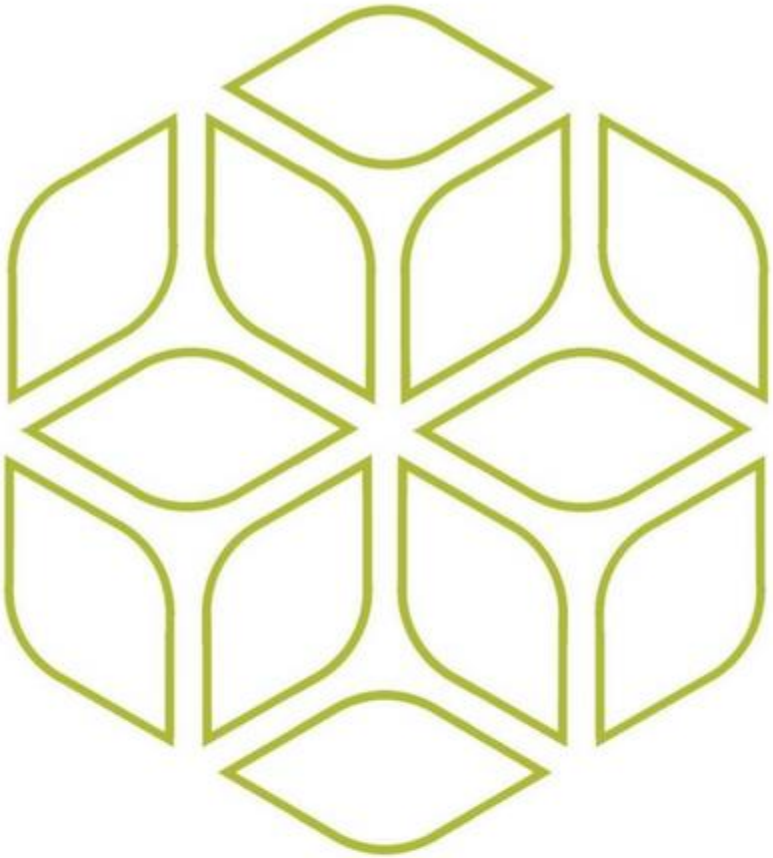

Mapping Economic, Behavioural and Social Factors within the Plastic Value Chain that lead to Marine Litter in Scotland

Artificial grass pitch report

The Scottish Government

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resourcefutures

Document prepared for

Client	The Scottish Government

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Executive Summary

Aims and approach

In the context of growing public concern around marine litter and a fast moving policy landscape of measures to address marine litter and plastic waste, this research sought to understand opportunities within the plastic value chain to help tackle marine litter. The factors and decisions that lead to marine litter in Scotland were researched with a focus on four products that are not fully addressed by current or planned marine litter and plastics waste policy measures. These four product categories were:

1. Commercial fishing gear
2. Crisps, snack and sweet wrappers
3. Artificial grass pitch
4. Menstrual products

The research findings are presented in six documents as follows:

1. **Summary report**
2. **Commercial fishing gear**
3. **Crisps, snack and sweet wrappers**
4. **Artificial grass pitch**
5. **Menstrual products**
6. **Literature review**

This document is the *Artificial grass pitch report*. Key findings for are introduced below. Recommendations are presented for the Scottish Government. The recommendations presented have different potential efficacy, costs and timescales, and to some degree the likely impact is related to the resources and support invested in any single measure.

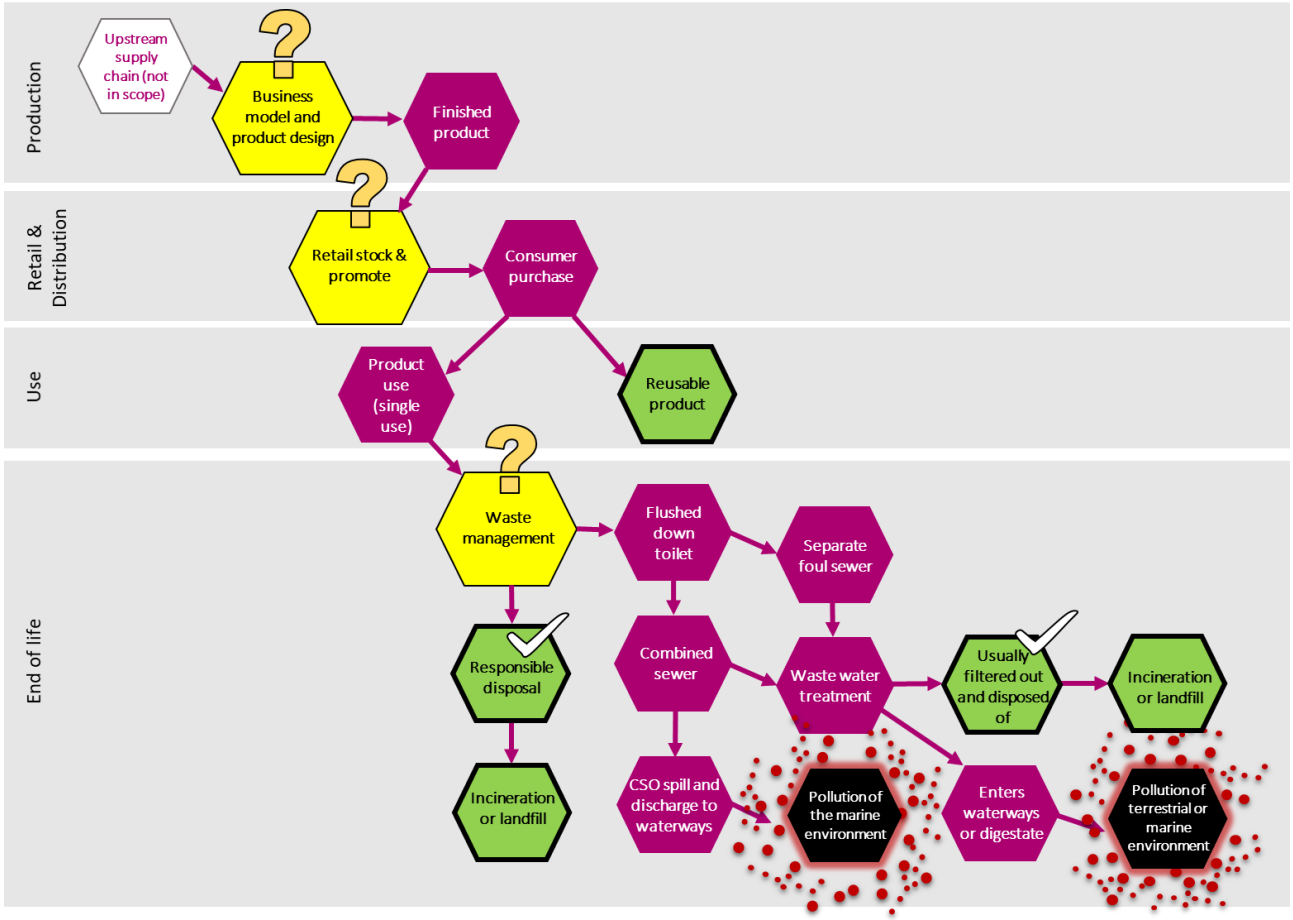
Artificial grass pitch

Artificial grass pitch represents a unique problem. Plastic infill granules, known as rubber crumb, are used to improve the playing surface for performance and safety. These granules are typically made of shredded waste tyres. Other materials are available but are not in widespread use due to differences in cost and performance.

The infill can be walked off the pitch on players' clothing and in their boots and washed down drains in showers or washing machines. Infill can also be blown off pitch and washed off during rainstorm events and maintenance work with similar risk of entering drains that transport it to the marine environment. Furthermore, there are reports that end of life pitches are not managed properly, and many are stored indefinitely, with insufficient funds to treat the waste, or handled illegally. Industry has developed solutions to address infill loss but they are not widely adopted. Marine litter pathways and key decision points are illustrated in Figure E1. Key decision points explored in this research are highlighted in yellow. Business models were also identified as potential key decision points if companies can adopt circular economy principles and provide services over different phases of the product life cycle. However, wider examples

such as leasing models were not found and so business models are not highlighted and explored in detail due to a lack of examples to draw upon.

Figure E1: Artificial grass pitch - Marine litter pathways and key decision points



The procurement process acts as a major barrier as the issue of infill loss is not recognised in the process and so solutions are not properly valued. Procurement rules often stipulate a 90:10 price to quality scoring system for tenders, and in a very competitive market this prevents a company offering infill management solutions as the additional cost will lose them the contract. Suggested solutions address this issue via procurement guidance, accreditation of suppliers, a green procurement framework, or simply education and training opportunities across the value chain. Funding for retrofitting infrastructure to reduce infill loss would help address pitches already in installed. There is also activity to transpose best practice guidance on infill loss into a European Eurocode standard (EN), and ECHA is currently consulting on a potential ban of synthetic infill altogether. Table E1 presents an analysis of where potential solutions may have the most influence in relation to key decision points shown in Figure E1. Solutions will have varying degrees of impact, which will to some extent depend on their design and implementation.

Table E1: Artificial grass pitch - where solutions can most influence key decision points

Life cycle stage	Key decision point	Green procurement framework	Accreditation	Education	Funding	Guidance	Eurocode Legislation	ECHA Ban
Production	Product design	✔	✔	✔	✔	✔	✔	✔
Retail	Procurement decision	✔	✔	✔	✔	✔	✔	✔
Use	Maintenance decision	✔	✘	✔	✘	✔	✔	✔
End of life/recovery	Waste management decisions	✔	✔	✔	✘	✔	✔	✘

✔ = Yes, ✘ = No, ✔ = Yes - if solution designed with this in mind, ? = Unknown

On the basis of the research findings, the following recommendations are made for subsequent action by the Scottish Government and the private sector to tackle marine litter from artificial grass pitch:

1. Support education and engagement measures
2. Develop a green procurement framework
3. Develop guidance for procurement teams
4. Review and improve current waste management processes
    a. Mandate reporting on the collection and treatment of waste
    b. Understand current (baseline) waste management costs
    c. Enforce appropriate duty of care requirements for waste from end of life artificial grass pitch
5. Support best-practice and new technology

Contents

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1 Introduction

Whilst there is significant activity on reducing marine litter in Scotland, there are some products which cause marine litter that are not fully addressed by current activities. The aim of this research study was to identify these problem products and investigate opportunities throughout the value chain to tackle marine litter issues, with Government support or interventions where necessary.

The research findings are presented in six documents: an overarching summary and discussion, a separate report for each of the marine litter product groups researched in detail, and a literature review. The list of six report documents is as follows:

1. **Summary report**
2. **Commercial fishing gear**
3. **Crisps, snack and sweet wrappers**
4. **Artificial grass pitch**
5. **Menstrual products**
6. **Literature review**

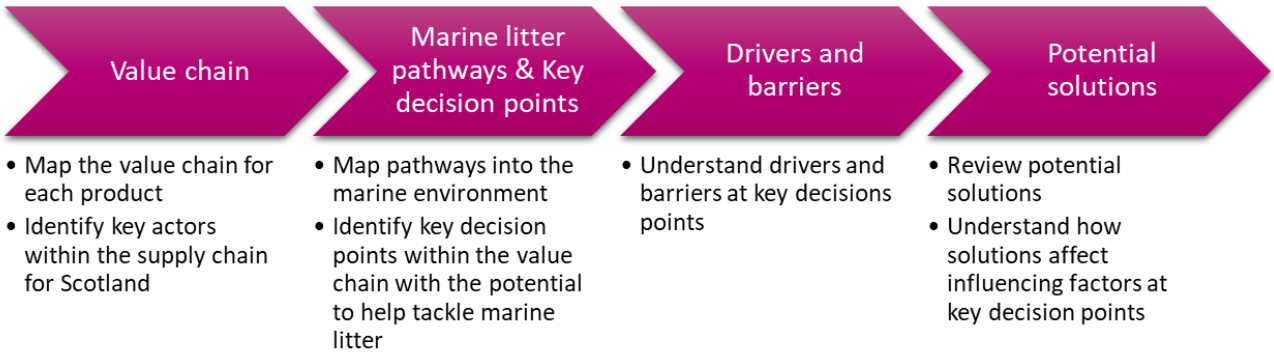
This document is the *Artificial grass pitch report* and is structured as follows:

- **Methodology** - section 2
- **Introduction to product and marine litter issue** - section 3
- **Value chain and stakeholder engagement** - section 4
- **Marine litter pathways and key decision points** - section 5
- **Drivers and barriers** - section 6
- **Potential solutions** - section 7
- **Recommendations** - section 8
- **Comparable products** - section 9

2 Methodology

Over the product life cycle, materials and products pass through multiple actors in the Scottish economy, from raw materials extraction and product manufacturing to the point when products are discarded and recycled or disposed of. The pathways a specific product takes are dictated by decisions taken by the actors in the value chain. This raises an important question: why do some products become marine litter, i.e. what decisions have been made and by whom, *throughout* the product's value chain, that result in 'leakage' into the marine environment? To answer this question, it is necessary to understand decision making in the value chain. Whilst actors may already be aware of marine litter issues and may want to address them, there may be barriers or more dominant drivers that dictate how key decisions are currently made. With an understanding of key decision points in the value chain it is possible to consider how potential solutions can affect decision making to help tackle marine litter. This is the basis of the research framework used in this study, as summarised in Figure 1. The research framework is reflected in the structure of this report and referred to throughout.

Figure 1: Outline of research framework



The framework above outlines the approach taken within the research. To gather this information to inform the study, research activities were conducted in four stages:

1. Scoping study
2. Literature review
3. Interviews and workshops
4. Public survey

Products made from bioplastics were considered out of scope in this research. Research and innovation in material science is leading to the development of many new polymers marketed as biodegradable plastics. However, there is ongoing debate over the efficacy of these polymers to biodegrade in the marine environment over short enough timescales to reduce the impacts of marine litter. This is a complicated subject worthy of a dedicated research project, and so was considered outside the scope of this study to assess. Instead, the research scope starts after polymerisation at the point in the value chain where plastic products, or semi-finished products, are manufactured.

The main product life cycle stages are used as the structure for value chain analysis, to represent and understand the sources of marine litter, marine litter pathways and key decision points within the value chain. This enables a clear and consistent structure for analysis and comparison between products that have different value chains and marine litter pathways. The stages in the product life cycle described in this research are:

- Raw materials
- Production
- Retail & distribution
- Use
- End of life/recovery

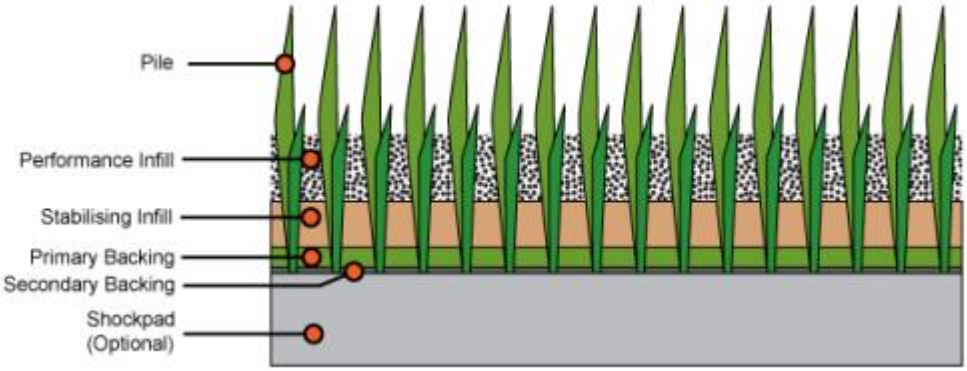
Further details on the methodology and engagement approach are given in the *Summary report* document for the study as a whole.

3 Introduction to product and marine litter issue

The artificial grass pitch market took off in the early 2000's when UEFA and FIFA began sanctioning their use in tournaments[1]. Their use has since become widespread, providing a durable, consistent and hard-wearing playing service, especially useful in wet climates where the pitch is frequently used, relative to real grass turf. It is a growing market in Scotland and the UK. For example, in 2012 it has been estimated Scotland had 296 full size synthetic pitches[2]. With a lifespan of around 7-10 years, many of the original pitches have now been replaced. Synthetic pitches are useful to teams, leagues, schools and community groups, mainly due to their ability to withstand inclement weather, reducing match cancellations and increasing the number of hours used per week[3].

First developed in 1960s, the engineering of artificial grass pitch has improved, and the product is now in its third generation (3G). Artificial grass pitch includes small plastic blades of artificial grass – known as 'yarn' or 'pile' – which are attached to a carpet-like base or primary backing material. The primary backing and pile are then bound together using a secondary backing. There is a distinction between filled and non-filled artificial grass pitch - Figure 2 shows the different components that make up a typical, filled artificial sports pitch. In 3G artificial grass pitch, which is a filled system, the product requires both stabilising and performance infill to keep the synthetic fibres upright during use and provide impact resistance. Infill must be regularly topped up as it is lost from, or compacted on, the pitch. Stabilising infill is most commonly sand, and performance infill generally styrene butadiene rubber (SBR) however other options are in use, as shown in Figure 3. These two infills make up roughly 93% of a typical 3G pitch weight, as shown in Figure 4. SBR is manufactured from recycled tyres[4]. It is estimated that at both a European[5] and Worldwide[6] scale, around one-third of all used tyres go into the sports industry.

Figure 2: Components used in the manufacture of artificial grass pitches[7]



[1] Interview with industry trade association
[2] ESTC, Synthetic turf in Scotland, https://www.estc.info/synthetic-turf-in-scotland/
[3] Interview with organisation which procures artificial grass pitches
[4] Fidra (2019), Turf, tyres and health, https://www.fidra.org.uk/turf-tyres-and-health/
[5] 30% of European truck tyres end up in artificial pitches; interview with turf testing and research and development company
[6] 37% of all used tyres in the world go into the sports world; interview with artificial pitch recyclers
[7] Eunomia (2018), Investigating options for reducing releases in the aquatic environment of microplastics emitted by products, https://www.eunomia.co.uk/reports-tools/investigating-options-for-reducing-releases-in-the-aquatic-environment-of-microplastics-emitted-by-products/

Figure 3: Performance infill use[8]

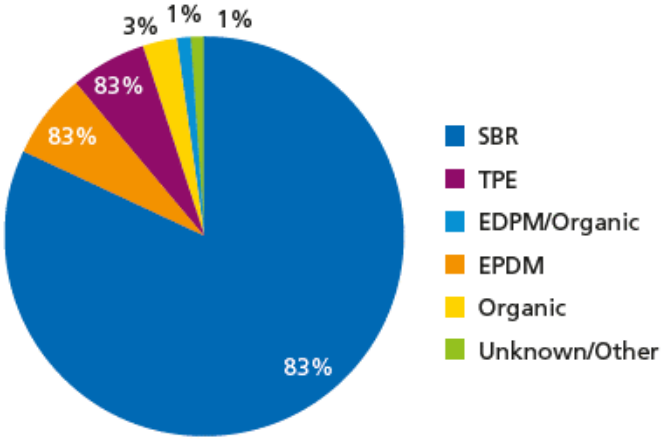
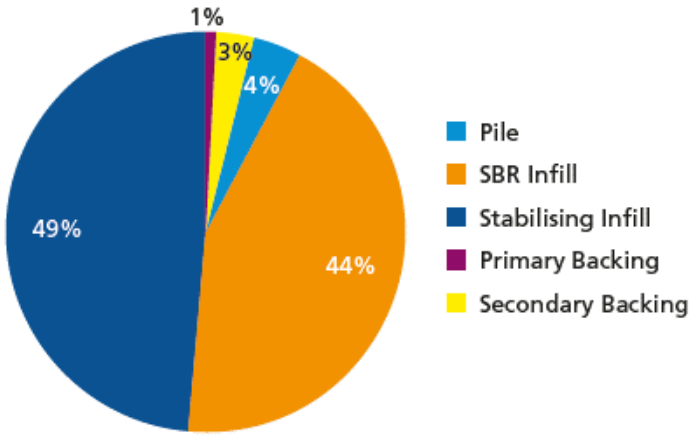


Figure 4: Typical turf composition by weight[9]



There are some artificial pitches which come without infill, which are promoted for use on small pitches (up to five-a-side)[10]. These operate using a shock absorbing underlay and shorter turf with a special yarn and tuft design – curled fibres keep the synthetic 'grass' stems upright. Less than half of artificial grass pitch users surveyed in Scotland had experience playing on a pitch without rubber crumb infill, including hybrid pitches, further information on this survey is included in Appendix D.

The Scottish industry became aware of the microplastics issue resulting from infill leakage roughly two years ago[11]. Since then, there has been much work to reduce leakage and find alternatives[12], and guidelines

[8] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[9] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[10] Arturf (https://bit.ly/2JbjEbm)
[11] Interview with turf testing and research and development company
[12] Interview with turf testing and research and development company

have been produced to clarify best practice for reducing infill leakage[13, 14]. Sector engagement with this issue seems generally high and has increased rapidly in recent years. However, public and purchaser awareness mainly remains low.

Rubber crumb infill from artificial grass pitches would be very difficult to identify in marine litter surveys and would likely be grouped into the smallest plastic pieces category. Risks to Scotland's commercial marine species, and marine, freshwater and terrestrial ecosystems from microplastics including infill from artificial grass pitch have been reviewed in a parallel study conducted over similar timeframes as this research project[15]. There is a European-wide consultation ongoing regarding banning rubber crumb infill, alongside multiple other intentionally added microplastics (particles with all dimensions less than 5mm) due in part to their extreme persistence in the environment[16].

Alongside the microplastics issue, there is a significant issue with improperly and sometimes illegally managed waste from artificial grass pitch. End of life solutions are limited, and cost of appropriate disposal has proved a barrier which has allowed the proliferation of unregulated disposal[17]. This links to the microplastic issue as irresponsible disposal practices including long term storage allow leakage of infill to the environment. However, it is a bigger issue in that the entire turf is stored outside and exposed to the elements, and will eventually degrade over time, polluting the area and eventually adding to microplastic marine litter.

The subsequent sections analyse the issues and potential solutions, following the research framework set out in Figure 1.

4 Value chain and stakeholder engagement

The following sections discuss the value chain and the specific stakeholders engaged within this study. This relates to the starting point of the research framework, shown below.

4.1 Value chain

The value chain for artificial grass pitch starts with the producers of raw materials, mostly plastics, as well as recyclers of rubber tyres or producers of organic alternative infills. Manufacturers then produce the artificial grass pitch and bid for installation contracts put out to tender by both public and private sector organisations. Such tenders may also include the lifting and disposal of existing pitch, as well as a fixed term maintenance contract. Once the contract has been won, pitches are installed and should be maintained

[13] KIMO International, Pitch In, http://www.kimointernational.org/pitch-in/
[14] ESTC (2018), Minimising the risk of micro-plastic pollution, https://www.estc.info/wp-content/uploads/2018/05/ESTO-Minimising-Micro-Plastic-Pollution-Report.pdf
[15] Eunomia (2019), Understanding microplastics in the Scottish environment
[16] ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73
[17] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf

throughout their ~10-year lifespan. At end of life, pitches should be lifted and disposed of, either to landfill or (in very few cases) recycled. End of life turf has also historically been stored due to prohibitive cost and limited availability of alternative waste management options. These actors are mapped on to the product life cycle stages in Table 1.

Table 1: Artificial grass pitch - Mapping actors within the value chain onto life cycle stages

Life cycle stage	Value chain actors
Raw materials	Producers of plastic pellets, tyre recyclers and other raw materials (including organics)
Production	Manufacturers of artificial grass pitch (backing, pile, shock pads etc.)
Retail & distribution	Manufacturers & suppliers Public and private sector procurement
Use	Public and private sector uses Maintenance (in-house or contracted)
End of life/recovery	Waste management companies Recycling Storage

A list of private sector organisations operating in Scotland in the role of manufacturing and installing artificial grass pitches is provided in Appendix A.1.

A number of the major manufacturers and installers in Scotland are Scottish or UK branches of multi-national organisations. A single organisation may also operate at multiple levels in the supply chain, generally including manufacturing, installing, and maintaining pitches. Manufacturers stock a variety of different pitch types, with different sports requiring different turf specifications.

Public data was not available to estimate the number of artificial grass pitches installed and removed in Scotland. However, one installer estimated that in the last year in Scotland they had installed roughly 160,000 square metres and had removed roughly the same amount and were close to removing 200,000 square metres this year[18]. This is equivalent to installing roughly 21 full size football pitches (7,526 square metres each) and would involve around 2,576 tonnes of infill[19]. No data was available on the market share

[18] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions

[19] Length and width of pitches and infill density (kg/m²) from Eunomia (2018), Investigating options for reducing releases in the aquatic environment of microplastics emitted by products, https://www.eunomia.co.uk/reports-tools/investigating-options-for-reducing-releases-in-the-aquatic-environment-of-microplastics-emitted-by-products/ (page 171)

of this company, and as such cannot be used to infer the amount installed and removed in Scotland as a whole.

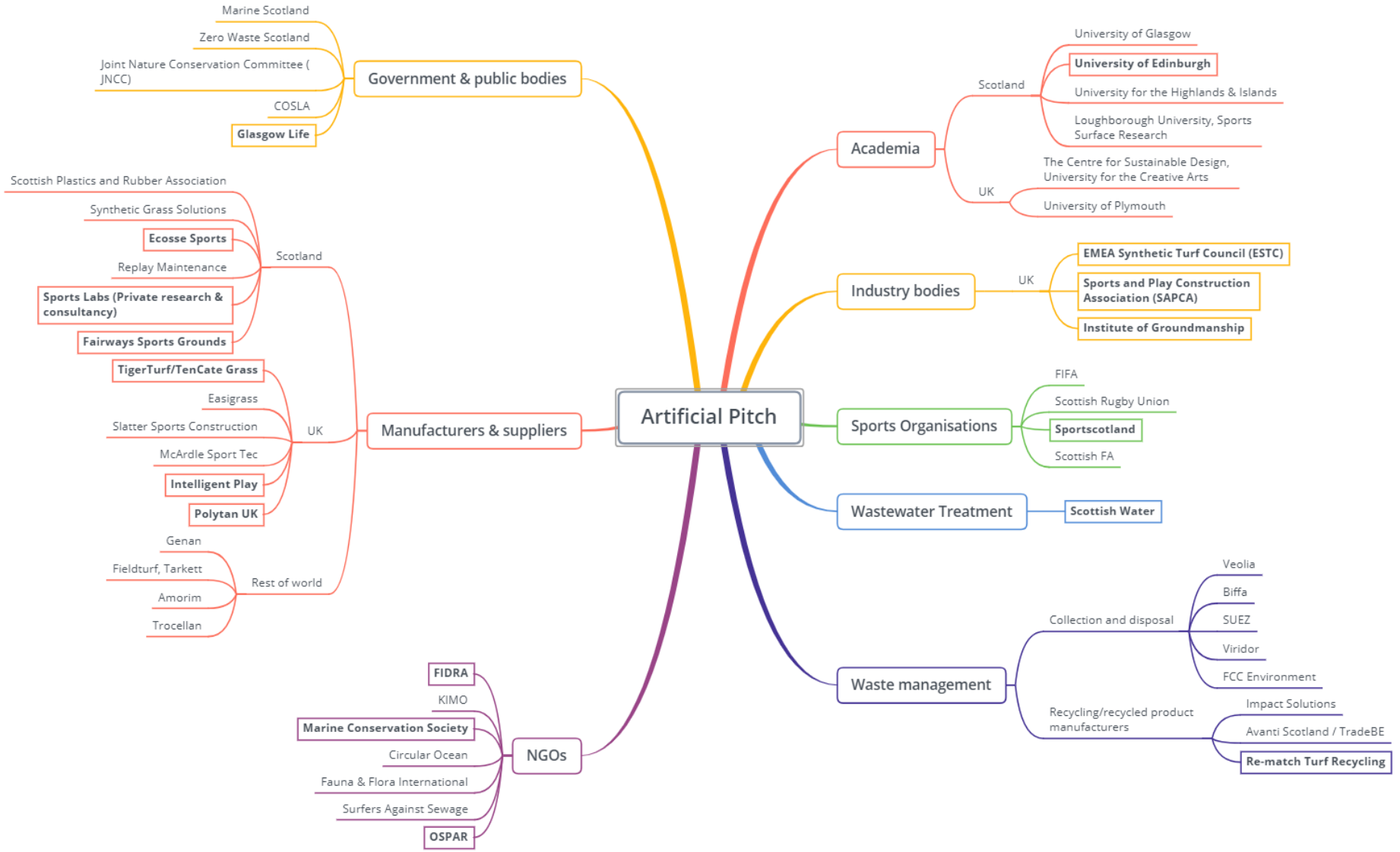
4.2 Stakeholder engagement

While multiple stakeholders will be impacted by the artificial grass pitch marine litter issue as it is a microplastic, awareness of the issue outside the supply chain remains limited[20]. A map of the wider stakeholder groups relevant for Scotland is shown in Figure 5.

Figure 5 highlights those who engaged in the research activities. A high level of awareness and interest in the issue was found across all stakeholder groups who engaged in the study. Common themes raised by stakeholders focussed on shortcomings of the procurement process which negatively impact infill loss and waste management at end of life. Views did not differ significantly amongst stakeholders over the cause of the issue and the solutions needed, with many of the required product design solutions ready for market. However different parties prioritised solutions, barriers and enablers differently. These themes are explored in later sections.

