Revised Submission to the NSW Department of Environment and Planning in relation to the NorthConnex Environmental Impact Statement.

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Although I am not a resident of the areas likely to be impacted by the proposed NorthConnex development my long experience with tunnels, starting with the notorious M5East tunnel, leads me to believe that I may be able to shed light on some of the issues which are arising during this planning process.

My experience over some 15 years of involvement with tunnel issues includes:

- Membership of the M5East Consultative Committee on Air Quality from mid 1999 until 2007-8
- The 3 parliamentary inquiries into the M5East ventilation system.
- The parliamentary inquiry into the Lane Cove Tunnel
- The parliamentary inquiry 'Health impacts of air pollution in the Sydney basin'.
- Taking part in the 'International Workshop on Tunnel Ventilation 2000"
- Member of the consultative group for the NHMRC report "Systematic Literature Review to Address Air Quality in and Around Traffic Tunnels. 2008"
- Submissions to the Senate inquiry 'Impacts on health of air quality in Australia. 2013'
- Extensive involvement in consultation with the RTA on issues directly relating to the M5East ventilation system, the ill effects experienced by users and the planning of the 'Filtration Trial'.
- In addition, I can claim to be one of the few people in Australia who has actually visited and inspected a modern tunnel filtration system in operation (Madrid. Jan 2008)

A personal note.

I am sometimes asked why, after 15 years of campaigning about tunnels, I am still motivated to continue. The answer is fairly simple. Prior to the M5East stack starting operations, I, always the technological optimist, had assured my neighbours that all would be well and that there would be no impact from the stack.

I have an ineradicable memory of walking around streets in Undercliffe, close to the stack, soon after the tunnel opened and passing into and out of patches of air which stank of stack emissions.

Almost immediately I started getting reports of people getting ill, of people with controlled asthma reverting to an acute state, of people finding it impossible to tolerate the impacts and putting their houses up for sale.

All this occurred in an area which air quality modeling suggested there would be low but acceptable impacts of less than 0.5μg/m^3 PM10.

Generalities

The proposed NorthConnex tunnel system is exceptionally large by world standards. The use of a single 9km ventilation segment from start to stack for a potentially high traffic volume tunnel is probably unique in the world.

This radical departure from established norms of tunnel design means that it is essential that the assumptions, both explicit and implicit, upon which the ventilation engineering, the air quality and the operational systems be rigorously examined, upon which this proposal are based.

I know of only two urban, high traffic volume tunnels (outside of China) which are larger, the Yamate tunnel in Tokyo (which is ventilated using a transverse system) and the Duplex A86 near Paris (which is ventilated in 3 separate segments). The rural Kanetsu tunnel (11km long) in Japan carries a traffic load which is comparable with that predicted for the NorthConnex. It is this tunnel which established the utility and potential performance of in-tunnel filtration as an effective and economical method of tunnel ventilation

An examination of the information provided in the EIS shows a confusing mish-mash of potentially contradictory assumptions and conclusions. In many ways the figures just do not add up and when they do they provide a confronting picture.

The issue of maximum in-tunnel concentration.

In an unfiltered tunnel, the maximum concentration will be experienced at the point of emission.

To maintain a 'steady state' inside the tunnel, it is necessary that the quantity of emissions leaving the tunnel be equal to the emission rate - which is calculated using PIARC or other appropriate figures, vehicle number predictions , slope and other factors affecting vehicle emissions inside the tunnel.

The figures provided in the EIS document (App G-Air Quality-3) show that maximum emissions occur in the Northbound tunnel between 6.00pm and 7.00pm under Scenario 2a (2019) and Scenario 2b (2029) and using the maximum ventilation volume available in the system of 700 m^3/sec then the maximum concentrations at the tunnel end and given by dividing the emission rate by 700 cubic metres.

The results are:

2019: 0.685g/sec / 700 m^3/sec = **985 μgm/m^3**

2029 : .726g/sec / 700 m^3/sec = **1037 μg/m^3**

Two concerns emerge immediately:

1. both of these figures are significantly higher that the highest PM10 emission concentrations recorded in the M5east stack between February and June, 2014.
2. both of these figures are different from those given in Table 7-101 of the EIS (respectively 2019: 504μg/m^3 , 2029: 585μg/m^3
3. **3.** The natural variation and uncertainty within the tunnel ventilation system makes it certain that portions of the in-tunnel atmosphere will inevitably exceed the 1000μg/m3 PM10 concentration noted by the NHMRC report as "clearly dangerous to health".

Daily emission rates.

These can be calculated from the previously mentioned emission rates by converting the rates per second (for each hour) to hourly rates and then summing the 24 hour period. This is clearly a valid method of calculation.

Daily PM10 emissions from the tunnel stacks and the tunnel as a whole.

