45"	66.485
59	230°43'20"	88.835
60	222°06'05"	71.63

SURVEYING AND SPATIAL INFORMATION REGULATION 2006 CLAUSE 35(i)(b) & CLAUSE 61(2)

MARK	MGA COORDINATES		ZONE	ACC CLASS	ORDER	DATE
	EASTING	NORTHING				
PM 79659	279110	6431340	56	U	U	14/05/2012
PM 151292	278806	6431255	56	U	U	PLACED

SOURCE: LPI NSW, SCIMS SURVEY MARKS & HAND HELD GPS

Surveyor: REBECCA JONES
Date of Survey: 16/05/2012
Surveyor's Ref: 207141DP2

PLAN OF SUBDIVISION OF LOTS 8 AND 14 IN DP252956, LOT 14 IN DP548913, LOT 222 IN DP750968 AND RIGHT OF CARRIAGE WAY OVER LOT 13 IN DP548913 AND LOT 161 IN DP750968

LGA: MUSWELLBROOK
Locality: WYBONG AND MANOBALAI
Subdivision No: 319
Reduction Ratio: 1:6000

Registered
24.12.2012

DP1181253

DEPOSITED PLAN ADMINISTRATION SHEET

Sheet 1 of 2 sheet(s)

SIGNATURES, SEALS AND STATEMENTS of intention to dedicate public roads, public reserves and drainage reserves or create easements, restrictions on the use of land and positive covenants

PURSUANT TO SECTION 88B OF THE CONVEYANCING ACT 1919 IT IS INTENDED TO CREATE :-

1. **RIGHT OF CARRIAGEWAY 20 WIDE (A)**
2. **RESTRICTION ON USE OF LAND (B)**
3. **RIGHT OF CARRIAGEWAY VARIABLE WIDTH (C)**
4. **EASEMENT FOR WATER SUPPLY 5 WIDE (D)**
5. **EASEMENT FOR ELECTRICITY PURPOSES 5 WIDE (E)**
6. **RIGHT OF CARRIAGEWAY OVER EXISTING TRACK IN USE (APPROX. POSITION) (F)**
7. **EASEMENT FOR WATER SUPPLY VARIABLE WIDTH (G)**

If space is insufficient use PLAN FORM 6A annexure sheet

Crown Lands NSW/Western Lands Office Approval

I..in approving this plan certify (Authorised Officer) that all necessary approvals in regard to the allocation of the land shown herein have been given

Signature: ....

Date: ....

File Number: ....

Office: ....

Subdivision Certificate

I certify that the provisions of s.109J of the Environmental Planning and Assessment Act 1979 have been satisfied in relation to:

the proposed ....SUBDIVISION.................... set out herein

(insert 'subdivision' or 'new road')

SMDonald

* ~~Authorised Person~~/*General Manager/~~*Accredited Certifier~~

Consent Authority: MUSWELLBROOK SHIRE COUNCIL

Date of Endorsement: .....29 AUGUST 2012.........

Accreditation no: ....N/A..................

Subdivision Certificate no: ....319..................

File no: ....DA 340/2008..................

* Strike through inapplicable parts.

Office Use Only

DP1181253 S

Office Use Only

Registered: 24.12.2012

Title System: TORRENS

Purpose: SUBDIVISION

PLAN OF SUBDIVISION OF LOTS 8 AND 14 IN DP252956, LOT 14 IN DP 548913, LOT 222 IN DP750968 AND RIGHT OF CARRIAGEWAY OVER LOT 13 IN DP548913 AND LOT 161 IN DP750968

LGA: MUSWELLBROOK

Locality: WYBONG AND MANOBALAI

Parish: BROGHEDA

County: WYBONG

Survey Certificate

I, REBECCA LYN JONES

of M.M. HYNDES BAILEY & CO. MUSWELLBROOK

a surveyor registered under the Surveying and Spatial Information Act 2002, certify that the survey represented in this plan is accurate, has been made in accordance with the Surveying and Spatial Information Regulation 2006 and was completed on: 16/05/2012

The survey relates to LOTS 101-102 AND RIGHT OF CARRIAGEWAY

(specify the land actually surveyed or specify any land shown in the plan that is not the subject of the survey)

Signature ....Dated: 8/6/12

Surveyor registered under the Surveying and Spatial Information Act 2002

Datum Line: 'X' – 'Y'

Type: ~~Urban~~/Rural

Plans used in the preparation of survey/~~compilation~~

DP 232470 1595-2096
DP 252956 3629-2096
DP 548913 4553-2096

If space is insufficient use PLAN FORM 6A annexure sheet

Surveyor's Reference: 207141DP2

DEPOSITED PLAN ADMINISTRATION SHEET

Sheet 2 of 2 sheet(s)

PLAN OF SUBDIVISION OF LOTS 8 AND 14 IN DP252956, LOT 14 IN DP 548913, LOT 222 IN DP750968 AND RIGHT OF CARRIAGEWAY OVER LOT 13 IN DP548913 AND LOT 161 IN DP750968

Office Use Only

DP1181253

Office Use Only

Registered: 24.12.2012

Subdivision Certificate No.: 319

Date of Endorsement: 29 AUGUST 2012

ALI ALI

35 CLARENCE STREET, SYDNEY 2000

The Trust Company (Australia) Limited ACN 000 000 993 formerly known as Trust Company Fiduciary Services Limited ACN 000 000 993 by its attorneys who state that they have no notice of revocation of: (a) The Power of Attorney dated 1 June 2005 registered in New South Wales Book 4472 and numbers 607 and 603 and (b) The Power of Attorney dated 1 September 2007 registered in New South Wales Book 4528 No 947 whereby they execute this deed, document or instrument. 91467

Tier 1
Signature.........
Name JOHN MEYER
Title VICE PRESIDENT

Tier
Signature
Name LAURA ALVAREZ
DOCUMENT CUSTODY MANAGER

Upper Hunter Resources Pty Limited. (ACN 107441752)

Russell Byrnes
Sole Director. & Secretary.

Wybong Estate (Vineyard) Pty Limited (ACN 114 572 039).

KAREN WILLIAMS
Sole Director & Secretary

Wybong Estate Pty Limited. (ACN 114 572 002)