[20] Eunomia (2018), Investigating options for reducing releases in the aquatic environment of microplastics emitted by products, https://www.eunomia.co.uk/reports-tools/investigating-options-for-reducing-releases-in-the-aquatic-environment-of-microplastics-emitted-by-products/

Figure 5: Artificial grass pitch - Stakeholder mapping. Note: organisations that engaged in the research activities are highlighted in a square box

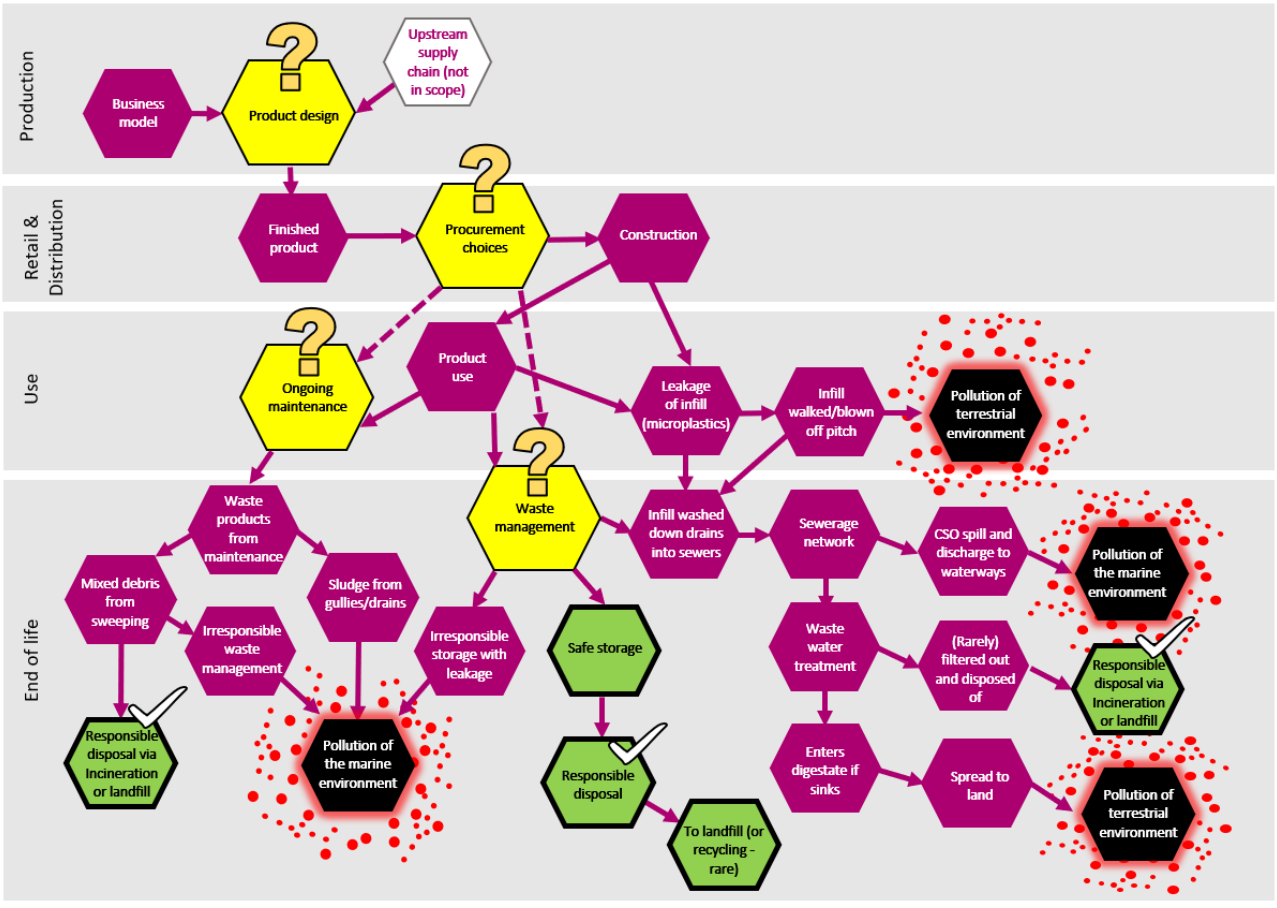


5 Marine litter pathways and key decision points

The following section discusses the marine litter pathways and key decision points, as per the second stage in the research framework, shown below.

The marine litter pathways for artificial grass pitch were investigated in the literature and stakeholder engagement. Figure 6 shows how these pathways stem from key decision points where one choice results in marine litter and another does not. For example, the procurement decision impacts installation design and waste management if an existing pitch is being replaced. For this reason, the waste management decision point has been discussed within the procurement choices discussion in section 6.1. Sometimes the first year of pitch maintenance is also included in an installation tender, alternatively the service can be procured separately or conducted in house. As such, ongoing pitch maintenance has been discussed as a separate decision point in section 6.3. Other key decision points are found across the value chain. For example, product design can also help tackle marine litter from artificial grass pitch infill and is discussed in section 6.2.

Figure 6: Artificial grass pitch - Marine litter pathways and key decision points



It is recognised that certain business models have the potential to help tackle marine litter. However due to the lack of relevant examples found it was not possible to explore this in detail. It will be important to consider how best to support beneficial new business models as they emerge in this context.

6 Drivers and barriers

The following section discusses the drivers and barriers at key decision points, as per the third stage in the research framework, shown below.

Stakeholder engagement highlighted three key decision points as the most important for artificial grass pitch, and are as follows:

1. Procurement decision for installation or replacement of artificial grass pitch (thus including the waste management decision point);
2. Product design; and
3. Maintenance decisions.

These key decision points are discussed in the sections below, drawing upon stakeholder engagement in the workshop and interviews, and literature review.

6.1 Procurement decision for installation or replacement of artificial grass pitch

Procurement of pitch installation services occurs either by: [21]

- direct commissioning - of a contractor by a client, who may have budgetary constraints or be unaware of key issues), or
- design and build - including involvement of designers and architects giving greater opportunity for them to lead on regulatory issues.

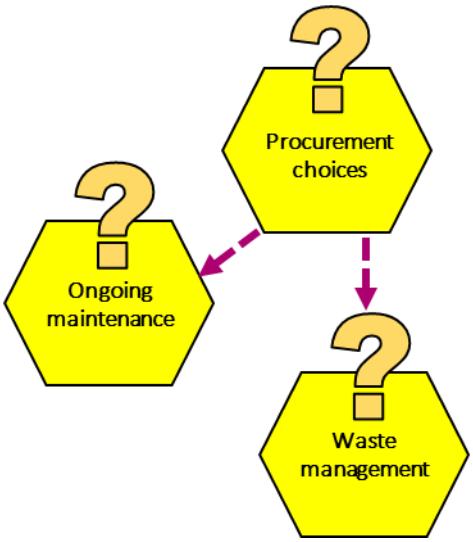
The latter was not discussed further during the current project as all but one interview focussed on the former; as such this section is solely based upon direct commissioning. As only one stakeholder mentioned design and build contracts it is assumed that these are less common than direct commissioning.

The key actors at this decision point are procurement teams, manufacturers, installers, and waste management companies (if an existing pitch is being replaced). As discussed in section 4.1, organisations operate across multiple parts of the value chain, but tenders for pitch installation may involve subcontracting certain aspects.

The point of procurement choice is illustrated in Figure 7 as a simplified extract from the full mapping of marine litter pathways and key decision points in Section 5. Waste management is discussed alongside procurement choices as stakeholder engagement suggests that these two decision points are always linked. However ongoing maintenance is discussed separately in Section 6.3 as maintenance can be done in house and as such is not always linked to procurement decisions.

[21] Interview with turf testing and research and development company

Figure 7: Decision point – procurement choices (simplified)



The point of procurement choice, focussing on procurement of pitch installation is illustrated in Figure 8 as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

Figure 8: Decision point - procurement of pitch installation

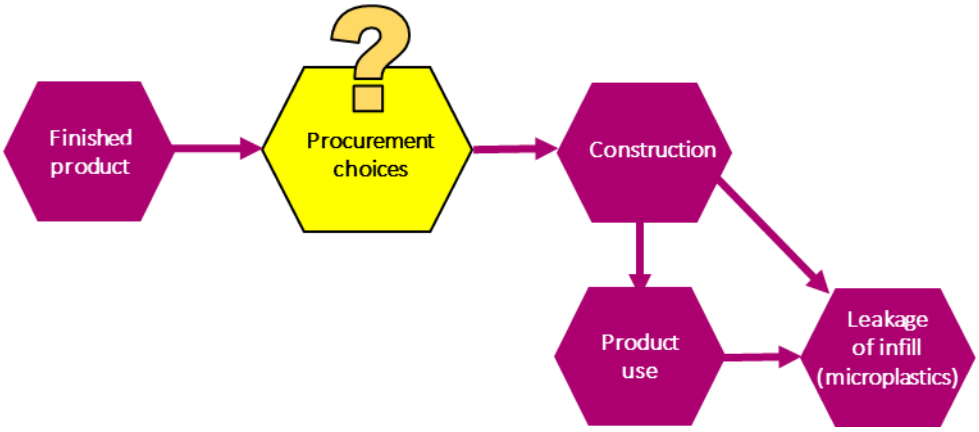
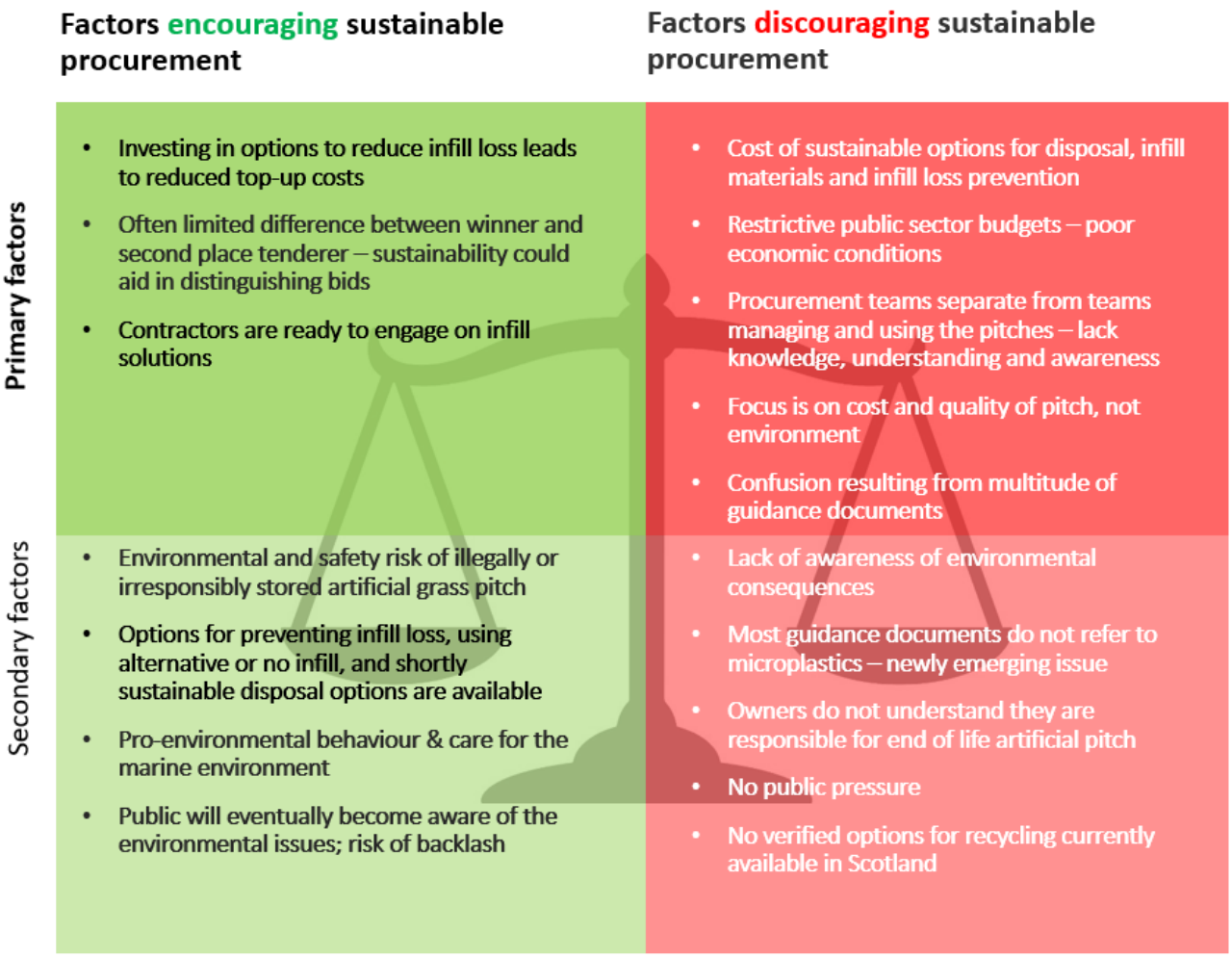


Figure 9 shows drivers and barriers identified affecting procurement decisions particularly focussing on sustainable procurement. This information was derived from stakeholder interviews, workshops and literature review. On the left of the figure; pro-environmental behaviours, readiness of contractors to engage and reduced spend on infill top-up encourage sustainable procurement decisions. On the right; sustainable procurement is discouraged by cost and lack of understanding of key issues.

Figure 9: Drivers and barriers in procurement decisions



Procurement processes

Historically, procurement at a Local Authority (LA) level was undertaken by the sports teams[22]. This is now done by the authority's procurement team who are isolated from pitch use and playing requirements[23]. When attempts were made to contact a Scottish University's artificial grass pitch procurement team, the Operations Manager for sports and exercise directed us to the Estates team, who suggested that all procurement including maintenance was contracted out. In both cases, specialist knowledge which should (and did previously for LAs) drive procurement has been lost[24].

[22] Comment in workshop by artificial grass pitch company involved in installation, maintenance and developing end of life

[23] Comment in workshop by artificial grass pitch company involved in installation, maintenance and developing end of life

[24] Comment in workshop by artificial grass pitch company involved in installation, maintenance and developing end of life

Despite multiple attempts to engage this part of the supply chain in the research, both at LA level and from sports clubs, only one organisation involved in procuring pitches was willing to engage. This organisation suggested that they ensure that there has been independent quality testing on pitches they procure[25], which could mitigate against lack of awareness and specialist knowledge in procurement teams.

Tenders are generally weighted almost entirely to cost, with discussions in the focus group suggesting a 90:10 cost to quality ratio. This has resulted partially from the lack of knowledge of some procurement teams but primarily from poor economic conditions and LA budget cuts[26]. Often only four or five companies will bid and the price differential between the company who wins the contract and the company in second place is very small[27], suggesting a highly competitive market where environmental considerations are side-lined by cost. The small price differential is becoming a driver for some procurement teams to place a higher (but not equal) weighting on quality in order to distinguish between bids[28], however it does not seem that this is common practice.

Guidance and standards

Available guidance documents appear both a barrier and a potential driver for sustainable procurement. A vast number are available, with some documented in Appendix C. One stakeholder stated that industry must align with SAPCA guidance, which covers all levels of construction in a bottom up guidance document[29]. This is compared with guidance from FIFA (and other sporting bodies), which only covers the upper layers (turf, infill and shockpad), to regulate quality standards for sports performance[30]. As the guidelines differ, they provide a barrier to procurement teams who can be confused by which guidance to follow[31].

SAPCA's guidance is used by LAs, schools, architects and others[32], however this is currently being updated so at present does not include any direction on the microplastics issue[33]. One company involved in installation and maintenance was unwilling to engage in this research any further than stating that they followed SAPCA guidance. Multiple other stakeholders also mentioned these guidance documents, showing stakeholders are aware of them. As such they could provide a familiar avenue to recommend best practice on both the microplastic and end of life issues if they were brought up to date.

Other than guidance from sporting associations which are monitored to ensure standards are maintained, compliance with other guidance documents is not audited[34], limiting its influence as a driver. However, there are currently plans to adopt the guidelines from Fidra and KIMO's Pitch In campaign on reducing infill loss throughout the supply chain[35] as a European Eurocode standard (EN) to provide a means of mandating

[25] Interview with organisation which procures artificial grass pitches
[26] Comment in workshop by artificial grass pitch company involved in installation, maintenance and developing end of life and interview with organisation which procures artificial grass pitches
[27] Interview with organisation which procures artificial grass pitches and interview with artificial grass pitch recyclers
[28] Interview with organisation which procures artificial grass pitches – used a 60:40 cost to quality ratio
[29] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[30] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[31] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[32] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[33] Interview with industry trade association
[34] Interview with industry trade association
[35] KIMO International, Pitch In, http://www.kimointernational.org/pitch-in/

best practice[36]. Enforcing this legislation could become a crucial driver for procurement teams and is discussed in full in section 7.6.2.

Sustainability

Currently, sustainability in the artificial grass pitch supply chain has been described as a box ticking exercise during the procurement process[37]. With tenders currently being assessed mainly on price, aspects of design or products which ensure greater sustainability cannot compete financially[38]. It has been estimated that fully fitting a pitch to prevent infill loss would cost £30,000[39]. To put this into perspective, in 2015 a tender was released by West Dunbartonshire Council for the construction of full sized all-weather 3G artificial sports pitches, including the provision or upgrading of floodlighting, perimeter fences and associated sports equipment, on two sites[40]. Where this involved replacement of an existing 3G pitch, the budget was £302,000[41]. Where this involved replacement of a natural pitch and so required earthworks, drainage and base construction, the budget was £545,000[42]. As such, installing infill loss reduction infrastructure would add 6-10% to the budget; a cost increase likely to lose a contract in an industry with tenders so competitive on price.

There is also a lack of understanding of "marine pollution" as terminology throughout the supply chain – individuals and organisations who may be aware of infill loss may not link this to marine pollution and to enable understanding, language needs to be very clear[43]. Despite bids being assessed mainly on price, those involved in procurement are beginning to become aware of the risk of a backlash once the public begin to understand this issue further if they do not choose to act, which could drive change in this industry[44]. However, there is no sign currently of increased public awareness, with only 23% of pitch users surveyed aware of environmental issues of artificial pitch and less than half aware of the risk of rubber crumb infill loss to rivers and seas (11% very aware and 34% vaguely aware; discussed further in Appendix D).

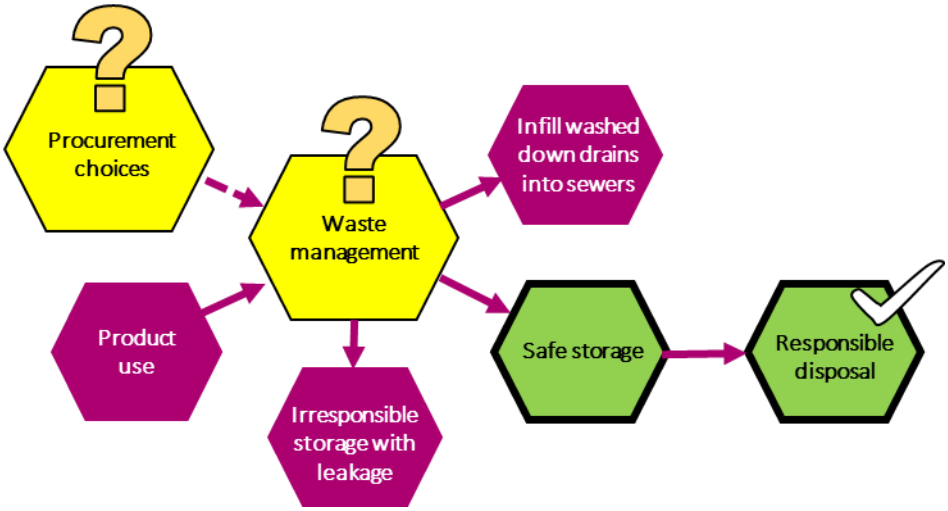
End of Life

The point of procurement choice, focussing on procurement of waste management is illustrated in Figure 10 as an extract from the full mapping of marine litter pathways and key decision points in Section 5. Waste management in this case refers to the pitch as a whole. However, in some cases waste management for the pitch may differ from management of infill, for example when infill is lost from the pitch it cannot be

[36] Interview with industry trade association and interview with turf testing and research and development company
[37] Comment at workshop by artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[38] Comment at workshop by artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[39] Interview with turf testing and research and development company
[40] Public Contracts Scotland (2015), PCS-Tender, https://www.publiccontractsscotland.gov.uk/search/show/search_view.aspx?ID=APR205938
[41] Public Contracts Scotland (2015), PCS-Tender, https://www.publiccontractsscotland.gov.uk/search/show/search_view.aspx?ID=APR205938
[42] Public Contracts Scotland (2015), PCS-Tender, https://www.publiccontractsscotland.gov.uk/search/show/search_view.aspx?ID=APR205938
[43] Interview with industry trade association
[44] Interview with organisation which procures artificial grass pitches

managed in the same manner and some 'recycling' options state that they shake out the infill before the turf is removed for reuse[45] – it is then unclear what happens to the infill.

Figure 10: Decision point - procurement of waste management



As well as procuring installation of new pitches, there is a growing requirement for replacing old pitches[46], with some organisations replacing their pitches on an 8-10 year rolling programme[47]. When pitches are replaced, waste management for the old pitch is procured in the same contract as the new installation, with installers also responsible for lifting and removing the old pitch[48], or subcontracting this role[49]. Owners and procurement teams (including local government) often do not realise that they have a legal obligation to ensure their end of life pitch is disposed of appropriately[50]. This is despite duty of care requiring that all bids should be evaluated for details of waste management, ensuring all is legal, correct and properly costed.

With contracts being awarded almost entirely on cost, there has been a race to the bottom on prices, with end of life being an area of major cost cutting[51]. An artificial grass pitch can be expected to weigh 140-190 tonnes at end of life[52]. It costs £110/tonne to landfill this material[53]. Waste management is being priced at around a third of true cost in bids, and a bid that priced at more than this would not win the contract[54]. As

[45] ESTO (2016), Quarterly Issue 7, https://www.estc.info/wp-content/uploads/2017/04/ESTO-Quarterly-7.pdf
[46] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[47] Interview with organisation which procures artificial grass pitches
[48] Interview with organisation which procures artificial grass pitches
[49] Interview with artificial grass pitch recyclers
[50] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[51] Interview with artificial grass pitch recyclers
[52] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[53] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[54] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions

the customer (procurement teams) are now used to paying prices too low to cover disposal costs, safe waste management via landfill is inhibited and the uptake of waste disposal options higher up the waste hierarchy are unfeasible unless they offer cheaper disposal routes than landfill.

There is no monitoring of artificial grass pitch collectors[55] resulting in great potential for foul play. To 'dispose' of this material at this price, it is currently being taken to 'storage' sites[56], where stockpiles are building up, as shown in Figure 11. There is a substantial issue with illegal dumping internationally[57], and in the Netherlands, a company selling its services as a recycling company but actually storing artificial grass pitch illegally experienced a large fire[58] - showing that this is both a huge environmental and safety risk. One stakeholder reported that waste turf is sometimes transported without waste transfer notes[59] – an illegal process. The potential for loss of infill from such sites and during transport is very high risk, as is the degradation of pile and backing due to exposure to the elements. Also, because they have charged a third of the true disposal cost, there are no funds available to move the material to adequate waste processing facilities. Local authorities in the Netherlands have conceded a fear of shutting down illegal operators in case they are then required to bear the cost of disposing safely of the stockpiled turf[60].

Figure 11: Stockpiled artificial grass pitch in the UK[61]

Figures are not available for Scotland, but in Oslo, Norway, of 46 fields replaced, 28 fields went to unknown locations[62]. The situation is believed to be considerably worse in the UK[63], with one site in the south of

[55] Interview with artificial grass pitch recyclers
[56] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions and interview with artificial grass pitch recyclers
[57] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[58] BN DeStem (2018), Artificial grass mats dumped by Tuf in Maasdriel have to go, but where to?, https://www.bndestem.nl/oosterhout/door-tuf-in-maasdriel-gedumpte-kunstgrasmatten-moeten-weg-maar-waarheen~afb43722/
[59] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[60] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[61] Shred and Recycle Ltd, http://www.shredandrecycleltd.com/page7.htm
[62] Interview with artificial grass pitch recyclers
[63] Interview with artificial grass pitch recyclers

England currently storing 25,000-30,000 tonnes of old artificial pitch[64]. A tender was put out on behalf of the FA, Sport England and others in 2016 to recycle 3G pitches in the UK, which the recycling company we spoke to had responded to, however it is understood this contract has not yet been awarded[65]. As Re-Match is the only verified recycler[66], if operators wish to procure a verified process they must effectively negotiate with a monopoly, which many are reluctant to do, thus acting as a barrier in some areas[67].

While some collectors may suggest they are recycling material there is no specific definition of this for artificial grass pitch[68] and some businesses refer to reuse as recycling[69]. While reuse is generally preferred to recycling as it is higher up the waste hierarchy, this is not the case regarding artificial grass pitch for multiple reasons:

- There is no clear market for reuse[70];
- Reuse is in lower value applications[71];
- Reuse most often involves segmenting the turf into small pieces for use in domestic applications, and if whole sports pitches are difficult to capture and efficiently recycle, small pieces are even less likely to be so and as such would be landfilled or incinerated[72];
- Reuse in this form is not necessarily legal as it is being resold in its original form despite being a waste product[73];
- Removing sand and rubber infill is likely to be ineffective[74] so reuse in alternative locations gives further potential for the spread of infill to the environment; and
- Material awaiting reuse is commonly stored in unregulated sites as shown in Figure 11.

The procurement organisation that engaged in this issue stated that they were actively trying to tackle the end of life issue. They were attempting to reuse their lifted material once the infill had been removed as walkways but had only been able to reuse 25% in the last three years[75], however as discussed above, this may not be legal. No recycling options are available in Scotland at present.

[64] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[65] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[66] Eunomia (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[67] Interview with artificial grass pitch recyclers
[68] Interview with industry trade association
[69] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[70] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[71] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[72] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[73] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[74] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[75] Interview with organisation which procures artificial grass pitches

One company in Scotland is in the process of bringing to market a recycling solution in response to the amount of material which they were having to send to landfill (160,000 square metres last year, 200,000 square metres this year)[76]. When questioned about how they would ensure feedstock for the plant when buyers are not willing to pay for responsible disposal options, they stated that they will only process the material they lift from contracts they win as an installer[77]. As such, they will continue pricing their work as they have to date but will process their own waste thereby saving on disposal costs. They will not rely on feedstock from any other contractors, as they would have to charge these contractors to process their waste, resulting in the contractors passing these costs on to their potential client, who would likely award the contract to a cheaper contractor.

Independently verified recycling of artificial grass pitch is currently available in Denmark and is in the early stages of development in the Netherlands[78]. Recycling can be cheaper than both landfill and incineration, which is often not possible due to the high calorific content of the material, and demand for recycling is growing[79]. Re-Match are the only turf recyclers that have their claims verified under the Environmental Technology Verification scheme[80]. They have a fully automated process which separates and processes all components[81]. Performance infill is processed to the degree that it can be used again on pitches, but other materials are lower grade streams unsuitable to replace virgin materials[82]. Transporting end of life artificial grass pitch from Scotland to Denmark for recycling would be too expensive[83], and also involves environmental costs in terms of carbon impacts. To open a facility in the UK, a significant financial investment would be required, as well as a guarantee of material feedstock for processing[84]. At present, this is not guaranteed[85] as the competition are able to charge lower prices by indefinitely storing pitches[86] and potentially illegal dumping[87], and are as such likely to win more contracts which would reduce the feedstock Re-Match could expect.

In order to compete with virgin materials, pitch recyclers must be able to guarantee the quality of their output[88]. As such they must be cautious regarding their feedstock to reduce contamination risk. They can

[76] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[77] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[78] Re-match (2019), Re-Match to build 24 factories - starting in the Netherlands, https://re-match.dk/news/re-match-to-build-24-factories-starting-in-the-netherlands?PID=7786&M=NewsV2&Action=1
[79] Interview with artificial grass pitch recyclers
[80] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[81] Interview with artificial grass pitch recyclers
[82] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[83] Interview with artificial grass pitch recyclers
[84] Interview with artificial grass pitch recyclers
[85] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[86] Interview with artificial grass pitch recyclers
[87] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[88] Interview with artificial grass pitch recyclers

therefore not risk processing stockpiled material[89], which is often in a very poor state[90], due to long exposure to the elements, and because the quality of pitches in general has increased so much in the last two decades[91].

All stakeholders with whom this topic was discussed recognised the 'end of life' issue, with several stakeholders emphatic that this was a much greater environmental risk, with the potential for significantly more infill loss than occurs during the life of the pitch[92]. One individual working in the recycling of 3G pitches in the UK suggested that in the next 10-15 years there will be enough artificial grass pitch to fill Wembley Stadium[93].