	Northbound	Southbound	Total
2019 scenario 2a	29.27kg/day	18.49kg/day	47.76kg/day
2019 Design analysis A	27.83 kg/day	25.49 kg/day	53.32 kg/day
2019 Design analysis B	20.45 kg/day	16.31 kg/day	36.76 kg/day
Mean	25.85 kg/day	20.10 kg/day	45.95 kg/day
2029 scenario 2b	31.01 kg/day	19.84 kg/day	50.85 kg/day
2029 Design analysis B	25.78 kg/day	20.30 kg/day	46.08 kg/day
Mean	28.49 kg/day	20.07 kg/day	48.47 kg/day

(From Appendix G - Air Quality, 'Emission calculations' (Appendix H)

<u>Recent weekday in-stack measurements for PM10 from the M5East tunnel (last week of June 2014) show an emission rate from its single stack of 16.42 kg/day.</u>

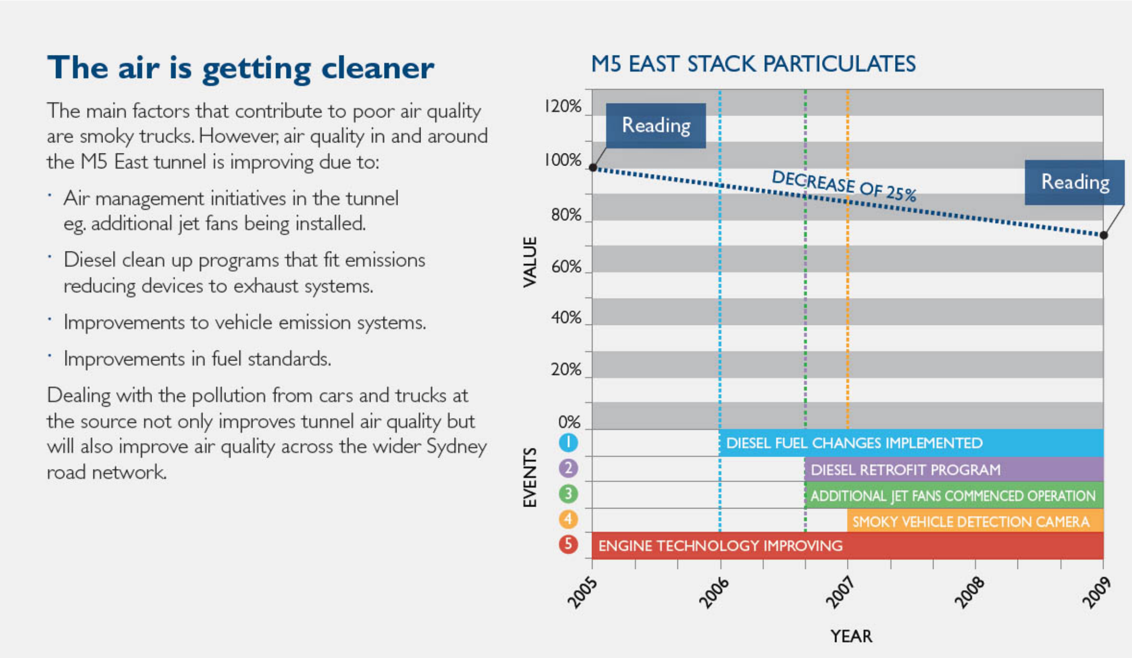
The issue of concern is that the PM10 emission rates from the proposed NorthConnex tunnel will be up to 3 times greater than those form to notorious M5East tunnel stack. Even if there is some short term problem with the in-stack monitoring in the M5East stack, these figures suggest that the total emissions from the NorthConnex will be greater than those experienced at any time during the operation of the M5 tunnel and that each stack will have an total emission rate similar to that experienced in recent years from the M5East stack at Turella