Karen Williams
Sole Director. & Secretary

MUSWELLBROOK COUNCIL

.........General Manager

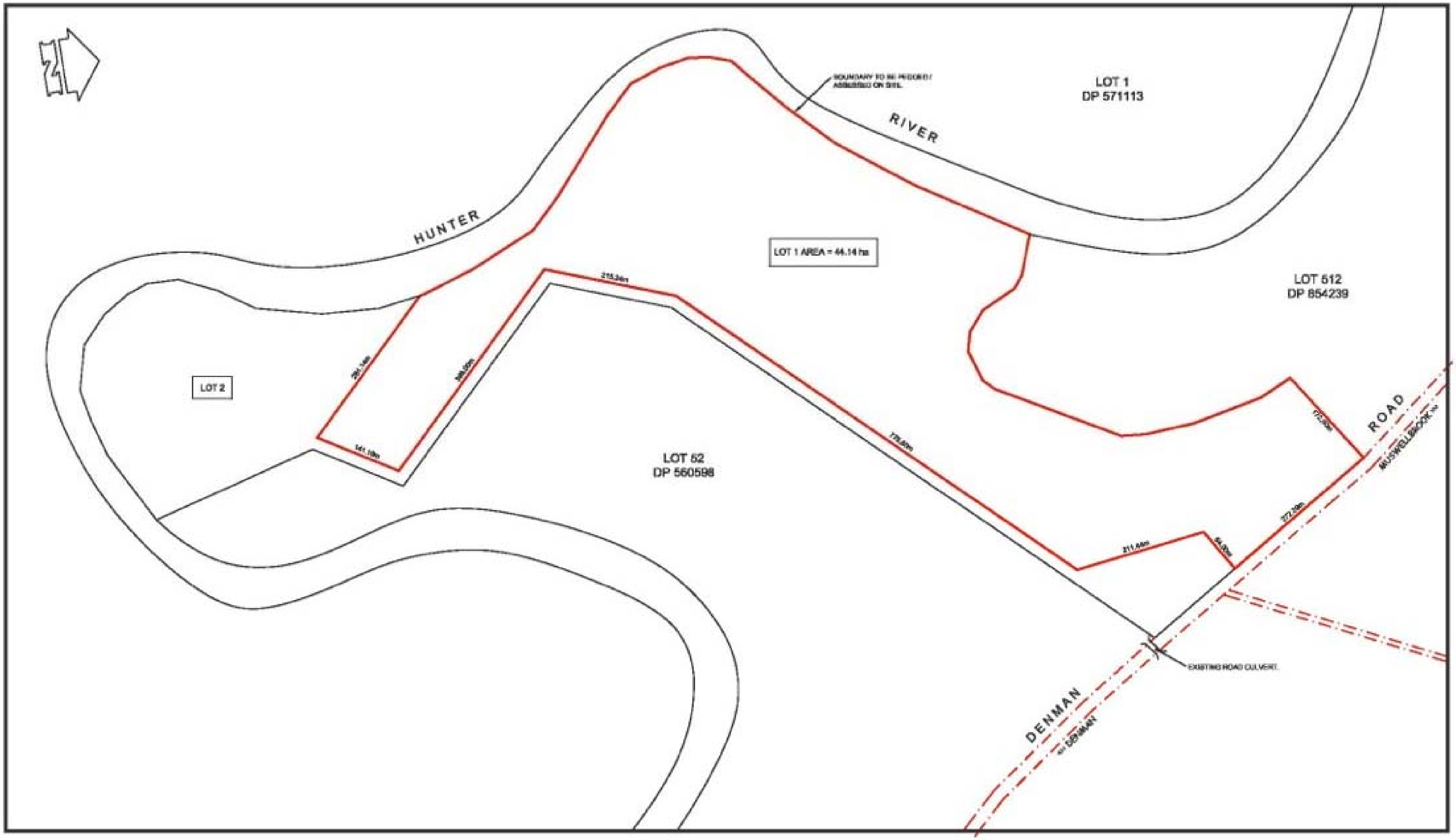
Surveyor's Reference: 207141DP2

Attachment 6: Masterplan ‘Riverslea’ Denman Road, Muswellbrook

MASTERPLAN "RIVERSLEA" DENMAN ROAD, MUSWELLBROOK

Attachment 7: Riverslea Subdivision of Lot 511 DP 854289

"RIVERSLEA" SUBDIVISION LOT 511 DP 854289



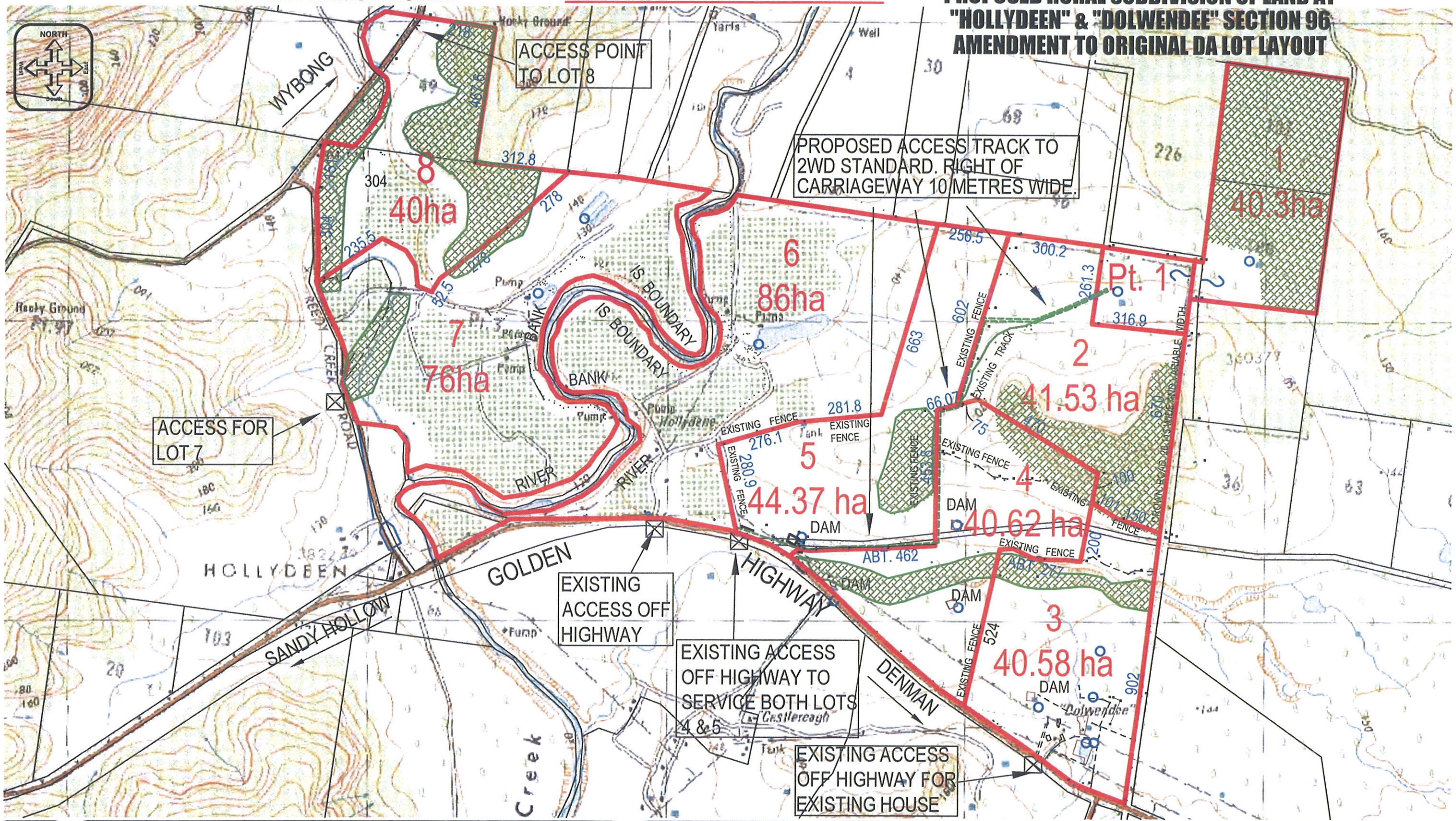
Attachment 8: Sub Plan 4620_001

AREAS DENOTE NO ERECTION OF DWELLINGS ALLOWED

"DEVELOPMENT APPLICATION" PURPOSES ONLY

UPPER HUNTER HOLDINGS PTY LIMITED

PROPOSED RURAL SUBDIVISION OF LAND AT "HOLLYDEEN" & "DOLWENDEE" SECTION 96 AMENDMENT TO ORIGINAL DA LOT LAYOUT



Revision No. : 1 Revision Information : ALTERNATIVE ROUTE FOR RIGHT OF CARRIAGEWAY NOTE:- DIMENSIONS & AREAS ARE SUBJECT TO A FINAL SURVEY & REGISTRATION OF A DEPOSITED PLAN AT THE NSW LAND TITLES OFFICE *Liability Limited by a Scheme Approved under Professional Standards Legislation*	COVER OF EXCELLENCE	Drawing File : S4953DA_PLAN_SEC96_2.dwg Survey Data File : S4953.Cc5 Date : 14th APRIL 2009	Scale : AS SHOWN Datum : MGA/AHD Drawn : RH Checked : PS	**Boardman Peasley Pty Limited** **Consulting Surveyors & Engineers** (Ph) 02 65 433600 (Fax) 02 65 425957 44 Market Street Muswellbrook NSW 2333 P.O. Box 404 WWW.BOARDMANPEASLEY.NET.AU **UPPER HUNTER HOLDINGS PTY. LIMITED** PROPOSED RURAL SUBDIVISION OF LAND AT "HOLLYDEEN" & "DOLWENDEE" SECTION 96 AMENDMENT TO ORIGINAL DA LOT LAYOUT	Sheet No. 1 of 1 Sheets Job No. S4953 Plan No.

Attachment 9: Atmospheric Environment (NO_x Emission from Blasting Operations in Open Cut Coal Mining)

Atmospheric Environment 42 (2008) 7874–7883

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

NO_x emissions from blasting operations in open-cut coal mining

Moetaz I. Attalla*, Stuart J. Day, Tony Lange, William Lilley, Scott Morgan

CSIRO Energy Technology, P.O. Box 330, Newcastle, NSW 2300, Australia

ARTICLE INFO

Article history:
Received 1 February 2008
Received in revised form 1 July 2008
Accepted 7 July 2008

Keywords:
NO_x
Open-cut mining
Australia
Miniaturised ultraviolet spectrometer
Mini-DOAS

ABSTRACT

The Australian coal mining industry, as with other industries is coming under greater constraints with respect to their environmental impacts. Emissions of acid gases such as NO_x and SO_x to the atmosphere have been regulated for many years because of their adverse health effects. Although NO_x from blasting in open-cut coal mining may represent only a very small proportion of mining operations' total NO_x emissions, the rapid release and high concentration associated with such activities may pose a health risk. This paper presents the results of a new approach to measure these gas emissions by scanning the resulting plume from an open-cut mine blast with a miniaturised ultraviolet spectrometer. The work presented here was undertaken in the Hunter Valley, New South Wales, Australia during 2006. Overall this technique was found to be simpler, safer and more successful than other approaches that in the past have proved to be ineffective in monitoring these short lived plumes. The average emission flux of NO_x from the blasts studied was about 0.9 kt t^{-1} of explosive. Numerical modelling indicated that NO_x concentrations resulting from the blast would be indistinguishable from background levels at distances greater than about 5 km from the source.

1. Introduction

Open-cut coal mining is widespread in the upper Hunter Valley in New South Wales (NSW) with several large mines operating within close proximity to the towns of Muswellbrook and Singleton. Consequently, there is community concern about the potential environmental impacts of mining on nearby populations.

Blasting, in particular, has the potential to affect areas outside the mine boundary and accordingly, vibration and dust emission limits are set in each mine's environmental licence. However, gaseous emissions of environmental concern, such as nitrogen dioxide (NO_2) may also be released during blasting operations. Currently, there are very little quantitative data relating to the magnitude of these emissions and it is not yet possible to determine if they contribute significantly to ambient levels in the main population centres.

The explosive ammonium nitrate/fuel oil (ANFO) is used almost universally throughout the open-cut coal mining industry. Under ideal conditions, the only gaseous products from the explosion are carbon dioxide (CO_2), water (H_2O) and nitrogen (N_2).

$$3NH_4NO_3 + CH_2 \rightarrow 3N_2 + CO_2 + 7H_2O \quad (1)$$

However, even quite small changes in the stoichiometry (either in the bulk material or caused by localised conditions such as moisture in the blast hole, mineral matter or other factors) can lead to the formation of substantial amounts of the toxic gases carbon monoxide (CO) and nitric oxide (NO) as shown.

$$2NH_4NO_3 + CH_2 \rightarrow 2N_2 + CO + 5H_2O \quad (2)$$

$$5NH_4NO_3 + CH_2 \rightarrow 4N_2 + 2NO + CO_2 + 7H_2O \quad (3)$$

In addition, some of the NO formed may oxidise in the presence of oxygen (O_2) to produce NO_2.

* Corresponding author.
E-mail address: moetaz.attalla@csiro.au (M.I. Attalla).

1352-2310/$ – see front matter Crown Copyright © 2008 Published by Elsevier Ltd. All rights reserved.
doi:10.1016/j.atmosenv.2008.07.008

$$2NO + O_2 \rightarrow 2NO_2 \tag{4}$$

Often in practice, large quantities of NO_2 are released from blasts which are observed as intense orange plumes.

Although these gases are not considered in their environmental licences, each mine is required to estimate annual emissions of CO, NO_x and SO_2 for the National Pollutant Inventory (NPI), compiled each year by the Australian government. These estimates are made by multiplying the amount of explosive consumed by an emission factor which is currently 8 kg t^{-1} for NO_x, 34 kg t^{-1} for CO and 1 kg t^{-1} for SO_2 (National Pollutant Inventory, 1999). These emission factors, however, are based on limited overseas data and are subject to high uncertainty.

Most of the studies which have examined NO_x formation from blasting have used blast chambers. The results from these studies do not necessarily correlate with what is observed during actual blasts. Few studies have attempted to measure NO_x emissions under actual field conditions, presumably because of the practical difficulties involved. Plumes from blasting lack confinement, can be very large in size and are affected by prevailing weather conditions. There is also a large quantity of dust associated with the blast and these factors combine to make physical sampling of the plume very difficult. There are also the obvious safety implications which restrict access to blast sites. Consequently, quantitative measurements of plume characteristics are generally unavailable. Nevertheless, it is important for mine operators, particularly when their operations are close to residential areas, to have some method for assessing NO_x formation and more importantly, predicting the severity of the NO_x plume. At present predictions of NO_x formation are subjective and are based on the blast engineer's knowledge of the area to be blasted (e.g. rock type, area of the mine, presence of water in the holes, etc.) and the ratings obtained from blasts performed under similar conditions. Quantitative flux estimations of NO_x released from a blast require measurement of concentration through the plume in both the horizontal and vertical axes.

Some of the options available to make these measurements are given in the following sections.

1.1. Physical sampling

Sampling of blasting fumes involves taking a sample of gas from the plume for subsequent analysis, which could be either on site or in an off site laboratory. Although physical sampling could in principle provide sufficient information to characterise a plume, there are a number of serious logistical problems with this approach:

- The size of the plume means that a large number of sample points would be required to sample across the width and height of the plume.
- The force of the explosion and the resulting debris would restrict the proximity of any sampling packages to the initial gas release.
- The potential toxicity of the plume; personnel cannot move through it to take samples, hence sampling stations must be fixed prior to the blast. This means that the path of the plume must be anticipated before the blast.

1.2. Continuous analysis

Another option is to use portable analysers to measure NO_x concentrations in real time. There are, however, disadvantages with this approach since a sample of the plume must be presented to the instrument for analysis. Usually a pump draws air through a small diameter tube into the instrument, but to achieve the necessary spatial characterisation of the plume, sample tubes would need to be positioned at various points throughout the plume. Thus many of the problems identified for the physical sampling would also apply to the use of continuous analysers.

1.3. Optical methods

There are several optical methods of analysis currently available that may be applicable to field measurements of NO_x. These include open-path Fourier Transform Infra-Red Spectroscopy (FT-IR), Correlation Spectroscopy (COSPEC) and Differential Optical Absorption Spectroscopy (DOAS). FT-IR has often been used in air pollution studies (e.g. Levine and Russwurm, 1994). It has also been used in mine situations to measure fugitive methane emissions. Kirchgessner et al. (1993) used open-path FT-IR (op-FT-IR) to estimate methane emissions from open-cut coal mines in the United States. The technique relies on passing a collimated infrared beam through ambient air over a path length of up to several hundred metres. In the Kirchgessner et al. (1993) study, the concentration of methane across the plume was measured then wind speed data and a Gaussian plume dispersion model were used to estimate the methane emission rate from the mine. These authors subsequently developed a modification of their method which improved its accuracy (Piccot et al., 1994, 1996). The improved method was essentially the same as described above except that methane concentrations were measured at several elevations to better characterise the plume.

In principle, open-path FT-IR could be used to measure NO_x in blast plumes since it is sensitive to NO, NO_2, and CO along with other gases. Infrared radiation is also strongly absorbed in many parts of the spectrum by both CO_2 and water which are very likely to be present in high concentrations in blast plumes and this may tend to obscure the NO_x signal. High resolution instruments may resolve at least some of the NO_x absorption lines, however, a more serious drawback with op-FT-IR is that the infrared beam would be substantially attenuated by the dust thrown up by the blast. In the period immediately after the blast when the dust level is very high it is likely that the IR beam would be completely blocked thus making measurements impossible.