6.2 Product design

In this value chain, the customer will only purchase artificial grass pitch readily available on the market[94], and there is a certain amount of mistrust amongst consumers regarding new products[95]. New artificial grass pitch products are developed by manufacturers and research companies and are tested to ensure they meet industry standards. The key actors in this decision point are manufacturers, research and development companies and, to a degree, the relevant industry bodies. The point of product design is illustrated in Figure 12 as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

Figure 12: Decision point - product design

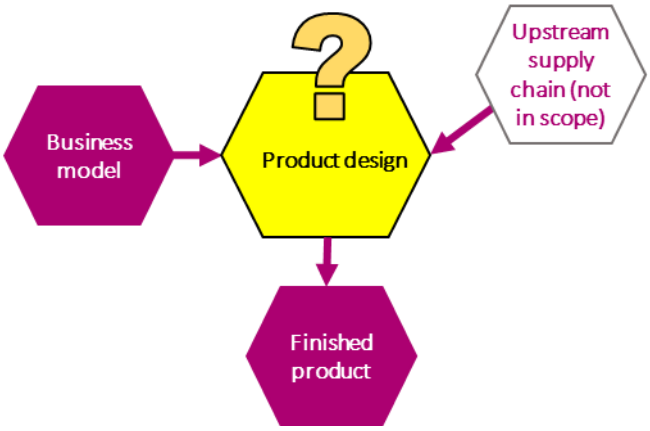
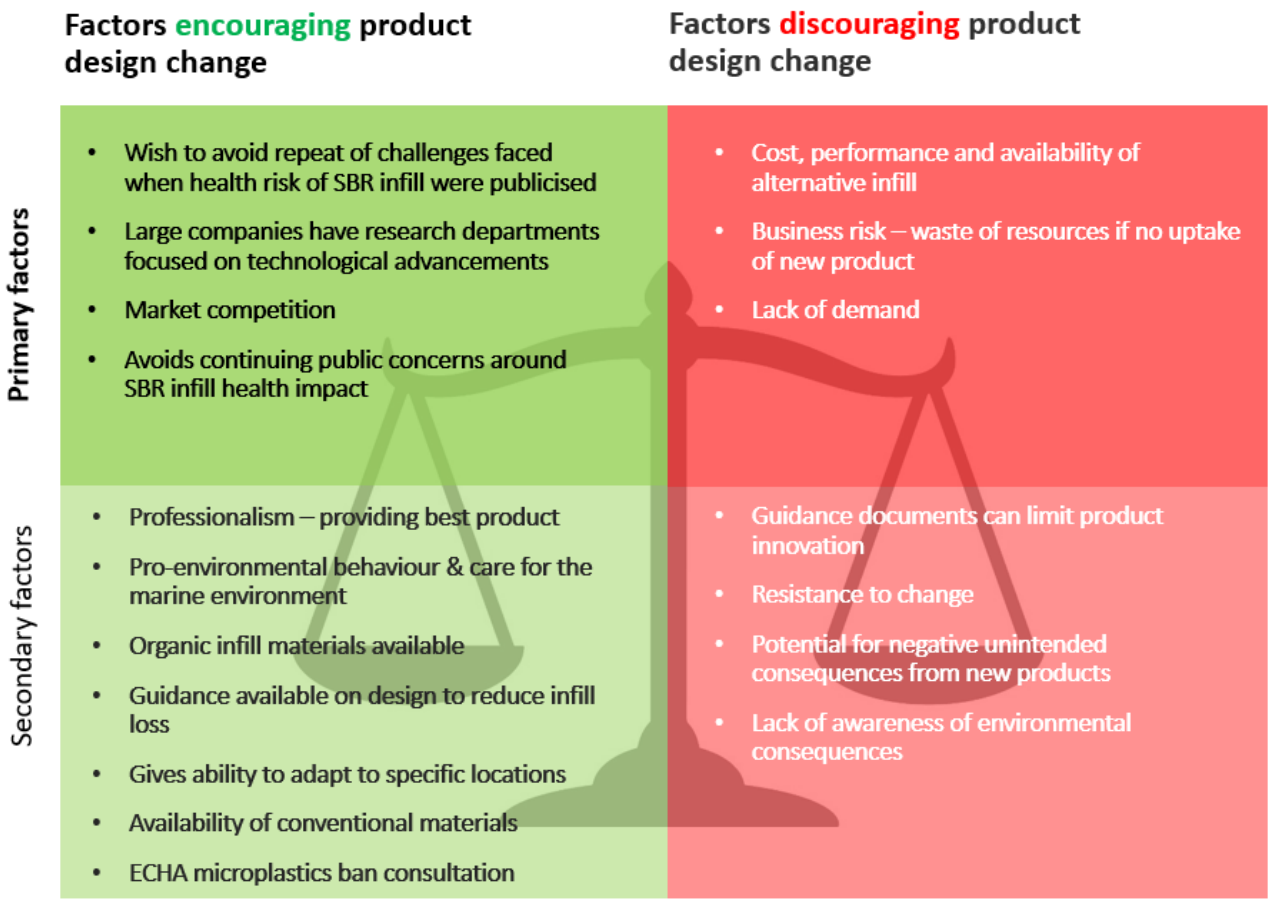


Figure 13 shows drivers and barriers identified affecting product design decisions. This information was derived from stakeholder interviews, workshops and literature review. On the left of the figure, pro-environmental behaviours, and market competition encourage product design change, as well as the wish to avoid further public concern around artificial pitch having recently responded to much debated health

[89] Interview with artificial grass pitch recyclers
[90] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[91] Interview with industry trade association
[92] Interview with artificial grass pitch recyclers
[93] The Telegraph (2018), Major new fears emerge over absence of recycling plan for 3G pitches, https://www.telegraph.co.uk/football/2018/09/12/major-new-fears-emerge-absence-recycling-plan-3g-pitches/
[94] Interview with organisation which procures artificial grass pitches
[95] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

risks (discussed below). On the right, product design change is discouraged by cost and lack of demand for products that address the marine litter issue.

Figure 13: Drivers and barriers in product design decisions



In this industry, product design development seems to be driven by market competition; the large multinational companies have their own research and development divisions[96, 97, 98], which have advanced artificial grass pitch technologies as new materials are developed to ensure improvements in the surfaces in terms of safety, quality, play performance and aesthetics[99]. Quality standards produced by world sporting bodies[100, 101] regulate minimum standards of artificial grass pitch quality for the varying divisions of play, which drives product design as manufacturers strive to produce products which meet these standards[102].

[96] FieldTurf (2019), A philosophy of innovation, http://www.fieldturf.eu/en/the-fieldturf-difference/a-philosophy-of-innovation
[97] SIS Pitches (2019), Innovation, https://www.sispitches.com/products/innovation/
[98] TenCate Grass (2019), Research and development, https://www.tencategrass.com/emea-en/technology-innovation/research-development
[99] TenCate Grass (2018), The evolution of grass, https://www.tencategrass.com/emea-en/technology-innovation/guidance-synthetic-turf/Evolution-of-Grass
[100] FIFA (2015), FIFA quality programme for football turf: handbook of requirements, https://football-technology.fifa.com/media/1239/fqp-handbook-of-requirements-v26.pdf
[101] World Rugby (2017), World Rugby Handbook Regulation 22, https://www.world.rugby/handbook/regulations/reg-22/reg-22?lang=en
[102] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

Developing new products also ensures manufacturers have products to suit the specific needs of individual locations; one stakeholder reported that they had only be able to install their novel products which address marine litter concerns in contracts where special conditions enabled detailed consideration of their products[103]. However, it was suggested that some members of the industry are resistant to change[104].

The industry is becoming more aware of the environmental risks associated with artificial grass pitch, and multiple products have been developed to address environmental concerns; including using recycled materials[105], shockpads[106], revolutionary yarn and tuft designs which allow for non-infill pitches[107] and hybrid turf systems[108] – details of each are provided in Table 2. However, with the exclusion of the Ecocept product which uses recycled materials and differs in its construction methods[109, 110], these systems are generally considerably more expensive, especially non-infill systems[111].

Table 2: Product design changes which address the marine litter issue

Solution	Description	How does this address marine litter issues?
Use of recycled materials	Ecocept works similarly to a shockpad in that it enhances biomechanical properties, but also offers load bearing capacity to reduce the need for a thick crushed stone layer, and has drainage capabilities[112].	Made from recycled turf systems including SBR rubber, creating demand for waste material from pitches. Also requires less infill.
Shockpads	Has similar performance characteristics to infill, but is in a single layer under the secondary backing as shown in Figure 2	Reduces the amount of infill needed for the same performance level[113]

[103] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[104] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[105] TigerTurf (2016), TenCate Ecocept in Numbers, https://tigerturf.com/uk/tencate-ecocept-in-numbers
[106] Progame, Football shock pads, https://progame-shockpads.com/football/
[107] ARTURF (2019), Infill Or Non-infill Artificial Grass, Which Is Better?, https://www.arturf.com/support/infill-or-non-infill-artificial-grass/
[108] Sports Labs (2018), What is the Big Fuss About Hybrid Turf Systems?., https://www.sportslabs.co.uk/field-notes/2018/3/14/what-is-the-big-fuss-about-hybrid-turf-systems
[109] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance
[110] TenCate, Ecocept product outline, https://tigerturf.com/nz/images/uploads/blog/Product_outline_TenCate_Ecocept_v1.5_.pdf
[111] Interview with organisation which procures artificial grass pitches and interview with industry trade association
[112] TenCate, Ecocept product outline, https://tigerturf.com/nz/images/uploads/blog/Product_outline_TenCate_Ecocept_v1.5_.pdf
[113] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf

Solution	Description	How does this address marine litter issues?
Non-infill pitches	Non-infill pitches can be seen as a step backward for artificial grass pitch as original designs do not have infill. However, new versions have "revolutionary" tuft and yarn systems which acts to support the pile similarly to infill[114]	No infill needed, but cannot meet the same performance standards[115]
Hybrid pitches	Hybrid systems involve strengthening soils with fibres or plastic mesh to allow more extended play[116]	No infill needed

The industry is wary of creating a new environmental problem while addressing an existing one, and as such some companies are undertaking Life Cycle Assessments on their key products to demonstrate overall improvement[117].

Materials

Alternative infill materials are now coming to the fore, including cork, coconut and walnut shell, however there are a number of concerns surrounding cost, durability, quality, health and social impacts[118, 119]. However, even when considering coconut husk, repurposed paper/cellulose, woodfill chip, cork, and walnut husks together, current production would not be enough to supply more than half of the market and each has its own significant disadvantages[120].

Regarding traditional materials, products such as Ecocept are designed to maximise resource use efficiency by ensuring materials from old pitches can be used in new[121], and will support developments underway regarding recycling of artificial pitch in the UK[122]. A factor involved in current product development is the ECHA consultation on a ban on intentionally added microplastics, including rubber crumb infill from artificial grass pitch[123]. There are currently uncertainties regarding the outcome of this consultation[124],

[114] Sports Labs (2018), Another look at non-filled artificial turf, https://www.sportslabs.co.uk/field-notes/2018/11/7/another-look-at-non-filled-artificial-turf
[115] Sports Labs (2018), Another look at non-filled artificial turf, https://www.sportslabs.co.uk/field-notes/2018/11/7/another-look-at-non-filled-artificial-turf
[116] Sports Labs (2018), What is the big fuss about hybrid turf systems, https://www.sportslabs.co.uk/field-notes/2018/3/14/what-is-the-big-fuss-about-hybrid-turf-systems
[117] Comment during workshop from artificial grass pitch company involved in design, manufacturing, installation and maintenance
[118] PlanMiljø (2017), Environmentally friendly substitute products for rubber granulates as infill for artificial turf fields, https://www.miljodirektoratet.no/publikasjoner/2018/januar-2018/environmentally-friendly-substitute-products-for-rubber-granulates-as-infill-for-artificial-turf-fields/
[119] KIMO, Guidelines for Designers and procurement specialists, http://www.kimointernational.org/download/9756/
[120] Interview with turf testing and research and development company
[121] TigerTurf (2016), TenCate Ecocept in Numbers, https://tigerturf.com/uk/tencate-ecocept-in-numbers
[122] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[123] ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73
[124] Interview with industry trade association

however multiple industry players have responded stating that if a ban were to be enforced, a transitional period of around 6 years would be required[125].

Demand

Product design is heavily influenced by buyer demand. Buyers want a pre-made pitch, which has already been certified to industry standards[126]. While product innovation is constantly ongoing, buyers are wary of products too far from what they are used to[127]. This places those who are innovating at a disadvantage; only able to sell their new products when tenders include specific conditions which allow for greater detail assessment of their alternative products[128]. Once manufacturers can provide evidence and case studies of their product in use, the trust in and demand for the new product designs will begin to grow[129]. Large amounts of continued development, player feedback and monitoring are required to ensure demand by addressing issues around skin abrasion, stability and to ensure the pros and cons of these surfaces from a player's perspective are understood[130].

Industry guidelines can also limit the uptake of innovative products. Non-infill systems do not meet FIFA requirements and as such a new standard must be developed to test them against[131]. Another innovative product includes recycled materials, and as this changes the construction from the bottom up it is difficult to convince buyers that required surface characteristics can be achieved when everything below the infill layer is different[132].

Health scare debate

The artificial grass pitch industry has been involved in a multi-decadal debate regarding the purported health risks of SBR infill. Studies exist suggesting lack of risk and others demonstrate severe risk; considerable knowledge gaps remain despite the length of time the debate has raged for[133]. The quality of infill now is considerably different to that used 10 years ago[134], and any potential (and believed negligible) risks are regularly suggested to have been countered by the health, community and wellbeing benefits of regular sporting activity[135]. However, the experience gained through this scare has given the industry an understanding of how to approach the microplastics problem, a wish to avoid a similar experience and a desire to get ahead of any negative consequences, before they are forced to[136]. The industry is faced with a cost benefit analysis regarding both society and the environment when developing artificial grass pitch products.

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[125] ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73

[126] Interview with organisation which procures artificial grass pitches

[127] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

[128] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

[129] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

[130] Sports Labs (2018), Another Look at Non-Filled Artificial Turf, https://www.sportslabs.co.uk/field-notes/2018/11/7/another-look-at-non-filled-artificial-turf

[131] ESTC (2019), ECHA calls for total ban on plastic infill, https://www.estc.info/echa-calls-for-total-ban-on-plastic-infill/

[132] Interview with artificial grass pitch company involved in design, manufacturing, installation and maintenance

[133] Watterson (2017), Artificial Turf: Contested Terrains for Precautionary Public Health with Particular Reference to Europe?, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5615587/

[134] Interview with industry trade association

[135] Interview with turf testing and research and development company

[136] Interview with turf testing and research and development company

6.3 Maintenance decisions

Maintenance of artificial grass pitches is key in reducing infill loss, ensuring suitable playing conditions and prolonging pitch lifespan. The key actors in this decision point are maintenance companies (or in-house maintenance teams), owners (or whoever procures maintenance services) and, to a degree, the relevant industry bodies, manufacturers and installers who can give guidance on maintenance regimes. The point of ongoing maintenance is illustrated in Figure 14 as an extract from the full mapping of marine litter pathways and key decision points in Section 5.

Figure 14: Decision point - ongoing maintenance

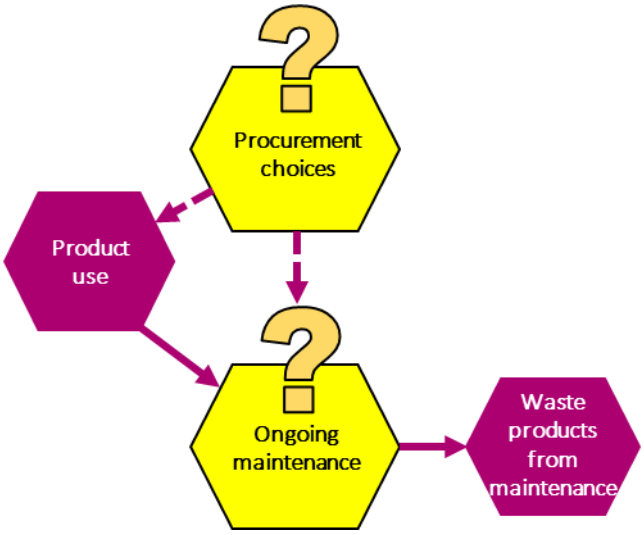
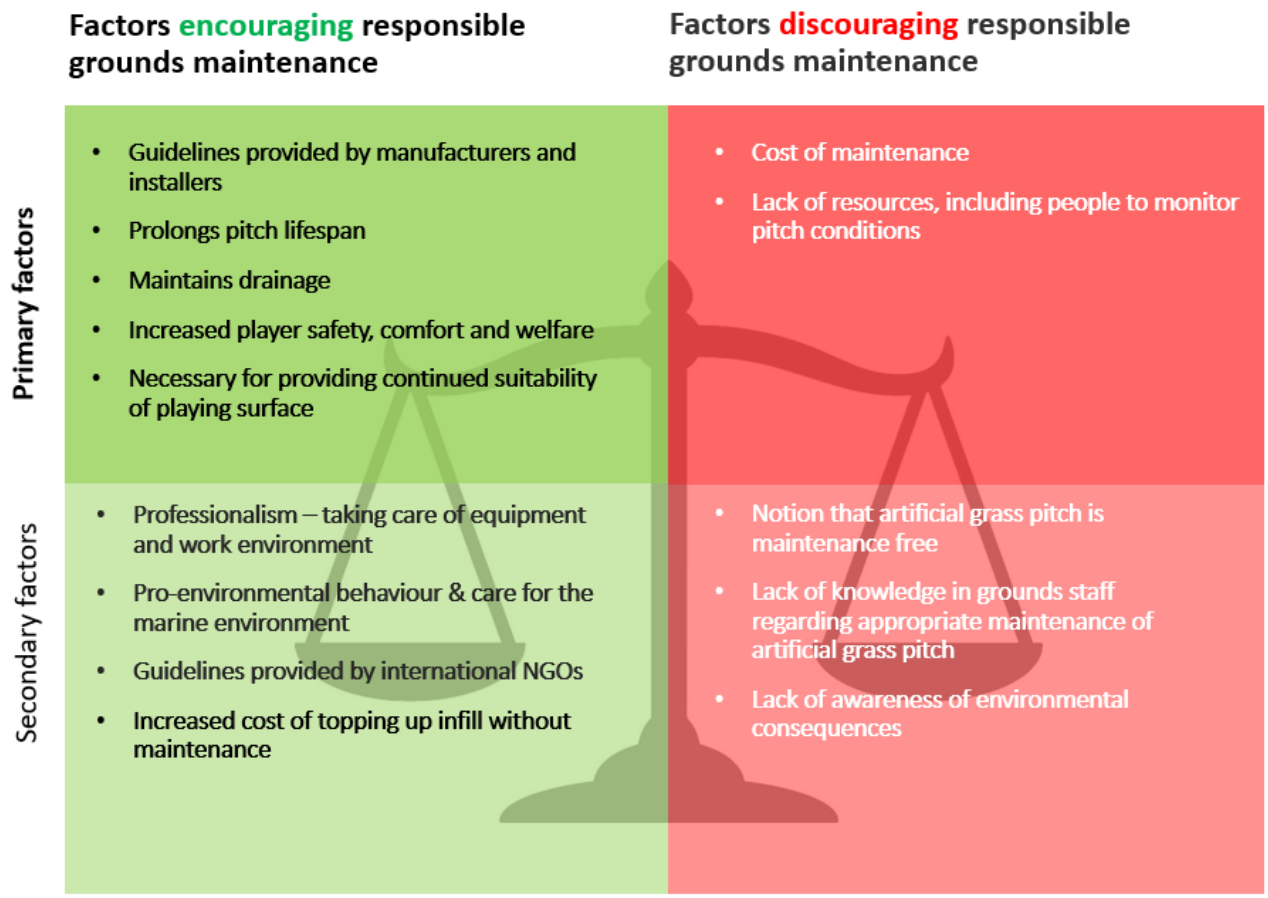


Figure 15 shows drivers and barriers identified affecting maintenance decisions. This information was derived from stakeholder interviews, workshops and literature review. On the left of the figure, pro-environmental behaviours, guidelines provided by manufacturers and installers and the desire to provide a suitable playing surface in terms of playability and comfort encourage responsible maintenance. On the right, responsible maintenance is discouraged by cost and lack of awareness of those that own the pitch that maintenance is required.

Figure 15: Drivers and barriers in maintenance decisions



Cost

In terms of discouraging responsible artificial grass pitch maintenance, cost may be a major barrier for small organisations or LAs – the annual cost of maintenance for one artificial grass pitch has been estimated at £14,000[137]. One organisation interviewed, which contracted out the fortnightly maintenance for the 46 artificial grass pitches it is responsible for in Glasgow, ensured that pitch managers also checked surfaces daily to monitor for repair needs[138]. As such, on smaller community pitches, cost both in terms of finances and human resources to conduct maintenance and monitor the pitches will likely be a major barrier to undertaking appropriate maintenance regimes.

However, as artificial grass pitches are often chosen to maximise income from the number of hours the pitch is used, maintenance is a necessary cost if owners are to maintain playing performance and encourage customers wishing to use the pitch[139]. One company we spoke with estimated that they had a

[137] TigerTurf (2017), The price of winter weather – how much is your pitch costing you?, https://tigerturf.com/uk/the-price-of-winter-weather-how-much-is-your-pitch-costing-you

[138] Interview with organisation which procures artificial grass pitches

[139] Pitchcare (2012), Artificial pitch maintenance - who, how, when and why?, https://www.pitchcare.com/news-media/artificial-pitch-maintenance-who-how-when-and-why.html

£1-million turnover in maintenance contracts from around 160 service agreements across Scotland[140], showing that a number of pitch owners are aware that they require this service for their pitches.

Maintenance guidelines are generally set out by manufacturers and installers[141], and failure to follow the recommendations can lead to invalidation of the pitch warranty[142], another financial risk.

Benefits

While there are costs associated with maintenance, the benefits acquired by thorough, responsible maintenance regimes are high. Poor or lacking maintenance results in infill loss, which could be prevented[143, 144], with associated negative impacts on the environment and finances as the infill must then be topped up. Responsible maintenance prolongs the lifespan of pitches[145], maintains drainage[146] and playability and ensures player safety and comfort[147].

Awareness

Artificial grass pitch was once thought of as maintenance free[148], and in some cases this notion remains, despite maintenance being essential to ensure the continued suitability of the surface for play. There is a lack of awareness around necessary and suitable artificial pitch maintenance regimes. These differ from natural grass pitch maintenance and as such require maintenance staff or groundsmen experienced in maintaining artificial pitch. Guidance documents[149] and training courses are available[150], however no information was available on the uptake of these resources. It seems likely that smaller facilities which do not have contracted maintenance teams are most at risk of lacking awareness of correct maintenance procedures due to lack of resources and small staff teams.

7 Potential solutions

The following sections discuss the potential solutions, the final stage in the research framework, shown below.

[140] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[141] Interview with organisation which procures artificial grass pitches
[142] Pitchcare (2012), Artificial pitch maintenance - who, how, when and why?, https://www.pitchcare.com/news-media/artificial-pitch-maintenance-who-how-when-and-why.html
[143] Interview with industry trade association
[144] Interview with organisation which procures artificial grass pitches
[145] Pitchcare (2012), Artificial pitch maintenance - who, how, when and why?, https://www.pitchcare.com/news-media/artificial-pitch-maintenance-who-how-when-and-why.html
[146] Interview with organisation which procures artificial grass pitches
[147] STM, Football pitch maintenance, https://syntheticturfmaintenance.co.uk/sports/football
[148] Replay Maintenance (2013), Artificial Turf Pitch Maintenance is Key, https://www.replaymaintenance.co.uk/2013/08/22/artificial-turf-pitch-maintenance-is-key/
[149] KIMO, Guidelines for owners and maintenance teams, http://www.kimointernational.org/download/9759/
[150] Institute of Groundsmanship, On course to protect 3G investments, https://www.iog.org/news/course-protect-3g-investments

A number of potential solutions have been identified through the course of this research. They are explored further in sections 7.1-7.5, and are linked to key decision points in Table 3. The table shows where the direct impact of each solution will be felt. However, changes to the procurement process will have knock on effects throughout the supply chain, ensuring environmental considerations can be properly valued and incorporated into financially competitive tenders. Stakeholders recommended that the Scottish Government needs to continue to work across the supply chain, due to the scale of this issue[151].

[151] Interview with industry trade association

Table 3: Artificial grass pitch - where solutions can most influence key decision points

Life cycle stage	Key decision point	Green procurement framework	Accreditation	Education	Funding	Guidance	Eurocode Legislation	ECHA Ban
Production	Product design	✔	✔	✔	✔	✔	✔	✔
Retail	Procurement decision	✔	✔	✔	✔	✔	✔	✔
Use	Maintenance decision	✔	✘	✔	✘	✔	✔	✔
End of life/recovery	Waste management decisions	✔	✔	✔	✘	✔	✔	✘

✔ = Yes, ✘ = No, ✔ = Yes - if solution designed with this in mind, ? = Unknown

7.1 Green procurement framework

Workshop participants and interviewed stakeholders emphasised that the current procurement process, particularly in LAs, needs to change[152]. A green procurement framework could be designed as a solution to both the microplastics and end of life problem. To succeed it must be properly enforced, and not simply self-assessed with tick boxes on procurement forms as is the common test for 'sustainability' at present. It could act as a solution by ensuring that the value of solutions to mitigate infill loss were properly valued, and key processes in waste management are audited. A framework would also ensure that all who procure artificial grass pitches through the framework comply with high standards and are engaged with this issue, rather than expecting individual procurement teams to act to address these issues individually[153], and at cost to themselves.

Example frameworks and sustainable procurement processes are available for Scottish Government to build on – these are detailed in sections 7.1.1 and 7.1.2. Learnings could be gathered from the stakeholders involved in these examples to develop a successful framework.

There is already a procurement framework available in Scotland for artificial outdoor surfaces – Scotland Excel use this to evaluate contractors suitable to be on a framework for councils to use. In 2020, Scotland Excel will begin consulting with stakeholders across the value chain on their new framework, which will run from 2021 to 2025. They have already had enquiries regarding making this more sustainable, and will be looking to achieve this. While individual councils can change aspects of their tenders to account for sustainability immediately, Scotland Excel's existing framework cannot change; all changes will have to be included in the new framework[154].

Crucial areas relating to sustainability for the framework to cover would be:

- Infill loss prevention (including infrastructure and duty of care required to prevent infill loss during installation and removal);
- LCA of products, allowing room for product innovation to advance quality, safety and sustainability of artificial grass pitch; and
- End of life treatment (including auditing practices to ensure compliance with waste management legislation).

A key aspect of a green procurement framework would be to assess bids weighting quality higher than cost. The Football Foundation framework discussed in section 7.1.1 assessed bids based on a 30:70 cost to quality basis[155]. Unlike the 90:10 cost to quality ratio currently used in most bids[156], this would ensure sustainable options could compete financially, and can be assessed based on cost effectiveness, not simply cost. Weighting quality higher than cost would allow procurement of 'best value' manufacturing and installation services in terms of whole-life cost, quality, and sustainability available to meet client

[152] Interview with artificial grass pitch recyclers and interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[153] Interview with organisation which procures artificial grass pitches
[154] Interview with Scotland Excel
[155] TED (2019), Works - 158306-2019, https://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:158306-2019:TEXT:EN:HTML
[156] Interview with organisation which procures artificial grass pitches

requirements, which local and national governments previously had the duty of obtaining[157]. An alternative would be to set minimum requirements for mitigating pellet loss and fully auditing waste management, and separately score the quality of suppliers' responses to these aspects.

Having a specialist team develop the framework with guidance from the existing examples would reduce the risk posed by the loss of knowledge along long procurement chains and could be a way to provide guidance to procurement teams. There is guidance to reduce infill loss[158], which could inform the development and review of this framework. However, any questions relating to end of life treatment would need to be developed carefully, and require specific, transparent, verifiable answers. Any responses relating to reuse would need to be extremely specific[159] and defined correctly[160]. Also, organisations procuring through the framework would need to ensure they had the capacity to monitor waste management practices[161], and the framework should dictate that any contractors found operating illegally would be removed from the framework.

One stakeholder suggested that if a tender requested zero infill loss, either no one would bid for it, or it would be bid for using so many conditions that the request would be irrelevant[162]. However, if all LA (or other bodies for which the framework is awarded in behalf of – see section 7.1.1 for example list) contracts required it, as would be expected of this framework, solutions would be developed in time. The same stakeholder reported that specific language would need to be used in tenders. This could include requesting clean construction sites and containment areas[163], using guidance like that of Operation Clean Sweep (guidance to help the plastic industry to reduce the accidental loss of pellets from processing facilities)[164] to monitor and prevent spills during construction. However, to use specific terminology across a wide framework would limit competition and innovation. As such, it is recommended to request an outcome (for example: zero pellet loss, all end of life turf recycled) and allow bidders to develop solutions.

The recycling company we interviewed stated that at present they are generally contracted by the company installing the new pitch to take away their material. In this existing system, illegal waste operations and underfunding waste management are hidden in bids. They would prefer to deal with pitch owners directly in order to create a market for recycling, as this would expose illegal operations which stand out by pricing removal at lower than cost price of landfill or recycling. To enable this, waste management should be a specific section of the framework, where those bidding must explicitly define their waste management plans, including timescales and costs. Any tenders with unrealistically low waste management costs should be disqualified – using the cost of £110 per tonne for landfilling this material could potentially provide a benchmark cost while no approved recycling options are available. To prevent contractors from charging extra but continuing to dispose of the waste using current practices, the

[157] Designing Buildings (2019), Best value, https://www.designingbuildings.co.uk/wiki/Best_value
[158] KIMO International, Pitch In, http://www.kimointernational.org/pitch-in/
[159] Interview with industry trade association
[160] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[161] Interview with industry trade association
[162] Interview with industry trade association
[163] Interview with industry trade association
[164] Plastics Industry Association (2017), Operation Clean Sweep Program Manual, https://www.opcleansweep.org/wp-content/uploads/OCS-Manual.pdf

framework should also specify the requirement of providing evidence in the form of waste transfer notes following the waste until final treatment or end of waste criteria is satisfied, and those procuring through the framework should accept the responsibility of monitoring and auditing this evidence, as is their duty of care. External audits may be necessary to ensure this is being undertaken. Developing a market for recycling would also encourage innovation and could be another step forward for the Scottish recycling sector alongside Project Beacon.

