IMPLEMENTATION OF BEST PRACTICES IN SYNTHETIC TURFS TO AVOID THE RELEASE OF MICROPLASTICS FROM RUBBER GRANULATE INTO THE ENVIRONMENT

EuRIC AISBL - Recycling: Bridging Circular Economy & Cilmate Policy

TABLE OF CONTENTS

1 Introduction

In March 2019, the European Chemical Agency (ECHA) launched a public consultation following the publication of a restriction dossier for microplastics intentionally added to products[1]. The dossier proposes to ban certain consumer and professional uses, while other uses would be subject to labelling/information requirements and annual reporting. Microplastics covered by the dossier are used in multiple applications, including in agriculture, horticulture, cosmetic products, paints, coatings, detergents, maintenance products, medical and pharmaceutical applications, oil and gas sectors, etc. The scope of the restriction also includes **granules from end-of-life tyres (ELT) used as infill in synthetic turf pitches**.

ECHA's restriction dossier[1] defines microplastics as solid-polymer-containing particles, to which additives or other substances may have been added, and where ≥ 1% w/w of particles have (1) dimensions 1 nm ≤ x ≤ 5 mm, or (2), for fibres, a length of 3 nm ≤ x ≤ 15 mm and a length to diameter ratio (L/D) of >3. The diameter of ELT infill often varies between 0.5 and 3 mm, which thereby classifies the rubber granules as primary microplastics as defined in this report.

Artificial turfs are designed for the infill to be able to absorb impacts from players into the field thus helping to prevent potential injuries and mimic the feel of natural turf. The material used as 'infill' is in the form of small particles (i.e., <5mm size) distributed throughout the turf surface under the artificial grass pile (Figure 1).

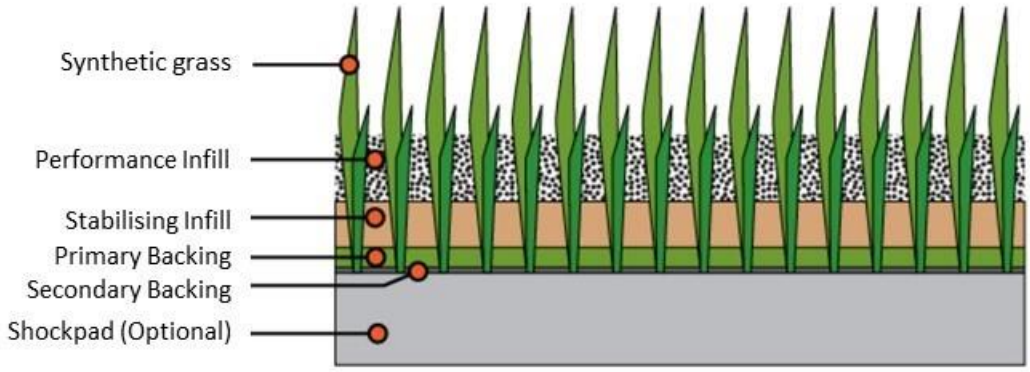

Figure 1. Typical synthetic turf composition[2].

Rubber crumb from recycled tyres is conventionally used as 'infill' material – often referred as SBR (styrene-butadiene rubber) (ELT) infill. Particularly in Europe, more than 80% of synthetic turfs are filled with this material[3]. It is not only used in sport turfs, but also in recreational playgrounds for example (Figure 2).

Figure 2. Example of a recreational playground made using SBR from ELT as a base layer (i.e., under the coloured EPDM layer).

Despite some studies have pointed out that microplastics from synthetic pitches are released into the environment in large quantities[2,4] (i.e., between 1.5 and 5 tonnes per year per pitch), these figures were based on theoretical simulations and also on reports of the yearly volume of granulate refill topped up on the pitches under the assumption that an equal amount has been lost into the environment over the year. However, this assumption is false, as the very important factor of compaction of the rubber layer and the stabilising sand layer has not been taking into consideration.