Another well established optical method is Correlation Spectroscopy (COSPEC). The system was first described by Moffat and Milan (1971) and was designed to measure point source emissions of SO_2 and NO_2 from industrial plants but found a niche application in the measurement of SO_2 fluxes from volcanoes (Galle et al., 2002). The COSPEC system utilises a "mask correlation" spectrometer and was designed to measure vertical or slant columns using sky-scattered sunlight. By traversing beneath plumes with the mobile instrument, the concentration of the column is calculated and, once multiplied by the plume velocity, produces a source emission rate. These instruments are limited to detecting only those species where masks are available. They also suffer from interferences from other atmospheric gases and light scattering from clouds or aerosols that can produce errors in column densities (Chalmers Radio and Space Science, website).

The DOAS technique is a relatively new technique that is gaining widespread acceptance as an air pollution monitoring method. Like the open-path FT-IR method, the DOAS can simultaneously measure concentrations of a number of species over path lengths which typically range from hundreds of metres to kilometres.

A DOAS, configured as an 'active system', Fig. 1, has three main parts – a light emitter, a light receiver and a spectrometer. The emitter sends a beam of light to the receiver (in some cases the emitter and receiver are contained in the same unit and the light beam is reflected off a remotely located passive reflector). The light beam contains a range of wavelengths, from ultraviolet to visible, although instruments are now available with an infrared source, which extends the range of compounds that can be detected. Different pollutant molecules absorb light at different wavelengths along the path between the emitter and receiver. The receiver is connected to the spectrometer which measures the intensity of the different wavelengths over the entire light path and through the data system converts this signal into concentrations for each of the species being monitored.

DOAS instruments are routinely used to measure SO_2, NO_2 and O_3.

More recently, advances in miniaturising UV–vis spectrometers has lead to the development of much more compact DOAS units, configured as a passive system (Fig. 1), which have come to be known as "mini-DOAS". The mini-DOAS system has so far been used mainly in the study of SO_2 fluxes in volcanic emissions (McGonigle et al., 2003).

2. Methodology

2.1. Field measurements

A portable DOAS (mini-DOAS) manufactured by Resonance Ltd was used in this study. The instrument covers a spectral range of 280–420 nm and can measure sub-part per million levels of NO_2 and SO_2. The unit, which comprises a telescope, scanning mirrors, calibration cells and a miniature CCD array spectrometer (Ocean Optics USB2000 spectrometer), is housed in a small package which is mounted on a tripod. Calibration of the instrument was carried out using the internal calibration cell. The concentration of the cell was equivalent 50 ppm m. No SO_x measurements were undertaken.

Data collection and processing were performed by Ocean Optics OOIBase32 software loaded in a laptop computer. This results in a more compact system that is easier to deploy at mine sites and provides greater flexibility in positioning the instrument in relation to the blast plume.

Prior to each monitored blast, a dark spectrum was collected by blocking light from entering the spectrometer and a scan was performed. To produce a reference spectrum, a further scan was performed in a clear sky background which contained background absorption from NO_2. The reference spectrum was required in order to determine the increase in concentration of NO_2 above ambient levels in the blast plumes.

The plume resulting from each blast was tracked with the spectrometer until the NO_2 concentration was indistinguishable from the surrounding sky. During each field measurement, the mini-DOAS and a video camera were positioned a safe operating distance from the blast at all times.

NO_2 concentrations in the plume were calculated by subtracting the dark spectrum from the measured spectrum and the reference spectrum using the supplied software.

The results obtained from the mini-DOAS are a path-averaged NO_2 concentration profile measured in units of parts per million metre (ppm m). The mini-DOAS results must be divided by the path length through the plume to yield a concentration. To estimate the amount of NO_2 released from each blast it was necessary to multiply the concentration by the volume of the plume. Hence it was necessary to estimate the dimensions of each plume.

All of the blasts monitored were video-taped using at least one, and sometimes two, video recorders. The distances between the cameras and the blast were measured by locating their positions with a handheld GPS receiver.

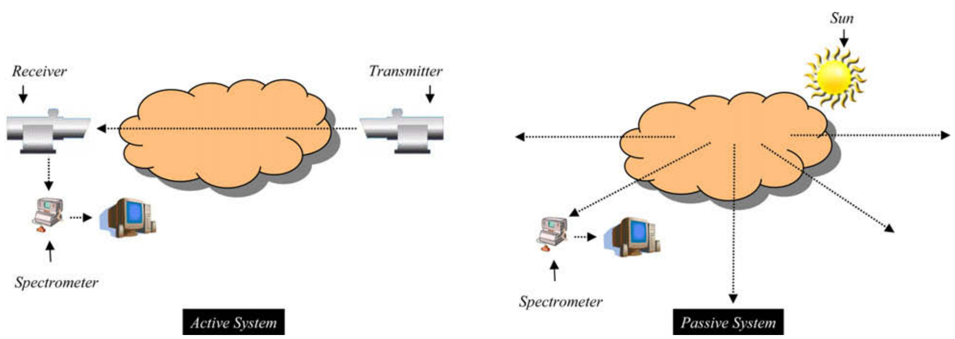


Fig. 1. Schematic diagram of DOAS systems operating in both active and passive modes.

Wind speed and directional data used to plot the directional path of the plume were obtained from a series of meteorological stations located around the mining lease. Simple trigonometry was employed to determine the distance from the video camera to the plume at the corresponding time intervals.

A rudimentary method of photogrammetry was then used to estimate the size of the plume based on still images extracted from the videos. Ratios of the plume to picture size in both the vertical and horizontal planes were made.

Once the plume to camera distance and the constraining angle for the plume is known, a crude three-dimensional estimate of the plume dimension was calculated using basic trigonometric functions. An example of the dimensions determined for a plume using this method is shown in Fig. 2.

Ground level measurements were carried out using a Greenline 8000 portable gas analyser. This instrument is capable of continuous, simultaneous analysis of O_2, CO_2, CO, SO_2, NO and NO_2. It is battery powered and can operate unattended for up to about 2 h. The instrument was calibrated against a standard gas mixture before each use. Data were logged on a laptop computer connected to the instrument.

For each experiment, the instrument was set up downwind of the blast in a location where the plume was expected to pass, but far enough away to avoid flying debris. The inlet probe was fixed at about 2 m above ground level.

It must be noted that selecting an appropriate location for the instrument was often difficult. In many cases, the wind conditions were quite variable, especially within the pit so it was not always possible to correctly anticipate the path of the blast plume. As well, the layout of the mine pit and safety considerations imposed constraints on where the instrument could be placed. Because of these problems, the plumes from many of the blasts did not pass over the analyser and data was not recorded.

2.2. Modelling

A simple modelling exercise was undertaken for this study to determine if the release of NO_2 from a blast could be of detriment to persons exposed to the plume within 5 km of the release. The results of this study are indicative and based on the assumption that the model used is appropriate. Modelling generally relies on local observational data to confirm the performance of the model. The difficulty in measuring emissions from mining blasts has meant that in this case the model is used as an indicator relying on the verifications used in the development of the chosen model. For this reason we have modelled concentrations directly downwind of theoretical blasts with AFTOX (Kunkel, 1991), a USEPA approved dispersion model (http://www.epa.gov/scram001/dispersion_alt.htm#aftox). The original DOS based QuickBasic code was transformed into Excel macros to enable many scenarios to be run.

AFTOX is a Gaussian Puff model developed for the United States Air Force to assess real time toxic chemical releases. The model uses information from US Air Weather Service (AWS) stations to calculate dispersion based on measured atmospheric conditions. As for all Gaussian models, the spread of pollutants is governed by dispersion coefficients in the horizontal (σ_y) and vertical (σ_z) directions. These coefficients depend on the atmospheric stability derived from the AWS data. In this study, the scenarios were modelled by predefining the wind speed and atmospheric stability classes. The wind speeds modelled ranged from very low ($0.5\ m\,s^{-1}$) to moderate ($10\ m\,s^{-1}$). Stability was modelled in six steps representing the standard Pasquill-Gifford stability classes, i.e. A–F, where A, B and C represent unstable conditions (where A is the most unstable), D is neutral and E and F are stable conditions. These stability classes are used to categorise the rate at which a plume will disperse. Unstable conditions might be found on a sunny day with light winds leading to rapid plume dispersion while the stable conditions may occur in clear skies with light winds and perhaps a temperature inversion present. Plume spread is slow in these circumstances.

AFTOX is operated by assuming an emission release from a single location. The emissions can be either continuous or instantaneous. In this study AFTOX was used to describe an area source by representing it as a large number of individual points. The area of the emission (i.e. the area over which the explosives were distributed) was

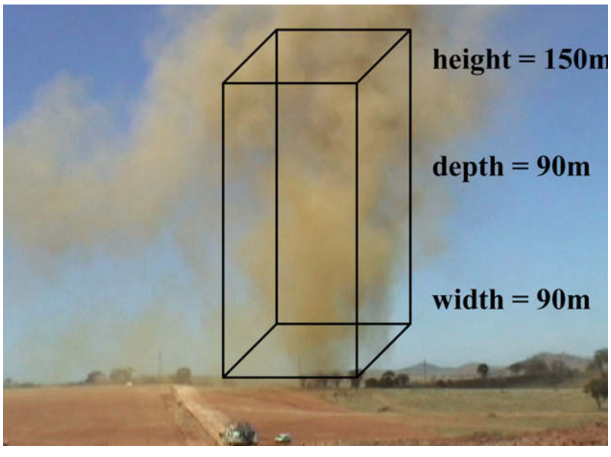


Fig. 2. Blast plume with estimated dimensions.

assumed to be 100 m × 200 m based upon sizes commonly observed during the field measurements. The area was subdivided into 10 m × 10 m units. Each square was represented by a point source with its source at the centre. In total, the area was modelled as 231 separate point sources (see Fig. 3). The total flux of emissions for the source was set at 100 kg. To estimate the maximum concentration and pollutant exposure values, the values should be multiplied by an appropriate scaling factor.

One hundred and twenty scenarios were modelled in which the 100 kg of emissions were spread randomly throughout the source area. A multi-stage process was employed for this task. In the first step, the total maximum number of points emitting was determined. This was defined by a random number between 20% and 80% of the maximum number of sources (in this case 231). The range chosen was an estimate from the portion of blasts that appeared to fume in conditions witnessed during this study. The total emission was then divided by this number. Each portion of the total emission was then placed randomly within the emission area. This process allowed certain points to receive multiple portions of the total emissions enabling the formation of hot spots. An example of one emission grid (Scenario 1 of 120) is displayed in Fig. 4.

Concentrations were determined for each of the 120 emission scenarios at distances of 200 m, 300 m, 400 m, 500 m, 750 m, 1 km, 1.25 km, 1.5 km, 2 km, 2.5 km, 3 km, 4 km and 5 km from the origin of the source. A concentration was determined for a number of discrete times that encompassed the complete plume travelling past the receptor. Further the concentrations were determined at 21 locations 10 m apart in a plane parallel and directly downwind of the source area (see Fig. 3). An average concentration from each of the receptors was determined; in this case with N equal to 21.

$$C^{*} = \frac{1}{N}\sum_{i=1}^{N} C_i \tag{5}$$

The average for each scenario was then used to create an ensemble average and standard deviation for the entire run (i.e. $N = 120$).