The solutions to the microplastic issue are available, and there are multiple manufacturers and installers willing to engage and work with procurement teams to develop more solutions. Recycling of artificial grass pitch is also on the horizon in Scotland[165]. However, there must be a change in the buying side to allow sustainable options to overcome cost barriers[166], and be valued economically, environmentally and socially. Manufacturers will only deliver what there is a demand for, and as such there needs to be a solution which stimulates demand for contracts that address the microplastics issue[167], which a green procurement framework could deliver. If the framework is awarded on behalf of the majority of the market and only contractors on the framework can be awarded the works, as exemplified in section 7.1.1, a green procurement framework would be very similar to accreditation, discussed in section 7.2.

7.1.1 Frameworks in the artificial grass pitch supply chain

Frameworks are already commonly used in the artificial grass pitch procurement process. For some LA contracts, contractors must be on the council's framework[168]. In 2015, a partnership between The Football Foundation, The Football Association, Rugby Football Union (RFU), England Hockey and Sport England tendered a framework to establish a means of ensuring that the procurement and installation of England's artificial grass pitches were of a consistent quality and price[169]. The framework was established to address concerns over the quality of artificial grass pitches and the inconsistent support offered by the industry at the time throughout the lifetime of the product[170]. The resultant high standards are now recognised by the wider industry and the framework was nominated for a national procurement innovation award[171].

[165] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[166] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[167] Interview with artificial grass pitch company involved in installation, maintenance and developing end of life solutions
[168] Interview with organisation which procures artificial grass pitches
[169] The Football Foundation (2016), Football Foundation Artificial Pitch Framework Nominated for Procurement Award, https://www.footballfoundation.org.uk/news/archive/football-foundation-artificial-pitch-framework-nominated-for-pro/
[170] The Football Foundation (2016), Football Foundation Artificial Pitch Framework Nominated for Procurement Award, https://www.footballfoundation.org.uk/news/archive/football-foundation-artificial-pitch-framework-nominated-for-pro/
[171] The Football Foundation (2016), Football Foundation Artificial Pitch Framework Nominated for Procurement Award, https://www.footballfoundation.org.uk/news/archive/football-foundation-artificial-pitch-framework-nominated-for-pro/

One of the members of the framework stated that for grassroots sport: [172]

> "it means local authorities, schools, and sports clubs around the country are able to access the best pitches from the best manufacturers, regardless of the source of their funding. They are then supported every step of the way through the technical design, installation, inspection, accredited testing processes, and maintenance, which enables them to acquire first class facilities at a more affordable cost."

Six suppliers and installers were appointed to this framework and undertake all the resulting work[173]. The Football Foundation framework was awarded on behalf of[174]:

- National Sports Centres;
- Applicants for Awards to Sport England;
- Central Government Bodies;
- Charities;
- Sports Councils;
- National Governing Bodies (of Sport) and their Applicants;
- Local Authorities;
- Education Bodies;
- The Football Association;
- Rugby Football Union;
- England Hockey;
- Rugby Football League;
- English Sports Council; and
- Community Sports Clubs.

7.1.2 Sustainable procurement of artificial grass pitch

As well as previous exemplars of frameworks in this supply chain, there are also examples of the microplastic issue being discussed in tenders in this industry. One stakeholder reported that the FA was currently putting their artificial grass pitch framework out to tender and would be including the microplastics issue and waste management as part of this[175]. A Norwegian County Council this year put out a Prior Information Notice (PIN) regarding the procurement of environmentally friendly artificial grass focussed on the risk of rubber crumb spreading to the environment[176]. The FA tender, and conversations resulting from the Norwegian PIN, could provide a basis to inform the appropriate wording of a green procurement framework in Scotland.

[172] TigerTurf (2016), What exactly is a framework agreement?, https://tigerturf.com/uk/what-exactly-is-a-framework-agreement
[173] England Hockey (2015), Sports bodies work together in new agreement on artificial grass pitches, http://www.englandhockey.co.uk/news.asp?itemid=32849&itemTitle=Sports+bodies+work+together+in+new+agreement+on+artificial+grass+pitches&section=22
[174] Ted (2015), Works - 150868-2015, https://ted.europa.eu/udl?uri=TED:NOTICE:150868-2015:TEXT:EN:HTML
[175] Interview with industry trade association
[176] TED (2019), Works - 158306-2019, https://ted.europa.eu/TED/notice/udl?uri=TED:NOTICE:158306-2019:TEXT:EN:HTML

Table 4: Desired effect of a green procurement framework on key decision points. Please note – waste management decision point is discussed alongside procurement decisions in section 6.1

Key decision point	Driver/barrier	Effect of solution
All	Lack of awareness of environmental consequences	Any publicity around and engagement with the framework will increase awareness
Product design	Large companies have research departments focused on technological advancements	Ensures there is a demand and so stimulates market to continue development of more sustainable artificial grass pitch, and solutions to target infill loss and waste management.
	Market competition	
	Lack of demand	
	Business risk – waste of resources if no uptake of new product	
Procurement decision	Procurement teams separate from teams managing and using the pitches – lack knowledge, understanding and awareness	The existence of the framework will increase awareness and understanding of key requirements which contractors must adhere to in order to tackle key issues.
	Restrictive public sector budgets – poor economic conditions	Framework to increase weighting towards quality; allowing for procurement of best value services economically, environmentally and socially; while representing true cost of waste management, and true value of maintenance.
	Focus is on cost and quality of carpet, not environment	
Maintenance decision	Cost of maintenance	
Waste management decision	Cost of sustainable options for disposal, infill materials and infill loss prevention	
	Owners do not understand they are responsible for end of life artificial pitch	The existence of the framework will increase understanding of duty of care for waste management.
	Environmental and safety risk of illegally or irresponsibly stored artificial grass pitch	Framework to prevent dumping or irresponsible storage of turf and allow development of recycling options.
	No verified options for recycling currently available in Scotland	

7.2 Accreditation

Scottish Government could develop an accreditation for manufacturers and installers to show they are actively reducing the risk of infill loss in their products and installations. There is already the European Technology Verification to increase the credibility of recycling processes[177], and we suggest that funding is directed to a training course for those responsible for maintenance (section 7.3). As such developing an accreditation scheme for manufacturers and installers would ensure there is a marker for procurement teams to identify best practice at each point in the supply chain.

Accreditation could cover the same aspects as suggested for the green procurement framework (section 7.1) – ensuring that manufacturers and installers are acting to reduce infill loss, are conducting life cycle assessments for their new products, and can demonstrate auditable waste management processes. It would need to operate alongside the existing standards used by FIFA and World Rugby.

If accreditation was implemented, and continuously updated, it could be used as a condition to assess quality in a procurement framework. Specifying that only accredited contractors would be considered would significantly simplify procurement, thereby overcoming part of the barrier of lack of awareness in procurement teams.

While this has the potential to have a large impact across the value chain, it would be a significant undertaking, and would require continuous monitoring as technology develops and new organisations apply for accreditation. As such, this may not be feasible for Scottish Government to implement and maintain, and could be better placed incorporated into FIFA or World Rugby existing standards.

If an accreditation was developed, it would need to be accompanied by education of procurement teams to create awareness and demand for accredited products.

Table 5: Desired effect of accreditation on key decision points. Please note – waste management decision point is discussed alongside procurement decisions in section 6.1

Key decision point	Driver/barrier	Effect of solution
All	Lack of awareness of environmental consequences	Introducing an accreditation scheme would raise awareness within the supply chain.
Product design	Market competition	Accreditation could stimulate market innovation as manufacturers compete to provide the best product.
	Professionalism – providing best product	
	Potential for negative unintended consequences from new products	Accreditation could require full LCA of key processes and products.

[177] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf

Key decision point	Driver/barrier	Effect of solution
Procurement decision	Often limited difference between winner and second place tenderer – sustainability could aid in distinguishing bids	Accreditation could aid in distinguishing competing suppliers and products.
	Procurement teams separate from teams managing and using the pitches – lack knowledge, understanding and awareness	
Waste management decision	Environmental and safety risk of illegally or irresponsibly stored artificial grass pitch	Accreditation to include necessity for auditable waste management procedures.

7.3 Education

Education was considered a vital solution by all present at the artificial grass pitch workshop, and it was deemed crucial that education particularly focus on the procurement decision stage. Education should be focused on infill loss and end of life issues, and should cover the causes, consequences and solutions to both of these problems. This could be delivered through funding seminars, knowledge transfer opportunities, or awareness raising initiatives which would enable people to better familiarise themselves with the environmental issues, with existing industry events providing opportunities for a slot on microplastics[178].

A trade body representing groundskeepers recommended that funding be directed towards ensuring those responsible for maintaining artificial grass pitches are fully aware of all the relevant issues. This would include the risk of marine litter from lost infill. It was suggested that funding be directed towards a specialist training course[179]. As poor maintenance, or a lack of maintenance is a key point of infill loss during the lifetime of the pitch, and the cost of topping up infill which has compacted due to lack of maintenance can be significant, this is likely an appropriate avenue to direct funding for education. However, it must be ensured that the owners of artificial grass pitches are aware of the training programme and send at least one of the individuals responsible for pitch maintenance to a training course, or that they employ maintenance contractors who have been through the training scheme.

While education and awareness raising around both the microplastics and end of life issues would be beneficial, this research has suggested that education alone would not be enough to address these issues. Barriers around cost would not be solved by further educating the supply chain on this issue. Alternative measures such as a procurement framework or an accreditation scheme provide opportunities for education and awareness raising, alongside removing barriers such as cost.

There is the potential that raising awareness of end users (those playing on the pitch) may have an impact up the supply chain, as seen in the 'Blue Planet effect'. However, as this research has shown that often those responsible for procurement are far removed from those using the pitch, this may not be a sufficient solution to drive a reduction in marine litter risk. If education was going to be made available for users,

[178] Interview with turf testing and research and development company
[179] Comment during workshop by a trade body representing groundskeepers

posters showing how rubber crumb reaches rivers and oceans and the importance of stopping this happening may be an appropriate educational tool. Our survey of Scottish artificial grass pitch users suggested that 66% would change their behaviour if they saw such posters. This survey is discussed further in Appendix D.

Table 6: Desired effect of education on key decision points. Please note – waste management decision point is discussed alongside procurement decisions in section 6.1

Key decision point	Driver/barrier	Effect of solution
All	Lack of awareness of environmental consequences	Education will be designed to increase awareness in those responsible for maintaining pitches, and those who operate at the procurement decision point, who directly influence product design and waste management.
	Pro-environmental behaviour & care for the marine environment	Once awareness is increased, there is potential for this issue to be carried in the 'Blue Planet' momentum.
Product design	Business risk – waste of resources if no uptake of new product	Increased awareness and engagement with the issue has the potential to stimulate demand for solutions to infill loss.
	Lack of demand	
	Potential for negative unintended consequences from new products	Increased education around different solutions to ensure a full lifecycle approach is prioritised.
Procurement decision	No public pressure	Increased awareness within the supply chain had the potential to spread to the public.
	Public will eventually become aware of the environmental issues; risk of backlash	
	Procurement teams separate from teams managing and using the pitches – lack knowledge, understanding and awareness	Education to be targeted at procurement teams.
Maintenance decision	Guidelines provided by international NGOs	Education could raise awareness of other resources including the Pitch In campaign.
	Notion that artificial grass pitch is maintenance free	Funding of training courses for those maintaining artificial grass pitches to ensure their understanding of required maintenance routines and the risks arising if from pitches which are not maintained.
	Lack of knowledge in grounds staff regarding appropriate maintenance of artificial grass pitch	

Key decision point	Driver/barrier	Effect of solution
Waste management decision	Owners do not understand they are responsible for end of life artificial pitch	Education to include duty of care for waste management.

7.4 Funding

Funding could be targeted at retrofitting of infill loss reduction infrastructure as described in Table 7. While the only procurement organisation engaged with this research stated that all their artificial grass pitches were fitted with the infrastructure required to minimise infill loss, it is likely that many are not so diligent.

Table 7: Infill loss reduction infrastructure[180]

Pitch infrastructure	Description
Solid boundary	Adding a solid (e.g. tarmac) surface 1-1.5m wide around the pitch means maintenance staff can easily collect scattered infill and put it back on the pitch. Should be designed without joints in which infill can accumulate and without using loose substrate which could contaminate infill material.
Elevated boundary	If there is no room for solid boundary, or in order to add additional protection, an elevated curb can be used to reduce microplastic spread. This is especially important if the pitch is elevated relative to its surroundings.
Low level perimeter boarding	Low level perimeter boarding around the pitch are is one of the easiest ways to reduce infill loss. This must be durable, or appropriate height for ball retention and safe, i.e. not a trip or head strike risk hazard. Best practice is to locate 5m from edge of play.
Storm drains and gutters	Avoid letting storm drains and gutters drain near the path around the pitch to avoid spreading infill to the aquatic environment.
Silt traps	Including silt traps in drainage plans can prevent 35% of infill lost to drains from entering watercourses. Advanced versions are available which filter out a higher percentage.
Entrance and exit infill removal stations	Provide players an area to remove infill from their clothes and shoes before they leave their pitch. Cattle grids can be used to stamp infill off of boots and brushing areas can be used where surrounded by a physical barrier to prevent further spread of infill.
Shower drain filters	Granular traps in changing room drains to prevent microplastic loss via shower water.
Bins in changing rooms	Provide a bin for loose infill in changing rooms collected from shoes and kit.

Of artificial grass pitch users surveyed, a third of respondents were already taking action to reduce the amount of rubber particles being removed from the pitch, and over 75% of those would leave all rubber crumb that they could on the pitch, use brushes to remove infill from clothes and boots and would stamp off and empty boots. Only 8% of users would be unlikely to brush down and empty their boots and 14% would be unlikely to shake their clothing out in a designated area. This suggests that an investment in such infrastructure would be utilised by users. Only 16% were willing to return granules to the field, showing

[180] KIMO, Guidelines for Designers and procurement specialists, http://www.kimointernational.org/download/9756/

users are at present only willing to take comparatively easy actions to reduce infill loss. However, 72% of all users would change their behaviour if there were specific stations set up to help them reduce rubber crumb escaping to the oceans. This survey is discussed further in Appendix D.

The Norwegian Environment Agency is currently consulting on new regulations for reducing infill loss and as part of this calculated that the average cost of fitting the necessary infrastructure is approximately 150,000 Norwegian kroner[181], or £14,000. One organisation suggested that the Scottish Government could contribute 50% of capital costs to each pitch requiring retrofitting, which could reduce the cost to the pitch owners to around £10,000[182], suggesting that cost of retrofitting in Scotland may be more than those estimated in Norway or that they envisioned different measures to be used.

Table 8: Desired effect of funding on key decision points. Please note – waste management decision point is discussed alongside procurement decisions in section 6.1

Key decision point	Driver/barrier	Effect of solution
Procurement decision	Cost of sustainable options for disposal, infill materials and infill loss prevention	Fund to help remove cost barrier to enhance the sustainability of community pitches, including retrofitting where necessary.
	Restrictive public sector budgets – poor economic conditions	

7.5 Guidance

A Scottish Government approved and publicised guidance document for those involved in the procurement process could influence the supply chain in a similar way to the green procurement framework discussed in section 7.1. This could be a light touch alternative to the green procurement framework and the accreditation scheme, designed to educate those procuring artificial grass pitches on environmental issues and how they link to all the services they procure – installation, maintenance and waste management. This was suggested by one stakeholder to be a simple way to tackle this issue[183].

Guidance should ensure that those involved in the procurement process are aware of the necessary questions to include in a tender for installation, maintenance and replacement (including waste management) of artificial grass pitch to ensure environmental issues are adequately considered by contractors. It should also provide procurement teams with a sufficient understanding of the issue of infill loss throughout the artificial grass pitch supply chain and the waste management issue, to ensure they are able to evaluate responses. It should ensure that procurement teams are aware not just of the cost of the services they procure, but their value, including both the costs and benefits of each decision economically and environmentally. Guidance documents could link to accreditation schemes (section 7.2) or include minimum requirements for waste management and infill loss prevention. This would ensure clear

[181] Miljødirektoratet (2019), Foreslår ny forskrift for håndtering av gummigranulat (2019/8215), https://tema.miljodirektoratet.no/no/Horinger/Regelverk/Foreslar-ny-forskrift-for-handtering-av-gummigranulat-20198215/

[182] Interview with turf testing and research and development company

[183] Interview with industry trade association

standards for procurement teams to check bids against and would provide an incentive for contractors to gain the accreditation.

This guidance document would not replace any existing guidance but could be used as a point of reference to direct stakeholders to existing guidance documents, including others addressing environmental issues[184, 185, 186, 187].

At present, there are a large number of guidance documents available for this industry (Appendix C), several of which have a great deal of influence on the industry, as discussed in section 6.1. However, guidance documents can also limit product innovation, present a barrier when they are out of date, or may simply not reach their intended audience[188]. To avoid these barriers, a project should be initiated by Scottish Government to develop a guidance document with input from the industry, potentially by holding a workshop as an opportunity to review and get feedback on draft guidance. It would be vital that multiple procurement teams engage with this project, a level of engagement which was not achieved during the current research. The document should also be updated periodically, as research progresses.

Table 9: Desired effect of guidance on key decision points. Please note – waste management decision point is discussed alongside procurement decisions in section 6.1

Key decision point	Driver/barrier	Effect of solution
All	Lack of awareness of environmental consequences	Guidance will increase awareness of procurement teams, who influence all other actors.
Product design	Guidance documents can limit product innovation	Guidance to be developed with input from across the supply chain.
	Business risk – waste of resources if no uptake of new product	Increased awareness resulting from guidance document may stimulate demand for more sustainable products.
	Lack of demand	
Procurement decision	Procurement teams separate from teams managing and using pitches – lack knowledge, understanding and awareness	Guidance document to aid procurement teams in designing and assessing tenders which require consideration of infill loss and end of life issues.
	Most guidance documents do not refer to microplastics – newly emerging issue	Guidance document to be updated as research and development around the topic continues.

[184] KIMO, Guidelines for Designers and procurement specialists, http://www.kimointernational.org/download/9756/
[185] KIMO, Guidelines for owners and maintenance teams, http://www.kimointernational.org/download/9759/
[186] ESTC (2018), Minimising the risk of micro-plastic pollution, https://www.estc.info/wp-content/uploads/2018/05/ESTO-Minimising-Micro-Plastic-Pollution-Report.pdf
[187] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf
[188] Interview with organisation which procures artificial grass pitches

Key decision point	Driver/barrier	Effect of solution
Maintenance decision	Guidelines provided by manufacturers and installers	Guidance to ensure procurement teams are aware that maintenance teams should be following these guidelines.
	Guidelines provided by international NGOs	
Waste management decision	Owners do not understand they are responsible for end of life artificial pitch	Guidance to include duty of care for waste management and information on the end of life issue.
	Environmental and safety risk of illegally or irresponsibly stored artificial grass pitch	

7.6 Other measures

There are a number of other measures currently under investigation which are external to the Scottish Government but which the Scottish Government may influence or benefit from. The development of these should be closely monitored to ensure any action taken by Scottish Government aligns with ongoing changes in the industry.

7.6.1 ECHA Ban

Currently, ECHA is consulting on a potential ban of intentionally added microplastics, including the infill used in 3G artificial grass pitches[189]. This is based on the lack of information with which to conduct a threshold-based assessment and their extreme persistence in the environment; as minimisation of release would also ensure minimising environmental risk and cumulative impacts[190]. As part of the response documents for this consultation, specific information requests were made in order to assess the implications of the restriction on these materials and to assess the possible need for a derogation, including requests for data on the amount of infill used and lost to the environment, examples of best practice for preventing infill loss and information on the impacts to society of banning this material[191].

While a ban would negate the risk of infill loss to the marine environment, multiple responses which have been submitted to date have stated the huge negative impact it would have across the whole industry, which would likely need several years to respond to the ban[192]. Stakeholders in the recycled tyre industry have responded to the consultation reporting on the negative impact this could have due to the amount of tyres reprocessed to be used in artificial pitch, which they argue could end up dumped in the environment if a ban was enforced.

[189] ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73
[190] ECHA (2019), Annex XV Restriction Report, https://echa.europa.eu/documents/10162/0724031f-e356-ed1d-2c7c-346ab7adb59b
[191] ECHA (2019), ECHA proposes a restriction on intentionally added microplastics, https://echa.europa.eu/documents/10162/b949137e-57a6-dde0-9f62-7ad0f58b123b
[192] ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73

7.6.2 Eurocode legislation

One stakeholder[193] spoke in depth about the current work between the European Synthetic Trade Council (ESTC) and KIMO regarding transposing the guidance documents developed during KIMO's Pitch In campaign into a European Eurocode standard (EN). This was also recommended as a solution by workshop attendees. These would provide minimum standards of design to stop or mitigate the loss of rubber crumb infill from artificial grass pitches.

The purpose would be to provide:

- Consistent and effective requirements to address infill loss;
- A means to prove compliance with requirements;
- A 'best practise' basis for construction and engineering contract specifications; and
- A framework for creating harmonized technical specifications (CE mark).

The Eurocode would be mandatory, like a building code, which may be enforced via the law and/or planning regulations. Elements might include:

- Use infill materials which reduce microplastic pollution;
- Install perimeter barriers, exit grates and other physical infrastructure adjustments to reduce microplastic emissions from existing fields;
- Provide maintenance staff with training regarding practical guidelines to mitigate the amount of infill lost during routine maintenance
- Guard against spillage (especially in maintenance and/or in pulling up pitches/refurbishment); and
- Ensure infill is not lost to surface water drains which drain into watercourses and ultimately the ocean.

If it was properly enforced, this is thought to effectively address infill loss during the use-phase of the pitch, however it does not go any way to tackle the potentially larger problem around end of life.

8 Recommendations

The analysis above presents opportunities for the Scottish Government to support the artificial grass pitch value chain in addressing this marine litter issue. Some members of the value chain recognise the problem of artificial grass pitch infill as microplastic marine litter, as well as the issue caused by irresponsible disposal practices at end of life. Many are willing to act, and options are available which can mitigate against the issue. However, as with all industry, supply and demand is the nucleus around which all operates. Solutions to manage infill loss exist but the market fails to recognise their value and so demand is lacking. As such government intervention is recommended in order to stimulate demand. Government intervention is also required to identify and prevent the continuation of illegal waste management practices.

Based on the research findings, the following recommendations are made to The Scottish Government in Table 10, with some broken down into smaller tasks. The recommendations presented have different potential efficacy, costs and timescales. To some degree the likely impact is related to the resources and support invested in any single measure. The recommendations are presented in a logical order to start in.

[193] Interview with turf testing and research and development company

Supporting education and engagement measures was a common request from stakeholders and could be initiated in short timescales. Developing a green procurement framework and guidance for procurement teams could be complementary and should be considered together. Addressing waste management issues is high priority and the subtasks outline immediate action that can be taken, while the issue may take longer to address in its entirety. Some quick wins are also identified in supporting best practice and new technology, but this should be seen as an ongoing task.

Table 10: Recommendations to address marine litter from artificial grass pitch

Recommendation	Details
1. Support education and engagement measures	Education was one of the most common suggestions from the stakeholder engagement and can address a broad range of issues. This should be targeted across the value chain but especially those involved in procuring pitches, potentially using the guidance document discussed in recommendation 3. Priority areas are the pathways, impacts and solutions available to prevent infill loss in order to illustrate that there is a risk, but also measures already available to counteract this risk. Such work can lay the foundation for further policy measures. Industry engagement is necessary to inform and direct other interventions, and to gain industry support.
2. Develop a green procurement framework	Cost, and the evaluation of bids for contracts weighted heavily to cost, is a major barrier in this industry to adopting the available solutions. It prevents an assessment of the cost effectiveness of solutions and as such sustainable options are often unable to compete financially. Developing a new procurement framework to ensure sustainability is considered as not just a yes/no option, but on an equal level with the quality of the pitch, is vital in order to tackle this issue. Contractors are ready to respond. Scotland Excel's framework could be used as a vehicle for change as it is redeveloped for release in 2021.
3. Develop guidance for procurement teams	A project should be initiated to develop a guidance document with industry input, potentially using a workshop to get feedback on draft guidance. Guidance could act similarly to the green procurement framework. It should highlight environmental issues and how they link to procurement of installation, maintenance and waste management. Guidance should clarify necessary questions to include in a tender to ensure environmental issues are addressed and enable procurement teams to adequately analyse responses. Guidance could include minimum requirements for waste management and infill loss prevention. This would ensure clear standards for procurement teams to check bids against.

Recommendation	Details
4. Review and improve current waste management processes	
a) Mandate reporting on the collection and treatment of waste	This information is a prerequisite to better understand the issue and design the best solutions. While stakeholder engagement and the literature has clearly stated that artificial grass pitches are being moved and potentially dumped illegally at end of life, further information is required on how this is able to happen and the scale of the problem in Scotland.
b) Understand current (baseline) waste management costs	This is crucial to evidence to the procurement organisations how much they should expect to pay for each waste disposal option. This should also include development of guidance on the documentation required to prove waste has been processed legally, to prevent operators from charging the expected rate but continuing to dispose of waste as they do currently.
c) Enforce appropriate duty of care requirements for waste from end of life artificial grass pitch	Some of the waste management practices which we were informed of through the course of this research are illegal, including moving end of life pitches without waste transfer notes. As such, increased enforcement of regulations should occur to prevent these practices.
5. Support best-practice and new technology	In particular, infill loss prevention guidance from KIMO, development of non-infill turf and the recycling infrastructure in Scotland. Regarding infill loss prevention, funding could be made available to ensure retrofitting of pitches and appropriate training for maintenance personnel. Research could also be undertaken on the size on infill required to optimises both playing performance and player safety, without being small enough to be lost via surface runoff, wind or carried away on players.

9 Comparable products

Of the 1.6 million tonnes of end of life rubber from tyres in the EU, roughly 40% takes the form of rubber granules and fine rubber powder, inside the size range of microplastics[194]. Almost half of this is used in artificial grass pitches. The remainder of the microplastic sized output is comprised of:

- A quarter which is mixed with polyurethane binders to produce 're-moulded' rubber articles such as wheels for trolleys or urban furniture.
- Just under a quarter is used in other sports surfaces, athletic tracks and children's playgrounds due to its capacity to absorb impacts, and it's permeable, weather-resistant and durable nature.

[194] European Tyre and Rubber Manufacturers Association (ETRMA) contribution to the public consultation on Annex XV dossier *In:* ECHA (2019), Registry of restriction intentions until outcome, https://echa.europa.eu/registry-of-restriction-intentions/-/dislist/details/0b0236e18244cd73

- The remainder is a fine rubber powder which is used as raw material for some high value applications including roofing systems and rubber asphalt.

That which is used in sports surfaces and playgrounds has the potential to leak to the environment in similar ways to artificial sports pitch infill. However, the rubber product for these surfaces is generally not loose but bound together to form a mat and so would need to degrade sufficiently to shed loose particles to provide a risk of marine litter during its use phase.

Many of the research findings for Artificial grass turf may be applicable to a range of products associated with diffuse and multi pathway microplastic pollution. From the perspective of risk to the marine environment, the other intentionally added microplastics currently being examined in the ECHA microplastics ban consultation are the closest comparable products. These include microplastics added to[195]:

- Cosmetic products (e.g. exfoliating, cleansing, illuminating products in lipsticks);
- Detergents and maintenance products (e.g. in surface cleaning products, fabric softeners, dishwashing liquids, etc.);
- Agricultural and horticultural products (e.g. fertilisers, soil conditioners or seed coatings);
- Medical devices (e.g. in ultrasound devices and in vitro diagnostic medical devices);
- Medicinal products (e.g. controlled release medicines – delayed, extended or targeted release);
- Food complements and medical food;
- Paints, inks and other coatings;
- Oil and gas;
- Technical ceramics;
- Media for abrasive blasting;
- Adhesives;
- 3D printing; and
- Printing inks.

All are being examined in the consultation due to their extreme persistence in the environment and because it has not been possible to develop a threshold for safe levels of release[196].

The consultation document provides evidence where available of percentage of each product grouping in each of three principle pathways to the environment[197]:

- Down-the-drain disposal;
- Municipal solid waste disposal; and
- Direct release to the environment.

[195] ECHA (2019), Annex XV Restriction Report, https://echa.europa.eu/documents/10162/0724031f-e356-ed1d-2c7c-346ab7adb59b
[196] ECHA (2019), Annex XV Restriction Report, https://echa.europa.eu/documents/10162/0724031f-e356-ed1d-2c7c-346ab7adb59b
[197] ECHA (2019), Annex XV Restriction Report, https://echa.europa.eu/documents/10162/0724031f-e356-ed1d-2c7c-346ab7adb59b (page 34)

This was not assessed for artificial grass pitch infill in the ECHA consultation, but in the current research project we have demonstrated that artificial grass pitch infill can reach the environment through each of these pathways, which is unlike any other sector or product group[198].

Agricultural film was one of the products investigated in the scoping study and is comparable in that it suffers from similar waste management issues: lack of viable waste management options, particularly in remote areas, exacerbated by time and cost to the waste producer in managing the waste.

The comparable solutions are likely to be around education and engagement, enforcing appropriate waste management; and for microplastics, a potential ban.

[198] ECHA (2019), Annex XV Restriction Report, https://echa.europa.eu/documents/10162/0724031f-e356-ed1d-2c7c-346ab7adb59b (page 37)

Appendix A Key organisations in the value chain for Scotland

A.1 Artificial grass pitch

Table 11 outlines key private sector organisations for Scotland in the role of manufacturing and supply of artificial grass pitch identified in this research.

