Assessment of measures to reduce marine litter from single use plastics

Final report and Annex

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May 2018

EUROPEAN COMMISSION

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Luxembourg: Publications Office of the European Union, 2018

PDF ISBN 978-92-79-92898-7 doi:10.2779/500175 KH-03-18-234-EN-N

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Assessment of measures to reduce marine litter from single use plastics

Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'

30 May 2018

Submitted to:

Company name	European Commission - DG ENV - Sustainable Production, Products & Consumption (ENV.B1)
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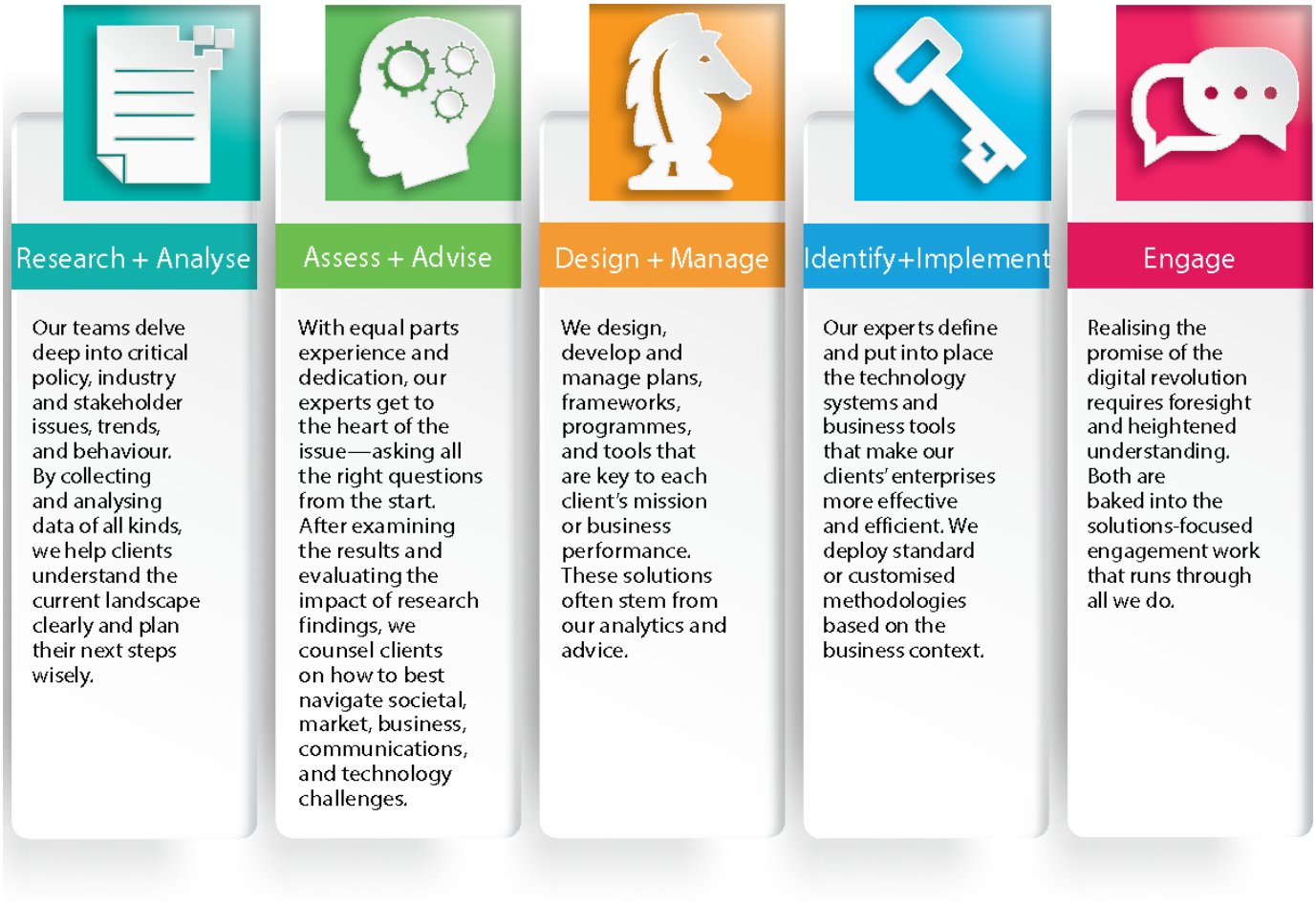

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Assessment of measures to reduce marine litter from single use plastics

Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'

A report submitted by ICF
in association with
Eunomia Research & Consulting Ltd (Eunomia)

Date: 30 May 2018

Job Number J320301241

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Document Control

Document Title	Assessment of measures to reduce marine litter from single use plastics Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'
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Date	30 May 2018

Abstract

This report, and its annexes, set out the methodology used to assess the impacts of introducing a range of measures tackling single use plastics (SUP). The outputs of this study were used to underpin the impact assessment carried out by the Commission for the proposal for a *'Directive of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment'*. The report firstly details the approach taken to produce the results. The rationale for selecting the top ten priority SUP items for inclusion in scope of the Directive is then summarised. The baseline policies set to influence the consumption and management of SUPs are outlined, along with the approach to defining the range of measures that would feasibly tackle each of the top ten items. The detail of the assessment model to produce the quantitative results is then described. Finally, the definition of the main options modelled is given, followed by a presentation of the outcomes of the assessment and associated narrative.

Ce rapport et ses annexes présentent la méthodologie utilisée pour évaluer les impacts de l'introduction d'une série de mesures concernant les plastiques à usage unique (PUU). Les résultats de ce rapport ont servi de base à l'étude d'impact réalisée par la Commission pour la proposition d'une «Directive du Parlement Européen et du Conseil concernant la réduction de l'impact environmental de certains produits plastiques». Le rapport détaille tout d'abord l'approche adoptée pour produire les résultats. Puis, la justification de la sélection des dix principaux produits PUU inclus dans le cadre de la directive est résumée. Les politiques de référence établies pour influencer la consommation et la gestion des PUU sont décrites, ainsi que l'approche adoptée pour définir l'ensemble des mesures qui permettraient d'adresser chacun des dix principaux articles. Le modèle d'évaluation qui a mené aux résultats quantitatifs est ensuite décrit en détail. Enfin, la définition des options principales incluses dans le modèle est donnée, suivie par une présentation des résultats de l'évaluation et de leur argumentation.

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Executive summary

ES1.1 Introduction

ICF and Eunomia Research & Consulting Ltd. are pleased to present this report to the European Commission. It constitutes the Final Report of the extension study on "Reducing litter from single use plastics", undertaken under the broader contract "Plastics: reuse, recycling and marine litter" (Specific Contract No. 07.0201/2017/756813/SER/ENV.B.1 under Framework Contract No. ENV.C.2/FRA/2016/0017).

This report on single use plastics builds upon work already undertaken in the ongoing study, presented in ICF and Eunomia (2018).[1] It provides analysis to support the development of the European Commission's Impact Assessment (IA) on single use plastics, and has been developed in line with the Better Regulation Guidelines. The objective of the analysis was

> *'to fine tune the possible options to reduce single use plastic litter, and to further analyse to the level of detail required by a full impact assessment, the potential impacts of a limited number of options for each of the items identified by the Commission.'*

This Executive Summary firstly summarises the work carried out prior to this IA on single use plastics (SUP). It then describes the key steps taken to assess the impacts and produce modelled results. It then summarises the key options that were modelled in the IA, and finally sets out the key results.

This work gave the analytical basis to the European Commission for the "proposal for a *Directive of the European Parliament and of the Council on the reduction of the impact of certain plastic products on the environment'*.

ES1.2 Summary of Work on the Preceding Plastics Strategy

The first main piece of work carried out under this contract was an assessment of the problems associated with the management of plastics more broadly. It was this initial work underpinning the Plastics Strategy that led to the additional work on SUP items supporting the Commission's impact assessment. The work assessed two key scenarios. 'Pragmatic' that represented the core policies of the Plastics Strategy and 'Blue Skies' that showed the potential additional benefits of a higher level of ambition that could be adopted by Member States. The key conclusions of the study were:

- The outcomes of both scenarios are shaped most strongly by the effects of measures on packaging and single-use plastics (SUPs). This reflects:
  - The significance of polymer demand for packaging and the presence of it in the waste stream overall;
  - The scope for further improvements in the management of packaging beyond what is seen in the baseline; and

[1] ICF and Eunomia (2018). 'Plastics: Reuse, recycling and marine litter, Final Report', 30th May 2018

  - The significant benefits of reducing consumption and littering, of SUPs, as the proportion of consumption and littering is high compared to other plastic types (by weight manufactured).

- Both scenarios result in significant environmental benefits, in fact externalities decrease under all sectors for all scenarios. These relate to:
  - The extent to which littering of plastic items, hence the environmental and social impacts of plastic litter, is reduced compared to the baseline;
  - The extent to which plastics are diverted away from energy recovery (the most common end-of-life destination for plastics in the baseline) and are either reused or diverted to recycling streams; and
  - Under the Blue Skies scenario, significant benefits might be achieved from the diversion of plastics from energy recovery to recycling as mandatory plastic sorting requirements at all energy recovery facilities are implemented. Significant benefits are achieved from these sorting requirements, as most residual wastes are sent to energy recovery facilities under the baseline scenario due to the landfill reduction targets set for 2030 under the Circular Economy package. The costs of increased recycling are outweighed by the benefits of recycling over energy recovery.
- Under both scenarios most sectors will see a net increase in costs.
- However, for all sectors, other than C&D, the beneficial reduction in externalities outweighs the increase in financial costs, so overall benefits to society are delivered.

A final point from the work related to single use plastics, was that there is strong pressure from the public for governments to take action on the rapidly emerging environmental issues related to plastics in the marine environment and industrial pollution. Such pressure should cause governments to create clear, enforced policies and actions at an EU and national level.

ES1.3 Methodology to Assess the Impacts of Measures Related to SUPs

The key aspects of the method used for the analysis can be summarised as follows (a full description of the method can be found in the Annex):

- **Identify top ten items on beaches.**
- **Gather consumption data.**
- **Define baseline polices.**
- **Define new policy measures and options to model.**
- **Effect of new policy measures.**
- **Model economic impacts.**
- **Model environmental impacts.**

In order to develop a bespoke, quantitative model through which to assess the costs and benefits, we revisited the data from the Joint Research Centre (JRC) to confirm the single use plastic (SUP) items that should be taken forward in this study. Selection of these included consideration of the top 10 items, by item count, found littered on beaches, as well as variations by regional sea. In order to develop the model, it was necessary to seek specific data related to the chosen items. To this end, in addition to desk-based data gathering, market data reports were purchased, giving the study team significant data on the SUP items identified.

ICF/Eunomia have used the problem tree analysis already provided under the existing contract to further developed the measures that could be used to address the key issue of littering of single use plastics. Our approach has been to consider the suitability of the different SUPs to be addressed by different types of measures (in a shorter or longer time scale), taking into account the nature of the product, and the ease of substitution by existing alternatives. The elaboration of the measures kept in mind the matters of feasibility of the application of different measures, matters of subsidiarity and legal issues likely to arise.

Finally, the analysis has considered a range of economic, social and environmental impacts building on the ongoing study. Further work was undertaken to understand better the externalities associated with litter, both when it is first dropped (usually on land, sometimes at sea), and once it has been transported to the beach / sea. In addition, the study team was grateful for the cooperation of a team, including Cambridge Econometrics, IEEP and Denkstatt, which in the process of undertaking a separate contract for DG Environment, provided relevant life cycle inventory data for the SUP items and their most likely single use non-plastic (SUNP) and multiple use (MU) substitutes.

This report assumes the following:

- The work undertaken by the JRC to identify those SUP items most frequently found in beach litter surveys are representative of the problem;
- The data provided in the market reports are accurate; and
- Different measures are related to different outcomes: as such, the range of ambition is reflected in the variation in the types of measures deployed.

In addition:

- The available data are variable in their quality and to the extent possible, we have sought to use those published sources that are, in the view of the project team, the most reliable, or the ones based on the most robust methodology; and
- Notwithstanding the above point, there remain gaps in the evidence: where data are missing, expert opinion has been used to develop estimates.

ES1.4 Definition of Key Options

There were 5 options modelled in total over the course of the study. An initial four, 2a to 2d, and an additional 2c+, modelled through the latter stages of the Commission's IA process. Option 2c+ contains the measures within the proposal for a Directive. Table ES1.1 sets out the measures included in Options 2a to 2d. The changes in Option 2c+ compared with Option 2c were:

- The DRS measure for beverage containers included only in 2d in the first assessment was included in 2c+;
- The reduction targets for wet-wipes were removed (meaning the measure as proposed under option 2b was modelled); and
- The obligation for extended producer responsibility (EPR) on litter collections was removed for sanitary towels/pads (meaning the measure as proposed under option 2a was modelled).

Table ES1.1 Measures included in the Options 2a to 2d.

Item	Information campaigns	Voluntary action	Label	Best practices for WWTW	EPR ~ cost of litter	DRS for beverage containers	Consumption levies	Product Design	Reduction targets			Ban (of SUP items)
									25% by 2030	30% by 2025 50% by 2030	50% by 2025 80% by 2030	
Cigarette filters	a,b,c,d	a,b,c,d	d		b/c					d		
Drinks bottles	a,b,c,d	a,b,c,d			b/c	d		b/c (caps)				
Cotton bud sticks	a,b,c,d	a,b,c,d	a									b/c/d
Crisp packets	a,b,c,d	a,b,c,d			b/c/d							
Wet wipes	a,b,c,d	a,b,c,d	a	d	b					c		
Sanitary towels	a,b,c,d	a,b,c,d	a		b/c				d			
Cutlery	a,b,c,d	a,b,c,d			b					b		c/d
Straws	a,b,c,d	a,b,c,d			b					b		c/d
Stirrers	a,b,c,d	a,b,c,d			b					b		c/d
Drinks cups & lids	a,b,c,d	a,b,c,d			b/c					b/c	d	
Food containers	a,b,c,d	a,b,c,d			b/c					b/c	d	
Balloons	a,b,c,d	a,b,c,d	a/b/c/d		b/c/d							
Balloon sticks	a,b,c,d	a,b,c,d	a		b/c							b/c/d

Note: The information campaigns / voluntary actions are assumed to be in place for all Options: they are not always explicitly modelled (clearly, if a ban is part of the Option, this would make voluntary actions redundant)

ES1.5 Summary of Key Results

The summary impacts of the Options are presented in Table ES1.2. All impacts are measured relative to the Baseline (Option 1 in the Commission's IA).

Table ES1.2 Summary of Key Impacts

	Option				
	2a	2b	2c	2c+	2d
Marine litter by count (as % of SUP Top 10)	-16%	-50%	-56%	-53%	-74%
Marine Litter, tonnes	-2,750	-4,450	-4,850	-9,190	-12,070
Change in GHG, million tonnes	-1.28	-2.02	-2.63	-3.42	-3.97
External Costs, € billion	-7.1	-9.5	-11.1	-23.2	-30.9
Savings for consumers, € billion	3.7	5.1	6.5	6.6	10.0

	Option				
	2a	2b	2c	2c+	2d
Impact on producer turnover, € billion	-1.8	-2.5	-3.2	-3.8	-5.0
Information campaign costs, € million	714	698	596	596	596
Business compliance, commercial washing & refill scheme costs, € million	338	1081	1385	1763	2099
Waste management costs, € million	30	445	511	783	9175
Employment, 000 FTE	-3.8	3.8	4.0	29.3	27.8
Feasibility	**High**	**Med**	**Med**	**Med**	**Low**
Ensure Internal Market	**-**	**+**	**++**	**++**	**++**

Source: Eunomia SUP IA model

The Table indicates the changes in environmental and economic parameters. Of particular interest is the fact that the environment benefits are far greater than the total losses in sales to producers.

The following comments are made on the results:

- Economic impacts:
  - Under the different Options, as might be expected, the change in sales for producers of SUP items decreases as the strength of the measures increase (moving from Option 2a to 2d); whilst sales of SUNPs and MU items increase.
  - There is a net loss to producers as a whole ranging from €1.8 billion in Option 2a to €5.0 billion in Option 2d.
  - Consumers generally make savings (the change in costs is negative), these ranging from €3.7 billion in Option 2a to €10 billion in Option 2d. In essence, if consumers choose to spend this elsewhere in the economy, so the loss in sales revenue to producers would be expected to be offset by an increase in activity in other sectors of the economy (reflecting the shift in the consumer spend).
  - Business compliance costs are estimated to be close to zero under Options 2a and 2b (other than what is calculated separately for the costs of information provision, or for what is noted as waste management costs). The compliance costs increase as more businesses are required to report, for example, information related to the reduction in use of SUPs, which we assume to be a corollary of these measures in Options 2c, 2c+ and 2d.
  - The waste management costs include the level of spend on activities related to EPR, additional waste water treatment costs, and implementation of deposit refunds, as well as managing changing flows of material under the different Options. The measure leading to the greatest change in cost, is the implementation of a requirement to install improved technology at WWTWs in Option 2d. Because the measure is included in the Option only to address wet wipes, this high cost may be considered disproportionate.
  - Moving from Option 2a to Option 2d, the employment effects – measured only in terms of a microeconomic assessment (i.e. a sector specific not

macro economic) – show increases in numbers employed as the Options change. The increased employment relates in part to the assumed existence of, for example, take back and washing schemes for food containers and cups, as well as increased employment following the introduction of a DRS.
  - It is important to understand that the costs of the Options to the different actors cannot be considered as additive, and properly speaking, they do not represent 'costs' of the policy measures. This is important to bear in mind when considering these results. Also not factored into the analysis is the potential for innovation to be called forward by the measures, in terms of the design of products and the implementation of new business models designed to foster more sustainable consumption patterns (for example, deposit refund schemes for refillable cups).
- Environmental impacts:
  - **Option 2a** consists primarily of measures for information campaigns and voluntary actions, as well as mandatory labelling on flushable items. The impacts on reducing marine litter are relatively slight. The majority of the change in marine litter – as measured by weight – comes from the impact on SUP bottles (this is also the case for most of the other Options).
  - **Option 2b** introduces – for all items – the use of producer funding to support improved litter clean-up. The option also includes reduction targets for cutlery, straws, stirrers, drinks cups and food containers, a ban on SUP cotton buds, and the tethering of lids to SUP bottles (as an eco-design measure).
  - **Option 2c** generates a further improvement in all parameters except for the issue of land-take: under Option 2c, a target for reducing SUP flushable wet-wipes is introduced, occasioning a switch to cotton based alternatives, which generate an increase in land take. Indeed, the increase in land-take is highest for Option 2c because of the effects of this switch.
  - **Option 2c+** introduces much more significant reductions in marine litter, and associated benefits. The main changes are related to the introduction of a DRS on SUP bottles (it is assumed that there would be other beverage containers included, but the analysis relates to the plastic containers only), This leads to significant additional environmental benefits. It prevents 53% of the total number of SUP in marine litter (with the remainder mainly being cigarette filters), or 9 thousand tonnes in weight terms (a large proportion of the total). It also delivers 3.5 million tonnes of GHG reduction per annum in 2030 and almost €23 billion of external benefits, mainly related to avoided impacts associated with terrestrial and marine litter. There is an increase in the land-take implied by the life-cycle impacts, but this is relatively small at 27km^2 of land.
  - **Option 2d** finally includes the implementation of technical standards for WWTW and CSOs to deal with wet-wipes, the reduction target for sanitary towels, the reduction target for SUP cigarette filters, and the higher reduction targets for drinks cups and lids, and food containers. This option has the greatest overall impact out of all the options considered here. The targets on food containers and cigarette filters, which lead to increases in use of fibre based materials, lead to increases in land-take, though this is not as great as in Option 2c (where the effect is on wet-wipes). Otherwise, the impacts are generally experienced as an improvement in impact across the board.

Synthèse

ES1.1 Introduction

ICF et Eunomia Research & Consulting Ltd. sont heureux de présenter ce rapport à la Commission Européenne. Ceci est le Rapport Final de la prolongation de l'étude «Réduire les déchets des plastiques à usage unique», réalisée dans le cadre du contrat «Plastiques: réutilisation, recyclage et déchets marins» (Contrat Spécifique n°07.0201/2017/756813/SER/ENV.B. accordé sous le contrat-cadre n° ENV.C.2/FRA/2016/0017).

Ce rapport sur les plastiques à usage unique est basé sur la recherche présentée dans le rapport ICF et Eunomia (2018), dans le cadre de l'étude en cours.[2] Il fournit l'analyse qui soutient l'étude d'impact préparée par la Commission Européenne sur les plastiques à usage unique, et a été développé conformément aux lignes directrices pour une meilleure réglementation. L'objectif de l'analyse était

> *'d'affiner les options possibles pour réduire les déchets plastiques à usage unique et analyser davantage le niveau de détail requis par une étude d'impact complète, les impacts potentiels d'un nombre restraint d'options pour chacun des produits identifiés par la Commission'.*

Cette synthèse résume d'abord la recherche qui a déjà été effectuée sur les plastiques à usage unique (PUU), précédant la présente étude. Elle décrit ensuite les principales considérations prises pour évaluer les impacts et produire des résultats du model. Elle résume ensuite les options clés qui ont été incluses dans l'étude d'impact et présente enfin les principaux résultats.

Ce travail a fourni la base analytique à la Commission européenne pour la "proposition *d'une Directive du Parlement européen et du Conseil relative à la réduction de l'impact de certains produits plastiques sur l'environnement*".

ES1.2 Synthèse du Travail Réalisé pour la Stratégie Plastiques

Le premier rapport réalisé dans le cadre de ce contrat était une évaluation des problèmes liés à la gestion des plastiques de façon générale. Ce travail initial sous-tend la Stratégie sur les Plastiques. Il a conduit à un travail supplémentaire sur les produits plastiques à usage unique (PUUs) qui soutient l'étude d'impact de la Commission. Le travail évalue deux scénarios clés: un scenario "Pragmatique" qui représente les politiques au centre de la Stratégie sur les Plastiques et un scénario "Blue Skies"[3] qui montre les bénéfices supplémentaires possibles si un niveau d'ambition plus élevé était adopté par les États Membres. Les principales conclusions de l'étude sont:

- Les résultats des deux scénarios sont influencés le plus fortement par les effets des mesures sur les emballages et les plastiques à usage unique (PUUs). Cela reflète:
  - L'importance de la demande en polymères plastiques pour les emballages et leur présence dans le flux des déchets en général;

[2] ICF and Eunomia (2018). 'Plastics: Reuse, recycling and marine litter, Final Report', 30th May 2018

[3] Pensée creative et visionnaire.

  - la possibilité d'améliorer davantage la gestion des emballages au-delà de ce qui est prévu dans le scénario de référence; et
  - les bénéfices importants apportés par la réduction de la consommation des produits PUUs et des déchets en PUUs jetés dans la nature, car leur proportion en matière de consommation et de pollution dans la nature est élevée par rapport aux autres types de plastiques (par poids manufacturé).

- Les deux scénarios entraînent des bénéfices environnementaux significatifs, en effet les externalités diminuent dans tous les secteurs pour chacun des scénarios. Ceux-ci concernent:
  - La mesure dans laquelle les détritus d'articles en plastique, et donc des impacts environnementaux et sociaux des déchets plastiques, sont réduits par rapport aux scénario de référence; et
  - La mesure dans laquelle les plastiques sont détournés de la récupération d'énergie (la destination de fin de vie la plus courante pour les plastiques dans scénario de référence) et sont réutilisés ou détournés vers des filières de recyclage.
  - Dans le scénario “Blue Skies”, des bénéfices significatifs pourraient être obtenus grâce au détournement des matières plastiques de la récupération d'énergie au recyclage, étant donné la mise en oeuvre d’exigences obligatoires en matière de tri plastique dans toutes les installations de récupération d'énergie. Des bénéfices importants sont obtenus grâce à ces exigences de tri car dans le scénario de référence, la plupart des déchets résiduels sont envoyés en installation de récupération d'énergie en raison des objectifs de réduction de la mise en décharge des déchets fixés pour 2030 dans le cadre du Paquet ‘Economie Circulaire’. L’augmentation des coûts du recyclage sont compensés par les bénéfices obtenu par le recyclage par rapport à la récupération d'énergie.

- Dans les deux scénarios, la plupart des secteurs verront une augmentation nette des coûts.
- Toutefois, pour tous les secteurs autres que C&D, la réduction bénéfique des externalités l'emporte sur l'augmentation des coûts financiers, de sorte que de façon générale des bénéfices sont générés pour la société.

Les points suivants décrivent certaines des principales conclusions de la recherche, et expliquent les aspects qui contribueraient à apporter les bénéfices décrits ci-dessus:

- Les mesures doivent soutenir une augmentation du contenu recyclé dans les produits afin de stimuler la demande en plastiques secondaires. Ceci est particulièrement important entant donné l'interdiction d'exporter certaines matières plastique pour le recyclage en Chine.
- Il est clairement nécessaire d'améliorer la traçabilité des différents polymères, mélanges et constituants chimiques dans les plastiques, afin de soutenir les augmentations de contenu recyclé dans le futur.
- Afin de favoriser la traçabilité et le recyclage, il serait avantageux de réduire la gamme des mélanges de polymères, des formats et des permutations de composites.

- Étant donné qu'il est peu probable que tous les impacts environnementaux négatifs d'un produit soient intégralement incorporés dans les prix du marché, ces mécanismes doivent être associés à une augmentation des objectifs de réutilisation et de recyclage et à l'élimination progressive des objectifs de valorisation. L'élimination progressive des objectifs de récupération est particulièrement importante car ceux-ci conduisent généralement au développement de la le combustion des plastiques dans les usines traitées thermiquement. Ce traitement est plus bas dans la hiérarchie des déchets que la réutilisation et le recyclage et, dans le contexte de la décarbonisation des sources d'énergie, constitue un obstacle à la réduction des émissions de gaz à effet de serre.
- Lié à ce qui précède, il semble important de veiller à ce que le plus de plastique possible soit extrait des déchets mixtes avant que de les envoyer au traitement thermique.

Le public exerce une forte pression sur les gouvernements pour qu'ils prennent des mesures face aux problèmes environnementaux émergents liés aux plastiques dans l'environnement marin et à la pollution industrielle. Cette pression devrait amener les gouvernements à créer des politiques et des actions claires et appliquées au niveau européen et national.

ES1.3 Méthodologie pour Evaluer les Impacts des Mesures liées aux PUUs

Les principaux aspects de la méthode utilisée pour l'analyse peuvent être résumés comme suit (une description complète de la méthode se trouve dans l'Annexe):

- **Identifier les dix premiers articles sur les plages.**
- **Rassembler les données de consommation.**
- **Définir des politiques de référence.**
- **Définir les nouvelles mesures politiques et les options à modéliser.**
- **Identifier l'effet des nouvelles mesures politiques.**
- **Modéliser les impacts économiques.**
- **Modéliser les impacts environnementaux.**

Afin de développer un modèle quantitatif sur mesure pour évaluer les coûts et les bénéfices, nous avons réexaminé les données du Joint Research Centre (JRC) pour confirmer les produits plastiques à usage unique (PUUs) à inclure dans cette étude. La sélection de ceux-ci s'est faite par l'examen des 10 principaux produits, par nombre d'articles, trouvé sur les plages, ainsi que les variations par mer régionale. Afin de développer le modèle, il était nécessaire de rechercher des données spécifiques liées aux articles choisis. À cette fin, en plus d'une recherche documentaire, des rapports sur les données du marché ont été achetés, ce qui a fourni à l'équipe des données importantes sur les produits PUUs identifiés.

