

Tue 31/05/2022 10:38 AM

Peter Hehir [REDACTED]

RAW submission on Public consultation on the draft Clean Air Regulation POEO Clean Air Regulation 2022



<http://rozelleagainstwestconnex.org>

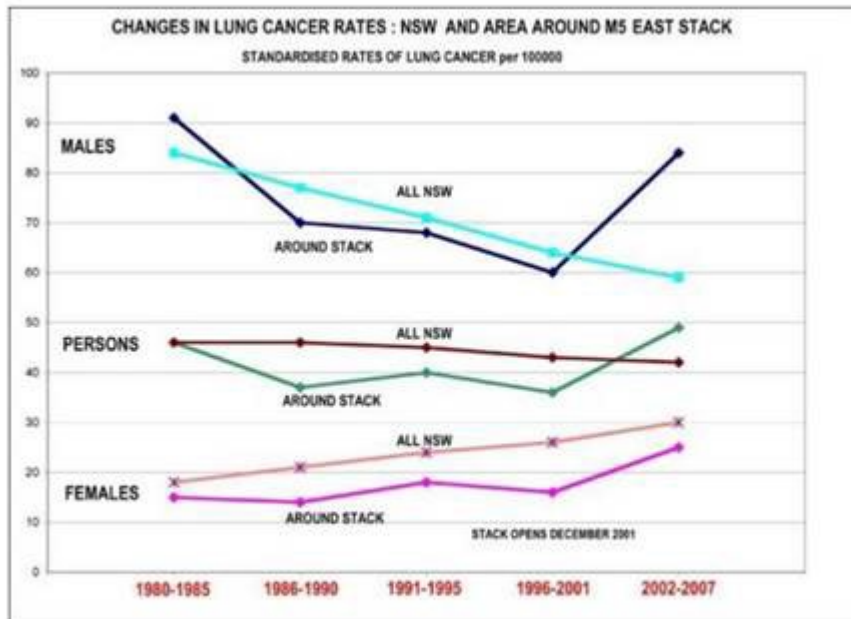
Dear Sir/Madam,

Please find attached the **RAW** submission on the draft **Clean Air Regulation**.

This paper deals specifically with the significant contribution to the poor air quality in the Inner Sydney region directly attributed to the unfiltered road tunnel exhaust stacks. Clearly, as the name of your organisation suggests, you have both a mandate and a legal responsibility to take whatever steps are necessary to improve the quality of the air that we are all forced to breathe.

The **NSW Government** has consistently lied to the community about utilising the “*world’s best practice*” in relation to road tunnel construction and filtration, as the **RAW** paper clearly demonstrates. The methodology employed by the tunnel designers and builders, is the very antithesis of “*the world’s best practice*”. Japan, Spain, Italy, Norway and other countries have clearly shown that it is possible to remove over 99% of the carcinogenic small diesel and other particles, (<2.5 PM) and the harmful oxides of nitrogen in the tunnel itself, thereby radically improving the overall quality of the air released from the tunnels and therefore of Sydney’s air in general.

The data contained in our submission was provided by the **RMS** over a period of a couple of decades and was compiled for **RAW** by a committee which included two scientists well versed in the specific subject of unfiltered road tunnel exhaust stack emissions and their impact on the morbidity and mortality of residents downwind of the unfiltered plumes. The **M5 East** and the emissions from the **Turrella exhaust stack** was used as a case study. Claims by the **EPA, NSW Health** and the **NSW Government** that the cluster was also possibly caused by either the proximity to the port and/or the airport were discounted, *as no such cluster developed in the adjoining suburbs*, also equally adjacent to both the port and airport.



Data from the South Western Sydney and Sydney Local Health Districts showing changes in lung cancer rates around the M5 East Stacks. Photo: South Western Sydney and Sydney Local Health Districts

Many of the residents of Rozelle, Lilyfield, Annandale, Leichhardt, White Bay, Balmain and Drummoyne will suffer painful and premature deaths from any of eight different cancers caused by the ingestion of hundreds of tonnes of small diesel particles, that can be directly attributed to the four unfiltered stacks in Rozelle when they become operational. A preventable cancer cluster will develop here, just as it did with the residents downwind of the **Turrella M5 East stack**, as clearly shown in the graph prepared by the South Western Sydney and the Sydney Local Health Districts. The actions on the part of both the Government and the inaction of your Department have been described as nothing short of criminal. This is a conclusion that **RAW** concurs with.

Thank you for the opportunity to lodge our submission. This email is also being circulated to all of the approximately 850 members of **RAW**, many of whom reside in the path of the plumes.

Sincerely

Peter Hehir
Convenor RAW
(Rozelle Against WestConnex)

31st May 2022



<http://rozelleagainstwestconnex.org>

ROAD TUNNEL POLLUTION FILTRATION

COMPILED BY RAW
(Rozelle Against WestConnex. 2018)



Revised April 2022.

1. Foreword

Although the geographic focus of this paper is on **Rozelle** and adjoining suburbs - as this is the area that will be most affected by **WestConnex with four unfiltered stacks in close proximity and perhaps a fifth at Waverton just 400 metres across from the northern tip of the peninsula**- the underpinning research and rationale, along with the cogent argument for filtration, applies to all existing and proposed urban road tunnels here in Sydney, including those proposed as part of Stages 2 and 3 of WestConnex, NorthConnex, the Western Harbour Tunnel and the Northern Beaches Link.

The material herein draws heavily on the experience of the **M5 East, Cross City and Lane Cove Tunnels**, The **NHMRC Report 'Air Quality in and around Traffic Tunnels'**, various **Parliamentary Inquiries** by the **NSW Legislative Council** as well as information and approaches adopted by other countries including **Spain, Japan, Italy, China and Norway, all of whom have filtered road tunnels!**

In the interests of transparency it should be noted that many of the source documents that inform this paper and relate to the **M5 East, have now been removed from the RMS website**, even though they are regularly referred to by the tunnel proponents in order to justify their position in relation to tunnel filtration. These include;

- **M5 East Tunnel Filtration Trial. Evaluation Programme. – Review of Operational Performance. AMOG**
- **Final Report - Air filtration Plant of the M5 Tunnel - Determination of Particle Removal Efficiencies. CSIRO**
- **Final Report - Air filtration Plant of the M5 Tunnel - Determination of Nitric Oxide and Nitrogen Dioxide Removal Efficiencies. CSIRO**
- **Chief Scientist's Report** <http://www.chiefscientist.nsw.gov.au/reports> which was once freely available on the internet under the **Chief Scientist web site**.

It is interesting to note that **RMS** promotional material, press releases and photos of the trial however are readily available - and attempts to copy passages from reports, such as the one compiled by **AMOG**, found elsewhere on the internet, just result in unreadable encoded text.

This **Road Tunnel Pollution Filtration** document was prepared by **RAW – (Rozelle Against WestConnex)** - and is designed to inform the public on road tunnel pollution in general and the unfiltered WestConnex exhaust stacks in particular.

By examining the published material in detail, it challenges the validity of the **RMS's position on road tunnel filtration and clearly discredits their tendentious and erroneous assertions that 'filtration is ineffective', 'it's too expensive' and that the RMS utilizes 'world's best practice' in relation to tunnel design and operation.**

It is a compelling and cogent argument for adopting the recommendations in **Section 14** of this document and has been offered in response to the questions on notice requested of **RAW** by the Parliamentary Inquiry into the Western Harbour Tunnel.