Claims explicitly or implicitly made in justification of essential assumptions

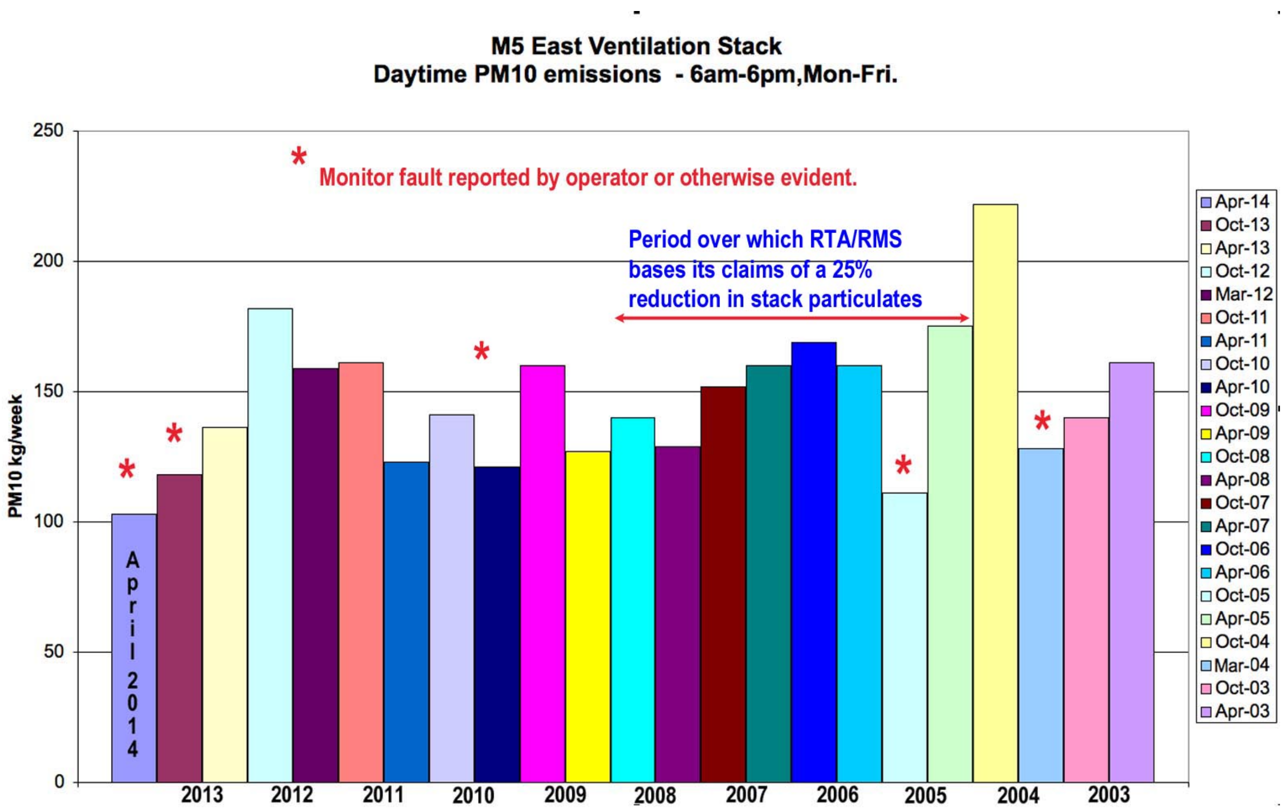
Air Quality issues and claims, NorthConnex.

The RTA/RMS has regularly made claims about significant reductions in emissions from the M5 East tunnel, claiming that this demonstrates the success of various actions to clean up truck emissions and to improve ventilation systems.

The claims were initially made in the RTA's March 2010 Community Update "M5 East tunnel air filtration trial" and are pure spin, possibly combined with wishful thinking. They are not supported by the records of stack emissions from the tunnel which, when analysed, tell an entirely different story.



Portion of the RTA web brochure relating to air quality improvements



Graphical representation of PM10 emissions per working week between 2003 and 2014 calculated from stack emission data from the M5 East stack at Turrella.

The data presents stack emissions between 6am and 6pm on work days (Monday-Friday) for weeks which did not have a public holiday in them or were neither preceded by or followed by a public holiday (ie a long weekend). Using the day time emissions excludes the possible impact of night time maintenance involving fan shut-downs.

As such they represent a fair sample of what actually happens in the tunnel.

There has been no significant difference or decrease in particulate emissions as claimed by the RTA.