ICF/Eunomia ont utilisé une analyse à l'aide d'arbres à problems, fournie dans le cadre du contrat existent, pour développer davantage les mesures qui pourraient être utilisées pour résoudre le problème clé des déchets en PUUs jetés dans la nature de plastiques à usage unique. Notre approche a consisté à considérer l'aptitude des différents PUUs à être géré par différents types de mesures (sur une échelle de temps plus ou moins longue), en tenant compte de la nature du produit et de la possibilité de substitution avec des alternatives existantes. En élaborant les

mesures, les questions de la faisabilité des différentes mesures, de la subsidiarité de celles-ci et de tout problème juridique susceptible de se poser on éte considérés.

Enfin, l'analyse a pris en compte une série d'impacts économiques, sociaux et environnementaux s'appuyant sur l'étude en cours. De la recherche supplémentaire a été entreprise pour mieux comprendre les externalités associées aux déchets, à la fois lors de leur premier abandon (généralement sur terre, parfois en mer), et une fois transportés vers la plage/mer. De plus, l'équipe d'étude est reconnaissante de la collaboration d'une équipe dirigée par Cambridge Econometrics, qui, en cours d'un autre travail sur un différent contrat pour DG Environnement, a fourni des données d'inventaire du cycle de vie pour les articles PUUs et leurs alternatives non-plastiques à usage unique (NPUU) et à usage multiple (UM) les plus communs.

Ce rapport suppose ce qui suit:

- Le travail entrepris par le JRC pour identifier les produits PUUs les plus fréquemment trouvés dans les relevés de déchets sur les plages est représentatif du problème;
- Les données fournies dans les rapports de marché sont exactes; et
- Différentes mesures sont liées à différents résultats: en tant que tel, la gamme d'ambition se reflète dans la variation des types de mesures déployés.

En outre:

- Les données disponibles sont de qualité variable et, dans la mesure du possible, nous avons cherché à utiliser les sources publiées qui, de l'avis de l'équipe d'étude, sont les plus fiables ou celles qui reposent sur la méthodologie la plus rigoureuse; et
- Nonobstant ce qui précède, il subsiste des lacunes dans les éléments de preuve: lorsque des données manquent, l'opinion d'experts a été utilisée pour élaborer des estimations.

ES1.4 Definition des Options Clés

Au total, cinq options ont été modélisées au cours de l'étude: quatre premières options, 2a à 2d, et une option supplémentaire (2c+), modélisée pendant les dernières étapes de l'étude d'impact de la Commission. L'option 2c+ contient les mesures retenues dans la proposition d'une Directive. Le Table ES1.1 présente les mesures incluses dans les options 2a à 2d. Les modifications de l'option 2c+ par rapport à l'option 2c sont les suivantes:

- La mesure d'une consigne sur les contenants de boissons, incluse dans l'option 2d dans la première évaluation, a été incluse dans 2c+;
- Les objectifs de réduction pour les lingettes ont été supprimés (ce qui signifie que la mesure proposée dans l'option 2b a été modélisée); et
- L'obligation d'une responsabilité élargie des producteurs (REP) sur les collections de déchets a été supprimée pour les serviettes hygiéniques (ce qui signifie que la mesure proposée dans l'option 2a a été modélisée).

Table ES1.3 Mesures incluses dans les Options 2a à 2d

Produit	Campagnes de communication	Action volontaire	Etiquetage	Meilleures pratiques pour le traitement des eaux usées	REP ~ coût des déchets jetés dans la nature	Consignes pour contenants boissons	Niveau de consommation	Conception des produits	Objectifs de reduction			Interdiction (des PUUs)
									25% d'ici 2030	30% d'ici 2025 50% d'ici 2030	50% d'ici 2025 80% d'ici 2030	
Filtres Cigarettes	a,b,c,d	a,b,c,d	d		b/c					d		
Bouteilles de boissons	a,b,c,d	a,b,c,d			b/c	d		b/c (capuchons)				
Cotons-tiges	a,b,c,d	a,b,c,d	a									b/c/d
Paquets de chips	a,b,c,d	a,b,c,d			b/c/d							
Lingettes	a,b,c,d	a,b,c,d	a	d	b					c		
Serviettes hygiéniques	a,b,c,d	a,b,c,d	a		b/c				d			
Couverts	a,b,c,d	a,b,c,d			b					b		c/d
Pailles	a,b,c,d	a,b,c,d			b					b		c/d
Agitateurs	a,b,c,d	a,b,c,d			b					b		c/d
Gobelets & couvercles	a,b,c,d	a,b,c,d			b/c					b/c	d	
Récipients alimentaires	a,b,c,d	a,b,c,d			b/c					b/c	d	
Ballons de baudruche	a,b,c,d	a,b,c,d	a/b/c/d		b/c/d							
Bâtons à ballons	a,b,c,d	a,b,c,d	a		b/c							b/c/d

NB: Les campagnes de communication / actions volontaires sont supposées être en place pour toutes les options: elles ne sont pas toujours explicitement modélisées (clairement, si une interdiction fait partie de l'option, cela rendrait les actions volontaires redondantes)

ES1.5 Résumé des Principaux Résultats

Le résumé des impacts des différentes options modélisées est présenté dans le Table ES1.2. Tous les impacts sont mesurés par rapport au scénario de référence (option 1 dans l'étude d'impact de la Commission).

Table ES1.4 Résumé des Principaux Impacts

	Option				
	2a	2b	2c	2c+	2d
Quantité de déchets marins par nombre (en % du Top 10 PUUs)	-16%	-50%	-56%	-53%	-74%
Déchets marins, tonnes	-2,750	-4,450	-4,850	-9,190	-12,070
Différence en GES, en millions de tonnes	-1.28	-2.02	-2.63	-3.42	-3.97
Coûts externes, en milliards €	-7.1	-9.5	-11.1	-23.2	-30.9
Économies pour les consommateurs, en milliards €	3.7	5.1	6.5	6.6	10.0
Impact sur le chiffre d'affaires des producteurs, en milliards €	-1.8	-2.5	-3.2	-3.8	-5.0
Coûts des campagnes d'information, en millions €	714	698	596	596	596
Conformité commerciale, coûts commerciaux de lavage et de recharge, en millions €	338	1081	1385	1763	2099
Coûts de gestion des déchets, en millions €	30	445	511	783	9175
Emploi, millier ETP	-3.8	3.8	4.0	29.3	27.8
Faisabilité	**Haut**	**Moy**	**Moy**	**Moy**	**Bas**
Garanti sur le marché intérieur	**-**	**+**	**++**	**++**	**++**

Source: Eunomia SUP IA model

Le tableau indique les changements dans les paramètres environnementaux et économiques. Le fait que les avantages pour l'environnement sont bien plus importants que les pertes totales de ventes aux producteurs est particulièrement intéressant.

Les résultats mènent aux commentaires suivants:

- Impacts économiques:
  - Selon les différentes options, comme on pouvait s'y attendre, le chiffre de ventes pour les producteurs de produits PUUs diminue à mesure que la force des mesures augmente (en passant des options 2a à 2d), tandis que les ventes des produits NPUUs et des produits UM augmentent.
  - Il y a une perte nette pour les producteurs dans l'ensemble, allant de 1,8 milliard € pour l'option 2a à 5,0 milliards € dans l'option 2d.
  - Les consommateurs réalisent généralement des économies (la variation des coûts est négative), allant de 3,7 milliards € pour l'option 2a à 10 milliards € pour l'option 2d. Essentiellement, si les consommateurs choisissent de dépenser leurs économies ailleurs dans l'économie, la perte de revenus des ventes devrait être compensée par une augmentation de l'activité dans d'autres secteurs de l'économie (reflétant l'évolution des dépenses des consommateurs).

- Les coûts de conformité commerciale sont estimés proches de zéro pour les options 2a et 2b (à l'exception de ce qui est calculé séparément pour les coûts de la mise à disposition d'information ou pour les coûts de gestion des déchets). Les coûts de conformité augmentent lorsque de plus en plus d'entreprises sont tenues de déclarer, par exemple, des informations relatives à la réduction de l'utilisation des PUUs, que nous supposons être le corollaire de ces mesures pour les options 2c, 2c + et 2d.
- Les coûts de la gestion des déchets comprennent les dépenses pour les activités liées à la REP, les coûts supplémentaires de traitement des eaux usées et la mise en œuvre des remboursements des consignes, ainsi que la gestion du changement des flux de matériaux selon les différentes options. La mesure qui entraîne le plus grand changement de coût est la mise en œuvre de l'exigence d'installer une technologie améliorée dans les stations de traitement des eaux usées dans l'Option 2d. Étant donné que la mesure est incluse dans l'option uniquement pour répondre au problème posé par les lingettes, ce coût élevé peut être considéré comme disproportionné.
- En passant de l'option 2a à l'option 2d, les effets sur l'emploi - mesurés uniquement en terme d'évaluation microéconomique (c'est-à-dire spécifique à certains secteurs et non macroéconomique) - montrent une augmentation du nombre d'employés. L'augmentation de l'emploi est liée en partie à l'existence présumée, par exemple, de programmes de reprise et de lavage de tasses et de récipients alimentaires, ainsi qu'à une augmentation de l'emploi suite à l'introduction d'un système de consignes sur les contenants de boissons.
- Il est important de comprendre que les coûts des options pour les différents acteurs ne peuvent pas être considérés comme des coûts additifs, et à proprement parler, ils ne représentent pas les «coûts» des mesures politiques. Ceci est important à garder à l'esprit en considèrant ces résultats. L'analyse ne tient pas non plus compte du potentiel que ces mesures apportent en matière d'innovation, en termes de conception de produits et de mise en œuvre de nouveaux modèles d'affaires visant à favoriser des modes de consommation plus durables (par exemple, des systèmes de remboursement des gobelets réutilisables).

■ Impacts environnementaux:
- **L'option 2a** consiste principalement en des campagnes d'information et des actions volontaires, ainsi qu'en un étiquetage obligatoire des produits jetables dans les toilettes. Les impacts sur la réduction des déchets marins sont relativement faibles. La majeure partie de la variation des déchets marins – mesurée par poids – provient de l'impact sur les bouteilles PUUs (ceci est également le cas pour la plupart des autres options).
- **L'option 2b** introduit – pour tous les produits PUUs – l'utilisation d'un financement par les producteurs pour soutenir l'amélioration du nettoyage des déchets jetés dans la nature. L'option comprend également des objectifs de réduction pour les couverts, les pailles, les agitateurs, les gobelets et les récipients alimentaires, l'interdiction des cottons-tiges PUUs et l'attachement des couvercles aux bouteilles PUUs (en tant que mesure d'écoconception).
- **L'option 2c** génère une amélioration supplémentaire de tous les paramètres, sauf pour la question de l'occupation de terrain: dans l'option 2c, un objectif de réduction des lingettes synthétiques jetables PUUs est introduit. Ceci permet de passer à des alternatives à base de coton, ce qui à son tour génère une augmentation de l'occupation de terrain. En effet, l'augmentation de l'occupation de terrain est la plus élevée pour l'option 2c en raison des effets de ce changement.

- **L'option 2c+** introduit des réductions de déchets marins beaucoup plus importantes et des avantages affiliés. Les principaux changements sont liés à l'introduction d'un d'un système de consignes sur les contenants de boissons sur les bouteilles PUUs qui entraîne d'importants avantages environnementaux supplémentaires (il est supposé que d'autres contenants de boissons seraient aussi inclus, mais l'analyse concerne uniquement les contenants en plastique). Cette option évite 53% du nombre total de PUUs dans les déchets marins (le reste étant principalement constitué de filtres à cigarettes), soit 9,000 tonnes (une grande partie du total). Elle prévoit également une réduction de 3,5 millions de tonnes de GES par an en 2030 et près de 23 milliards € d'avantages externes, principalement liés aux impacts évités associés aux déchets jetés dans la nature. Il y a une augmentation de l'occupation du terrain impliquée par les impacts du cycle de vie, mais cela est relativement faible à 27km^2 de terrain.
- **L'option 2d** enfin inclut la mise en œuvre de normes techniques pour stations de traitement des eaux usées et les déversoirs de trop-pleins pour les lingettes, l'objectif de réduction pour les serviettes hygiéniques, l'objectif de réduction pour les filtres à cigarettes PUUs et les objectifs de réduction plus élevés pour les gobelets et les récipients alimentaires. De toutes les options considérées, celle-ci a le plus d'impact. Les objectifs de réduction sur les récipients alimentaires et les filtres à cigarettes, qui conduisent à une augmentation de l'utilisation de matériaux à base de fibres, conduisent à une augmentation d'occupation de terrain, bien que ce soit moins important que dans l'Option 2c. Sinon, les impacts sont généralement perçus comme une amélioration de l'impact dans tous les domaines.

1 Introduction

ICF and Eunomia Research & Consulting Ltd. are pleased to present this report to the European Commission. It constitutes the Final Report of the extension study on "Reducing litter from single use plastics", undertaken under the broader contract "Plastics: reuse, recycling and marine litter" (Specific Contract No. 07.0201/2017/756813/SER/ENV.B.1 under Framework Contract No. ENV.C.2/FRA/2016/0017).

This report on single use plastics builds upon work already undertaken in the ongoing study, presented in ICF and Eunomia (2018)[4]. It provides analysis to support the development of the European Commission's Impact Assessment (IA) on single use plastics, and has been developed in line with the Better Regulation Guidelines. The objective of the analysis was

> *'to fine tune the possible options to reduce single use plastic litter, and to further analyse to the level of detail required by a full impact assessment, the potential impacts of a limited number of options for each of the items identified by the Commission.'*

The report first provides an overview of the approach to the analysis (section 2). This is followed by an introduction to the priority single use plastic products (section 3), and then a description of the cross-cutting policy measures (section 4). In section 4, the baseline situation, against which the impacts of various options were measured, is also described.

A summary of the assessment model is offered in section 5. Impacts of the options are then presented in section 6, including a description of the nature and likely effect of the individual measures included in each option. Their impacts are then explained. The text considers the financial costs, environmental benefits, employment effects and other economic impacts.

A detailed set of technical annexes accompanies this main report, available as a separate document. This includes some additional modelling and analyses following comments from the regulatory scrutiny board. The reader is referred to these annexes for, *inter alia*, details of the assumptions underpinning the analysis.

[4] ICF and Eunomia (2018). 'Plastics: Reuse, recycling and marine litter, Final Report', 30th May 2018

2 Approach to the Analysis

2.1 Overarching Approach

The assessment presented in this report establishes the impacts of measures that may be used to address the issue of single use plastics (SUPs) being mis-managed, and ending up on beaches and in the ocean.

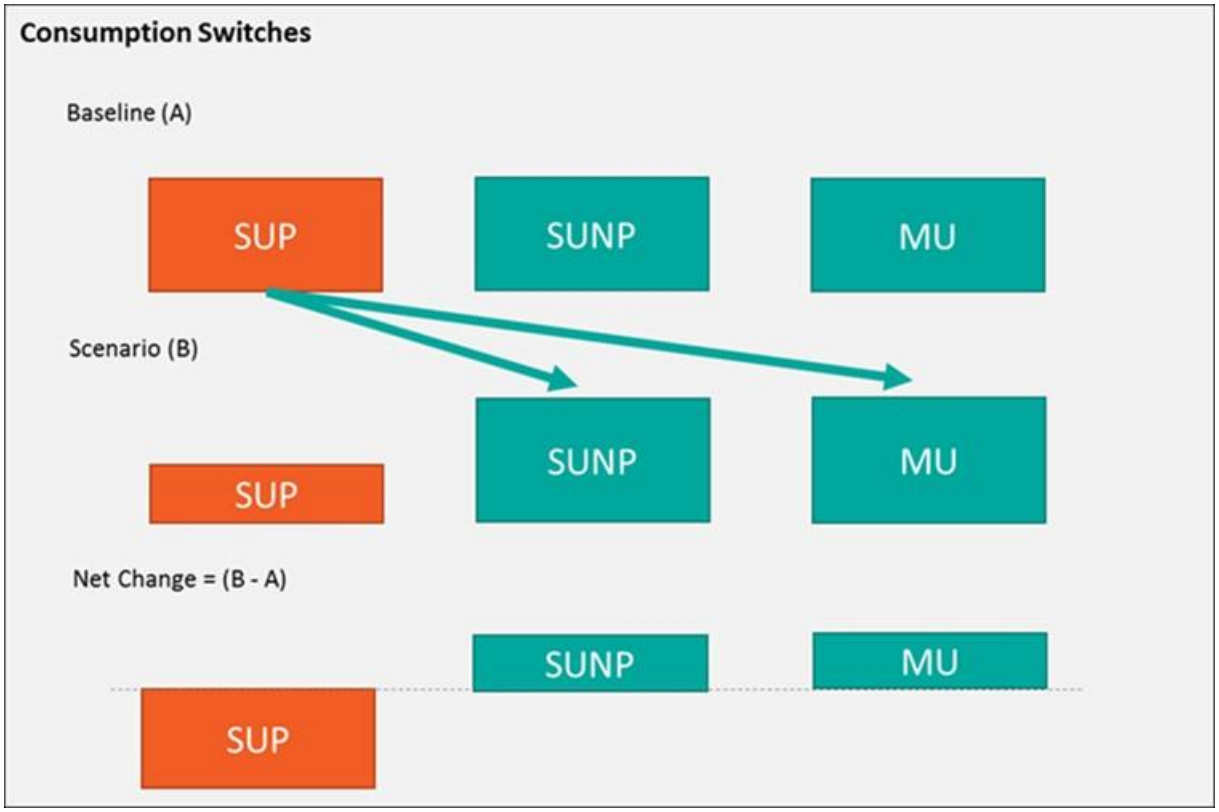
The method used for the analysis was as follows (a full description of the method can be found in the Annex):

- **Identify top ten items on beaches:** Analysis was undertaken to identify the top ten most frequently found SUP items in beach litter surveys.
- **Gather consumption data:** For each of these items, the market for the SUP item and its direct substitutes was analysed in terms of:
  - The market share for the SUP item itself;
  - The market share for the competing equivalent single use non-plastic (SUNP) items. In this work, the term SUNP is effectively shorthand for single use items that are believed to biodegrade in the marine environment, and hence are believed to be less problematic if they reach the marine environment (see also below);[5] and
  - Competing equivalent multi-use (MU) (i.e. reusable / refillable) items.

  Market reports were purchased for most items to give up to date data on consumption volumes as well as current and future growth rates for a varying number of years ahead.
- **Define baseline polices:** The way in which the market for a given item will be affected by already firmly planned policies likely to have an effect in the near future was modelled. The shift in market shares was considered, as well as the anticipated change in the fate of the different items.
- **Define new policy measures and options to model:** as well as modelling the impact of all feasible measures on each of the items, four options were modelled. Each option comprised of a selection of multiple measures applied to the different items, with each option representing an upward step in the level of ambition in respect of outcomes.
- **Effect of new policy measures:** Whilst some measures were expected to affect the rate at which these items might be 'intercepted' before they reached the ocean, others were expected to affect the level of consumption of the SUP items under consideration – in terms of the shift away from SUPs and into SUNPs and MU items. This is depicted in Figure 2.1.

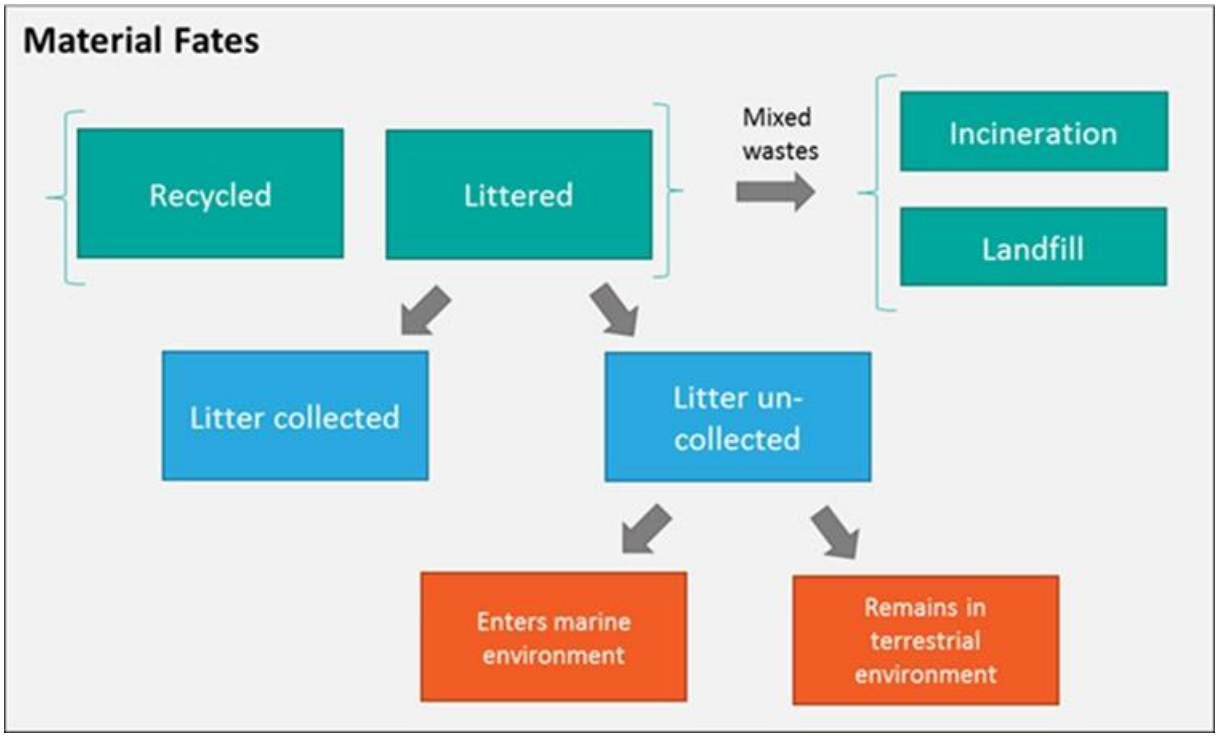
[5] There are no readily accepted standards for assessing whether specific items are, or are not, to be considered as 'biodegradable in the marine environment' as yet. Work is clearly needed in this area and it might reasonably have as its focus the need to clarify which items were likely to give rise to no harmful effects in the marine environment.

Figure 2.1 Schematic of Modelling of Switches in Response to Measures



- **Model economic impacts:** The effect of these changes in consumption have a range of different economic impacts. As the market shares of SUPs, SUNPs and MU items shift, some producers lose and some gain.
  - The effect on retailers and the hotel/restaurant/café (HoReCa) sector was also considered, these being linked to the effects on consumers (which were also identified).
  - In some cases, the measures are also likely to stimulate innovation, in terms of SUNP and MU equivalents. Although this represents a potential opportunity for EU business growth, one that may be global, given the rapidly growing awareness of this issue, these are not quantified in the study (being, as they are, uncertain).
  - Businesses are also affected through changes in fees to any extended producer responsibility schemes, or other obligations such as changes to labelling or information campaigns.
  - The costs of managing the waste items were also included, although as the total weight of these items in total municipal waste is low the changes are small.
- **Model environmental impacts:** In terms of consumption related elements, life-cycle assessments for the SUP, SUNP and MU items were used to model the change in resource use, greenhouse gas emissions and emissions of other pollutants. In addition, changes in consumption directly affects the quantity of material at a given end destination. The impacts of these changes were also estimated, including the impacts associated with changes in the quantity of litter. The fates, and changes in these, were modelled based on the schematic depicted in Figure 2.2 below. Critical here was the impact on the flow of SUPs into the marine environment.

Figure 2.2 Schematic of Modelled Fates of Materials



2.2 Research Methodology

Research was undertaken through deployment of a range of methods including: literature reviews of existing research; review of inputs made under the public consultation; one-to-one interviews with a number of stakeholders; workshops involving Commission officials and external stakeholders; and desk-based research.

In order to develop a bespoke, quantitative model through which to assess the costs and benefits, we revisited the data from the Joint Research Centre (JRC) to confirm the single use plastic (SUP) items that should be taken forward in this study. Selection of these included consideration of the top 10 items, by item count, found littered on beaches, as well as variations by regional sea. In order to develop the model, it was necessary to seek specific data related to the chosen items. To this end, in addition to desk-based data gathering, market data reports were purchased, giving the study team significant data on the SUP items identified.

ICF/Eunomia have used the problem tree analysis already provided under the existing contract to further developed the measures that could be used to address the key issue of littering of single use plastics. Our approach has been to consider the suitability of the different SUPs to be addressed by different types of measures (in a shorter or longer time scale), taking into account the nature of the product, and the ease of substitution by existing alternatives. The elaboration of the measures kept in mind the matters of feasibility of the application of different measures, matters of subsidiarity and any legal issues likely to arise.

Finally, the analysis has considered a range of economic, social and environmental impacts building on the ongoing study. Further work was undertaken to understand better the externalities associated with litter, both when it is first dropped (usually on land, sometimes at sea), and once it has been transported to the beach / sea. In

addition, the study team was grateful for the cooperation of a team, led by Cambridge Econometrics, which in the process of undertaking a separate contract for DG Environment, provided relevant life cycle inventory data for the SUP items and their most likely single use non-plastic (SUNP) and multiple use (MU) substitutes.[6]

The baseline has been modelled to 2030 – which reflects the date of targets in related legislation, e.g. the Packaging and Package Waste Directive (PPWD), the Waste Framework Directive (WFD) and the Plastics Strategy. The baseline option includes all existing European laws and policies, and those which are agreed and will come into effect over the period being considered. The implementation and impacts of the measures deemed relevant to address each item were each modelled over the same time horizon.

2.3 Assumptions

This report assumes the following:

- The work undertaken by the JRC to identify those SUP items most frequently found in beach litter surveys are representative of the problem;
- The data provided in the market reports are accurate; and
- Different measures are related to different outcomes: as such, the range of ambition is reflected in the variation in the types of measures deployed.

In addition:

- The available data are variable in their quality and to the extent possible, we have sought to use those published sources that are, in the view of the project team, the most reliable, or the ones based on the most robust methodology; and
- Notwithstanding the above point, there remain gaps in the evidence: where data are missing, expert opinion has been used to develop estimates.