Furthermore, more current studies pointed out this difference and analysed the real amounts of microplastics released from synthetic turfs into the environment. Indeed, a recent study at Bergavik's IP (Sweden) has found that the potential spread of plastic material from artificial turf may have been **overestimated up to 50 times**[5]. A study in the Netherlands analysed the potential pathways for microplastics losses per field and determined that on average between 60-330 kg of infill is yearly lost through different pathways (i.e., attached on players clothing, waste water and surface water, surrounding grass and pavement)[6]. Another study developed by the Danish Technological Institute[7], reported a mass balance for all the potential routes for material loss and determined that between 300-730 kg of infill is yearly lost from every field. Most of this material can be recovered and reintroduced into the fill.

Moreover, it has been further demonstrated by recent studies that both, **microplastics release and compaction can be substantially reduced by proper maintenance and the implementation of Best Practices (BPs)**[8].

As an example of the effectiveness of implementing those measurements in controlling the microplastics released from synthetic turfs, a study was developed during one year by Ecoloop (Sweden) in a synthetic turf installed in September 2018 at Bergavik's IP (Kalmar, Sweden)[9]. The artificial turf had the recommendations of the Swedish Football Association for the construction of artificial turfs, and based on this plus the internal expert knowledge, the following prevention measures were installed:

- Surface water and drainage water were separated;
- Sealing layer under the field was installed to collect all drainage water;
- Granulate traps in all stormwater drains around the pitch (> 200 µm);
- Granulate filter for both surface water and drainage water (100 µm);
- Winter lining to pile up snow on the pitch instead of a hard surface;
- A fence around the entire pitch with a board at the bottom;
- A brushing station and information signs for players when entering and leaving;
- Systems to brush off vehicles and other implements after operation and maintenance when leaving the ground.

The results of the project showed that at least 99% of the potential spread of microplastics can be prevented. The spread of microplastics from the artificial pitch that cannot currently be stopped (with the preventions) were about 0.1 kg per year, 10% of which is estimated to be rubber granules from the infill (i.e., 10 g).

The main objective of this report is on one side, to create awareness among pitch manufacturers and operators about their role in preventing the spread of microplastics and encourage them to implement BPs measures to prevent spread of rubber granulates. But also advocate the development of financial and regulatory incentives, at European level, to promote the implementation of those BPs further mitigating the risks of release of microplastics from synthetic turfs into the environment.

2 Microplastics emission pathways

Infill from artificial turfs can be inadvertently removed by players (i.e., attached to their clothes and footwear) and also through maintenance activities (e.g., cleaning, snow clearance, etc.) or due to environmental phenomena (e.g., wind, rain, snow). Microplastics can then enter drains or get spread into the environment (i.e., soil and closer water bodies) (Figure 3).

