NACOE P120/WARRIP-2021-016: Task 8 Potential Use of Recycled Waste Plastics in Temporary Traffic Management Devices

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Investigating the use of recycled and reclaimed plastic in safe, sustainable future road infrastructure

This report forms one element of a multi-stage research project undertaken as a joint initiative between the Western Australian Road Research and Innovation Program (WARRIP) and the National Asset Centre of Excellence (NACOE).

Stage 1 (2020–21) aimed to:

- review local and international projects that used recycled waste plastic in road and transport infrastructure
- identify the potential uses for recycled plastics in road construction and the relative quantities of materials that could be realistically used by each application
- review plastic waste streams in Queensland and Western Australia to understand market trends and capacity
- investigate workplace health and safety (WHS) requirements and environmental considerations associated with the use of waste plastics in road construction.

The publications completed under Stage 1 include:

- **Task 2–4: Investigating the use of recycled plastic in road infrastructure**
  - **2: Literature review**
  - **3: Plastic waste management (industry survey)**
  - **4: Workplace, health and safety, and environmental implications**

Stage 2 (2021–23) aimed to:

- explore safe and sustainable ways to expand the potential uses of waste plastics in transport infrastructure
- understand the health, safety and environmental impacts of using waste plastics in asphalt and bitumen, including microplastics, leaching, fuming and emissions.

The publications completed under Stage 2 include:

- **Task 5: Recycled plastics in infrastructure (Factsheet)**
- **Task 6: Health and environmental effects of incorporating plastics in binders and asphalt**
  - **6A: Laboratory fuming and emissions**
  - **6B: Microplastics and leaching**
- **Task 7: Potential use of recycled waste plastics in geosynthetics**
- **Task 8: Potential use of recycled waste plastics in temporary traffic management devices**

Summary

The objectives of this project Task 8 were to review the current state of play for temporary traffic management, road delineation and other control devices that contain reclaimed and recycled plastic (RP) and to identify barriers and opportunities for incorporating RP in these devices. The objectives were pursued through reviewing current standards and available products as well as through consulting with industry suppliers. The key findings of this investigation include:

- Current standards and specifications or procurement processes are performance based and, as such, do not pose any restrictions on the use of RP in these products.
- Currently, PVC (up to 100% by mass), uPVC, polypropylene (up to 70% by mass), low-density polyethylene (LDPE) (up to 37.5%) and high-density polyethylene (HDPE) (up to 37.5%) are being used in Australia in various applications such as base of traffic cones, barrier boards and safety signs.
- Due to the lack of consistency and potential low quality of RP feedstock, visual properties, such as colour and light fastness, as well as flexibility of products may be negatively impacted. As such, there are concerns on the use of RP in products such as stem of traffic cones.
- For the lower order products that do not have flexibility and/or bright or retroreflective colour requirements, such as base or footing components, there is great opportunity for use of RP.
- The products containing RP and currently being used in Australia are manufactured overseas, with suppliers highlighting the high cost of local manufacturing as the primary reason. However, the high cost of local manufacturing forcing manufacturing overseas is anticipated to be a broader issue, rather than one specific to RP. Overall, the use of RP in temporary traffic management devices (TTMDs) does present a low impact to the Queensland and Western Australian plastic waste streams.
- From a health, safety and environmental perspective, use of RP in the manufacture of traffic management devices is not expected to cause a different risk profile than that of virgin plastics currently being used.
- Given the application, none of the devices containing RP are products causing concerns in relation to consumer exposure.
- State road agencies can promote the increased uptake of RP in these products by encouraging suppliers and manufacturers to view the uptake of RP as a competitive advantage. For instance, requiring tender applications to include details on the percentage of RP within their products.

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1 Introduction

1.1 Background

With recent bans on waste plastic exports, Queensland and Western Australia are looking to limit the disposal of used plastics in landfill and find sustainable alternative applications for these materials. As such, the Queensland Department of Transport and Main Roads (TMR), Main Roads Western Australia (MRWA) and the Australian Road Research Board (ARRB), under both the National Asset Centre of Excellence (NACOE) and the Western Australian Road Research and Innovation Program (WARRIP) agreements, have launched a multi-year project ‘Investigating the Use of Recycled and Reclaimed Plastic in Safe, Sustainable Future Road Infrastructure’. One of the objectives of this project is to explore ways to safely and sustainably expand the potential uses of waste plastics in transport infrastructure.

Following sustainable practices within the road infrastructure has the potential to positively impact the country’s economy by reducing the burden of waste management, lessen environmental issues and decrease the costs associated with building and maintaining transport infrastructure. One of the major environmental concerns currently is the generation and unsustainable management of waste plastics. In 2019–20, Queensland and Western Australia consumed approximately 611,000 and 315,000 tonnes of plastic, respectively. Of the plastic consumed, both states recycled approximately 15% (O’Farrell et al. 2021).

This Task 8 report has been prepared as part of the project to focus on investigating the sustainable use of reclaimed and recycled plastic (RP) in temporary traffic management, road delineation and other control devices. In comparison to other applications of RP in road infrastructure, temporary traffic management devices (TTMD) generally have a short service life and limited structural requirements. TTMDs require a visual safety effect rather than structural strength, which creates an opportunity for the use of RP. However, as traffic management devices are low value, the available market for a product is highly sensitive to its price, which is heavily influenced by production costs.

1.2 Scope of the Project Task

This project task reviewed the current opportunities for TTMD containing RP and identified gaps and/or barriers for their use, and this report provides recommendations on the safe and appropriate use of these devices in transport infrastructure applications.

This report was prepared based on a thorough review of the relevant standards and specifications on the use of TTMD, particularly those of Queensland and Western Australia, as well as currently available products and consultations with the industry suppliers. A suitably qualified professional (SQP) was consulted for the assessment of potential harm to human health and the environment by using RPs in the manufacture of these devices. The devices considered in this project included:

- traffic cones
- temporary bollards
- temporary signage backing
- barriers (excluding noise barriers)
- guideposts

- temporary fence footings.

The main objectives of this project task were identifying:

- in what TTMDs RP is currently being used
- in what TTMDs RP can be used
- the barriers and opportunities to utilise these devices containing RPs.

2 Traffic Management Devices

2.1 Definition of Traffic Management Devices and Products

According to AS 1742.2:2009, a traffic control device is any installation which is used to regulate, warn or guide road users. For the purposes of this project task, the definition of a TTMD has been extended to include any disposable device which can be used to ensure the safety of road users, road work personnel, pedestrians and the general public within the road network. Examples include traffic cones, barriers, temporary bollards, guideposts, temporary fence footings and temporary signage.

2.2 Current Requirements for Traffic Management Devices

Within the context of low risk/semi-disposable products that are used within the infrastructure and construction industry, relevant Australian standards were consulted to determine if there are any restrictions on material type. In a general sense, standards for these products have broad performance requirements such as 'durable and resistant to traffic impacts' with no metrics of assessment.

AS/NZS 3845.2:2017 states that these products must demonstrate satisfactory impact performance by passing *Manual for Assessing Safety Hardware* (MASH) testing (AASHTO 2016) or, alternatively, a more appropriate impact performance test for the device. However, this requirement is not mentioned in some 'parent' standards, such as for traffic cone requirements in AS 1742.3:2019. In all cases, there seemed to be no restrictions within the Australian standards or state specifications for the type of material these products are required to be made from. Table 2.1 lists the Australian Standards that are currently relevant in setting the selected device requirements and includes some remarks to note when considering the incorporation of RPs.

Table 2.1: Summary of selected device requirements according to Australian standards

Device	Relevant standard	Remarks
Traffic cones	AS 1742.3:2019 Section 4.11.1 AS 3845.2:2017 Section 5 (1)	There are no restrictions on material type with non-quantifiable performance requirements (from AS 1742.3:2019): '*traffic cones shall comprise cones of fluorescent orange material that is resilient to impact.'* *'Cones and bollards shall be designed to be stable under reasonably expected wind conditions and air turbulences from passing traffic…can be displaced by passing traffic…provide adequate stability from passing traffic when unattended*.'
Temporary bollards	AS 1742.3:2019 Section 4.11.1 AS 3845.2:2017:2017 Section 5(1)	As above for traffic cones in addition to: *'Temporary bollards shall comprise a vertical parallel sided or tapered tube of fluorescent orange or red material that is resilient to impact.'*
Permanent bollards	None	Permanent bollards are primarily used to restrict access to adjacent land near low-speed roads such as parks and are, therefore, not crash tested.
Speed/road hump	AS 1742.13:2009 Section 2.4 AS/NZS 2890.1:2004 Section 4.9	Both AS 1742.13:2009 and AS/NZS 2890.1:2004 only provide dimensional requirements for speed humps with no restriction on material. There is no mention of performance requirements in the context of structural capacity.

Device	Relevant standard	Remarks
Temporary fencing footings	AS 4687:2007 Section 2.1.7	There are no restrictions on footing/base plate systems for temporary fencing as long as the whole fencing system is able to pass the required tests. *'engineered of such weight that will support the fence/hoarding system in accordance with in-service performance requirements and subsequent performance testing'*
Longitudinal channelising devices (LCD) (incl. barrier boards, water-filled barriers)\barricades (2)	AS/NZS 3845.2:2017 Section 3.2.3, Section 5 AS 1742.3:2019 Section 4.10.2	LCDs are not to be confused with road safety barriers. The definition of an LCD is broad enough to encompass a very broad range of devices as long as they do not serve a crash/road safety barrier function. *'LCDs are used to provide either visible or physical containment of pedestrians or workers on foot and plant within the safe workplace boundary established at a particular worksite or as traffic channelising devices and may be used in situations where a road safety system is not required'* LCDs must be tested using the MASH system. Barricades, as specified by AS 1742.3:2019, shall '*comprise either barrier boards or stand-alone non-interconnected lightweight modules'* and must conform to AS/NZS 3845.2:2017.
Safety signs	AS 1319:1994	The relevant standard is to ensure that standardised sizes, colours and symbols are used.
Bicycle lane separator	None	Rely on local technical specifications.

1. AS 1742.3:2019 is the primary standard for cones and temporary bollards that road agencies and suppliers reference; however, Sections 5.2 and 5.3 of AS/NZS 3845.2:2017 suggest that cones and temporary tubular bollards must be subjected to MASH tests 70, 71 and 72 (AASHTO 2016).
2. AS/NZS 3845.2:2017 and AS 1742.3:2019 refer to the same products but in different functions.

2.3 Industry Consultation

ARRB initiated preliminary contact with various suppliers via emails and informal phone conversations to seek advice on various products and to identify potential avenues for the use of RP. TMR-approved suppliers were included in these consultations. The main questions presented to suppliers were:

1. Does your business offer RP options for the product class you are approved for?
2. What types of plastic/what proportion of recycled material is included in your product?
3. Are your products manufactured within Australia?
4. Please describe any barriers to the use of RPs, be it from a technical perspective or from current standards or specifications.

Table A.1 outlines the responses which suppliers provided to these questions, with key findings from the industry consultation discussed in Section 3.

During a conversation on 10 December 2021, the TMR Traffic Engineering Technology & Systems department confirmed that TMR's accepted product register for traffic management devices is focused on documenting that a supplier has provided evidence of compliance, rather than TMR assessing whether a product is non-compliant. A notable exception is that retroreflective materials are assessed by TMR for compliance. However, retroreflective materials are usually supplied independent of the main product (such as the sleeves on traffic cones). Additionally, it was indicated that tracking annual product purchase volumes is difficult, and tracking annual product volumes purchased by subcontractors is impractical for a state road agency. Therefore, it is more practical to engage with industry to identify trends and changes in volume.