Table 11: Artificial grass pitch - key organisations involved in manufacturing, installation and maintenance

Key Players	Location	Role within the supply chain
Synthetic Grass Solutions	Glasgow, Scotland	Surfacing contractor
Ecosse Sports	Midlothian, Scotland	Installation and maintenance contractor, developing recycling solution
Sports Labs	Livingston, Scotland	Testing/Research
Replay Maintenance	Midlothian, Scotland	Pitch maintenance contractor
Slatter Sports Construction	Berkshire, UK	Installation and maintenance contractor
TigerTurf	Hartlebury, UK	Surfacing manufacturer
McArdle Sport Tec	Oxfordshire, UK	Installation and maintenance contractor
Genan	Germany, EU	Tyre / Rubber crumb manufacturer
Fieldturf, Tarkett	France, EU	Pitch manufacturer (yarn)
Amorim	Portugal, EU	Pitch manufacturer (natural Infill)
Trocellen	Germany, EU	Pitch manufacturer (shockpad)
Polytan	Germany, EU	Pitch manufacturer offering installation, repair and maintenance

Appendix B Workshop activities

B.1 Introduction

Workshops were conducted to engage actors across the value chain and facilitate discussion of the marine litter issues. The workshops followed the research framework of the project, and informed by preliminary findings from the literature review and 1-2-1 interviews, focussed on key decision points in the supply chain to understand the drivers and barriers that lead to marine litter. This was followed by a discussion of solutions and a prioritisation exercise to help identify which of the points discussed were felt to be most pertinent by the participants in the room.

The workshop aims, agenda and participant lists are given below. The agenda was tailored to the product group and so workshops for each product in the study varied slightly, and reflected key knowledge gaps and discussion points that needed to be addressed.

The authors would like to thank all participants of the workshops and interviewees who contributed enormously to the research.

B.2 Artificial grass pitch workshop

Workshop intended outcomes

- Cross-supply chain discussion on influencing factors at key decision points that contribute to marine plastics
- Favoured solutions – generated from cross-value chain dialogue
- Noting differences of opinion across stakeholder groups / supply chain points

Workshop content

Part 1 – Potential solutions:
- Establish common understanding of broad categories of solutions to infill as marine litter
- Voting exercise on solutions most feasible / likely to succeed

Part 2 – Key decision points, barriers and enablers:
- Identify the key decision points in the value chain where solutions need to be adopted
- Discuss the barriers and enablers to adopting the solutions
- Voting exercise on most important barriers and enablers

Part 3 – Government support and other considerations:
- Discuss what the Scottish Government can do to encourage and support value chain solutions
- Discuss what other factors and stakeholder needs should be considered

Table 12: Artificial grass pitch workshop attendees

Organisation	Sector	Attendees
ESTC	Manufacturer trade association	1
SAPCA	Manufacturer trade association	1
Ecosse Sports	Manufacturer/supplier	1
Polytan UK	Manufacturer/supplier	1

Organisation	Sector	Attendees
Fairways Sportsgrounds	Manufacturer/supplier	1
TenCate Grass	Manufacturer/supplier	1
Sports labs	Sports industry	1
Sportscotland	Sports industry	1
Institute of Groundsmanship	Sports industry	1
Intelligent Play	Sports industry	1
Glasgow Life	NGO	2
Fidra	NGO	2
Marine Conservation Society	NGO	1
School of Geosciences at Uni of Edinburgh	Academia	2
Scottish Government	Government and public bodies	2

Appendix C Artificial grass pitch guidance documents for the supply chain

Guidelines	Details
Scottish Government (2018) Sustainable procurement guidance[199]	Guidance to help public sector bodies embed sustainability into procurement; covering climate change, materials, waste, biosecurity, biodiversity, and more
Scottish FA (2016) Stadia 3G Construction and Installation[200]	Guidance on installation of a 3G-football turf surface in a stadium environment, outlining key elements for consideration relevant to procurement, installation and post-installation (maintenance and sustainability)
Sportscotland (2012) 3G synthetic turf pitch[201]	Guidance for synthetic pitch design and suitability
Sportscotland (2006) School playing fields planning and design guidance[202]	Advice and guidance on detailed layout, design, specifications and maintenance for both primary and secondary school playing fields.
Football Foundation, The Football Foundation's Guide to developing third generation football turf pitches[203]	This Guide provides applicants with advice on procuring a Third Generation Football Turf Pitch (3G FTP) using The Football Association (FA), the Football Foundation (FF), the Rugby Football Union (RFU) National Framework for Football Turf Pitches, and either as a new facility, or as a refurbishment of your existing facility.
SAPCA (2009) The SAPCA code of practice for the construction and maintenance of synthetic turf sports pitches[204]	This document provides prospective clients and specifiers with guidance on the basic construction requirements and specifications currently employed in building a synthetic turf sports pitch.
SAPCA (2004) The SAPCA code of practice for the maintenance of synthetic sports surfaces[205]	This document provides owners, operators, grounds staff and managers of sports facilities with guidance on the basic maintenance requirements of tracks, pitches, and courts etc., which are surfaced with synthetic materials.

[199] Scottish Government (2018), Sustainable procurement guidance: index, https://www.gov.scot/publications/sustainable-procurement-guidance/
[200] Scottish FA (2016), Stadia 3G Construction and Installation, https://www.scottishfa.co.uk/media/2367/stadia-3g-construction-installation-guidelines.pdf
[201] Sportscotland (2012), 3G synthetic turf pitch, https://sportscotland.org.uk/documents/facilities/pitches_and_pavilions/101_-_3g_synthetic_turfs.pdf
[202] Sportscotland (2006) School playing fields planning and design guidance, https://sportscotland.org.uk/documents/resources/ssc0100192amendedplayingfields_playingfields_web.pdf
[203] Football Foundation, The Football Foundation's Guide to developing third generation football turf pitches, https://www.footballfoundation.org.uk/_resources/assets/attachment/full/0/22846.pdf
[204] SAPCA (2009), The SAPCA code of practice for the construction and maintenance of synthetic turf sports pitches, https://sapca.org.uk/wp-content/uploads/2018/07/SAPCA_Code_of_Practice_Construction_Maintenance_Synthetic_Turf_01.pdf
[205] SAPCA (2004), The SAPCA code of practice for the maintenance of synthetic sports surfaces, https://sapca.org.uk/wp-content/uploads/2018/07/Code_of_Practice_for_the_Maintenance_of_Synthetic_Surfaces_01.pdf

Guidelines	Details
FA (2010) The FA Guide to Artificial Grass Pitches[206]	Guidance notes to provide impartial advice to organisations considering the installation of artificial grass pitches, describing factors that need to be considered during the design, specification and construction of an artificial grass pitch and describes surfacing and construction options being offered by contractors. They also include advice on maintenance, life cycle costs, sinking funds and post installation monitoring and testing.
FA (2013) The FA guide to 3G football turf pitch design principles and layouts[207]	Guidance on the quality standards required in order to receive FA support for planning applications and funding submissions, whilst outlining the recommended layouts for the multiple formats of the game.
FA, Third generation football turf guidance[208]	The FA has produced this guide to help provide the facts concerning the use of these pitches and eradicate some of the myths that currently exist. The guide tries to answer some of the frequently asked questions and is targeted at players, referees, maintenance staff, leagues and clubs.
World Rugby (2017) World Rugby Handbook Regulation 22[209]	Documentation of Rugby Turf Performance Specification which sets a minimum standard for artificial playing surfaces which may be used in rugby.
FIFA (2015) FIFA quality programme for football turf[210]	Framework for the installation and use of high-quality artificial turf playing surfaces for football competitions and training sites
FIFA (2015) FIFA quality programme for football turf: handbook of requirements[211]	Testing procedures required to satisfy FIFA quality standards testing for artificial pitch
UEFA (2018) UEFA pitch quality guidelines[212]	Section 3.4 covers hybrid pitches

[206] FA (2010), The FA Guide to Artificial Grass Pitches, http://www.thefa.com/GetIntoFootball/Facilities/~/media/Files/PDF/TheFA/Facilities/FA%20Artificial%20Pitch%20Guideline%202009%20May%202010.ashx

[207] FA (2013), The FA guide to 3G football turf pitch design principles and layouts, http://www.thefa.com/-/media/files/pdf/leagues/fa-guide-to-3g-football-turf-pitch-designs-layouts.ashx

[208] FA, Third generation football turf guidance, http://www.thefa.com/-/media/files/pdf/get-involved/3g-guidance-and-faqs.ashx

[209] World Rugby (2017), World Rugby Handbook Regulation 22, https://www.world.rugby/handbook/regulations/reg-22/reg-22?lang=en

[210] FIFA (2015), FIFA quality programme for football turf, https://www.uefa.com/MultimediaFiles/Download/uefaorg/Stadium&Security/02/54/11/96/2541196_DOWNLOAD.pdf

[211] FIFA (2015), FIFA quality programme for football turf: handbook of requirements, https://football-technology.fifa.com/media/1239/fqp-handbook-of-requirements-v26.pdf

[212] UEFA (2018), UEFA pitch quality guidelines, https://www.uefa.com/MultimediaFiles/Download/uefaorg/Stadium&Security/02/54/11/97/2541197_DOWNLOAD.pdf

Guidelines	Details
Sport England (2013) Artificial surfaces for outdoor sport[213]	Guidance covering: the benefits of various surface materials; design concepts; common technical expressions; technical classifications of various playing surfaces; suitability of surfaces for various levels of sports at training or performance levels; and other sources of information and more detailed advice.
KIMO, Guidelines for Designers and procurement specialists[214]	Guidelines created for industry to take into account microplastic loss during design, build and renewal of pitches. These guidelines are also relevant to procurement specialists, and those submitting a pitch construction to tender. Recommendations are made assuming a new pitch to be built, but many also apply to retrofitting old pitches.
KIMO, Guidelines for owners and maintenance teams[215]	Guidelines to help to make sure any infill used stays on the pitch, with ideas for adding physical barriers, making small changes to standard maintenance routines and by working together with pitch users.
ESTC (2018) Minimising the risk of micro-plastic pollution[216]	Good practice recommendations for reducing infill loss
FIFA (2017) Environmental impact study on artificial football turf[217]	Best practice guidance on approaching the key decision points and the options available at those points that impact the environmental impact of football turf disposal

[213] Sport England (2013), Artificial surfaces for outdoor sport, https://www.sportengland.org/media/4536/artificial-surfaces-for-outdoor-sports-2013.pdf
[214] KIMO, Guidelines for Designers and procurement specialists, http://www.kimointernational.org/download/9756/
[215] KIMO, Guidelines for owners and maintenance teams, http://www.kimointernational.org/download/9759/
[216] ESTC (2018), Minimising the risk of micro-plastic pollution, https://www.estc.info/wp-content/uploads/2018/05/ESTO-Minimising-Micro-Plastic-Pollution-Report.pdf
[217] FIFA (2017), Environmental impact study on artificial football turf, https://football-technology.fifa.com/media/1230/artificial_turf_recycling.pdf

Appendix D Artificial grass pitch public survey results

D.1 Introduction

A survey to collect public responses on the topic of artificial pitches was built in Survey Monkey and advertised to potential respondents through three different methods. This included targeted Facebook advertising, sharing on Facebook and Twitter by Sports Scotland and paid response collection through Survey Monkey. All survey channels included qualification questions and targeting to ensure:

- All respondents were over 18
- All respondents lived in Scotland
- All respondents had a predisposition for sports typically played on artificial pitch
- Only those who played on artificial pitch, or were responding on behalf of a minor who played on artificial pitch, could participate

Three questions relating to the 2008 WRAP committed recycler metric[218] were included to provide a baseline for comparison in relation waste reduction awareness.

A full breakdown of the responses to each question is included below.

D.2 Targeting and demographics

The artificial pitch survey received 1,136 entrants, of which 772 continued onto the survey and 364 were disqualified for not playing sports on artificial pitches. The number of responses to each question reduced as people progressed further through the survey, with 539 completing all artificial pitch related questions.

Respondents were younger than average, with 62% under the age of 44. Respondents were overwhelmingly **male**, with only 19% of respondents identifying as female. Respondents were likely to be in **full time employment** (51%), have **one or more dependants** (57%), and **live within 30 miles of the coast** (71%). Respondents to this survey were **slightly less engaged with recycling** (68% recycle even if it requires additional effort, compared to 74% in the WRAP study).

D.3 Key findings

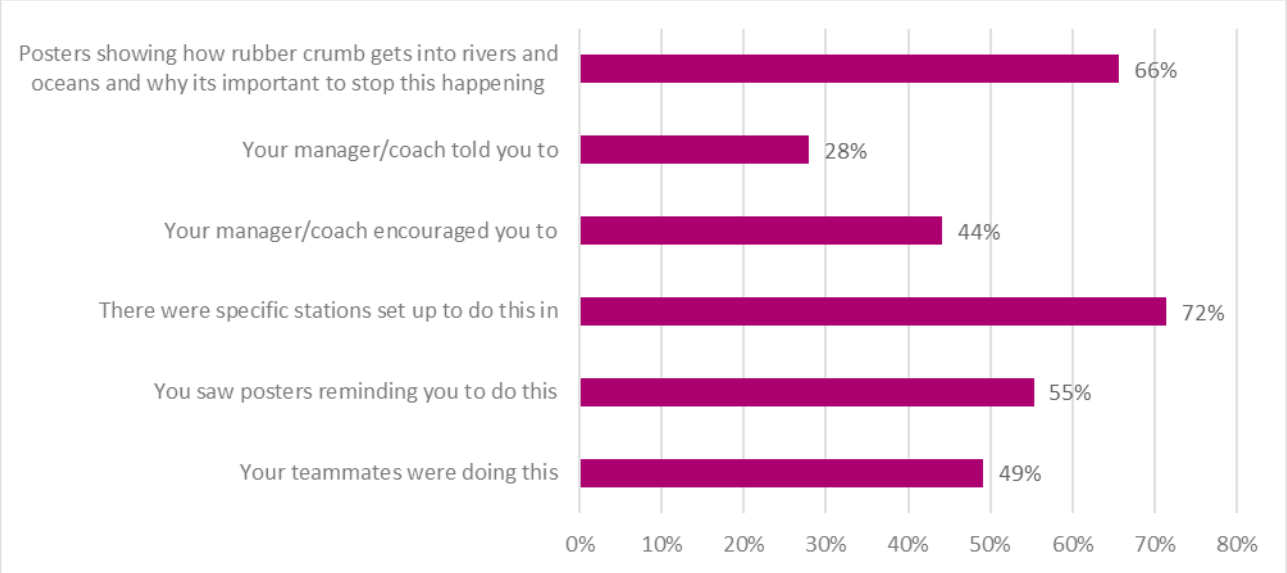
Survey responses suggested a **low level of awareness of both environmental issues** surrounding artificial pitch (23% aware of any issues) and the issues surrounding leakage from the artificial pitch into rivers and oceans (11% very aware and 34% vaguely aware). The environmental issues that respondents raised included its link to human health, plastic being used, rubber particle leakage and the recyclability of the pitch at end of life. Many respondents (40%) had experience of non-infill pitches and of these many also commented that they preferred these to pitches with rubber crumb infill.

A third of respondents (33%) were already taking action to reduce the amount of rubber particles being removed from the pitch. Of these a large number were **already brushing down their clothes** (77%) and **emptying their boots** (70%). Whilst those already taking action showed a low willingness to take additional action (44%), those that aren't currently taking any action showed a high level of willingness to do so (72%).

[218] WRAP (2008), Barriers to recycling at home, http://www.wrap.org.uk/sites/files/wrap/Barriers_to_Recycling_at_Home_Technical_Report.pdf

Respondents reported that having **specific stations to reduce the crumb escaping** would have the highest likelihood of making them change their behaviour (72%), followed by **posters showing how the crumb escaped into rivers and oceans** and why it's important to stop this happening (66%) (Figure 16). Manager/coaches telling them to do this was likely to have the least impact, with just 28% of respondents reporting that this would change their behaviour.

Figure 16: Pitch Q11: Please select the three options that would make you most likely to change your behaviour to reduce the crumb escaping into the ocean



Respondents were generally unwilling to pay more than 10% extra to ensure the pitch did not contribute to marine plastic pollution. The most popular options were 0% extra (24%), 5% extra (20%), and 10% extra (22%). 15% of respondents did not currently pay anything to play sports.

D.4 Summary of results

Q1 and Q2: Over half of respondents played sports on artificial pitches regularly (54%, n=618), and a further 154 respondents completed the survey on behalf of a child who played sports on artificial pitches regularly.

Q3: Respondents were asked *Do you think artificial pitches or grass pitches are better to play on.* They were likely to rank grass as a preference over artificial pitch, with 37% of respondents stating that grass was **a lot better** (n=256) and 18% of respondents stating that it was **a bit better** (n=126). A further 7% had no opinion (n=45) and 38% preferred artificial pitch (n=261).

- Those who ranked grass as better cited various reasons for this, including that it was softer and less injuries were incurred. Six respondents mentioned the black beads/sand on artificial pitch as a reason why grass was better.

Those who believed artificial pitch was better cited various reasons including that it is playable in all weather, the pace is quicker and the ground is flatter. Respondent demographic had high levels of impact on responses to this question, including:

- Those responding on behalf of a child were more likely than average to report grass as a lot better (53%, n=68 compared to 37%, n=256),

- Those over 45 were more likely to prefer grass (65% reported that grass is a bit/a lot better compared to 56% average),
- Females were more likely to prefer artificial pitch that males (61% of females prefer artificial pitch compared to 36% of males).

Q4: Respondents were asked *Are you aware of any environmental issues with the use of artificial pitch*. Results showed that respondents were generally **not aware** of any environmental issues (77%, n=532). Those who were aware stated various environmental issues with the use of artificial pitch, including:

- Human health and links to cancer (mentioned 20 times)
- Plastic used in the pitch (mentioned 15 times)
- Rubber ball leakage from the pitch (mentioned 13 times).
- End of life and recyclability of the pitch (mentioned 8 times)

Q5: Respondents were asked *Do you have experience of modern artificial pitches that don't use rubber crumb infill*. Of all respondents, 40% had used modern artificial pitches that didn't use rubber crumb infill (n=254) and 235 provided comment on the differences between these. Many of those who commented **preferred hybrid or 4G pitches** to those with rubber crumb infill. The crumb within pitches with rubber crumb infill was mentioned 40 times, mostly with respondents saying that non-infill pitches were better as the rubber crumb often leaked from the pitch. This was generally mentioned as an annoyance rather than as an environmental concern, e.g. **"[4G pitches are] much better as the crumbs enter my boots and can't ever get them off my socks"**

Q6: Respondents were asked *were you aware of the risk of rubber crumb escaping into rivers and oceans*. Only 11% (n=70) were **very aware**, with 34% (n=208) self-reporting as **vaguely aware** and 54% (n=331) **not aware**. Those who were over 45 were more likely than average to be very aware (17%, n=38).

Q7: One third (33%) of respondents responded **yes** to the question *Do you currently do anything to reduce the amount of rubber particles being removed from the pitch after playing or to dispose of these in a waste bin?* (n=204). A further 39% (n=240) reported that they **did not do anything to reduce this** and 27% (n=165) reported that they had **never noticed this happening**.

Q8: Those that did do something to reduce the amount of rubber particles being removed from the pitch or disposed of the rubber particles in a waste bin were asked to *Select all actions that apply*. Of these:

- 79% (n=161) reported that they **stamped off and emptied their boots**,
- 77% (n=158) reported that they **brushed down or emptied their shoes** and
- 75% (n=152) reported that they **left all rubber crumb that they can on the pitch**.

Less popular actions included:

- shaking kit off over the bin rather than over drains or outside (47%, n=96),
- collecting granules and throwing them in the waste bin (36%, n=73) and
- collecting granules and returning them to the pitch (16%, n=32).

Q9: Those who responded to question 8 were asked *Would you be willing to take further action to reduce the amount of rubber crumb escaping into the oceans*. Only 44% of respondents (n=85) were **willing to take further action.**

Respondents were asked to comment on the actions they were willing to take, and many were unsure of actions but would like guidance on these. Additional ideas were suggested that included filters on the on-site showers, designated washing machines with filters and hoovering up the excess rubber crumb.

Q10: Those that did not currently do anything to reduce the amount of rubber particles being removed from the pitch after playing or to dispose of these in a waste bin were asked *Would you be willing to take personal steps to reduce the amount of rubber crumb escaping into the ocean.* Respondents were very willing to do this, with 72% (n=280) responding **yes** and a further 21% (n=81) responding **maybe**. Females were more willing to take personal steps (81%, n=52) compared to males (72%, n=194).

Q11: Those who responded to question 10 were asked *How likely would you be to stamp-off or brush down and empty your boots after playing if brushes were provided at the pitch exit.* Results indicate that 84% of respondents were **very likely** or **likely** to do this (n=328).

Q12: These respondents were also asked *How likely they would be to shake off their clothing over a bin or in a designated area in the changing rooms before packing their kit away*. Three quarters (76%) of respondents reported that they would be **very likely** or **likely** to do this (n=298), which is slightly less than that reported in Q11.

Q13: All respondents were asked: *Select three options that would make them most likely to change your behaviour to reduce the rubber crumb escaping into rivers and oceans*. The most popular responses were:

- there were specific stations set up to do this in (72%, n=384),
- posters showing how rubber crumb gets into rivers and oceans and why it's important to stop this happening (66%, n=353) and
- you saw posters reminding you to do this (55%, n=297).

Less popular options included:

- your teammates were doing this (49%, n=264),
- your manager/coach encouraged you to (44%, n=237) and
- your manager/coach told you to (28%, n=150).

Q14: Finally, all respondents were asked *How much they were willing to pay extra for sports club membership (or similar) to ensure the pitches do not contribute to marine plastic pollution.* Responses were varied to this, with the top response being **0%** (24%, n=128), followed by answers of **10%** (22%, n=117) and **5%** (20%, n=109). 15% of respondents **did not currently pay anything to play sports** (n=79).

D.5 Responses to the artificial pitch survey

Figure 17: Pitch Q1- Do you play sports on artificial pitches regularly? (n=1136)

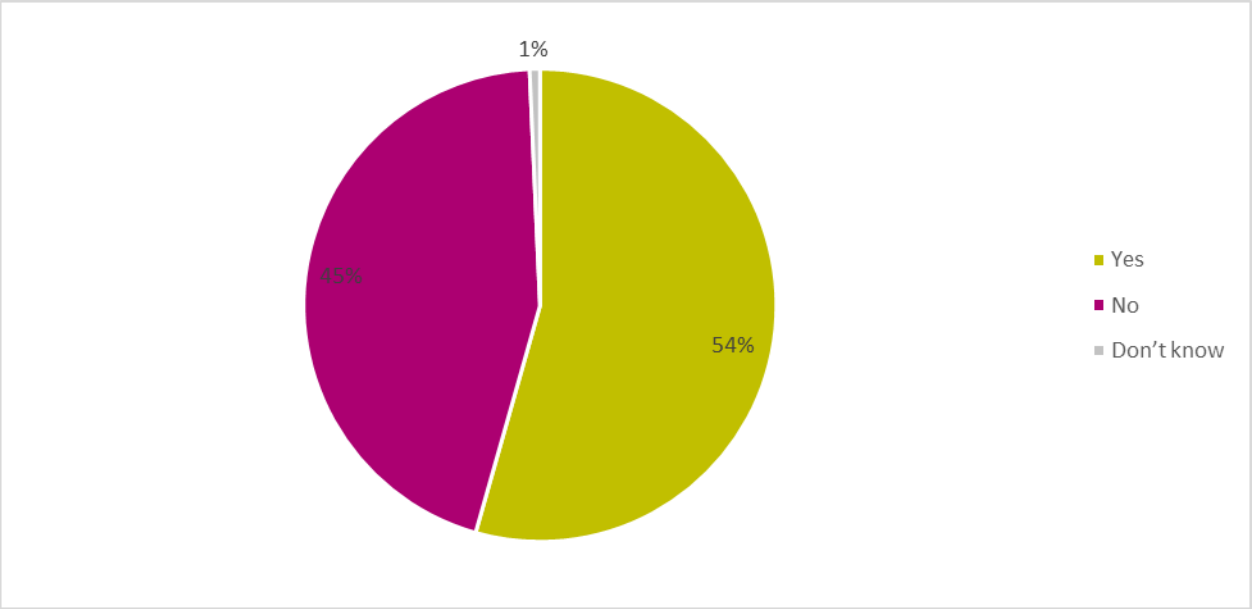


Figure 18: Pitch Q2- Would you like to complete this survey on behalf of a person under the age of 18? (n=510)

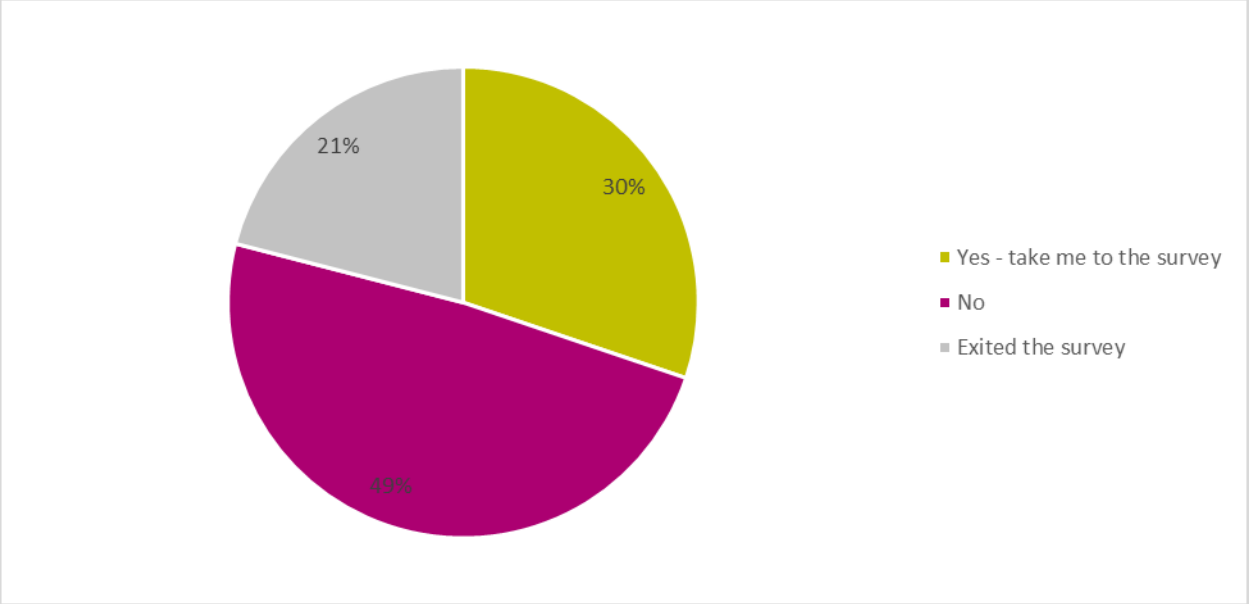


Figure 19: Pitch Q3- Do you think artificial pitches or grass pitches are better to play on? (n=668)

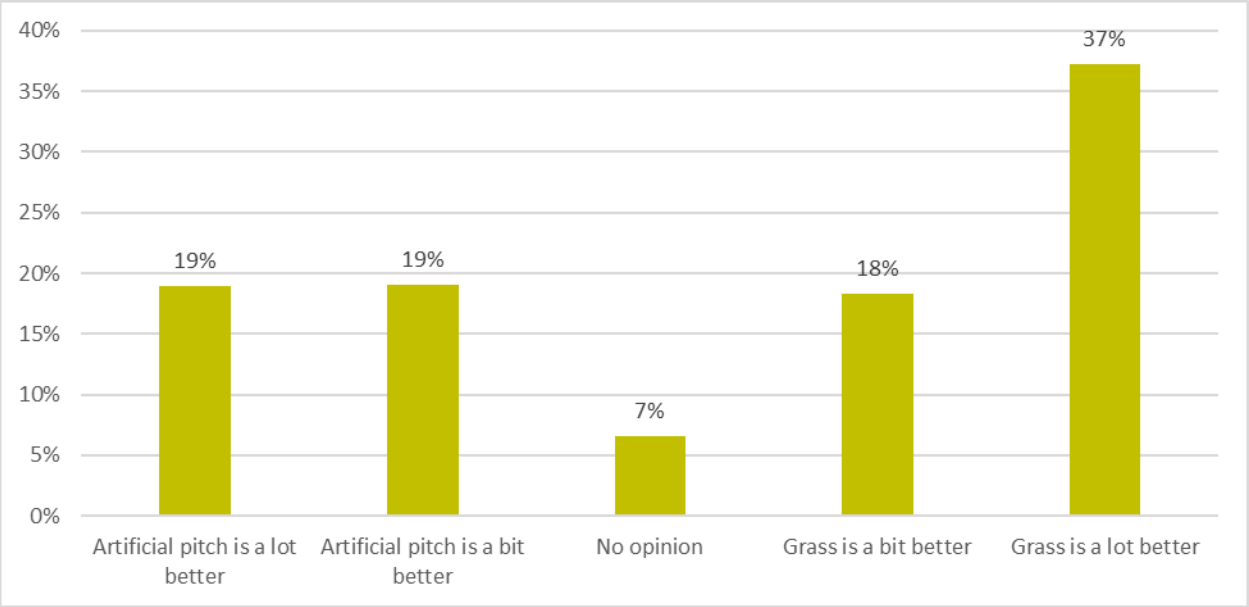


Figure 20: Pitch Q4- Are you aware of any environmental issues with the use of artificial pitch? (n=688)