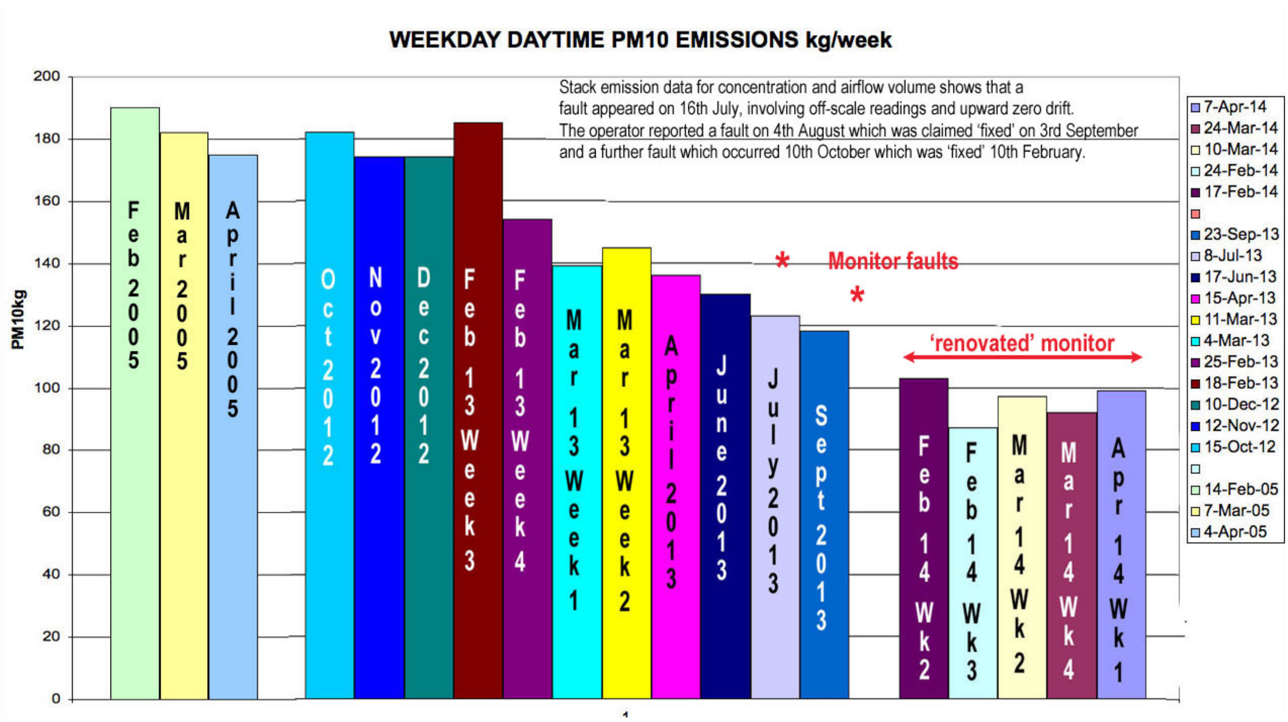
What the stack records do show is that the tunnel ventilation system was under severe stress between June and November 2008. In addition to long term maintenance which led to the entire ventilation system or the stack exhaust being turned off for periods of between 4 and 8 hours per night on over 40 nights, there were daytime shutdowns of the stack on 8 days in October-November. In most cases the shutdowns were between 4 and 11 hours and did not involve closure of the tunnel but there was a 2 day shutdown which closed the tunnel 1st -2nd November.

The problem of poor monitoring

What is outstanding in the monitoring record is:

- the number of outright monitor failures ,
- the number of times when the monitors have obviously lost calibration and readings have drifted either up or down and
- the time it takes the operator to respond to and fix the faults.

Recently there has been a truly remarkable set of changes in the M5 stack monitoring record.



Stack emissions between 6am and 6pm on work days (Monday-Friday) for weeks which did not have a public holiday in them or were neither preceded by or followed by a public holiday (ie a long weekend) based on the concentration of PM10 and the ventilation volume of the M5 East stack .

RMS and the various proponents of traditional tunnel ventilation systems may wish to promote these apparent reductions as evidence of significant improvements in both M5 and general vehicle emissions.

In September 2013 the in-stack PM10 monitor broke down. In February 2014 the records *note "In February 2014, LCPL technicians carried out comprehensive repair works on the GRIMM Particulate monitor located within the tunnel exhaust stack at Turrella which successfully restored the unit to full functionality. PM10 levels have been recorded consistently since the repairs were completed on 10th February 2014."* Since that time the notation has been *"All instruments are operating reliably with no issues to report for the month of ……..*"

These records should not be taken at face value.

Although the RMS clean fleet actions have probably had some impact and the fact that over this period, the filtration system was operating, the apparent 50% reduction in stack emissions since February 2013 in not credible.

No action available to RMS nor any improvement in emissions can have produced this result.

Possible explanations are:

1. As the PM10 readings up until February 2013 are consistent with historical levels evident since the stack first reached capacity, the readings from late February 2013 and April 2014 are the result of a serious monitor error.
2. The operator has been carrying out portal emissions on a level at least as large as those used in 2003-4
3. A combination of the above.

<u>The laws of physics do not suddenly change, nor does the capacity of the tunnel ventilation system to reduce pollution suddenly increase.</u>

The effect of the filtration system in the west-bound tunnel would be included in the 2012-2013 figures as the system was operating then. This would actually be equivalent to a 6-8% reduction in these figures as the filter only operated during the afternoon.

Although it seems likely that there have been some improvements in vehicle emissions over the last 4-5 years the evidence is not to be found in the M5 stack emission record used by the RTA to make their claims in 2010.

Any arguments which use these figures as a basis are likely to be flawed, to say the least.

It is evident that there is a need for monitoring records of critical pollutants both inside and outside the tunnel be quality assured, preferably by an independent expert body, and that they be made available to the public in a timely and accessible manner.

Other claims

• the ventilation outlets will already be designed to make a negligible impact to local and regional air quality.

"Negligible' is in the eye of the beholder. The belief that ventilation outlets and stacks have a negligible effect is based on monitoring of the type which is specifically designed to demonstrate compliance with the (NEPM) air quality guidelines, yet the NEPM documents clearly state that such monitoring is not suitable for areas dominated by local activities such as a road tunnel. Absence of evidence (of adverse affects from a stack) is NOT evidence of absence.

