AUSMAP

AUSTRALIAN MICROPLASTIC ASSESSMENT PROJECT

'A Dive into Australia's Rubber Crumb Issue'

Webinar Q&A Summary

August 2023

AUSMAP Rubber Crumb Webinar Fact Sheet

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AUSMAP
Australian Microplastic Assessment Project
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Note: This is not an exhaustive literature review, but highlights key developments in research on this topic. Resources are hyperlinked, and where possible, open access links have been provided.

WHAT IS RUBBER CRUMB?

- Rubber crumb, known as crumb rubber, tyre crumb, rubber mulch and rubber granules, is comprised primarily of rubber polymer (40-60%), and combined with reinforcing agents (20-35%), aromatic extender oils (~20%), vulcanisation additives (~4%), antioxidants (~1%) and processing agents (<1%) https://mel2.xmu.edu.cn/member/upload_paper/2016715153525-jENMJB.pdf **(2010)**
- The crumb is produced through a range of shredding processes that mechanically fracture tyre material including: ambient grinding, wet grinding, cryogenic grinding and ozone cracking https://expert.taylors.edu.my/file/rems/publication/108021_9043_1.pdf **(2021)**
- Rubber crumb granules are < 5mm in size and are considered referred to as 'microplastics'. https://www.nature.com/articles/s41598-022-10691-1 **(2022)**

POTENTIAL FOR HUMAN HEALTH IMPACTS

- **Release of Polycyclic Aromatic Hydrocarbons and Heavy Metals from Rubber Crumb in Synthetic Turf Fields: Preliminary Hazard Assessment for Athletes (Marsili et al. 2014).**
  - Estimated the risks for athletes inhaling polycyclic aromatic hydrocarbons (PAHs) at high temperatures often reached by synthetic sports fields.
  - Highlighting that at an ambient **air temperature of 26 degrees**, synthetic **surfaces can reach 60 degrees celsius.**
  - Evaporation tests demonstrated that four PAHs did not decrease over time which suggests chronic effects on surface users may be possible.
  - ***Conclusion***: the effect of these substances on human health is **not negligible**.

- **Evaluation of potential carcinogenicity of organic chemicals in synthetic turf rubber crumb (Perkins et al. 2019)**
  - Using an Absorption, Distribution, Metabolism, Excretion and Toxicity (ADMET) Predictor, it was determined that of the **306 chemicals in rubber crumb, 197 met the theoretical criteria for carcinogens**.
  - Many of these chemicals were known carcinogens, and many were associated with high cancer risk.

- **Comprehensive multipath way risk assessment associated with recycled ("crumb") rubber in synthetic fields (Peterson et al. 2019)**
  - Conducted a review of all available North American data on the chemical composition of recycled rubber and air sampling data collected from synthetic turf fields.
  - Different exposure scenarios for adults, adolescents and children were considered.
  - Conclusion demonstrated **negligible risks to human health**.

- **ERASSTRI - European Risk Assessment Study on Synthetic Turf Rubber Infill - Part 2: Migration and Monitoring Studies (Schneider et al. 2020)**
    - Investigation of the bio accessibility of substances in rubber crumb infill from synthetic sports fields.
    - The study found that some PAHs, aluminium, cobalt, benzothiazole, tert-butylamine, MIBK, 4-tert-octylphenol, bisphenol A, and the phthalates DINP and DEHP were found in some samples of sweat from athletes on synthetic turf fields.
    - Bio accessibility varied between substances with high migration rates obtained for benzothiazole compounds, amines (**6PPD**, DPG) and MIBK and cyclohexanone.
    - Aluminium was the only material detected from skin swipe samples of 43 people.
    - These findings are significant to estimate oral and dermal exposure of field users.

- **Global Evaluation of the Chemical Hazard of Recycled Tire Crumb Rubber Employed on Worldwide Synthetic Turf Football Pitches (Armada et al. 2022)**
    - Analysed rubber crumb samples from 91 synthetic football fields from 17 countries across 4 continents - **this is the largest study to date on hazardous chemicals in rubber crumb.**
    - PAHs, plasticisers and vulcanisers were found in all samples. Of the **PAHs, eight that are considered carcinogens and have been banned by the European Chemicals Agency were found in most samples.**
    - Infill consisting of rubber crumb is considered a microplastic.
    - Recommends cork as an alternative.