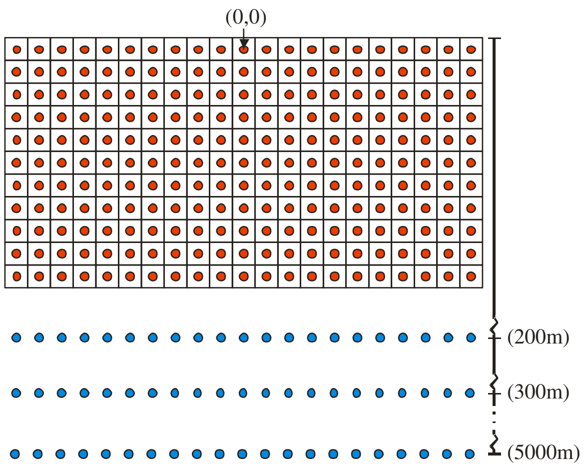


Fig. 3. Emission grid and receptor array setup.

$$\overline{C} = \frac{1}{N}\sum_{j=1}^{N} C_j^{*} \tag{6}$$

$$\sigma_{\overline{C}} = \frac{1}{N}\sum_{j=1}^{N}\left(C_j^{*} - \overline{C}\right)^2 \tag{7}$$

$$C_{\max} = \max_{k=1}^{N}[\overline{C}_k] \tag{8}$$

A dosage expressed in ppm s was determined from the times when the ensemble average plume travelled past the receptors located at each distance downwind of the source. Again N represents each discrete time step (dt) where $C' \neq 0$.

$$C_{\text{dose}} = \sum_{k=1}^{N}(\overline{C}_k)\,\mathrm{d}t \tag{9}$$

The relative variation for the dosage is provided by similarly treating the ensemble standard deviation.

$$\sigma_{\text{dose}} = \sum_{k=1}^{N}(\sigma_{\overline{C}k})\,\mathrm{d}t \tag{10}$$

3. Results and discussion

3.1. Field measurements

Plume measurements were made using the mini-DOAS spectrometer at two open-cut mine sites located in the Hunter Valley. The combination of the spectral analysis and the plume estimation technique allowed for NO_2 concentration and mass flux estimates to be made remotely, totally eliminating the requirement of physical sampling.

An example of the spectral output produced by the mini-DOAS is shown in Fig. 5. The spectral output consists of the NO_2 concentration (ppm m) as a function of time. The figure also contains a series of photographs depicting the formation of a blast plume at time intervals of 70, 110, 163, 250 and 350 s post-blast initiation. It is worth noting the change in intensity of the colour of plume and size as a function of time.

Reliable concentration measurements with the mini-DOAS may only be made when the spectrometer is aimed into a sky background above the horizon from the point of observation. In this example, a peak concentration of 580 ppm m was achieved in 163 s post-blast initiation (third image from the left). At this time the plume has risen above the horizon from the point of observation. The plume to mini-DOAS distance at this stage is approximately 500 m, with an estimated plume depth of 105 m. This results in a NO_2 concentration of 5.6 ppm at that particular stage of the plumes' dispersion.

After 350 s, the plume is barely visible and is now estimated to be approximately 650 m from the mini-DOAS unit. The plume depth has increased to 125 m with

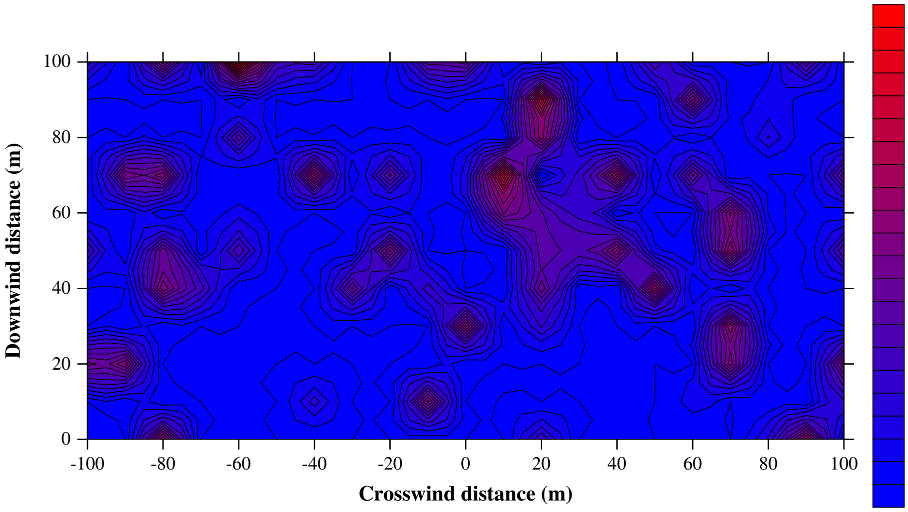


Fig. 4. Example of emission grid for 1 of the 120 scenarios modelled (the scale on the right hand side refers to NO_2 concentration in ppm).

a corresponding increase in plume volume by a factor of two. This expansion of the plume corresponds to a decrease in NO_2 concentration to 2.8 ppm.

At 360 s the plume was no longer visible to the eye and was lost for a short period of time to the mini-DOAS. This, however, was rectified with scanning of the sky with the spectrometer until the invisible plume was tracked for a further period.

Results for all plumes monitored during field work at both mine sites are given in Table 1. The table gives the peak NO_2 concentration as measured by the mini-DOAS above the horizon. Also given in the table is the plume volume at peak concentration and the calculated mass of NO_2 released from the blast. The mass of ANFO typically used in a blast was on average 210 tonnes, ranging from 60 to 565 tonnes. The explosive was distributed over an area of typically 200 m × 100 m containing approximately 200 bole holes with 200 mm diameter and to a depth of 25 m.

From the table the maximum NO_2 concentrations were found to range from 0 to about 7 ppm. This range of concentrations translated to 0–63.3 kg of NO_2 in the plume. However, no correlation can be made between blast charge and NO_2 levels.

During the measurements with the mini-DOAS ground level measurements were also carried out using a portable combustion gas analyser (Greenline 8000) to augment the airborne measurements made by the mini-DOAS. For NO_2 the ground level measures were higher than those observed using the mini-DOAS at higher altitudes. When the results of both measurement methods were applied to

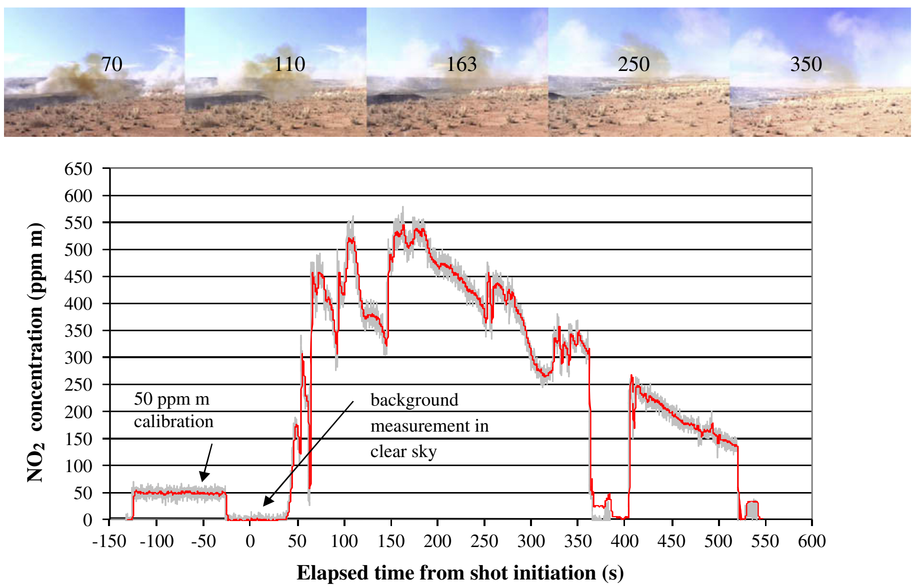


Fig. 5. Typical NO_2 spectrum demonstrating plume colour characteristics relative to concentration level.

Table 1
Through plume measurement results

Date	Total ANFO charge (t)	Peak NO_2 Conc (ppm)	Plume volume ($m^3 \times 10^{-6}$)	Mass of NO_2 (kg)	Emission flux ($kg\,t^{-1}$ ANFO)		
					NO	NO_2	NO_x
12/12/2005	281	3.7	1.4	9.9	0.5	0.03	0.6
13/12/2005	150	0.4	5.3	3.7	0.4	0.03	0.4
14/12/2005	119	0.0	0.0	0.0	0.0	0.00	0.0
21/12/2005	229	1.0	4.4	7.9	0.6	0.04	0.6
22/12/2005	211	0.0	0.0	0.0	0.0	0.00	0.0
23/12/2005	222	0.0	0.0	0.0	0.0	0.00	0.0
5/01/2006	177	1.0	0.2	0.4	0.0	0.00	0.0
6/01/2006	275	1.1	15.3	30.6	1.8	0.12	1.9
12/01/2006	225	1.6	6.2	18.3	1.3	0.08	1.4
18/01/2006	169	1.3	1.7	0.2	0.4	0.02	0.4
23/01/2006	139	2.1	4.2	16.7	1.9	0.12	2.0
25/01/2006	155	0.4	4.4	2.9	0.3	0.02	0.4
30/01/2006	132	0.7	5.3	7.1	0.8	0.05	0.9
22/02/2006	224	0.0	0.00	0.0	0.0	0.00	0.0
1/03/2006	194	1.6	20.6	63.3	5.0	0.32	5.3
12/05/2006	362	6.5	1.9	23.3	1.0	0.06	1.1
15/05/2006	131	0.3	3.2	1.7	0.2	0.01	0.2
19/05/2006	168	0.0	0.00	0.0	0.0	0.00	0.0
30/05/2006	100	0.8	0.00	1.0	0.0	0.00	0.0
1/06/2006	365	0.7	3.5	4.9	0.2	0.01	0.2
6/06/2006	145	0.8	11.5	17.5	1.9	0.12	2.0
15/06/2006	60	0.0	0.00	0.0	0.0	0.00	0.0
26/06/2006	254	4.3	0.3	2.1	0.1	0.01	0.2
27/06/2006	212	5.6	0.9	10.0	0.7	0.04	0.7
28/06/2006	241	0.0	0.00	0.0	0.0	0.00	0.0
6/07/2006	565	2.8	2.7	14.0	0.4	0.03	0.4
13/07/2006	184	7.0	1.0	12.6	1.1	0.07	1.2

dispersion modelling techniques strong agreement was observed.