1.1 Glossary of terms

AIGNER	Supplier of Electronic Precipitators
AMOG	Consultancy engaged by the RMS to review the M5 East Trial
APS	Aerodynamic Particle Sizer
AFP	Air Filtration Plant
CALLE 30	A road tunnel complex in Madrid
CSIRO	Commonwealth Scientific Industrial Research Organisation
CTA	Supplier of Electronic Precipitators (Norway)
DE	Diesel Exhaust
DELOITTE	Probity Advisor for the M5 East Filtration Trial
DENOX	The process for filtering NO ₂
DPM	Diesel Particulate Matter
EP	Electrostatic Precipitator
EU	European Union
FILTRONTEC	German supplier of Electronic Precipitators
IARC	International Agency for Research on Cancer
MICRON	1,000 th of a millimetre
M5 EAST	M5 East Road Tunnel
NIWA	National Institute of Water and Atmospheric Research (New Zealand)
NHMRC	National Health Medical Research Council
NO	Nitrogen oxide
NO₂	Nitrogen dioxide
NOX	Includes both NO or NO ₂
PANASONIC	Japanese supplier of Electronic Precipitators
PM	Particulate Matter
PM 10	Particulate Matter 10 microns in diameter
PM 2.5	Particulate matter 2.5 microns in diameter
RMS	Roads and Maritime Services
RTA	Roads and Traffic Authority (Now the RMS)
RTPR	Road Tunnel Pollution Report
RAPS	Residents Against Polluting Stacks
RAW	Rozelle Against WestConnex
WHO	World Health Organisation
µm	Symbol for micron

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THE M5 EAST FILTRATION TRIAL

2. Tunnel Design Technology in Relation to Filtration

Filtration is supported by government policy in Japan and Italy as it was by Norway in the past. It is notable that each country's recommendations in relation to tunnel design and filter installation tends to be driven by the physical characteristics of the 'local' equipment. There is no standard method of filter installation any more than there is a standard way of installing air conditioning with design details depending on the rate of flow of air through the filters which can vary between 3/meters/sec to 10 metres/sec. Where it is large and complicated, as in Japan and Italy, the preferred installation method tends to be in a by-pass, which also simplifies maintenance.

It is notable that in Norway the recommended installation techniques changed (from by-pass to above the traffic way) as their 'local' technology evolved. Air flow is simplified for installations above the traffic way and energy requirements are reduced. Optimal installation is rarely possible when retrofitting is attempted, with solutions being driven by other engineering and space constraints. A classic example of this was the uniquely complicated installation in the **M5 East** tunnel.

Obviously tunnels that are designed to incorporate 'in tunnel' filtration during construction, not only eliminate almost all harmful emissions but have been proven to be cheaper to run than the unfiltered system presently employed by the **RMS** here in NSW. The benefits to the community will be demonstrated in the following sections.

3. Comparison of PM Filtration Technology

The experience obtained in the massive **Calle 30** installations in Madrid can guide decisions about the potential for filter installations. The whole project, which is over 90 km in length and involves numerous tunnels, has 30 ventilation stations (exhaust stacks) fitted with particle filtration and 4 fitted with both particle filtration and NO₂ removal.

Four different organisations provided the equipment, **Panasonic** and **Aigner** (electrostatic precipitators only) and **CTA** and **Filtrontec** who provided both electrostatic precipitator and NO₂ removal. Based on reports from the company maintaining the installations (but independent of any of the suppliers), two of the competing technologies (**CTA** and **Aigner**) gave good service with particle removal efficiencies of around 90%, even after 6 years in operation, however the **Aigner** equipment was noted as having high maintenance costs.

The Japanese (**Panasonic**) equipment, which is of a very 'conservative' design was less effective (80% removal).

[The German Filtrontec equipment](#), which was also used in the **M5 East** trial *was reported to be unreliable in service and to have poor particle removal efficiency (75%).*

4. Nitrogen Oxide NO and Nitrogen Dioxide NO₂ Filtration Technology

Removal of nitrogen dioxide inside tunnels by the use of activated carbon - following particle removal by use of Electrostatic Precipitation EP filtration - must be regarded as an established technology.

The only problems lie in ensuring that appropriate methods are used for displaying the carbon in order to avoid uncleaned air bypassing the carbon beds. The main drawbacks however are the expense - it costs about three times as much to treat equivalent volumes of air for nitrogen dioxide and particles as it does for particles alone, due to increased fan use and replacement of spent carbon - and the large volume of space required to house the carbon if the installation is underground, which obviously increases construction cost.

The CSIRO report "**Air filtration plant of the M5 tunnel. Determination of nitric oxide and nitrogen dioxide removal efficiencies.**" showed that the NO₂ removal efficiency of the active carbon used in the tunnel was "99% or greater over a wide range of gas flow rates," but that nitrogen dioxide removal generated (converted) nitrogen oxide which was released over time.

They noted: "Catalytic behaviour with respect to NO₂ removal was observed as an "off-gassing" of NO from activated carbon after exposure to NO₂." This curious relationship between NO and NO₂ is explained in Section 5 of this document.

The removal efficiency of the actual installation in the tunnel was repeatedly reported as being around 56% however this is completely explained by the last comment made in the Executive Summary which reads:

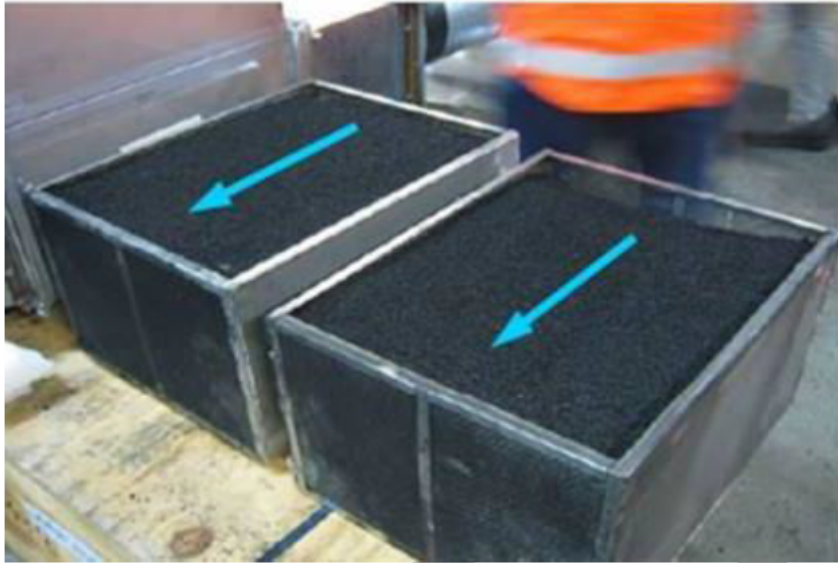
"The removal efficiency of the DeNO_x system installed within the AFP was measured to be less than the efficiency of activated carbon alone. It was observed that the most likely origin of this discrepancy arises from air leakage within and air leakage around the modules that are used to house and support the activated carbon."

Hence the deficiency is *not* in the carbon removal method *but in the incompetent way in which the trial was set up, which allowed the carbon granules to settle*, exposing an air gap at the top of the containment cage which allowed part of the air flow to bypass the carbon bed.