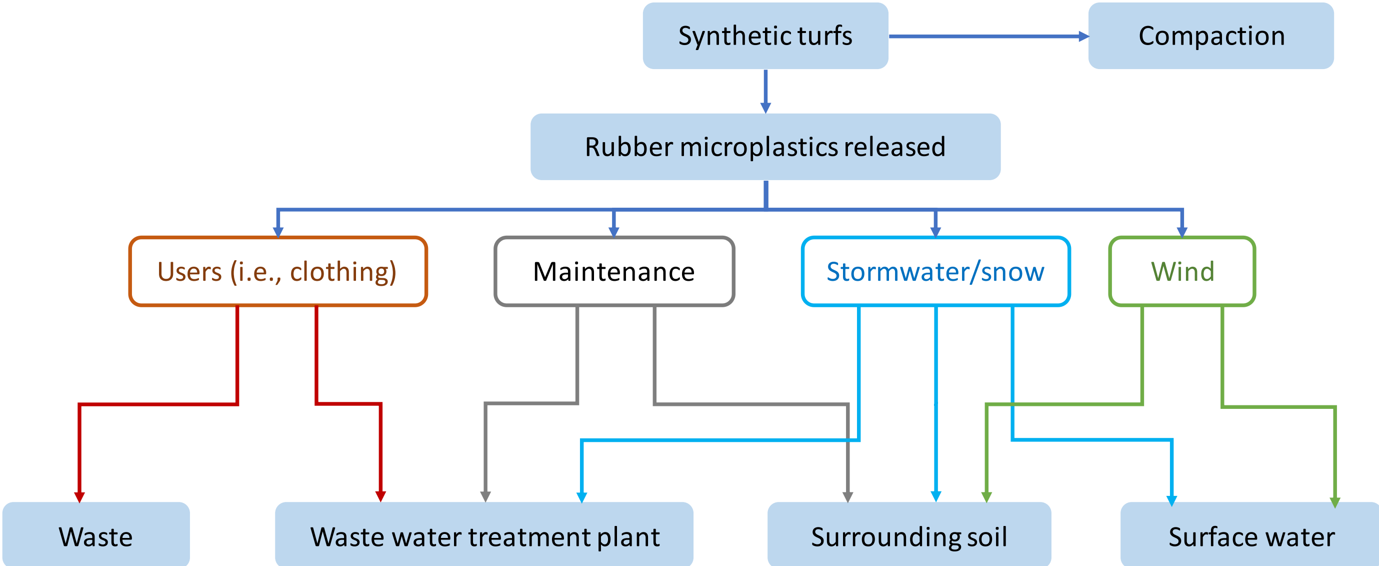

Figure 3. Summary of the main routes of spread of microplastics from synthetic turfs, (adapted[6,7,10]).

Reported studies regarding the proportion of released microplastics that can go onto the different identified pathways is very variable, due to the independent characteristics of every field and its location. For instance, the "Fraunhofer Konsortialstudie" calculates that in Germany 96.6 g/capita/year of microplastics is released from football fields due to wind as the only pathway[11]. While Weijer et al. (2017) do not even consider wind as a pathway[6] and Løkkegaard et al. (2018) reports that water dispersion should be considered as the main transportation mechanism[7]. Therefore, the pathway followed by microplastics released into the environment is case-dependant and cannot be generalised for all synthetic turfs.

In order to avoid the uncontrolled release from microplastics into the environment and reduce the compaction of the turf, the following section focus on the most commonly implemented BPs across European synthetic turfs. Experience shows that apart from a good infra-structure design, implementing suitable routine maintenance measures (i.e., BPs) can minimise the effects of such infill movement.

3 BPs for synthetic turfs

3.1 BPS TO REDUCE COMPACTION

Decompaction maintenance processes are specifically aimed at reducing pitch 'hardening' caused by the compaction of the rubber infill that occurs from the continuous use of the surface by players. If the surface without proper maintenance measures eventually becomes too hard, it may fail the field accreditation tests and will require further investment for its repairment to bring it back to satisfactory standards[8].

The de-compaction process consists in agitating the rubber infill layer causing it to de-compact to achieve a looser state.

Various de-compaction methods can be employed to shake the infill and return it to its previous levels. Conventionally rakes are dragged across the pitch width (to avoid crossing longitudinal seams) on a single or double pass, and this process is performed every 1-2 months[8]. This process is more efficient when undertaken in conjunction with cleaning and grooming of the field[8].

3.2 BPS TO REDUCE MICROPLASTICS RELEASE INTO THE ENVIRONMENT

The focus of this report is on describing BPs used in synthetic turfs to avoid the loss of infill as microplastics into the environment. The following measures have been conventionally used.

1. Placement of fences[9,12]

Figure 4. Example of fences surrounding a sports field.

Fences (Figure 4) help to delimit the field and prevent the entrance of big machinery and elements from the surrounding trees to enter the field affecting its surface.

2. Leaf blowing[13]

Figure 5. Person performing leaf blowing activities from outside to inside the field.

In the case that leaves have fallen into the field and a leaf blowing is required. It is important to perform it from the outside to the inside (Figure 5) of the field and remove collected leaves. By blowing the artificial turf in the other direction, microplastics can be also blown out from the field into the surroundings.

3. Side paved areas[9,12,13,14,15,16,17]

Figure 6. Example of paved area around the field.