There is a question as to whether some bio-based plastics, such as those where non-fossil material is used to produce a polymer traditionally manufactured from fossil-derived material, e.g. bio-based polyethylene terephthalate (bio-PET), and some supposedly biodegradable plastics, such as polylactic acid (PLA), should be included in the definition of SUP, or SUNP, in this study. There is currently a lack of evidence to suggest that such bio-based plastics would not have similar impacts in the marine environment; in other words, the source of the plastic is not the relevant aspect its end of life management is the issue in question. This will depend on the extent to which either of these, or other possible alternatives in future, can be demonstrably shown to degrade in the marine environment. Therefore, for the purposes of this study, these have *not* been considered as SUNP alternatives. That is not to say that in future, such alternatives could not emerge.

2.4 Limitations

This report has the following limitations:

- The report has been prepared in a limited time, and to a defined budget, and so the approach was simplified where needed;
- There are sometimes challenges in interpreting data supplied by those with a specific commercial, or political interest in securing a certain outcome, leading to uncertainty of some assumptions;

[6] The team also included also Denkstatt and IEEP

- Some data are less than straightforward to obtain, particularly cost data which is often not public due to reasons of commercial confidentiality. Thus some assumptions could not be corroborated or had to be estimated using expert opinion;
- Identifying sources and pathways of specific items is challenging – in the case of beach litter, the major source is land-based (e.g. related to the direct activities on the terrestrial, beach/coast environment) and a minor element is sea-based, therefore some simplifying assumptions had to be made;
- Determining the benefits of reducing the amount of plastic litter entering the marine environment is not straightforward: the relevant body of literature is growing, but the figures should be treated with some caution;
- In the case of many of the items, there are no existing policies, or associated / relevant case studies, on which to base assumptions about behavioural change;
- Not all of the environmental changes are amenable to monetisation - such benefits are described qualitatively;
- Some analysis has been done at the EU28 level and not varied by Member State, which may increase the margin of error in the results;
- Forecasting what impacts the measures will have over the next 12 years is a challenge to do with any degree of accuracy;
- An 'optimisation' analysis across the measures has not been undertaken, so the stated benefits may be lower or higher than in the actual case; and
- Some concerns have arisen, in the course of this study, that the reported quantity of plastic packaging placed on the market understates the true position. This might be, for example, because the reporting is based on clean, dry packaging, whereas most data on recycled quantities are reported when materials are not dry and often still contaminated, which would overstate the amount.

3 Single use Plastic Priority Products

3.1 Introduction

In order to determine possible policy measures to reduce single use plastics (SUPs) and to model the impact they have, it is firstly necessary to define the SUPs being considered. SUPs are a broad category, encompassing a wide variety of packaging and non-packaging items, some of which enter the marine environment due to being flushed down the toilet, whereas others do not. Their use and prevalence in everyday life varies significantly.

An exercise was undertaken to prioritise specific SUP items, specifically those which currently appear to have the greatest impact (including in the marine environment), and which present the largest scope for reduction of impact. We have, therefore, identified a list of the top ten SUP items, by item count, based on the composition of beach litter.

This chapter explains the process used to determine the top ten priority SUP items, including the methodology. The analysis is necessarily constrained by the availability of data. Following the elaboration of the top ten, we then:

- Disaggregated two categories into five sub-categories which were not identified individually in the original source data, but which merit consideration in their own right; and
- Executed a "light" assessment for ‘balloons and balloon sticks’, and ‘plastic bags’ for reasons explained below.

We have adopted a Europe-wide approach, but we go on to briefly consider the extent of regional variation across the major seas within the EU.

While this report focuses on the top ten SUP items in beach litter, all sources of marine and terrestrial litter ultimately warrant attention and the full list of SUPs, based on the categories provided in the JRC Technical Report, is included in section 1 of the Annex.

3.2 Approach to Identifying the Top Ten SUP Items in Beach Litter

The JRC Technical Report, *Top Marine Beach Litter Items in Europe (JRC108181),* lists marine litter items collected in the year 2016 from 276 beaches across 17 EU Member States, covering 4 Regional Seas. The report is a compilation of data from 679 monitoring programmes, clean-up campaigns and research projects, which include seasonal variability. The JRC has adopted a total sum approach (summing all counts under various different methodologies), with the studies they considered, variously following OSPAR, TGML and UNEP/IOC derived methods.

The JRC list identifies 251 different types of litter and a total of 355,744 items. Since the list does not identify ‘plastics’ specifically, or ‘single use items’, we first divided the list into items that were plastic, non-plastic, or fishing items. Plastic items were then assessed as SUP or not. A more detailed explanation of this process is available in Chapter 12 of “Plastics: Reuse, Recycling and Marine Litter; Annex to the Final Report” (ICF, January 2018).

As countries and regions have adopted different methods; there is significant overlap between some of the categories listed (such as “4/6-pack yokes, six-pack

rings" and "4/6-pack yokes, six-pack rings/bags/shopping bags including pieces/small plastic bags, e.g. freezer bags including pieces"). This indicates that some items may be listed in a number of categories from different methods.

The JRC list was used to compile a shorter list of discrete categories that provide the relative contributions of items that are alike in terms of source, or use or material.

Although the JRC category list assigns litter counts to specific items (such as 'food containers'), several of the JRC categories, presumably, reflecting the way some beach litter counts were reported, contain multiple items in one category (for example, "Food containers, sweet wrappers, cups"). 31 of the SUP categories in the JRC list that represented multiple items were disaggregated into the component items. This was done through pro-rating the combined items in line with the prevalence of the individual items as reported elsewhere in the category list. For example, "Food containers, sweet wrappers, cups" was divided into up using three separately reported categories: "Food containers including fast food packaging"; "Cups and cup lids"; and "Crisps packets/ sweet wrappers".

It should be noted that this process for apportioning the items affects the final rankings. There is, however, no obvious alternative approach to the one we have taken. The method reflects a reasonable approach to managing the data available given the way in which the data was recorded.

Once the broader groupings had been disaggregated into the most relevant specific category, we aggregated the similar categories and those where, for the purpose of this analysis, it was not important to distinguish between relatively similar items. Considering material composition, manufacturing, usage and policy approach for instance, it was not considered necessary to distinguish between crisp packets and sweet wrappers. Conversely, sweet wrappers and food containers are different in terms of material composition and morphology (the former is typically flexible and small, the latter rigid and larger), and exhibit differing potentials for substitution, so we concluded that it was important, as well as informative, to disaggregate the two. Similarly, beverage bottles were disaggregated from other types of plastic bottle.

The process of disaggregation and aggregation of categories generated 17 classifications of SUP, representing 141,277 items in total; the full break-down is provided in section 1 of the Annex.

3.3 Top Ten Items

Table 3.1 below lists the top ten SUP items, as well as the ranking to which the above process gives rise. The complete list, including a full break-down of the categories contributing to the top ten and the proportions allocated, is included in section 1 of the Annex.

The table demonstrates that by focussing on these top ten items, potentially 78% of the general plastic items found on beaches can be addressed; while a full 94% of the single use plastic items that are found on beaches could be addressed.

The remaining identified SUP items in the list are shown in Table 3.2. These, together, account for a further 6%, by item, count of SUPs. The policy measures assessed in this IA focus on the top ten, however, this does not preclude Member States taking further national policy measures to target these additional items.

Table 3.1 Top Ten Single Use Plastic Items, by Item Count as reported on Beaches in the EU

Ranking	Item	Total Number on sample of beaches monitored in 2016	% as proportion of general plastic items[1]	Cumulative % of items in scope as a proportion of general plastic items[1]	% as proportion of single use plastic items[2]	Cumulative % of items in scope as a proportion of single use plastic items[2]
1	Drinks bottles, caps and lids	24,541	19%	19%	23%	23%
2	Cigarette filters	21,854	17%	36%	21%	44%
3	Cotton bud sticks	13,616	11%	47%	13%	56%
4	Crisp packets/ sweet wrappers	10,952	9%	55%	10%	67%
5	Sanitary applications	9,493	7%	63%	9%	76%
6	Plastic bags (CBD[3] & non-CBD)	6,410	5%	68%	6%	82%
7	Cutlery, straws and stirrers	4,769	4%	71%	4%	86%
8	Drinks cups and cup lids	3,232	3%	74%	3%	89%
9	Balloons and balloon sticks	2,706	2%	76%	3%	92%
10	Food containers including fast food packaging	2,602	2%	78%	2%	94%

[1]"General plastic items" – is the group of items excluding non-identifiable items such as fragments, non-plastic items, and items associated with fishing and aquaculture.

[2]"Single use plastic items –– is the group of items excluding non-identifiable items such as fragments, non-plastic items, items associated with fishing and aquaculture, and non-single use plastics.

[3]CBD = Carrier Bags Directive

3.4 Limitations

It was only possible to use the disaggregation method for categories that contained items reported individually elsewhere in the category list. Cups and cup lids, like straws and stirrers, are always grouped together so there is no data to indicate what proportion are cups, and what proportion are lids; where there was no suitable evidence available which allowed us to further disaggregate the data, it was decided to retain the original group.

In addition, a cup with a matching lid or a bottle and a matching cap could come from the same source and represent one incidence of consumption/ littering, but will be counted separately; this potentially means that these are over-represented in the final rankings. This is, however, unavoidable given the way the data are reported.

3.5 Additional Items

'Sanitary applications' is a category which comprises a number of different items. The following list is based on the data reporting categories used in the JRC report, so is constrained by the methodologies used in the studies JRC has compiled:

- Sanitary towels/ panty liners/ backing strips;
- Sanitary (nappies, cotton buds, tampon applicators, toothbrushes);
- Tampons and tampon applicators;
- Other (e.g. diapers, toilet paper, tissue paper, shaving razors);
- Toilet fresheners;
- Syringes/ needles; and
- Condoms (including packaging).

Having contacted organisations in 8 Member States, as well as Northern Ireland, regarding their beach monitoring data and beach cleaning experiences, it is suggested that sanitary applications should be disaggregated further, with wet wipes listed separately.

The UK and the Republic of Ireland are the only locations that could be found where the frequency of wet wipes is recorded as a specific category. These data are not recorded as part of the OSPAR reference beach dataset in those countries, as wet wipes are not a category within the OSPAR litter monitoring lists. Rather, the data comes from parallel monitoring efforts – the Great British Beach Clean (run by the Marine Conservation Society, MCS) in the UK, and the Clean Coasts Big Beach Clean in the Republic of Ireland. The following statistics were produced:

- UK – wet wipes constitute 45% of sanitary items. When cotton buds are separated out from sanitary items (since our analysis for the top ten includes them as a separate category), wet wipes constitute 80% of sanitary items; and
- Republic of Ireland – wet wipes constitute 51% of sanitary items. Excluding cotton buds, they constitute 72% of sanitary items.

None of the other nations collect data related to 'wet wipes' as a distinct category.

For Spain, the OSPAR guidelines found ambiguity in the term "sanitary towel", as the Spanish words for wet wipe and sanitary towel (toallitas higiénicas/toalla higiénica) are very similar. However, the data holder indicated that only wet wipes were found in this category. It suggests wet wipes make up 6% of all sanitary items; 31% when cotton buds are excluded.

Data from the countries we questioned suggested that wet wipes are not a problem on the particular beaches for which data were available, which were all reference beaches for national litter monitoring efforts. This includes; the Netherlands, Northern Ireland, France, Sweden, Italy and Denmark. However, we note in particular that reference beaches are not necessarily the types of beaches that have problems with wet wipes. For example, a criterion for choosing reference beaches is that they should not be regularly cleaned. This often rules out beaches near populous areas, which are precisely the beaches where this type of waste would be expected. Qualitative information, from people who conduct beach cleans, or who are in direct communication with those that do, was received from:

- The Netherlands (non-OSPAR reference beaches); and
- Northern Ireland (non-OSPAR reference beaches).

These communications suggested that there are beaches, near centres of population, which have severe issues with sanitary items and, in particular, wet wipes.

In conclusion, the data are limited not just by the category lists but also by the types of beaches that are monitored. There is evidence from several countries that wet wipes are a particular problem, and because of the limitations of the data, we suspect that there will be other places where this is an issue, but where it is not immediately discernible under the current monitoring regime. Moreover, the consumption data suggests that wet wipes are likely to be prevalent in many Member States: around 40 billion baby and personal care wipes are sold in the EU each year (see A2.1.6). Whilst per capita consumption is highest in Ireland and the UK, there are several Member States with similarly high per capita consumption rates, particularly some large countries such as France and Germany. The prevalence of combined sewerage overflows (CSOs) is also high, on average, across the EU (at 55% - see section A2.5.7 of the Annex). Therefore, there is a high risk that wet wipes are entering the marine environment from many Member States, as flushed items are the key pathway to the marine environment for these items (see section 4.4). Consequently, it was recommended that wet wipes be explicitly included – distinct from sanitary towels/ tampons (the second highest contributor to the overall sanitary category) and other sanitary items.

Moreover, wet-wipes also cause externalities before they reach the marine environment. It is reported by Water UK – the trade body representing all of the main water and sewerage companies in the United Kingdom – that there are approximately 300,000 sewer blockages every year costing circa €120 million to clear. It is further noted that wipes made up around 93% of the material causing the sewer blockages which the study investigated.[7,8]

3.6 Regional Seas Analysis

The regional data sent to the project team by the JRC was analysed to understand whether the top ten items varied across the different seas, or whether they remained broadly the same. The detailed methodology as described above could not be repeated on a regional basis in the given time. The reported number of total counts

[7] Water UK (2017) Press release: New proof that flushing wipes is a major cause of sewer blockages, available at https://www.water.org.uk/news-water-uk/latest-news/new-proof-flushing-wipes-major-cause-sewer-blockages

[8] Water UK (2017) Wipes in Sewer Blockage Study, available at https://www.dropbox.com/s/4d5wdcumvmgvzvs/Wipes%20in%20sewer%20blockage%20study.pdf?dl=0

varies quite significantly by sea, possibly reflecting the length of coastline and the number of surveys undertaken. Figure 3.1 shows the proportion of the top ten items in the beach litter counts. This suggests that the Black and Mediterranean Seas have higher incidences of SUP items in the beach counts. It also shows that the problem is prominent across all the seas of the EU.

Figure 3.1 Proportion of the Top Ten Items in Total Beach Litter Counts

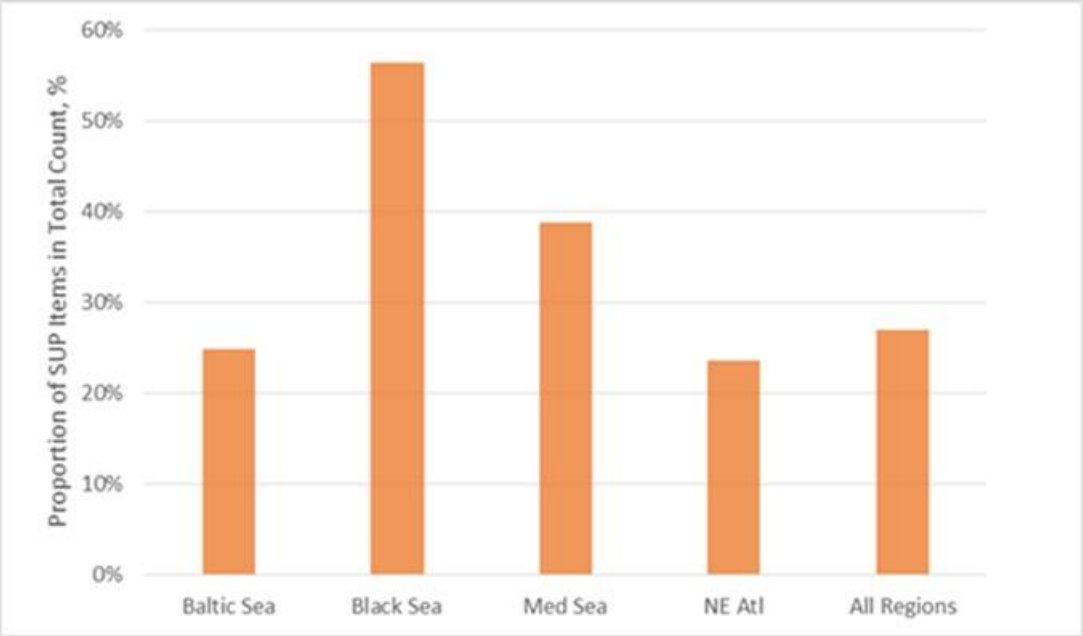
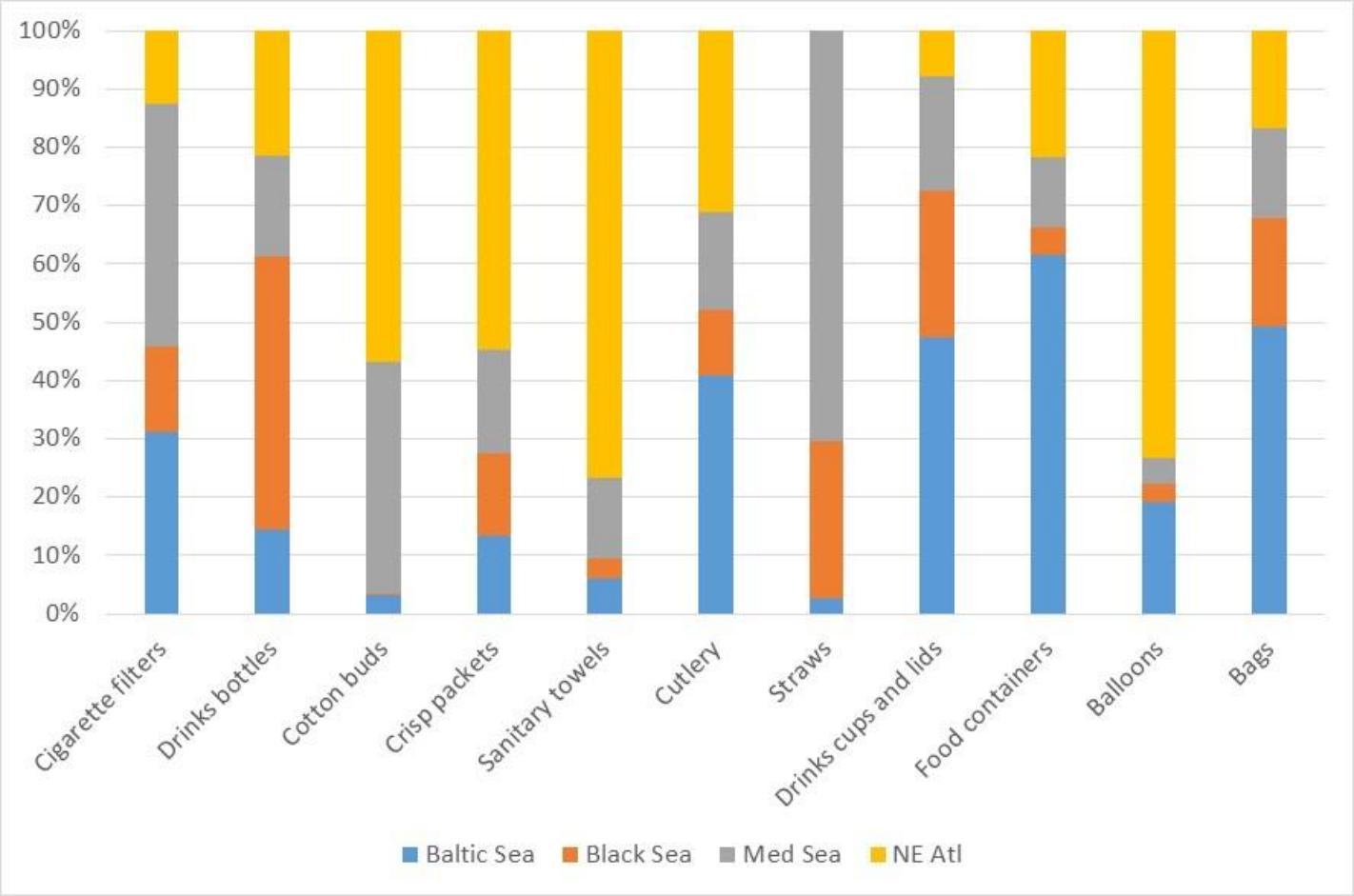


Figure 3.2 shows the relative shares of the key items by sea (note the list doesn't map exactly to the top ten set out above due to the scope of the data categorisation in the studies). This indicates that most of the items are present in all seas. The apparent lack of straws in the North East Atlantic is a factor of how the items were categorised, rather than an absence of straws. However, it does appear that sanitary items are significantly higher in the North East Atlantic, and Mediterranean, than the other seas.

Further cross-checks of the data were carried out confirming that the top ten SUP items changed very little across the seas. The regional seas analysis confirms, therefore, that the top ten list is representative of an EU-wide problem, and so, is suitable for European intervention and thus appropriate to be analysed in this Impact Assessment.

Figure 3.2 Relative Shares of Key Items by Sea



4 Policy Measures

4.1 Defining ‘single use’

In order to amend or develop a legal instrument to bring the measures into force, there is likely to be a need to clarify the scope of the legislation being developed. In this case, it may be necessary either to develop a clear definition of ‘single use’ (plastic) items, or to do so ‘by exception’ (by defining multi-use items). Our current views on possible ways of defining ‘single use’ for the items concerned are given in Table 4.1.

Table 4.1 Defining ‘Single use’

Item	Definition
Cigarette filters	The vast majority of littered cigarette filters are single use: although there are MU filters for removing additional tar or stopping tobacco reaching the consumers mouth, they are not like-for-like. If a solid legal definition was required, it might be suggested to set a limit of 0.5g as all commonly available single use filters will be under this weight (0.12g on average), whereas MU filters would be in the order of 5-10g. Moreover, additional text could be proposed along the lines of ‘single use cigarette filters are those designed to capture various chemicals from tobacco use, including tar, which cannot be extracted from the filter.
Drinks bottles, caps and lids	For bottles, the definition of SU might not be so straightforward: some bottles which are generally used only in ‘single use mode’ can be used multiple times (generally where they have screw on caps). The MU variants are either designed for multiple use / refill by individuals, or they are designed to be part of a bottle reuse scheme. In this case, it may be simpler to define the MU alternatives with the SU items defined ‘by exception’. MU items for multiple use / refill by individuals are generally sold empty and would be expected to be sold expressly for the purpose as a refillable bottle. It would be useful to consider some minimum standards related to ability to withstand wear and tear, or to be effectively resealed, so that the use of low standard MU items (which did not last many refills) did not compromise environmental objectives. Where bottles are sold ‘pre-filled’, then the MU definition would apply only if they were part of a reuse network that achieved a minimum level of reuse (note that this ‘network’ might have to be defined sufficiently flexibly as to allow ‘a café’ to be defined as a network). This would prevent the use of refillables (often thicker containers) as one-trip (SU) containers. If the aim was to define SU items, then this could be done in relation to weight, but this would be complicated by the range of weights and volumes available.
Cotton bud sticks	SU cotton bud sticks are those to which the cotton is directly attached; and from which the cotton cannot be readily removed; and where there is no widely available cotton bud that can be simply attached to the stick.
Crisps packets / sweet wrappers	SU crisp packets / sweet wrappers could be defined as those which when opened for the first time destroy the vapour seal of the packaging and do not allow similar storage conditions to occur thereafter. This is not the same as resealable.

Item	Definition
Sanitary towels and tampons	Sanitary towels and tampons would be SU when there is no potential to wash them and reuse them multiple times, as the washing processes degraded the structure and function of the product. A minimum number of uses could be set to define MU e.g. 50.
Wet wipes	Wet wipes would be defined as those sold on the market as SU wipes which are pre-moistened with lotion and do not pass strict legally defined standards for 'flushables', such as those developed by UK Water Industry Research (UKWIR); the most stringent in Europe, more so than standards developed by European Disposables and Nonwovens Association (EDANA).[9,10]
Cutlery	SU cutlery could be defined through a technical certification standard for the number of uses it is able to perform, with a view to avoiding manufacturers' claims that weak plastic knives and forks could be used more than once. To be claimed as MU, certain testing regimes could be developed that would match the current functionality of steel cutlery, to ensure MU was only defined during long use phases. The weight of the item could be a benchmark, such as 10g (compared to 0.5 to 2.6g for SU items found in the research phase – see section 2 of the Annex). There is a risk that manufacturers simply start making 10.1g cutlery items, but the material could be tenfold, and much higher cost, than SUNP which would compete strongly on price, so it is not likely. Dishwasher standards (i.e. lack of deformation due to the heat) might be feasible, but it is likely that some polymer types would pass dishwasher standards tests, or manufacturers could switch to avoid being deemed as SU. Alternatively, it might prove simpler to define MU cutlery as being made from a range of non-plastic materials, typically metals, with a view to asserting a positive list of long-lasting MU items. There is merit in doing this since the aim of a ban / reduction in SUP / SUNP items should be to encourage a switch into MU items for which the likely number of uses lasts decades or longer (as would be the case with much of the cutlery that residents use in their homes).
Straws and stirrers	Technical standards may be the most appropriate solution to define what could be classed as SU, in terms of number of uses to be define as MU. For example, some mechanical strength or hardness or deformation prevention standards that, for straws for example, would limit tooth marks forming or the straw creasing when bent. Alternatively, as above, a positive list of MU items is defined with others being considered as SU.
Food containers including fast food	For SU food containers there are two key issues, first what is SU or MU from a material perspective and secondly from a use perspective. Again, MU boxes are significantly (150 grammes vs 20 grammes) heavier than SU, so a weight standard could be implemented. Alternatively, a standard related to its ability to withstand washing could be used. MU could be defined, therefore, as being able to withstand 1,000 washes with no degradation of function. That having been said, we suspect that there are many items currently used for a single function that could withstand washing of this nature.

[9] https://www.ukwir.org/reports/14-WM-07-17/66923/Test-Protocol-to-Determine-the-Flushability-of-Disposable-Products-Review-of-the-Manufacturers-3rd-Edition-Guidance-Document

[10] https://www.edana.org/industry-initiatives/flushability

Item	Definition
	A definition of MU food containers might prove more straightforward. As with the case of bottles, MU variants are either designed for multiple use / refill by individuals, or they are designed to be part of a container reuse scheme. MU items for multiple use / refill by individuals are generally sold empty and would be expected to be sold expressly for the purpose as a refillable food container. It would be useful to consider some minimum standards related to ability to withstand wear and tear, or to be effectively resealed, so that the use of low standard MU items (which did not last many refills) did not compromise environmental objectives. Where food containers are sold 'pre-filled', then the MU definition would apply only if they were part of a reuse network that achieved a minimum level of reuse. This would prevent the use of refillables (often thicker containers) as one-trip (SU) containers (again, this 'network' might have to be defined sufficiently flexibly as to allow 'a café', or restaurant, to be defined as a network). Another aspect that could be considered is the scope of any definition, in terms of the part of the market to which it applies. Single use food containers are used in many applications, such as salad boxes, ready meals or cereal packs. The scope could be delimited to what is filled at the point of sale, although this may lead to a significant shift towards off-site manufacture and filling of products in plastic containers, which would still result in littering of plastic products. It is therefore recommended to seek to define SU in such a way that includes these products. The question then might be whether the scope could be delimited to the food packaging that is not usually leading to a problem of littering; for example, used in ready meals consumed at home. A possibility is to include reference to whether the product needs to be reheated or not. This would exclude ready meals designed to be reheated at home. It would still include SU salad servings for home consumption, for example, but in reality, the location of consumption of this would not be known at the time of purchase. This might, therefore, be an acceptable compromise given the problems faced, and the fact that SU servings are leading to over consumption and are not resource efficient.
Cup and cup lids	A similar approach to that taken with bottles and cups is likely to be relevant here. MU variants are either designed for multiple use / refill by individuals, or they are designed to be used repeatedly after each wash. MU cups for multiple use / refill by individuals are generally sold empty and would be expected to be sold expressly for the purpose as a refillable cup. It would be useful to consider some minimum standards related to ability to withstand wear and tear, or to be effectively resealed, so that the use of low standard MU items (which did not last many refills) did not compromise environmental objectives. Where drinks are sold in reusable cups, then the MU definition would apply only if they were part of a reuse network that achieved a minimum level of reuse. This would prevent the use of refillables (often thicker containers) as one-trip (SU) containers. Recognising that many shops already use reusable cups, then compliance should be made straightforward for such 'networks'.