In contrast, whilst MRWA does not currently utilise a centralised list of approved suppliers, any contractor will have to demonstrate compliance with relevant standards and specifications before being engaged to supply traffic management devices.

2.4 Health, Safety and Environmental Implications of Using Recycled Plastics

ARRB engaged an SQP to assess and provide advice on any health, safety and environmental concerns associated with utilising TTMD and other applicable products incorporating RPs.

Advice provided by Wright (Appendix C) stated that due to the nature of the proposed applications in this investigation, it is unlikely that any risks to human health and the environment would arise. Specifically, traffic management applications do not raise concerns regarding human exposure as would, for example, packaging for the food industry or toys for children. As such, should the release of any chemicals be evident, they would not be of concern to human health. Additionally, as TTMDs are only exposed to the environment for short periods of time, they are unlikely to release microplastics. However, where more permanent installations are considered, further investigation is warranted. It needs to be noted, though, that the toxicity of any microplastics released by RPs would not be different to those that may be released by virgin materials, and the overall risk profile would not change.

The SQP report also identified that it is preferable to limit feedstock from older plastics as they may contain chemicals which have since been banned from use in plastic food packaging and toys. However, it is recognised that identifying RP which contain these chemicals is difficult. Additionally, it is less likely that traffic management devices will be sucked or chewed by people and, therefore, present a lower safety risk to the public.

For more details, please refer to the SQP report in Appendix C.

2.5 Current Recycled Plastic Offerings

Table 2.2 summarises products currently within Australia that utilise RP, and Table 2.3 provides examples of products containing RP available overseas. Both Table 2.2 and Table 2.3 include information regarding RP utilisation as it allows the RP limits to be observed before suppliers perceive the use of RP as too detrimental to the product (via either economic market forces or difficulties in achieving performance and standard requirements).

Product and company references have been removed, with each row denoting a separate product.

Table 2.2: Examples of current recycled plastic products offered by Australian suppliers

Product type	Relevant standard/specification	RP utilisation	Product performance outcome	Performance impact of incorporated RP
Traffic cones A	No reference to AS 1742.3:2019 or AS/NZS 3845.2:2017	Advertised as a 100% recycled PVC base with virgin stem	Delineation Colour degradation UV resistance Structural integrity	Recycled material is incorporated in the base resulting in no impact for traffic cone performance outcomes for visibility and structural integrity of the stem. The dark or black base colour is not an issue for recycled material within the context of manufacturing quality or consistency
Traffic cones B	No reference to AS 1742.3:2019 or AS/NZS 3845.2:2017	Advertised as a recycled PVC base with virgin stem; however, no exact values are provided		
Traffic cones C	No reference to AS 1742.3:2019 or AS/NZS 3845.2:2017	Advertised as 'Recycled black base' without specifying material potentially being recycled rubber rather than plastic		
Pedestrian barriers Pedestrian barriers see widespread use on worksites as delineation and segregation of pedestrians, workers and plant	Advertised as being compliant for anti-climb with AS 4687:2007, no reference to other stability tests such as wind resistance	Only the base is advertised as containing recycled PVC with no proportion provided. Each base unit weighs 18 kg. Similar to traffic cones or bollards, the majority of mass for this product is contained within the base for stability purposes	Visibility Stability under pedestrian climbing and wind loadings UV resistance	The incorporation of recycled materials in the base component of the barrier does not detract from the primary performance outcomes of barrier visibility or function. The dark or black base colour is not an issue for recycled material
Bollards (permanent) A Supplier offers a wide range of hollow RP bollards for permanent use delineation and movement restriction applications. These products are designed for access restriction and are not rated for crashes. The products are offered to be modified with retroreflective materials	Product is not intended to arrest the impact of a vehicle and, as such, does not need to conform to AS/NZS 3845.2:2017	Supplier advertises that an average of 90% RP material is used, with the remainder being a combination of the Master Batch, Light Fastener, UV stabiliser package, and other virgin plastics Depending on bollard size, each unit can weigh from 9.1 kg to 18 kg. Assuming a 1.5 m spacing allows for approximately 546 kg to 1,080 kg of waste plastic per 100 m of installed bollards	Aesthetics Colour fade Vehicle movement restriction	Supplier advises that their RP products have a minimum 10-year service life before there is visible UV degradation
Bollards (permanent) B This product is a permanent rigid bollard used to define boundaries or deter vehicles and pedestrians	This product is to be used for delineation and access restriction purposes and is not rated for crashes	Product information does not specify levels of RP		
Bollards (permanent) C There is no information regarding suggested use from the supplier; however,	This product is to be used for delineation and access restriction purposes and is not rated for crashes	Advertised as100% RP at 22.4 kg per unit Assuming a 1.5 m spacing allows for 1,478 kg of RP per 100 m installed		

Product type	Relevant standard/specification	RP utilisation	Product performance outcome	Performance impact of incorporated RP
provided photographs suggest permanent delineation				
Bollards (permanent) D Supplier provides a range of products for parks, including permanent bollards. Bollards have been used to delineate parkland from roads	This product is to be used for delineation and access restriction purposes and is not rated for crashes	Advertised as100% RP at 9.2 to 21.0 kg per unit	Aesthetics Colour fade Vehicle movement restriction	Supplier advises 40+ year life span & resistant to sun damage
Wheel stops As an alternative to concrete provisions for parking, these RP wheel stops are available in a wide range of colours and markings to suit a wide range of needs	Supplier states the product conforms to AS/NZ 2890.1:2004	Supplier advertises that an average of 90% RP material is used, with the remainder being a combination of the Master Batch, Light Fastener, UV stabiliser package, and other virgin plastics Unit mass is not provided	Aesthetics Colour fade Rigidity	Supplier advises that their RP products have a minimum 10-year service life before there is visible UV degradation
Rumble bars According to the supplier's website, rumble bars are designed to delineate lanes, control traffic and improve safety	Product is not compliant with dimensions for AS 1742.2:2009 and AS/NZS 1906.3:2017 These standards have no restriction on material type, provided the product meets the visual and structural requirements particularly for AS/NZS 1906.3:2017	Supplier advertises that an average of 90% RP material is used, with the remainder being a combination of the Master Batch, Light Fastener, UV stabiliser package, and other virgin plastics	Structural integrity Colour fade	Supplier advises that their RP products have a minimum 10-year service life before there is visible UV degradation
Speed hump The speed hump is designed for use in off-street parking applications such as driveways or carparks	Manufacturer advises product is non-AS compliant due its dimensions and is, therefore, limited to off-street parking applications. There are no restrictions on material	Supplier advertises that an average of 90% RP material is used, with the remainder being a combination of the Master Batch, Light Fastener, UV stabiliser package, and other virgin plastics Each 1.5 m segment weighs 16 kg and is advertised to be easily installed by one person. It has been advised through private conversations that temporary adhesives do not bond well with this material and, therefore, are not suitable for non-destructive temporary traffic management.	Colour fade Structural integrity	Supplier advises that their RP products have a minimum 10-year service life before there is visible UV degradation
Temporary fencing footings	AS 4687:2007 outlines overall performance requirements for fence	Advertised as 100% RP and rubber materials	Lightweight relative to traditional temporary	Benefits to worker safety by providing a lighter product that

Product type	Relevant standard/specification	RP utilisation	Product performance outcome	Performance impact of incorporated RP
A temporary fencing footing alternative to traditional blown plastic and concrete filled options	stability under loads. There are no restrictions on materials or form for footings or baseplates	Each unit weighs 17 kg, which allows for a moderate to high RP utilisation depending on the total length of temporary fencing required for a project	fencing feet while maintaining performance outcomes for fence stability under wind loading Colour fade Structural integrity from wear and tear (foot traffic, stacking, placement)	delivers the same fencing performance outcomes
Safety signs Supplier offers a wide range of safety signs made from recycled material	AS 1319:1994 for safety signs used in an occupation environment	Advertised as 70% recycled polypropylene, 1.6 mm thick sheeting	UV resistance Colour retention Crack and fade resistance Visibility	Supplier states that recycled material contains UV resistant additives to ensure a 5-year resistance to fading and cracking
Barrier boards Barrier boards are widely used on roadwork and construction sites as delineation and movement controls for pedestrians and vehicles. These boards also see extensive use in large crowd events such as festivals	Supplier states that product is compliant with NSW Specification IC-QA-3385 Supplier states that retroreflective materials used on board are compliant with AS 1742.3:2019	Advertised as manufactured with recycled uPVC. Proportional recycled material contents not specified. Each unit weighs 2.7 kg	Weight Impact strength UV degradation Colour retention	Incorporation of recycled materials results in a reduction in weight from 3.7 kg (virgin plastic) to 2.7 kg per unit (recycled uPVC) while maintaining performance outcomes reducing strain risk to workers
Bicycle lane separator Bicycle lane separators provide a boundary between cyclists and vehicles	Supplier states that the product meets UV resistance standards; however, the standard reference was not provided	Advertised as 90% ‘hard to recycle plastics’ with the remaining 10% made from recycled disposable paper coffee cups. Each approx. 1 m long unit weights 12 kg	Colour fade Structural integrity	Supplier states that paper fibres provide additional rigidity

Table 2.3: Examples of current recycled plastic products offered by international suppliers for use outside of Australia

Product type	RP utilisation	Product performance outcome	Performance impact of incorporated RP
Traffic cones Made in New Zealand from recycled materials including old or damaged cones	The stem is virgin PVC material; however, the base is advertised as 15% RP sourced from used cones. The website does not specify if this is plastic or rubber	Colour degradation UV resistance Structural integrity	Recycled material is incorporated in the base resulting in no impact for traffic cone performance outcomes for visibility and structural integrity of the stem
Traffic cones Made in the USA from 80% recycled materials, predominantly low-density polyethylene (LDPE) compared to the traditional PVC	The supplier advertises that the stem of the cone is made of 80% recycled LDPE which makes up to 20% to 40% of the total cone weight. Each cone weighs 3.2 to 4.5 kg depending on size, which allows for approximately 0.5 kg to 1.5 kg of RP utilisation per unit	Colour degradation UV resistance Structural integrity	The manufacturer advises that run over and deformed cones may be reshaped by hand into their original form to remain fit for purpose after coming into contact with a vehicle
Safety signs The US arm of a global supplier (including Australia) offers signage produced from RP. Although there is an Australian branch and website, this product is not available in Australia. There is an extensive range of commercial and safety signs available on the US website	The product description advertises that the sign is 100% recycled HDPE and that it is 'over 50% recycled content (PCR- Post-Consumer Recycled Material)'	Visibility UV resistance Colour degradation Retroreflectivity	The degradation of the sign's message is more dependent on the printing process rather than the physical backing material Concerns over message visibility resulting from UV degradation are decreased with temporary signage which typically will be physically destroyed through wear and tear before having the chance to be exposed for extended periods
Barrier board Are widely used over a range of infrastructure and non-infrastructure applications	The board is advertised as made from RP; however, the description is a generic background which says that these types of boards are typically made from PVC	Visibility UV resistance Colour degradation Retroreflectivity	

3 Opportunities and Barriers for Wider Use of RP in Traffic Management Devices

3.1 Opportunities for Wider Use of RP in Traffic Management Devices

This report identified opportunities for growth in utilising RP in low-risk and semi-disposable construction or infrastructure-related products. Many products can be partially manufactured with RP whilst maintaining their performance characteristics, particularly moulded plastic bases and components that are not colour critical. However, according to suppliers, traffic management devices (TMDs) incorporating RP are unable to meet the visual characteristic requirements of traffic device standards, such as fluorescent orange and red colours. These devices are usually, or at least have the capacity to be, designed as assemblies, which allows for targeted addition of recycled materials in bases/weighted components without impacting the virgin, brightly coloured segments. Bases and footings of various products such as traffic cones, temporary bollards and temporary barriers have already been identified as containing RP, and their procurement should become business as usual.