Point measurements which were made on Greenline 8000 indicated that a loose relationship existed between NO and NO_2 concentration. Although a strong correlation was not found, there is a general trend of increasing NO_2 with increasing NO. It was generally found that the relative proportion of NO to NO_2 from our data set was 27 to 1. This

Table 2
Maximum calculated NO_2 concentrations downwind of source

	200 m	300 m	400 m	500 m	750 m	1000 m	1250 m	1500 m	2000 m	2500 m	3000 m	4000 m	5000 m
WSPD = 0.5 $m\,s^{-1}$													
Stab A	83.0	30.0	14.4	7.9	2.5	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	145.8	69.3	40.8	25.4	10.1	4.8	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	219.4	122.0	80.8	55.9	26.8	14.3	8.6	5.6	2.8	1.6	1.0	0.5	0.3
Stab D	321.1	201.5	146.0	113.1	64.6	40.2	26.1	18.6	10.5	6.7	4.5	2.4	1.4
Stab E	390.2	267.4	204.3	165.5	109.6	75.9	54.6	41.3	26.4	17.9	12.7	7.1	4.5
Stab F	464.1	339.8	269.0	222.6	154.5	114.9	88.6	69.7	50.4	37.0	27.8	16.7	11.0
WSPD = 3 $m\,s^{-1}$													
Stab A	78.5	29.1	14.2	7.7	2.4	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	137.6	67.7	39.7	25.1	10.0	4.8	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	211.6	118.7	77.6	55.2	26.0	14.0	8.6	5.6	2.8	1.6	1.0	0.5	0.3
Stab D	312.5	197.9	143.2	110.0	62.5	39.3	26.1	18.2	10.5	6.7	4.5	2.4	1.4
Stab E	383.0	267.0	202.1	162.6	106.3	73.7	54.1	40.3	26.1	17.7	12.5	7.2	4.5
Stab F	461.5	344.6	268.4	220.8	151.1	112.3	86.1	67.6	48.9	36.4	27.5	16.6	11.0
WSPD = 7.5 $m\,s^{-1}$													
Stab A	62.5	25.5	13.0	7.3	2.3	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	111.9	56.1	34.2	22.6	9.4	4.6	2.6	1.6	0.7	0.4	0.2	0.1	0.1
Stab C	173.3	100.4	66.5	47.7	23.8	13.2	8.2	5.4	2.7	1.6	1.0	0.5	0.3
Stab D	261.2	167.9	122.1	92.3	54.8	35.3	23.7	17.2	10.1	6.5	4.4	2.3	1.4
Stab E	325.9	232.2	175.8	139.6	89.5	63.8	46.7	36.0	23.9	16.8	12.1	7.0	4.4
Stab F	394.6	302.7	237.0	194.3	132.2	96.1	73.3	59.0	43.6	33.3	25.7	15.8	10.5
WSPD = 10 $m\,s^{-1}$													
Stab A	53.0	22.6	11.9	6.9	2.3	0.9	0.4	0.2	0.1	0.0	0.0	0.0	0.0
Stab B	92.3	49.7	31.0	20.9	9.0	4.5	2.5	1.5	0.7	0.4	0.2	0.1	0.1
Stab C	140.1	84.2	57.7	42.1	21.7	12.6	7.9	5.3	2.7	1.6	1.0	0.5	0.3
Stab D	205.5	138.3	102.4	79.9	48.6	31.8	22.1	16.4	9.7	6.4	4.3	2.3	1.4
Stab E	254.0	184.0	143.0	116.4	78.0	56.2	42.6	33.1	22.7	16.0	11.6	6.9	4.4
Stab F	306.8	235.8	189.6	157.9	109.9	82.8	64.5	52.2	40.0	30.9	24.0	15.2	10.2

relationship enabled the estimation of the NO fluxes in the blast plume with a reasonable level of confidence.

The results obtained in this study are the only published quantitative data available on blast plume gas composition that the authors are aware of and it is useful to compare them to the emission factors currently used for NPI estimates.

Based on the NO_2 measurements and estimates of NO, the flux for NO_x was calculated to be in the range of 0.04–5.3 kg t^{-1} ANFO. The average flux level for all the blast plumes measured was 0.9 kg t^{-1}. This figure is considerably lower than the current NPI emission factor which is 8 kg t^{-1}.

3.2. Modelling

Results of the modelling runs are summarised in Table 2 and show the peak NO_2 concentrations (ppm) at various points downwind of the blast for the six atmospheric stability classes considered.

Examples of the modelled data are plotted in Fig. 6 and Fig. 7. In Fig. 6 a plot is displayed for the concentration estimate of one scenario at a distance of 200 m from the source origin and for a wind speed of 2 m s^{-1} and a stability class C. In this plot 21 lines are shown representing the dose received directly downwind of the source at the locations displayed in Fig. 3. In this figure it is apparent that there is a considerable difference in the concentration predicted at each of the 21 receptors. It should be noted that the distance of 200 m is defined from the origin of the source area (0, 0) as displayed in Fig. 3. At this distance emission sources at 100 m will cause significantly higher concentrations than those occurring at positions toward the origin. In comparison the concentrations predicted at the receptor array 1 km from the source show more normally defined distributions with maxima occurring towards the middle receptors as a result of crosswind diffusion. Receptors toward the edge of the sample array receive less crosswind influence and are, therefore, smaller in concentration. Also apparent in these two figures is the considerable difference in the predicted peak concentrations with the values at 1 km up to 25 times lower than at 200 m. When viewing Table 2, the peak values at 5 km approach ambient levels for all but the most stable conditions which are quite commonly over predicted with Gaussian models. For future studies it is recommended that a long path technique on a mining lease boundary may provide both a measure of the model accuracy as well as a direct measure of the impact in areas directly surrounding the mining area.

The data presented in this study represent a dose directly downwind of the source and as such are a worst case scenario for exposure. The averages of the 21 receptors (i.e. the average concentration directly downwind of the source) for each of the 120 scenarios modelled were used to determine the selected data. The number of scenarios modelled was arbitrarily chosen to allow 10 scenarios to be run on each machine in a cluster of 12 computers. The maximum concentration in Table 2 is the maximum ensemble average obtained from the average of the 21 receptors for the 120 scenarios modelled. Maximum concentrations at individual locations directly downwind of hot spots are obviously higher than the values reported in this table.

When viewing Table 2 it is apparent that the peak concentrations drop dramatically as the receptor moves away from the source. It is also apparent that the peak concentrations vary little as a function of wind speed although the plume width will vary. In AFTOX a downwind concentration is determined in two steps. In the first step the size of the initial plume envelope is estimated. In its default mode AFTOX determines the size of the envelope (assumed to be a cylinder of equal height and width) from the magnitude of the emission rate. In this report the size is set at 10 m to match the grid structure used for the area

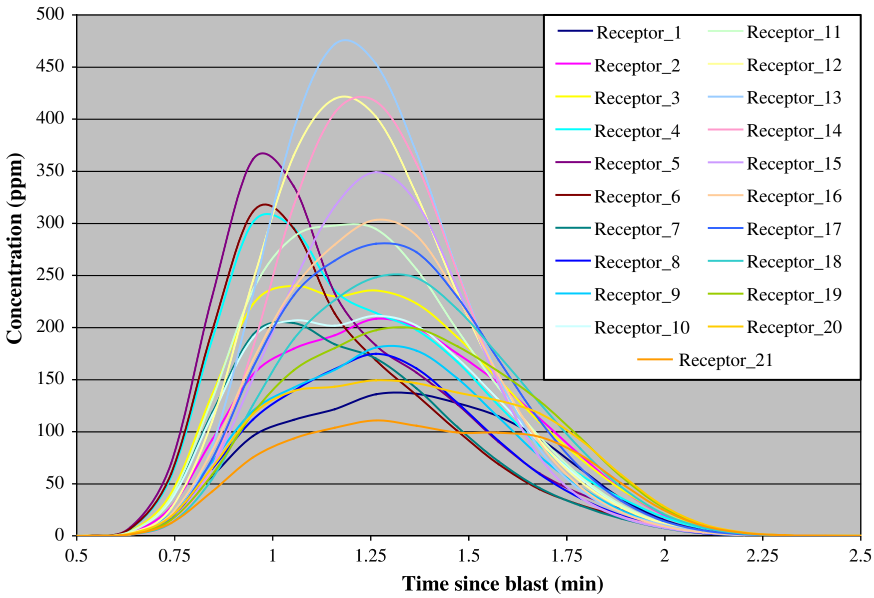


Fig. 6. Calculated NO_2 concentration profiles 200 m from source.

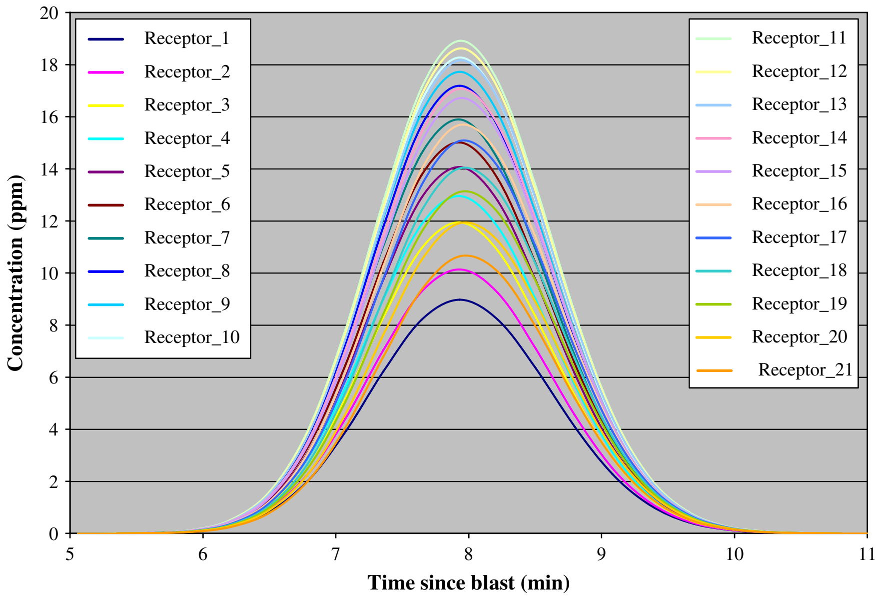


Fig. 7. Calculated NO_2 concentration profiles 1 km from source.

source. AFTOX in this regard ignores the effect of wind speed on the size of the initial envelope and as such the initial concentration of the plume is identical irrespective of wind speed by ignoring longitudinal (i.e. downwind) spread of the initial release. In the second step the concentration downwind of the initial release is determined by estimating the growth of a puff in three dimensions which in this case explicitly includes longitudinal plume spread which is assumed to be equal to the degree of crosswind spread. The degree of this spread is determined solely from the prescribed atmospheric stability class which ignores any wind speed dependence.

While the peak concentrations are similar, the dose received at a receptor is linearly dependent on wind speed. Emissions released into an atmosphere with higher wind speeds result in a receptor receiving doses for a smaller period of time. It should be noted that some of the differences in the peak concentrations displayed in Table 2 result from the number of discrete time steps used to calculate the concentrations. This was set at 25 intervals between the onset and finish of a plume as it passes by the receptor. This time is dependent on atmospheric stability and the distance from the source. In AFTOX, the puffs are assumed to disperse in the direction of plume travel proportionally with the degree of crosswind spread. As such, portions of the plume arrive before and after the main bulk of the emissions and the effect clearly demonstrated in Figs. 6 and 7. The moderate number of discrete times modelled to capture this effect while generally adequate may have led to a degree of variation particularly at larger distances from the source.

Again it should be noted that the modelled figures assume an area wide flux of 100 kg which is larger than observed in the blast recorded during this study. It should also be noted that while some of the concentrations are high close to the source the concentration at a particular location occurs for a brief period of time which is determined by the wind speed.

4. Conclusions

A portable open-path spectroscopic method was found to be effective for measuring NO_2 emissions from blasting. Overall this technique was found to be simpler, safer and more successful than other approaches that in the past have proved to be ineffective in monitoring these short lived plumes.

Quantitative measurements of NO_2 in plumes from blasting were made at two open-cut mines. The results showed that NO_2 was present in most of the plumes but in relatively low concentrations (typically ranging between 0 and 7 ppm). The highest concentration measured during all the field campaigns was about 17 ppm at ground level.

Based on field measurements, the emission factor currently used in compiling the Australian National Pollutant Inventory was found to be approximately eight times greater than that observed in our investigation. This would suggest that an over estimation of NO_x is made if the current factor is used.

Numerical modelling of the behaviour of plumes resulting from blasting was made to assess the possible downwind concentrations of NO_2. These results were compared to ambient NO_x measurements made in Muswellbrook.

- Modelling results were consistent with concentration measurements within the plumes at relatively short distances from the blast (i.e. up to about 1 km).
- Ambient monitoring did not detect NO_x events that could be attributed to individual blasts. Modelling suggested that these emissions would be very low at

distances greater than 5 km from the blast and may be indistinguishable from background levels; typically of the order of several parts per billion, in most cases.

Acknowledgements

We gratefully acknowledge the financial support of the Australian Coal Association Research Program (ACARP) and the staff at the Hunter Valley mine sites.

References

Chalmers Radio, Space Science. The optical remote sensing group. Available from: <http://www.rss.chalmers.se/ors/ >.