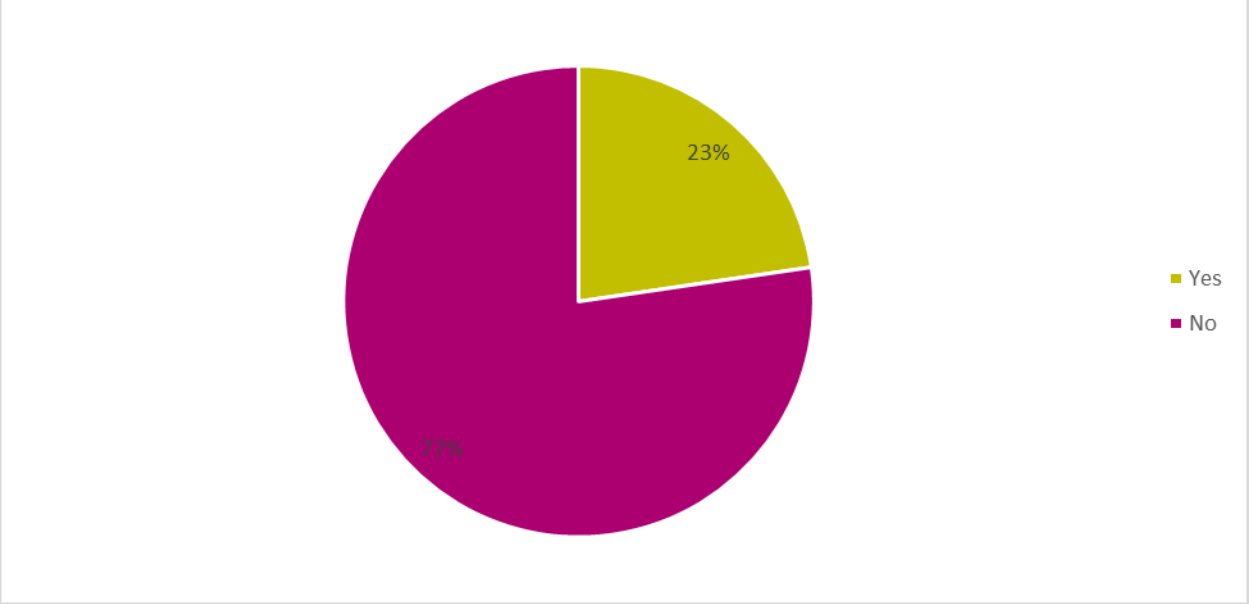


Figure 21: Pitch Q5- Do you have experience of modern artificial pitches that don't use rubber crumb infill? E.g. 4G or hybrid pitches? (n=635)

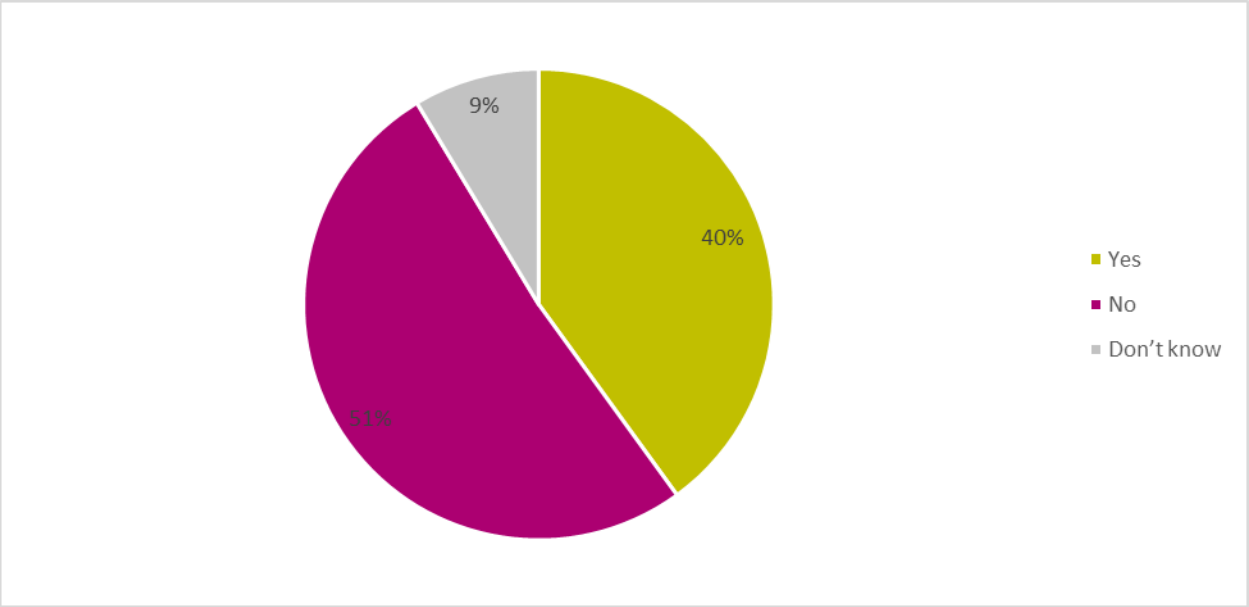


Figure 22: Pitch Q6- Before this survey, were you aware of the risk of rubber crumb escaping into rivers and oceans? (n=609)

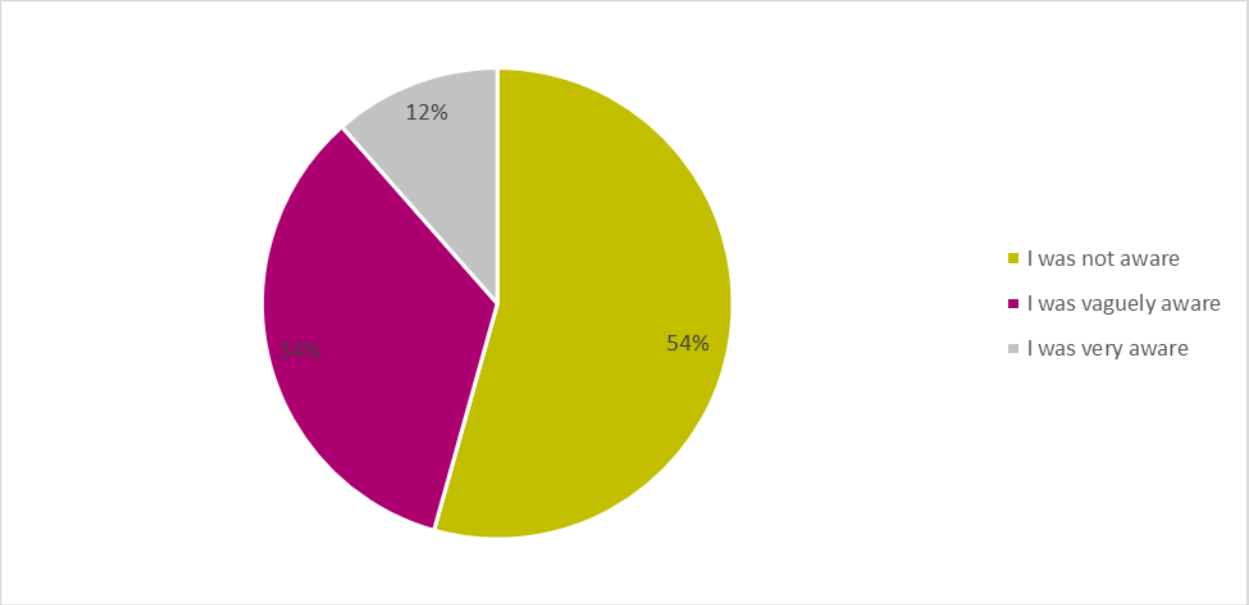


Figure 23: Pitch Q7- Do you currently do anything to reduce the amount of rubber particles being removed from the pitch after playing or to dispose of these in a waste bin? (n=609)

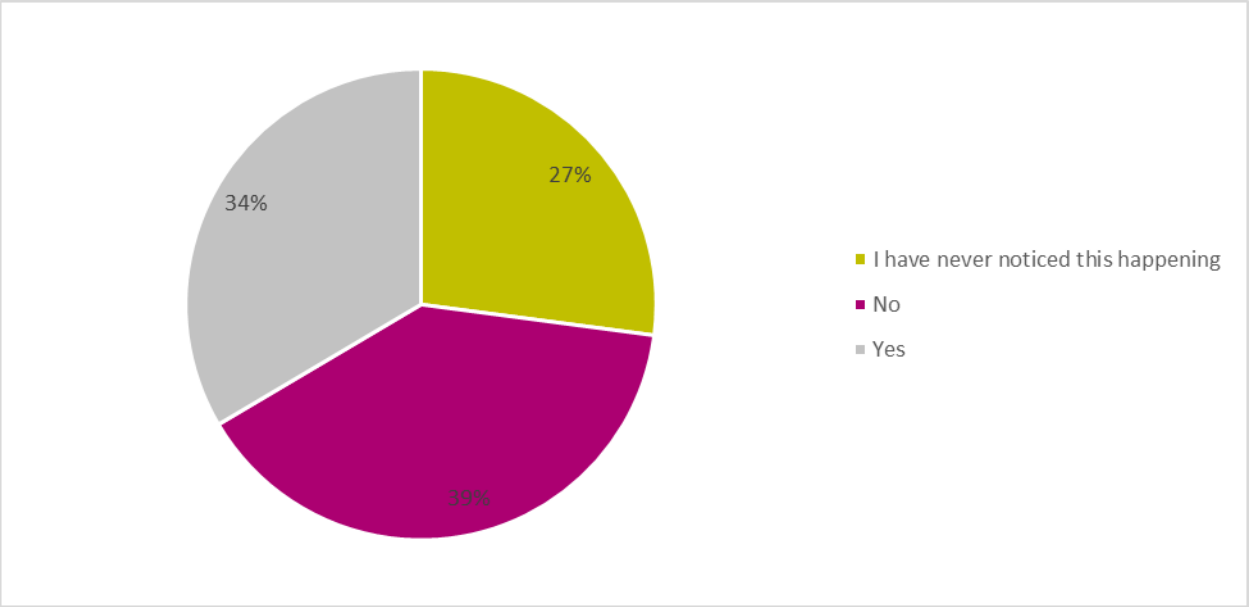


Figure 24: Pitch Q8- Yes, please select all actions that apply (n=194)

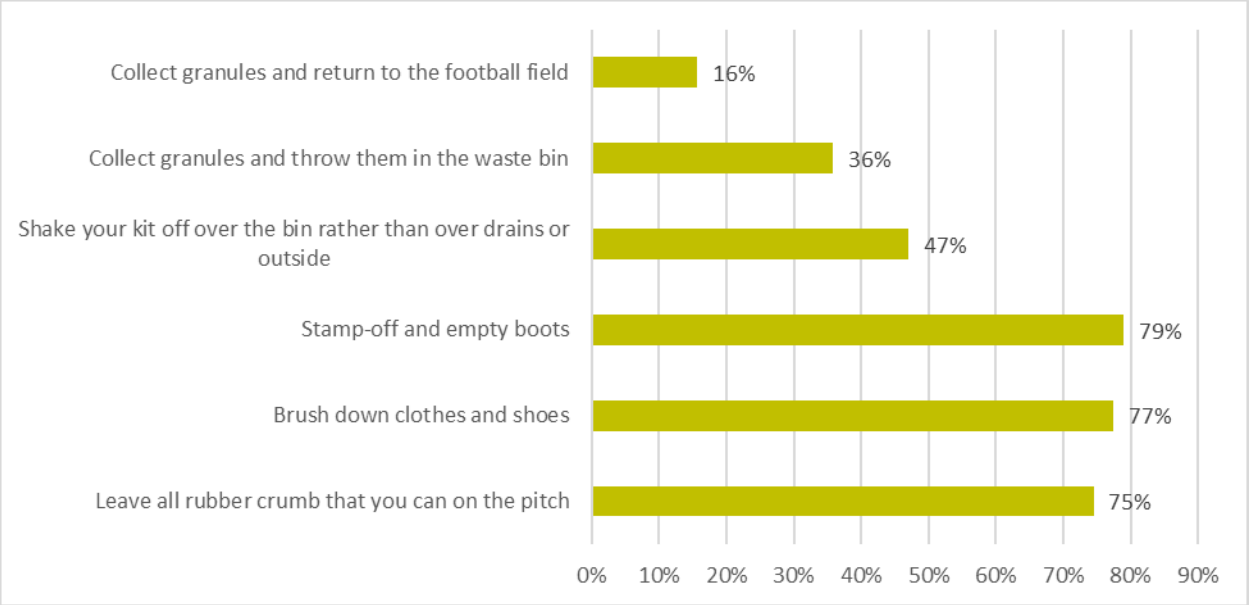


Figure 25: Pitch Q9- Would you be willing to take further action to reduce the amount of rubber crumb escaping into the ocean? (n=194)

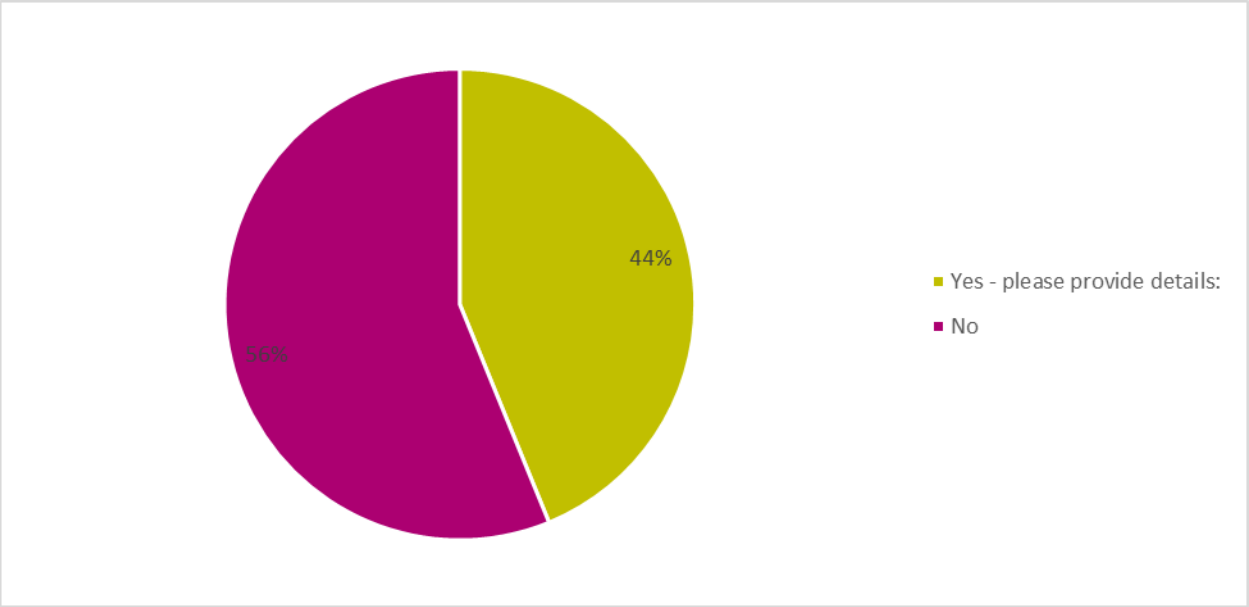


Figure 26: Pitch Q10- Would you be willing to take personal steps to reduce the amount of rubber crumb escaping into the ocean? (n=391)

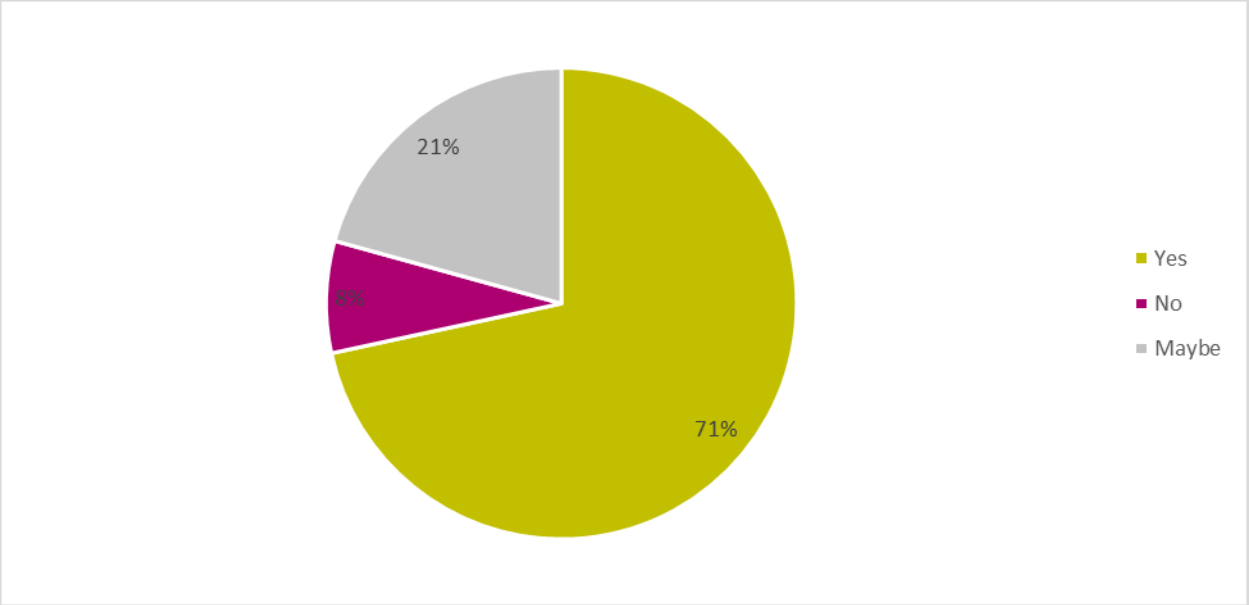


Figure 27: Pitch Q11 and Pitch Q12- How likely would you be to stamp-off or brush down and empty your boots after playing if brushes were provided at the pitch exit? (n=391) and How likely would you be to shake

off your clothing over a bin or in a designated area in the changing rooms before packing your kit away? (n=391)

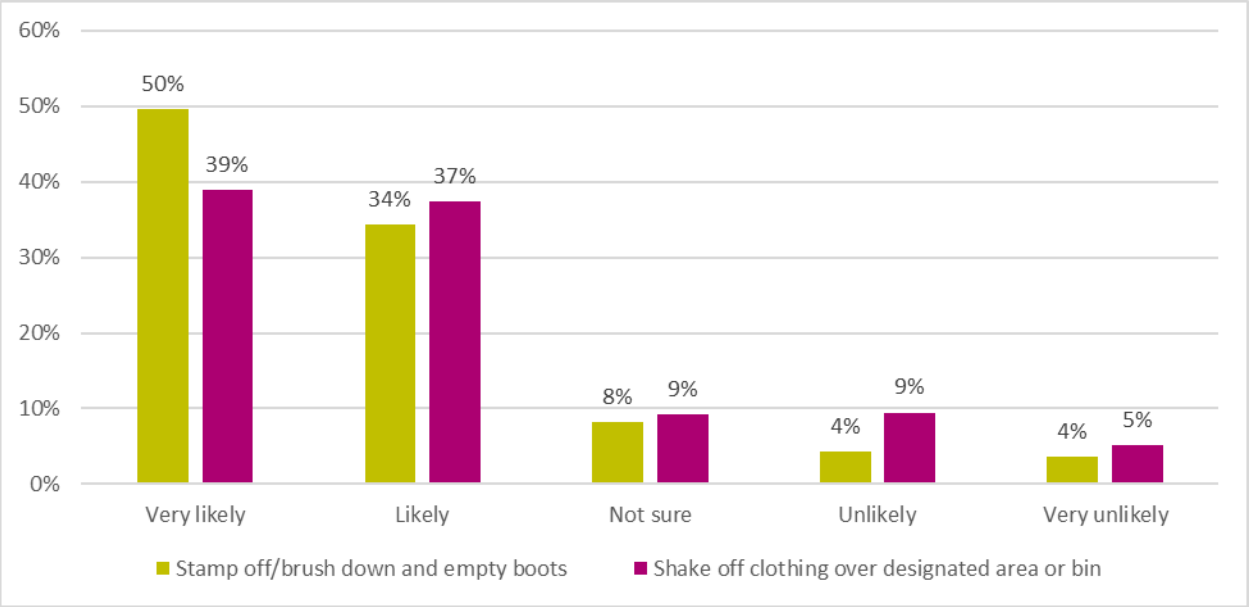


Figure 28: Pitch Q13- Please select the three options that would make you most likely to change your behaviour to reduce the crumb escaping into the ocean. (n=537)

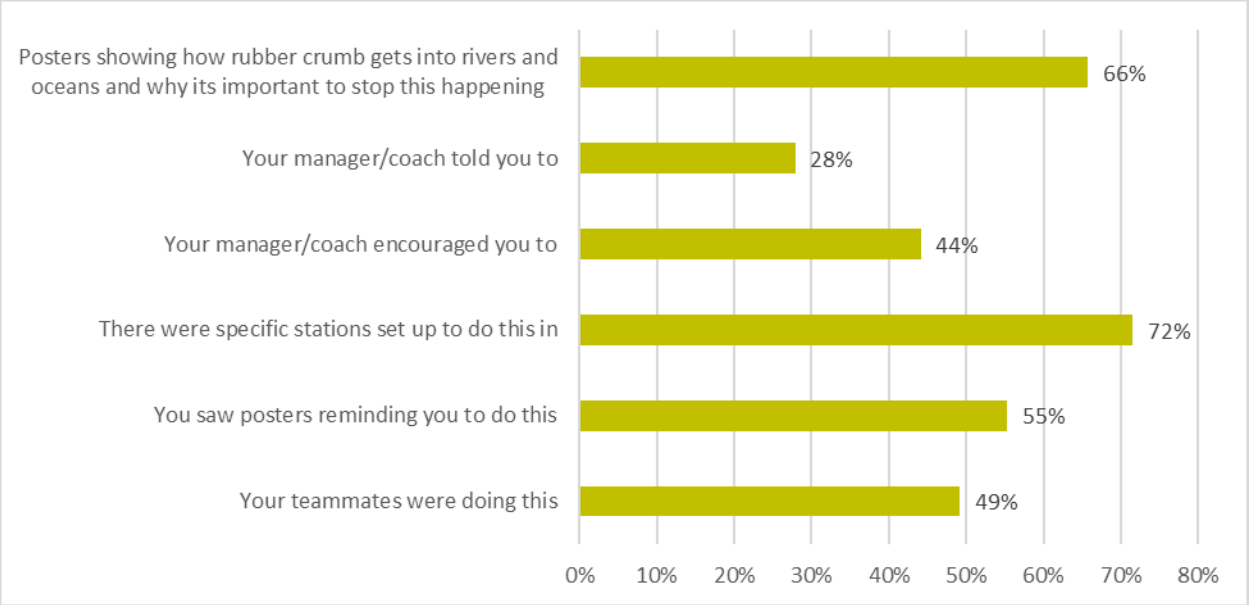
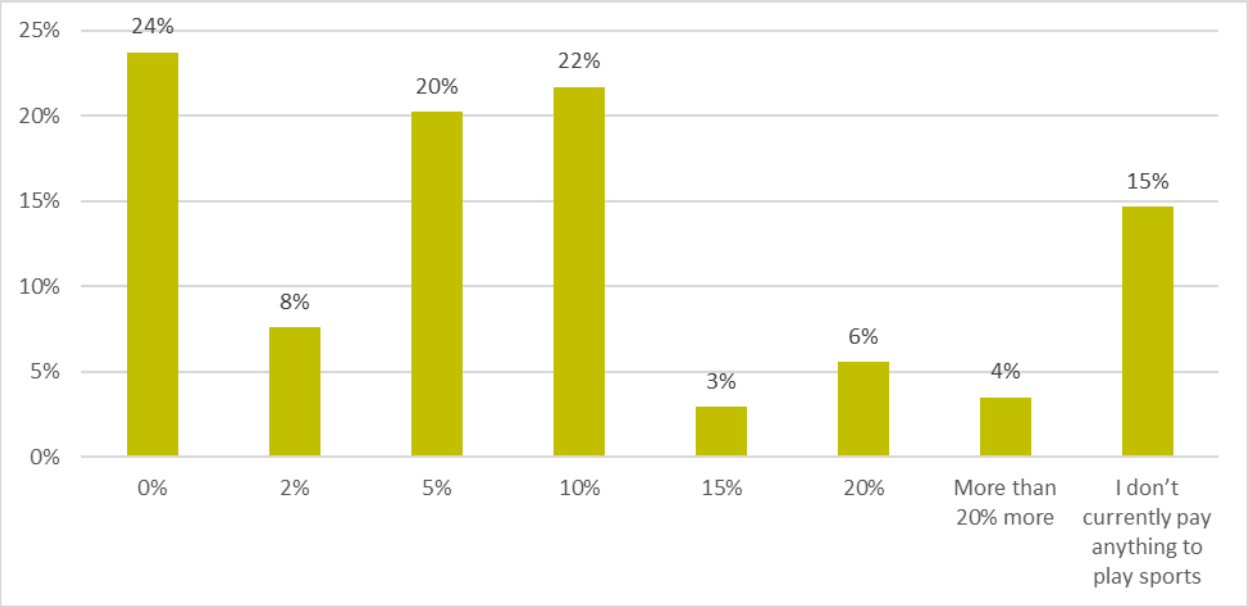


Figure 29: Pitch Q14- How much are you willing to pay extra for sports club membership (or similar) to ensure the sports pitches don't contribute to marine plastic pollution?