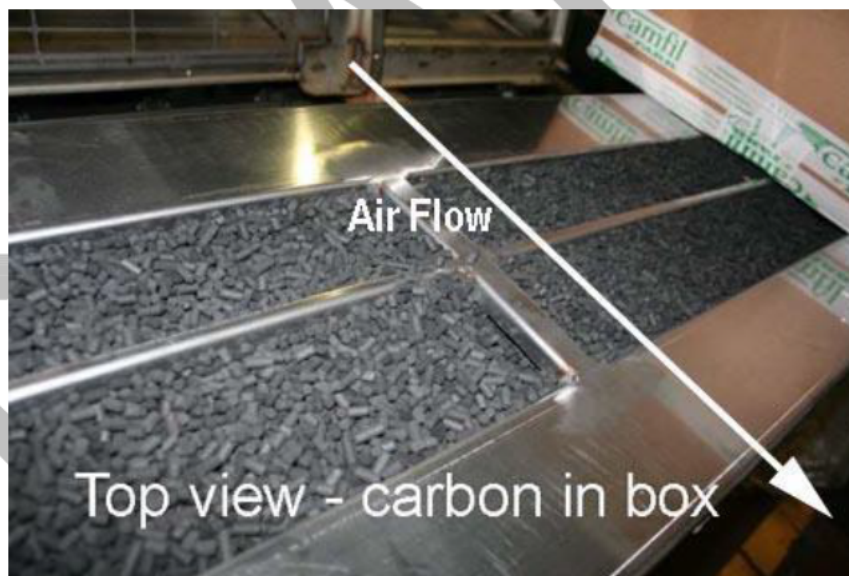
The Filtrontec carbon consisted of carbonised crushed coconut shells which were prone to crushing and creating the air gap.

The CTA- Camfill system used in Madrid used reconstituted compressed carbon granules of a regular size and shape. Even so the settling problem was both observed and solved during initial installation.

The two pictures below show the difference in the carbon Filtrontec in the top pic and the CTA in the one below it.



Filtronic's activated carbon modules used to remove NO₂ and NO used in the M5 East trial.



CTA – Camfill modules used in Madrid showing the compressed carbon granules. This clearly illustrates the higher quality of engineering in the CTA gear! The central rib in the CTA box projects down into the carbon to limit bypass.

Clearly the equipment exists to remove almost all (> 99%) of the oxides of nitrogen within a road tunnel.

All that is lacking is the will...

5. The Effect of Sunlight on NO (Nitrogen Oxide)

The emphasis on **NO₂** (nitrogen dioxide) comes mainly from central Europe in places like Sweden, Germany, France, Austria, and Italy where **NO₂** levels are typically much higher, two to three times than they are here in Australia. Nitrogen dioxide is proven to be injurious to health whereas **NO**, (nitrogen oxide), is considered benign. However it must be understood that **NO** emitted from the unfiltered exhaust stacks *is rapidly converted into the harmful NO₂ by the action of sunlight and ozone in the air!*

Here in Sydney it acts across the region, contributing to smog formation - and in areas where exhaust stacks are to be concentrated, such as the four stacks proposed in Rozelle – it will guarantee concentrations many times higher than the maximum recommended exposure. This is especially true during periods in winter, where temperature inversions trap emissions and allow them to build up to dangerous levels, well above the ‘so called safe levels’.

Rozelle, Lilyfield, White Bay, Glebe, Annandale, Camperdown and Leichhardt are especially vulnerable as parts of these suburbs lie in a valley where the effects of inversions would be compounded, allowing huge toxic concentrations to linger for days on end. Periods where there is little or no wind will further exacerbate the problem.

In the tunnels, drivers delayed by breakdowns will no doubt be tempted to use their air conditioning in an attempt to ‘purify’ and so ‘filter’ the air within their vehicles, contrary to instructions issued via the tunnel PA system, which will in turn raise the level of pollutants in the tunnels.

On the basis of measurements here in Sydney, tunnel users will be exposed to levels of **NO₂** ten to twenty times higher than those drivers using an open road. This impact is exacerbated by the presence of high levels of particulate matter. It cannot be stressed more cogently that existing ‘in tunnel’ filtration technology is capable of almost completely eliminating this health issue!

6. World's Best Practice in Relation to Tunnel Design and Filtration

Japan has the most experience over the longest period of time. The Japanese are quite clear that they are determined to protect people both inside and outside their tunnels. They were the first to use filtration in 1985 and also the first to point out that it was possible to save significant amounts of money by installing progressive in-tunnel filtration to reduce particulate matter.

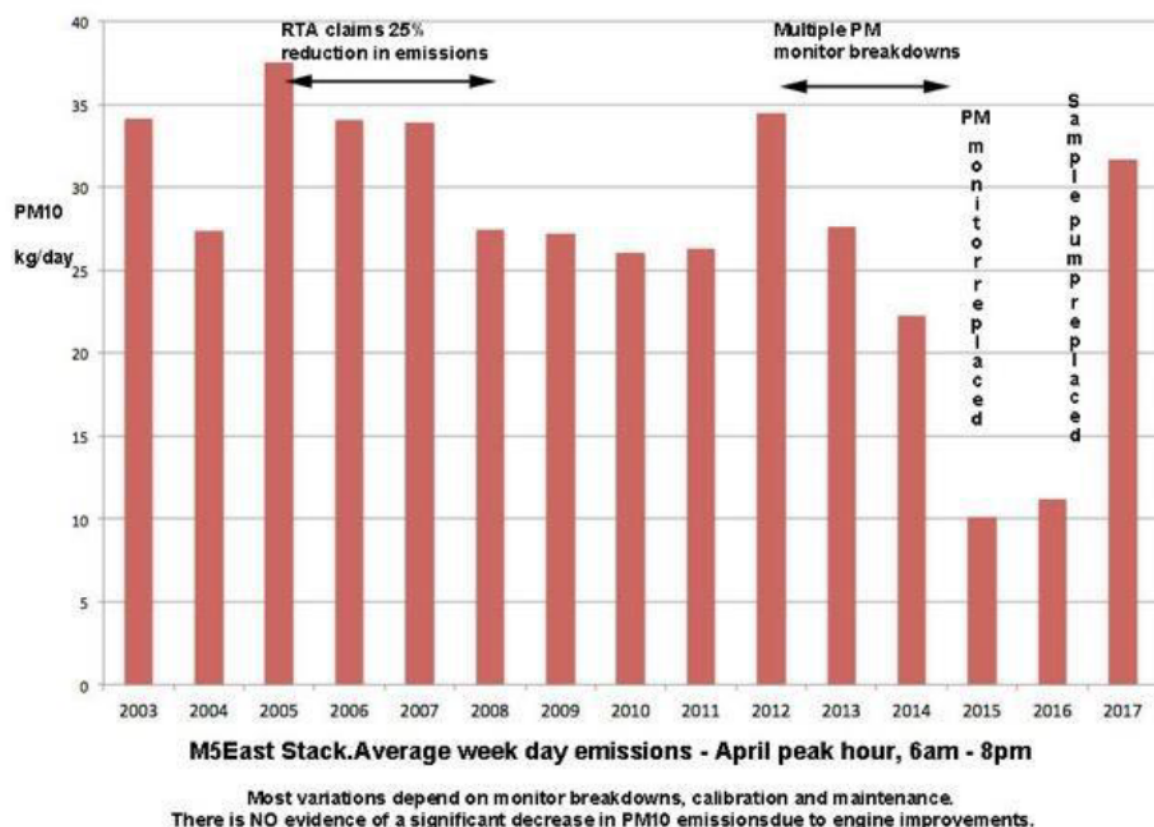
The **Yamate** tunnel in Tokyo was completed in 2015 and at 18.2 kilometres is the longest urban road tunnel in the world, apart from the 33 kilometre WestConnex. The **Yamate** tunnel is filtered for particles inside the tunnels at various points along its length and its stacks are filtered for both particulate matter and nitrogen oxides.