Finally, there is a question as to whether some bio-based plastics, such as those where non-fossil material is used to produce a polymer traditionally manufactured from fossil-derived material (e.g. bio-based polyethylene terephthalate (bio-PET)), and some supposedly biodegradable plastics (such as polylactic acid (PLA)) should

be included in the definition of SUP, or SUNP, in this study. There is currently a lack of evidence to suggest that such bio-based plastics would not have similar impacts in the marine environment; in other words, the source of the plastic is not the relevant aspect its end of life management is the issue in question. This will depend on the extent to which either of these, or other possible alternatives in future, can be demonstrably shown to degrade in the marine environment. Therefore, for the purposes of this study, these have not been considered as SUNP alternatives. That is not to say that in future, such alternatives could not emerge.

4.2 Existing EU and Non-EU Measures

Notwithstanding the issues associated with bio-based and biodegradable plastics (explained above), many of the existing measures to address SUPs are focused on switching fossil-based plastics to either non-fossil, or sometimes, oxo-degradable plastics. The evidence of the benefits to society as a whole of such an approach is not clear, as production of bio-based plastics also creates some impacts and the end of life management may still create similar issues, or introduce additional issues such as contamination of recycled plastics with biodegradable material.

Table 4.2 Summary of existing measures regarding SUPs across EU Member States and globally

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
Within the EU			
Belgium – Brussels Region[11]	Ban	A decree has been enacted which bans ultra-lightweight plastic bags.	September 2018
Denmark, Island of Samsø[12]	Ban	All plastic bags	2018
France[13,14]	Ban	Plastic cups, glasses, plates and cutlery. Includes plastic coffee cups, which will instead be delivered in compostable containers.	2020
France[15]	Ban	Plastic cotton buds	2018
France[16]	Ban	Ultra-lightweight plastic bags “produce bags” e.g. those used to pack fruit and vegetables, meat and fish. Compostable bags are exempt.	2017

[11] *Regulations in EU*, accessed 6 February 2018, http://www.thepaperbag.org/for-compliance-with-the-law/regulations-in-eu/

[12] *Samsø: Entire Danish island to ban plastic bags in favour of fabric versions | The Independent*, accessed 31 January 2018, http://www.independent.co.uk/news/world/europe/samso-denmark-island-plastic-bag-ban-danish-environment-recylcing-a8105046.html

[13] *France ban disposable plastic cups and plates - CNN*, accessed 29 January 2018, https://edition.cnn.com/2016/09/19/europe/france-bans-plastic-cups-plates/index.html

[14] *France to Ban Disposable Plastic Cups - The Green Parent*, accessed 31 January 2018, https://thegreenparent.co.uk/articles/read/france-to-ban-disposable-plastic-cups

[15] *France Notifies EC on Ban of Cotton Buds with Plastic Stems | Industries | UL*, accessed 6 February 2018, https://industries.ul.com/news/france-notifies-ec-on-ban-of-cotton-buds-with-plastic-stems

[16] *What you need to know about France’s ban on plastic bags - The Local*, accessed 31 January 2018, https://www.thelocal.fr/20160701/what-does-frances-ban-on-plastic-bags-actually-mean

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
France[17]	Ban	Oxo-fragmentable bags	Date not listed, in law
Italy[18]	Ban	Non-biodegradable cotton buds	2019
Italy[19]	Ban	Ban on ultra-lightweight bags e.g. those used to pack fruit and vegetables, meat and fish. These are to be replaced with biodegradable or compostable alternatives which a charge will be applied to.	2019
Portugal	Ban	Ban on the import and placing on market of disposable plastic utensils.	Proposed Bill – would have three years to adopt[20]
Scotland [21]	Ban	Plastic cotton buds – Proposal to introduce a ban will be put to public consultation.	2018 (proposed)
Scotland	Ban	Plastic straws – Investigating the potential for banning straws in Scotland under devolved powers.	Proposed ban
Scotland[22]	Ban	SUPs – Ensure plastic is reusable or recyclable by 2030. Have committed to this measure regardless of Brexit and UK position with respect to EU policy.	2030
Spain – Balearic Islands[23]	Ban – Regional	All single use consumer plastics – items will have to become "easily recyclable" or switch to biodegradable alternatives.	2020
Spain – Balearic Islands	Law – Regional	Wet wipes will be required to be clearly labelled so as to prevent flushing.	2020
Spain – Balearic Islands	Law Regional	Law will address plastic bottles by requiring restaurants to provide tap water free of charge.	In discussion
Asia			

[17] *France's Single Use Plastic Bag Regulation* | Planete Energies, accessed 28 January 2018, https://www.planete-energies.com/en/medias/close/france-s-single-use-plastic-bag-regulation

[18] *Manovra, dal 2019 vietati i cotton fioc non biodegradabili - La Stampa*, accessed 29 January 2018, http://www.lastampa.it/2017/12/19/scienza/ambiente/focus/manovra-dal-vietati-i-cotton-fioc-non-biodegradabili-CvPcI6JnS81ZDHZ75vtitM/pagina.html

[19] *Ambiente: dal 2018 al bando sacchetti di plastica leggeri e ultraleggeri*, accessed 29 January 2018, http://www.adnkronos.com/sostenibilita/in-pubblico/2017/12/28/stop-sacchetti-plastica-leggeri-ultraleggeri-bando-dal-gennaio_FxtHj2zpoT4uTeDUc2BZLN.html

[20] https://www.dn.pt/portugal/interior/pev-entrega-diploma-para-proibir-comercializacao-de-pratos-copos-e-talheres-de-plastico-8645937.html

[21] *Scotland to ban plastic cotton buds from being made | The Independent*, accessed 29 January 2018, http://www.independent.co.uk/environment/plastic-cotton-bud-ban-scotland-manufacturing-latest-a8156741.html

[22] *Scotland to ban single-use plastics by 2030*, accessed 29 January 2018, http://www.heraldscotland.com/news/environment/15886304.Scotland_to_ban_single_use_plastics_by_2030/

[23] *Balearic Islands to ban plastic by 2020 in bid to clean its beaches*, accessed 29 January 2018, http://www.telegraph.co.uk/news/2018/01/17/balearic-islands-ban-plastic-2020-bid-clean-beaches/

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
Bangladesh[24]	Ban	Total ban on polyethylene (PE) plastic bags.	2002
Bhutan[25]	Ban	Total ban on plastic bags.	2009
China – Jilin Province[26]	Ban – Regional	Total ban on non-biodegradable plastic tableware (and bags) in the Jilin Province.	2015
Indonesia – Badung[27]	Ban – Regional	Ban on the use of Styrofoam in the city of Badung.	2016
India - Karnataka[28]	Ban – Regional	All plastic – covers sale of plastic carrier bags, plastic plates/cups/spoons, and cling film.	2016
India - Delhi [29]	Ban – Regional	All single use plastic items including plastic cups, bags, plates and cutlery, in the national capital territory area.	2017
Philippines[30]	Ban	Ban on the sale and use of non-biodegradable plastic bags in >59 municipalities. Use of Styrofoam containers is prohibited in Manila.	2011
Sri Lanka[31]	Ban	Ban on Styrofoam containers.	2017
Taiwan[32]	Ban	Ban on beverage cups, straws, plastic bags and single use tableware.	2030
America			
USA – San Francisco[33]	Ban – Regional	Plastic water bottles on city properties.	2014
USA – New York City[34]	Ban- Regional	Ban on single use Styrofoam containers in New York. The ban was challenged by a coalition of recycling firms and plastic	2013, lifted in 2015 and

[24] *Plastic Bag Ban Assessment DRAFT*, UN Environment - International Environmental Technology Centre (IETC), February 2018.

[25] *Plastic Bag Ban Assessment DRAFT,* IETC

[26] *Plastic Bag Ban Assessment DRAFT,* IETC

[27] *Plastic Bag Ban Assessment DRAFT,* IETC

[28] *Total plastic ban in Karnataka - Times of India*, accessed 6 February 2018, https://timesofindia.indiatimes.com/city/bengaluru/Total-plastic-ban-in-Karnataka/articleshow/51397198.cms

[29] *Planet Ark News - Disposing of Disposable Plastic in Delhi*, accessed 1 February 2018, http://planetark.org/news/display/1195

[30] *Plastic Bag Ban Assessment DRAFT,* IETC

[31] *Plastic Bag Ban Assessment DRAFT,* IETC

[32] (2018) *Taiwan Sets Aggressive Timeline to Ban Straws and Other Single-Use Plastics*, accessed 19 February 2018, https://www.ecowatch.com/taiwan-plastics-ban-2535001646.html

[33] Levin, S. (2017) *How San Francisco is leading the way out of bottled water culture*, accessed 6 February 2018, http://www.theguardian.com/environment/2017/jun/28/how-san-francisco-is-leading-the-way-out-of-bottled-water-culture

[34] *Plastic Bag Ban Assessment DRAFT,* IETC

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
		manufacturers who claimed the material is recyclable. The ban was lifted in 2015, and reintroduced in 2017.	reintroduced in 2017.
USA – Washington D.C[35]	Ban – Regional	On wet wipes labelled as flushable, unless it can be proven that they break down in normal sewer conditions.	2018
USA – Seattle, Washington, Portland, Oregon, Westchester, Berkeley and Malibu	Ban – Regional	Ban on styrofoam foodware.	Date not listed
USA – Laguna Beach and Santa Monica	Ban – Regional	Ban on polystyrene (PS) foodware.	Date not listed
USA - Seattle[36]	Ban - Regional	Ban on plastic straws and plastic utensils.	2018
South and Central America			
Costa Rica[37]	Ban	All single use plastics.	2021
Antigua and Barbuda[38]	Ban	Total ban on the importation and use of plastic utensils and Styrofoam containers.	2019
Chile, Punta Arenas and coastal regions[39]	Ban- Regional	Total ban on PE bags in Punta Arenas. Total ban on the sale of plastic bags in 102 coastal villages and towns.	2014, 2017
Columbia[40]	Ban	Ban on disposable plastic bags smaller than 30x30cm.	2016
Guatemala, San Pedro La Laguna[41]	Ban - Regional	Total ban on plastic bags and Styrofoam containers in San Pedro La Laguna.	2016
Guyana[42]	Ban	Ban on the import and use of Styrofoam items.	2016

[35] muffinmonster (2017) *Court Case Over a New D.C. Law Mandating What Wipes Can be Labeled 'Flushable'*, accessed 1 February 2018, https://www.nomorewipes.com/2017/09/25/court-case-new-d-c-law-mandating-wipes-can-labeled-flushable/

[36] *Seattle to Ban All Plastic Straws, Utensils in Restaurants in 2018*, accessed 1 February 2018, https://www.globalcitizen.org/en/content/seattle-restaurants-ban-plastic-straws-utensils/

[37] (2017) *Plastics, Be Gone! Costa Rica To Enact A Plastics Ban | The Problem With Plastics*, accessed 1 February 2018, https://cleantechnica.com/2017/08/15/plastics-gone-costa-rica-enact-plastics-ban-problem-plastics/

[38] *Plastic Bag Ban Assessment DRAFT,* IETC

[39] *Plastic Bag Ban Assessment DRAFT,* IETC

[40] *Plastic Bag Ban Assessment DRAFT,* IETC

[41] *Plastic Bag Ban Assessment DRAFT,* IETC

[42] *Plastic Bag Ban Assessment DRAFT*, IETC

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
Haiti[43]	Ban	Ban on the import and production of plastic bags and Styrofoam containers.	2013
Jamaica[44]	Ban	Ban on all non-biodegradable plastic bags below 50-gallon capacity and on Styrofoam containers.	2018
St Vincent and the Grenadines[45]	Ban	Ban on the import of Styrofoam products, VAT removed from biodegradable alternatives to lower their costs.	2017
Australia/Oceania			
Australia, Hobart, Tasmania[46]	Ban - Regional	Ban on plastic takeaway containers.	2020
Australia, Coles Bay[47]	Ban - Regional	Ban on all non-biodegradable plastic bags.	2003
Australia, South Australia[48]	Ban - Regional	Ban on lightweight plastic bags.	2009
Vanuatu[49]	Ban Potential Ban	Ban on polystyrene takeaway boxes. Considering the introduction of a ban on the use and import of single use plastic bags and bottles.	2018 2018
Africa			
Benin[50]	Ban	Total ban on import, production, sale, and use of non-biodegradable plastic bags.	2018
Cameroon[51]	Ban	Total ban on non-biodegradable plastic bags.	2014
Cape Verde[52]	Ban	Total ban on the sale and use of plastic bags.	2017
Eritrea[53]	Ban	Ban on the import, production, sale and distribution of plastic bags.	2004

[43] *Plastic Bag Ban Assessment DRAFT,* IETC

[44] *Plastic Bag Ban Assessment DRAFT,* IETC

[45] *Plastic Bag Ban Assessment DRAFT,* IETC

[46] *City plans to ban plastic takeaway food containers - NZ Herald*, accessed 1 February 2018, http://www.nzherald.co.nz/lifestyle/news/article.cfm?c_id=6&objectid=11900906

[47] *Plastic Bag Ban Assessment DRAFT,* IETC

[48] *Plastic Bag Ban Assessment DRAFT,* IETC

[49] (2018) *Vanuatu bans plastic bags and polystyrene takeaway boxes*, accessed 1 February 2018, https://www.radionz.co.nz/international/programmes/datelinepacific/audio/2018628994/vanuatu-bans-plastic-bags-and-polystyrene-takeaway-boxes

[50] *Plastic Bag Ban Assessment DRAFT,* IETC

[51] *Plastic Bag Ban Assessment DRAFT,* IETC

[52] *Plastic Bag Ban Assessment DRAFT,* IETC

[53] *Plastic Bag Ban Assessment DRAFT,* IETC

Member State/ Country/Region	Measure	Item Addressed / Detail	Year
Guinea-Bissau[54]	Ban	Total ban on the use of plastic bags.	2016
Kenya[55]	Ban	Total ban on the import, production, sale and use of plastic bags.	2017
Mali[56]	Ban	Total ban on the production, import, possession, sale and use of non-biodegradable plastic bags.	2012
Mauritius [57]	Ban	Ban on the import, manufacture, sale or supply of plastic bags.	2016
Morocco[58]	Ban	Ban on the production, import, sale and distribution of plastic bags.	2016
Rwanda[59]	Ban	Total ban on production, use, import and sale of all PE bags.	2008
Tanzania[60]	Ban	Total ban on all plastic bags.	2018
Zimbabwe[61]	Ban	Total ban on Styrofoam products – was temporarily lifted after introduction to allow businesses time to replace Styrofoam containers with reusable, recyclable or biodegradable ones.	2017

The number of actions being taken, as well as the scope of their intended impact, at both the EU and global level, is growing as concern regarding the underlying issue of marine plastic pollution grows. From the perspective of the EU, there is some concern that unilateral action taken by Member States could fragment the Single Market. In part, the rationale for EU action stems from the desire to respond to the problem of marine plastic pollution whilst also, as far as possible, maintaining the integrity of the Single Market.

4.3 Baseline Polices

All of the measures considered as part of this research have been considered against a baseline option. The baseline option includes all existing European laws and policies and those which are agreed and will come into effect over the considered period.

In order to understand the effect of these baseline policies, a 'no change' option was developed, with projections of item consumption out to 2030. The effect of baseline policies was then estimated, recognising that this cannot be known with certainty. These changes, overlaid on top of the 'no change' option, constituted a baseline

[54] *Plastic Bag Ban Assessment DRAFT,* IETC
[55] *Plastic Bag Ban Assessment DRAFT,* IETC
[56] *Plastic Bag Ban Assessment DRAFT,* IETC
[57] *Plastic Bag Ban Assessment DRAFT,* IETC
[58] *Plastic Bag Ban Assessment DRAFT,* IETC
[59] *Plastic Bag Ban Assessment DRAFT,* IETC
[60] *Plastic Bag Ban Assessment DRAFT,* IETC
[61] *Plastic Bag Ban Assessment DRAFT,* IETC

option against which the effect of the measures considered in this report were modelled.

The key policies and measures in the baseline are:

- the program of measures to reduce marine litter under the Marine Strategy Framework Directive (MSFD);
- the recycling targets, the effect of improved implementation of extended producer responsibility (EPR) schemes, including the shift towards modulation of fees, and national litter measures under the Circular Economy Package; and
- a target to make all plastic packaging 'recyclable' by 2030 and plans to increase the recycling rate of plastic packaging to a level 'similar to other materials'.

A summary of the effects under the baseline option and how they are modelled is as follows:

4.3.1 General Policies and Measures

- In 2017, the Commission reported on the status of implementation of the monitoring requirements of the MSFD.[62] The report indicates that only 30% of monitoring programmes related to marine litter show full coverage of good environmental status, with 40% only indicating partial. The report highlights marine litter as one area where gaps have been noted. This monitoring framework does not affect the future baseline modelling.
- The programmes of measures which the Member States have developed under the MSFD have been reported to the Commission, and some initial evaluation has been carried out – though this has not yet been published. The analysis suggests that the measures related to the marine litter indicator are not likely to be especially effective. Carrying out a thorough evaluation of effectiveness was beyond the scope of this study; as the effects are not deemed to be significant, no change was modelled from this policy in the baseline over and above the others highlighted below.
- The plastic bags Directive (amending Directive 94/62/EC) is not relevant for this analysis, as the category of bags covered by the Directive is not being assessed during this contract. The reduction in the number of carrier bags littered may improve the amenity of a site, and lead to some citizens not (or reducing) littering other items. However, the effect is uncertain and so not included in the baseline.
- The existing plastic packaging recycling target under the Packaging and Packaging Waste Directive 94/62/EC (PPWD), the 50% municipal waste recycling target under the existing Waste Framework Directive 2008/98/EC (WFD) may have some effect for countries where these targets are currently being missed. However, this is only likely to be the case for plastic drinks bottles and food containers, as the other items; a) contribute minimal weight to the total amount of plastic packaging and municipal waste and are therefore unlikely to be targeted, particularly as the current levels of recycling are very low for most other items (i.e. around 0-5%); and b) have proved difficult to collect and recycle on an economic basis. The recycling rate for plastic drinks bottles will grow as Member States improve packaging collection systems in order to meet the 50% target in 2020. It was assumed that the current average recycling rate of 52% (see section 3 of the Annex) increases to 60% by 2020 (recycling of SUNP and MU

[62] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52017DC0003&from=EN

bottles are also assumed to increase by 5 percentage points by 2020). For SUP food containers it was assumed that the current recycling figure, estimated at 5%, increases to 15% by 2020, SUNP increases from 10% to 20%, and MU, from 38% to 45%.

4.3.2 Circular Economy Package

- **Increased packaging recycling targets:** Increased targets for municipal waste recycling (55% by 2025 and 65% by 2030) and for the recycling of plastic packaging (50% by 2025 and 55% by 2030) are expected, as above, to have an impact on the recycling of the larger SUP items, such as bottles and food containers. They are expected to exert a far weaker impact on the smaller items, particularly the non-packaging items that are not in scope of the PPWD. For small, non-sanitary items the recycling rate is assumed to increase by 5 percentage points by 2030. The current maximum plastic bottle recycling rate in countries without a deposit refund scheme (DRS), and with all losses taken into account, is considered to be around 70%. Some Member States may report higher figures, but it remains to be seen whether the figures will be so high once the change in measurement methods proposed under the PPWD are enforced. All countries are assumed to meet a 70% recycling rate for plastic beverage bottles where they are not already doing so by 2030 (recycling of SUNP and MU bottles are also assumed to increase by 10 percentage points by 2030). For food containers, it was assumed that the recycling rate increases to 25% by 2030, SUNP increases to 40% and MU to 60%.
- **Further implementation of EPR:** improvements to EPR schemes will help support the delivery of the above mentioned targets. No additional effect, over and above the level of recycling needed to meet these targets is modelled. In addition, the final package does not require Member States to enact legislation that would ensure producers cover the full costs of their littered products. Consequently, no additional effect on littering is modelled: the implied assumption is that increasing recycling does not necessarily translate into improved behaviour in respect of littering.
- **Modulated fees:** these are anticipated to have some effect on recycling rates for some items which are not currently well-designed for recycling (and where the fees motivate changes in design), but the effect is less likely to translate into an increase in recycling for larger items. The effect is not certain and so no additional changes are assumed over and above the changes highlighted above for plastic bottles and food containers. The effect on littering is even more uncertain. One might speculate that producers may shift away from expanded / extruded polystyrene (EPS/XPS) food containers, for example, as these are currently difficult to recycle. If this occurred then one might expect a corresponding reduction in littering of EPS/XPS. However, the net effect in respect of recycling and littering would depend on what alternatives producers decided to use. If card products were favoured, the overall littering rate of plastics might fall, but equally, other plastic products which were ‘recyclable’ and attracted lower fees could be the preferred choice. Even if this did result in an increase in recycling, it might not result in major changes in littering. Therefore, no changes to littering rates are modelled.
- **National litter plans:** Article 28 of the WFD is to be updated to include the requirement that ensure Member States include in national waste management plans ‘(f) measures to combat all forms of littering and to clean up all types of litter’. The effect of this measure depends upon the robustness of any measures

that are included in the plans. There is no legal requirement for any specific instruments to be deployed, simply that measures be considered, so the effect is uncertain and might be limited. All Member States are likely to be taking, already, some measures that would fall under the above description. If Member States chose to implement measures such as encouraging local / regional authorities to minimise the amount of SUP items they procured, or if local authorities were encouraged to ensure that all licensed events made use of reusable cups, cutlery, etc., then the effect could be enhanced. Equally, it may be that the elaboration of guidelines for the preparation of these plans could support more effective implementation, but this has not yet happened. Even if it did, the lack of any compulsion by Member States to take specific action might still limit effectiveness. Conservatively, therefore, and because there is little evidence for certainty of significant improvement, the littering rate is reduced marginally, by 5% of the total, and the litter collection rate increased by 2 percentage points, both by 2025 (note that the current rate of litter collection is assumed to be 88% across the EU).

- **Landfill reduction targets:** the target for Member States to landfill no more than 10% of municipal wastes by 2035 will impact on the treatment of mixed wastes. This would change the management of the items considered in this study, as all items will be present to some extent in the mixed waste stream. The treatment of mixed waste is set on a trajectory to ensure consistency with the target that no more than 10% of waste is landfilled by 2035 (i.e. 15% is landfilled in 2030). SU items are assumed to be evenly distributed in mixed wastes, and so are split across landfill or incineration in accordance with the treatment shares in the Member State concerned. The amount in residual waste overall is calculated based on the amount not littered, and not recycled.

4.3.3 Plastics Strategy

- As noted at the beginning of section 4.3, a target for all packaging to be recyclable by 2030 has been set. This has not been modelled to have a separate impact over and above those already discussed: rather, it is assumed to contribute to the meeting of the higher targets mentioned above. The Plastics Strategy indicates that the 2030 recycling target for plastic packaging will be kept under review, and may be increased as a result. However, no firm target has been established as yet, so no further effect over and above increases described over were modelled.
  It is also possible that there might be a switch in consumption from SUP to SUNP or MU items. However, there are a significant range of possibilities and no clear evidence to suggest what the changes would be. Consequently, consumption switches have not been modelled in the baseline.

4.3.4 National Measures

In addition to the EU-level measures mentioned above, the following national measures were included in the Baseline:

- A deposit refund system for one-way beverage packaging will be implemented in Malta.
- Specific single use plastic measures being taken in some Member States (see Table 4.2). The key measures included in the baseline are as follows:
  - France – a complete ban on inter alia plastic drinks cups and cutlery is effected by 2020. In terms of the modelling it is assumed that, for cutlery, this

leads to consumption switches of 80% to SUNP cutlery and 20% to MU cutlery. For drinks cups, no completely plastic free alternative is currently available at commercial scale. It is assumed that the ban will stimulate a switch to paper cups with bio-based, biodegradable plastic liners. In line with what is discussed above, the approach taken in this study is that materials are still considered 'single use plastics' unless their potential to biodegrade in the marine environment is clearly evident. Because it is unclear, yet, what the SUNP alternative would be for cups containing hot drinks, the switch from SUP to compostable alternatives is assumed to be a switch from one SUP to another. It may well be that this changes as a result of innovation, and improvement in our knowledge of the fate of these materials. For the purposes of the modelling here, however, the switch we have modelled is that 10% of demand is met through MU drinks cups rather than SUPs. It should be noted that in terms of model results, alternative assumptions would not radically affect the results (and that this assumption is not restricted only to the French case).

- France – a complete ban on plastic cotton buds by 2018. In terms of modelling this measure is assumed to lead to consumption switches of 90% to SUNP and 10% to MU cotton buds by 2020.
- Italy – a complete ban on non-biodegradable cotton buds by 2019. In terms of modelling, this measure is assumed to lead to consumption switches of 90% to SUNP and 10% to MU cotton buds by 2020 (as the model only has inputs for 2018 and 2020, amongst others, but not 2019).

The following policies are not taken into account as they were not confirmed at the time of writing:

- **Drinking Water Directive 98/83/EC (DWD)**: A recent impact assessment (IA) on making drinking water more readily available indicated that plastic bottle use could be significantly reduced;
- **Urban Waste Water Treatment Directive 91/271/EEC (UWWTD)**: This aims to protect the environment from the adverse effects of waste water discharges and includes regulation of "sewage related debris": including items flushed down the toilet such as wet wipes and cotton buds.