D.6 Artificial pitch survey demographics

Figure 30: Demographics of pitch survey respondents Q1-What is your age? (n=539)

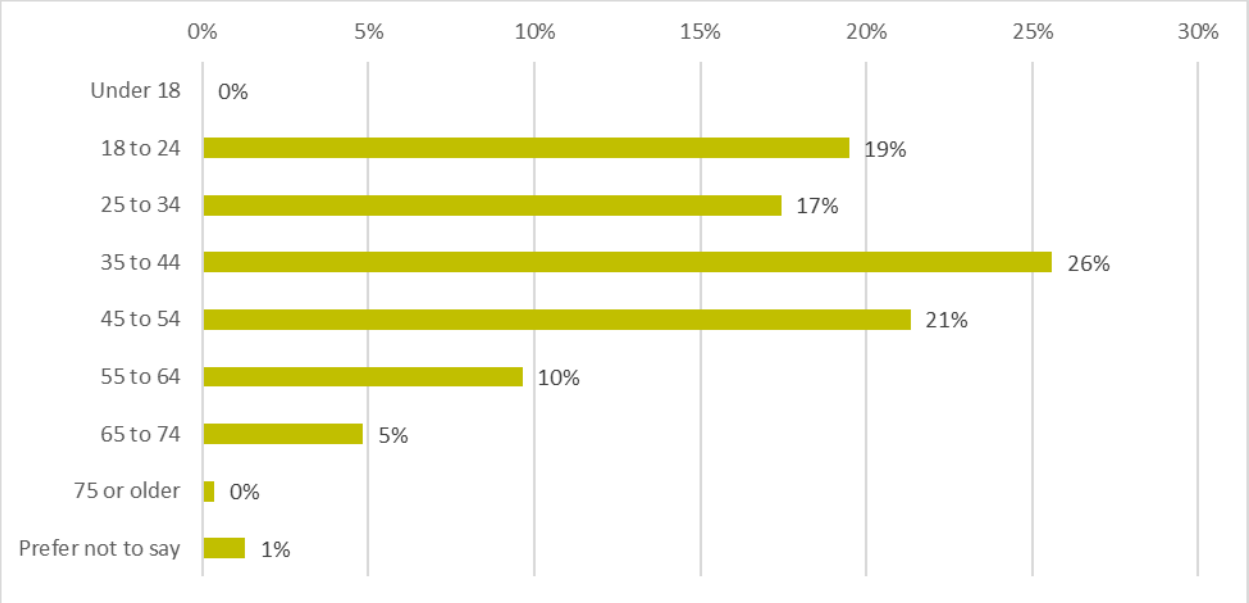


Figure 31: Demographics of pitch survey respondents Q2-What gender do you identify with? (n=522)

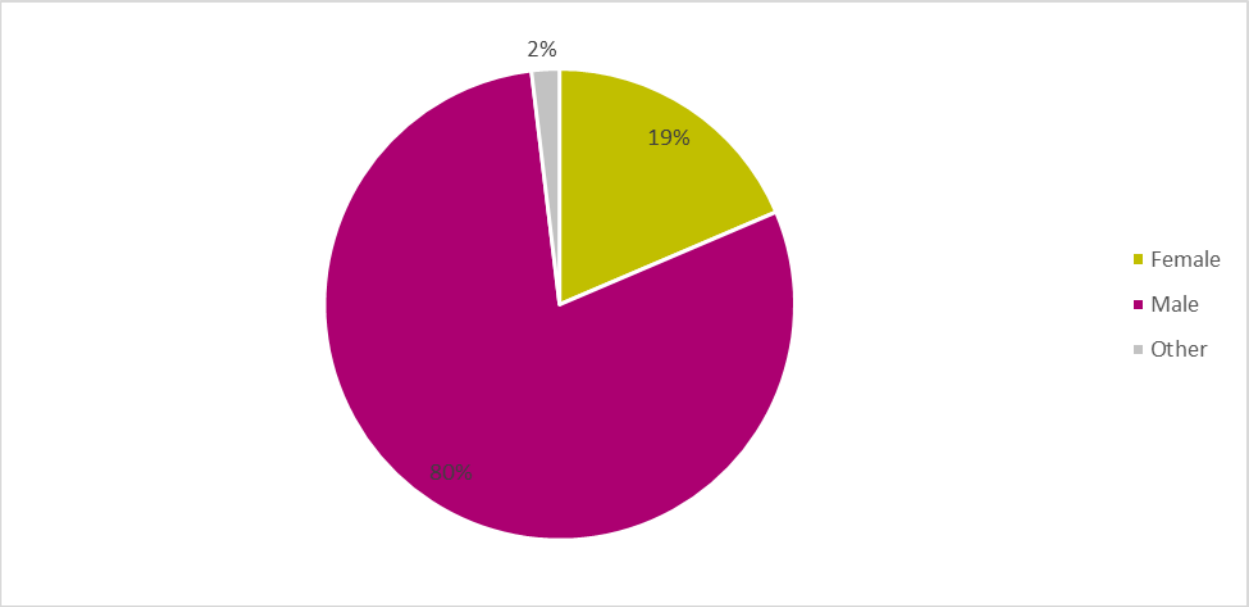


Figure 32: Demographics of pitch survey respondents Q3-What is your current employment status? (n=522)

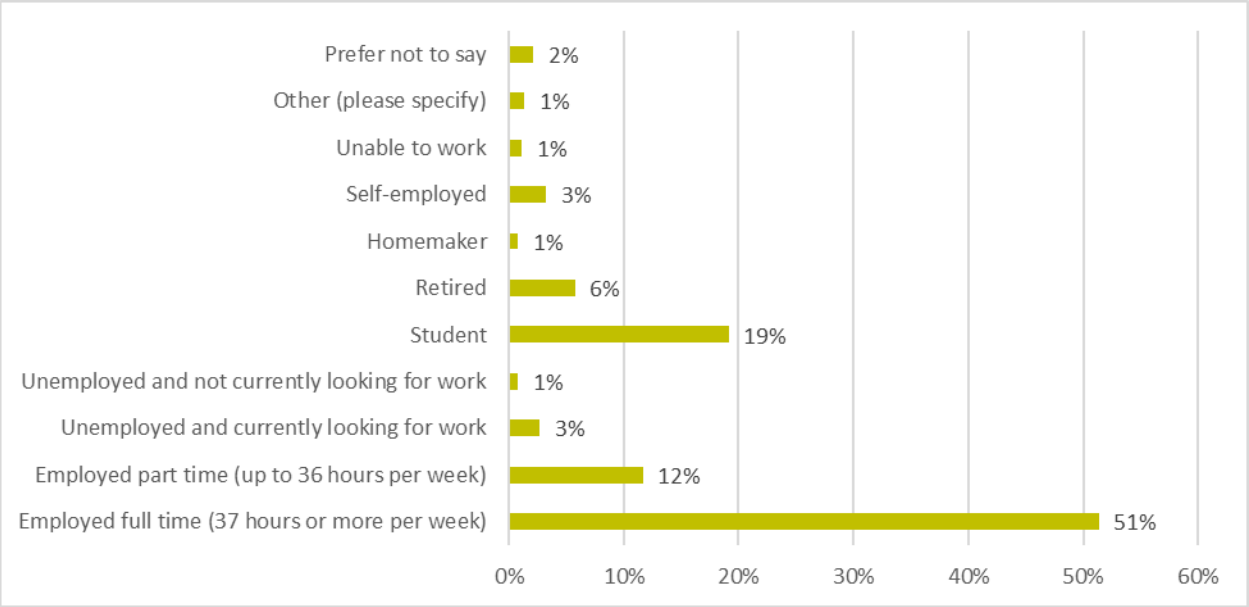


Figure 33: Demographics of pitch survey respondents Q4-How many dependants do you have? (n=522)

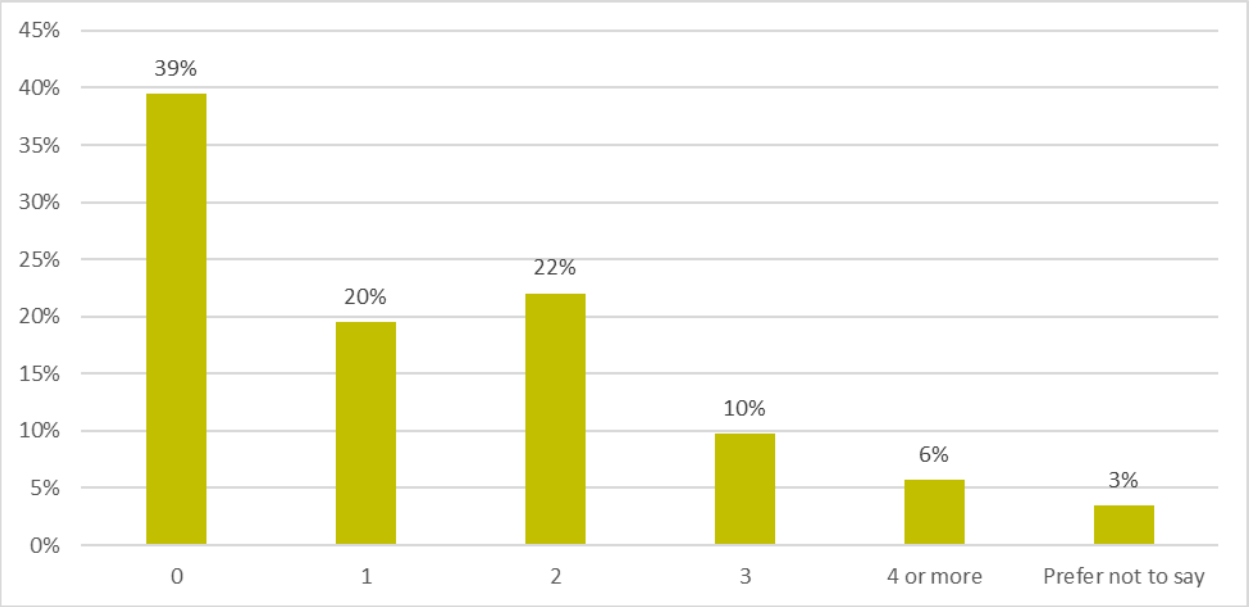


Figure 34: Demographics of pitch survey respondents Q5- How far away from the coast do you live to the nearest mile? (n=522)

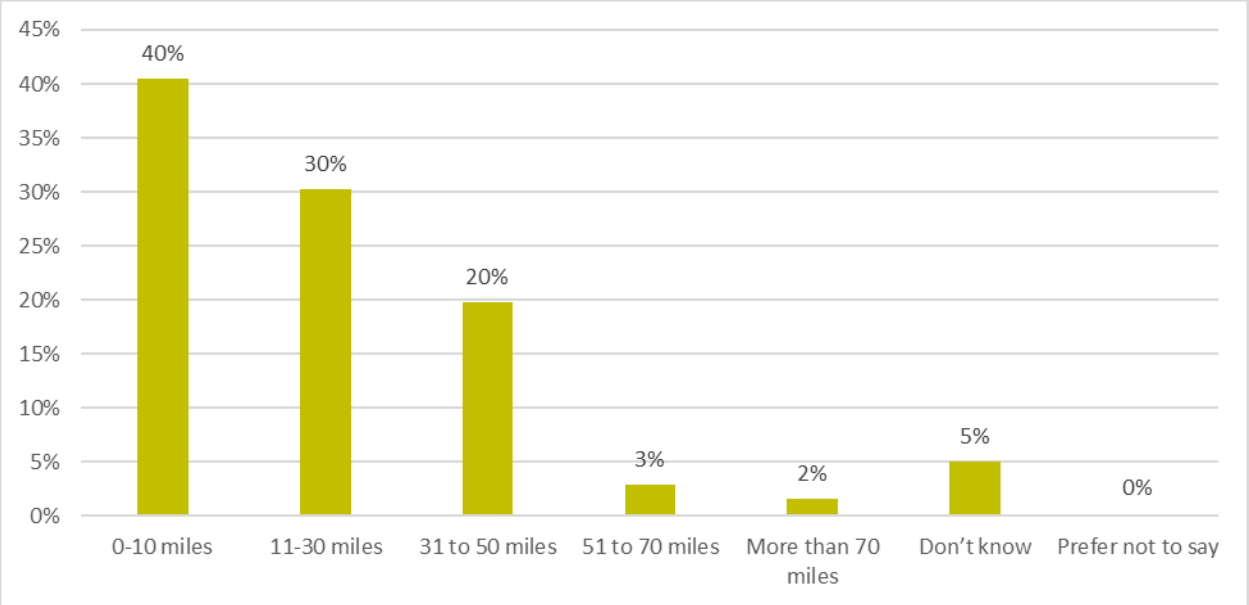


Figure 35: Demographics of pitch survey respondents Q6- Thinking about recycling household waste, which of these statements best describes how important recycling is to you personally? (n=522)

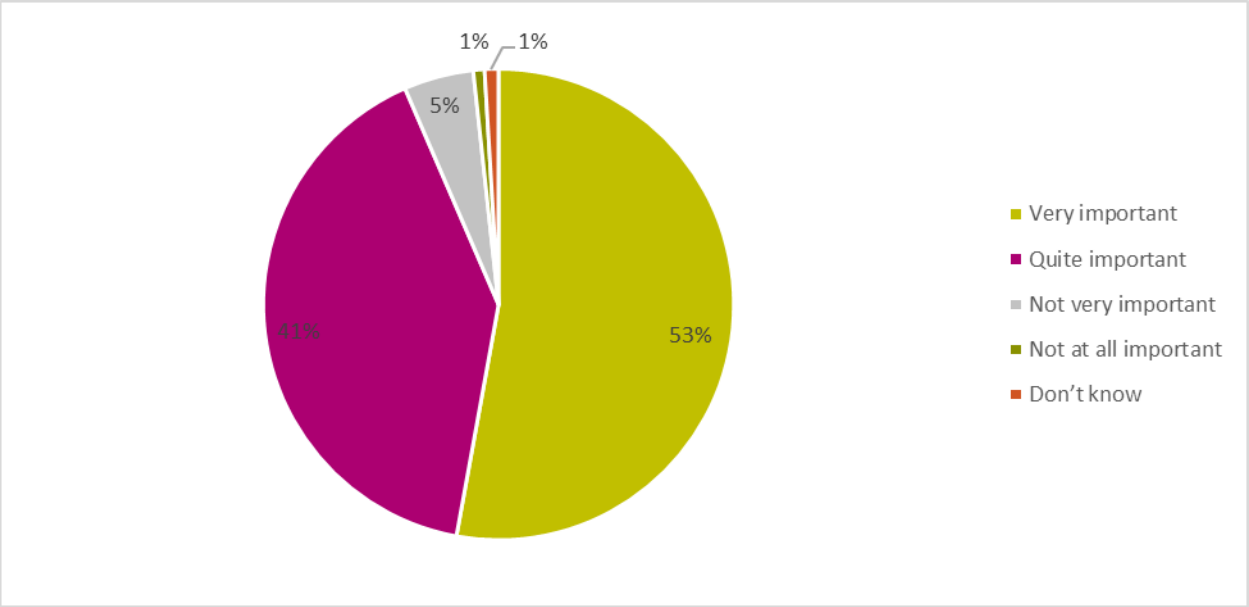


Figure 36: Demographics of pitch survey respondents Q7- Which of these statements best describes your attitude to recycling? (n=522)

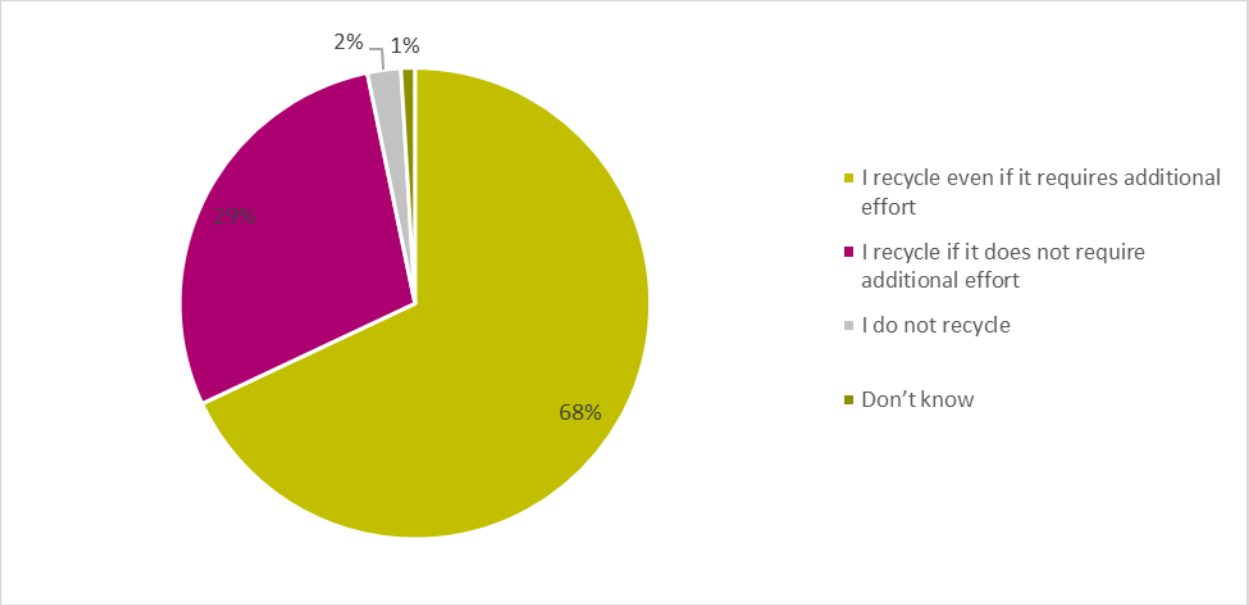
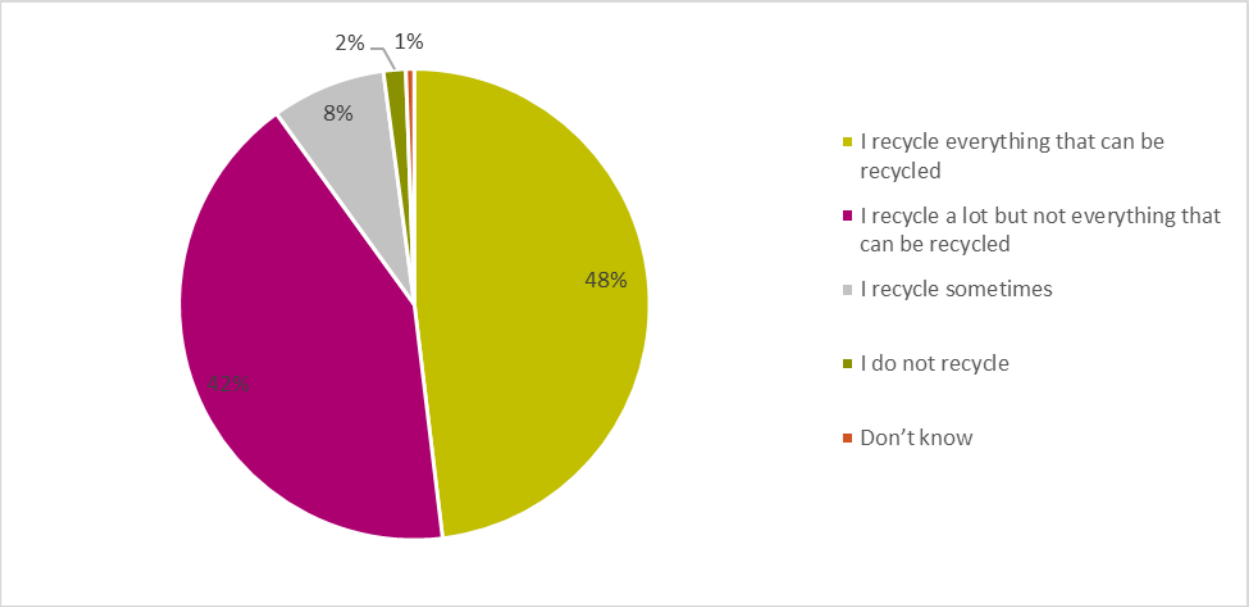


Figure 37: Demographics of pitch survey respondents Q8 - Which of these statements best describes how much you recycle? (n=522)



Artificial grass pitch (and performance infill)

Artificial grass pitch (and performance infill)

The main pathways to the marine environment are illustrated on the next slide.

Key decision points in the value chain have been identified where there is opportunity to help tackle marine litter.

Click on the yellow decision points to view more, including drivers and barriers and potential solutions.

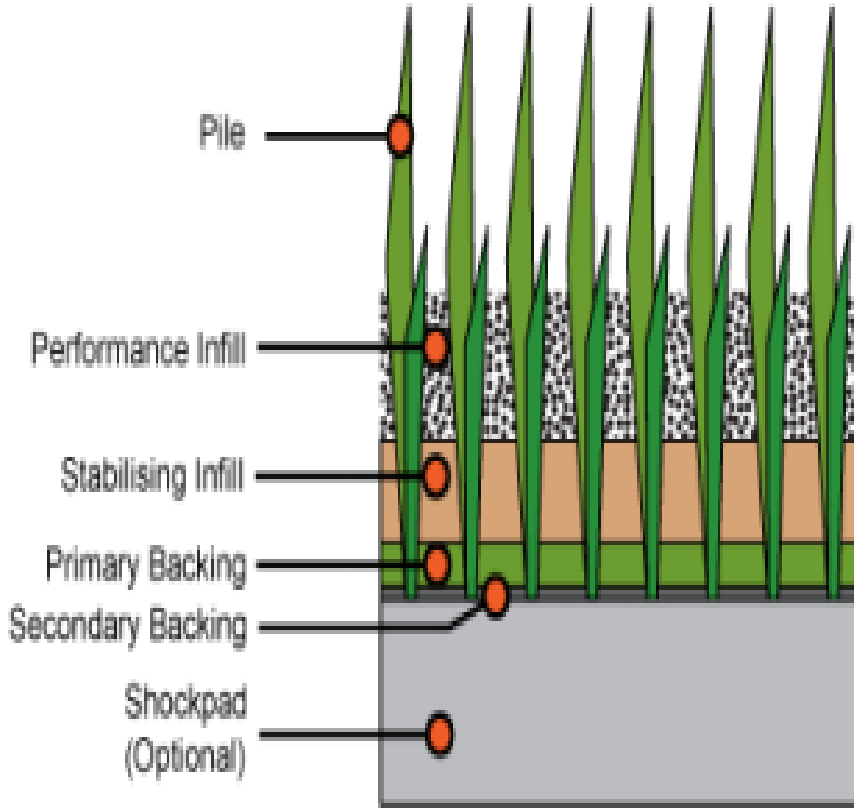
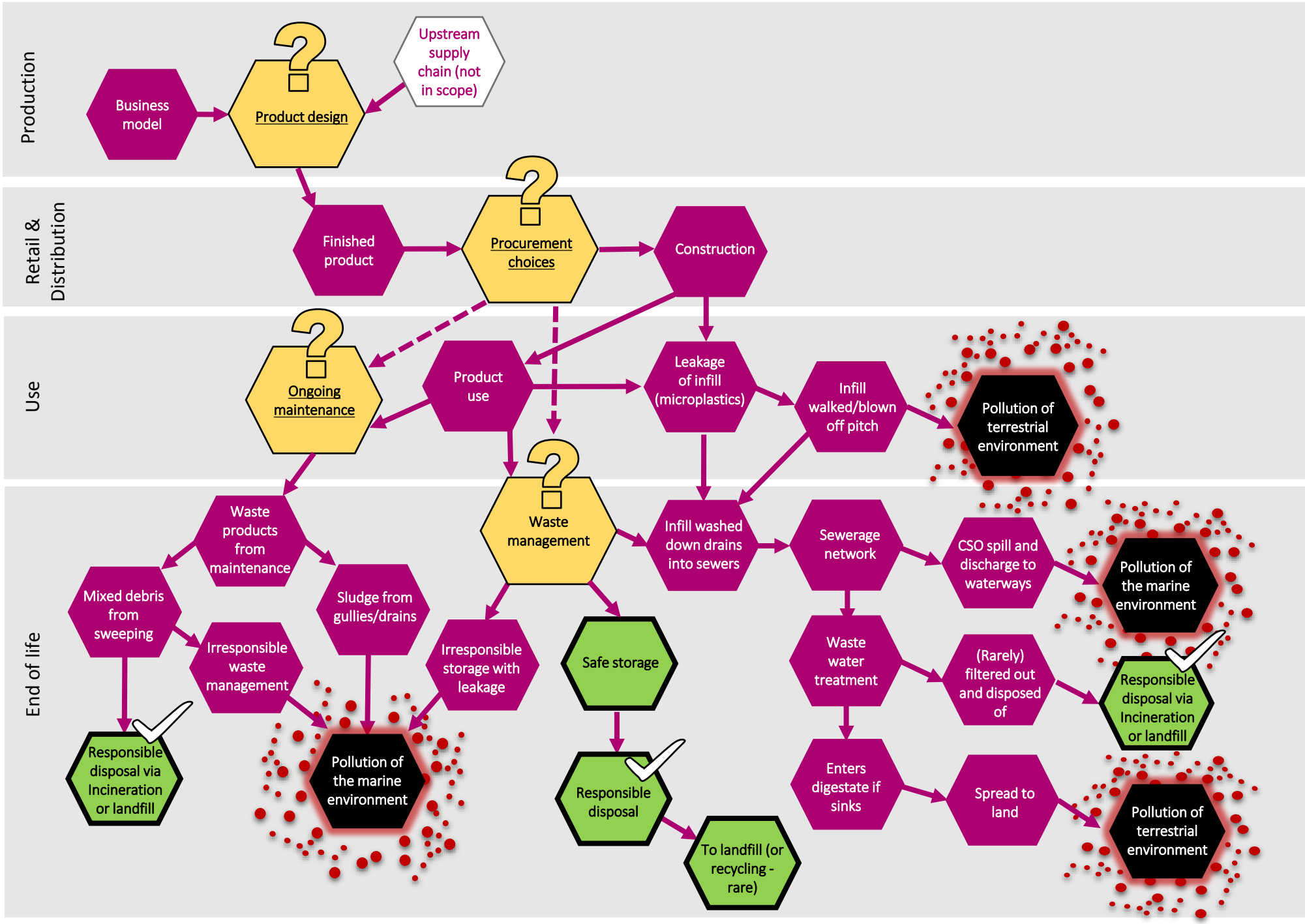
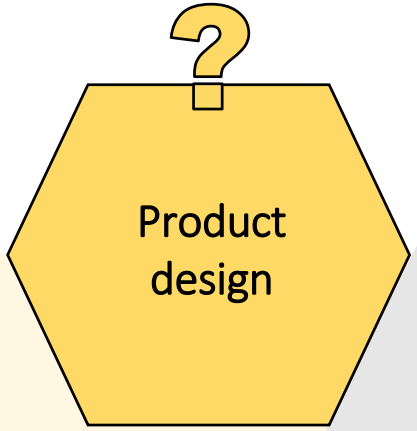


Image: Typical 3G Turf Composition (Eunomia)

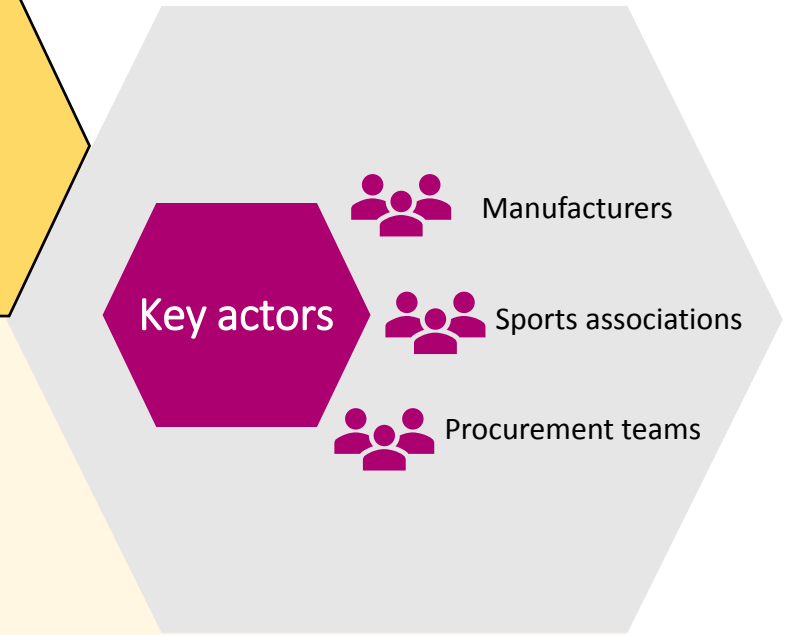

Production
Retail & Distribution
Use
End of life
Business model
Product design
Upstream supply chain (not in scope)
Finished product
Procurement choices
Construction
Ongoing maintenance
Product use
Leakage of infill (microplastics)
Infill walked/blown off pitch
Pollution of terrestrial environment
Waste products from maintenance
Waste management
Infill washed down drains into sewers
Sewerage network
CSO spill and discharge to waterways
Pollution of the marine environment
Mixed debris from sweeping
Sludge from gullies/drains
Irresponsible waste management
Irresponsible storage with leakage
Safe storage
Waste water treatment
(Rarely) filtered out and disposed of
Responsible disposal via Incineration or landfill
Responsible disposal via Incineration or landfill
Pollution of the marine environment
Responsible disposal
To landfill (or recycling - rare)
Enters digestate if sinks
Spread to land
Pollution of terrestrial environment



Key decision point

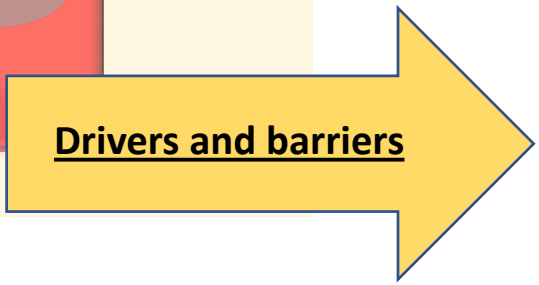
Large manufacturers develop and design artificial grass pitch systems in their own research and development departments. Products can be independently tested by consultancies to ensure they meet sport association standards. Established products are favoured by procurement teams.

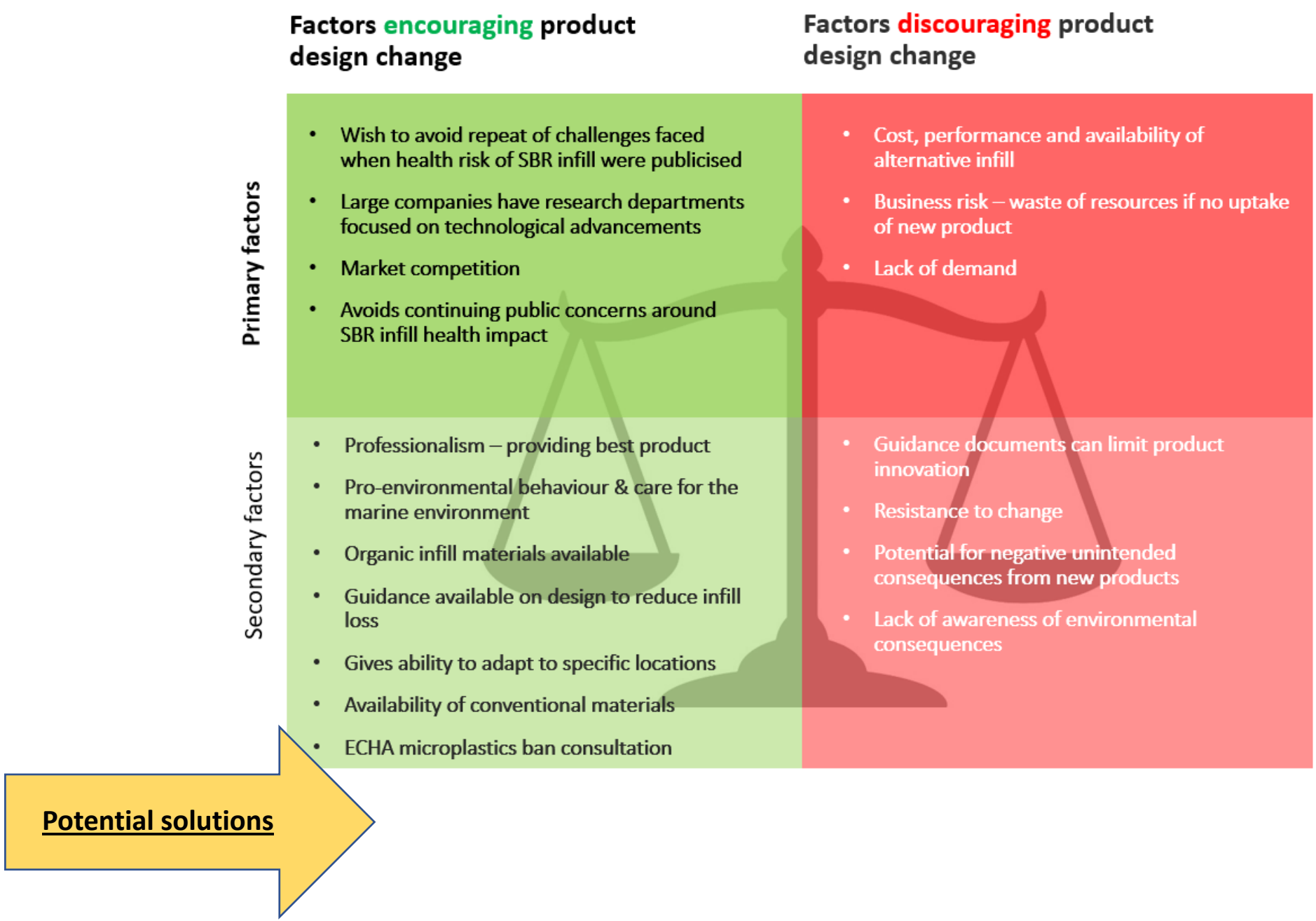
The key actors at this decision point are manufacturers, sports associations and procurement teams.