One supplier who incorporated up to 80–90% recycled PVC into the black bases of traffic cones and bollards, produced in Taiwan, explained that they receive extruded pellets sourced from a broad range of PVC waste, which is processed to meet quality requirements. PVC is considered one of the more difficult plastic waste streams to work with due to the variability of PVC compositions by product. According to O’Farrell et al. (2021), in 2019–20 approximately 1% of consumed PVC was recovered in Queensland and Western Australia. Thus, utilising waste PVC in these products is advantageous.

With regards to temporary barriers, it is important to distinguish those that are used for general delineation or pedestrian movement restriction/separation (referred to as longitudinal channelising devices (LCDs) as per AS/NZS 3845.2:2017) and those for situations that require an impact/vehicle crash arresting system. There may be greater opportunity for RP utilisation for components of barriers used as LCDs.

It is worth mentioning that many of these semi-disposable/low-risk products are marketed as ‘recyclable’. Table 3.1 presents some examples of such low-risk traffic management devices with potential to absorb greater amounts of RPs than they currently are.

Table 3.1: Potential opportunities for wider use of recycled plastic in low-risk traffic management products

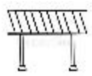
Device	Remarks
Traffic cones	Some suppliers already offer cones which incorporate RP into the base. However, these are still produced overseas and there may be opportunity for local production from Australian waste material (from industry consultation). Other advertised products do not specify source of recycled material.
Temporary bollards for roadworks	As above for traffic cones, with some suppliers providing bases with recycled material.
Replacement of plywood sheeting with RP sheeting for site screens	One supplier offers RP sheeting of varying thickness which may be used as an alternative to traditional plywood sheets for site perimeter cladding.
Guideposts	Plastic options for both temporary and permanent guideposts are readily available throughout Australia; however, they are not advertised as containing RP.
Guard rail delineators	While being relatively small, there is an opportunity to incorporate moderate volumes of RP over long lengths of guard rails installed throughout road networks.

3.2 Use Case

The use of RP to replace virgin plastics in TTMD is feasible and is currently being implemented by manufacturers and suppliers in Australia and internationally. The increase in utilisation of RP instead of virgin plastics will proportionally reduce the amounts of plastics ending up in landfill. With the growth in construction to improve the road network around Australia, the utilisation of these TTMDs will only increase. Example volumes of plastic diverted from landfill, should 10,000 units of each product type be implemented annually, are shown in Table 3.2 below. 10,000 units has been engaged for comparison purposes, as accurate figures on the use of these products across Queensland and Western Australia is not available.

Table 3.2: Examples of RP uses and potential landfill diversion

Product type	Total RP mass per unit (kg)	Total RP mass over 10,000 units (tonnes)	% of annual diversion from landfill (tonnes)	
			Queensland[1]	Western Australia[2]
Traffic cones A (base only) 	7	70	0.0115	0.0222
Pedestrian barriers 	18	180	0.0295	0.0572
Round hollow bollards (permanent) 	10	100	0.0164	0.0318
Square hollow bollards (permanent) 	10	100	0.0164	0.0318
Solid square bollards (permanent) 	22.4	224	0.0367	0.0712
Wheel stops 	15	150	0.0246	0.0477
Rumble bars 	3	30	0.0049	0.0095
Speed hump 	16	160	0.0262	0.0508

Product type	Total RP mass per unit (kg)	Total RP mass over 10,000 units (tonnes)	% of annual diversion from landfill (tonnes)	
			Queensland[(1)]	Western Australia[(2)]
Temporary fencing footings 	17	170	0.0278	0.0540
Safety signs 	0.5	5	0.0008	0.0016
Barrier boards 	2.7	27	0.0044	0.0086
Total			0.1991	0.3864

1. 610,900 tonnes plastic reaching end of life, 2019–20
2. 314,700 tonnes plastic reaching end of life, 2019–20

Note: The products listed are as per the products in Table 2.2, with plastic percentage and approximate product weight as per advertised material from selected suppliers.

As illustrated, an approximate total of 0.199% and 0.386% of plastic waste could be diverted from landfill in Queensland and Western Australia, respectively with the use of RP TTMDs (national and State figures as per O'Farrell et al. 2021). It can be noted that this is a low impact to the plastic waste stream.

Further investigation was undertaken regarding traffic cones, to understand procurement in each state annually. One of the major traffic control companies was contacted for information. This company purchases around 300 700 mm cones and 200 900 mm cones annually in Western Australia; and around 1300 700 mm cones and 180 900 mm cones annually in Queensland. They are classed as large company. In Queensland, there are 5-10 large traffic control companies, 30-50 mid-sized traffic control companies and a significant number of smaller companies. There is approximately half this value in Western Australia. From this information, and a set of assumptions (see Appendix B), it is estimated that around 136 tonnes and 25 tonnes of RP could be used in traffic cones annually in Queensland and Western Australia respectively. This equates to 0.022% and 0.008% of the annual waste plastics generated in Queensland and Western Australia, respectively. This demonstrates that the calculations in Table 3.2 are reasonable, however the use of RP in TTMDs will still have a low impact on the waste plastic stream.

3.3 Barriers for Wider Use of RP in TMD

Key barriers to the wider use of RP for TMDs following industry consultations include:

- Many TMD applications include visually based performance requirements to ensure traffic easily recognises the device. There are concerns over UV degradation of recycled material impacting visual performance (Liu et al. 2014) as well as lack of consistency in recycled material feedstock to produce a consistent product, particularly those that are white or bright orange. Note that this barrier does not apply to device components that do not have visual-based requirements such as traffic cone bases.
- Concerns exist over the lower performance of aging of RP feedstock on impact resistance due to embrittlement (Eriksson et al. 1997). This barrier is generally restricted to thin plastics, as the increased embrittlement does not impact the performance of thick plastic bases.

- One supplier noted that the end users choose the product they perceive as providing best value, which may not be the cheapest product. Therefore, products with RPs are at a competitive disadvantage if they have a shorter design life or do not meet a customer's quality requirements.
- The capital required to conduct research and development and to then establish local processing facilities for low value products such as traffic management devices is a barrier.
- Whilst conducting the review of available RP traffic management devices, competing products using alternative recycled materials such as recycled rubber were identified. These alternative recycled materials are likely to be more suitable and/or sustainable than RP for certain traffic management device applications.
- Partial RP use in traffic management devices might be cost prohibitive as multiple production lines are required, which lowers the economies of scale, compared to 100% RP products.
- The performance barriers can be mitigated by thickening the plastic; however, the success of low value products like traffic management devices is typically driven by the products' cost competitiveness.

4 Conclusions

4.1 Key Learnings

Following the literature review of current standards, specifications, product offerings, industry consultations and seeking SQP advice, the following conclusions can be drawn:

- There are no restrictions from current standards, specifications or procurement processes that would preclude the use of TTMDs utilising RP.
- There are traffic management devices that contain RP currently available in Australia. Table 4.1 presents the types and contents of RPs being utilised in these devices.
- RP can be used extensively in traffic management device components where the material does not have visual-based requirements such as traffic cone bases and temporary fence bases. However, their use is limited where visual based requirements apply as earlier UV degradation leads to earlier colour fading and brittleness in the material.
- The incorporation of RPs into traffic management devices is not expected to cause a different health, safety and environmental risk profile than that of virgin plastics.
- There is great opportunity for use of RP, especially those of lower quality, in the base/footing components of lower order products which do not require flexibility and/ or specific colour requirements.
- Many of these lower order or semi-disposable products are manufactured overseas, and achieving local production from Australian waste may require higher level intervention outside of the scope of state road agencies.
- Table 3.2 offers an example use case of RP TTMDs, evidencing that overall, their use presents a low impact to the Queensland and Western Australian plastic waste streams.

Table 4.1: Current recycled plastic types and contents used in traffic management products in Australia

Application	Type of RP	Content of RP
Base of traffic cones	PVC(1)	Up to 100%
Base of bollards	Unclear	Unclear
Base for the pedestrian barrier	PVC	Unclear
Bollards (permanent)	Unclear	Up to 100%
Wheel stops	Unclear	Up to 90%
Rumble bars	Unclear	Up to 90%
Speed hump	Unclear	Up to 90%
Temporary fencing feet	RP (unclear) and rubber	Up to 100%
Safety signs	Polypropylene	Up to 70%
Barrier boards	uPVC	Unclear
Bicycle lane separator	Unclear	Up to 90%

1. Traffic cone bases with 80% recycled LDPE are available overseas.

4.2 Recommendations

It has been identified that significant higher level systemic changes and infrastructure development would be required to expand RP utilisation within temporary or semi-disposable traffic management products.

Current standards and specifications are largely performance based and pose no explicit restrictions for recycled material use. However, devices incorporating RP are generally not competitive to virgin plastic when they are required the achieve these standards and specifications.

However, mandating materials or otherwise imposing materials via state road agency contractual requirements is not recommended considering the current state of waste plastic processing and subsequent feedstock availability, quality, volumes and price. Additionally, establishing economies of scale, overcoming market forces and achieving domestic production of lower order plastic items are difficult obstacles to initially overcome against the backdrop of current waste plastic industry infrastructure.

Thus, the following are recommended approaches that may be implemented by a state road agency:

- Promote the increased uptake of RP in traffic management devices by encouraging suppliers and manufacturers to view the uptake of RP as a competitive advantage. For instance, requiring tender applications to include details on the percentage of RP within their products.
- Liaise with industry to highlight implemented resource recycling strategies and encourage the use of RPs in their products.
- Liaise with suppliers and manufacturers to encourage the use of RPs in their products.
- Monitor the RP trends and demands within the traffic management device industry.

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Australian Standards

AS 1319:1994, *Safety signs for the occupational environment*.

AS 1742.2:2009, *Manual of uniform traffic control devices: part 2: traffic control devices for general use*.

AS 1742.3:2019, *Manual of uniform traffic control devices: part 3: traffic control for works on roads*.

AS 1742.13:2009, *Manual of uniform traffic control devices: part 13: local area traffic management*.

AS/NZS 1906.3:2017, *Retroreflective materials and devices for road traffic control purposes: part 3: raised pavement markers (retroreflective and non-retroreflective)*.

AS/NZS 2890.1:2004, *Parking facilities: part 1: off-street car parking*.

AS/NZS 3845.2:2017, *Road safety barrier systems and devices: part 2: road safety devices*.

AS 4687:2007, *Temporary fencing and hoardings*.

New South Wales Technical Specification

IC-QA-3385 2020, *Barrier boards*.