7. RMS Current Tunnel Design in Relation to World's Best Practice.

There is nothing wrong with the *civil* design of Sydney tunnels - except to say that they are unlined - which results in drain down of the water table, that they occasionally pass through areas of shale *and* are extraordinarily expensive when compared with other tunnels around the globe. This is in spite of generally encountering some of the easiest tunnelling conditions anywhere - relatively soft, stable, Sydney sandstone. Obviously, as was mentioned earlier, designing tunnels with filtration from the beginning is significantly less expensive than retro fitting filtration equipment.

The RMS have consistently stated - and continue to state - that '*filtration doesn't work*', that even if it did it would be '*too expensive to install, maintain and operate*' and that the road tunnels in NSW '*embrace the world's best practice*'. All three statements are demonstrably false as this paper will unequivocally show!

Emissions from the M5 East stack are constantly monitored for oxides of nitrogen and particulate matter so it is possible to measure the quantity of pollution leaving the stack on an hourly basis. It was on the basis of these measurements that the RTA claimed in 2008 that there had been a 25% reduction in particle emissions. However this was shown to have no factual basis when the old - *and regularly faulty* - pollution instrument was repaired in late 2016 and eventually replaced in late 2017!



The most recent set of **RMS** figures on stack emission data show the following. *Remember these are their figures.* Measuring during peak hours between 6am and 8pm, the **M5 East** stack emitted 33 kg of particles per day in April 2007 and 31kg in April 2017. In 2004 the particulate mass averaged 35 kg per day. These calculations were done on a weekly basis in the month of April, selected so that they were not affected by holidays. The figures are the total weight of particulate matter emitted between 6 am and 8 pm Monday to Friday.

Put another way, *this one stack alone has emitted over 9.6 tonnes of unfiltered highly toxic particulate matter, including the cancer causing diesel particles, each and every year since it became operational!* This figure is a conservative one as it is arrived at by excluding Sundays and Public Holidays and is based on only 300 days per year.

N.B. This tonnage is drawn from a total tunnel length of just 4.2 kilometres!

It is now generally accepted (cf. Particulate emissions from motor vehicles. Peter Eastwood. 2008. John Wiley), that the engine design actions intended to increase engine efficiency and reduce **PM10** emissions (the EU design rules) have led directly to a decrease in particle sizes and a corresponding significant increase in particle numbers.

It is also clear that, on a weight for weight basis, *smaller particles are more harmful than bigger ones!* The observation that the weight of stack **PM10** emissions from the **M5 East** stack has not decreased significantly during the life of the tunnel (from 32kg/day in 2004, to 31kg/day in 2017) means that the actual potential for harm has significantly increased!

The smaller the particle, the more likely it is to bypass the body's defences and be absorbed via the lungs straight into the blood stream. The **WHO** has identified at least 8 separate cancers that have been attributed to these diesel particles lodging in various organs throughout the body.

As the vehicle numbers in the **M5 East** have remained relatively constant since 2004, the **RMS** claim that there has been a significant reduction in particulate emissions over time with the improvement in vehicle emissions at source, is yet another one of their claims that has no basis in fact.

One of the obvious reasons to continue to deny impact on the health of the population or to accept that importing and releasing massive quantities of vehicle pollution in one location, is simply down to cost. The other is an acutely embarrassing loss of face.

It is this loss of revenue that was the driver behind the battle the tobacco companies so tenaciously fought, only to have them finally and begrudgingly accept that smoking IS injurious to health. The same can be said today with those who, even now, in spite of overwhelming evidence to the contrary, continue to deny the reality of climate change.

The problem is one of attitude and the arrogant refusal on the part of the Government and the **RMS** to even consider potential health effects and benefits of filtration, both in relation to in-tunnel conditions and out-of-tunnel impacts.

Table 1 shows particulate separation rates for 10th to 28th January 2011. The results during plant operation indicate an approximately 65% reduction in both PM_{2.5} and PM₁₀ through the ESP.

Table 1: Daily Separation Rates For PM_{2.5} And PM₁₀ (Monday 10th January 2011 – Friday 28th January 2011)

Averages 3pm-5pm	Upstream PM _{2.5}	Downstream PM _{2.5}	Upstream PM ₁₀	Downstream PM ₁₀	PM _{2.5} Removal In ESP	PM ₁₀ Removal In ESP
	µg/m³	µg/m³	µg/m³	µg/m³	%	%
Monday 10/01/11	266.1	109.4		146.2	58.9%	
Tuesday 11/01/11	319.6	109.8	390.5	127.7	65.6%	67.3%
Wednesday 12/01/11	351.9	123.5	419.3	158.8	64.9%	62.1%
Thursday 13/01/11	333.7	105.8	400.2	127.4	68.3%	68.2%
Friday 14/01/11	351.0	121.3	432.4	144.0	65.4%	66.7%
Monday 17/01/11	389.2	164.1	465.7	198.4	57.8%	57.4%
Thursday 20/01/11	340.6	128.7	409.9	146.0	62.2%	64.4%
Friday 21/01/11	296.4	104.9	358.4	131.2	64.6%	63.4%
Monday 24/01/11	417.4	120.2	507.6	154.1	71.2%	69.6%
Tuesday 25/01/11	385.3	136.5	459.3	175.2	64.6%	61.9%
Thursday 27/01/11	393.1	119.9	470.9	170.9	69.5%	63.7%
Friday 28/01/11	274.6	94.7	341.8	129.3	65.5%	62.2%
Average	343.2	119.9	423.3	150.8	64.9%	64.3%

The information about the particulate composition is extracted from this table from the filter trial evaluation report. It is roughly the ratio between the 'Upstream PM10' and the 'Upstream PM2.5' figures, both of which come from equivalent samples.

Clearly if the Government and the **RMS** were forced to admit that filtration would indeed save

tens of thousands, perhaps even hundreds of thousands of lives, there would no doubt be a State wide community campaign to retro-fit filtration to existing tunnels.

For the reasons outlined above this is something that the RMS and the NSW Government can't and won't accept, unless significant community pressure can be applied to all existing and aspirant politicians.

8. Comparative Cost of Inbuilt Filtration versus Retrofitted Systems

The M5 East filtration plant cost about \$65 million to build. This cost was recognized as excessive from the onset and it was accepted that the cost of the installation in no way represented what the cost of a properly designed filtration unit would be *if* it were integrated into the tunnel ventilation system and installed during the construction of the tunnel.

As was shown by the M5 East debacle, it is possible to write your own ticket in relation to cost. The actual equipment cost scaled from what was quoted for the first 'trial' should have been between \$10 and \$12 million.

The rest of the \$65 million came from on-costs and tunnel construction etc. The going cost for Electrostatic Precipitation (EP) equipment installed and running in a space prepared during the construction process is \$2 -3 million per hundred cubic metres/sec treated.