Galle, B., Oppenheimer, C., Geyer, A., McGonigle, A.J.S., Edmonds, M., Horrocks, L., 2002. A miniaturised ultraviolet spectrometer for remote sensing of SO_2 fluxes: a new tool for volcano surveillance. Journal of Volcanology and Geothermal Research 119, 241–254.

Kirchgessner, D.A., Piccot, S.D., Chadha, A., 1993. Estimation of methane emissions from a surface coal mine using open-path FTIR spectroscopy and modelling techniques. Chemosphere 26, 23–44.

Kunkel, B.A., 1991. AFTOX 4.0 – The Air Force Toxic Chemical Dispersion Model – A User's Guide. PL-TR-91-2119, Environmental Research Papers No. 1083, Phillips Laboratory, Directorate of Geophysics, Air Force Systems Command, Hanscom AFB, MA 01731-5000, p. 62.

Levine, S.P., Russwurm, G.M., 1994. Fourier transform infrared optical remote sensing for monitoring airborne gas and vapour contaminants in the field. Trends in Analytical Chemistry 13, 263–266.

Moffat, A.J., Milan, M.M., 1971. The applications of optical correlation techniques to the remote sensing of SO_2 plumes using sky light. Atmospheric Environment 5, 677–690.

McGonigle, A.J.S., Thomson, C.L., Tsanev, V.I., Oppenheimer, C., 2003. A simple technique for measuring power station SO_2 and NO_2 emissions. Atmospheric Environment 38, 21–25.

National Pollutant Inventory, 1999. Emission Estimation Technique Manual for Explosives Detonation and Firing Ranges. Environment Australia. Available from: <http://www.npi.gov.au/handbooks/approved_handbooks/fexplos.html>.

Piccot, S., Masemore, S., Ringler, E., Srinivasan, S., Kirchgessner, D., Herget, W., 1994. Validation of a method for estimating pollution emission rates from area sources using open-path FTIR spectroscopy and dispersion modelling techniques. Journal of the Air & Waste Management Association 44, 271–279.

Piccot, S., Masemore, S., Ringler, E., Bevan, W.L., Harris, D.H., 1996. Field assessment of a new method for estimating emission rates from volume sources using open-path FTIR spectroscopy. Journal of the Air & Waste Management Association 46, 159–171.

Attachment 10: Dangers of Toxic Fumes from Blasting

Richard J Mainiero, Marcia L Harris, and James H Rowland III

Dangers of Toxic Fumes from Blasting

By Richard J. Mainiero, Marcia L. Harris, and James H. Rowland III

Abstract

This paper reviews the potential hazards posed by the toxic fumes produced by detonating explosives in surface mining and construction operations. Blasting operations produce both toxic and nontoxic gaseous products; the toxic being mainly carbon monoxide (CO) and the oxides of nitrogen (NO_x). The quantity of toxic gases produced by an explosive is affected by formulation, confinement, age of the explosive, and contamination of the explosive with water or drill cuttings, among others. Techniques to protect workers and the public from the potential hazards of explosive-related toxic fumes are discussed. These include:

- Minimizing the quantity of toxic fumes produced.
- Determining where the fumes may go so workers and neighbors can be moved out of harm's way.
- Preventing the fumes from moving towards workers and neighbors.
- Monitoring the air near workers and neighbors so they can be relocated if fumes appear.
- Ventilating structures or confined spaces until CO falls below a hazardous concentration.

Background

Ideally, the gaseous detonation products of explosives would consist of water (H_2O), carbon dioxide (CO_2), and nitrogen (N_2). Due to the kinetics of the chemical reaction, the detonation of explosives in a blasting operation also produces toxic nitrogen dioxide (NO_2), nitric oxide (NO), and carbon monoxide (CO) (ISEE, 1998). The concentrations Immediately Dangerous to Life or Health (IDLH) for NO_2, NO, and CO are 20, 100, and 1,200 ppm, respectively (NIOSH, 1994). Blasters working in underground or confined environments have long been aware of the hazards of these gases and must ensure adequate ventilation to quickly dilute them below harmful levels. In an effort to protect workers, extensive research has been done on the toxic fumes generated by the detonation of high explosives and many countries have test procedures and formal or informal requirements in place for the maximum permitted fumes production by a given amount of explosives (Streng, 1971, Karmakar and Banerjee, 1984, and International Society of Explosives Engineers, 1998).

Blasters at surface mines and construction operations have not been as concerned about blasting fumes as their counterparts in underground mines, believing that fumes would disperse in the open air (ISEE, 1998). Surface blasters, however, must be aware that toxic fumes have the potential to create hazards in their operations. Large surface mines may detonate up to two million pounds of blasting agent in a single shot. Some of the shots produce a product cloud colored red or orange by the presence of NO_2 (Barnhart, 2004), (Barnhart, 2003), and (Lawrence, 1995). At present it is not known whether the orange cloud contains toxic levels of NO_2 since there have been no published reports of direct measurements. However, in the interest of safety every blaster should assume that any blasting product cloud is unsafe to breathe.

For surface blasting operations, the CO in the gaseous products released immediately after a blast is not of great concern since CO is much less toxic than NO_2; the IDLH for CO is 1,200 ppm compared to 20 ppm for NO_2. For CO, the danger lies with the gas that remains in the ground after the blast. This CO will be released during loading operations or may migrate hundreds of feet through the ground and collect in confined spaces. Since 1988, there have been eighteen documented incidents of CO migration in the United States and Canada; the confined space typically being a home and in one case a sewer manhole vault (NIOSH, 1998), (Eltschlager, Schuss, Kovalchuk, 2001), (NIOSH, 2001), and (Santis, 2001). There have been thirty-nine suspected or medically verified carbon monoxide poisonings, with one fatality. In one incident in Kittanning, Pennsylvania, blasting fumes traveled 450 feet from a coal strip mine into a home, poisoning a couple and their baby. Fortunately, all three recovered following treatment in a hyperbaric chamber (Eltschlager et al. 2001) and (NIOSH, 2001).

Protecting Personnel

There are a number of ways to protect workers and neighbors from toxic fumes produced by blasting operations. Several of these are:

1. Minimize the quantity of toxic fumes produced,
2. Determine where the fumes may go so workers and neighbors may be moved out of the way,
3. Prevent the fumes from moving towards workers and neighbors,
4. Monitor the air near workers and neighbors so they can be relocated if fumes appear, and
5. Ventilating structures or confined spaces until CO falls below a hazardous concentration.

Each of these items will be discussed.

1. Minimize the quantity of toxic fumes produced.

Due to expansion and subsequent cooling of detonation product gasses, the combustion reactions are quenched before they can go to completion. The quenching freezes out CO and NO_x at concentrations higher than those expected for equilibrium. It is not possible to entirely prevent the release of CO and nitrogen oxides (NO_x) in blasting, but the quantities can be minimized. Some factors that lead to excessive CO and NO_x production are incorrectly formulated explosives, use of deteriorated explosives, reaction in diameters below the critical diameter, loading wet boreholes with explosives that are not water resistant, mixing of explosive with drill cuttings at the top and bottom of the hole, and poor confinement (ISEE, 1998), (Rowland III and Mainiero, 2000), (Roberts, Katsabanis, and deSouza, 1992), and (Engsbraten, 1980).

An explosive containing a stoichiometric mix of fuel and oxidizer minimizes the production of CO and NO_x. If there is an excess of fuel, detonation of the explosive or blasting agent will generate increased quantities of CO. If there is not enough fuel, detonation of the explosive or blasting agent will generate increased quantities of NO_x. Figures 1 and 2 illustrate the effect of ANFO fuel oil content on CO and NO_x production.

Explosive manufacturers are careful to balance the oxidizer and fuel in their explosive formulations to minimize fumes production. Blasters must insure the proper compositions for explosives and blasting agents mixed in the field. The performance of modern explosives is controlled by both the composition and the physical structure of the chemical mix. Explosives that are beyond the manufacturer-recommended shelf life or visibly deteriorated should not be used. As some explosives age, ingredients may leak out of the packaging, changing their compositions or their physical structure may break down. Either of these will result in an explosive that may not function as intended by the manufacturer and may produce excessive fumes.

Proper use of explosives and blasting agents is also very important in minimizing toxic fume production. For every explosive or blasting agent there is a minimum charge diameter, commonly referred to as critical diameter, below which it will not detonate properly. Below this critical diameter, the surroundings absorb sufficient energy from the explosion front to quench the detonation. Bulk-loaded blasting agents used in large-scale surface mine blasting do not detonate properly in boreholes of 1-inch diameter or less (ISEE, 1998). If the blasting agent is diluted by mixing with drill cuttings at the top or bottom of the borehole it may not detonate properly and excessive quantities of toxic fumes may be produced (Sapko, 2002). Similarly, the blasting agent may flow into cracks and crevices around the borehole where it may not detonate properly because the width of the cracks and crevices may be below the critical diameter. Incomplete detonation of the blasting agent leads to excessive toxic fumes (ISEE, 1998). Stemming plugs may be placed in the top and bottom of the blasthole to prevent mixture of the blasting agent with drill cuttings or rocks. Flow of the blasting agent into cracks and crevices may be prevented through the use of packaged product or borehole liners.

Production of excessive NO_x during blasting may also be caused by incomplete detonation as a result of loading wet boreholes with an explosive that is not water resistant. When wet boreholes are encountered, the water must be removed or they must be loaded with explosives or blasting agents that are packaged to keep out the water or with a product that is designed to be water resistant. ANFO is not water resistant and will not shoot properly in wet holes unless it is packaged to resist the water. Emulsion blasting agents are water resistant and may be loaded in bulk in wet boreholes. ANFO/emulsion blends exhibit water resistance to varying degrees depending on the ratio of ANFO to emulsion. The explosive supplier can recommend a mix ratio that is appropriate for a given application.

2. Determine where the blasting fumes are likely to go.

For surface blasting, much of the detonation products can be seen as a cloud of gas and dust coming off the blast. When a surface blast is initiated all workers should be positioned at locations outside of the likely path of the product cloud. Monitoring the wind direction immediately prior to the blast can be useful in accomplishing this. Some mines also have blasting plans that specify a blast should not be initiated if the wind will carry the cloud in the direction of neighbors off mine property. In addition, detonation product gases may be present in the muck pile and may also move into cracks and fissures in the ground. The gases move through the ground and may collect in a nearby confined space such as underground sewers, pipeline trenches, or basements of homes and businesses. As the gases move, CO will be the toxic gas of main interest since NO_2 and indirectly NO are absorbed by the soil. (NO oxidizes to NO_2 which is readily absorbed by the soil.)

In most cases the fumes will spread slowly through the ground in all directions. However, in some cases, pathways exist that allow the gases to move preferentially in one direction. Such pathways may be created by broken rock from an earlier blast (ISEE, 1998), a hill seam (a pathway caused by the movement of rock layers on a hillside) (Eltschlager et. al. 2001) and (NIOSH, 2001), underground utility lines, a French drain, or fractures in the ground (Harris, Sapko, and Mainiero, 2005). A review of available maps and examination of nearby structures should reveal utility lines or French drains that may serve as pathways. Identifying naturally occurring pathways would be much more difficult and it would be impractical to do this for every blast. However, once CO migration has been identified as a problem at a blast site, the blaster may want to consult a geologist for aid in identifying the pathway. Knowledge of the probable pathway will be useful in deciding how to minimize the likelihood of CO migration problems in future blasts.

3. Prevent the fumes from moving towards workers and neighbors.

For surface blasts there is no practical way to change the direction in which the product cloud will move; all a blaster can do is try to ensure that no one will be in the cloud's path. This is not the case for blasting fumes moving through the ground.