Appendix A Industry Consultation Responses

Table A.1: Supplier responses to consultation questions

Product	Does the supplier currently advertise RP device type (Table 2.2 and Table 2.3)?	From consultation, does supplier offer RP options?	Product & supplier remarks
Traffic cones	No	Yes (the base)	The base is made with recycled PVC. Percentages vary from 30% to 50% by mass, with heavier traffic cones having more recycled content. The base is currently manufactured in Taiwan from presumably Taiwanese waste materials. According to the supplier, there has been little to no issue with recycled material quality for bases; however, the supplier stated that the recycled pellets would cause issues in colour variability and impact consistency for mechanical properties such that it cannot be used in the 'stem' of the product.
	No	Unclear	Provided a document stating their products are 'recyclable' without directly responding to the question in the email.
Temporary bollards	No	Yes (the base)	The base component is made from 89% and 92% recycled PVC for the 6 kg and 8 kg versions, respectively. The base is currently manufactured in Taiwan from presumably Taiwanese waste materials. According to the supplier, there has been little to no issue with recycled material quality for bases; however, the supplier stated that the recycled pellets would cause issues in colour variability and impact consistency for mechanical properties such that it cannot be used in the 'stem' of the product.
	No	Unclear	Phone conversation indicated: • The supplier is supportive of using more sustainable materials for their products; however, there needs to be a market available for these products. • The supplier will select to use RP in their traffic control devices in the following situations: – the RP is competitive to produce – a minimum standard makes RP the most competitive to produce. • The supplier discussed the goal to simplify production lines, including: – Harmonisation between states is desired as there are cost efficiencies from a simpler production line. – When different states set different requirements for traffic control devices, the supplier cannot simplify their production line by making their products to the strictest requirements as they will not be competitive against local suppliers. – It is not desirable to partially use RP in traffic control devices, as that requires multiple production lines which will always cost more to produce.
	No	Unclear	Provided a document stating their products are 'recyclable' without directly responding to the question in the email.

Product	Does the supplier currently advertise RP device type (Table 2.2 and Table 2.3)?	From consultation, does supplier offer RP options?	Product & supplier remarks
Guideposts	No	Unclear	Provided a document stating their products are 'recyclable' without directly responding to the question in the email.
	No	No	100% Virgin, HDPE
	No	No	Phone conversation indicated: • R&D is a prohibitive roadblock for developing new products/plastic mixes. • For disposable products such as top bollards, even virgin offering produced in Australia did not sell/could not compete with overseas offering and the supplier had to discontinue their local line. • Plastic guideposts are manufactured locally, typically HDPE, but some states allow uPVC. • Quality of a hypothetical RP feedstock is a major concern. • UV degradation for guideposts is a limiting factor; there is a limit on additive without affecting strength. • Depends on end user, e.g. some owners view guideposts as disposable and re-install whenever the grader pulls them out, whereas other jurisdictions want a longer lasting product. • RP may affect colour.
	No	Unclear	Phone conversation indicated: • PP, PET and PC made locally from imported pellets. • There should not be too much issue with using RP material. • Current post design was from iterative process once material was selected indicating that product geometry can be altered to compensate for reduced material properties if needed.
Temporary road humps	No	Recycled rubber	20% virgin rubber/80% recycled material (rubber)
Temporary barriers	No	No	100% virgin – UV stabilised LLDPE (linear low-density polyethylene)

Appendix B Use of recycled plastics in traffic cones calculations

This Appendix outlines the supplier information and assumptions made, to inform the potential use case of RP traffic cones, as discussed in Section 3.2.

Number and size of traffic control companies

These calculations have been made using Victoria as an example. There are 300 prequalified traffic control companies here in Victoria ranging in size. There are 5-10 large companies and around 30-50 mid-size, with the remainder being small companies. Whilst this information is unavailable for Queensland and Western Australia, it is expected that there is a similar size industry in Queensland and around 50% smaller industry in Western Australia. For the basis of these calculations, it is assumed the number of traffic control companies is in the middle of the values quoted; i.e., 7.5 large companies and 40 mid-sized in Queensland and 3.75 large and 20 mid-sized in Western Australia. Small companies are excluded from these calculations as a reasonable estimate of new cones purchased per annum cannot be made.

Number of cones purchased in each state annually

A typical large traffic control company in Queensland purchases[1] around 1300 700mm and 180 900mm cones per annum. A typical large traffic control company in Western Australia purchases[1] around 300 700mm and 200 900mm cones per annum. An assumption is made that a mid-sized company purchases one quarter of the number of new cones per annum than a large company.

Mass of RP in a traffic cone

Based on supplier information, a 900 mm traffic cone base weighs approximately 7 kg and could be made from RP. A 700 mm traffic cone base weighs approximately 5 kg and could be made from RP. Table B.1 and Table B.2 outline the estimate annual use of traffic cones in Queensland and Western Australia, considering the above assumptions and the volumes of annual plastic waste generated as outlined in O'Farrell et al. (2021).

Table B.1: Estimated annual use of traffic cones in Queensland

	Number of cones	Number of companies	Total cones	Mass of RP (kg)	Total (kg)	Total (tonnes)
700 mm cones						
Large companies	1300	7.5	9750	5	48750	
Mid-sized companies	325	40	13000	5	65000	
Total	1625		22750		113750	113.75
900 mm cones						
Large companies	180	7.5	1350	7	9450	
Mid-sized companies	45	40	1800	7	12600	
Total	225		3150		22050	22.05
					Grand total	135.80
					% of annual diversion from landfill*	0.0222%

*610,900 tonnes plastic reaching end of life, 2019–20

[1] Based on figures from one large traffic control company that operates in Queensland and Western Australia.

Table B.2: Estimated annual use of traffic cones in Western Australia

	Number of cones	Number of companies	Total cones	Mass of RP (kg)	Total (kg)	Total (tonnes)
700 mm cones						
Large companies	300	3.75	1125	5	5625	
Mid-sized companies	75	20	1500	5	7500	
Total	375		2625		13125	13.13
900 mm cones						
Large companies	200	3.75	750	7	5250	
Mid-sized companies	50	20	1000	7	7000	
Total	250		1750		12250	12.25
Grand total						25.38
% of annual diversion from landfill*						0.0081%

*314,700 tonnes plastic reaching end of life, 2019–20

Appendix C Suitably Qualified Professional Report

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25 October 2022

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Attention: James Grenfell

SQP review – Task 8: Potential use of recycled waste plastics in temporary traffic management devices

1.0 Introduction

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by Australian Road Research Board (ARRB) to undertake a technical review of documents prepared by ARRB in relation to specific aspects or research work related to the recycled plastics research project (Investigating the use of recycled and reclaimed plastic in safe, sustainable future road infrastructure (Stage 2)).

This letter relates to review of the report prepared to address Task 8: Potential use of recycled waste plastics in temporary traffic management devices.

The purpose of Task 8 is as follows:

> *This task will review current products and providers of plastic temporary traffic management devices to understand performance requirements and capabilities. Investigate whether current products contain recycled content.*
>
> *Identify barriers to including or increasing recycled plastic content in temporary traffic management devices. Provide recommendations on safe and appropriate use of recycled plastics in temporary traffic management devices. Refine recycled plastic usage calculations on potential reclaimed and recycled plastic usage based on new knowledge developed in temporary traffic management devices.*
>
> *Undertake consultation with stakeholders to discuss potential options to refine implementation approach and procurement system to encourage incorporation of higher recycled content, e. g. acceptance processes for recycled plastic containing products and incentives to increase recycled plastic content in product*

The following report has been prepared by ARRB in relation to Task 8:

- Nicols, J. Williams, B., Yaghoubi, J., and Grenfell J., 2020. NACOE P120/ WARRIP-2021-016: Task 8 Potential use of recycled waste plastics in temporary traffic management devices. ARRB Project No.: 015430C/015611. Draft report, referred to as the **Task 8 report**.

The purpose of the work presented in this letter is as follows:

- undertake a review of the Task 8 report
- provide advice on any concerns over utilising temporary traffic management devices and other applicable products incorporating recycled plastics.

2.0 Qualification of author/SQP

This review has been undertaken by Dr Jackie Wright, Director of enRiskS. **Appendix A** presents a curriculum vitae for Dr Jackie Wright which demonstrates that she meets the requirements of a Suitably Qualified Professional (SQP) for the assessment of harm to human health and the environment.

3.0 Review comments

The Task 8 report was prepared for the Department of Transport and Main Roads Queensland (TMR), Main Roads Western Australia (MRWA) and the Australian Road Research Board (ARRB), under both the NACoE and WARRIP agreements. The focus of the report relates to the use of recycled plastic (RP) in temporary traffic management, road delineation and other control devices. These items include the following:

- Traffic cones
- Temporary Bollards
- Temporary signage backing
- Barriers
- Guideposts
- Temporary fence footings
- Noise walls.

These items have a short design life and limited structural requirements.

Table 2.1 provides a listing of the current standards that are applicable to the traffic management devices considered in the Task 8 report. The standards listed are Australian Standards that include specifications on aspects such as colour and structural integrity/requirements.

Table 2.2 provides a listing of traffic management devices that currently utilise RP in Australia. These devices encompass most of the devices listed above. The most commonly used RP in these materials is recycled PVC (used in the base of a number of items), or just 'recycled plastic' with no information on the composition of the RP materials included. Safety signs are indicated to include 70% recycled polypropylene. Noise walls have been identified to include LDPE and HDPE.

While this information is very helpful in understanding that existing devices are incorporating RP, it would be helpful to understand how long RP has been used in these devices, and if there are any issues with contamination in the RP materials provided for use in manufacture (in terms of the presence of other types of plastic in the RP waste stream provided or the presence of other, non-plastic materials). It is unclear if this information is available.

The Task 8 report identified a range of opportunities and barriers to the use of RP in the traffic management devices evaluated. The issues identified are relevant to the devices and ensuring the standards required to be met can be achieved with the inclusion of RP. The report has not specifically addressed whether the RPs used would be of concern in relation to human health or the environment.

4.0 Additional comments in relation to human health and the environment

As the proposed reuse scenarios are replacing virgin plastic with RP, it is expected that there would be no change in risk profile, in terms of human health and the environment.

None of the traffic management devices where RP is to be used are items that would be considered to be of greater concern in relation to consumer exposure. For example, the devices are not used as children's toys or in locations where children would be interacting with the materials during play. In addition, the devices are not in contact with food or agricultural products. As a result, the potential presence of chemicals present in RP, that may have been phased out of virgin plastics, such as phthalates, bisphenol A, brominated flame retardants, as well as some metals (such as lead, chromium and cadmium which were previously used as stabilisers and colorants in PVC) (Stenmarck et al. 2015) is unlikely to be of concern should they be present in the RP where used as proposed. European countries have evaluated ways to minimise or eliminate the presence of these older materials (that have the more hazardous chemicals) in RP for use in a range of products. However, the focus relates to materials with higher exposure potential (e.g., toys, food packaging etc) (Stenmarck et al. 2015), which is not relevant to the traffic management devices evaluated in the Task 8 report. While unlikely to be of concern for the proposed use in traffic management devices, opportunities to minimise the presence of older plastic materials that may include some of the additives of concern (noted above) in the RP materials used would be of benefit.

The use of RP in the traffic management devices proposed (particularly as most devices are temporary or used for short periods of time) is unlikely to result in the generation of microplastics. Where RP is used in noise walls the materials may be in the environment for a longer period of time. The durability of the plastic barriers is less clear and if left in the environment for extended periods of time, may degrade and result in some microplastics. There is no evidence that microplastics from recycled materials are more toxic to aquatic environments than virgin plastics (Jemec Kokalj et al. 2021). Hence, the use of recycled plastics is not expected to change the risk profile of these devices.