Potential Environmental Impacts

There are limited studies on the impacts of these materials and/or leachate. What has been produced is mostly conducted outside Australia.

- **The Response of Earthworms (*Eisenia fetida*) and Soil Microbes to the Crumb Rubber Material Used in Artificial Turf Fields (Pochron et al. 2017)**
    - Examined the response of earthworms and soil microbes to rubber crumb in artificial turf fields.
    - Soil contaminated by rubber crumb contained concentrations of heavy metals.
    - No effect was observed on earthworm survivorship or stress response; however, weight gain was reduced by 14%.

- **Car Tire Crumb Rubber: Does Leaching Produce a Toxic Chemical Cocktail in Coastal Marine Systems (Halsband et al. 2020)**
    - Examined the effect of leaching chemicals from tyre road wear particles (TRWP) on copepods (small crustaceans) in coastal marine systems.
    - Benzothiazole (a common vulcanisation agent in rubber production) and heavy metals, including zinc, leached from TRWP.
    - Marine Copepods exposed at high concentrations demonstrated high mortality in 48 hours, though some species were more tolerant.

- **A Ubiquitous Tire Rubber-derived Chemical Induces Acute Mortality in Coho Salmon (Tian et al. 2021)**
  - Regular acute mortality events observed in Coho Salmon in the Western United States. These were thought to be stormwater runoff related.
  - Demonstrated widespread occurrence of 6PPD-quinone from TRWP which is used to prevent tyre damage from ozone.
  - "Measurements from road runoff and immediate receiving waters show concentrations of 6PPD-quinone high enough to account for the acute toxicity events."

- **Unpublished data (Wilson, AUSMAP) has indicated that leachate from rubber crumb is toxic to both freshwater and marine species down to approximately 3% of the leachate.**
  - Rubber crumb was leached for 18 hours.
  - Acute toxicity tests conducted with 1 freshwater and 2 marine species.
  - This toxicity was likely due to high zinc concentrations.

Chief Scientist Report Summary – NSW Context

The NSW Chief Scientist's report was released in early 2023 and highlighted current knowledge and gaps on the impacts of synthetic turf fields. Key findings are summarised below with page numbers listed.

- **There are 181 synthetic turf sports fields in NSW, a sharp increase from 24 in 2014 and 30 in 2018** (p. 4).
- Many sports fields are now importing rubber crumb which is not **subject to standards. The composition of materials in tyres unknown for those imported (pre-shred)** (p. 5).
- **Methods by which infill is travelling off fields:**
  - Transportation on field-users clothing and shoes
  - Runoff during rainfall events
  - Maintenance vehicles or equipment
  - Removal with leaves
  - Wind
  - 'Splash' from play (p29).
- **Concerns for Human Health:**
  - **The EU has brought in restrictions on 8 identified carcinogenic PAHs** (Polycyclic aromatic hydrocarbons), while the **US EPA has designated 16 PAHs as chemicals of concern (p. 42).**
- **Environmental Concerns:**
  - The Report estimated that a synthetic turf field without structures to mitigate infill loss may lose tens to hundreds of kilograms of infill per year into nearby waterways and stormwater. Turf fibre loss alone could "be in the 100s of kilograms per year," and this value may be higher depending on field age and maintenance (p. 6).
  - Life spans of these surfaces may be reduced within the Australian climatic context whilst volumes of loss may increase (p. 5).
  - Impacts of rubber crumb and leachates are poorly studied, however laboratory studies have highlighted negative impacts on indicator species (p. 53).
  - Zinc leachate from the vulcanisation process in rubber crumb, has been found in runoff and exceeds the guidelines for freshwater ecosystems. Concentrations of Zinc are highest in Styrene Butadiene Rubber infill which is most commonly used in Australia (p. 50)

- **Surface alternatives: Organic Infill**
    - Organic options are typically more costly (p. 32).
    - Many, including cork, can require fungicides, herbicides or antimicrobial agents which can leach into the environment (p. 32).
    - Reduced density makes particles more mobile (p. 32).
- **Key gaps in legislation and field approval:**
    - *The Protection of the Environment Operations Act 1997 (POEO Act)* includes micro and nanoplastics in its definition of waste and water pollution, in conjunction with synthetic fibre wastes being recognised by the EPA Waste Classification Guidelines. And yet, micro and nano plastics are generally not considered in a Review of Environmental Factors (REF) and an Environmental Protection Licence (EPL) or mitigation measures are not required (p. 59).
    - REF's do not address end-of-life plans for synthetic turf and associated products.
    - More listed (p.59).