Techniques for mitigating the migration of CO were evaluated during blasting research conducted at the NIOSH Pittsburgh Research Laboratory (PRL) (Harris et al. 2005). When no actions were taken to prevent or mitigate CO in the ground, CO was measured for several days in monitoring boreholes after a blast. This has been demonstrated at the PRL site and also during reported incidents in the field. However, when the muck pile is immediately excavated after the shot, the levels of CO measured in monitoring holes are orders of magnitude lower and do not last for a long duration. When negative pressure was applied to a monitoring hole close to the blast location after a blast that was not excavated, the levels of CO measured were comparable with immediate excavation and were of a short duration as well. A reasonable and immediate source of negative pressure is the vacuum from the dust collection system of a drill rig. If a hole is drilled in the near proximity of the blast, the end of the drill boom can be located on top of the drilled hole and the dust collection system turned on for a period of time. A more extensive system may be constructed using several holes connected to a fan. These techniques need not be applied to every shot but rather only when a problem with CO migration is encountered.

Mucking will remove some gas that is trapped in the muck pile (Harris et al. 2005). Over time CO may migrate beyond the rubble zone and mucking will not remove any CO that has migrated beyond the rubble area. To be effective, mucking should be carried out as soon after the blast as possible.

Blasters' awareness is important in preventing future CO poisonings. Monitoring nearby enclosed spaces for toxic gases before and after blasting still remains the best recommendation for a first approach to intervention and triggering other actions.

4. Monitor the air near workers and neighbors so they can be relocated if fumes appear.

Studies at blasting sites in Amherst, New York (Harris and Mainiero, 2004) and Bristow, Virginia (Harris, Rowland III, and Mainiero, 2004) identified ways to protect people from the CO that may migrate from a blast into nearby homes or other confined spaces. Based on these studies, it was recommended that the blaster place CO monitors in occupied parts of nearby homes and businesses. CO monitors of the type sold in department and hardware stores for home use should be adequate if the instructions on the packaging are followed. These detectors are designed and tested to protect people in their homes from CO poisoning, whatever the source. Each CO migration occurrence is unique and depends on the route of entry, distance of site from CO generation source, and geology. Therefore, possible monitoring of nearby homes or businesses may continue for an extended period of time, from several hours to a few days. Monitoring should continue until CO from the blasting operation no longer enters the home or business. In recent years CO poisonings were most likely prevented by the early warning of a homeowner-installed CO detector. Because of early warning, the source of CO was determined and affected homes were evacuated and closely monitored before anyone could become ill. To the best of our knowledge, no one has had to be treated for blasting-related CO poisoning since the western Pennsylvania incident in April, 2000 (Eltschlager et al. 2001) and (NIOSH, 2001).

It is important that workers follow the confined space requirements of the Occupational Safety and Health Administration when entering a manhole vault, trench, or other confined space near a blasting site (OSHA, 2005). In 1998 a worker was killed and two injured when they entered a manhole vault 45 minutes after a nearby blast. No one had checked the vault for toxic gases prior to entry. The vault contained toxic levels of CO (NIOSH, 1998).

5. Ventilate structures or confined spaces until CO falls below a hazardous concentration.

Once CO is detected in a confined space near a blast site, no one should reenter until safety personnel have stated that it is safe to do so. Local firefighters and other emergency response personnel may be called to assist. These people have been trained and are equipped to deal with toxic atmospheres in homes, businesses, and other confined spaces, and will take appropriate action.

Conclusion

The major toxic gases produced by detonation of commercial explosives and blasting agents are CO and NO_x. These gases may migrate through the ground into the basements of nearby homes and businesses, trenches, manhole vaults, and other confined spaces. NO_x does not migrate through the ground because it is absorbed by the soil as the gases travel. However, NO_x is a concern in surface blasting because it is very toxic; much more toxic that CO. Excessive NO_x production at a blasting site may be evidenced by the presence of an orange or red cloud produced by the blast. The boreholes must be properly loaded to minimize the production of NO_x. To the best of the authors' knowledge, no one knows the concentrations of NO_x in a blasting product cloud but it is best to err on the side of safety and assume the cloud is toxic. People should be kept out of contact with the product cloud. Carbon monoxide is a serious concern because it is not absorbed on passage through the ground. Carbon monoxide may travel up to several hundred feet and collect at toxic levels in a confined space. Carbon monoxide is odorless so there is no obvious indication that a hazard exists. This hazard may be dealt with at several levels. A blaster should use explosives and blasting agents in the manner specified by the manufacturer to minimize the quantity of CO produced. The blaster should attempt to identify any pathways by which gases produced by the detonation may travel from the blast site into homes, businesses, or other confined spaces. If a blaster is aware that there is a likelihood of CO migrating into occupied spaces he/she may minimize the hazard by excavating the blasted rock soon after the blast or may connect a fan to a borehole near the blast to pull the CO out of the ground. The blaster may place home-type CO monitors in homes or businesses near the blast site so occupants will be alerted if CO concentrations rise to unsafe levels. OHSA's confined space regulations must be followed when a worker enters a trench, manhole vault, or other confined space. Firefighters or other emergency personnel may be called in to ventilate any homes or businesses where CO has been detected and determine when a CO hazard no longer exists.

It is very difficult to predict when CO produced by a blast will migrate into homes, businesses, and other confined spaces. It would be impractical to do this for every blast. At present the best defense is to ensure that people are alerted if the air they are breathing contains toxic levels of CO.

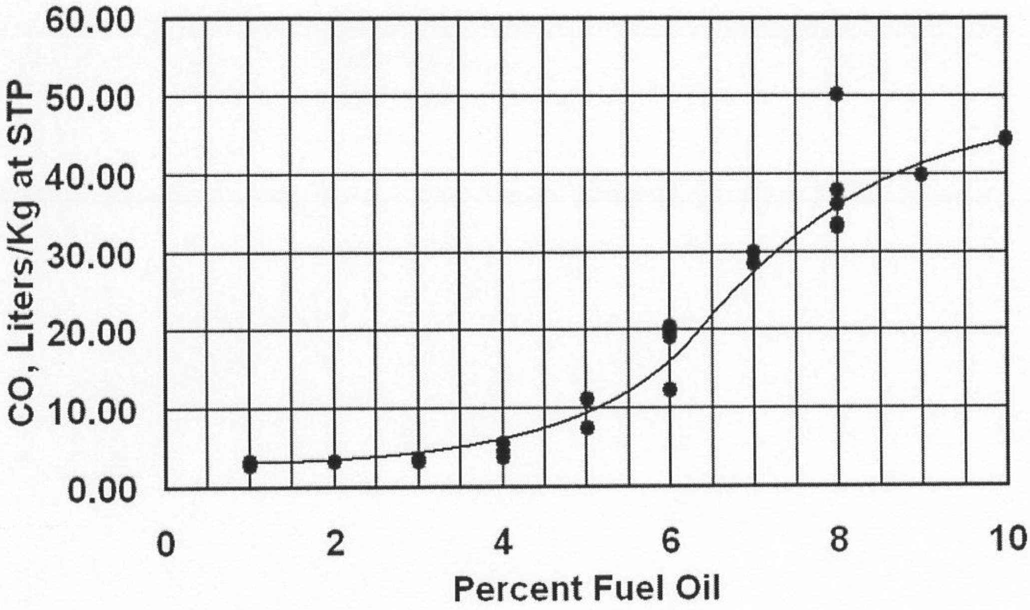


Figure 1. The effect of fuel oil content on the quantity of carbon monoxide produced by detonating ANFO. (Rowland III and Mainiero, 2000)

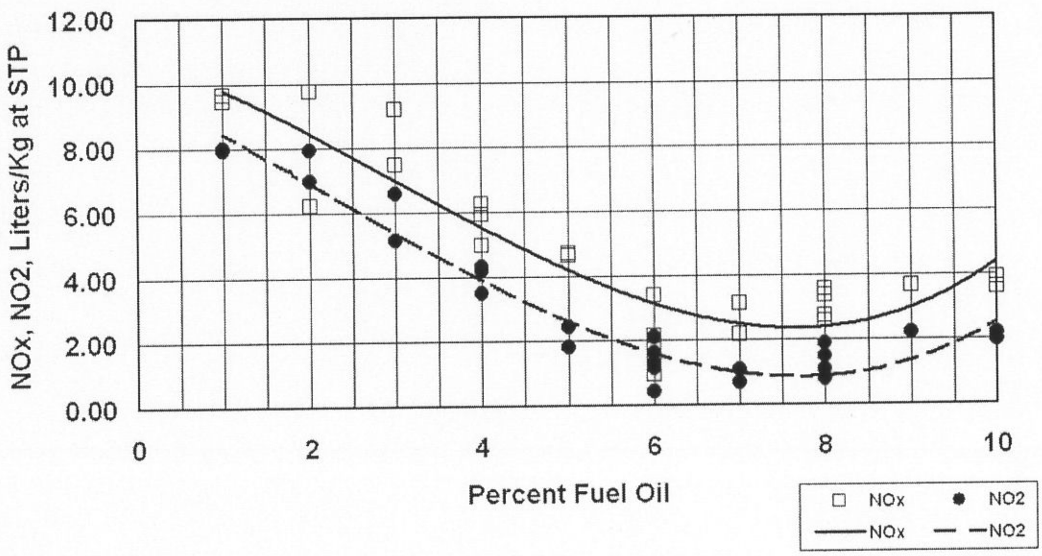


Figure 2. The effect of fuel oil content on the quantity of nitrogen oxides produced by detonating ANFO. (Rowland III and Mainiero, 2000)

References

Barnhart, C. R. (2004). Analytical Measurements in Cast Blasting to Identify the Cause and Cure for "Orange Smoke." *Proceedings of the 30th Annual Conference on Explosives and Blasting Technique, February 1-4* (pp 1-15) Cleveland, OH: International Society of Explosives Engineers.

Barnhart, C. R. (2003). Understanding the "Orange Smoke" Problem in Cast Blasting. *Proceedings of the 29th Annual Conference on Explosives and Blasting Technique, February 2-5* (pp. 1-11) Cleveland, OH: International Society of Explosives Engineers.

Eltschlager, K. K., Schuss, W., Kovalchuk, T. E. [2001]. Carbon Monoxide Poisoning at a Surface Coal Mine....A Case Study. *Proceedings of the 27th Annual Conference on Explosives and Blasting Technique, January 28-31.* Cleveland, OH: International Society of Explosives Engineers.

Engsbraten, B. (1980). Fumes from Detonation of Commercial Explosives in Boreholes and Steel Tubes. *Proceedings of the 6th Annual Conference on Explosives and Blasting Technique, February 5-8.* Cleveland, OH: International Society of Explosives Engineers.

Harris, M. L. and Mainiero, R. J. (2004). CO Migration from Trench Blasting in Amherst, New York. *Proceedings of the 30th Annual Conference on Explosives and Blasting Technique, Vol. II, February 1-4.* (pp 25-39). Cleveland, OH: International Society of Explosives Engineers.

Harris, M. L., Rowland III, J. H., and Mainiero, R. J. (2004). Blasting-Related Carbon Monoxide Incident in Bristow, Virginia. *Proceedings of the 30th Annual Conference on Explosives and Blasting Technique, Vol. II, February 1-4.* (pp 319-327). Cleveland, OH: International Society of Explosives Engineers.

Harris, M. L, Sapko, M. J., and Mainiero, R. J. (2005). Field Studies of CO Migration from Blasting. *Proceedings of the 31st Annual Conference on Explosives and Blasting Technique, Vol. II, February 6-9.* (pp 49-69). Cleveland, OH: International Society of Explosives Engineers.

International Society of Explosives Engineers [ISEE] 1998, Blaster's Handbook, 17th Edition. Cleveland, OH, p. 48.

Karmakar, N. C. and Banerjee, S. P. (1984). A Review of Laboratory and Field Test Methods for Studying Fume Characteristic of Explosives. *Journal of Mines, Metals and Fuels,* Vol. 32, No. 1/2, Jan-Feb, pp. 398-402.