Side paved areas (Figure 6) can contribute to collect the rubber granules that have been spread from the field into its surrounding. Rubber granulate can be easily swept up from this area for its re-use in the field, further avoiding its spread to surrounding green areas. In addition, rubber granulates that are released into those areas can be cleaned up by vacuuming up the material periodically.

4. Collection areas for snow[9,17,18]

Figure 7. Example of a collection area for snow.

For those fields that could be affected by snow, it is recommendable to place side collection areas (Figure 7) to keep the collected snow from the field that also allows to collect the rubber granules that have been drawn with the snow. Is important to keep into account that those collecting installations must be disconnected from drainage systems (i.e., lines for diverting stormwater) to avoid losing the collected particles when snow has melted.

5. Drainage, water filtration systems and traps for microplastics retention[9,12,14,15,16,17,18,19,20,21]

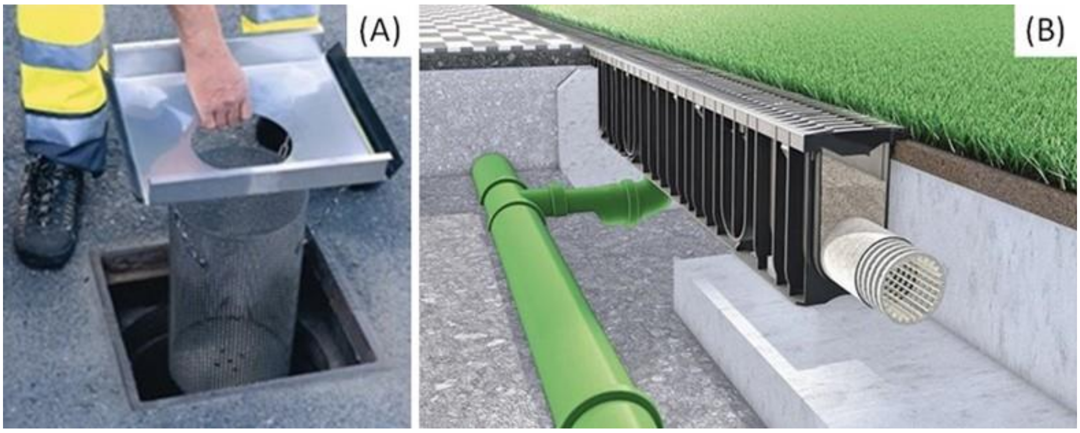

Figure 8. Example of a granular trap (A) and a filtration system (B).

Open water drains (i.e., storm drains and drainage troughs) should be avoided within the field and at its surroundings. For those rubber granules that are drawn by stormwater or water used to clean or cool down the pitch in hot summer days, drainage and water filtration systems should be put in place to collect them, thus avoiding losing them into stormwater drainage systems (Figure 8). A filtration system could also be considered to be placed in the shower room.

6. Brushing stations in every entrance of the field[9,12,13,14,15,16,17,18,19,20]

Figure 9. Example of a brushing station for the field users.

When leaving the field, players should brush off the rubber granules (i.e., using mats and metal foot-grills) that they can carry attached to their boots so they can be collected, ensuring that they will not end up in the environment (Figure 9). In addition, when creating a culture of responsible behaviour on the use of artificial pitches, setting up signals to users could make a difference in the correct implementation of those actions[17,22].

7. Entrance points with cattle grids[13,16,17]

Figure 10. Example of an entrance with a cattle grid to capture rubber granulate.

A cattle grid can be also placed in every entrance point to the field where players can stump off infill granulates.

8. Side boards around the field or raised perimeters[14,15,16,17,19,20]

Figure 11. Example of fence and side boards in a synthetic turf.

Side barriers placed around the field (Figure 11) or raised side perimeters are the easiest way to reduce infill loss. They could act as a barrier and prevent the spread of rubber granulate outside the field as a result of weather or due to regular maintenance. They can be installed as rigid barriers or soft barriers using different materials (e.g., metal plates, tarpaulin, etc.).