4.3.5 Effectiveness of existing policies

With regards to existing policies, WFD makes no reference to litter. However, most Member States have implemented laws to make littering and fly-tipping an offence, often backed by financial sanctions. Given the levels of littering seen across Member States are considerable, it is clear that these deterrents are not fully effective. It would seem inappropriate to significantly raise the penalty for this type of offence, in order to increase the threat of sanction and deter behaviour. Moreover, littering occurs through a high volume of incidence in often isolated locations or away from the sight of enforcement officers. Therefore, policing this offence is very challenging. In addition, studies suggest that the value people place on an environment is rapidly eroded through the presence of any litter, and so if any litter is present, the likelihood of further littering increases significantly (see section 4 of the Annex). Finally, the cost of cleaning up litter is very high as the task is time consuming, manual and litter is often dispersed in difficult to reach locations. The high cost reduces the frequency at which litter is collected, leading to further littering

as littering rates increase where litter is already present.[63] . All of the above suggest why existing litter policies are not effective and why there is a need for further policies to tackle the problem.

This could also be said for problems related to items that can be flushed down sewer systems (see following section). It would not be possible to make flushing of these items illegal, as it would be impossible to enforce and current attempts by producers to dissuade consumers to not flush items are ineffective, as warning signs on packaging are too small and not clearly explained. Further action is therefore required.

Regarding the implementation of the UWWTD, the exact causes of breaches are not known, but the continuing occurrence of overflow events is strongly linked to the presence of combined sewer overflows, which are estimated represent 55% of the sewer network by population.[64]

4.4 Pathways

During the course of this study contract, a workshop on the problems of SUPs was carried out.[65] This included development of a problem tree which mapped out the causes, and the effects, of marine plastic pollution. Using this problem tree, presented in Figure 4.1, and some further research on pathways of SUPs to the marine environment, these were generalised in a pathways diagram (Figure 4.2).

The two main drivers leading to pathways to the marine environment, where many of the problems have been identified, are:

1. Consumers drop litter on the ground in urban or rural environments. This is, to some extent, due to the lack of convenience of finding a public bin or carrying litter home as well as the lack of incentives, economic or otherwise, to do the right thing. Many consumers will do the right thing, but some members of society are either unaware or uncaring of the consequences of dropping litter; and
2. Consumers flush items down the toilet or drains (e.g. cotton buds, wet wipes and sanitary towels). The driver in this instance is in part convenience but potentially more weighted towards perceived health risks from dealing with soiled sanitary items.

The measures identified in section 4.5 relate to these key drivers and the pathways described in Figure 4.2. The linking of these is described in the next section.

[63] Krauss et al. (1978), *Field and Laboratory Studies of Littering,* Journal of Experimental Social Psychology, Volume 14, Issue 1, pp109-122.

[64] Based on population data from Eurostat and proportion of CSOs in the following study. Milieu Law and Policy Consulting, 'Assessment of impact of storm water overflows from combined waste water collecting systems on water bodies (including the marine environment) in the 28 EU Member States' Final Report, 27th January 2016.

[65] ICF and Eunomia (2018) 'Plastics: Reuse, recycling and marine litter', Final Report for the European Commission.

Figure 4.1 Problem Tree Related to Littering of Single use Plastics

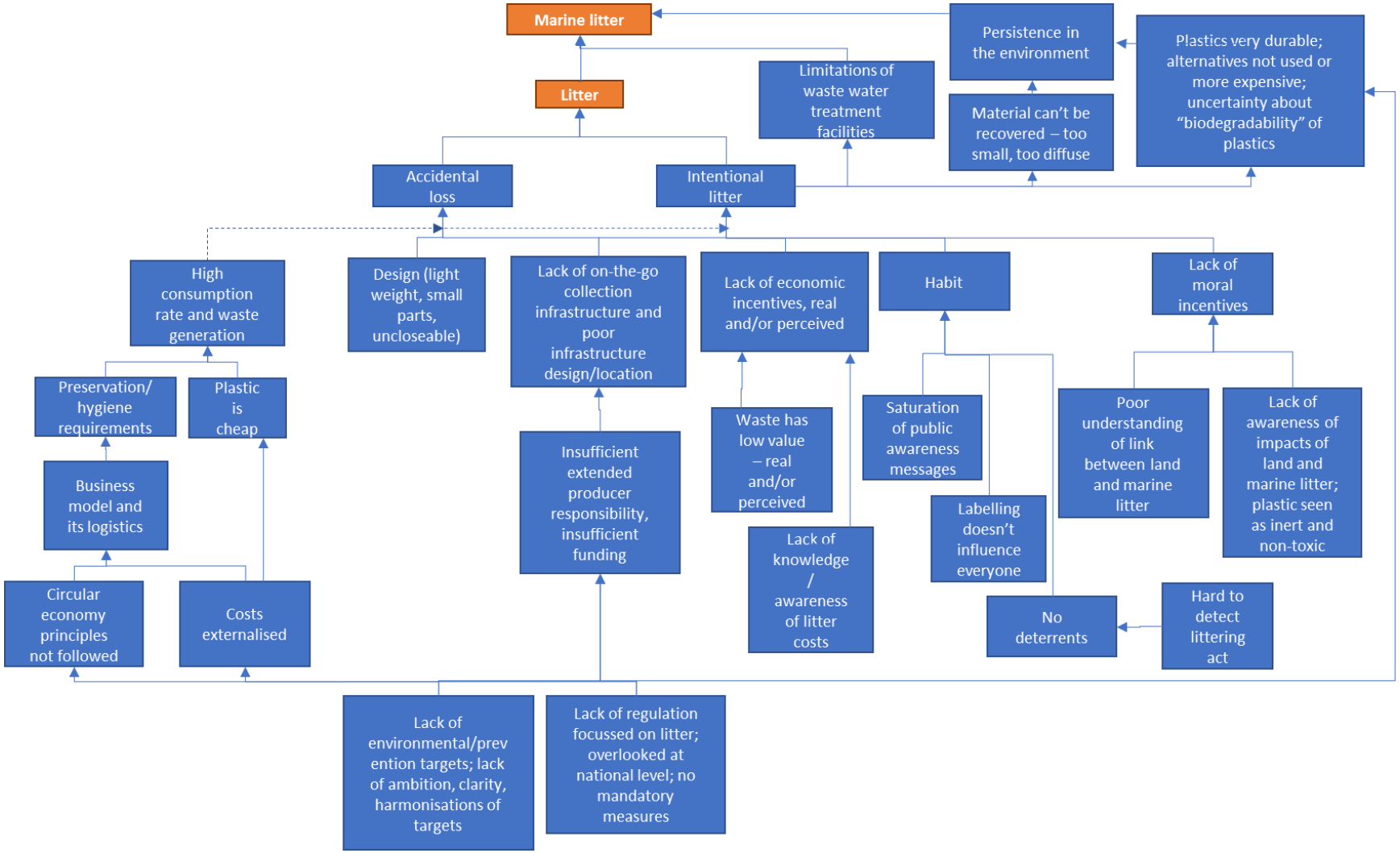
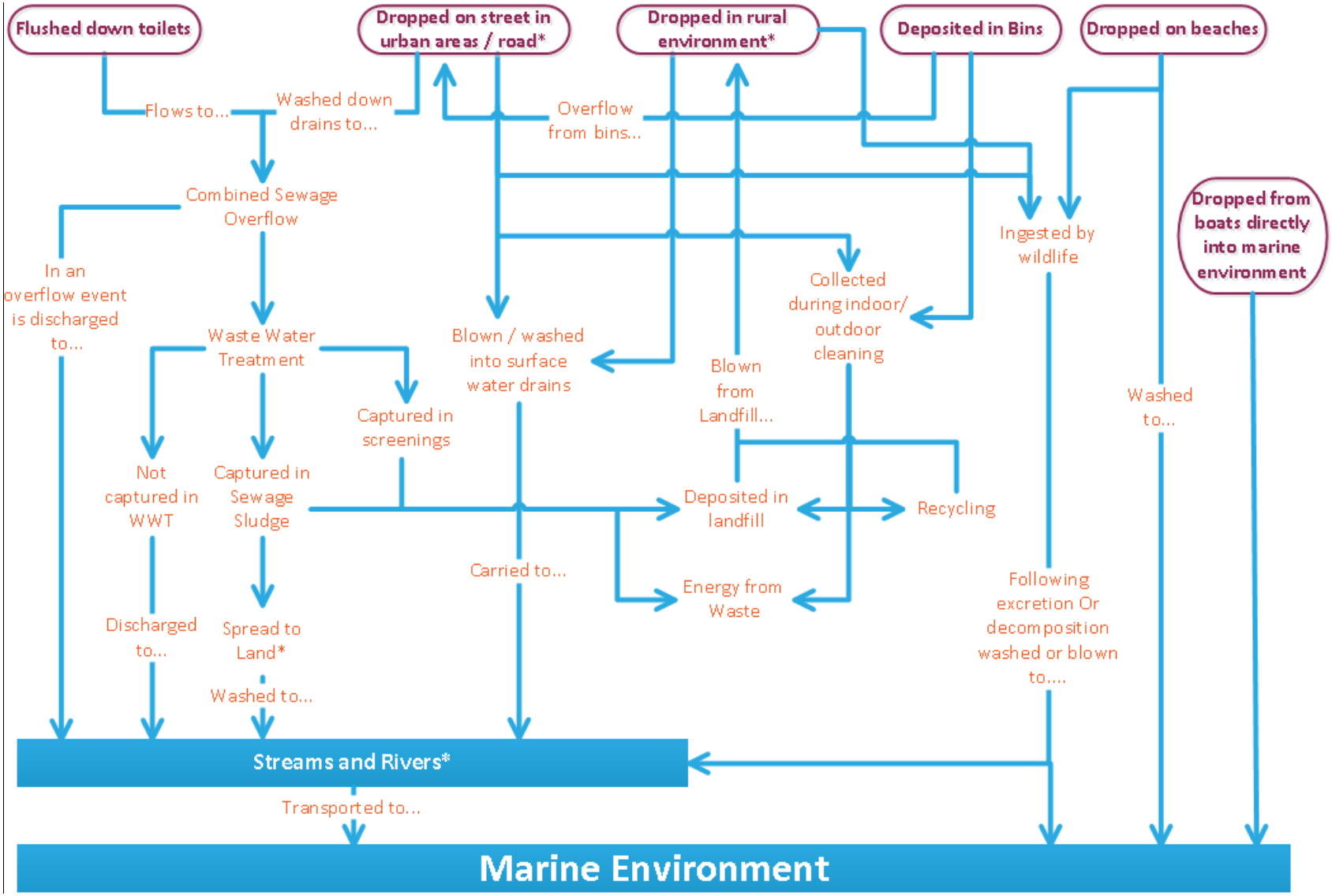


Figure 4.2 Key Pathways to the Marine Environment



4.5 Product-Measure Matrix

A product-measure matrix was developed to determine the range of policy measures to be modelled in the analysis. It identifies a range of key measures, and the items for which their application is deemed feasible or relevant. All feasible measures where then modelled for each item.

As noted above the measures were proposed in relation to the key issues and pathways identified in the problem tree and pathways diagrams approaches. The linking of key issues and associated measures are set out in Table 4.3.

Table 4.3 Linking the Selection of Measures to the Problems

Problem	Description
Consumers flushed items down the toilet / lack of awareness	■ Information campaigns ■ Mandatory labelling to discourage littering ■ EPR for flushed items
Consumers drop litter / lack of awareness / lack of on-the-go collection infrastructure	■ Information campaigns ■ Mandatory labelling to discourage littering ■ EPR – full cost coverage of litter collections ■ Implement DRS for beverage containers
Lack of economic incentives	■ Consumption levies
High consumption rate	■ Specified sales restrictions ■ Measures for adoption by public authorities, including Green Public Procurement (GPP) ■ Reduction targets (SUP) ■ Reduction targets (all SU) ■ Ban (of SUP items)
Poor design	■ Specific Requirements on Product Design
Flushed items escape through Combined Sewer Overflows (CSOs) / limitations of WWTW	■ Setting enhanced technical standards for WWTW[66] and CSOs[67]
All	■ Voluntary agreements, voluntary commitments and pledges

This section firstly presents a description of the key measures selected: these measures were developed over the course of the contract, including during the development of the Plastics Strategy, and reflecting also the consultation with industry stakeholders and the wider public. It then provides a review of the potential alternative SUNP and MU items to identify where feasible options exist in the market. A summary of the feasibility, by product and measure, is then presented. Finally, the product-measure matrix is displayed to summarise the measures to be modelled for each item.

4.5.2 Description of Measures

Table 4.4 provides a summary description of the individual measures being analysed in the model. It is noted that, despite modulation of fees being raised during stakeholder workshops, this has not been included in the list of measures as

[66] Waste water treatment works.

[67] Combined sewer overflows.

modulation of fees according to the potential for an item to be littered or not would be very difficult to determine.

Table 4.4 Short-listed Measures

Option	Description
Information campaigns	Information campaigns could be targeted at consumers with a range of aims depending upon the nature of the item. For example, campaigns might; a) aim to improve consumers' understanding of the impacts of littering with the objective of reducing litter rates; b) aim to reduce the incidence of sanitary items flushed down toilets and drains; or c) focus on broader impacts of marine plastics, with the aim of encouraging consumers to take up available SUNP alternatives, or start using MU items, instead.
Mandatory labelling to discourage littering	Whilst information campaigns may have a general, population-wide character, mandatory labelling of widely littered items could help deliver messages more directly to consumers. The effectiveness of such a measure depends on how clearly the message is conveyed and how much of an impact the message has on those who currently litter the labelled items.
Voluntary agreements, voluntary commitments and pledges	A range of measures could be taken by industry which require no specific legal instrument. Voluntary agreements (VAs) are generally those actions taken by industry to bring about changes without the need for changes in policy. At a European level, voluntary agreements typically involve a specific industrial sector, or category of producers; some formal recognition can be given through gaining approval from the European Commission. Voluntary commitments and pledges, on the other hand, might be made be made by individual companies and are usually made independently. The types of approach that could be considered (and one or more of these could be included in a given VA) are; a) improvements in anti-littering messages on packaging; b) switching material use to alternatives which are demonstrated to degrade in the marine environment; c) supporting the provision of street bin infrastructure; d) supporting litter clear up campaigns; e) implementing refill/reuse schemes in the HoReCa[68] sector; f) agreeing to offer discounts for those using own coffee cups; or g) funding the sorts of campaigns mentioned above.
Specific Requirements on Product Design	Product design measures could be taken to reduce the propensity for certain items to be littered. For example, bottle lids could be tethered to bottles. Bottle lids are found more frequently than bottles in litter counts, suggesting they are either more frequently littered or captured by litter clean-up services less effectively. In addition, cups could potentially be designed to integrate sipping lids. Another potential design change could be to integrate straws into drinks containers, rather than selling such items separately. Evidence suggests that smaller items are less frequently collected in litter clean-up processes than larger items (see section 3 of the Annex). Moreover, it could be speculated that smaller items are also littered more frequently as consumers see smaller items as less impactful. The aim of any design measures, therefore, is to integrate smaller items with larger items such that littering is reduced. Designers could also be required to have regard to insight of a behavioural nature insofar as these help to minimise the likelihood of SUPs (and other items) being littered.
Setting enhanced	A range of sanitary items are flushed down drains by consumers, such as cotton buds, wet wipes and sanitary towels. Smaller items may pass

[68] HoReCa = Hotels, Restaurants and Catering

Option	Description
technical standards for WWTW[69] and CSOs[70]	through screens at waste water treatment works (WWTWs) or, along with larger items, be flushed out into the rivers and seas through CSOs during overflow events. This measure implies requiring the implementation of measures believed likely to reduce the flow of SUP items into rivers, and hence, to oceans. In this measure, the costs would fall upon the water utilities and the measures would become integrated within standards under the UWWTD, or similar mechanism (see below for an equivalent measure where the SUP producers pay for the changes). Consultation with private operators in the water industry suggests a range of options which would mitigate flows of these items through this pathway: 1. Control at source; 2. Build bigger sewer systems including with larger overflow tanks; 3. Take surface water out of combined sewers; and 4. Reducing screen size from 6mm to 3mm, and install more screens at CSOs and WWTWs. Point 1 is the focus of the information campaigns indicated above. Points 2 and 3 require expensive civil engineering, although taking these actions would have wider environmental and efficiency benefits, and would have to be implemented over perhaps decades. Point 4 could target specific problem areas in the sewer network, but would still result in significant infrastructure changes.
EPR for flushed items	An EPR scheme for flushable items could be introduced with the intention of; a) recovering the costs of some / all of the measures identified in Points 1-4 in the previous measure (described above); and b) influencing the design of what is flushed into the WWTW. In this latter regard, fees could be modulated based upon the likelihood of their continuing to cause problems in the waste water treatment network once the measures have been implemented.
EPR – full cost coverage of litter collections	Currently there are very few instances where, under EPR, producers pay for the costs of cleaning up litter. Two examples can be found in Belgium and the Netherlands.[71,72] Under the principle of EPR, the full costs of managing a product at end of life ought to be covered, and this might be assumed to include the cost of cleaning up any items that are littered on land and on beaches. This measure places that burden upon producers, such that those currently operating street, highway and beach cleansing services are compensated. In this case, however, we assume that, in line with the emerging proposal for a revision of the WFD, producers are required to cover 80% of litter clean-up costs. There would need to be a method to discern the required standard of cleanliness to which streets, etc. would need to be cleaned of litter

[69] Waste water treatment works.

[70] Combined sewer overflows.

[71] In the Netherlands, packaging producers already make a financial contribution towards litter prevention activities, via the Producer Responsibility Organisation Afvalfonds Verpakkingen. This PRO, which is the only packaging PRO in the Netherlands, then provides funding to Stichting Nederland Schoon to undertake activities to prevent and address packaging litter, including by organising activities aimed at the Dutch public, schools, municipalities and businesses. It is understood that, Afvalfonds Verpakkingen provides financial support of €5.5m per annum to Nederland Schoon (€0.29 per inhabitant), which accounts for 100% of the budget of Nederland Schoon.

[72] In Flanders, Belgium, it is understood that producers pay €9.6 million annually to fund a national litter prevention programme (€1.50 per inhabitant). Fost Plus (the PRO for packaging waste in Belgium), FEVIA (the Belgian food industry association) and COMEOS (the Belgian federation for commerce and services), signed an "open agreement" with Flemish environment minister Joke Schauvliege to invest €9.6 million annually in the fight against litter. This does not appear to cover costs associated with managing litter and the basis upon which this figure was agreed upon is not clear.

Option	Description
	(effectively establishing the overall costs of clean-up). The approach to distributing the costs to producers would be to set up transparent funding formulas that estimated the cost of clean-up based upon the relative proportion of a given item within the total amount collected. However, it should be noted that some items, such as cigarette filters, will be under-represented in the collected wastes as often small items are left on the ground by street sweepers. This would need to be factored into any methodology.
Specified sales restrictions	This measure envisages that regulations are enacted that restrict the sale of SUP items in various locations. Examples might be to ban the sale of SU items at all major events (possibly supported by deposit refunds for cups / glasses, etc.), such as conferences or festivals. Other approaches that could be taken include: ■ Implementing regulations to restrict the sale of any SUP (or SUNP) cutlery, straw, stirrer or drinks cup for use on-site i.e. SU items would only be made available for on-the-go consumption. Most food service outlets that serve on-site and for on-the-go consumption ask the customer if they are eating in or taking out. Those which state eating in would use washable MU cutlery and drinks cups (this measure could also be extended to e.g. the means of delivering food to customers, ensuring MU plates are used wherever possible). ■ Restricting the sale of drinks bottles for on-site consumption where refillable alternatives could be made available (e.g. tap water, soda streams etc). ■ Restrict the sales of straws and stirrers by nudging consumers into not using them by requiring drink service establishments to only give out straws and stirrers if specifically requested by the consumer i.e. not by default, and not placing them in places where they are essentially freely available (on the basis that the ease with which they are made available supports their over-consumption).
Measures for adoption by public authorities, including Green Public Procurement (GPP)	Public authorities have specific competences and influence that can be brought to bear in order to reduce the flow of SUPs into the marine environment. Typically, public authorities may give consent to major public events: they also have significant spending power through their procurement of goods and services. Key examples of the actions that public authorities could take include: ■ Eliminating / reducing procurement of SUPs; ■ Requiring the use of MU items at events over which the public authority has some means of control (e.g. issuing licenses). They may also be able to influence the actions of franchisees on property which they own.
Implement DRS for beverage containers	A deposit refund system (DRS) on one-way beverage containers provides a clear economic incentive for consumers to return their empty containers, including plastic bottles, to return points. Moreover, any bottles that are initially littered have a relatively high economic value so are picked up by others and returned, and so, ultimately, avoid ending up in the marine environment. DRSs also achieve very high capture rates, so recycling levels can reach over 90%.[73] However, DRSs are not guaranteed to be implemented by Member States as this target can be met today through existing higher performing kerbside schemes and residual waste sorting at lower cost. Moreover, with the target for all

[73] Eunomia on behalf of the European Commission, 'Options and Feasibility of a European Refund System for Metal Beverage Cans' Final Report, November 2011.

Option	Description
	packaging to be recyclable by 2030, this would decrease the necessity for implementing DRSs solely to help meet the target, though Member States could implement for other reasons, such as litter reduction or resource efficiency or increasing recycled content.
Consumption levies	For the purposes of describing this measure, 'levies' are considered to be any economic instrument implemented at the Member State level that increases the cost of SUP items placed on the market, and incentivise non-use, or substitution by SUNP and MU items. The exact nature of the instruments cannot be determined here, but the overarching principles and estimated effects can be modelled in the spirit of an options analysis. Charges and levies are only likely to be effective for some items, and not others. The demand for sanitary towels, for example, is very inelastic as they are considered essential, not luxury, goods. There are, however, some convenience and use barriers that may limit a large shift to reusable items (further market research would be needed to confirm or deny this). Alternative economic instruments, such as EPR for commonly flushed items are likely to be more appropriate (these are modelled in the measures above). Cigarettes are also very demand inelastic; additional price increases would result in limited changes in demand if the price differential of alternatives was not significant.
Reduction targets (SUP)	Reduction targets would set legally binding reductions in consumption from a base year. Data related to the consumption of relevant items would have to be reported to the national governments. Targets are assumed to be as a percentage of the total consumption, but per capita targets could also be set as is the case under the plastic carrier bags Directive.
Reduction targets (all SU)	As above.
Ban (of SUP items)	This measure would see complete market bans on the sale of certain SUP items by a given year. Bans would have to be regulated to ensure products are not being sold after the date of implementation.

4.5.3 Availability of SUNP and MU Alternatives

This section explores some current and possible future SUNP and MU alternatives which either are successful or could be successful market competitors with the priority SUP items.

4.5.3.1 Cigarette Filters

Plant-derived cellulose or cotton filters could be used as an alternative, such as the RAW Biodegradable Slim Filter Tips although, according to anecdotal evidence the draw is not exactly the same as normal plastic based filters.[74] However, there may well be room for innovation here if companies were required to make the switch. Additionally, it has been argued that cigarettes should be sold without filters (such as filterless Gauloise-type cigarettes), as the filters do not have a demonstrable effect on health outcomes. Given that these could then be used with re-usable filters, this maintains choice for consumers.

[74] http://www.rollingpapersexpress.com/ocb-rolling-papers/raw-biodegradable-slim-filter-tips-6mm.html

4.5.3.2 Drink Bottles

Networks of water fountains in cities, tourist areas and at beaches (or any other high footfall area) can be installed, along with running of information campaigns, in order to avoid the need for bottles at all. Drinking fountains are available in most cities, but at a density where consumers can quickly find them.

To enable and encourage consumers to use refillable bottles, mobile applications can be developed to indicate to consumers where the nearest available refill points are, to ensure they are used.

Retailers could install carbonating machines for use with refillable bottles, rather than selling SUP bottles. Consumers would then bring refillable bottles to the outlet and purchase the volume of drink they require for their bottle.

Food and drink retailers can sell water from refillable bottles, rather than selling SUP bottles. Many small cafés take this approach already and do not sell water in plastic bottles at all.

4.5.3.3 Cotton Bud Sticks

The company Utility Tip produces MU sticks for cleaning ears, which are, according to the supplier, more efficient and safer than cotton buds. In fact, many medical professionals don't recommend the use of cotton buds at all. U-Tips could be wrapped in tissue paper to act in the role as single use applicators of cosmetics; although re-usable brushes and sponges are available for these applications too.

Alternatively, paper stemmed SUNP substitutes are now commercially available.

4.5.3.4 Wet Wipes

SUNP alternatives to wet wipes used for personal care, for example make-up removal, already exist in the form of cotton pads or balls.

Moreover, MU alternatives to wet wipes could include washable handkerchiefs or specially designed products, such as "Cheeky Wipes"; washable cloth baby wipes.[75] Lotions (such as soaps, anti-bacterial gels, or make-up removal creams) could be applied to these wipes to achieve the desired result.

4.5.3.5 Sanitary Towels

Competitively priced SUNP alternatives for sanitary towels are rare. However, MU panty liners and menstrual pads are already available from a number of producers.[76,77] These items are washable and reusable, and are usually made entirely of cotton, or of a mix of cotton or bamboo fibre with a waterproof poly-urethane layer.

4.5.3.6 Cutlery

Currently, there are 2 different situations where SU cutlery might be provided to customers at food and drinks establishments:

- Use on the premises, mainly to save costs of washing reusable cutlery; or

[75] http://www.cheekywipes.com/cloth-baby-wipes.html

[76] http://www.cheekywipes.com/cloth-sanitary-pads-kits.html

[77] http://www.caringpanda.info/home.html

- with takeaway food which cannot be eaten by hand on the go.

The latter is the most relevant to littering, whereas both relate to over-consumption of material.

Metal cutlery is the clear alternative and the majority of establishments make use of this approach. Therefore, washable items should be implemented for all eat-in sales.

For takeaway sales, reusable cutlery could be a clear alternative if consumers brought their own and knew which outlets allowed this.

If single use items are necessary, then wood alternatives could be used, and are very common already through large stockists.

Alternatively, edible single use cutlery is also available, although the extent of manufacture is not known.[78] However, edible products would have to meet national food standards and packaging regulations, which might provide a barrier to use in some cases.

4.5.3.7 Straws and Stirrers

For many drinks, straws and stirrers are not needed at all, and could simply be eliminated. MU straws and stirrers are also available made out of glass or metal.[79] Another option could be to innovate packaging design to build-in 'straws' to the pack itself, rather than have a separate disposable straw that could be littered – such as 'Straw Pak'.[80] Paper or bamboo alternatives are also very common and highly available.[81]

For stirrers, if consumers found SU options necessary, wooden stirrers are commercially available.

4.5.3.8 Food Containers

Currently, there are 3 different situations where food establishments provide SU containers to customers:

- To eat the food on the premises, mainly to save costs of washing reusable containers or plates;
- containing food for delivery and consumption at home; or
- to contain takeaway food for consumption on the go.

The latter is the most relevant to littering, whereas all relate to over-consumption of material.

Crockery is a clear MU alternative and the majority of eat-in establishments make use of this approach already. Eating takeaway food on site might not always be possible with crockery, but reusable containers would be an obvious alternative (washable tiffins or multi-compartment trays).