There appears to be no possibility of recovering value from this asset except as a filtration unit.

The estimations of running costs are based on the operation of the system on a trial, rather than on a commercial basis and also include the not-inconsiderable costs (maintenance, supervision, consumables and fan costs), directly attributable to the nitrogen dioxide removal system. This does not take into account the history of the project and why it was built in the way that it was.

The costs involved in operating a modified system consisting only of the electrostatic precipitators on a commercial basis would be significantly less and would provide real value for the public in terms of reduced adverse health impacts and significantly improved amenity for both drivers and local residents, in and around the M5 East.

Obviously retro fitting is significantly more expensive. At the very least proposed tunnels must be designed to facilitate the subsequent incorporation of 'in tunnel' installation of both NO₂ and electrostatic particulate filtration.

It seems inevitable however that existing road tunnels will be retro fitted with state of the art filtration systems, once the wider community is made aware of the health impacts and costs associated with the failure to filter, finally bringing Australia into line with the rest of the world.

The pressure brought to bear by ordinary members of the community will ensure that politicians will ultimately be forced to act, thus eliminating the hundreds of tonnes of carcinogenic particulate matter that will be emitted annually via the stacks right across Sydney, *if and when* WestConnex and its tentacles are completed.

9. Operational Costs of Inbuilt verses Retrofitted Systems

The Japanese report a 30% reduction in total tunnel ventilation running costs following retrofitting of filtration systems. Clearly on this basis alone all new road tunnels must incorporate in tunnel filtration as an essential part of tunnel design.

10. True Costs of Failure to Filter including Health and Mortality

Short term exposure to high concentrations of diesel exhaust and diesel particulate matter can cause headache, dizziness, and irritation of the eye, nose and throat severe enough to distract or even disable drivers. These effects are readily apparent when both approaching and especially when driving through the M5 East tunnel. The toxicity of the ambient air is such as to make drivers immediately wind up their windows well before entering the tunnel.

In June, 2012, the International Agency for Cancer Research (IARC) classified DE (diesel exhaust), including DPM (diesel particulate matter), as a *known human carcinogen (Group 1)*. It is also recognised as being both toxic and mutagenic.

As mentioned above at least **9.6 tonnes** of unfiltered and carcinogenic particulate matter are released annually by the M5 East stack. This is an *extremely conservative estimate* and is arrived at using the average annual emission data from the 4.2 kilometre tunnel which was provided by the RMS for the single M5 East stack (32 kg/day for 300 days). It excludes Sundays and Public Holidays, *as well as those emissions between 8 pm and 6 am.*

These four **Rozelle** stacks exhaust scores of lane kilometres, thus the true annual emission figure would be hundreds of tonnes, as the four exhaust stacks that are being built in **Rozelle** will release pollution generated in Ashfield, Cammeray, Homebush and St Peters, as it will be carried along the tunnels and finally exhausted in Rozelle.

Given the projected usage of both the Rozelle Interchange, the Western Harbour Tunnel, the Iron Cove Tunnel and the M4/M5 link, as well as the length and number of related tunnels, the real mass of carcinogenic material spewed out at White Bay could easily exceed 200 or even 300 tonnes per annum!

11. Advisory Committee on Tunnel Air Quality 2016 Independently Reviewed

Terms of Reference:

'To provide advice to the NSW Government based on national and international practice and experience with motorway tunnels that will:

- Enable setting of performance based standards for emissions associated with road tunnels.*
- Recommend appropriate monitoring, compliance and reporting mechanisms to support public confidence in the operation of road tunnels.*
- Provide ongoing advice to Government on air quality issues arising from the assessment and operation of road tunnels.'*

The Committee consisted of the following five members:

- NSW Chief Scientist and Engineer (Chair)
- NSW Chief Health Officer
- Chief Executive RMS
- Chief Executive SMC (Sydney Motorway Corporation)
- Dr Ian Longley Senior Urban Air Quality Scientist (NIWA)

A majority of the five members of this Committee have consistently failed to recognise the need for filtration of road tunnel exhaust stacks in NSW in spite of the Committee reaching agreement on the following findings:

- Exposure to motor vehicle pollution is linked to several adverse health outcomes – ranging from irritation of the airways and lost workdays to early mortality.
- Living in close proximity to major roadways is associated with adverse health outcomes that are likely to be partially attributable to exposure to on-road vehicle PM emissions.
- Exposure of the NSW population to all PM (regardless of source) should be minimised by reducing ambient PM levels to as low as possible.
- Outdoor air pollution is a known human carcinogen.
- The International Agency for Research on Cancer (IARC) has classified outdoor air pollution as carcinogenic to humans (IARC Group 1).
- Motor vehicle emissions are a major source of outdoor air pollution in NSW urban areas.
- The evidence linking exposure to traffic-related air pollution was suggestive of a causal relationship. These outcomes were the onset of childhood asthma, non-asthma respiratory symptoms, impaired lung function, total and cardiovascular mortality, and cardiovascular morbidity.

- Diesel engine exhaust is a known human carcinogen. The International Agency for Research on Cancer (IARC) has classified diesel engine exhaust as carcinogenic to humans (IARC Group 1).
- There is very good evidence that exposure to PM 2.5 causes cardiovascular disease, respiratory disease and mortality.
- Associations have also been observed between PM 2.5 exposure and reproductive and development effects such as low birth weight.
- Current levels of particulate matter in NSW will have adverse impacts on health, particularly in vulnerable people such as individuals with chronic respiratory and cardiovascular diseases, the elderly, and children.
- Reductions in particulate matter air pollution in NSW are likely to result in health benefits, particularly for these most vulnerable groups.
- The continued growth in the size and density of urban areas adjacent to road transport corridors has potential to increase population exposure to air pollution.

The members of the **Advisory Committee on Tunnel Air Quality 2016** who have not publically advocated filtration of road tunnel exhaust stacks are:

- **Dr Ian Longley Senior Urban Air Quality Scientist (NIWA)**
- **Chief Executive RMS**
- **Chief Executive SMC (Sydney Motorway Corporation)**

Residents Against Polluting Stacks (RAPS) and the Asthma Foundation were given an undertaking that the community would be involved in the development of this report. They were not!

This is what happens when the secretariat for the report is farmed out to the RTA by the chief scientist. The axiom '*Whoever controls the agenda controls the outcome*' was never more apt.

Obviously any discussion on the real cost of filtration *must include the cost to the community* in failing to filter the many hundreds of tonnes of carcinogenic particulate matter released annually from Sydney's unfiltered stacks.

As recognised and acknowledged by the Committee these include early death, preventable cancers, respiratory disease, impaired lung function, emphysema, asthma, heart disease, low birth weight, increased hospitalization and the loss of productivity through preventable morbidity.

A conservative estimate would be in the \$ billions and begs the question - Just how much is a human life worth?

For both the NSW Government and the RMS to ignore their duty of care and to continue to construct tunnels without addressing the impact on community health and the premature deaths that they *know* will naturally follow, is nothing short of criminal!

12. Rebuttal of the AMOG Report 7 Point Conclusion on Filtration in the M5 East

AMOG is the consultancy that was engaged by the RMS to evaluate the M5 East Filtration Trial. What follows is a critique of their 7 point conclusion on the effectiveness of the trial.

The M5 East twin lane tunnel tubes have two ventilation segments with the stack outlet between situated between them. The eastern end is about 1400m long and the western end is about 2500m long.