5.0 Outcome of review

The Task 8 report has provided an appropriate evaluation of the issues, opportunities and barriers to the use of RP in a range of traffic management devices.

It is not expected that the use of RP in traffic management devises would result in a different risk profile than the use of virgin plastics. However, where possible, opportunities to minimise the presence of older plastic materials that may include additives such as phthalates, bisphenol A, brominated flame retardants, as well as some metals (such as lead, chromium and cadmium which were previously used as stabilisers and colorants in PVC) in the RP used would be of benefit.

6.0 Limitations

Environmental Risk Sciences has prepared this report for the use of the Australian Road Research Board (ARRB), Main Roads Western Australia (MRWA) and the Queensland Department of Transport and Main Roads (TMR) in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in the **Section 1** of this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information provided for use in this assessment was false.

This report was prepared in March 2022 and finalised in October 2022. Environmental Risk Sciences disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

7.0 Closure

If you require any additional information or if you wish to discuss any aspect of this review, please do not hesitate to contact the undersigned on (02) 9614 0297.

Yours sincerely,

Dr Jackie Wright (Fellow ACTRA)
Principal/Director
Environmental Risk Sciences Pty Ltd

References

Jemec Kokalj, A, Dolar, A, Titova, J, Visnapuu, M, Škrlep, L, Drobne, D, Vija, H, Kisand, V & Heinlaan, M 2021, 'Long Term Exposure to Virgin and Recycled LDPE Microplastics Induced Minor Effects in the Freshwater and Terrestrial Crustaceans Daphnia magna and Porcellio scaber', *Polymers,* vol. 13, no. 5, p. 771.

Stenmarck, A, Belleza, EL, Fråne, A, Busch, N, Larsen, AM & Wahlström, M 2015, *Hazardous substances in plastics – ways to increase recycling, TemaNord 2017:505*, Nordic Council of Ministers, Denmark.

Attachment A: CV for Dr Jackie Wright

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Professional Profile

Jackie Wright has more than 30 years' experience in human health and ecological risk assessment in Australia. Experience includes leading and developing a national risk practice group for a major consultancy, training of staff, providing technical (and toxicological) direction, developing internal technical standards, participating in the development on industry guidance and standards, developing appropriate risk models and providing peer-review.

Areas of expertise include human and eco-toxicological review and evaluation of chemicals in line with Australian regulatory requirements, human health and ecological risk assessment, health impact assessment, impact of exposure to air and noise pollution, exposure modelling, indoor air quality assessment, fate and transport assessment, air dispersion modelling, environmental chemistry, environmental monitoring, and the assessment of air emissions and air toxics. Human health assessments have included a wide range of sites that involve the evaluation of emissions to air, waste sites, residential and recreation areas, operating industrial plants as well as other industrial plants that have been closed and are in the process of property sales or redevelopment and remediation. Ecological assessments have included screening level and detailed assessments of contamination, potential for contamination and remediation of contamination in soil and the aquatic environment. Risk assessments, ecological and human health, have been conducted for review by regulatory agencies (including Contaminated Land Auditors), with Jackie also providing expert support on both human health and ecological risk assessments (including detailed aquatic eco-toxicological assessments) for a number of Auditors in NSW, Victoria, South Australia, Western Australia and Queensland.

Jackie has been heavily involved in the development of national guidance and investigation levels as presented in the National Environment Protection Measure (NEPM) for Site Contamination (2013), CRC CARE Technical Guidance on Petroleum Vapour Intrusion and Silica-Gel Cleanup and Australian Crime Commission Assessment and Remediation of Clandestine Drug Laboratories (2011).

In addition, she has extensive experience in the assessment of vapour migration and intrusion, detailed evaluation of exposure by occupational, residential and recreational groups including the application of probability distributions to human health risk assessments. Jackie also been involved in a number of key projects that require regular risk communication with interest groups, including resident action groups.

- Toxicological (human and ecological) Review and Assessment
- Human Health Risk Assessment
- Environmental Risk Assessment
- Exposure Assessment and Modelling
- Occupational Exposure Assessment
- Clandestine Drug Laboratories
- Vapour Intrusion
- Indoor Air
- Health Impact Assessment
- Health impacts of air and noise pollution
- Environmental Chemistry, Fate and Transport
- Risk Communication
- Air Dispersion Modelling

Professional Accomplishments

Toxicology and Risk Assessment

- 2005 to 2022 (ongoing process of development and revision) - Prepared over 50 toxicity summaries for a range of chemicals relevant to the inclusion and assessment of these chemicals within human health and ecological risk assessments in accordance with Australian guidance. Toxicity summaries prepared provide detail on the chemical use, sources, exposures, chemical properties, ecotoxicity (terrestrial and aquatic), environmental fate and transport, health effects, review and identification of appropriate data relevant to acute and chronic exposures by the inhalation, oral and dermal routes, including assessment of carcinogenicity and genotoxicity. Range of compounds assessed includes particulate matter, petroleum compounds, chlorinated compounds, metals and more obscure industry-specific compounds. More specific, detailed review of arsenic dose-response has been undertaken based on current studies.
- 2014-2015 – conducting detailed toxicological review of TCE, particularly in relation to the quantification of inhalation dose-response.
- 2009 to 2013 – provided detailed toxicological review, determination of appropriate dose-response values, and derivation of proposed 2013 NEPM Soil Health Investigation Levels (HILs), including the interim soil gas HILs, and input into the petroleum Health Screening Levels (HSLs). The review included significant update and revision to Schedules B4 and B7 and involved incorporation of all comments from regulators, industry and the public.
- 2010 – provided detailed review of toxicological interactions, biomonitoring data and human exposure to metals (and metal mixtures) for a site in Tasmania.
- 2006 to 2022 (and ongoing) - Presentation and collaboration with regulatory bodies in Australia (New South Wales Environmental Protection Authority [EPA], New South Wales Department of Health and Victorian EPA) with regards to the approach adopted and information presented with toxicity summaries (addressing human health and aquatic toxicity where required) for key, high profile assessments.

Exposure and Risk Assessment (Human Health and General Environmental)

- 1992 to 2022 (ongoing) - Project management and evaluation of human health and environmental risks associated with over 350 contaminated sites in all states of Australia utilising national guidance that include NEPM, enHealth, ANZECC and NH&MRC guidance. Sites include operational sites as well as other industrial areas proposed for redevelopment for industrial, recreational or residential use. Most of the sites assessed are associated with petroleum contamination, chlorinated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and metals. Other sites include those impacted with dioxins, phthalates, PCBs and PFOS/PFOA.
- 1995 to 2022 (ongoing) - Detailed assessment and ongoing evaluation of risks to human health associated with contamination issues derived from the Orica Botany site in Sydney. A number of assessments have been undertaken over a period of 17 years and has involved detailed review of risks to residents (including groundwater extraction and use), workers and recreational users of a large area affected by the discharge of contamination in shallow and deep groundwater to surface water within a drain and an estuary, historically deposited sediments and volatile chlorinated compounds in air. The assessment of risk has been tied closely with ongoing monitoring with detailed exposure reviews, including the collection of additional data and ongoing review of methods, being undertaken for many key aspects of the project. The process required evaluation within context of the NEPM

(1999) and enHealth (2002) guidance with regular liaison with the NSW OEH, NSW Department of Health and independent reviewers.

- 2009 to 2015 - Derivation of national guidelines for the investigation and remediation of clandestine drug laboratories in Australia. The work involved the derivation of investigation levels, protective human health and the environment (terrestrial and aquatic), associated with former clandestine drug laboratories in Australia. Project required identification of key indicator compounds from over 200 base, intermediate and waste products that may be associated with over 20 different drug manufacturing methods. This required consideration of human health and environmental toxicity, behaviour/fate and transport in the environment and manufacturing methods. Guidelines were derived for indoor surface residues, indoor air, outdoor soil and the environment (local waterways and soil) for residential, commercial and recreational areas. The guidelines developed have been published by the Australian Government in April 2011. Further development of state guidelines, such as those from NSW Health have been undertaken to 2015.
- 2010 to 2022 – Detailed evaluation of community exposures and risks to PM10 and PM2.5 derived from urban (combustion) sources as well as crustal (mining) sources. A number of urban projects have been completed, including major road infrastructure projects such as NorthConnex, WestConnex M4 East, WestConnex New M5, WestConnex M4-M5 Link, F6 Stage 1, Western Harbour Tunnel and Beaches Link in NSW and West Gate Tunnel and North East Link in Victoria and rail infrastructure projects including the Moorebank Intermodal Terminal and Botany Rail Duplication in NSW and the Suburban Rail Loop East in Victoria. These infrastructure projects have involved the development and researching of appropriate methodologies for the assessment of particulate exposures, with particular focus on community exposures and risks. The work has also considered detailed assessments related to other criteria pollutants that include ozone, nitrogen oxides, sulphur dioxide, particulate matter and other combustion products (such as polycyclic aromatic hydrocarbons and volatile organic compounds). Projects have involved detailed review of current literature in relation to the health effects and the identification and use of appropriate dose-response relationships relevant to the quantification of relevant health endpoints, with consultation conducted with stakeholders, including state health departments and the community. Work undertaken for the West Gate Tunnel and North East Link project included the panel inquiry (presentation and attendance at the inquiry).
- 2018-2019 – Detailed assessment of particulate risks associated with power station emissions, including detailed critical peer review of public commentary papers as well as published papers and the available research underlying current understanding of health impacts from changes to particulate matter in urban and rural air environments.
- 2010 to 2021 – Detailed assessment of health impacts associated noise, as generated from major road or rail infrastructure or from aircraft noise. These assessments require an understanding of various noise guidelines, as well as current literature on the health effects of noise on the community. Assessments have included qualitative, semi-quantitative as well as quantitative assessments of risk and population incidence utilising published exposure-response relationships.
- 2016 to 2018 – Detailed assessment of roadway and tunnel design features to ensure public health is protected. This has included assessment of exposures to nitrogen dioxide and the build-up of carbon dioxide (in-cabin) in long tunnels, design of long tunnels to ensure public safety from fatigue and monotony and design of roadways to ensure flicker effects do not adversely affect road users.
- 2015 to 2020 – conduct of detailed human health and ecological risk assessments for a range of sites (in particular airport and defence sites) where PFAS issues are

of potential concern both on the site and in relation to offsite migration, discharge and exposure. Work has involved detailed evaluations and the development of site-specific guidelines and management measures within the context of a moving regulatory environment.