For food markets and mobile takeaway outlets, portable washing stations can be hired to undertake the task of washing the reusable containers customers use to eat

[78] http://www.bakeys.com/

[79] https://www.ecobrotbox.de/de/product/eco-strohhalm/

[80] https://ifworlddesignguide.com/entry/163812-straw-pak

[81] https://www.boutiquezerodechet.com/sortir-zero-dechet/241-paille-en-bambou.html

the food. This already happens at public events in Vienna and Munich for example.[82] In 2011, Vienna introduced an obligation to use MU items at events with more than 1,000 people, where more than 500 people are attending in venues recognised as "permanent" by the Viennese Government, or which are held on property owned by the Viennese Government.[83]

Alternatively, companies could provide a reusable container service to the street vendors, such as Go Box in Portland and San Francisco.[84] The company offers an app based reusable box service for take-away and street venders. Each box can be used 200-300 times before it is eventually recycled. However, to ensure a high return rate for the boxes, some form of DRS might be needed. Other schemes have been recently piloted, an example being the GrueneTatze scheme in Bern.[85] This pilot project has now grown into reCIRCLE, which operates in several cities in Switzerland.[86]

For at-home consumption of take-away meals, reusable containers can be used. These are already widely used in environmentally focused establishments, rather than SUP containers which are used by the majority. Consumers can purchase a metal tiffin, for example, for around €15-20 and take this to the takeaway outlet when they go to pick up the meal. They then wash it at home ready for the next visit. Or they can just bring a regular MU food container.

Where consumers are visiting take-away outlets and want to eat out 'on-the-go', the potential for utilising reusable containers is diminished. However, if this was not possible, then SUNP containers should be the only alternative. Moreover, alternatives which create other impacts should also be avoided. Cardboard containers without plastic liners or biodegradable bagasse clam shells are already available at commercial scale.[87]

In supermarkets, non-reheatable food to eat on-the-go is commonly served in SUP packaging, so it will be important to ensure that standards and regulations are consistent for all food-to-go vendors – whether they are cafes and restaurants or supermarkets. Chains such as Exki are exploring options for reusables that their outlets could return to their factory.

4.5.3.9 Drinks Cups

Currently, there are two different situations where food and drink establishments provide SU cups to customers:

- To drink on the premises, mainly to save costs of washing reusable cups; or
- taking out drinks for consumption on-the-go.

[82] http://www.prewaste.eu/index.php?option=com_k2&view=item&task=download&id=415&Itemid=94

[83] Eunomia (2012) *A Feasibility Study on a Legal Obligation Aimed at the Systematic Use of Reusable Containers for Drinks and Food Served at Events Held in Public Places in the Brussels-Capital Region*, Final Report to Bruxelles Environnement, August 2012.

[84] https://www.goboxpdx.com/mission/

[85] http://www.gruenetatze.ch/das-system

[86] https://www.recircle.ch/

[87] http://www.catering24.co.uk/no-3-brown-food-container-69oz.html

http://www.catering24.co.uk/goodlife-bagasse-lunch-boxes.html

The latter is the most relevant to littering, whereas both relate to over-consumption of material.

Crockery is a clear MU alternative for drinking on the premises and many establishments already make use of this approach.

Takeaway beverages for consumption on-the-go can readily be sold in reusable cups, which are now very well known, for example, KeepCup.[88] Moreover, some enterprises are also offering reusable cup clubs, which collect and return them to retailers.[89] The Freiburg Cup scheme is a city based scheme that has been piloted along these lines, with 72 venues participating as of March 2017. The cup has a €1 deposit associated and it can be returned to any participating venue.[90] At least 14,000 cups are in use.[91] DRSs for ceramic mugs can also often be found in markets.

In terms of SUNP beverage containers, some paper cups which are classified as compostable and have a waterproof layer because they are lined with plant-based polylactic acid (PLA).[92] However, composting is only likely to work under industrial conditions, and the plastic may not fully degrade under other conditions – such as the marine environment.[93] Consequently, SUNP alternatives are not included in the analysis as lined cups are required for coffee to ensure the mechanical strength is maintained even when filled with very hot liquid for a certain length of time.

Regarding the lids, the design of the coffee cup itself could be changed to integrate a sipping spout, eliminating the need for separate lids altogether. One example is the New Plastics Economy innovation prize winner, TrioCup.[94]

4.5.3.10 Balloons and Balloon Sticks

The most common pathway for balloons and balloon sticks to enter the marine environment is thought to be through accidental or intentional release of helium filled balloons, particularly at 'mass ascents'. Such practices are restricted in some Member States, and it may be appropriate to have this practice extended across Member States. There is no readily available balloon made of alternative materials that can be considered to degrade readily in the marine environment. Latex balloons are sometimes suggested as more 'environmentally friendly', on the basis that latex is suggested to degrade naturally in the environment. However, this is not supported by evidence, with some sources suggesting that latex balloons can take several months or even years to break down.[95] Balloon sticks, however, could potentially be manufactured from other materials, as per the switch from plastic to paper cotton bud sticks.

[88] http://uk.keepcup.com/

[89] http://www.cup-club.co.uk/

[90] http://www.bbc.co.uk/news/world-europe-38066528

[91] http://www.remondis-aktuell.com/012017/recycling/freiburg-cup-schafft-einwegbecher-ab/

[92] http://www.catering24.co.uk/double-walled-edenware-8oz-cups-lids.html

[93] It is thought that the degradability of PLA may be dependent on reaching reasonable temperatures, and this might not happen in the marine environment.

[94] https://newplasticseconomy.org/innovation-prize/winners/triocup

[95] ADAS (2013) Sky Lanterns and Helium Balloons: An Assessment of Impacts on Livestock and the Environment, Report to Welsh Government and Defra, May 2013.

4.5.4 Feasibility of the Measures

For each item and measure, the rationale for the level of feasibility and a description of what the measures are trying to achieve – where relevant – are given in Table 4.5 to Table 4.13.

Some simplification of the list has been made relative to what is included in Table 4.3 in section 4.5.1 above. The 'Specified Sales Restrictions' and 'Measures for Adoption by Public Authorities' have been amalgamated into one category (Sales Restrictions / Measures for Adoption by Public Authorities). These are expected to be the type of measures that would be used to implement a reduction target if such targets were introduced and so are not carried forward to the modelling stage.

The effectiveness of the measures is considered below in section 5.3 on model assumptions.

Although there are no pilot studies for the items under consideration to evaluate the feasibility of them section 4.2 indicates that measures are already being put in place for many of these items both within Europe and across the world – confirming the feasibility of approach in many cases. The technical feasibility is assessed here, with the economic feasibility within the IA itself. Political feasibility is not taken into account.

Table 4.5 Cigarette Filters

Measure	Feasibility and Aims
Information campaigns	Feasible. The aims of the campaign would be to inform smokers of the impacts of dropping cigarette filters, especially from filters, not only on beaches but also on land as many get washed into drains then into the sea. This would include information on the packs themselves.
Labelling	Feasible on packs of cigarettes and on packs of filters.
Voluntary measures	Feasible. A voluntary agreement could be considered by the tobacco industry to reduce the plastic content in filters over time. Chemicals would still remain in the filters, but this would still be the case with no action, and it would appear appropriate to take action on plastics if a separate chemicals related problem could not be addressed in parallel. Not least as communications campaigns are unlikely to be very effective.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not as frequently flushed and may be too small for CSO screens to be captured in any case.
EPR for flushed items	Not relevant, items are not frequently flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. San Francisco, for example, has implemented a scheme where cigarette manufacturers are charged according to the proportion of cigarette filters in litter counts.[96]
Sales restrictions / measures for adoption by public authorities	Not feasible. Although, in theory it might be possible to introduce bans on smoking outside in public places and/or on beaches.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP/MU alternatives.
Reduction targets (SUP)	Feasible. Non-plastic filters are available.
Reduction targets (all SU)	Not feasible. The aim is not to reduce cigarette consumption or filter use overall.
Ban (of SUP items not all SU)	Feasible. Non-plastic filters are available.
Ban (of all SU items)	Not feasible. MU alternative does not exist.

[96] In San Francisco, USA, the municipal authorities have implemented a scheme whereby the manufacturers of cigarettes pay the municipal authorities the relative cost of clean-up of dropped filters. In this case the proportion is 50% by count, and so the companies pay this share of the total cost.

Table 4.6 Drinks bottles, caps and lids

Measure	Feasibility and Aims
Information campaigns	Feasible. The aim would be to run information campaigns to incentivise consumers to use water fountains, reusable bottles and other alternatives to SU bottles, with the secondary affect that caps an lids would not be littered. In addition, target campaigns in the HoReCa sector to install water fountains and carbonating machines in outlets participating in refill schemes, and for municipalities to install water fountains in public spaces.
Labelling	Feasible. There may be issues with some very small bottles (e.g. miniatures sold in mini-bars), but otherwise, the measures could be readily adopted
Voluntary measures	Feasible. Voluntary agreements could focus on reducing the sale of plastic bottles, switching to other materials or installing refillable schemes.
Specific Requirements on Product Design	Feasible. Design features could be incentivised or made compulsory that ensure caps and lids are mechanically fixed to bottles to reduce the incidence of littering (through tethers, for example).
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Feasible. A 90% recycling target for beverage containers, for example, is highly feasible, as a number of EU Member States are already achieving over 90% recycling rate.
EPR – full cost of litter	Feasible. San Francisco, for example, has implemented a schemes where cigarette manufacturers are charged according to the proportion of cigarette filters in litter counts, the approach could be extended to other littered wastes.
Sales restrictions / measures for adoption by public authorities	Feasible. Regulations could potentially be implemented that banned venues from selling SU drinks bottles for consumption on-site; public authorities could mandate the use of refillables at events under their influence.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and non-SUP alternatives.
Reduction targets (SUP)	Feasible. Alternatives exist.
Reduction targets (all SU)	Feasible. Alternatives exist.
Ban (of SUP items not all SU)	Feasible. Alternatives exist.
Ban (of all SU items)	Feasible. Alternatives exist.

Table 4.7 Cotton bud sticks

Measure	Feasibility and Aims
Information campaigns	Feasible. Campaigns could focus on informing consumers about the impacts of flushing cotton buds down the drain or dropping on the ground when outdoors. Particularly using striking images such as the sea horse holding onto a cotton bud which won a National Geographic photo competition.[97]
Labelling	Feasible. The labelling would need to take place on packs of buds. However, where buds are made openly available for consumers (in hotels, for example), the ability to influence through labelling would be lost.
Voluntary measures	Feasible. Large manufacturers and retailers of cotton buds are already taking voluntary initiatives to switch away from using plastic cotton buds to paper, so voluntary agreements to switch to non-plastic alternatives would seem highly feasible.[98]
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Feasible. Implementing Best Available Techniques (BAT) to require minimum size of screen on inlet works at WWTW (6mm screen may be too large if cotton buds pass through end on, so might not capture all – smaller screens may not be feasible). Any bypass from storm overflows should also be screened. Screens should be automated to reduce maintenance burdens. Aim to capture large number of cotton buds flushed down toilets.
EPR for flushed items	Feasible. As per Setting enhanced technical standards for WWTW and CSOs.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. As with cigarette filters, cotton bud manufacturers could be charged according to the proportion of buds in litter counts – especially for beach clean ups as buds are often flushed.
Sales restrictions / measures for adoption by public authorities	Feasible by means of green procurement approach.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and non-SUP alternatives.
Reduction targets (SUP)	Feasible. As noted above under 'voluntary commitments' reducing the sale/use of plastic cotton bud stems is very feasible, and already occurring to a high extent in some Member States.
Reduction targets (all SU)	Feasible. Reusable alternatives do exist (U-Tips, for example) so reductions targets would be feasible, but some consumers may still demand single use options.[99]

[97] https://www.nationalgeographic.com/photography/proof/2017/09/seahorse-ocean-pollution/

[98] https://www.cottonbudproject.org.uk/news.html

[99] https://utilitytip.com/

Measure	Feasibility and Aims
Ban (of SUP items not all SU)	Feasible. As noted above, switching from plastic cotton bud stems to other materials is very feasible, and already occurring to a high extent in some Member States.
Ban (of all SU items)	Feasible. Alternatives exist.

Table 4.8 Crisp packets / sweet wrappers

Measure	Feasibility and Aims
Information campaigns	Feasible. The aim of such campaigns would be to target on-the-go consumers at point of sale, in order to inform about the potential impacts of littering and provide information on the location of litter bins that could be utilised.
Labelling	Feasible. There may be issues with some very small items, but otherwise, the measures could be readily adopted.
Voluntary measures	Feasible. The aims of any voluntary agreement are not entirely clear at this stage but could cover increasing the collection of littered packets or innovating to reduce the plastic content.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not generally specifically flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. Using a similar method to that mentioned for cigarette filters in Table 4.4.
Sales restrictions / measures for adoption by public authorities	Not feasible. Unlikely to be possible to restrict the sales of crisp packets or sweet wrappers by location.
Consumption levies	Feasible, though in this case, the principle would be more based on cost recovery / demand reduction.
Reduction targets (SUP)	Not feasible. No tried and tested SUNP alternative exists with the same performance characteristics as current laminated plastic / foil packaging (although some companies are seeking to develop non-plastics alternatives, e.g. foil and paper packaging).
Reduction targets (all SU)	Not feasible. No tried and tested MU alternative exists (although some companies are seeking to develop non-plastics alternatives, e.g. foil and paper packaging).Not feasible.
Ban (of SUP items not all SU)	Not feasible. As per reduction targets (SUP).
Ban (of all SU items)	Not feasible. No MU packaging formats exist for these foodstuffs.

Table 4.9 Wet Wipes

Measure	Feasibility and Aims
Information campaigns	Feasible. Aim to inform consumers of the impacts and stop flushing down toilet systems.
Labelling	Feasible. the labelling would be required on packs being sold and, preferably, on individual items where these are individually packaged. The approach to individual labelling would make it far more likely that the label's message would be conveyed irrespective of whether the consumption was through retail or other means.
Voluntary measures	Feasible. There may be the potential for voluntary agreements to be put in place where manufacturers look to reduce the plastic content of wet wipe products.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Moderately feasible. BAT to require minimum size of screen on inlet works at WWTW (6mm screen should be sufficient). Any by-pass from storm overflows should also be screened. Screens should be automated to reduce maintenance burdens. Aim to capture large number of wipes flushed down toilets.
EPR for flushed items	Feasible. As per Setting enhanced technical standards for WWTW and CSOs.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. As with cigarette filters, wet wipe manufacturers could be charged according to the proportion of wipes in litter counts – especially for beach clean ups as these are often flushed.
Sales restrictions / measures for adoption by public authorities	Feasible by means of green procurement policy.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP alternatives.
Reduction targets (SUP)	Feasible. Non-plastic alternatives, cotton wool, was the precursor product to many wet wipes applications today, so is very feasible. There are also MU alternatives to using wet wipes (e.g. washable handkerchiefs, anti-bacterial gels).
Reduction targets (all SU)	Feasible. Alternatives exist.
Ban (of SUP items not all SU)	Feasible. Alternatives exist.
Ban (of all SU items)	Feasible. Alternatives exist.

Table 4.10 Sanitary Towels

Measure	Feasibility and Aims
Information campaigns	Feasible. Aim to inform consumers of the impacts of flushing sanitary items down toilet systems.
Labelling	Feasible: the labelling would be required on packs being sold and, preferably, on individual items where these are individually packaged. The approach to individual labelling would make it far more likely that the label's message would be conveyed, irrespective of whether the consumption was through retail or other means.
Voluntary measures	Feasible. There may be the potential for voluntary agreements to be put in place where manufacturers look to reduce the plastic content of sanitary towel products.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Feasible. BAT to require minimum size of screen on inlet works at WWTW (6mm screen should be sufficient). Any bypass from storm overflows should also be screened. Screens should be automated to reduce maintenance burdens. Aim to capture large number of towels flushed down toilets.
EPR for flushed items	Feasible. As per Setting enhanced technical standards for WWTW and CSOs.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. As with cigarette filters, sanitary towel manufacturers could be charged according to the proportion of towels in litter counts – especially for beach clean ups as these are often flushed.
Sales restrictions / measures for adoption by public authorities	Feasible by means of green procurement approach.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP/MU alternatives.
Reduction targets (SUP)	Feasible. SUNP are not widely available. MU sanitary towels, sanitary pads or menstrual pads are already available.[100]
Reduction targets (all SU)	Feasible. Implies similar switch to MU above.
Ban (of SUP items not all SU)	Not feasible. No common SUNP alternatives are on the market.
Ban (of all SU items)	Not feasible. Assuming some consumers would not switch to MU items.

[100] http://www.cheekywipes.com/cloth-sanitary-pads-kits.html

Table 4.11 Cutlery

Measure	Feasibility and Aims
Information campaigns	Feasible. Campaigns could focus on giving consumers information about the impacts, and also encouraging them to ask to reusable cutlery at local food establishments they frequent. Other aims could target the HoReCa sector itself and provide information to them about alternatives and costs/benefits (particularly corporate social responsibility (CSR)) from reducing reliance on SUP cutlery, or SU use items at all.
Labelling	Only feasible in specific circumstances. The labelling approach would only be effective where purchases were being made of bulk items (or packaged sets). To the extent that much of the consumption is through HoReCa, and free of charge, because the labelling of individual items is not deemed feasible, much of consumption would not be affected.
Voluntary measures	Feasible. Agreements could be put in place in the HoReCa sector to reduce the reliance on SU cutlery in food sale establishments, or from the manufacturers of cutlery to switch to other materials. In addition, voluntary agreements to charge consumers for any SU items used could be adopted.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. Manufacturers could be charged according to the proportion of SUP cutlery found in litter counts (as with the cigarette filter example in Table 4.4).
Sales restrictions / measures for adoption by public authorities	Feasible. Through restricting the sale of SUP (or SUNP) cutlery item for use on-site i.e. single use items would only be available for on-the-go consumption. Moreover, SU items could be restricted through green procurement policy by public authorities.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP alternatives.
Reduction targets (SUP)	Feasible. SUNP/MU alternatives are highly available as are non-plastic items.
Reduction targets (all SU)	Feasible. MU alternatives are highly available.
Ban (of SUP items not all SU)	Feasible. SUNP/MU alternatives are highly available.
Ban (of all SU items)	Feasible. MU alternatives are highly available.

Table 4.12 Straws and Stirrers

Measure	Feasibility and Aims
Information campaigns	Feasible. There are already many campaigns targeting the reduction in use of plastic straws, by providing information about the impacts and alternatives – such as 'the Last Plastic Straw'.[101]
Labelling	Only feasible in specific circumstances. The labelling approach would only be effective where purchases were being made of bulk items (or packaged sets). To the extent that much of the consumption is through HoReCa, and free of charge, because the labelling of individual items is not deemed feasible, much of consumption would not be affected.
Voluntary measures	Feasible. Many companies are already replacing plastics straws with paper alternatives on a voluntary basis.
Specific Requirements on Product Design	Moderately feasible. The aim of any Essential Requirements measure relating to straws would be to seek to innovate packaging design to build-in 'straws' to the pack itself, rather than have a separate disposal straw that could be littered – such as 'Straw Pak'.[102]
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. Manufacturers may be charged in relation to the proportion of SUP straws and stirrers found in litter.
Sales restrictions / measures for adoption by public authorities	Feasible. Through restricting the inclusion of straws with drink-in beverages, i.e. SUP straws would only be available for on-the-go consumption. Moreover, SU items could be restricted through procurement policy by public authorities.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP alternatives.
Reduction targets (SUP)	Feasible. SUNP/MU alternatives are highly available as are non-plastic items e.g. paper straws, wooden stirrers
Reduction targets (all SU)	Feasible. MU alternatives are highly available, and the demand for both straws and stirrers is likely to be derived; in other words, consumers use them because they are made available but they wouldn't request them if not.
Ban (of SUP items not all SU)	Feasible. SUNP/MU alternatives are highly available e.g. paper straws, wooden stirrers.
Ban (of all SU items)	Feasible. MU alternatives are available.

[101] https://thelastplasticstraw.org/

[102] https://ifworlddesignguide.com/entry/163812-straw-pak

Table 4.13 Cups and cup lids

Measure	Feasibility and Aims
Information campaigns	Feasible. Campaign aims would be to help incentivise consumers to use their own reusable cups, such as KeepCups, and for beverage outlets to think about offering their own branded cups and what benefits they might achieve from this, in terms of reduced financial costs or increased CSR.[103]
Labelling	Feasible on SUP cups: the measure might be slightly more difficult for lids, but the labelling on the cup could draw attention also to the need to take responsibility for the lid also. Clearly, where consumers are buying from retail, then the packs of cups / lids would also be suitable for labelling.
Voluntary measures	Feasible. A range of voluntary agreements could be imagined. Firstly, for retailers to offer discounts for consumers bringing their own cups, or to offer reusable cups for sale in all stores, or to stop using single use cups at all. Secondly, manufacturers of cups could set up voluntary agreements to phase out the plastic content of the cups and lids over time.
Specific Requirements on Product Design	Feasible. Some innovation in Essential Requirements might be possible, particularly around integrating sipping lids into the cups rather than having separate items, as shown by a winner of the Ellen MacArthur Foundation's innovation prize – TrioCup.[104]
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles. Although deposits for MU drinks cups might also be implement as separate national measures.
EPR – full cost of litter	Feasible. Manufacturers may be charged in relation to the proportion of SU cups and lids found in litter.
Sales restrictions / measures for adoption by public authorities	Feasible. Through restricting the sale of SU cups and lids for use on-site i.e. single use items would only be available for on-the-go consumption. Moreover, SU items could be restricted through green procurement policy by public authorities.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP alternatives.
Reduction targets (SUP)	Feasible. Reusable alternatives are clearly available, however, currently there is no SUNP alternative without at least a plastic liner that ensures the mechanical strength of the cardboard outer material does not degrade through water infiltration.
Reduction targets (all SU)	Feasible. MU alternatives are available, though demand for on-the-go consumption of beverages is strong, so the extent of any reduction might be limited.

[103] https://uk.keepcup.com/about-us/?country=United%20Kingdom

[104] https://www.ellenmacarthurfoundation.org/news/innovators-win-1-million-to-prevent-ocean-plastics

Measure	Feasibility and Aims
Ban (of SUP items not all SU)	Feasible. Reusable alternatives are clearly available, however, currently there is no SUNP alternative without at least a plastic liner that ensures the mechanical strength of the cardboard outer material does not degrade through water infiltration.
Ban (of all SU items)	Feasible. MU alternatives are available, though demand for on-the-go consumption of beverages is strong, so a ban would result in a large change in consumer behaviour.

Table 4.14 Food containers including fast food

Measure	Feasibility and Aims
Information campaigns	Feasible. The aims of any information campaigns would be to help consumers understand the issue and decide to take their own containers to restaurants and fast food outlets and to help local businesses understand the impacts and alternatives for investing in reusable box schemes (particularly if implemented at the city level).
Labelling	Feasible. Clearly, where consumers are buying from retail, then the packs of containers would also be suitable for labelling.
Voluntary measures	Feasible. Voluntary agreements could target suppliers and users of SUP food containers to switch to SUNP/MU alternatives, and/or for local food establishments to offer discounts for consumers bringing their own containers or setup communal reusable box schemes.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles. Although deposits for MU food containers might also be implement as separate national measures.
EPR – full cost of litter	Feasible. Manufacturers may be charged in relation to the proportion of SUP food containers found in litter.
Sales restrictions / measures for adoption by public authorities	Feasible. Through restricting the sale of SU food containers for use on-site i.e. single use items would only be available for on-the-go consumption. Moreover, SU food containers could be restricted through procurement policy by public authorities.
Consumption levies	Feasible. More likely to lead to substitution (by SUNPs and MU) where SUP items are filled at the point of sale.
Reduction targets (SUP)	Feasible. SUNP/MU alternatives are highly available.
Reduction targets (all SU)	Feasible. MU alternatives are highly available.
Ban (of SUP items not all SU)	Feasible. SUNP/MY alternatives are highly available.
Ban (of all SU items)	Feasible. MU alternatives are highly available.

Table 4.15 Balloons and Balloon Sticks

Measure	Feasibility and Aims
Information campaigns	Feasible. Campaign aims would be to discourage balloon releases and encourage the use of SUNP/MU alternatives to SUP sticks.
Labelling	Feasible on packs of balloons and sticks, unlikely to be feasible for single items (although possible to have labelling that appears on balloons once inflated).
Voluntary measures	Feasible. A range of voluntary agreements could be imagined: eliminating SUP balloon sticks; voluntary information campaigns; seeking to ensure products were not made available at / for mass release events.
Specific Requirements on Product Design	Not feasible. No potential litter reduction design features were found.
Setting enhanced technical standards for WWTW and CSOs	Not relevant, items are not flushed.
EPR for flushed items	Not relevant, items are not flushed.
Implement DRS for beverage containers	Not relevant, only relates to drinks bottles.
EPR – full cost of litter	Feasible. Manufacturers may be charged in relation to the proportion of balloons found in litter.
Sales restrictions / measures for adoption by public authorities	Feasible, in terms of limiting the licensing of mass releases at events, and through general licensing of events. If public authorities purchase balloon sticks, they could seek to procure alternatives to SUPs.
Consumption levies	Feasible. The levy would be set such that a differential existed between SUP and SUNP alternatives.
Reduction targets (SUP)	Feasible for balloon sticks. There are fewer obvious SUNP alternatives to balloons but that does not necessarily prevent implementation of reduction targets.
Reduction targets (all SU)	Feasible. See above.
Ban (of SUP items not all SU)	Feasible for balloon sticks. Less likely to be feasible for balloons given lack of alternatives.
Ban (of all SU items)	Feasible for balloon sticks. Less likely to be feasible for balloons given lack of alternatives.

4.5.5 Product-Measure Matrix

Table 4.16 below shows a summary of the feasibility of the products and measures under consideration. The colour coding is as follows: Feasible = Green; Not feasible = Grey.

Table 4.16 Product-Measure Matrix

Product	Information campaigns	Labelling	Voluntary agreements	Specific Requirements on Product Design	Setting enhanced technical standards for WWTW and CSOs	EPR – for flushed items	DRS for beverage containers	EPR – full cost of litter	Sales restrictions / measures for adoption by public authorities	Consumption levies	Reduction targets (SUP)	Reduction targets (all SU)	Ban (of SUP items)	Ban (of all SU items)
Cigarette filters		Packs												
Drinks bottles												Water + soda only		
Cotton bud sticks		Packs												
Crisp packets														
Sweet wrappers														
Wet wipes		Packs												
Sanitary towels		Packs												
Cutlery		Packs												
Straws		Packs												
Stirrers		Packs												
Drinks cups / lids														
Food containers														

4.6 Items outside of addressed measures

Items outside of the Top Ten commonly found in marine litter are listed below, along with some alternatives – these are briefly discussed to provide some suggestions for further national measures should Member States chose to go over and over those that are in the 'top ten', moreover, as the current top ten items in beach litter counts reduce it might be expected for these items to move up into the top ten when the approach to defining the top ten is repeated in the future:

- Strapping bands for packing goods: alternatives could include metal strapping for heavy loads, or reusable polyester bands with buckles for smaller goods.[105] String could be used for light goods.
- Shotgun cartridges: cartridges with paper cases exist, and have been widely used historically.[106]
- Cigarette lighters: MU cigarette lighters are very common and would make a clear alternative.
- 4/6 pack yokes, six-pack rings: yokes and rings could be dispensed of altogether and packs of 4 to 6 could be packaged in cardboard, as are larger packs.
- Lolly sticks: paper and wood lolly sticks are already readily available and could be used as an alternative to plastic.[107]
- Tobacco pouches / plastic cigarette packaging: there is a question as to whether these items are SU, but they still do appear in beach litter counts so could be targeted. Historically, pipe smokers used tobacco cases or pouches (metal/leather respectively), so MU alternatives are possible to their current plastic counterparts (although potentially not to the same performance characteristics i.e. vapour barriers), although this would need a switch in method of sale to that once seen in old-fashioned tobacconist shops.
- Nappies: reusable baby nappies are already widely used[108] as are washable incontinence pants.[109]

The above shows that there are many SUNP and MU alternatives for the other SUP items that appear in beach litter counts. Policies at the Member State level could also target these items in order to further reduce the amount of SUP litter entering the marine environment.