The only certain way to ensure that a tunnel stack causes no harm is to ensure that it emits no harmful material.

There is a consensus across medical opinion that all exposure to fine particulate pollution is harmful and that there is no 'safe' level of exposure.

All stack and dispersal systems have some effects locally. In the past these may have been regarded as negligible but modern medical knowledge shows that this is probably not the case.

The NHMRC report is quite clear that there are serious deficiencies in the sort of monitoring that is carried out around stacks

- 'No clear evidence exists to show that monitoring such as that carried out to assess compliance with air-quality goals, especially for PM10, can reliably predict the size, nature and course of adverse health impacts."
- 'People who live near to tunnels or their stacks may be at risk if the presence of the tunnel alters the ongoing quality of the neighbourhood ambient air. Risks to cardio-respiratory health might arise if people are exposed to contaminated air from tunnel emissions. Important indicators for this risk are levels of NO2 and particulates. Of particular concern is an association between impaired lung development in children and emissions from traffic. Particulates from tunnels and volatile compounds including benzene may produce an increased lifetime risk for cancer.'
- We are not convinced that long-term monitoring of PM10 is useful for the purposes of managing the impact on a community of a road tunnel alone, as opposed to the road network in general. CO and NOx are more robust indicators of effects on traffic impacts.

• Alternative measures to manage in-tunnel and local external air quality are significantly more effective, sustainable and cost efficient in reducing particle emissions. These target vehicles as the source and include:

• engaging commercial vehicle operators to adopt cleaner technologies

• deterrents, such as fines for smoky vehicles in tunnels. This measure has had a significant effect on performance of the M5 East tunnel in particular, because of the high volume of heavy vehicles.

It undoubtedly true that reducing emissions at the source is the most effective way of controlling general emissions but these unavoidable and inconvenient truths remain:

- All vehicles, except those with electric motors emit harmful pollutants.
- The only unequivocal success is the removal of lead from petrol, the introduction of catalytic converters and the consequent reduction of carbon monoxide levels
- There is no coherent plan by the government to force the existing truck fleet to effectively upgrade engine technologies or to maintain particle filters already installed.
- The inescapable fact is that the air quality inside major tunnels is still unacceptable, even though there have been significant actions taken to reduce emissions at source.
- 'Clean' modern diesel engines still produce excessive levels of ultra fine and nano particles and significant and possibly increasing levels of nitrogen dioxide.
- Many reports question the long term effectiveness of diesel particle filters, pointing out unintended consequences such as increased nitrogen dioxide emissions.
- It is inevitable that these pollutants will be concentrated inside the tunnel.
- No matter how high the ventilation rate is, or how effective the distribution from the stack is, this concentrated emission will affect local areas. The only question is how much.
- Nowhere are we aware of effective strategies to drive such change in the time frames involved with the commissioning of road tunnels.
- The claims being made by the RTA/RMS relating to significant reductions in vehicle emissions emitted from the M5 stack are demonstrably incorrect and without basis. The record of stack emissions over time show that there has been no significant change in the level of emissions since 2003 until 2013. There have been fluctuations in apparent emission levels which can be related to monitor inaccuracies and to the use of portal emissions (2003-4).These issues were examined and were the subject of adverse comment in the DIPNR Compliance Audit Report - 2005. The situation has not changed in any meaningful way and monitor breakdowns and inaccuracies have continued unabated.

The Question of filtration

I have long been a proponent for filtration inside of tunnels, because I believe that it is both economically responsible and provides significant health benefits. I am continually shocked at the efforts made to deliberately misrepresent or to tendentiously 'misunderstand' available evidence. That is not to say that filtration is appropriate for every tunnel or that its use in many tunnels overseas is appropriate or provides any guide other than, sometimes, of what not to do.

The M5East ventilation trial

• The M5 East filtration trial focused on the removal of two pollutants; particulate matter (PM) and nitrogen dioxide (NO2). More details are available in Appendix B and on the Roads and Maritime website: http://www. rms.nsw.gov.au/roadprojects/projects/building_ sydney_motorways/tunnel_air_quality/m5_east/ filtration/index.html

The NorthConnex air quality document attempts to claim or imply that the filtration trial carried out in the M5 tunnel was a failure.

This misrepresents the true situation, mainly by misrepresenting what the 'trial' set about to do.

It CERTAINLY did not set out to 'improve' air quality outside the tunnel.

The aim of the trial as initially announced was to

- Examine the feasibility and effectiveness of electrostatic precipitator and nitrogen dioxide removal technologies.
- If possible, reduce particulate pollution and nuisance in the western end of the westbound tunnel.