FAQs

1. Where are the synthetic turf fields located? Is there a list of field names?

There is no central database for the location of these types of fields. In NSW, this data has been compiled but for other states and territories it is unknown.

NSW Chief Scientist Report (2023)

- Precise figures of the number and rate of increase of synthetic turf fields installed in NSW are difficult to confirm.
- There is no single dataset containing spatially referenced information about surface type or where a synthetic turf has been installed.
- The rate of field installation is increasing.
- Figures with natural and synthetic turf field locations can be found on page 12 and 13 of the report with more information available in Appendix 2.

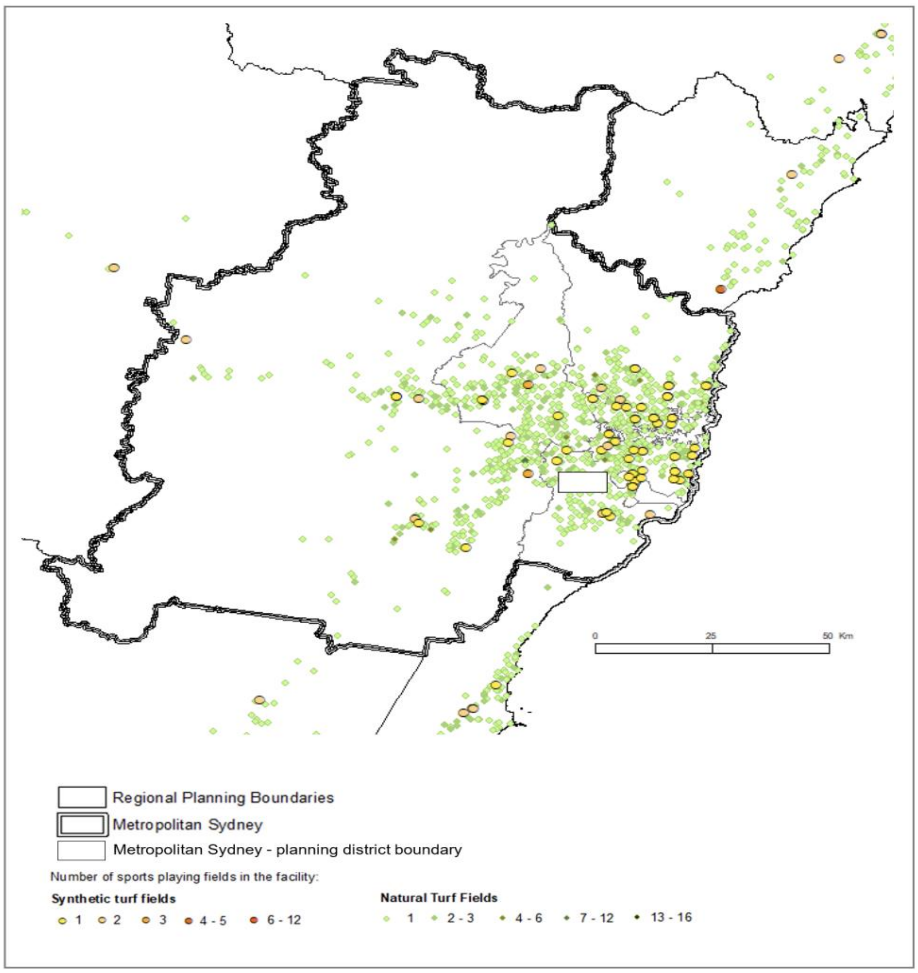

Figure 3b: Locations of synthetic and natural turf surface playing fields in Metropolitan Sydney regional planning area, which has the greatest number of synthetic turf playing fields
Data source: NSW Office of Sport, updated through consultation with various councils and with input from relevant sporting associations
Notes: Where there is more than one playing area at a facility this is indicated by darker colours. Boundaries within NSW show the regional planning areas. These figures only include fields as listed in Table 1, cricket pitches and baseball batting cages are not included

2. What are the most effective mitigation measures?

Mitigation measures for synthetic turf fields are mixed and generally not required in Australia. Engaging multiple pathways of loss is key to reducing the loss of microplastics from these surfaces, including through drain traps, and responsible use by surface users.