[105] https://www.theratchetshop.com/ratchet-straps/black-ratchet-straps/250kg-cam-buckles/250kg-cambuckle-2pcs-per-pack-5m.html

[106] https://www.hullcartridge.co.uk/game/cartridges/three-crowns-12

[107] https://www.cdiscount.com/maison/art-de-la-table/100pcs-150mm-batons-en-bois-rond-sucette-fric-gate/f-11790-baq2009786064792.html

[108] https://www.eco-bebe.com/42-couches-lavables-bebe

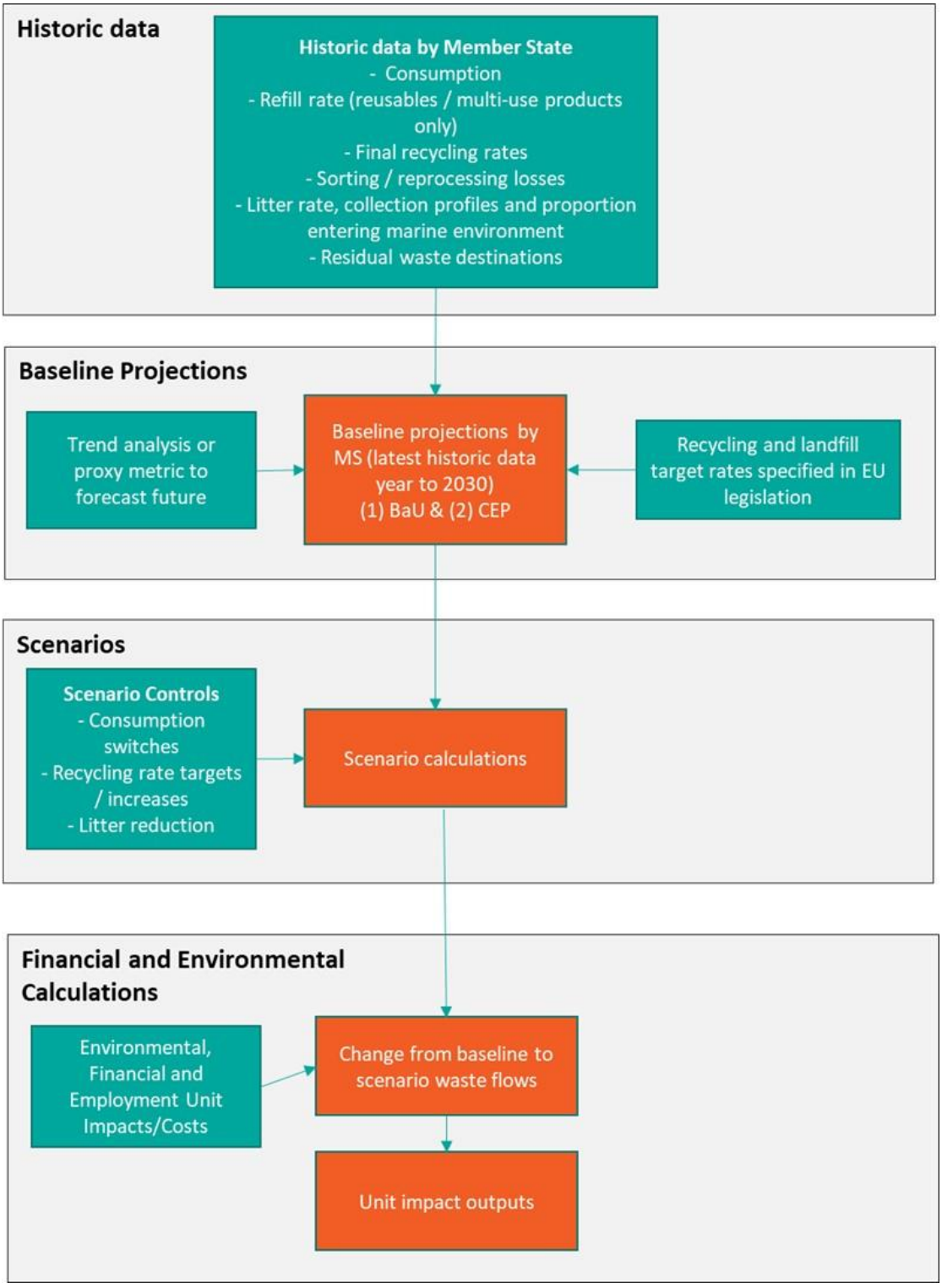
[109] http://www.ageukincontinence.co.uk/incontinence-shop/washable-incontinence-products/washable-incontinence-pants.html

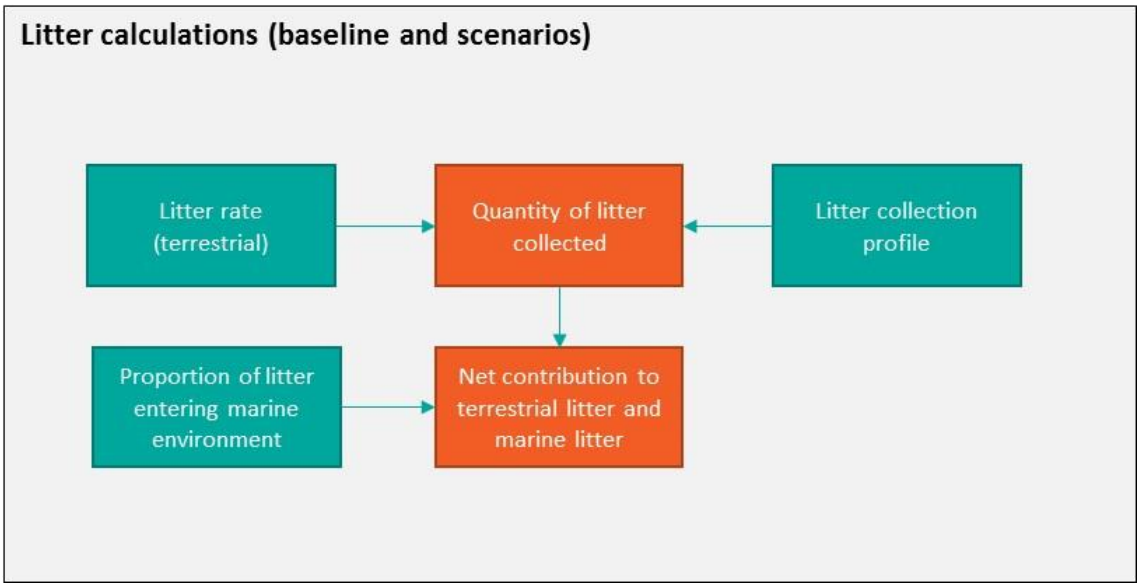
5 Assessment Model

5.1 Model Schematic

The following overview (Figure 5.1) highlights the basic elements of the model used to calculate the financial and environmental impacts of the options. Each element was calculated for each Member State, item and type (i.e. SUP, SUNP and MU).

Figure 5.1 Model Schematic





The model includes the following impact categories:

1. Greenhouse gas emissions. These include emissions from
   a. Manufacturing
   b. Refill Schemes (incl washing)
   c. Recycling
   d. Incineration
   e. Landfill
   f. Transport
2. External costs:
   a. Manufacturing
   b. Refill Schemes
   c. Recycling
   d. Incineration
   e. Landfill
   f. Land based litter
   g. Marine litter
3. Financial costs:
   a. Consumer's Purchases
   b. Retailer Sales
   c. Producer Turnover
   d. Retailer Turnover
   e. Producer Profit
   f. Retailer Profit
   g. Refill Schemes
   h. Consumer's Washing
   i. Recycling
   j. Mixed Waste Treatment
   k. Litter Clean-up
   l. Business Administration
   m. Waste Water Treatment Costs
4. Employment:
   a. Manufacturing

b. Refill Schemes
c. Recycling
d. Mixed Waste Treatment
e. Litter Clean-Up

5.2 Key Model Data Inputs

The following tables summarise some of the key input data for the model outlined in Figure 5.1. Firstly, the current levels of consumption for each item and type are given. In addition, the compound annual growth rate (CAGR) is provided. For some items quantitative data on market size could not be obtained, so a summary qualitative view on the market is given. The full details of these data, including data sources, are given in section 2 of the Annex.

Table 5.1 Consumption and Growth rates

Consumption in 2016, Million units				
Item	**SUP**	**SUNP**	**Multi-Use**	**CAGR[110] (2016-2030)**
Cigarette Filters	522,737	Established: Small Market	N/A	- 3.28%
Plastic Drinks Bottles	71, 651	Glass bottles, aluminium cans, and drinks cartons also have high market shares.	Established: Significant use of MU drinks bottles	1.28%
Cotton Buds	48,888	69,903	Emerging: MU cotton bud sticks are available	-7.92% (SUP) 5.30% (SUNP)
Crisp Packets	16,941	N/A	N/A	2.04%
Sweet Wrappers	27,740	Established: Use of paper sweet wrappers	N/A	1.53%
Wet Wipes	40,374	Cotton wool pad alternatives are currently sold in high volumes.	Cotton flannels are sold at high volumes, but specific reusable wet-wipes kits are currently limited but emerging.	4.34%
Sanitary Pads	21,763	N/A	3,123	4.15%
Cutlery	84,502	8,873	Established: Very significant use of metal and plastic MU cutlery	3.94% (SUP)
Straws	207,112	Established: Significant and growing use of non-plastic alternatives such a paper straws	Established: Some use of MU metal straws, and MU plastic straws	2.77%
Stirrers	215,741	Established: Significant use of wooden stirrers	Established: Significant use of MU alternatives in place of SUP stirrers	3.11%
Drinks Cups	18,723	1,988	Established: Significant and increasing use of MU drinks cups	2.28% (SUP) 2.27% (SUNP)
Drinks Cups Lids	21,574		Established: As per drinks cups	2.47%
Food Containers	26,299	30,405	Established: Significant use of MU food containers	1.53% (SUP) 2.09% (SUNP)

[110] Compound annual growth rate.

Growth forecasts indicate that the consumption of nearly all SUP items are projected to increase out to 2030. The only items for which consumption is expected to decline are cigarette filters (i.e. cigarettes, because of a decline in the prevalence of smoking) and plastic cotton buds (for which there is already a switch to fibre based alternatives).

Following submission of the initial Impact Assessment results, further consumption forecasts were provided by one of the market research company. These, alongside other estimates suggested that there is a clear level of uncertainty in these market projections, particularly for straw and stirrers, but also other items. As no clear alternative data were available, however, the figures presented in Table 5.1 were judged adequate and used in the modelling.

Table 5.2 below shows the current recycling rates as determined through a step-by-step assessment of the parameters of existing waste collection systems, and the physical characteristics of the items in question. The table shows that recycling of these items is very low for most, with the exception of beverage bottles and food containers. The methodology for this is outlined in detail in section 3 of the Annex.

Table 5.2 Baseline recycling assumptions for specific single use items.

Item	Item class	Final Recycling Rate
Cigarette filters	SUP	0%
	SUNP	0%
Drinks bottles, Caps and lids	SUP	52%
	SUNP	61%
Cotton bud sticks	SUP	0%
	SUNP	0%
Crisps packets / sweets wrappers	SUP	0%
	SUNP	9%
Wet-wipes	SUP	0%
	SUNP	39%
Sanitary towels and tampons	SUP	0%
	SUNP	-
Cutlery	SUP	1%
	SUNP	10%
Straws	SUP	0.6%
	SUNP	10%
Stirrers	SUP	0%
	SUNP	10%
Drinks cups and cup lids	SUP	1.5%
	SUNP	10%
Food containers including fast food packaging	SUP	5%
	SUNP	10%

Finally, the littering rates assumed in the model are presented below. These indicate that rates vary by item. The basis for the figures is set out in section 3 of the Annex.

Table 5.3 Littering rates of different items

Item	kg/capita littered	Tonnes littered	Consumption, EU 28, tonnes	SUP littering rate	SUNP littering rate	MU littering rate	Found in Marine Environment (tonnes)
Cigarette filters	0.014	2,416	7,531	32.1%	32.1%	-	121
Drinks bottles	0.37	187,388	2,703,641	6.9%	6.9%	0.0%	9,369
Cotton buds	0.00	1,337	9,547	14.0%	14.0%	0.0%	67
Crisp packets	0.02	4,370	117,045	3.7%	3.7%	-	219
Sweet wrappers	0.00	4,370	138,965	3.1%	3.1%	-	219
Wet wipes	0.00	14,793	47,720	31.0%	31.0%	0.0%	740
Sanitary towels	0.00	25,767	122,698	21.0%	21.0%	0.1%	1,288
Cutlery	0.00	959	206,605	0.46%	0.5%	0.0%	48
Straws	0.005	2,771	88,450	3.1%	3.1%	0.0%	139
Stirrers	0.000	213	139,252	0.2%	0.2%	0.0%	11
Drinks cups and lids	0.16	39,865	302,417	13.2%	13.2%	0.0%	1,993
Food containers	0.11	27,820	544,382	5.1%	5.1%	0.0%	1,391

For the single use plastic items considered here, the total tonnage of items dropped as litter is estimated to be around 270 thousand tonnes, while the tonnage of items flushed sums to around 42 thousand tonnes. Of a total of 312,070 tonnes of items, the amount then entering the marine environment is calculated to be 15,604 tonnes. This takes into account the proportion of “flushables” removed during waste water treatment.

All other detailed data and key assumptions are set out in Annexes 2 to 4, and include:

- Item weights and compositions;
- Unit costs;
- Impacts from waste management;
- Impacts from manufacture and washing;
- Costs related to retail route to sale;

- Costs related to HoReCa route to sale;
- Costs from washing of multi-use items;
- Administrative costs for businesses;
- Costs of municipal waste management;
- Installing screens at discharge points in waste water treatment systems;
- Approach to valuing external impacts:
  - the relationship between littered tonnages and litter prevalence;
  - the types of impacts thought likely to be amenable to valuation in monetary terms;
  - the impact of litter on land in the EU, and how this might be valued;
  - the problem of litter in European rivers;
  - litter on European beaches and the valuation that can be placed on this;
  - impacts on marine fauna;
  - impacts on specific high value ecosystems including coral reefs and seagrass beds; and
  - the impacts on European beach tourism.

5.3 Assumptions

This section sets out and explains the key assumptions that were made to model the future effects of the various options being assessed. The figures were estimated by the project team based upon the experience gained through this study, discussions with stakeholders in the workshops and any relevant literature.

A x% reduction indicates a reduction of x% from the baseline figure, whereas a figure of 'x percentage points' indicates an absolute reduction in the rate for consumption switches, and the absolute rate for the fates (for example, if the baseline rate were 50% a 10% increase would mean 55% whereas a 10 percentage point increase would mean 60%).

Table 5.4 Modelling Assumptions

Option	Modelling Assumptions
Information campaigns	Without broader policy changes, information campaigns might be limited in their effect. The segment of society which may be most amenable to changing their behaviour may be that with environmentally positive attitudes, but they may also already have altered their own behaviour. The following changes are modelled under this option for all items: ■ Littering / flushing rate decreases by 2%, 5% and 10% by 2020, 2025 and 2030 respectively; ■ Littering collection rates remain at baseline level; ■ Recycling rates remain at baseline levels; and ■ Consumption switches from SUP to SUNP and MU by 5 percentage points each by 2030 (where alternatives already exist e.g. all except, MU cigarette filters, SUNP sanitary towels, SUNP drinks cups and SUNP/MU crisp packets/sweet wrappers), and by 2 percentage points for MU sanitary towels only as rates are currently higher than the other items.
Voluntary agreements	VAs are most effective where there is a back-stop of policy intervention if agreements are not effective in delivering change: arguably, VAs are more likely to be effective where they align with the commercial and reputational outlook of businesses, for example, where non-plastic alternatives are already in place, and the measures taken result in limited, or negative costs, and improved public image. The latter could be said for some items such as cotton buds, straws, stirrers and cutlery, where companies are already putting such agreements in place, for example

Option	Modelling Assumptions
	Johnson and Johnson.[111] The HoReCa sector may also see the benefit from offering reusable food containers rather than having to spend money on single use packaging. The following changes are modelled under this option: ■ Littering / flushing rate decreases by 2%, 5% and 10% by 2020, 2025 and 2030 respectively; ■ Litter collection rate increases by 5% for all non-flushed items – they magnitude of the change is less than the litter reduction rate as increased collection implies a change in cost rather than just behaviour, which would limit the change; ■ Recycling rates remain at baseline levels; ■ Consumption switches from SUP to SUNP by 10 percentage points each for cotton buds, straws, stirrers, food containers and cutlery (items were producers are more likely to target campaigns, as already existing public support); and ■ Consumption switches from SUP to MU by 5 percentage points each for straws, stirrers, cutlery, drinks bottles, drinks cups and food containers (items where consumers can make switches to MU items from well understood easy to use alternatives).
Essential Requirements on Product Design	This measure is modelled focusing on the specific items being targeted. The key changes modelled are: ■ The unit weight of plastic bottles are increase by 2% in order to estimate the increased material requirement from the leashes. Material requirements for integrated lids or straws may not change, and currently there are few examples so no change in unit weight is modelled; ■ Littering rates reduce by 5% by 2030 for all items assuming that some consumers stop littering; ■ Littering collection rates increase by 5% by 2030 for plastic bottles to represent the increased collection of the caps themselves, by 25% for cup lids, assuming there are limits to how many consumers may purchase integrated lid versions, and by 50% for straws assuming there are market limitations where straws are not sold with beverages; ■ Recycling rates for plastic bottles increase by 1% to represent minor increases in recycling of caps which would also be collected alongside bottles, other items remain at baseline levels; and ■ Item types remain at baseline consumption levels.
BAT for WWTW[112] and CSOs[113]	This measure would affect a limited range of items that were flushed down drains, e.g. cotton buds, wet wipes and sanitary towels, and also cigarette filters that are washed down surface water drains in periods of rainfall. It was assumed that this measure would target BAT for the water treatment industry, and additional screening would be implemented to reduce leakage into the environment. The following changes are modelled under this option for all items: ■ Flushables collection rate increases by 50% for sanitary towels and wet-wipes and 25% for cotton buds by 2030 (the latter is deemed lower as cotton buds could still passed through 3mm screens end on).
EPR for flushed items	As per option above but costs fall on producers, not water companies.

[111] http://www.telegraph.co.uk/science/2017/02/13/johnson-johnson-ditch-plastic-cotton-buds-save-oceans/

[112] Waste water treatment works.

[113] Combined sewer overflows.

Option	Modelling Assumptions
EPR – full cost coverage of litter collections	In terms of the modelling for this analysis, we take the estimated total contribution of the top ten items in terrestrial litter and beach litter into account. For floor litter, by weight, this is estimated at around 15%. Litter surveys do not use categories with enough disaggregation to be able to identify the contribution of all items modelled in this study, however, some further disaggregation is available. To model this measure the following assumption has been made. In order to half the amount of litter currently not collected, the unit cost of litter clean-ups would have to double. The following changes are modelled under this option for all non-flushable items: ■ Litter collection rate increases to a level equivalent to capturing 50% of the remaining uncollected litter (e.g. Litter Rate = Litter Rate + (100% – Litter Rate) x 50%) by 2030 (10% by 2020 and 30% by 2025). ■ Litter clean-up costs double.
Sales restrictions (inc. events, GPP)	The magnitude of the effect from this measure would depend upon the proportion of the market which serviced events or public sector institutions, as well as the amount of drinks and food items sold for consumption on-site versus on-the-go. The scale of the public sector can be significant in some countries and is not likely to be trivial in any. The approach taken is: ■ Consumption switches from SUP to MU by 25% each for straws, stirrers, cutlery, drinks bottles and drinks cups by 2030; and ■ An overall reduction in consumption of 25% of straws and stirrers by 2020. No change to littering or recycling rates are modelled.
Implement DRS for beverage containers	Three primary effects are modelled due to implementation of a DRS. Firstly, recycling rates are assumed to increase to 90%.[114] Secondly, the initial litter rate will decrease as consumers return the containers to the DRS Finally, the litter collection rate will increase as some littered bottles will be picked up and returned to the DRS to claim the deposit value. It is assumed that DRS are implemented over the period to 2025. The following changes are therefore modelled under this measure for plastic beverage bottles only: ■ Recycling rate increases to 90%; ■ Litter rate reduces to 80% of the baseline level; and ■ Litter collection rate increases by 50%. The overall outcome regarding litter is that littering is reduced by 90% compared to baseline levels, with only 10% of what was littered still remaining in the terrestrial or entering the marine environment.
Consumption levies	The measure was modelled by assuming a levy at the point of consumption was put in place for these items: ■ Cutlery ■ Straws ■ Stirrers ■ Cotton buds ■ Drinks cups / lids ■ Drinks bottles ■ Food containers To simplify the approach to modelling of this measure, it was assumed that a similar charge to those implemented on carrier bags might be

[114] http://infinitum.no/english/the-deposit-system

Option	Modelling Assumptions
	implemented on the items considered here. The level of the charge is up to €0.10 in many Member States, so this value is added for items which are currently given away at the point of sale for free, or are integrated into products with a low unit cost. For the items sold as integral packaging to the food/drink product being sold (drinks cups, drinks bottles and food containers) the consumer pays for the overall cost of the product + packaging, and so the levy would need to be higher to have a similar effect (as economic theory suggest it is the relative price that determines change in behaviour, whereas carrier bags are considered zero cost as they were given away free by shops, a €0.10 charge on an item costing €1-5 is only a fractional increase) – consequently, a more significant charge of €0.25 was modelled. The price-demand relationship has also to be determined to assess the effects of the various charges on demand. Unlike the carrier bag impact assessment, there was no country wide example to base the likely effects upon (e.g. the Irish carrier bag levy). It has been assumed that for those items which are currently given away for free and not integrated into the purchased product (cutlery, straws and stirrers), the price effect is in line with that for carrier bags, i.e. an 80% reduction for a €0.10 charge – as stated above, the, assumed current zero cost of the item implies a significant relative increase in price so a significant decrease in demand would be expected. For and cotton buds, the level of the levy would be lower (a €0.01 charge would double the cost of the product, for example), but given the upcoming availability of alternative non-plastic alternatives, it is assumed that the levy would result in a 95% reduction in consumption of SUNP cotton buds is achieved. For drinks cups, evidence from a study in Wales suggests that consumers take the price increase relative to the product price into account, and so the demand reduction is less significant.[115] We have used the figure from this study to model the reduction of 30% consumption of SUP drinks cups, drinks bottles and food containers in response to a €0.25 charge. The nature of the alternative could either be MU if the consumer decides to switch to a reusable product to avoid the levy, or SUNP if the retailers switch material use, also to avoid consumers having to pay the levy (which would reduce demand for their products). The timing of introduction of the levies is assumed to be the following, giving additional time for some items to develop alternatives and behaviours to adapt: ■ Cutlery – 2020 ■ Straws – 2020 ■ Stirrers – 2020 ■ Cotton buds – 2020 ■ Drinks bottles – 2025 ■ Food containers – 2025 ■ Drinks cups / lids – 2025 The % reduction of SUP relates to a consumption switch to SUNP and MU, these vary depending on item type (see section 'A2.3.3 Consumption switches under the measures' in the Annex). In addition, for straws and stirrers, the total level of consumption of those items reduced by 50% as consumers decide they no longer need the items at all. No change to littering or recycling rates are modelled.

[115] Eunomia contributed to the report 'Disposable Packaging: Coffee Cups' published by the House of Commons' Environmental Audit Committee, December 2017.

Option	Modelling Assumptions
Reduction targets (SUP)	Reduction targets are set differently depending on the existence of SUNP alternatives (see section 'A2.3.3 Consumption switches under the measures' in the Annex). The % reduction of SUP relates to a consumption switch to SUNP and MU, these vary depending on item type (see below) (where MU alternatives are available). In addition, for straws and stirrers, the total level of consumption of those items is reduced by 50% as consumers decide they no longer need the items at all. No change to littering or recycling rates are modelled.
Reduction targets (all SU)	Reduction targets are set differently depending on the existence of MU alternatives (see section 'A2.3.3 Consumption switches under the measures' in the Annex). In addition, for straws and stirrers, the total level of consumption of those items is reduced by 50% as consumers decide they no longer need the items at all. No change to littering or recycling rates are modelled.
Ban (of SUP items)	The approach to modelling bans is to assumed a 100% reduction of the consumption of SUP items, where MU alternatives exist that could be adopted by the whole market (some items, such as sanitary are excluded as it is assumed not all users would shift to MU). The period for the reduction is set between 2 and 12 years depending on item. This relates to the current availability of alternatives, time needed for behaviour change (i.e. a shift to an unfamiliar approach) and the likely time innovation might need to take to deliver new approaches. ■ Cutlery – 2020 ■ Straws – 2020 ■ Stirrers – 2020 ■ Cotton buds – 2020 ■ Food containers – 2025 ■ Drinks bottles – 2030 ■ Wet wipes – 2030 ■ Drinks cups / lids – 2025 The % reduction of SUP relates to a consumption switch to SUNP and MU, these vary depending on item type (see section 'A2.3.3 Consumption switches under the measures' in the Annex) (where MU alternatives are available). In addition, for straws and stirrers, the total level of consumption of those items is reduced by 50% as consumers decide they no longer need the items at all. No change to littering or recycling rates are modelled.
Ban (of all SU items)	As above, but a complete switch from SUP and SUNP to MU by the given years.

5.4 Limitations

The model has the following limitations:

- Market data were not available for all countries so had to be estimated using GDP per purchasing power parity (PPP).
- Assumptions regarding the fates of the items through the waste management system were averaged across the EU in some cases, rather than being country specific. This may reduce the accuracy of the results.
- Forecasts are based on expert judgement as pilot studies / trials / country wide examples or evaluations are not available for these products-measures.
- Input data is of variable quality.