9. Cleaning stations for the machinery doing maintenance to the field[9,14,17,18]

Same as the brushing stations for players, cleaning stations for maintenance machines, installed in the field or just at the exit of the field, are important to avoid them for leaving the field adhering rubber granulate. It is also recommended to ensure a specific location for parking and storage of the maintenance equipment and machines with wells to prevent the spread of granulates attached on this equipment[13].

10. Regular brushing and drag matting of the field[15,19,21]

Figure 12. Brushing (A) and drag matting (B) of the field.

During the prolonged use of the synthetic turf, and if maintenance is inadequate, the infill rubber granules can be dispersed to the margins of the field. It is important then to implement measures that allows to regularly return the dispersed infill to the areas of higher use. It can be done by regular brushing and drag matting the field (Figure 12). It is important to point out that operations for the maintenance of the field should be carried out at least 1-2 times per week[9] and during dry weather conditions in order to avoid the granulates to stick to shoes or machinery and maintenance equipment[13].

4 Information on the costs of implementing BPs

The implementation of BPs in a synthetic field are case-dependant. The needs can vary depending on the location of the pitch (i.e., due to environmental conditions, availability of companies and options), and therefore the costs associated to its implementation. The objective of this section is providing an overview of estimated costs for the implementation of those BPs. The information presented has been gathered from various members in different countries across Europe (Table 1).

Implemented BPs	Costs (Country)
Hard plate barrier (side barrier) at the fence	~ 7,000 € (plus cleaning station) (Denmark) ~ 10,000 € (Netherlands) ~ 14 € per linear metre (plus cleaning station) (+VAT) (UK) ~ 30 € per meter installed (Denmark) ~ 33.50 – 40.00 € per linear metre of high double kickboard (UK) ~ 34 € per linear metre of road kerb to provide 200 mm upstand plus 250 mm kickboard ~ 23,300 € (plus cleaning station) per pitch
Soft barrier system (side barrier) at the fence	~ 130 € per 6-meter module tarpaulin (Excl. installation) (Denmark)
Cleaning station for field users (i.e., brushing station)	~ 1,000 – 1,500 € per brushing station (Denmark) ~ 2,300 € per brushing station (Excl. installation, transport and VAT) (Sweden) ~ 350-580 € per brushing station (+VAT) (UK) ~ 250 € standard entrance matting (+VAT and delivery) (UK) ~ 2,300-3,300 € pitch entrance with fence and gates, cattle grids, interception drainage filters and traps (UK) ~ 4,000 € (based on matted panels) (UK) ~ 350 € per set of boot cleaners (UK)
Traps for microplastics in drainage systems	~ 275 € per trap (Excl. installation, transport and VAT) (Sweden) ~ 350 – 400 € per trap (UK)

Implemented BPs	Costs (Country)
Filters for microplastics	< 1,000 - 1,100 € depending on the size (i.e., from 400 x 600 cm to 1000 x 600 cm) (Excl. installation, transport and VAT) (Sweden) ~ 115 € per metre of installed filter (UK)
Closed water system underlying construction, wells and filters, special entrance with brushing station plus a grid and an asphalt boarder with a retaining wall	~ 29,000 € (Sweden) ~ 42,000 - 46,700 € (UK)
Automatic cleaning machines for synthetic turfs	~ 35,000 € per unit (Germany)[19] ~ 7,650 € (+VAT) R.E.D® Range includes; drive unit, integral winger brushes and tines, sweeper collector with filter plate, delivery and certified training (UK)
Cleaning and care of synthetic turf	~ 0.35 – 0.50 €/m² per year (Germany) ~ 5,800 € per quarterly maintenance package per pitch (UK)

5 Conclusion

Microplastics release into the environment from synthetic turfs has gained a strong attention after, in March 2019, ECHA launched a public consultation following the publication of a restriction dossier for microplastics intentionally added to products, including granules from ELT used as infill in synthetic turf pitches.

Reports in the public of huge losses of rubber granulate into the environment solely based on refill top-up figures have now been proven overly exaggerated. Furthermore, microplastics release can be substantially reduced to negligible limits (i.e., 0.1 kg per year, 10% of which is estimated to be rubber granules) by proper maintenance and the implementation of BPs.