Fate of Recycled Tire Granulate Used on Artificial Turf (Verschoor et al. 2021)

- Reviews a range of valuable case studies from around Europe.
- 3000-5000 kg of rubber infill was used per field per year in Europe.
- This included 600-1200 kg of 'top-up' material to compensate for compaction of existing crumb and loss on field users and via stormwater networks.
- **Recommends containment of particles through "optimised field and drainage construction, suitable maintenance equipment and practices and good housekeeping rules for players and groundskeepers."**
- **Effective Drainage**
    - Stormwater systems are a conduit for transporting stray infill.

- Traps represent a good mitigation strategy to reduce loss.

- **Field Maintenance**
  - Leaf blowing should blow debris inwards towards the field to limit further dispersal.
- **Reducing Compaction**
  - Power brushing and raking should take place to reduce compaction of infill under soil and snow (where applicable).
- **Paper concludes that the loss of microplastics from synthetic fields can be "reduced to virtually zero."**

NSW Chief Scientist Report (2023)

- As more synthetic turf fields reach end-of-life there is an opportunity to improve mitigation in new installations.
- Mitigation through the use of less toxic alternatives to styrene butadiene rubber including virgin rubber or organic options - it is noted that this will not fully solve pollution problems.
- Recommended that fields are constructed with minimal slopes and a surrounding curb of 200 mm high at minimum.
- Fields should be designed so that all runoff will enter local drains with stormwater drain traps or filters in place.
- Priority research area identified by the Environmental Plastics Innovation Cluster at the University of Newcastle is to improve treatment solutions for micro and nano plastics in waste and grey water to extract more than filtration can (p.536).

3. What statistics are available on the shedding of synthetic grass blades and rubber crumb from synthetic turf fields?

There are no quantified studies in Australia at present, but AUSMAP is currently preparing a publication with recent results.

Report from Investigations into the Wastage of Rubber Granules from Artificial Grass Pitches (2017) **(note this resource is in Norwegian).*

- Using a citizen science approach in Norway, 12,591 participants helped to gather data on infill loss on field users.
- Findings demonstrated that particles on participants were predominantly styrene butadiene rubber (81%).
- Twice as many crumb particles stuck to shoes and clothes of participants on a wet field, in comparison to a dry field.
- Increased playing duration marginally increased rubber crumb loss on participants.

Dispersal of Microplastic from a Modern Artificial Turf Pitch with Preventative Measures (Regnell 2019)

- Quantified infill loss in socks and shoes of 376 players with a playing duration between 60-120 minutes in Sweden.
- Reiterated wet conditions as causing higher volumes of particles to stick to field users.
- Established an overall mean loss as 1.5g/player/occasion across all weather conditions.

- This study noted that stormwater drains represent the largest potential source of dispersal, with traps capturing approximately 15.5kg per year.
- Recommended preventative measures: brush/ blow off vehicles and implements after use on fields, establish solid barriers to physically limit loss, install brush off stations at entrances and exits alongside information for users and install drain traps in stormwater drains.

NSW Chief Scientist Report (2023)

- Recognises turf fibre blades as a form of plastic pollution from synthetic fields.
- These fibres are less dense than water and are more mobile - despite this very little research or risk assessments have been undertaken.

Riordan, J., Wilson, S.P., Blewitt, M. (*in prep*.) A Local Investigation into Rubber Crumb and Synthetic Grass Loss from a Synthetic Turf Pitch with Implications for ongoing Mitigation Measures. Water, Air and Soil Pollution.