At no stage was there a mention of effects on external air quality and, because of the size and nature of the proposed trial these would always be small, possibly a 15% reduction in particulate stack emissions. The reduction in NO2 emissions was too small to produce an effect which could be reliably identified. No measurements were made specifically to assess the impact of the trial outside of the tunnel

In fact it was successful in what it set out to do however it also demonstrated that the <u>selected</u> electrostatic precipitator technology was not suitable and did not meet the standards of operability or removal efficiency which would be expected from fully developed equipment and which is routinely achieved in tunnels overseas.

Approval for the planning of the filtration plant was granted mid 2007. By January 2008 two companies had demonstrated successful installations using the type of equipment envisaged for the M5 in the Calle 30 tunnels in Madrid.

It is up to the RTA to explain why they then selected a company which had never installed a full scale filtration system and why, when the equipment did not perform satisfactorily, they did not then pursue the suppliers to ensure that the equipment did perform satisfactorily.

The extent of the failure is given in the 'Review of operational performance' which notes:

" the average availability of the AFP was 84% over the period April 2010 to April 2011. The worst months were April 2010, October 2010 and December 2010 with availabilities of 76%, 71% and 76%. The best months were September 2010, March 2011 and April 2011, with availabilities of 96%, 93% and 93%. This compares with the target of 99.5% availability [10], which was never achieved.

In some months the plant was fully operational on only 7 or 8 days. As can be seen in Table 7 the proportion of days per month that the plant ran as specified was approximately 60%, while the proportion of days that the plant operated for 5 hours or less was on average 30%. It should be noted that:

- *Of the 56 weeks of operation since the beginning of the trial in April 2010 to the end of April 2011, no week included 5 days fault-free operation.*
- *52 out of 56 weeks of operation have featured at least one AFP start fault requiring a restart; an alarm stopping the plant, or the plant not running at all.*

- *On approximately 20% of days when it was scheduled to operate, the plant was difficult to start and experienced alarms and errors in the first half hour to hour of operation. This included faults such as high voltage generator errors, dampers not opening or fans failing to energise. When such failures occurred operations had to be performed by experienced personnel on-site, ranging from simple restarts to starting the plant manually."*

For reasons never properly explained, the filter system was only operated weekday afternoons for 5 to 6 hours. When it was operating the filter reduced stack emissions by between 12 and 16%. The figure of 3-4% quoted in the RTA's 'spin' comes from averaging this reduction over a 24 hour period, implying some sort of failure.

Electrical equipment does not work if it is not switched on!

The cost benefit calculation (upon which the claims relating to non-sustainability are based) was based on the total final cost of approximately $65 million and the 'operational costs' included the costs of staffing the filter building and of the 'testing ' done by the CSIRO. These do not represent costs which would occur in properly designed operational system, most of which operate under remote or automatic control.

The installation at Bexley North was always a 'trial' which, as the result of a political decision, was converted into a new and potentially useful installation. It is installed in a way which would never be considered in a properly designed ventilation system, installed during the construction or major renovation of a tunnel.

The 3 documents provided to the public do not contain enough data to calculate a realistic cost profile, however the going price from established providers for equipment such as that used in the trial is about $3million for the EP unit and $2million for the NO2 removal (activated carbon)

Filtration for the NorthConnex

Carbon monoxide is usually thought of as being the most hazardous component in tunnel atmospheres with its capacity to asphyxiate at high concentrations but particulate matter and nitrogen dioxide are also components of concern.

Of these particulate matter is most likely to cause both short term discomfort and long term harm. In addition, particulate matter interacts additively and possibly synergistically with nitrogen dioxide. The nitrogen oxide also present in a tunnel is of little practical concern inside the tunnel but may present problems outside the tunnel, as it converts to nitrogen dioxide.

There appear to be significant health benefits which would accrue from the reduction of both peak levels (ie short term) and total in-tunnel exposures to these pollutants.

In the past, the volume of air required to ventilate a tunnel was determined almost completely by the need to control carbon monoxide levels however, as carbon monoxide emissions were reduced (by up to 70% by the use of catalytic converters), the ratio of carbon monoxide to particulate matter has changed and now, under many conditions, the ventilation volume is determined by the need to maintain low PM10 levels.

This need is also driven by the improved knowledge about the harmful effects of particulate matter pollution, thought previously to be simply a nuisance.

Ventilation levels in the M5 are largely driven by the need to control PM10 (haze) levels.

As predicted in the NorthConnex EIS, Peak CO emission levels occur at the same times as do peak PM10 levels.

CO emission rates: Northbound 9am-10am 7.31g/sec, Southbound 6pm-7pm 5.54g/sec.

These figures allow the estimation of to maximum CO levels in the tunnel (which will occur at the stack) assuming a ventilation volume of 700m^3/sec.