There are different alternative BPs that can be used and require to be adapted to the specific needs of every case. Apart from the periodic maintenance of the field, the installation of side barriers in existing fences and paved areas around the pitch, traps in drainage systems and cleaning stations are the most conventional options in European synthetic fields. More sophisticated systems can also be installed, such as drainage lines for stormwater, filtration systems surrounding the field, and cleaning stations for the maintenance machines. The costs associated to the implementation of those different BPs will depend on the available options and installers operating in the different locations across Europe.

Despite the positive aspects of installing those measures have been broadly demonstrated, still its implementation is limited due to a lack of financial or harmonised regulatory incentives for pitch owners/managers to implement them. Furthermore, in the absence of obligatory 'design, build, and maintain' contracts, installers do not have an incentive to implement those BPs measures.

6. References

1 ECHA (2019). ANNEX XV RESTRICTION REPORT –Restriction proposal for intentionally added microplastics in the EU. European Chemicals Agency. Retrieved from https://echa.europa.eu/documents/10162/12414bc7-6bb2-17e7-c9ec-652a20fa43fc

2 Hann, S.; Sherrington, C.; Jamieson, O.; Hickman, M.; Kershaw, P.; Bapasola, A.; and Cole, G. (2018). Investigating options for reducing releases in the aquatic environment of microplastics emitted by (but not intentionally added in) products – Final report. Eunomia and ICF. Retrieved from https://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/pdf/microplastics_final_report_v5_full.pdf

3 Genan (2018), Market Potential 2018. Internal report.

4 Magnusson, K.; Eliasson, K.; Fråne, A.; Haikonen, K.; Hultén, J.; Olshammar, M.; Stadmarl, J.; and Voisin, A. (2017). Swedish sources and pathways for microplastics to the marine environment. Report number C 183. IVL Swedish Environmental Research Institute. Retrieved from https://www.ivl.se/webdav/files/Rapporter/C183.pdf

5 Cirkulation (2019). Mikroplast från konstgräs litet miljöproblem. Cirkulation VAtidskriften, Sweden. Retrieved from https://www.cirkulation.se/artiklar-ochnotiser/mikroplast-fraan-konstgraes-litet-miljoeproblem/

6 Weijer, A.; and Knol, J. (2017) Verspreiding van infill en indicatieve massabalans, Report for Branchevereniging Sport en Cultuurtechniek. Retrieved from https://www.bsnc.nl/wp-content/uploads/2017/05/Rapportage-Verspreiding-vaninfill-en-indicatieve-massabalans.pdf

7 Løkkegaard, H.; Malmgren-Hansen, B.; and Nilsson, N.H. (2019). Mass balance of rubber granulate lost from artificial turf fields, focusing on discharge to the aquatic environment. Retrieved from https://www.genan.eu/wp-content/uploads/2020/02/Teknologisk-Institut_Mass-balance-of-rubber-granulate-lost-from-artificial-turf-fields_May-2019_v1.pdf

8 Fleming, P.R.; Forrester, S.E.; and McLaren, N.J. (2015) Understanding the effects of decompaction maintenance on the infill state and play performance of third-generation artificial grass pitches. Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology, 229 (3) 169–182. Retrieved from https://repository.lboro.ac.uk/articles/Understanding_the_effects_of_decompaction_maintenance_on_the_infill_state_and_play_performance_of_third-generation_artificial_grass_pitches/9451073/1

9 Regnell, F. (2019). Mikroplastspridning från en modernt utformad konstgräsplan med skyddsåtgärder – Fallstudie Bergaviks IP, Kalmar (Dispersal of microplastic from a modern artificial turf pitch with preventive measures – Case study Bergaviks IP, Kalmar). Ecoloop. Retrieved from https://www.ragnsellstyrerecycling.com/globalassets/tyre-company/dokument/rapport---mikroplastspridning-fran-en-modernt-utformad-konstgrasplan-med-skyddsatgarder.pdf