- 2020 to 2022 – Detailed assessment of risks to human health and the environment in relation to the proposed reuse of materials in road infrastructure (considered a wide range of materials proposed for reuse, in a variety of use scenarios).
- 2008 to 2014 - Detailed evaluation of human health and environmental issues associated with a former chlor-alkali plant. The assessment involved detailed evaluation of mercury fate and transport with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered environmental issues associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment, as well as issues associated with mercury (elemental and inorganic) in soil and groundwater with respect to fate and transport, human health and environmental issues.
- 2010 to 2015 (with ongoing advice to 2022) – Conduct of a detailed Health Impact Assessment in relation to major rail infrastructure development proposal at Moorebank. The HIA involved consultation with stakeholders, in particular local councils, NSW Health and the community, with all aspects of the proposal being address in relation to health impacts, both positive and negative. The HIA was peer reviewed by the University of NSW and an international expert. Ongoing advice relates to construction and operational management of PFAS.
- 2016 to 2018 – Literature review and assessment of community health impacts associated with landfill gas emissions, and emissions from water to energy facilities.
- 2018 to 2022 – Conduct of a number of detailed human health risk assessment or health impact assessments in relation to the proposed development of waste-to-energy facilities in NSW, Victoria and Queensland. A number of the projects have been approved.
- 2011 – Quantitative assessment of risks to human health associated with the placement of remediated soil that contains residual levels of radiological contamination, beneath a proposed commercial/industrial development in South Australia.
- 2011 to 2016 – Detailed evaluation and development of chemical risk assessments for a range of products/compounds utilised during coal seam gas operations in NSW and Queensland.
- 2017 to 2018 – Panel member on the WA Government Technical Enquiry on hydraulic fracturing.
- 2011 – Development of a detailed scope of works for the assessment and remediation of an abandoned asbestos mine in NSW. The works required collaboration between key stakeholders including NSW Health and the NSW EPA with the focus of the works on the protection of off-site community health.
- 2011 to 2014 – Assessment of risk issues associated with the presence of friable and bonded asbestos materials on a range of sites, proposed to be used for residential or commercial/industrial purposes. The assessments include consideration of risk management measures required, monitoring requirements and establishing site specific criteria relevant for the protection of construction workers and off-site residents (as required).
- 2010 – Detailed assessment of risks (including detailed assessment of toxicity of individual compounds and mixtures) to human health associated with the presence of nitrate, nitrite and perchlorate contamination in drinking water (international project).
- 2009 to 2022 (and ongoing) – Expert support for contaminated land Auditors

located in New South Wales, Victoria, Queensland, South Australia and Western Australia. Expert support has included review of human health and ecological risk assessments for a range of projects and issues.

- 2000 to 2022 - Detailed evaluation of risks to human health and the environment associated with redevelopment of large a number of gasworks sites in New South Wales and Victoria. Projects have involved the evaluation of the vapour migration pathway, including the collection of relevant soil gas and vapour emissions data to quantify exposure consistent with the proposed developments. The process required liaison with relevant site auditors, Vic EPA, SA EPA, NSW EPA and NSW Department of Health as required.
- 1995 to 2022 - Detailed evaluation, modelling and risk assessment of a number of landfill and waste depots in Australia (in New South Wales, Australian Capital Territory, Queensland and Victoria). This includes proposed waste destruction technologies, proposed waste depots and landfills, operational landfills, composting operations and closed landfills with assessments considering workers, residents and recreational users of the site and surrounding areas. Assessments undertaken have considered issues associated with the presence of a wide range of chemicals, landfill gas emissions, leachate generation and leaks, stormwater management, bioaerosols and other pathogens and bacteria.
- 1995 to 2022 (ongoing process as vapour issues are relevant for many projects) - Evaluation of vapour migration (and vapour intrusion) from numerous sources including contaminated soils and groundwater (dissolved phase and free phase) for many different chemicals, and subsequent assessment of human health risks associated with the estimated vapour concentrations. In addition, Jackie has developed and managed various techniques for the direct measurement of vapour migration in residential, recreational and industrial settings as part of the risk assessment process.
- 2009 to 2022 - Detailed evaluation of public health issues associated with recreational exposures to arsenic, lead and/or PAHs in surface soil in primary/secondary schools, sporting areas and children's playgrounds. Provision of technical advice along with appropriate general advice relevant for presentation to the public and responses to questions from the general public.
- 1995 to 2021 - Evaluation of human health risks associated with potential exposure to emissions from coal mining activities, including the assessment of potential risks and health effects associated with exposure to fine particulates.
- 1998 to 2009 - Evaluation of human health risks associated with the existence of and potential remediation of encapsulated scheduled waste materials located near residential and recreational areas. The assessment has involved ongoing monitoring, review of toxicity and exposures on an ongoing basis, review of remediation options and risks derived from the application of preferred remediation options. The encapsulation has now been remediated.
- 2007 to 2013 – Assessment of risks to human health and the environment associated with the re-use of water (including irrigation uses) from a groundwater treatment plant located in Sydney.
- 2000 to 2005 - Evaluation of human health risks associated with a number of contaminated sites located in Abu Dhabi, Spain and Azerbaijan. These risk assessments involved assessment of human health risks using USEPA guidance as well as WHO guidance.
- 2005 - Project management of large human health risk assessment associated with the redevelopment of explosives and munitions factories and firing ranges within various areas of NSW.
- 1995 to 1998 - Evaluation of human health risks associated with off-site accumulation of lead from historical deposition associated with a former operating lead paint site located within a residential area in Sydney. Project involved the

review of lead exposure and toxicity, identification and agreement to lead action levels relevant for residential properties located close to and further away from the former source.

- 1995 - Evaluation and coordination of a multi-pathway health risk analysis for a large contaminated site in Sydney involving the use of probabilistic risk assessment methodology.
- 2000 to 2005 - Conducting a feasibility assessment for a waste destruction facility in Sydney, using a probabilistic risk assessment methodology. Conduct of a detailed health risk assessment associated with the operation of the selected technology, including presentation to the Commission of Enquiry. Subsequent review of the process and exposures in relation to placing the facility within a rural area (as opposed to an urban area) and consideration of other multi-pathway exposures.
- 1993 - Assessment of risks to human health and the environment associated with sewage sludge incinerators at North Head and Malabar Sewage Treatment Plants.
- 1992 to 2022 (and ongoing) - Determination of preliminary remediation goals for numerous contaminated sites based on risk criteria.
- 1995 to 2022 (and ongoing) - Development of air sampling procedures and techniques to collect air data relevant to the further assessment of vapour migration pathways in a range of areas. This includes the collection of ambient air, soil gas data (active and passive and sub slab) and flux emissions.

Ecological Risk Assessment

- 1998 to 2022 (ongoing) - Derivation of risk-based criteria for a range of projects that are based on the protection of the aquatic environment. Evaluations have considered the potential for physical parameters (turbidity, pH, dissolved oxygen) and contaminants (principally metals, polycyclic aromatic hydrocarbons [PAHs], PFAS, petroleum compounds and chlorinated compounds). The evaluations include the potential for contaminants to leach from soil, migrate to groundwater and potentially discharge to a receiving environment (considered both marine and freshwater [including ephemeral] systems). Some of the assessments have required review and consideration of fate and transport modelling.
- 2009 to 2022 (ongoing) – Identification and derivation of investigation levels protective the terrestrial and aquatic environments associated with former clandestine drug laboratories in Australia. Ecological Tier 1 levels (based on available ecotoxicological data primarily from overseas studies) were identified and proposed for use in remediation guidelines with additional guidance provided in relation to sites where more detailed assessments of environmental risk issues needs to be conducted.
- 2010, 2011 and 2012 – Conduct (co-presenter) of lectures at the University of Sydney for the Risk Assessment (Human Health and Ecological) module for undergraduates, School of Geosciences. Ecological risk assessment lectures addressed basic principles and frameworks, stressors, fate and transport, bioaccumulation, uptake, derivation of ANZECC Guidelines, reviewing available ecotoxicological studies and conduct of statistical analysis using the CSIRO Burrlioz software for establishing water guidelines.
- 2010 to 2011 – Expert witness in relation to ecotoxicological impacts of initial works proposed for the Barangaroo site in NSW.
- 2010 - Assessment and derivation of water criteria for petroleum hydrocarbons relevant to the protection of the terrestrial and aquatic environments from the reuse of urban run-off for irrigation or a public park and associated runoff into a lake. Assessment required a detailed assessment of not only phytotoxicity, but levels at which grass growth would be affected to the extent by which grass cover on an important AFL playing field would be affected.

- 2009 to 2011 – Detailed review of screening level risk ecological assessment (supporting studies and outcomes) for the discharge of contaminated groundwater into a sensitive marine environment in South Australia. Review required detailed consideration of the local environment, consideration that appropriate ecological indicator species have been selected, consideration of the range of urbanisation stressors within the environmental and potential for groundwater discharges to result in adverse effects to the aquatic environment, over and above those from urbanisation.
- 2008 to 2010 - Detailed evaluation of environmental fate and transport issues associated with a former chlor-alkali plant. The assessment involved detailed evaluation of mercury fate and transport with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered ecotoxicological risks associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment.
- 1992 to 2022 (and ongoing) - Determination of preliminary remediation goals for numerous contaminated sites based on risk criteria. In relation to environmental risk issues, this has included the identification of appropriate and screening level criteria that are protective of fresh and marine environments and phytotoxic effects. Where necessary more detailed evaluations of ecotoxicological effects have been considered. This has included the design of suitable surveys and sampling programs (including microtox, microalgae, fish, crustacean, amphipod (sediments), plant and earthworm), interpretation of information and data from these studies, discussion of results with relevant regulatory parties, uncertainty analysis and reporting. These studies have been conducted for the assessment of petroleum hydrocarbon, cyanide, inorganics, ammonia, chloride, phosphorous and nitrate concentrations in soil and discharges from groundwater.
- 2000 to 2008 - Detailed evaluation of risks to human health and the environment (particularly aquatic species and sediments) associated with redevelopment of large a number of gasworks sites in New South Wales and Victoria. The project in NSW involved collaboration with sediment experts to determine the nature and extent of sediment contamination, potential for adverse ecotoxicological effects and requirements for remediation. The process required liaison with relevant site auditors and the DECCW (formerly NSW EPA) as required.
- 2007 - Assessment of risks to terrestrial and aquatic (marine water) environments associated with the re-use of water from a groundwater treatment plant located in Sydney. Water is proposed to be reused for a range of proposes that include industrial water (where it may be directly discarded to the marine environment) and irrigation where the water may affect terrestrial species and runoff may enter local water ways. The assessment considered available ecotoxicological data and guidelines available from Australian and International studies (where relevant to Australian species).

Contaminant Transport

- All of the projects listed above have involved the assessment of contaminant transport in at least one media. More specific examples are listed below:
- Vapour partitioning and transport assessed for petroleum compounds, including the development of a national database of petroleum vapour data, related to over 300 petroleum impacted sites, and detailed review of the database in conjunction with technical specialists from the USEPA. The database developed has been peer-reviewed by the USEPA and has been incorporated into the USEPA technical review of data from both the US and Australia for the purpose of determining screening distances;
- Vapour partitioning and transport assessed for chlorinated compounds at

numerous contaminated sites, including the assessment of vapour risk issues at the Orica Botany site from 1994 to 2018;

- Review and use of groundwater fate and transport modelling conducted in support of numerous detailed risk assessment outcomes. Reviews have been conducted for the purpose of ensuring these models adequately address the potential movement of contaminants from a source to a point of discharge, utilising appropriate inputs and site data;
- 2008 to 2014 - Detailed evaluation of mercury fate and transport in groundwater and air (mercury vapour) with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered environmental issues associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment, as well as issues associated with mercury (elemental and inorganic) in soil and groundwater with respect to fate and transport, human health and environmental issues.