	Northbound	Southbound
Gravimetric	10mg/m^3	7.9mg/m^3
ppm at 25^{o}C	8.7ppm	6.9ppm

The highest figure is almost precisely 10% of the current WHO 15 minute CO goal applied to the M5 East. It is also comfortably less than the later slightly stricter goals applied to other Sydney tunnels.

Importantly , the in-tunnel PM10 levels are close to 1000µg/m^3, a demonstrably harmful level.

It follows from this that the ventilation volume required in practice in the tunnel will be driven, not by carbon monoxide levels but by the need to keep particulate levels at an acceptable level.

The tunnel ventilation system is usually the most expensive part of the total tunnel operating system because of the large amount of electricity required to drive the fans.

NorthConnex with its roughly 18km of tunnel with a cross section of about 100m^2 contains roughly 2200 tonnes of air. This must be accelerated to a velocity of 7-8m/sec and then extracted at right angles to the line of flow. Although some of this energy is provided by the movement of vehicles, it is not unlikely that the energy required to run the tunnel will be in excess of 80-90 Gwhrs per year (equivalent to over 90000 tonnes of carbon dioxide emissions per year). (In 2002, the M5 tunnel used 52Gwhrs of which 50% was peak or shoulder) . At around10c per kWhr the energy cost of running the NorthConnex ventilation system is likely close to $10 million per year and is likely to rise.

This is where the use of in-tunnel particle filtration gives a real possibility for reducing operating costs.

If the ventilation volume could be reduced by 30% there would be an equivalent saving in operational cost as the power consumption of electrostatic precipitators is in fact very low (about 3kW per 100 m^3/sec treated).

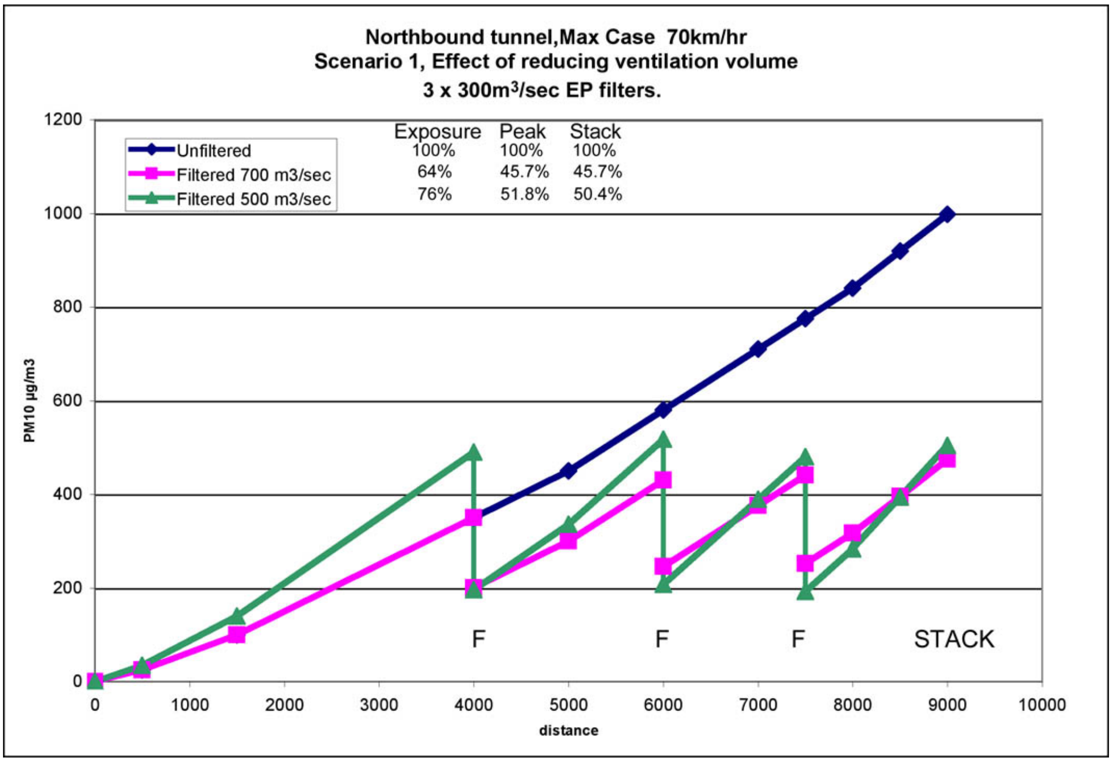
Assuming that 2 cleaning stations, each capable of handling 300m^3/sec, are used in each tube, peak PM10 levels could be reduced by roughly half at each station thus enabling the reduction of the ventilation volume by 25%(or more) and still maintaining better in-tunnel conditions than were achievable while using conventional ventilation systems.