10 Krång, A-S.; Olshammar, M.; Edlund, D.; Hållén, J.; Stenfors, E.; and Winberg von Friesen, L. (2019). Sammanställning av kunskap och åtgärdsförslag för att minska spridning av mikroplast från konstgräsplaner och andra utomhusanläggningar för idrott och lek. IVL Svenska Miljöinstitutet, report C359. Retrieved from https://www.ivl.se/sidor/publikationer/publikation.html?id=5698

11 Bertling, J.; Bertling, R.; and Hamann, L. (2018). Kunststoffe in der Umwelt: Mikro- und Makroplastik. Ursachen, Mengen, Umweltschicksale, Wirkungen, Lösungsansätze, Empfehlungen. Kurzfassung der Konzortialstudie, Fraunhofer-Institut für Umwelt-, Sicherheit- und Energietechnik UMSICHT (Hrsg.). Retrieved from https://www.umsicht.fraunhofer.de/content/dam/umsicht/de/dokumente/publikationen/2018/kunststoffe-id-umwelt-konsortialstudie-mikroplastik.pdf

12 SVFF (2018). Svenska Fotbollssförbundets rekommendationer för anläggning av konstgräsplaner. Retrieved from https://d01.fogis.se/svenskfotboll.se/ImageVault/Images/id_165173/scope_0/ImageVaultHandler.aspx180314111900-uq

13 Svensk Däckåtervinning AB (2019). Reply to the Public Consultation on the Annex XV dossier under REACH proposing a restriction on intentionally added microplastics. Retrieved from https://www.sdab.se/media/1421/sdab-reply-to-the-public-consultation-on-restricting-intentionally-added-microplastics-2019-05-20.pdf

14 RecyBEM B.V. and VACO (2017). Verantwoorde toepassing van infill van voertuigbanden in kunstgras voetbalvelden. Adviezen voor invulling zorgplicht Wet milieubeheer. Retrieved from https://www.bodemplus.nl/publish/pages/91226/zorgplichtdocument_toepassing_van_rubbergranulaat_van_voertuigbanden_als_infill_in_kunstgrasvelden_v.pdf

15 Svensk Däckåtervinning AB (2018). Guiden för mera spel och mindre spill [PowerPoint file]. Retrieved from https://www.sdab.se/media/1391/guide-till-mer-spel-och-mindre-spill.pdf

16 FIDRA (N.D.). Pitch In to reduce microplastic loss from artificial pitches: Guidelines for Designers and Procurement Specialists. KIMO and Fidra. Retrieved from https://www.fidra.org.uk/wp-content/uploads/Fidra-Pitch-Fact-Sheet-designers-and-procurement_v1.pdf

17 Genan (2020). Constructing an artificial turf pitch. January 2020. Retrieved from https://www.genan.eu/applications/sport-and-leisure/best-practice-artificial-turf/

18 Genan (2020). Maintenance of Artificial Turf Pitches with Rubber Infill. January 2020. Retrieved from https://www.genan.eu/applications/sport-and-leisure/best-practice-artificial-turf/

19 European Synthetic Turf Organisation (2018). Minimising the risk of micro-plastic pollution. ESTO Guidance Document. Retrieved from https://www.estc.info/wp-content/uploads/2018/05/ESTO-Minimising-Micro-Plastic-Pollution-Report.pdf

20 BSNC (2017). Verspreiding van infill en indicatieve massabalans. Retrieved from https://www.bsnc.nl/wp-content/uploads/2017/05/Rapportage-Verspreiding-van-infill-en-indicatieve-massabalans.pdf

21 Will, M. (2019). Faktencheck Mikroplastik - Eine Bestandsaufnahme. Retrieved from https://www.researchgate.net/publication/337224856_Faktencheck_Mikroplastik_-_Eine_Bestandsaufnahme

22 Genan (2020). Responsible conduct on artificial turf. January 2020. Retrieved from https://www.genan.eu/applications/sport-and-leisure/best-practice-artificial-turf/