The ventilation system is unusual in that at the tunnel ends, vitiated air is transferred from the end one segment to the other just before the tunnel exits. This air, together with a small fresh air intake, is returned to the central stack, so there is only one stack.

The dirtiest part of the tunnel is the west end of the westbound tunnel which generates about one third of the total stack emissions. This is a result of the length of this segment and the fact that there is an upward slope over most of the segment.

This is why the 'trial' was located in this section.

12.1 The ESP had a PM Reduction Efficiency of around 65%.

This is unlikely to be true as neither of the 'methods' used to measure particles was consistent with the methods used in other countries to determine efficiency. These methods involve optical counting and scattering equipment which record size specified particle number counts covering the range of particle sizes of most importance in vehicle emission assessment. These overseas measures give proper emphasis to very small particles.

The counting equipment used in the CSIRO measurements *was insensitive to particles less than 0.5 microns in diameter* and hence unsuitable for the assessment of the most lethal diesel particles.

There were a number of unresolved 'problems' in the gravimetric measurements (e.g. deposition of large particles on the LV measuring equipment) and the discussion of the 'counting' methods notes;

"The APS measures the particle number concentration over a size range from approximately 0.5µm to 20 µm at 1 Hz. However during the initial APS measurements it was observed that the data transfer speed of the logging computers produced problems with respect to the synchronisation of the sampling periods of each APS." (Final Report: Air Filtration plant of the M5 Tunnel.

Determination of the Particle Removal Efficiencies. P27)

Fundamentally this meant that the equipment being used was unsuitable for the task to which it was being put. The LV equipment is basically a regulatory device used to measure atmospheric particle levels at relatively low concentrations. Likewise the APS equipment is

designed for use in relatively low concentration of particles and was being overwhelmed by the massive numbers of particles inside the tunnel. It just could not count fast enough. This is not a new problem and is certainly something that the CSIRO should have been aware of!

12.2 The DeNOx filter had an efficiency of around 55%;

This is a highly tendentious finding. It is effectively misleading. There was a simple malfunction in the carbon system which was easily rectified. Once rectified the system was capable of a 100% removal efficiency. This is clearly illustrated in the pictures on page 7.

12.3 The AFP was unreliable with an average availability of 84%;

The filtration system and its associated engineering (automatic start-up systems) was unreliable and often failed to work. It did not go close to meeting commercial standards of reliability, nor did it meet the level of performance claimed by the supplier of the equipment.

According to reports supplied by the maintenance engineers of the **Madrid Calle 30** system, the equipment supplied by this company also failed there, the engineers specifically noting; *"Eficiencias bajas. No se genera residuo solido previsto"* (Poor efficiency, the equipment did not generate the expected solid waste.) In other words, the EP system did not work!

The really significant question is why didn't the RMS force the supplier to make the equipment function? The reluctance of the RMS to pursue this has never been explained.

12.4 The AFP provided a marginal improvement in visibility for 0.4km of the westbound tunnel in the 4km long M5 East tunnel.

This is simply untrue. When the filter system was actually operating, the tunnel air beyond the reinjection point was noticeably clearer and free of smell. This was widely noted by tunnel users. Insofar as driver comfort was concerned, the filtration system obviously worked - *but only if it was turned on!*

12.5 The cost per kg of pollutant removed was high when compared with techniques to reduce emissions at source, such as new Vehicle Emission Standards and retrofitting particle traps to older trucks.

This is a fatuous and unsupportable argument as there was no accurate assessment of cost, nor was the whole 'trial' designed in such a way as to permit this. In fact, the 'operating costs' noted included the full cost of the CSIRO carrying out the measurements which were part of the trial. These are not part of normal operation.

12.6 It is not possible to cost effectively remove pollutants with the system as installed or to modify that system to make it cost effective.

This is an unsupportable statement made without any evidence. In fact the EP system once made mechanically and electrically reliable (presumably at the cost of the equipment supplier), could cost effectively reduce particle pollution in more than one third of the tunnel, (West bound end and west end of the eastbound tunnel in to the stack exhaust) and reduce stack emissions by about 20%. The NO₂ removal system is redundant and was never intended to be other than an experiment.

12.7 Extensive knowledge has been gained from the trial that may enable the development of cost effective systems to reduce pollutants in tunnels.

Even this feel-good claim is dangerously untrue. The biased and inaccurate reporting of this 'trial' has been used in international road design literature to down play the possibilities of the use of filtration to the detriment of scientific clarity.

It is fair to claim that the reporting had more to do with spin doctoring and the production of a convenient 'truth' rather than the progress of reliable knowledge.

The comment by the probity advisors (Deloitte) who were retained, but ignored by the RTA as they commented as to the advisability of calling for new tenders when it was decided to enlarge the scope of the initial trial (from 50m³/ sec to 200m³/sec) is apposite.

They said: *"Obtaining value for money is enhanced when there is open competition and the market is tested regularly. We note that the RTA is currently proposing to invite the three short listed proponents from the RPP (i.e. the first proposed trial) to participate in the Stage 3 RDP on the basis of revised scope. However the key value for money probity risk is that the RTA will need to consider is whether the field of three proponents is sufficient to meet the proposed scale of the project?"*

The RTA did not 'test the market' selecting instead a company which had never done a full scale filtration installation in any tunnel, anywhere in the world!

Perhaps the RTA did not want 'value' of any kind?

A detailed examination of each of the 7 point AMOG conclusions, indicates that the available data strongly suggests that both AMOG and the RTA were simply going through the motions in order to both reach and to justify a predetermined conclusion!

13. The Chief Scientist's Report Examined

This is the document that is cited most by the RMS as justification for not filtering the tunnels. The RMS are at pains to try and distance themselves from any connection with the preparation of this report and go out of their way to suggest that it is a credible and completely independent document, compiled by reputable scientific organisations, without any bias.

This couldn't be further from the truth!

The report was compiled with four of the eleven technical papers actually written by RMS staff and a further three by Ian Longley, whose expertise with road tunnels of any length is questionable. These were based on the obviously faulty conclusions drawn from the discredited M5 East trial and the subsequent AMOG Report, whose conclusions simply can't be justified, as shown in the following section on page 21 titled: **The M5 East Filtration Trial**.

The authors and subject matter of the 11 technical papers in the Chief Scientists Report are as follows;

- TP 1 - *Trends in Motor Vehicles and their Emissions* (4/9/2014 NSW EPA)
- TP 2 - *Air Quality Trends in Sydney* (21/8/2014 NSW OEH)
- TP 3 - *Health Effects of Traffic-Related Air Pollution* (21/8/2014 NSW Health)
- TP 4 - *Road Tunnel Ventilation Systems* (4/9/2014 RMS)
- TP 5 - *Road Tunnel Stack Emissions* (21/8/2014 Ian Longley)
- TP 6 - *Road Tunnel Portal Emissions* (5/9/2014 Ian Longley)
- TP 7 - *Options for Reducing In-Service Vehicle Emissions* (21/8/2014 RMS)
- TP 8 - *Options for Treating Road Tunnel Emissions* (4/9/2014 RMS)
- TP 9 - *Evolution of Road Tunnels in Sydney* (21/8/2014 RMS)
- TP 10 - *Role of Regulators for Tunnel Projects* (4/9/2014 NSW DPE)
- TP 11 - *Criteria for In-Tunnel and Ambient Air Quality* (4/9/2014 Ian Longley)

Although the RMS may be able to claim some expertise in the 'Evolution of Road Tunnels in Sydney' it certainly is not competent to advise on tunnel ventilation systems and the control of tunnel emissions, especially after having overseen the construction of the notorious M5 East and the total mismanagement of the filtration equipment and the subsequent trial.