Lawrence, D. L. (1995). A Study of Post Blast Generation of Nitrogen Dioxide. *Proceedings of the 22nd Annual Conference on Explosives and Blasting Technique. February 2-5* (pp 1-12) Cleveland, OH: International Society of Explosives Engineers.

National Institute for Occupational Safety and Health [NIOSH]. (2001). *Technology News 488 - Migration of Blasting Fumes into a Western Pennsylvania Home*. Pittsburgh, PA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health.

National Institute for Occupational Safety and Health [NIOSH]. (1998) *NIOSH HETA 98-0020. Hazard Evaluation And Technical Assistance Report: Carbon Monoxide Intoxication And Death In A Newly Constructed Sewer Manhole.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health.

National Institute for Occupational Safety and Health [NIOSH]. (1994). *Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 94-116.* Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention. National Institute for Occupational Safety and Health.

Code of Federal Regulations, Title 29, Section 1910.146.

Roberts, W., Katsabanis, P. D., and deSouza, E. M. (1992). Experimental Investigation of the Fumes Produced by Modern Commercial Explosives. *Proceedings of the 18th Annual Conference on Explosives and Blasting Technique, January 19-23.* Cleveland, OH: International Society of Explosives Engineers.

Rowland III, J. H., and Mainiero, R. J. (2000). Factors Affecting ANFO Fumes Production. *Proceedings of the 26th Annual Conference on Explosives and Blasting Technique, Vol. I, February 13*-16 (pp 163-174) Cleveland, OH: International Society of Explosives Engineers.

Santis, L. D. (2001). A Summary of Subsurface Carbon Monoxide Migration Incidents, *Proceedings of the 27th Annual conference on Explosives and Blasting Technique, January 28-31.* Cleveland, OH: International Society of Explosives Engineers.

Sapko, M,. Rowland, J., Mainiero, R. and Zlochower, I. (2002). Chemical and Physical Factors that Influence NO_x Production During Blasting – Exploratory Study. *Proceedings of the 28th Annual Conference on Explosives and Blasting Technique,* February 10-13, Cleveland, OH: International Society of Explosives Engineers.

Streng, A. G. (1971). Evaluation of Toxic After-Detonation Gases Formed by Industrial Explosives. *Explosivstoffe,* Vol. 19, No. 3/4, pp. 58-64.

Attachment 11: Safety Alert (Prevention and Management of Blast Fumes)

Department of Employment, Economic Development and Innovation

Safety Alert

EXPLOSIVE
1

Explosives

Explosives Inspectorate

Safety Alert No. 44 V2
15 March 2011

Prevention and management of blast fumes

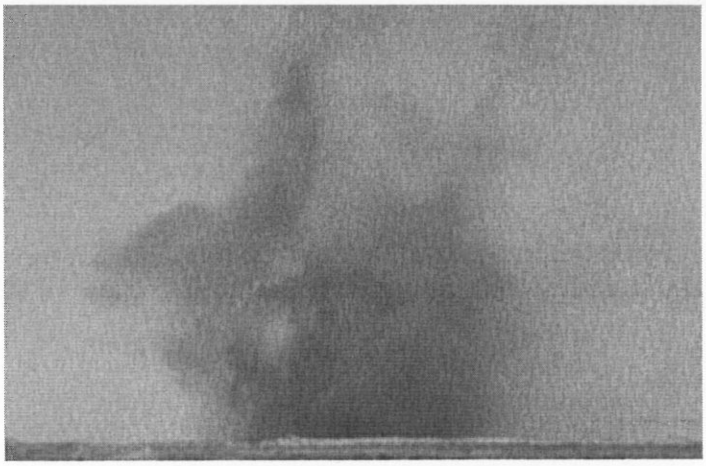


Figure 1 – Oxides of nitrogen generated by blasting

Reference

A. Queensland Mines Inspectorate Safety Bulletin No. 61
B. Queensland Explosives Inspectorate Safety Alert No. 28 Post Blast Gases
C. *Explosives Act 1999* (Qld)
D. *Coal Mining Safety and Health Act 1999* (Qld)
E. *Mining and Quarrying Safety and Health Act 1999* (Qld)

Purpose

1. The purpose of this alert is to make sure that everyone involved in open-cut blasting is aware of the potential for oxides of nitrogen to be generated from the use of ammonium-nitrate-based explosives (see Figure 1). Exposure to oxides of nitrogen can pose a serious health risk.

Scope

2. All Site Senior Executives, drill and blast superintendents, explosives company managers, shotfirers and other relevant people must risk-manage the potential hazards created by post-blast gases.

Background

3. Post-blast fume is a product of combustion from a blast. The products of combustion from a blast may include oxides of nitrogen, ammonia, nitric acid, carbon monoxide and carbon dioxide. These gases are often referred to as fumes. Nitrogen dioxide is visible as a reddish brown colour; the others are not visible.

4. Other than water ingress , known causes for the generation of oxides of nitrogen (including nitrogen dioxide) are:
    a. incorrect fuel to oxygen ratio
    b. product pre-compression
    c. insufficient priming
    d. acidic soils
    e. presence of pyrite
    f. product formulation.

5. Post-blast fume is composed of toxic gases (including oxides of nitrogen) which can be released into the atmosphere in significant quantities from blasting operations. Exposure to even quite low concentrations can pose a serious health risk.
6. The recent wet conditions and increased groundwater with the use of down hole ammonium-nitrate-based products have led to an increase in post-blast gases. Four events have occurred in the past fortnight in open-cut operations. In two of these events, 24 people required treatment and hospital observation for exposure to oxides of nitrogen.

   The department has previously provided References A and B in regard to the management of post-blast gases. These are available on its website at:
   a. http://www.dme.qld.gov.au/mines/safety_compliance.cfm (Reference A)
   b. http://www.dme.qld.gov.au/mines/safetyalerts.cfm (Reference B)

7. From 1992 to 2002, the United States of America had eight post-gas events that resulted in injuries to workers and the public, including a fatality.
8. In the Philippines in 2006, a shotfirer was conducting a post-blast inspection at a quarry when he fell eight metres into a cavity. He was rescued and taken to hospital with apparently only minor injuries. At the time of his recovery, it was noticed that his breathing was laboured, but this information was not passed on to the hospital staff. He died the next day of severe pulmonary oedema (NOx poisoning), which was not recognised by either the medical team or operational staff.

Issues

9. The operator's safety management system must include all the different control phases for post-blast fumes. The phases are:
   a. prevention — i.e. how to prevent or minimise post-blast fumes
   b. management of fumes — i.e. where post-blast fumes extend beyond the exclusion zone
   c. management of an exposure — i.e. for when people are exposed to fumes.

Prevention

10. To prevent or minimise post-blast fumes, it is necessary to have a knowledge and understanding of ground conditions, water (wet holes and the depth of the water), explosives product and their application, meteorology, and the toxicological effects of the gas.

11. There is a strong correlation between wet ground and the production of excessive fume. The presence of water can degrade the explosive resulting in a poor blast and excess fume.

12. Fume can be reduced if:
    a. the explosives product selected is correct for the conditions
    b. holes are dewatered before loading
    c. sleep times are kept to the minimum time recommended by the manufacturer.

13. An understanding and application of meteorology (i.e. weather conditions, wind speed and direction and stability classes) and gas cloud distributions will enable calculation of how long a gas plume will take to reach a point of interest such as a crib hut, workshop, house.[i] Such understanding and application also help determine the dispersion of the gas cloud, how far it will spread sideways, and how the gas concentration will change with distance. The people developing these plans must understand the gas toxicology, exposure to gas and the exposure standards of a gases, such as nitrogen dioxide, particularly high concentration exposures over relatively short periods.

---

[i] Buildings should not be used as shelters, unless they have been assessed by competent persons as safe havens.

Management of fumes

14. Before a gas plume occurs, it is important to have a system for managing a potential incident, including evacuations. The system should include information on wind speed and direction and on whether there is a gas-tight shelter nearby. Communication systems should also be in place, and there should be monitors to record concentrations of toxic fumes.

Management of an exposure

15. Exposure to nitrogen dioxide can result in delayed health effects that may be potentially life-threatening, even though the exposed person may at first appear relatively unaffected. For this reason, anyone who has been exposed to nitrogen dioxide should undergo an immediate medical assessment and a continued period of observation at the advice of the treating doctor.

16. The plan must include a health management plan for an exposure, which needs to be integrated with the local health providers. This should include medical advice to the treating physician. Attached to this alert is a sample advice letter that can be provided to the treating physician. Exposure should be treated seriously and referred for medical treatment based upon an exposure or stated dose.

17. All people involved in the management of blasting activities should review their safety management systems, including standard operating procedures and emergency response plans, to ensure that the management of situations, where clouds of oxides of nitrogen are generated, are properly managed.

Recommendations

1. All people involved in the management of blasting activities should ensure that the management plan for situations where plumes of oxides of nitrogen have been generated has been deployed and is operational. This should include health management and medical management plans.
2. The provision of material safety data sheets relative to the types of products being used should be made readily available to all persons involved in the blasting process.
3. All efforts should be made to reduce the likelihood of the production of post-blast gases during blasting operations.
4. Where doubt exists as to the potential cause of post-blast gases, those involved in the blasting process should contact the supplier of the explosives for further information.
5. Ensure that all relevant people in the organisation receive a copy of this Safety Alert.

The information contained in this Safety Alert is provided for guidance only. It is not to be taken as a statement of law and must not be construed to waive or modify any legal obligations.

Attachment: Information for Treating Doctor

Chief Inspector of Explosives

Southern Region	Central Region	Northern Region
3238 3728	4938 4442	4799 7004
sroexplosives@dme.qld.gov.au	croexplosives@dme.qld.gov.au	nroexplosives@dme.qld.gov.au

Internet : www.dme.qld.gov.au

INFORMATION FOR TREATING DOCTOR

Dear Doctor

This patient has been exposed to NOx. This is a gas usually produced on mines after the use of explosives.

NOx consists of multiple combinations of nitrogen and oxygen (N_2O, NO, NO_2, N_2O_4, N_2O_3, N_2O_5). Nitrogen Dioxide (NO_2) is the principal hazardous nitrous fume.

NOx irritates the eyes and mucous membranes primarily by dissolving on contact with moisture and forming a mixture of nitric and nitrous acids. But this is not the only way injury can occur. Inhalation results in both respiratory tract irritation and pulmonary oedema. High-level exposure can cause methhaemoglobinaemia. Some people, particularly asthmatics, can experience significant broncospasm at very low concentrations.

The following effects are commonly encountered after NOx exposure:

ACUTE

- cough
- shortness of breath
- irritations of the mucous membranes of the eyes, nose and throat

SHORT TERM

- pulmonary oedema, **which may be delayed from 4 to 12 hours**

MEDIUM TERM

- RADS (Reactive Airways Dysfunction Syndrome)
- in rare cases, bronchiolitis obliterans, which may take from two to six weeks to appear

LONG TERM

- chronic respiratory insufficiency

High-level exposure, particularly associated with methhaemoglobinaemia, can cause chest pain, cyanosis and shortness of breath, tachypnoea and tachycardia. Deaths have been reported after exposure and are usually delayed. Even non-irritant concentrations of NOx may cause pulmonary oedema. Symptoms of pulmonary oedema often show until a few hours after exposure and are aggravated by physical effort.

Before transfer to you the patient should have been advised to rest and, if any respiratory symptoms were present, should have been administered oxygen. The patient will need to be treated symptomatically, but as a base line it is suggested that the following may be required:

- spirometry
- chest x-ray
- methheamoglobin estimation.

Because of the risk of delayed onset pulmonary edema, it is recommended that as a precaution the patient be observed for up to 12 hours. As no specific antidote for NOx exists symptoms will have to be treated on their merits.

Information provided by Dr Vern Madden, Health Advantage Toowoomba