Air Emissions and Vapour Assessment

- Jackie Wright is experienced in all aspects of determining air quality, including monitoring, assessing and modelling soil gas, vapour emissions and emissions from stacks and other fugitive sources. Projects include analysing dust emissions from a number of quarries and coal mines, motor vehicle emissions; modelling vapour emissions from motor vehicles and sources such as creeks, ponds and waste areas; and assessing odour emissions from sewage treatment plants.
- 2012 to 2013 – Development of petroleum vapour intrusion guidance for Australia in conjunction with CRC CARE. The project has involved the development of clear, prescriptive guidance that incorporates current science on the assessment of petroleum vapour intrusion. The guidelines being developed have been presented at a series of PVI training workshops (supported by ALGA and CRC CARE) run in Sydney, Melbourne and Perth.
- 2009 to 2022 (ongoing) - Development of a petroleum vapour database to assist in the interpretation and understanding of the behaviour of petroleum vapours in the subsurface environment. The database is unfunded and independent and has been interpreted by Jackie as well as industry experts in Australia and the US. The database has been peer-reviewed by the USEPA, and incorporated into the USEPA publication on the use of field data (from the US, Canada and Australia) to support and develop vertical exclusion/separation distances (refer to the following website for the USEPA review and access to the database developed: http://www.epa.gov/oust/cat/pvi/). This data is being used to support the development of screening distances that are being incorporated into guidance being developed in Australia and the US.
- 2005 to 2022 (ongoing) - Preparation of conceptual site models and completing screening level modelling (using published models such as Johnson & Ettinger) for the assessment of vapour migration and intrusion issues on a wide range of sites (over 200) affected by petroleum and chlorinated hydrocarbons.
- 2010 to 2022 – Detailed evaluation of community exposures and risks to PM10 and PM2.5 derived from urban (combustion – associated with road and rail infrastructure) sources as well as crustal (mining) sources. A number of urban projects have also considered community exposures and risks to other criteria pollutants that include ozone, nitrogen oxides and sulphur dioxide. Projects have involved detailed review of current literature in relation to the health effects and appropriate dose-response relationships relevant to the quantification of relevant health endpoints, with consultation conducted with stakeholders, including state health departments.
- 1995 to 2022 (ongoing) - Development of methods and approaches for the sampling and assessment of vapour (e.g. soil gas, flux emissions, indoor and

ambient air). Works conducted has involved the conduct of field activities for the purpose of collecting this data.

- 1995 to 2022 (ongoing) - Interpretation and assessment of vapour data for the purpose of characterising inhalation exposures in a range of scenarios. These include existing buildings and proposed developments.

Risk Communication

- 2000 to 2022 (ongoing) - Jackie Wright has experience in the preparation and presentation (communication) of risk outcomes from a number of key projects across Australia to a range of community groups. These groups include workers and unions, residents and community action groups. Successful communication with stakeholders and the community on controversial projects including infrastructure, coal seam gas and other mining projects has been required.

Air Quality Assessment

- 1990 to 1995 – Air dispersion modelling and air quality impact assessment conducted for various mining (coal mining and quarry activities) and transport (major roadways) in NSW and Victoria. Projects included the development of emissions inventories, setting up and running air dispersion models and reporting.
- 2011 to 2015 - Air dispersion modelling conducted for the assessment of exposures (and risks to human health) to crop, grain and timber fumigants. The assessment have been undertaken based on trial data, with scaling to address commercial application.
- 2010 to 2018 - Air dispersion modelling conducted for the assessment of exposures (and risks to human health) to grain fumigants, timber fumigants, hydrogen sulphide, chlorinated compounds, silica and dust (particulate) emissions from a range of facilities. Modelling has been conducted using Screening level and mode detailed Ausplume and Calpuff dispersion modelling packages.
- 2010 to 2021 - Review of air dispersion modelling undertaken for a range of projects. The reviews have been undertaken to determine if the assessments are adequate for the purpose of understanding and characterising community health impacts. In some cases the review has been undertaken as part of a larger assessment of public health impacts. Projects have included communication of the air quality assessment and health impact assessment to community groups.

Noise Impact assessment

- 2019 to 2022 - Systematic review of health impacts of transport noise for Waka Kotahi NZ Transport Agency in New Zealand. The work has involved a detailed systematic review of the evidence in published and grey literature in relation to the health effects of transport noise (road, rail and air) and whether the evidence is sufficient to support quantification of health impacts using exposure-response functions. The review has considered recent literature and the GRADE system of review to establish the robustness of the available publications and strength of evidence. This review considered the most recent reviews completed by the WHO and enHealth in 2018.
- 2014 to 2021 - Detailed Evaluation of Community Exposure and Risk to impacts associated with transport infrastructure projects for Transport for NSW and Transurban/Western Distributor Authority/ North East Link Authority in Victoria, Australia. Health impact assessments have included a detailed assessment of impacts from noise during construction and operation. This included a detailed review of current science in relation to health impacts of construction noise, as well as road transport noise sources. In some assessments quantitative risk assessment was required to be undertaken to address impacts on community

health. Projects have included: NorthConnex (road - NSW); WestConnex projects - M4 East, New M5, M4-M5 Link (road - NSW); F6 Stage 1 (road - NSW); Gateway project (road and rail – NSW); Western Harbour Tunnel and Beaches Link (road - NSW); West Gate Tunnel (road -Victoria); North East Link (road – Victoria).

- 2016 to 2017 - Brisbane Airport Corporation, Queensland, Australia. Conduct of a review of the health impacts of aircraft noise as these relate to the identification and use of exposure response relationships for assessing health impacts, particularly related to flight paths near major airports.

Expert Witness

- Long Term Containment Facility at Nowingi, case presented in VCAT. The proponent was Major Projects Victoria, approvals application WA58772.
- Lend Lease (Millers Point) Pty Ltd and Orsats Australians for Sustainable Development Inc., Land and Environment Court Proceedings, 40965 of 2010 (NSW).
- Seppanen&Seppanen v Ipswich City Council, Minister for Economic Development Queensland and Queensland Urban Utilities (2016).
- Westgate Tunnel Project, Expert Witness, Inquiry and Advisory Committee (IAC) hearings (Victoria, August-September 2017).
- Child care centre project, Provision of advice as expert witness for ACT Government Solicitor (2017).
- Caltex Petroleum Pty Ltd v Campbelltown City Council Environment, Resources and Development Court Proceedings No 258 of 2015 (2017 to 2019) (SA).
- North East Link Expert Witness, Inquiry and Advisory Committee (IAC) hearings, Expert Witness (Victoria, 2019).
- Clermont Quarries Pty Ltd v Isaac Regional Council, ECL Dalby Pty Ltd, Chief Executive, Department of State Development, Manufacturing, Infrastructure and Planning and Environment Court (Qld), Expert witness (2019 - 2020).

Teaching

- 2010 to 2012 – Conduct of lectures at the University of Sydney for the Risk Assessment (Human Health and Ecological) module for undergraduates, School of Geosciences.
- 2009, 2010, 2012, 2013 to 2021 – Conduct of lectures at the University of Technology Sydney as part of the Contaminated Site Assessment and Management (CSARM) Professional Development Short Course, Risk Based Site Assessment.
- 2020 and 2022 – Toxicological Risk Assessment lecture to UNSW School of Business.
- 2017 – ALGA Risk Assessment Training Course: New Zealand
- 2014 – ACLCA (Qld) Training Course on Vapour Intrusion and Landfill Gas Assessment (organising and teaching) – May 2014
- 2014 and 2015 – ACLCA (SA and VIC) Training Course on Vapour Intrusion (teaching) – June 2014.
- 2013 and 2015 – ALGA Training Course on Vapour Intrusion (teaching).
- 2013 and 2015 – Vapour Intrusion Short Course. Training Course conducted at CleanUp 2013 and 2015, CRC CARE (teaching).
- 2016 – Clandestine laboratories – risk assessment (teaching) ALGA and ACTRA (separate workshops)
- 2014-2018 – Short courses/branch forums for ALGA – various issues regarding PFAS assessment, vapour intrusion, bioaccessibility methods, clandestine laboratories

- 2016 and 2018 – Short course for WasteMINZ – bioaccessibility methods
- 2010-2011 – Basic and Advanced Risk Assessment Course for Queensland Branch of the Australian Contaminated Land Consultants Association

Work History

Principal/Director/ Owner	Environmental Risk Sciences Pty Ltd	2008 (current)
Adjunct Lecturer	Flinders University	2016 (current)
Principal Environmental Scientist	URS Australia, North Sydney, NSW (formerly Woodward-Clyde)	1992 to 2008
Project Engineer	Sydney Water, Sydney, NSW	1991-1992
Environmental Scientist	Nigel Holmes & Associates, Sydney NSW	1990-1992
Assistant	Dames & Moore, Crows Nest, NSW	1988-1990

Education

BE (Hons)	University of Sydney, Bachelor of Engineering (Hons)	1989
PhD	Public Health, Health and Environment, Flinders University	2016

Professional Accreditation

Fellow of the Australasian College of Toxicology and Risk Assessment (ACTRA)

Professional Development

American College of Toxicology - Virtual Advanced Comprehensive Toxicology Online training course (25 modules) (2021)

Invited member of task force - WA EPA scientific inquiry into fracking in WA (2018)

Clandestine laboratory safety and investigator training and synthesis run by the Clandestine Laboratory Investigators Association (8-hour course, 2011)

Ecological Risk Assessment Course run through AEHS and credited by University of Massachusetts Boston (2010)

Mid-America Toxicology Course (35 hours, 2010)

Dose-Response Boot Camp run by Toxicology Excellence for Risk Assessment (TERA) (5 day course, 35 hours, 2008)

Vapor Intrusion Assessment and Mitigation Short Course run by Air & Waste Management Association (4 hours, 2006)

USEPA Human Health Risk Assessment Short Course (24 hours, 1995)

Affiliations

Member (former committee member, remains co-opted committee member), Australasian College of Toxicology and Risk Assessment (since 2007).

Member, Australian Land and Groundwater Association (since 2010).

Clean Air Society of Australia and New Zealand (re-joined 2015)

Member, Environmental Health Australia (since 2011).

Member, SETAC (Asia Pacific) (since 2011).

Member, Air & Waste Management Association (since 2006).

Member, Society for Risk Analysis (since 1997).

Member, Association for Environmental Health and Sciences Foundation (since 1997).

Awards

2020: Winner of Best Case Study (principal author), Australia New Zealand Policing Advisory Agency and National Institute of Forensic Science

2017: Winner of Best Case Study (principal author), Australia New Zealand Policing Advisory Agency and National Institute of Forensic Science

2017: Winner of ALGA Outstanding Leadership by a Woman in the Contaminated Land & Groundwater Industry

2017: Finalist of ALGA Outstanding Individual in the Contaminated Land & Groundwater Industry

Publications

Peer-reviewed journal articles:

Kuhn, E.J., Walker, G.S., Whiley, H. Wright, J. and Ross, K.E., 2021. Overview of Current Practices in the Methamphetamine Testing and Decontamination Industry: An Australian Case Study. International Journal of Environmental Research and Public Health 18, 8917.

Wright, J., B. Symons, J. Angell, K. E. Ross and S. Walker, 2021. Current practices underestimate environmental exposures to methamphetamine: inhalation exposures are important. Journal of Exposure Science & Environmental Epidemiology 31: 45-54.

Kuhn, E.J., Walker, G.S., Wright, J., Whiley, H. and Ross, K.E., 2021. Public health challenges facing Environmental Health Officers during COVID-19: methamphetamine contamination of properties. Australian and New Zealand Journal of Public Health, 45: 9-12.