Ian Longley, the air quality scientist, who wrote 3 of the technical papers on air quality and emissions, was the co-author of [Systematic Literature Review to Address Air Quality in and Around Traffic Tunnels](#) preparatory to the NHMRC report. However many of his opinions in were rejected out of hand or were significantly modified in the final version of that report.

He was also one of the 5 members of the **Advisory Committee on Tunnel Air Quality 2016** discussed earlier. His recent road tunnel experience was with NIWA in New Zealand where, until June of 2017 with the opening of the Auckland Harbour Tunnel, the longest urban road tunnel was less than 1 km long.

The **Chief Scientists Report** has all the hallmarks of a 'tick the boxes' effort designed to give the appearance of actually doing something - with its grandiose title creating the impression of genuine scientific input. In reality it falls well short of objective science and is little more than a transparent attempt to justify the retention of the demonstrably deficient status quo.

The inescapable fact remains that the specific deficiencies in both regulation and practice identified in the **NHMRC** report of 2008, which have also been identified in various ways in the international literature, have been left unaddressed, over 14 years later!

The **Chief Scientist's Report** used to be generally available on the internet under the **Chief Scientist** web site: <http://www.chiefscientist.nsw.gov.au/reports> , but now it has mysteriously vanished...

14. Recommendations for Road Tunnel Filtering

Obviously, for the health of the community and tunnel users - and in the interests of fiscal responsibility in terms of preventable health issues - filtration is *absolutely essential in all but the very shortest of road tunnels!* The longer the tunnel, the greater the need for state of the art filtration equipment. This obviously *must* be correctly installed and maintained by competent and approved operators who are licensed by the filtration equipment suppliers.

Filtration is now recognised worldwide as a prerequisite in road tunnel construction and is clearly undisputed as 'worlds' best practice'!

Governments everywhere readily acknowledge that they have a duty of care towards tunnel users and to the wider community. Not only to those who regularly use the tunnels but especially so to those who live in the vicinity of the portals and exhaust stacks.

To import vehicle exhausts from locations as far afield as Homebush, St Peters and Cammeray, when the WHT comes on line and to then dump hundreds of tonnes of unfiltered carcinogens each year at White Bay is nothing short of criminal!

WE BELIEVE THE FOLLOWING RECOMMENDATIONS MUST BE ADOPTED.

- **All new urban road tunnels must be designed and built incorporating in tunnel state of the art particle and nitrogen oxides filtration such as those used in Japan.**
- **State of the art filtration equipment must not only be correctly installed and tested prior to handover, but it must also be maintained by competent operators who are licensed and approved by the equipment suppliers.**
- **Existing road tunnels must be retro fitted with state of the art particle and nitrogen oxides filtration.**

- **Pollution monitors must be installed and maintained at all tunnel portals, ventilation facilities and exhaust stacks.**
- **The existing development consent conditions requiring 'zero emissions' at tunnel portals must be enforced.**
- **Costs associated with upgrading existing filtration are to be borne by the tunnel operators.**
- **National standards for PM and NO₂ need to comply with the most stringent overseas standards, be clearly articulated, regularly updated, enshrined in legislation and rigidly enforced.**

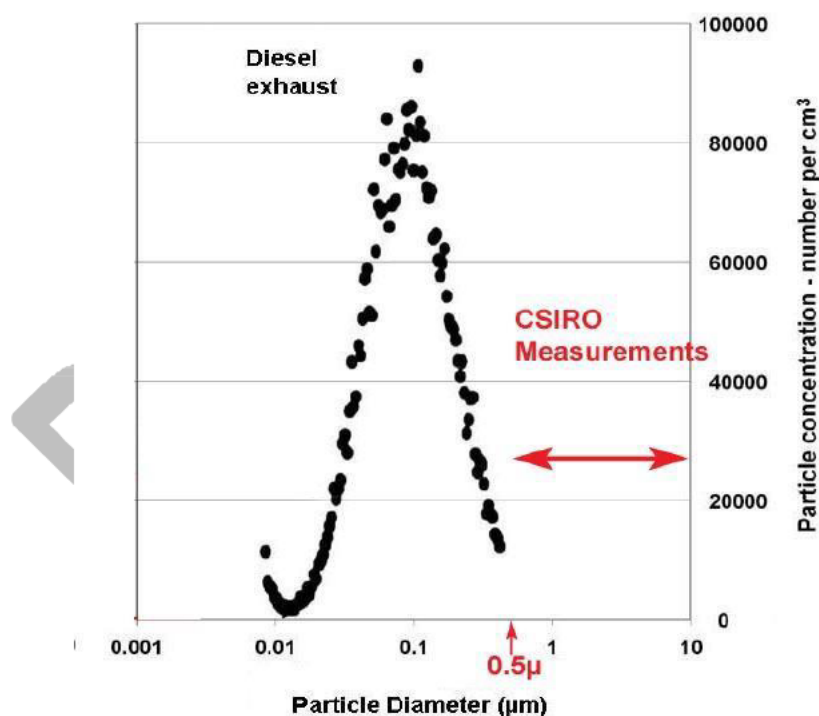
Supplementary Material: The M5 East Filtration Trial

1.1 M5 East Filter Trial Community Analysis.

The detailed information that is included in the following sections was drawn in part from documents obtained by a call for papers that had been lodged with the NSW Legislative Council and from the CSIRO and AMOG reports on the filter trial.

The decision to stop the trial appears to have been based on a series of questionable financial calculations which failed to take into account the fact that this was a trial and on 'measurements' of filtration efficiency done by the CSIRO.

1.2 Analysis of CSIRO Measurement methods



The **CSIRO** based its analysis on two types of measuring systems, one based on mass (a **LV Filter** system) such as is used in ambient monitoring stations and capable of measuring **PM10** and **PM2.5** and a particle counting system capable of measuring (counting) some but not all of the smaller particles by optical means.

Diesel exhaust is made up, overwhelmingly, of particles around 0.2 microns in diameter. Much of the danger posed by diesel exhaust results from the high degree of bronchial penetration which can be achieved by these 'nano' particles.

Overseas practice in measuring filter efficiency (most recently in Madrid) uses size class specified particle number counts to determine removal efficiency. The smallest size class measured used to be 0.3 μ (0.3 microns) but it has been recognized that measurement is needed to go down to 0.1 microns and equipment is now available to achieve this.

By their own admission, the equipment used by the **CSIRO** was incapable of adequately measuring particles less than 0.5 microns in diameter!

Filtrontec 'performance data' in their promotional material claims particle removal in excess of 90% for all size classes of particles greater than 0.1 microns.

The inescapable conclusion is that the measurements carried out by the **CSIRO** are incapable of adequately assessing either the filter performance (which **MUST** be able to remove nano-particles), or the equipment performance claims made by **Filtrontec**.

1.3 What Actually Happened in the M5 East Tunnel?

The filter is located above the west bound tunnel and draws (and returns) air from vents 500m before the western portal. The 'cleaned' air then moves towards the west end of the tunnel where, due to the peculiar design of the ventilation system, it is moved to the east bound tunnel and thence to the stack.