- AUSMAP has partnered with a Sydney Council to quantify rubber crumb and synthetic turf loss from a sports field via multiple pathways, and evaluate the effectiveness of current mitigation measures.
- Preliminary results from 1 drain trap from a 'wet' sampling round (>10mm rainfall in 24 hours):
    - Rubber crumb captured ranged from 21,080 to 76,760 pieces
    - Synthetic grass captured ranged from 6,720 to 56,020 pieces.

4. What are alternatives to rubber crumb?

There is a selection of alternatives to rubber crumb; cork, coconut fibre, sand and plastic material similar to the blades all being potentially available.

Global Evaluation of the Chemical Hazard of Recycled Tire Crumb Rubber Employed on Worldwide Synthetic Turf Football Pitches (Armada et al. 2022)

- Cork has been recommended as an alternative as it complies with the circular economy.
- It appears to be chemically adequate.
- Natural materials including cork also contain PAHs, though this is at much lower levels in comparison to rubber crumb.

NSW Chief Scientist Report (2023)

- Cork and other natural materials produce a cooler surface and are biodegradable, however they are more costly and their performance is yet to be evaluated.
- Cork has lower flammability than styrene butadiene rubber.
- Cork has a lower density and therefore fields using it may require additional top-ups in comparison to fields that use styrene butadiene.

5. What regulatory actions are currently in place or being discussed in Australia?

Australia:

- In response to the NSW Chief Scientist's Report (2023), a working group with key government agencies and stakeholders is working to develop guidelines. These are expected to be released later this year.
- AUSMAP is currently preparing submissions to relevant Ministers to support the uptake of stringent measures in line with developments in Europe.

Europe:

- On the 26th April 2023 the European Commission voted to ban intentionally added microplastics, including rubber crumb.
- This will come into effect after a transitional period of 8 years, in line with Option B (below).
- Synthetic turf surfaces may remain but only natural infill materials can be used.

Committee for Risk Assessment (RAC). *Opinion related to the request by the Executive Director of ECHA under Art. 77(3)(c) of REACH to prepare a supplementary opinion on: CEN technical report 17519 on risk management measures for artificial pitches and the ESTC study on their effectiveness and the proposed derogation for polymers without carbon atoms in their structure* (European Chemicals Agency 2021)

- "Microplastics used as infill in synthetic turf sport pitches are the largest contributor at a European level in terms of both quantities of intentionally-added microplastics used and released to the environment, with a central estimate of 16,000 tonnes released to the environment per year." (p. 4).
- Explored two options to address this issue:
    - **Option A** - use of risk management measures to ensure that annual releases of microplastic do not exceed 7 g/m^2 (equivalent to 50 kg/full-size pitch/year 3) after a transitional period of three years.
    - **Option B** - a ban on placing on the market after a transitional period of six years.
- Determined that a complete ban would be more effective in preventing the release of microplastics over the longer term than the use of risk management measures.
- Estimates suggest that the loss of microplastics could reach 160,000 tonnes across the 10 years taken to negotiate and fully implement the ban (equivalent to the weight of 16 Eiffel Towers) - this loss is preventable and unacceptable.

Landmark Decision - Intentionally-added Microplastic Restrictions are About to be Adopted by the EU (Fidra 2023)

- This article argues that the 8-year phase out period provides too much time for microplastics to continue reaching the environment.

Tussle over Artificial Football Pitches Comes to a Head(er) (Cater for POLITICO 2023)

- A statement by the European Commission noted that "current recycling of used tires into infill material for artificial sport surfaces cannot be considered as fully circular," as that infill material is "almost never further recycled at end-of-life but is either incinerated or landfilled."

Joint Letter - Proposal for the Restriction of the Use of Polymeric Infill in Synthetic Turf Pitches (2023)

- Joint letter of 17 signatories from industry in response to the EU's ban on rubber crumb and synthetic turf.
- Support the need for action to address microplastic loss through mitigation measures, but state that it would compromise the EU Green Deal and result in more EOLT's being incinerated instead of recycled.

6. If this isn't the solution for EOLT, then what is?

The solution to EOLT regrettably remains unsolved.

Despite banning 'intentionally added microplastics' including rubber crumb, the EU is yet to determine a suitable waste pathway for these materials.

For more information or you would like to investigate rubber crumb in your LGA, please contact data@ausmap.org.