Wright, J., M. Kenneally, K. Ross and S. Walker, 2020. Environmental Methamphetamine Exposures and Health Effects in 25 Case Studies. Toxics 8 (3): 61.

Wright, J., G. S. Walker and K. E. Ross, 2019. Contamination of Homes with Methamphetamine: Is Wipe Sampling Adequate to Determine Risk? International Journal of Environmental Research and Public Health 16 (19): 3568.

Kuhn, E. J., G. S. Walker, H. Whiley, J. Wright and K. E. Ross, 2019. Household Contamination with Methamphetamine: Knowledge and Uncertainties. International Journal of Environmental Research and Public Health 16(23): 4676.

Capon, A. and J. Wright, 2019. An Australian incremental guideline for particulate matter ($PM_{2.5}$) to assist in development and planning decisions. Public Health Research & Practice 29 (4).

Wright, J., Kenneally, M. E., Edwards, J.W. and Walker, S., 2017. Adverse Health Effects Associated with Living in a Former Methamphetamine Drug Laboratory — Victoria, Australia, 2015. Morbidity and Mortality Weekly Report (MMWR) January 6, Vol.65, No. 52, p1470-1473

Wright, J., Edwards, J. and Walker, S., 2016. Exposures associated with clandestine methamphetamine drug laboratories in Australia. Reviews on Environmental Health.

Lahvis, M.A., Hers I., Davis, R.V., Wright, J. and DeVaull G.E., 2013. Vapor Intrusion Screening at Petroleum UST Sites. Groundwater Monitoring & Remediation.

Wright J. and Howell M., 2003. "Volatile Air Emissions from Soil or Groundwater – Are They as Significant as Model Say They Are?". In Contaminated Soils, Volume 8, Edited by Edward J. Calabrese, Paul T. Kostecki and James Dragun, p375-393.

Gorman J., Mival K., Wright J. and Howell M., 2003, Developing Risk-Based Screening Guidelines for Dioxin Management at a Melbourne Sewage Treatment Plant. Water, Science and Technology, Vol 47 No 10, pp 1-7.

Wright J., and Howell M., 1995, "Health Risk Assessment - Practical Applications Related to Air Quality Issues". Clean Air, Volume 29, No. 2, May 1995.

Government and industry publications:

Environmental Health Australia, 2019. Australian Voluntary Code of Practice, Assessment, remediation and validation: Former clandestine drug laboratories and other methamphetamine contaminated properties. Principal author.

CRC CARE, 2018. Weathered Petroleum Hydrocarbons (Silica Gel Clean-up), CRC CARE Technical Report no. 40, CRC for Contamination Assessment and Remediation of the Environment, Newcastle, Australia. Principal author.

CRC CARE, 2013. Petroleum Vapour Intrusion (PVI) Guidance. CRC Care Technical Report No 23, CRC for Contamination Assessment and remediation of the Environment, Adelaide, Australia. Principal author.

NEPM 2013 Revision (released in 2013), Schedule B4 (Guideline on Site-Specific Health Risk Assessment Methodology) and Schedule B7 (Guideline on Derivation of Health-Based Investigation Levels). Primary author of toxicological evaluations and derivation of health investigation levels and contributing author to the Schedules (conducting full revision/rework of both Schedules, including responding to public comments and comments from state health agencies).

Australian Government, 2011. Guidelines for Environmental Investigations, Remediation and Validation of former Clandestine Drug Laboratory Sites [Guidelines], April 2011. Primary author of toxicological evaluations and derivation of remeidation guidelines using risk based approach and listed contributor to main document.

Davis G.B., Wright J. and Patterson B.M., 2009. Field Assessment of Vapours, CRC CARE Technical Report no. 13, CRC for Contamination Assessment and remediation of the Environment, Adelaide, Australia.

Invited lectures

Wright, J. 2020 to 2022. Toxicological risk assessment. Guest lecture to University of New South Wales School of Business.

Wright, J., 2013. Petroleum Vapour Intrusion Guidance in Australia. AEHS 23rd Annual International Conference on Soil, Water, Energy, and Air and AEHS Foundation Annual Meeting, March 18-21, 2013, Mission Valley Marriott, San Diego, California. Invited lecture

Wright, J., 2012. Evaluation of the Australia Hydrocarbon VI Data Base: Exclusion Criteria. AEHS 22nd Annual International Conference on Soil, Water, Energy, and Air and AEHS Foundation Annual Meeting, March 19-22, 2012, Mission Valley Marriott, San Diego, California. Invited lecture.

Conference Proceedings (Oral Presentations):

Wright, J. (2021) Weathered Petroleum – Assessing the toxicity of polar metabolites vs petroleum hydrocarbons. ACTRA Annual Scientific Meeting, Sydney 26-27 August 2021

Wright, J. (2021) Risk Assessment and CSMs? Presentation to ACLCA – Western Australian branch meeting

Wright, J. (2020) Clan labs and meth contaminated properties - Risks and issues. Environmental Health Australia, Professional Development Workshop

Wright, J. and Manning, T. (2020) Basements, Really, you thought THAT was a good idea !!!!. ALGA Ecoforum 2020

Wright, J. (2020) Attenuation Factors and VI. ACLCA Webinar, 29 April 2020

Wright, J. and Manning, T. (2020) Chlorinated Hydrocarbons - Myths and Realities. ACTRA webinar (industry training) 27 February 2020

Wright J. and Stratford, M. (2020) Methamphetamine Risk Management Industry Voluntary Code of Practice. ACTRA webinar (industry training) 20 February 2020

Wright, J. and Manning, T. (2018) Perplexing guidelines: What it means for measurement, RACI PFAS Symposium, November 2018

Wright, J. (2018) Contrasting current contamination issues: Inside the home – methamphetamine, ALGA Regional Conference, Townsville October 2018

Wright, J. (2018) Contrasting current contamination issues: Outside the home – PFAS, ALGA Regional Conference, Townsville October 2018

Capon, A. and Wright, J. (2018) An Australian incremental guideline for particulate matter less than or equal or 2.5 micrometres (PM2.5). ACTRA Conference, October 2018

Manning, T. and Wright, J. (2018) Contaminated Land Risk Assessment and the Building Code of Australia, Ecoforum October 2018

Jarman, R., Wright, J., Manning, T. and Pendergast, D. (2016). Using oral bioaccessibility testing to refine exposure assessment for carcinogenic PAHs in soil. EcoForum, October 2016.

Manning, T., Wright, J., Jarman, R. and Bowles, K. (2016) Per and poly fluorinated alkyl substances – where are we, ecologically speaking? SETAC AU October 2016.

Jarman, R., Manning, T., and Wright J. (2016). Setting toxicity reference values for PFAS – what can we learn from TOXCAST and TOX21. ACTRA Annual Scientific Meeting, September 2016.

Manning, T., Wright, J., Jarman, R. and Bowles, K. (2016) Per and poly fluorinated alkyl substances – the Australian Story. EmCon 2016 September 2016.

Manning, T. and Wright, J. (2016). Particulate Risk Assessments – Issues and Challenges. EcoForum, October 2016.

Manning, T. and Wright, J. (2015). Review of Ecological Investigation Levels for Total Petroleum Hydrocarbons. 6th International Contaminated Site Remediation Conference (Cleanup 2015), September 2015.

Manning, T. and Wright, J. (2015). Particulate Risk Assessments – Issues and Challenges. 22nd Clean Air and Environment Conference, September 2015.

Wright, J. and Manning, T. (2015). Bioavailability/Bioaccessibility – Practical Considerations. ALGA Workshop, Use of Bioavailability and Bioaccessibility Techniques to Refine Assessment of Human Health Risk, November 2015.

Wright, J. and Manning, T. (2015). PAHs and Bioaccessibility. ALGA Workshop, Use of Bioavailability and Bioaccessibility Techniques to Refine Assessment of Human Health Risk, November 2015.

Manning, T. and Wright, J. (2014). Contaminated Land – How do environmental guidelines get used? SETAC-AU Conference Adelaide September 2014.

Manning, T. and Wright, J. (2014). Use of Health Impact Assessment in Environmental Impact Statements. Ecoforum Conference Gold Coast October 2014.

Wright J., 2014. Particulate Risk Assessments – Issues and Challenges. ACTRA Annual Scientific Meeting, Sydney October 9-10 2014.

Wright J. and Manning T., 2014. Health Impact Assessment – Role in EIS. Keynote presentation. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J. and Manning T., 2014. Addressing Risk Perceptions through Risk Assessment. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J. and Manning T., 2014. Vapour Assessment for TCE. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J., Howell J. and Newell P., 2014. Assessment and Remediation of Illegal Drug Laboratories. Ecoforum, 29-31 October 2014, Gold Coast.

Wright, J., 2014. Clandestine Drug Laboratories – Understanding Exposures and Public Health. The Second International Conference on Law Enforcement and Public Health, Amsterdam 5-8 October 2014.

Wright, J. 2014. ASC NEPM – Implementation. AEBN (Australian Environment Business Network) Conference on Managing Contaminated Land, September 2014.

Wright, J. 2014. Managing Vapours – The Issues to Consider for Developers and Councils. AEBN (Australian Environment Business Network) Conference on Managing Contaminated Land, September 2014.

Wright, J., 2012. Exposure and Risk Issues associated with Clandestine Drug Laboratories – development of guidelines. British Occupational Hygiene Society (BOHS), Occupational Hygiene 2012 Conference, 24-26 April 2012, Mercure Holland House Hotel, Cardiff.

Wright, J., 2012. Risks of Not remediating Clandestine Drug Laboratories. 66th Annual Western Australian Environmental Health Australia (WA) State Conference Environmental Health: Imagine Life Without Us, 28-30 March 2012.

Wright, J, 2011. Establishing exclusion criteria from empirical data for assessing petroleum hydrocarbon vapour intrusion. CleanUp 2011: Proceedings of the 4th International Contaminated Site Remediation Conference, 11-15 September, Adelaide, Australia.

Wright, J., 2010. Review of Petroleum Vapour Data from Australia. Abstract presented at Ecoforum 2010, 3rd ALGA Annual Conference 23-24 February 2010.

Wright, J., 2010. Interpretation and Use of Soil Gas and other Vapour Data. Abstract presented at Ecoforum 2010, 3rd ALGA Annual Conference 23-24 February 2010.

Weaver T., Hassell T., Wright J., Stening J. and Apte S., 2009. Speciation and Geochemical Modelling as a Tool to Refine a Risk Assessment for Mercury in Groundwater. Presented at EcoForum, Sydney 28-30 April 2009.

Wright J. and Robinson C., 2009. The Reality of Sampling and Assessing Vapour Intrusion on Petroleum Sites. Presented at Air &Waste Management Association's Vapor Intrusion 2009, January 27-29 2009, San Diego CA.

Wright J., Lee A. and Howell M., 2008. Role of Risk-Based Concentrations in Assessment and remediation of Contaminated Sites. Presented at EcoForum, Gold Coast, 27-29 February 2008.

Wright J., Howell M. and Barnes J., 2006. Risk Assessment – Important Tool for Managing Issues on Contaminated Sites or Just a Task. Presented at Enviro06, Melbourne 2006.

Hall, A, Wright J. and Calabrese N, 2006. Ray Street Landfill – Audit Acceptance Levels for CO_2 in Redeemed Soils. Presented at Enviro06, Melbourne 2006.

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