For reasons which have never been made clear, *it was decided that the filters would only be operated for about 6 hours on weekday afternoons*. This may have been due to problems which arose in the performance of the measurements which required access into the dirty part of the tunnel.

In spite of the findings of the '**CSIRO** study' which we conceive to be inept, misdirected and contrary to good practice, we believe that the filtration system when actually operating was effective and produced value to the public.

- When the filter operated in the afternoon, the air in the western end of the tunnel, in both directions, was noticeably clearer.
- Residents who live around the Bexley North portal reported that local pollution and annoyance has been reduced since the filter started operating.
- The quantity of **PM10** exiting the stack, as recorded by the in-stack monitoring, is reduced by approximately 15% when the filter is operating. This is based on comparison between like-for-like weeks before and after the filter system commenced operating. The reduction recorded is entirely consistent with the expected levels of reduction which would be achieved by an efficient filter system.

- The claim that the particle filtration system only produces a 5% improvement is deliberately misleading in relation to the actual operation of the system. This claim appears to have been achieved by taking the observed improvement - a 15-20% reduction during the evening peak period of emissions (6 hours of operations) and expressing it as a 24 hour value. It is obviously intended to mislead!
- *Clearly electrical equipment does not work if it is not switched on!*

1.4 What Should Have Happened?

Instead of closing down the filtration plant, which provided benefit both for motorists and for local residents, the following actions should have been taken:

- Removal of the redundant nitrogen dioxide **NO2** equipment. It has proven that it will work but is not needed and is too small to be useful. It interferes with the operation of the electrostatic filters.
- Reconstruction and reconfiguration of the **EP** filtration system so that it could handle a larger volume of air, as much as 220 to 250 cubic metres per second. This should be possible with the removal of the **NO2** system and the consequent reduction in fan back pressure.
- Get the equipment working to the standard achieved by other, more competent equipment suppliers. Once this is done the removal efficiency would be well in excess of 90%. The actual **EP** system is only a small proportion of the total, but it is not working properly. If necessary get a new, competent firm to do the work and make the necessary modifications.
- Operate the system at least 12 hours every day.

1.5 What Actually Happened During the Trial?

The report of the trial shows a litany of breakdowns and equipment failures which apparently remained unresolved, without any real attempt to discover the base cause or to force the equipment suppliers to rectify the problems and their clear failure to meet the performance expectations they had given.

There seems to have been an acceptance of the fact that the equipment could only achieve a removal efficiency for particles of 65% and that the system showed an 'availability' of 84% rather than the 99.5%.

The 'Review of Operational Performance' 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 which was never achieved. In some months the plant was fully operational on only 7 or 8 days. 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, there was not one week that included 5 days of 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."*

Such a performance record is risible. It does not represent a commercially or technically viable technology. It cannot be claimed to provide any guidance as to the utility, feasibility or operational cost of a properly developed system, easily available on the world market.

The selection of the experimental Filtrontec equipment must be seen as perverse and contrary to good practice as represented by the Deloitte probity advice.

Commonly available electrostatic precipitator equipment from suppliers such as Mitsubishi or CTA routinely show removal efficiencies in excess of 95%, high levels of reliability and unattended operation!

During the whole process there has been no evidence of any real effort to produce a successful outcome for the M5 East trial.

There remains an inescapable conclusion that at least some of those involved were satisfied for the trial to fail in some perverse attempt to demonstrate their unique 'expertise' in tunnel design and the correctness of their long held opposition to the use of new technologies, or worse, to justify arrival at the pre-determined outcome, that being filtration does not work....

1.6 What Went Wrong?

A major part of the problem lies in the way the project was conceived, planned and especially how it was put into action and how the supplier was selected. As stated earlier it should be of concern to all that this debacle demonstrates significant problems within the RTA both in its methods and in its culture.

The companies short-listed for the trial were Panasonic, Kawasaki and Siemens-Filtrontec in that order of initial preference.

There was no open tender or call for registrations of interest for the supply of equipment after the first one in 2004, even though the size of the particle filtration unit was increased fourfold in 2006 and it was not until 2008 that the contract was issued to Balderstone.

It would appear that the two Japanese firms were not interested in proceeding with the changed proposal and Siemens-Filtrontec were selected by default.

The tunnelling and construction of the filtration house and its associated structures was carried out by the tunnel operator and, of course, there was no possibility of any competitive quotations.

The RTA was clearly advised by a number of well-informed organizations and individuals that there were significant problems with the course they were taking during the selection of the supplier for the filtration equipment. The most significant of these was their selected probity advisor, Deloitte who in 2006 advised:

Under the heading of '**Transparency of Process**'

"However, the RTA may wish to consider undertaking additional market research to confirm its current position that the proposed increase in flow has not shifted the filter technology into an area which might now interest suppliers that did not originally participate."

Under the heading of '**Addressing conflicts of interest**' - in relation to the amount of time which had elapsed and staff changes.

"As with confidentiality above, due to the length of time that has elapsed since the start of the selection process, all parties involved in the Project should be reminded of their responsibilities in respect of disclosing and addressing conflicts of interest."

And "An additional probity risk mitigation strategy that the RTA should consider, regardless of any changes to proponent teams is for all RTA staff, independents and advisers involved in the Project to provide an updated and detailed related interest disclosure. All disclosures will need to be recorded and assessed for any conflicts that may require management. This assessment process should also be documented."

Under the heading '**Value for Money**' they advised:

'Obtaining value for money is enhanced when there is open competition and the market is tested regularly. We note that the RTA is currently proposing to invite the three short-listed proponents from the RPP to participate in the Stage 3 REP on the basis of the revised scope.'

However, a key value for money probity risk that the RTA will need to consider is whether the field of three proponents is sufficient to meet the proposed scale of the Project.'

It should be noted that the whole of Deloitte's advice to the RTA process depended on the advice, given by the RTA, "the RTA considers the revised scope would not have changed the weightings, selection criteria or result from the EOI" (the initial expressions of Interest).

This is a guess which is unsupported and unlikely to be true given the changed nature of the project and the expectations from it.

One is entitled to wonder if **Deloitte** might have given an even stronger warning if they had not been given this tendentious assurance.

It is clear that, if the **RTA (RMS)** had accepted this advice, a different company would almost certainly have been selected, which no doubt would have resulted in an entirely different outcome.

1.7 Summary

Clearly the trial for the reasons described above was an abject failure and as such any conclusions drawn from it must be viewed as having no demonstrable scientific value. Under no circumstances should the trial have ever been used as justification by the **RMS** who continue to erroneously assert that “filtration is ineffective”! in order to protect the health of tunnel users as well as that of the population adjacent to the unfiltered stacks.

The experience from elsewhere in the world demonstrates beyond any shadow of a doubt that filtration is not only extremely effective; but it is an absolutely essential requirement in any well designed road tunnel system, in order to protect the health of tunnel users as well as that of the population adjacent to the unfiltered stacks

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This document was prepared by members of **RAW**, some of whom have a scientific background and have hard evidence provided by the **RMS** in relation to filtration and tunnel emissions from the 4.2 klm long **M5 East** tunnel, dating back over 20 years.

Two of the members have visited the **Yamate** tunnel in Japan and are totally conversant with the operation of their in tunnel filtration system, which is indeed “World’s best practice”!

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