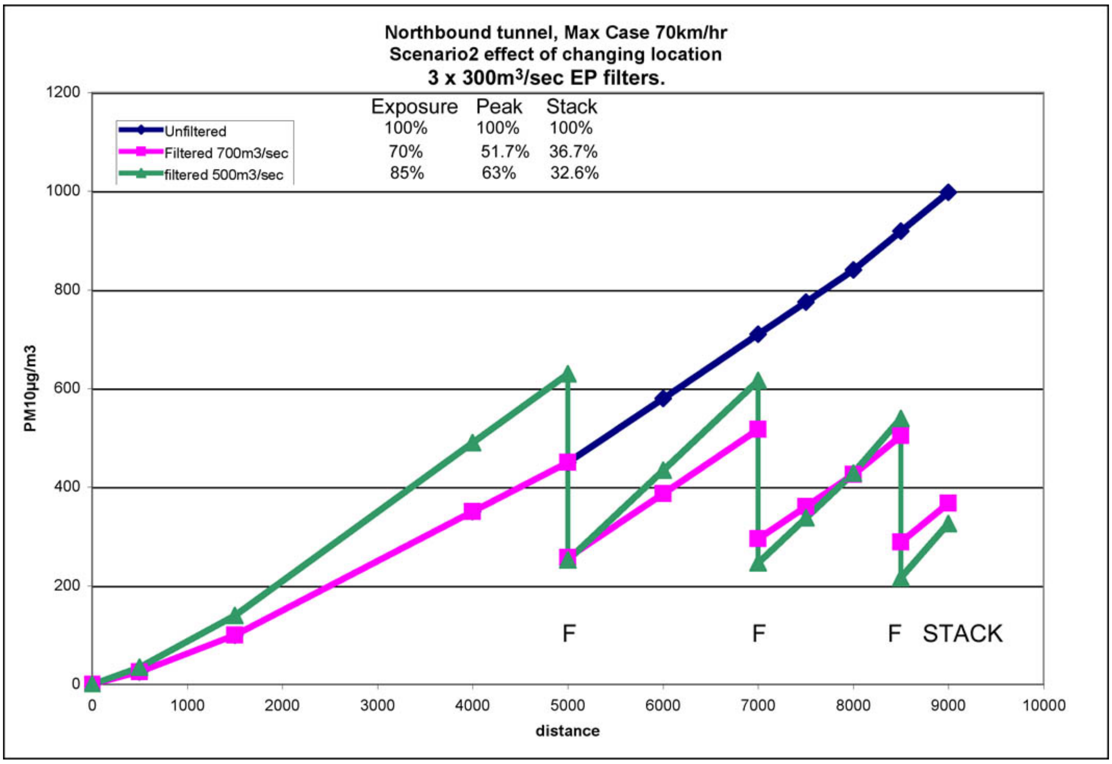
Total particulate emissions from the stack would be reduced by about 50%.

Assuming the use of filtration for 12 hours a day, the power consumption would be equivalent to 500kWhr per day or (say) 3Mwhr per week or about $15000 per year.

The fan costs are not a significant factor as the larger, more efficient ventilation fans used in the EP systems replace most of the function of the inefficient jet fans, which remain mainly for emergencies.

To demonstrate the concepts involved, I have worked up 2 possible scenarios for deploying filtration in the tunnel to show the impact of filter location and reduction of ventilation volume on the particulate matter profile inside the tunnel.





Little attempt has been made to optimise this layout either in filter size or location however the schemes show that it is possible to reduce significantly both stack emissions and peak exposure and slightly less significantly the time weighted exposure in the tunnel. It also shows that there is little adverse impact from significantly reducing the ventilation volume and thus the cost (and carbon emissions) of the tunnel.

I believe that any approval should be made only on the condition that the proponent has conscientiously and openly examined the possibilities implicit in the use of filtration technologies (specifically for particle removal) by approaching competent suppliers and requesting registrations of interest in the design and supply of such technologies. The results of such an enquiry should be open to public scrutiny to the extent possible in a commercial situation.

In conclusion

This EIS is no better and perhaps a little worse than those for other, recent tunnels.

It conceals or misrepresents significant issues of potential concern, in some cases by the very size and complexity of the document and the lack of a logical layout.

In its representations of likely impacts outside the tunnel, its deliberate and continued use of the NEPM air quality guidelines as effective performance goals must raise serious questions about the validity of the claims of lack of harm being made.

There is the continual assumption that if pollution impacts cannot be measured or are not predicted by the modelling, that there will be no harm resulting.

This assumption, perhaps better described as a mindset has been repeatedly dismissed as without basis and leading to dangerous outcomes. In the past, complaints from affected residents have been dismissed as imaginary because 'monitoring' did not show impacts.

The observation made by the NHMRC report is germane: *'No clear evidence exists to show that monitoring such as that carried out to assess compliance with air-quality goals, especially for PM10, can reliably predict the size, nature and course of adverse health impacts."*

I believe that significant questions remain about the viability of the project, its justification , as considered in competition with other projects and with its safety and impact on public and private amenity.

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