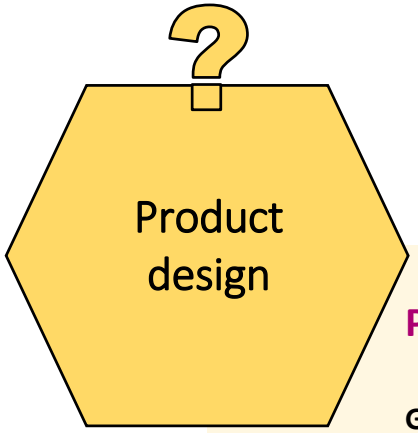


Opportunity

There is opportunity to stimulate demand for products which reduce the need for infill or provide a market for closed-loop recycling of materials.




Factors encouraging product design change
Factors discouraging product design change
Primary factors
Secondary factors
Wish to avoid repeat of challenges faced when health risk of SBR infill were publicised
Large companies have research departments focused on technological advancements
Market competition
Avoids continuing public concerns around SBR infill health impact
Cost, performance and availability of alternative infill
Business risk – waste of resources if no uptake of new product
Lack of demand
Professionalism – providing best product
Pro-environmental behaviour & care for the marine environment
Organic infill materials available
Guidance available on design to reduce infill loss
Gives ability to adapt to specific locations
Availability of conventional materials
ECHA microplastics ban consultation
Guidance documents can limit product innovation
Resistance to change
Potential for negative unintended consequences from new products
Lack of awareness of environmental consequences
Potential solutions



Potential solutions

Green procurement framework

- Ensure that products which tackle the microplastic or end of life issue are valued appropriately, stimulating demand for these products

Accreditation

- Provide a means of identifying manufacturers and installers actively reducing the risk of infill loss in their products and installations

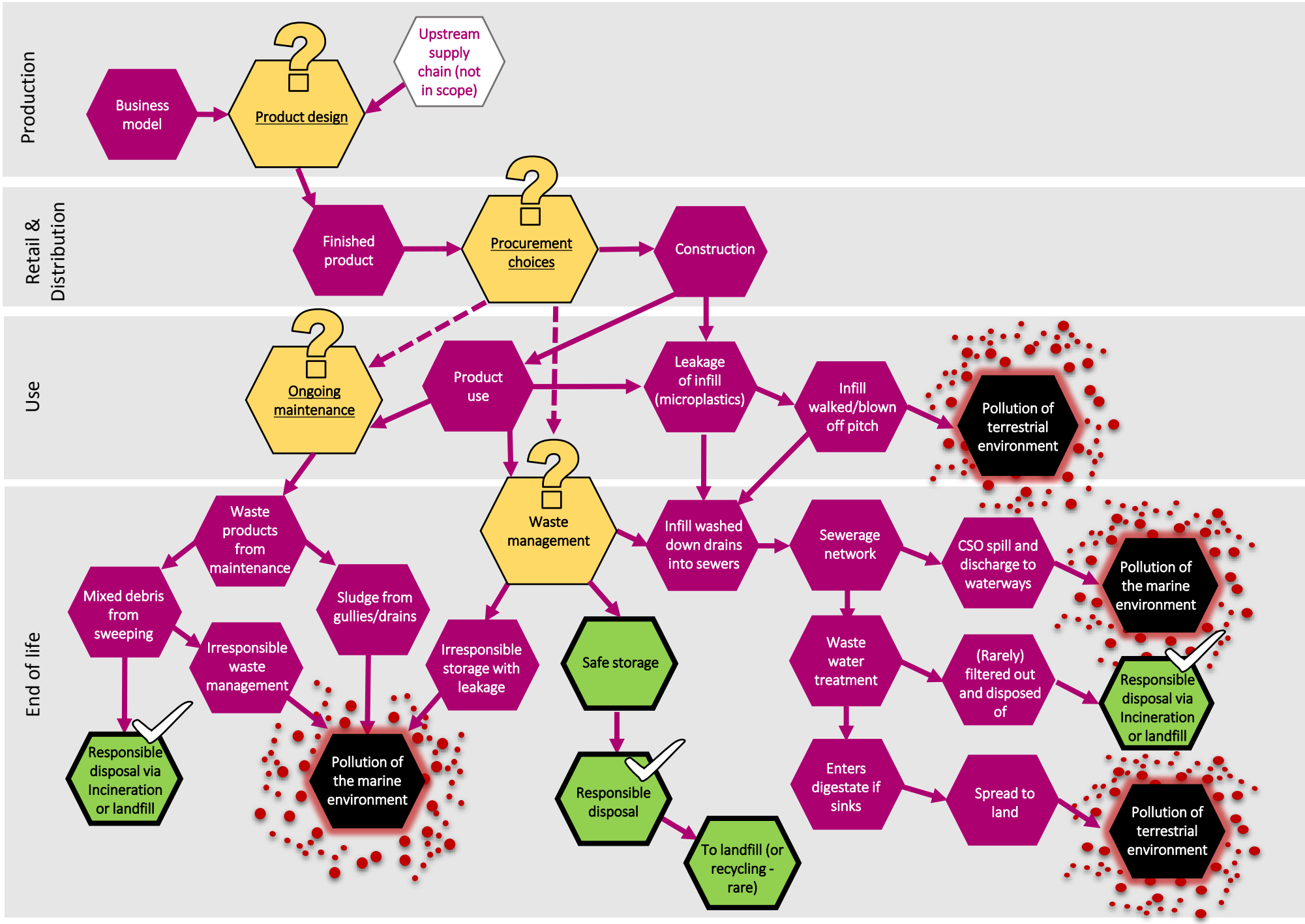
Education

- Disseminate information on the causes, consequences and solutions to infill loss and end of life issues to stimulate demand for products tackling these issues

Guidance

- Guidance to increase awareness of microplastic and end of life issues, stimulating demand for products which tackle these issues

Back to start


Production
Retail & Distribution
Use
End of life
Business model
Product design
Upstream supply chain (not in scope)
Finished product
Procurement choices
Construction
Ongoing maintenance
Product use
Leakage of infill (microplastics)
Infill walked/blown off pitch
Pollution of terrestrial environment
Waste products from maintenance
Waste management
Infill washed down drains into sewers
Sewerage network
CSO spill and discharge to waterways
Pollution of the marine environment
Mixed debris from sweeping
Sludge from gullies/drains
Irresponsible waste management
Irresponsible storage with leakage
Safe storage
Waste water treatment
(Rarely) filtered out and disposed of
Responsible disposal via Incineration or landfill
Responsible disposal via Incineration or landfill
Pollution of the marine environment
Responsible disposal
To landfill (or recycling - rare)
Enters digestate if sinks
Spread to land
Pollution of terrestrial environment

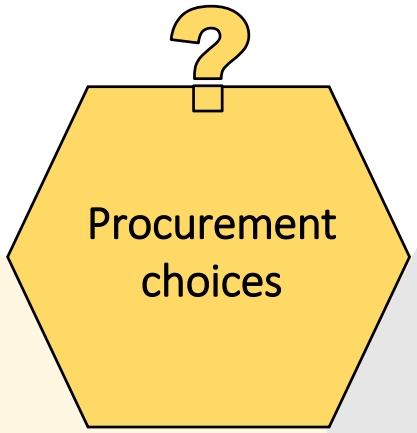
Key decision point

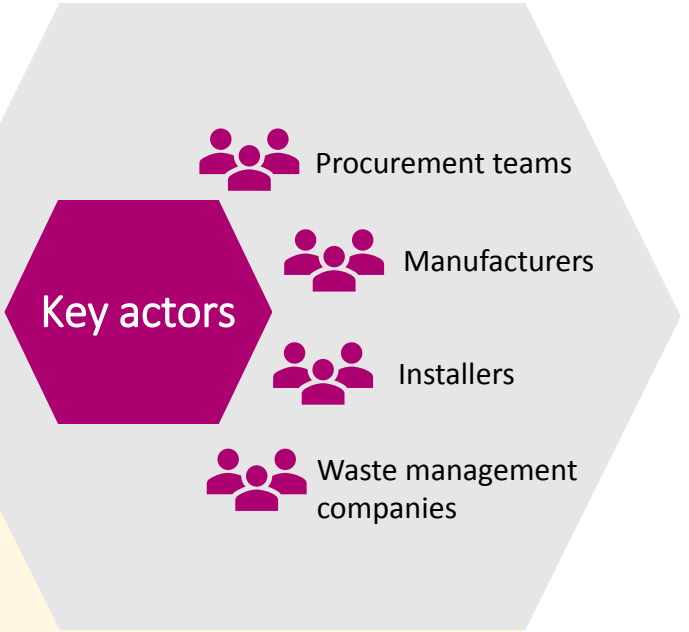
Procurement decisions are currently weighted heavily to cost, leaving little scope for environmental concerns to impact in contract awards. Procurement teams are often far removed from teams using and managing pitches, and as such lack awareness of issues impacting these stakeholders further down the chain.

The key actors at this decision point are procurement teams, manufacturers, installers and waste management companies.

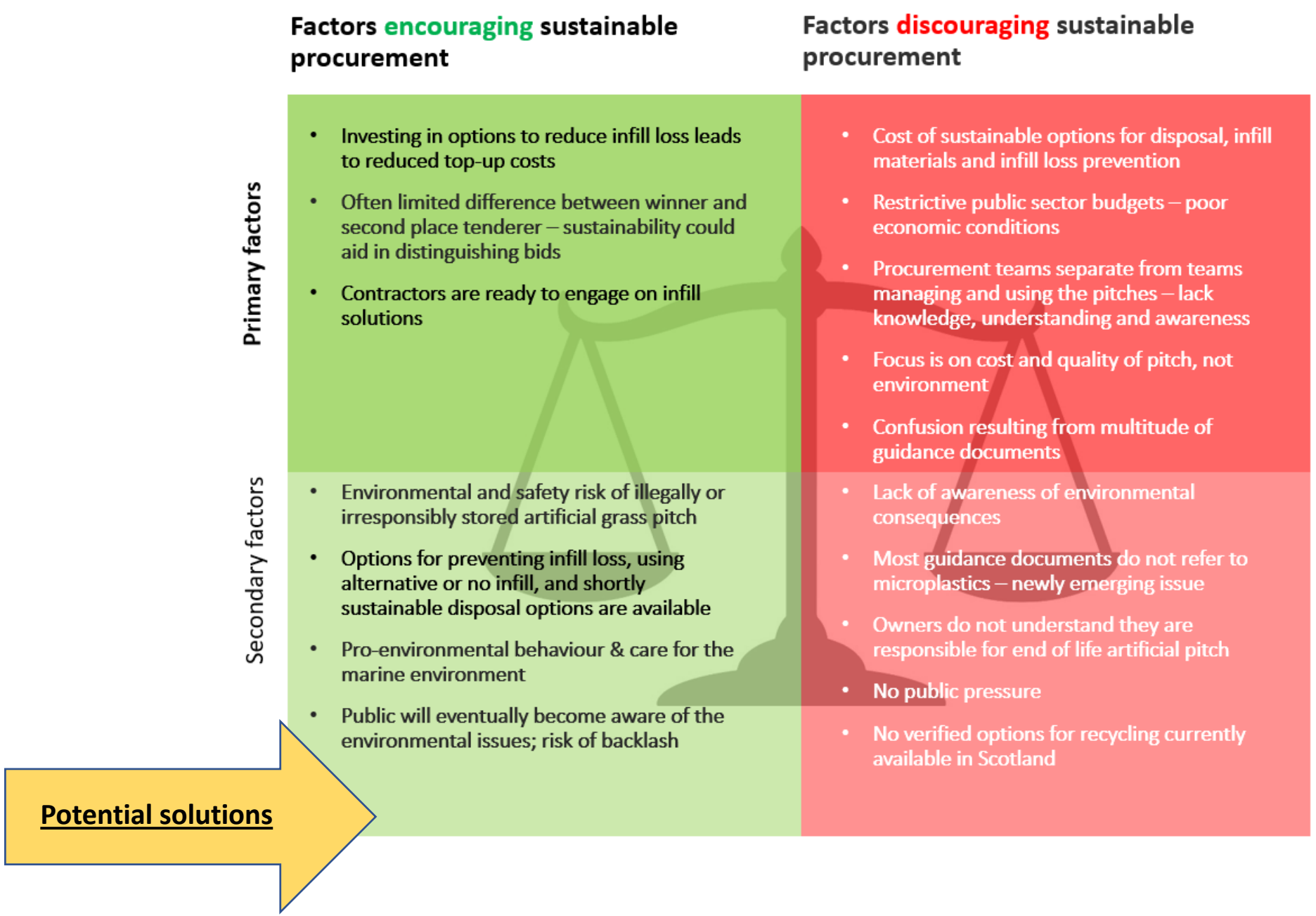
Opportunity

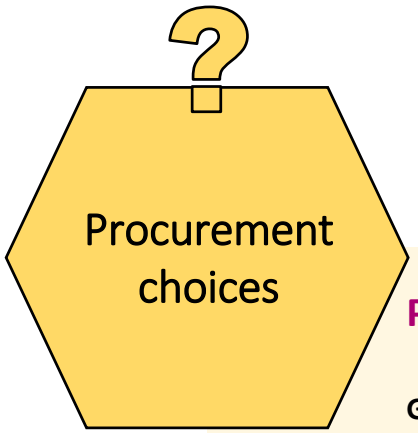
There are opportunities to enable procurement teams to make informed decisions regarding best value products and services both economically and environmentally.





Drivers and barriers


Factors encouraging sustainable procurement
Factors discouraging sustainable procurement
Primary factors
Secondary factors
Investing in options to reduce infill loss leads to reduced top-up costs
Often limited difference between winner and second place tenderer – sustainability could aid in distinguishing bids
Contractors are ready to engage on infill solutions
Cost of sustainable options for disposal, infill materials and infill loss prevention
Restrictive public sector budgets – poor economic conditions
Procurement teams separate from teams managing and using the pitches – lack knowledge, understanding and awareness
Focus is on cost and quality of pitch, not environment
Confusion resulting from multitude of guidance documents
Environmental and safety risk of illegally or irresponsibly stored artificial grass pitch
Options for preventing infill loss, using alternative or no infill, and shortly sustainable disposal options are available
Pro-environmental behaviour & care for the marine environment
Public will eventually become aware of the environmental issues; risk of backlash
Lack of awareness of environmental consequences
Most guidance documents do not refer to microplastics – newly emerging issue
Owners do not understand they are responsible for end of life artificial pitch
No public pressure
No verified options for recycling currently available in Scotland
Potential solutions



Potential solutions

Green procurement framework

- Ensures bids are assessed appropriately in terms of quality as well as cost. Create demand for higher quality products which meet required standards regarding infill loss and end of life treatment. Aid procurement teams with evaluating tenders.

Accreditation

- Provide a marker with which procurement teams can identify manufacturers and installers which are acting on infill loss and end of life issues.

Education

- Promote awareness and understanding of causes, consequences and solutions regarding infill loss and end of life issues to ensure procurement teams can evaluate the quality of products appropriately.

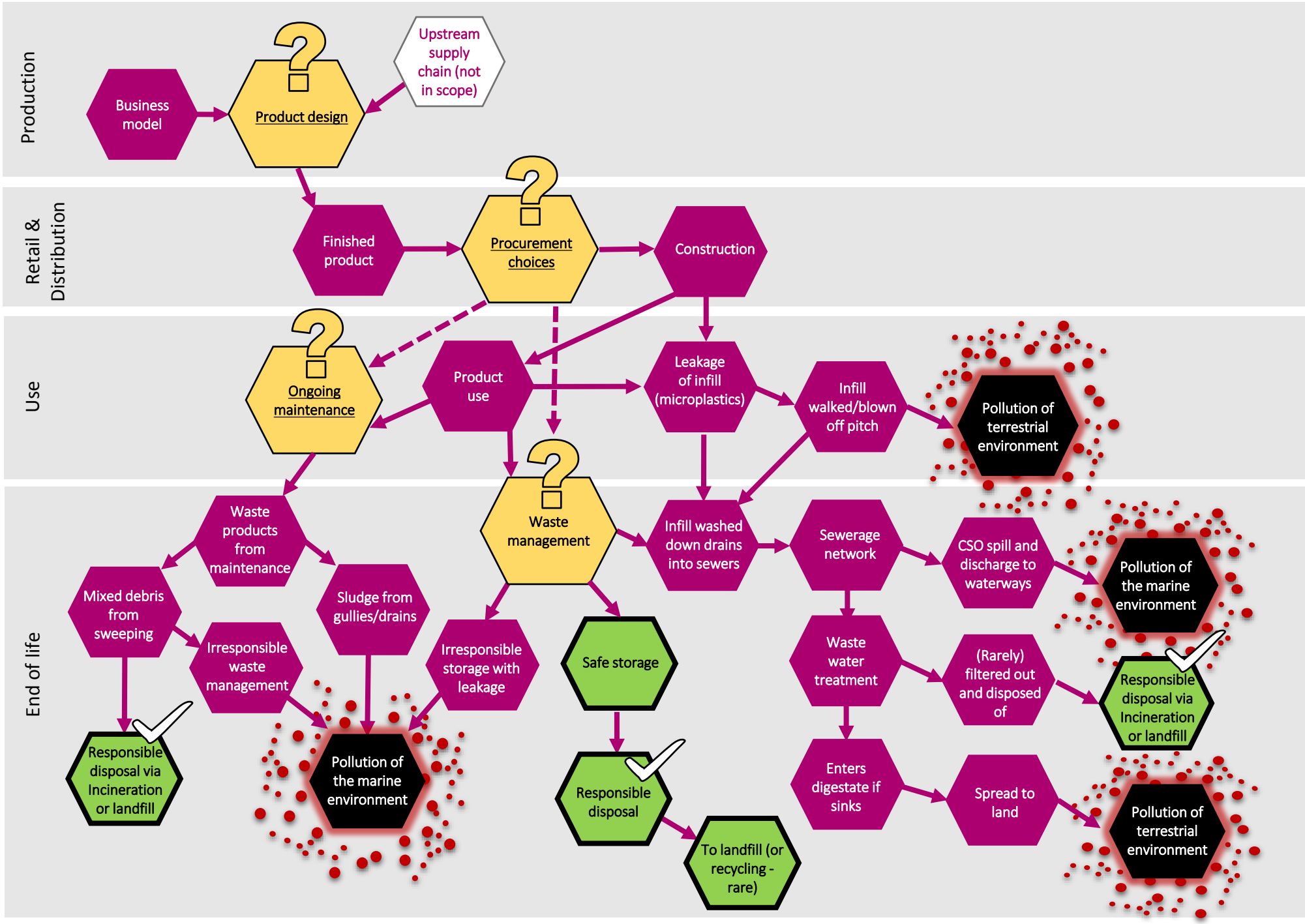
Funding

- Provide funds to procurement teams to allow retrofitting of infill loss prevention infrastructure.

Guidance

- Ensure procurement teams have a source of information to aid sustainable procurement decisions for installation, maintenance and waste management contracts.

Back to start


Production
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Upstream supply chain (not in scope)
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Responsible disposal via Incineration or landfill
Pollution of the marine environment
Responsible disposal
To landfill (or recycling - rare)
Enters digestate if sinks
Spread to land
Pollution of terrestrial environment

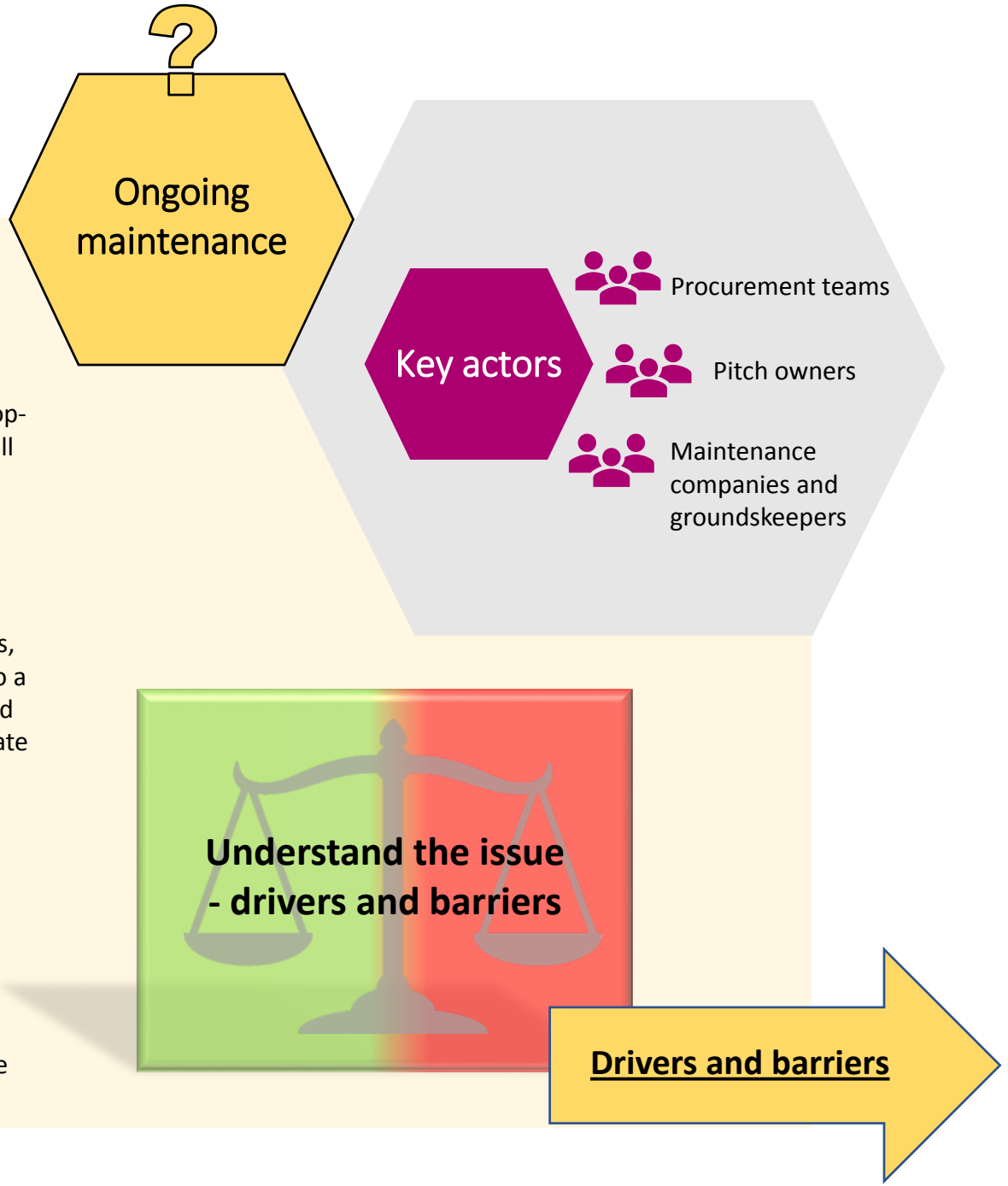
Key decision point

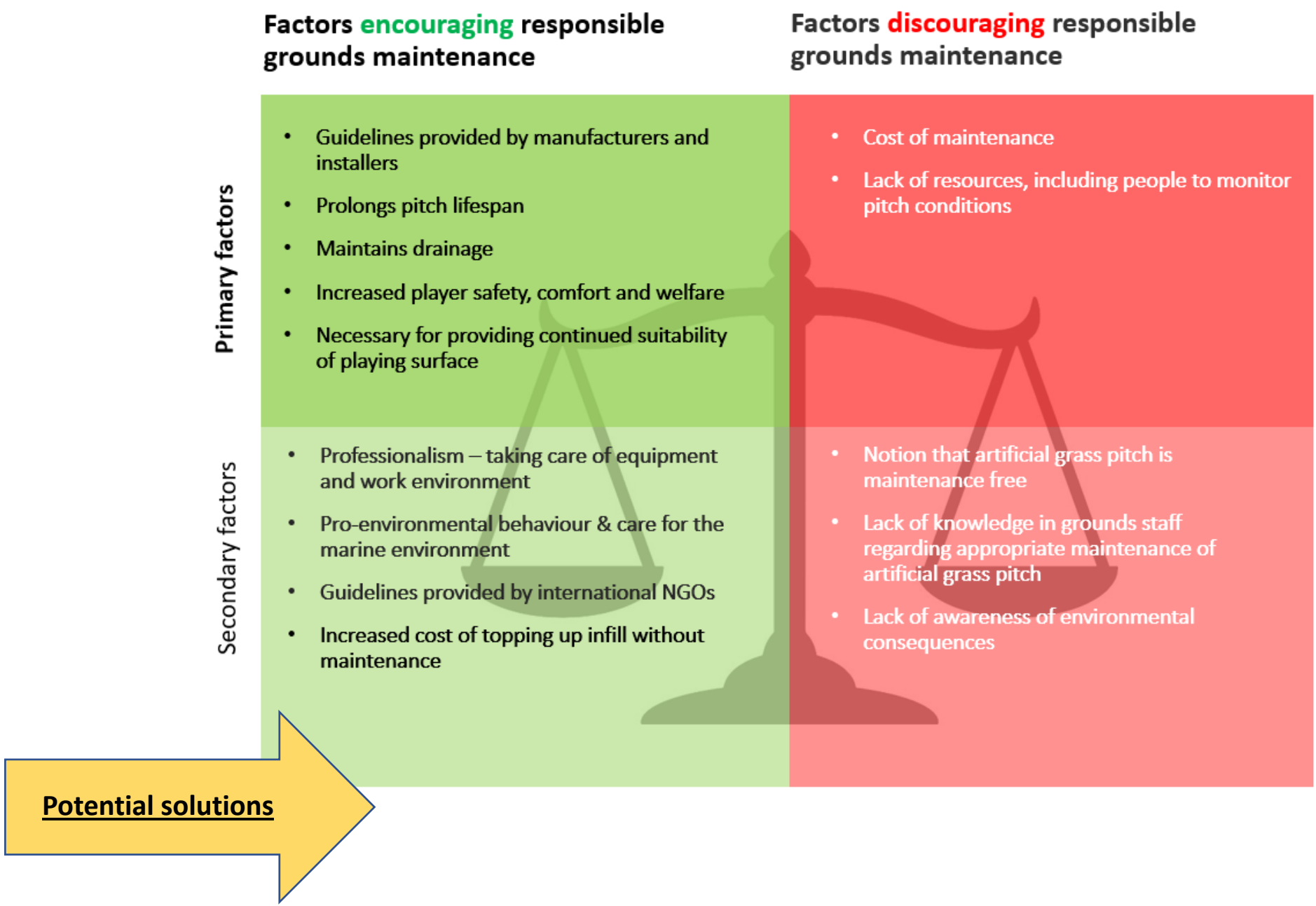
Good maintenance routines can help reduce infill loss and will reduce the need for infill top-up resulting from compaction and loss of infill to the surrounding area. It is also key for ensuring playability and prolonging pitch lifespan.

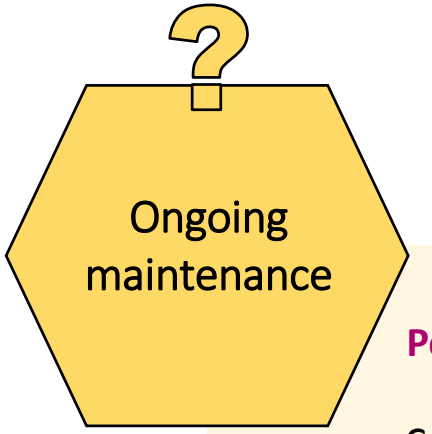
The key actors at this decision point are maintenance companies and groundskeepers, procurement teams and pitch owners, and to a degree sports associations, manufactures and installers who provide guidance on appropriate maintenance routines.

Opportunity

There are opportunities to ensure key actors fully understand the need for appropriate maintenance of artificial grass pitches, and training is available educate maintenance personal on artificial grass pitch maintenance processes.




Factors encouraging responsible grounds maintenance
Factors discouraging responsible grounds maintenance
Primary factors
Guidelines provided by manufacturers and installers
Prolongs pitch lifespan
Maintains drainage
Increased player safety, comfort and welfare
Necessary for providing continued suitability of playing surface
Cost of maintenance
Lack of resources, including people to monitor pitch conditions
Secondary factors
Professionalism – taking care of equipment and work environment
Pro-environmental behaviour & care for the marine environment
Guidelines provided by international NGOs
Increased cost of topping up infill without maintenance
Notion that artificial grass pitch is maintenance free
Lack of knowledge in grounds staff regarding appropriate maintenance of artificial grass pitch
Lack of awareness of environmental consequences
Potential solutions



Potential solutions

Green procurement framework

- Enable the assessment of maintenance bids based on their true value, not simply cost.

Education

- Funding of training courses for those maintaining artificial grass pitches to ensure their understanding of required maintenance routines and the risks arising if from pitches which are not maintained.

Guidance

- Guidance for procurement teams to emphasise the need for appropriate maintenance regimes and to make them award of best practice guidance maintenance teams should be utilizing.

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