- The approach to assessing welfare costs is straightforward and not fully comprehensive, given the number items needing to be assessed.
- Evidence and impacts on marine wildlife are still being understood, and so the impacts are uncertain, and potentially understated.
- It is not possible to value water and land use with any certainty due to the lack of scientific literature, and so these impacts cannot be compared against the rest of the costs and benefits in monetary terms.

These limitations suggest that there is some margin of error in the results, and further research would be needed to confirm the level of accuracy. The model results are presented in to a level of detail (2 d.p. for example) though this does not mean the figures are precisely accurate, the margin of error is not possible to calculate, however, the figures should be viewed as indicative. However, this research has made a significant step forwards in understanding the impacts associated with the mis-management of SUP items.

6 Impacts of the options

The assessment of impacts has considered each of the measures deemed to be feasible in Table 4.16. These have been assessed against a Baseline Option, defined as Option 1 in the Commission's Impact Assessment. Section 6.2 sets out the main changes associated with the Baseline options relative to a 'no change' option, to understand the effects within the Baseline itself. Section 6.2 presents the Options assessed. The remaining sections present the assessment results against the baseline. The final section (6.7) provides an overall comparison of the quantified impacts of the Options.

The assessment considers the following impacts outlined in Table 6.1 (Env. = Environmental, Econ. = Economic, Soc. = Social).

Table 6.1 Summary of Impacts Assessed in the Analysis

Type	Specific Impact	Description
Env.	Reduction in marine plastics, kt	The absolute reduction in plastics entering the marine environment by weight.
Env.	Marine litter reduction - % of SUP by count	The relative reduction in SUP entering the marine environment by number of items reduced.
Env.	Change in GHGs, million tonnes	The change in GHG emissions from production, washing and waste management.
Env.	Change in external costs (total), € million	The value of external costs arising from emissions of GHGs and other air pollutants from production, washing and waste management, as well as the external cost of littering on land and plastics entering the marine environment.
Env.	Change in manufacturing related land use, km2	The change in land use associated with the manufacture of SUP, SUNP and MU items. This is reported separately as it cannot be valued as an external cost.
Env.	Change in material demand, kt	The total change in material demand, as a measure of resource efficiency.
Econ.	Change in consumer costs, € million	The change in the value of sales of the items to the consumer.
Econ.	Change in retailers turnover, € million	The change in the turnover of retailers selling SUP, SUNP and MU items.
Econ.	Change in producer turnover, € million	The change in the turnover of producers manufacturing SUP, SUNP and MU items.
Econ.	Business compliance costs, € million	The additional costs associated with, for example, complying with the need to provide annual data returns on # items sold on an annual basis.
Econ.	Information costs, € million	Any costs associated with running information campaigns.
Econ.	Commercial washing and refill scheme costs, € million	The costs associated with running commercial refill schemes and washing MU items.
Econ.	Change in waste management costs, € million	The costs associated with the management of items when they become waste, including, collection, recycling, mixed waste treatment/disposal, litter collections or WWTW.
Econ.	Change in employment, Thousand FTEs	The change in employment from the above-mentioned activities.

Type	Specific Impact	Description
Econ.	Impact on SMEs	Any specific impacts on SMEs compared to the business sector as a whole.
Soc.	Change in external costs (litter), € million	The external costs of litter include the disamenity value people place on litter in the environment.
Soc.	Impacts on crime and the third sector	Any impacts related to social benefits such as on crime or the third (charity) sector.

6.2 Changes in the Baseline

First, the key changes which are assumed to occur under the Baseline between 2018 and 2030 are presented in order to understand the situation against which the options are being assessed. Table 6.2 shows the change in the share of the market which is assumed to take place, relative to the 'no change' situation, under the Baseline. The main changes relate to national policies regarding tackling cotton buds in France and Italy, and cutlery / drinks cups in France.

Table 6.2 Change in Consumption of Top Ten Items under the Baseline (expressed in change in market share over period from 2018 to 2030 relative to 'no change')

Item	SUP	SUNP	MU
Cigarette filters	0%	0%	0%
Drinks bottles	0%	0%	0%
Cotton buds	-24%	25%	-1%
Crisp packets / sweet wrappers	0%	0%	0%
Wet wipes	0%	0%	0%
Sanitary towels	0%	0%	0%
Cutlery	5%	-3%	-2%
Straws	0%	0%	0%
Stirrers	0%	0%	0%
Drinks cups and lids	1%	0%	-1%
Food containers	-2%	2%	0%

Table 6.3 shows the main changes in the way the items are managed under the Baseline. The Baseline assumes relatively minimal changes in littering behaviour, and reflects the fact that the main change likely to occur as a result of the Baseline policies is a shift away from landfill due to the landfill reduction target in 2035. Because many of the items are so difficult to recycle (because of their small size), for many items the principle shift in the Baseline is away from landfill and into incineration. For some items, such as drinks bottles and food containers, the increase in the packaging recycling targets, as well as the requirement for recyclability, lead to increases in recycling. Some reductions in littering are also seen due to Baseline policies.

Table 6.3 Change in Waste Management Routes under the Baseline (2018 to 2030)

Item	Recycling	Incineration	Landfill	Litter - remains in terrestrial	Litter - remains in marine
Cigarette filters	0.0%	30%	-29%	-0.37%	-0.37%
Drinks bottles	9.0%	-4%	-5%	-0.05%	-0.05%
Cotton buds	-0.4%	21%	-20%	-0.12%	-0.12%
Crisp packets / sweet wrappers	0.0%	35%	-35%	-0.06%	-0.06%
Wet wipes	0.0%	28%	-28%	-0.05%	-0.05%
Sanitary towels	0.0%	23%	-23%	-0.27%	-0.27%
Cutlery	0.0%	20%	-20%	-0.18%	-0.18%
Straws	4.7%	18%	-22%	0.00%	0.00%
Stirrers	4.8%	17%	-22%	-0.02%	-0.02%
Drinks cups and lids	-0.3%	19%	-19%	0.00%	0.00%
Food containers	4.7%	17%	-22%	-0.10%	-0.10%

6.3 Option Definition

The initial results of the analysis were then considered as the basis for elaborating four different Options for the impact assessment. Each Option consists of measures to be implemented for each specific item and is assessed for its effects relative to the Baseline (Option 1 in the Commission's IA). The Options move to progressively more ambitious measures – in terms of the impact they have on SUPs entering the marine environment – as one moves through these options, these being:

- Option 2a low impact
- Option 2b medium impact
- Option 2c medium-high impact
- Option 2d highest impact

The choice of measures under each option are indicated in Table 6.4 below. The lettering in the cells indicates the Option for which the measure is chosen. In some cases, more than one measure is included under an Option, and for some measures, the measure appears under more than one Option. Information campaigns and voluntary actions are included in Option 2a for all items, but are also included in all other Options, other than where a much more impactful measure is being proposed for a given item, which effectively renders the information campaigns and voluntary actions redundant.

Balloons and balloon sticks have not been modelled in the IA: the measures regarding balloons would be expected to be similar as for some items, such as crisp packets, where we have assumed no clear substitution possibilities, whilst the impact related to balloon sticks might be expected to follow, broadly, that related to cotton buds. As can be seen in the tables below, the measures as applied to cotton buds and crisp wrappers are not the interventions that drive the costs and benefits under the IA.

Table 6.4 Measures included in the Options 2a to 2d.

Item	Information campaigns	Voluntary action	Label	Best practices for WWTW	EPR ~ cost of litter	DRS for beverage containers	Consumption levies	Product Design	Reduction targets			Ban (of SUP items)
									25% by 2030	30% by 2025 50% by 2030	50% by 2025 80% by 2030	
Cigarette filters	a,b,c,d	a,b,c,d	d		b/c					d		
Drinks bottles	a,b,c,d	a,b,c,d			b/c	d		b/c (caps)				
Cotton bud sticks	a,b,c,d	a,b,c,d	a									b/c/d
Crisp packets	a,b,c,d	a,b,c,d			b/c/d							
Wet wipes	a,b,c,d	a,b,c,d	a	d	b					c		
Sanitary towels	a,b,c,d	a,b,c,d	a		b/c				d			
Cutlery	a,b,c,d	a,b,c,d			b					b		c/d
Straws	a,b,c,d	a,b,c,d			b					b		c/d
Stirrers	a,b,c,d	a,b,c,d			b					b		c/d
Drinks cups & lids	a,b,c,d	a,b,c,d			b/c					b/c	d	
Food containers	a,b,c,d	a,b,c,d			b/c					b/c	d	
Balloons	a,b,c,d	a,b,c,d	a/b/c/d		b/c/d							
Balloon sticks	a,b,c,d	a,b,c,d	a		b/c							b/c/d

Note: The information campaigns / voluntary actions are assumed to be in place for all Options: they are not always explicitly modelled (clearly, if a ban is part of the Option, this would make voluntary actions redundant)

6.4 Model Outputs

The summary impacts of the Options are presented in Tabular form in Table 6.5 and Table 6.6 below before we discuss them in the following sections. More detailed results for Options 2a, 2b, 2c and 2d, by item, are given in section 5 of the Annex. All impacts are measured relative to the Baseline (Option 1 in the Commission's IA).

The Tables indicate the changes in environmental and economic parameters. Of particular interest is the fact that the environment benefits are far greater than the total losses in sales to producers. The losses in sales to producers are somewhat lower than the reduction in sales to retailers, which is entirely to be expected as the latter is simply a reflection of the former, and retailers sell products at a mark-up. These two figures for sales reductions should be seen neither as additive, nor as, strictly speaking, costs, in the sense of a loss to the economy. The loss might rather be approximated by the loss in GVA associated with retail sales, taking into account the multiplier effects. However, specific GVA data for the items in question was not available. Employment impacts are generally positive when strong policies lead to increases in the implementation of refillable take-away box schemes, as they require reasonably significant numbers of staff to operate them, in relation to collection and washing. These offset reductions in staffing at manufacturing related to decreased turnover. However, when the switch from SUP to MU is not as strong, manufacturing losses outweigh any gains and the net position is a reduction in employment.

Table 6.5 Model Outputs (2030) – Option Comparison, Relative to Baseline, Environmental Impacts

Item	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight	Marine litter reduction - % of SUP by count	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Option 2a	-2.75	-1,060	-18.5%	-15.5%	-1.28	-€ 7,116	-€ 112	-€ 7,228	12.49	-97
Option 2b	-4.45	-3,433	-30.0%	-50.2%	-2.02	-€ 9,477	-€ 127	-€ 9,605	3.06	-444
Option 2c	-4.85	-3,817	-32.6%	-55.8%	-2.63	-€ 10,955	-€ 162	-€ 11,117	134.86	-479
Option 2d	-12.07	-5,095	-81.2%	-74.5%	-3.97	-€ 30,868	-€ 297	-€ 31,165	26.70	-786

Table 6.6 Model Outputs (2030) – Option Comparison, Relative to Baseline, Financial Impacts

Item	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Change in producer turnover (Total), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Option 2a	-€ 3,682	-€ 3,689	-€ 3,130	€ 1,253	€ 33	-€ 1,844	€ 0	€ 714	€ 338	€ 30	-3.8
Option 2b	-€ 5,071	-€ 5,071	-€ 5,645	€ 2,976	€ 134	-€ 2,535	€ 0	€ 714	€ 1,081	€ 445	3.8
Option 2c	-€ 6,457	-€ 6,457	-€ 8,468	€ 5,097	€ 142	-€ 3,229	€ 70	€ 714	€ 1,315	€ 511	4.0
Option 2d	-€ 10,043	-€ 10,123	-€ 11,679	€ 6,345	€ 272	-€ 5,062	€ 276	€ 714	€ 1,823	€ 9,175	5.0*

* Note, following submission of the results to the Regulatory Scrutiny Board, additional DRS related jobs were added to the modelling, and are presented in the 2c+ results in section 6.4.2 – the additional jobs are in the order of 22 thousand FTEs.

6.4.2 Results from Scenario 2c+

As discussed above, an additional scenario was developed during the impact assessment. The modelled results of this scenario are compared against the initial four scenarios in Table 6.7 below.

Table 6.7 Summary of model analysis per option

	Option				
	2a	2b	2c	2c+	2d
Marine litter by count (as % of SUP Top 10)	-16%	-50%	-56%	-53%[1]	-74%
Marine Litter, tonnes	-2,750	-4,450	-4,850	-9,190	-12,070
Change in GHG, million tonnes	-1.28	-2.02	-2.63	-3.42	-3.97
External Costs, € billion	-7.1	-9.5	-11.1	-23.2	-30.9
Savings for consumers, € billion	3.7	5.1	6.5	6.6[2]	10.0
Impact on producer turnover, € billion	-1.8	-2.5	-3.2	-3.8	-5.0
Information campaign costs, € million	714	698	596	596	596
Business compliance, commercial washing & refill scheme costs, € million	338	1081	1385	1763	2099
Waste management costs, € million	30	445	511	783	9175
Employment, 000 FTE	-3.8	3.8	4.0	29.3	27.8[3]
Feasibility	**High**	**Med**	**Med**	**Med**	**Low**
Ensure Internal Market	**-**	**+**	**++**	**++**	**++**

Notes:

1. *The reduction in marine litter by count is lower under 2c+ as the wet wipes reduction target has been removed under this option. By count, fewer wet wipes are consequently removed than additional beverage bottles from implementation of a DRS, so the net position is a lowering of the proportion compared to 2c. In tonnage terms, however, the reductions are significantly greater due to the higher reduced mass of plastic bottles ending up as marine litter.*
2. *Under the revised calculations for the new option, 2c+, €1bn of unredeemed deposits from DRS is accounted for under savings for consumers, whereas under the reporting for 2d in the initial results presented in the main report it is accounted for under the waste management costs category – the accounting approach was revised during the review process to better reflect he apportionment of costs across different actors.*
3. *Corrected from 5,000 FTEs, as the initial figures were missing DRS related employment impacts. The effect of the correction is an increase is employment under 2d.*

6.5 Environmental impacts

Option 2a consists primarily of measures for information campaigns and voluntary actions, as well as mandatory labelling on flushable items. The impacts on reducing marine litter are relatively slight. The majority of the change in marine litter – as measured by weight – comes from the impact on SUP bottles (this is also the case for most of the other Options).

In relation to greenhouse gases, the reduction in use of items, and the switch to materials with lower embodied fossil carbon content, reduces GHG emissions. Again, the largest impact relates to the SUP bottles. In terms of monetised environmental impacts, although the LCA related impacts are significant, the litter-related externalities are much higher. Together, the impact of these amount to some €7.2 billion of savings under Option 2a.

The land-use impacts are show that land-take increases: this is the consequence of the assumed switch from SUP flushables to cotton-based alternatives, and the switch – for cotton buds – away from plastic sticks to natural fibre-based ones. The same type of switch accounts for the increased land-take from the switch from SUP food trays to fibre based ones. Even so, the net change in land-take is a relatively small 12.5km^2 for the whole Option. There is a change in material use of 97 thousand tonnes.

Option 2b introduces – for all items – the use of producer funding to support improved litter clean-up. The option also includes reduction targets for cutlery, straws, stirrers, drinks cups and food containers, a ban on SUP cotton buds, and the tethering of lids to SUP bottles (as an eco-design measure). The reduction in SUPs entering the marine environment increases, but the related reduction in external costs of littering are lower than under Option 2a because of the way in which these are achieved (mainly through reducing the use of SUP cups and lids, and food containers, as opposed to SUP bottles – these have different substitution profiles). In addition, the increase in land-take is lower than for Option 2a as the shift to MU flushable items which occurs under Option 2a does not take place in Option 2b, since the flushable items are subject only to measures related to recovering the cost of litter clean-up.

Option 2c generates a further improvement in all parameters except for the issue of land-take: under Option 2c, a target for reducing SUP flushable wet-wipes is introduced, occasioning a switch to cotton based alternatives, which generate an increase in land take. Indeed, the increase in land-take is highest for Option 2c because of the effects of this switch. Apart from this measure and impact, the only change relative to Option 2b is the introduction of a ban, instead of a reduction target for cutlery, straws and stirrers. This gives rise to an increase in the extent of switching, but in tonnage terms, these items account for a relatively small proportion of the total constituted by the items. The increase in litter avoidance is greater when expressed in terms of item count.

Option 2d introduces much more significant reductions in marine litter, and associated benefits. The main changes are related to the introduction of a DRS on SUP bottles (it is assumed that there would be other beverage containers included, but the analysis relates to the plastic containers only), the implementation of technical standards for WWTW and CSOs to deal with wet-wipes, the reduction target for sanitary towels, the reduction target for SUP cigarette filters, and the

higher reduction targets for drinks cups and lids, and food containers. The deposit refund system leads to significant additional environmental benefits. Of all the measures considered under all Options this has the greatest impact. The targets on food containers and cigarette filters, which lead to increases in use of fibre based materials, lead to increases in land-take, though this is not as great as in Option 2c (where the effect is on wet-wipes). Otherwise, the impacts are generally experienced as an improvement in impact across the board.

Option 2d prevents 81% of the weight of the SUP marine litter constituted by these items. It also delivers 4 million tonnes of GHG reduction per annum in 2030 and almost €31 billion of external benefits, mainly related to avoided impacts associated with terrestrial and marine litter. There is an increase in the land-take implied by the life-cycle impacts, but this is relatively small at 27km^2 of land.

6.6 Economic impacts

The economic impacts presented in Table 6.6 are discussed in more detail below, but in respect of the overall impact of the different options, the following comments are made:

- Under the different Options, as might be expected, the change in sales for producers of SUP items decreases as the strength of the measures increase (moving from Option 2a to 2d); whilst sales of SUNPs and MU items increase
- There is a net loss to producers as a whole ranging from €1.8 billion in Option 2a to €5.0 billion in Option 2d.
- There is also a downstream loss in sales for retailers ranging from €3.7 billion under Option 2a to €10.1 billion in Option 2d.
- Note that it would be wrong to consider the loss in sales by retailers as additive to the loss in sales by producers. The two figures reflect the same type of change, and would overstate the full economic consequences of the changes – note as mentioned above, the retailer turnover is higher reflecting the mark-up in sales over and above production costs;
- Consumers generally make savings (the change in costs is negative), these ranging from €3.7 billion in Option 2a to €10 billion in Option 2d. In essence, if consumers choose to spend this elsewhere in the economy, so the loss in sales revenue to producers would be expected to be offset by an increase in activity in other sectors of the economy (reflecting the shift in the consumer spend) – which is likely to include an increase in spending on other products provided by retailers and the HoReCa sector.
- Business compliance costs are estimated to be close to zero under Options 2a and 2b (other than what is calculated separately for the costs of information provision, or for what is noted as waste management costs). The compliance costs increase as more businesses are required to report, for example, information related to the reduction in use of SUPs, which we assume to be a corollary of these measures in Options 2c and 2d.
- The waste management costs include the level of spend on activities related to EPR, additional waste water treatment costs, and implementation of deposit refunds, as well as managing changing flows of material under the different Options. The measure leading to the greatest change in cost, is the implementation of a requirement to install improved technology at WWTWs in Option 2d. Because the measure is included in the Option only to address wet wipes, this high cost may be considered disproportionate.
- Moving from Option 2a to Option 2d, the employment effects – measured only in terms of a microeconomic assessment (i.e. a sector specific not macro

economic) – show increases in numbers employed as the Options change. The increased employment relates in part to the assumed existence of, for example, take back and washing schemes for food containers and cups under the Options including the reduced use of SUPs, and increased resort to MU items.

As noted above, the costs of the Options to the different actors cannot be considered as additive, and properly speaking, they do not represent 'costs' of the policy measures. This is important to bear in mind when considering these results. Also not factored into the analysis is the potential for innovation to be called forward by the measures, in terms of the design of products and the implementation of new business models designed to foster more sustainable consumption patterns (for example, deposit refund schemes for refillable cups).

6.6.1 The impacts on producers

Producers of single use plastic items are negatively affected by a reduction in consumption of their products. Some of the measures – such as the measures in relation to extended producer responsibility, requiring that the costs of clean-up are paid, have less of an impact on consumption, as they seek to reduce marine litter mainly through the means of clean-up. The measures which affect consumption most are those related to reduction targets, and the bans. However, in both these cases, there are shifts in demand so that whilst consumption of SUPs falls, demand for SUNPs and / or MU items increases. In practice, therefore, wherever there are losers in the market, so there are also winners. The effects do not balance each other out: the overall number of items purchased changes, and is redistributed across the market. Because the products being manufactured are relatively specific, the relevant economic data regarding, for example, the change in Gross Value Added (and associated multiplier effects) associated with the shifts in demand across SUPs, SUNPs and MU items are not available at the desired level of resolution. As a result, the assessment reports on the estimated change in the value of sales. These changes are based on estimates of the unit sales prices for the different items.

The assessment indicates that under the different Options, SUP producers lose between €3.1 billion and €11.7 billion under Options 2a and 2d, respectively. The compensating gains for others lie at €1.3 and €6.6 billion, respectively, for Options 2a and 2d. The net loss in sales ranges, therefore, from €1.8 to €5.1 billion across the EU on an annual basis by 2030. Neither figure is significant in the macroeconomic context. The corollary of this is that consumers may reduce expenditure (and although this has not been examined in this work, these savings might lead to expenditure elsewhere in the economy).

The extent to which individual businesses are negatively affected will depend upon a number of aspects, including:

- The proportion of their turnover (and indeed profit) accounted for by the sale of the specific single use plastic items in question;
- Their flexibility in being able to re-orientate production to other plastic items, such as reusable plastic items, and the revenue that they might generate from doing so; and
- Their ability to manufacture items out of materials other than plastic.

As well as there being clear benefits to some parts of industry from the estimated shift in consumer demand, there may be dynamic effects also, related to innovation in the sector. For example, alternatives to some SUP items are not yet at a stage where one could clearly state that they were biodegradable in the marine

environment. Whilst producers should certainly not be designing products with 'being littered' in mind, the potential for alternative, less environmentally damaging options to be developed is considerable. Similarly, there may be new business models that could be developed around the way MU items are made available to consumers, and taken back, in such a way that costs decline, especially as options are scaled up, and demand increases.

The proportion of sales that are within the EU rather than outside the EU is also considered (see Table 6.8, Table 6.9 and Table 6.10 for a breakdown of production options). This is relevant to the overall changes in producer turnover, of which a greater importance is put on businesses within the EU than outside of the EU. This initial assessment is to some extent superseded by further analysis carried out after submission of the first results to the Regulatory Scrutiny Board – see section 5 of the Annex.

Table 6.8 Production options – SUP

Item	Production option
Cigarette filters	Acetate tow is produced by five main companies, based in the US, Japan and Germany.[116] It is undetermined where cigarettes are principally produced.
Drinks bottles	Drinks bottles are mainly produced and filled at factories within the EU.[117]
Cotton buds	Europe is a net importer of cotton buds. Countries in the Asia-Pacific region (specifically China, India, Taiwan and the Philippines) and the US are the major manufacturers of cotton buds, due to labour costs and/or the availability of cotton.[118]
Crisps / sweets	Flexible packaging is produced in rolls that are used in product manufacturing plants to make crisps packets and sweet wrappers. The original flexible material is mainly produced in the EU.[119]
Wet wipes	The majority of nonwoven wipes used in the EU are produced in the geographical region of Europe. The report includes Turkey within this region, who is a major producer of nonwoven wipes for Europe, so further research is needed to determine whether wet wipes production is centred within the EU or the non-EU geographical region.[120]
Sanitary towels	The European geographical region is a net exporter of hygiene products such as sanitary towels.[121]
Cutlery	These items are predominantly and increasingly imported from the Asia-Pacific region into Europe.[122] For example, Huhtamaki, one of the principal food service packaging businesses in Europe, owns 14 manufacturing centres in India.[123]
Straws	
Stirrers	
Drinks cups and lids	
Food containers	

[116] https://www.prnewswire.com/news-releases/global-cellulose-acetate-industry-222508321.html

[117] Confidential industry source.

[118] Acute Market Reports (2018). Cotton Buds Market – Growth, Opportunities, Share & Competitive Analysis, 2018-2026

[119] Confidential industry source.

[120] Smithers Pira (2016). The Future of Global Nonwoven Wipes to 2021.

[121] Personal communication with market research authors of the following report: TechSciResearch (201&) Global Sanitary Pads Market by Product Type, by Sales Channel, Competition Forecast & Opportunities, 2012-2022

[122] Transparency Market Research (2018). Foodservice Packaging market – Global Industry Analysis and Forecast 2017-2025.

[123] http://www.huhtamaki.com/web/flexible-packaging#/

Table 6.9 Production options – SUNP

Item	Production option
Cigarette filters	Undetermined.
Drinks bottles (glass/aluminium)	Undetermined.
Cotton buds (paper)	Undetermined, although can assume a large portion imported from the Asia-Pacific region due to the presence of cotton.
Crisps / sweets	n/a
Wet wipes	Undetermined, although can assume a large portion imported from the Asia-Pacific region due to the presence of cotton.
Sanitary towels	n/a
Cutlery (wood)	Undetermined.
Straws (paper)	Undetermined.
Stirrers (wood)	Undetermined.
Drinks cups and lids	n/a
Food containers	Undetermined, although can assume a large portion is imported from Asia as are many food service items. See SUP food service packaging reference.

Table 6.10 Production options – MU

Item	Production option
Cigarette filters	n/a
Drinks bottles	Undetermined, although can assume a large portion is imported from Asia as are many food service items. See SUP food service packaging reference.
Cotton buds	Undetermined, although can assume these are manufactured in the US, as this is where the Utility Tips company is based.
Crisps / sweets	n/a
Wet wipes	Cheeky Wipes reusable wipes are produced in China.[124]
Sanitary towels	Reusable sanitary pads are principally produced in China due to the labour costs and the presence of the materials (bamboo and cotton).[125]
Cutlery (steel)	Undetermined, although can assume a large portion is imported from Asia as are many food service items. See SUP food service packaging reference.
Straws (steel/silicone)	
Stirrers (steel)	
Drinks cups and lids	
Food containers	

One of the key aspects that business frequently calls for is a clear policy steer, and the avoidance of sudden, unexpected announcements. The European Commission's Plastic Strategy has been foreseen for some time, and it is perhaps not unexpected that measures to tackle such items are now being considered and implemented. Some producers have already begun considering their options, and

[124] Personal communication with Cheeky Wipes.

[125] Personal communication with Cheeky Wipes and Caring Panda.

the best path to pursue in light of what the Commission might propose. Many restaurant chains are already phasing out plastic drinking straws, for example, voluntary initiatives such as refill schemes are becoming more widespread, and a growing number of Member States are considering introducing deposit refund schemes for beverage containers.

The Commission's proposals will serve to give further clarity as to the likely direction of travel, including a timeline for any proposed changes.

6.6.2 The impacts on retailers

For food and drink related items (food containers, cups and cup lids, cutlery, straws and stirrers), retailers have to pay for the single use plastic items that they then provide to customers 'free of charge', or at least without the cost being explicitly passed on – albeit it will be covered by the consumer in the overall price the consumer pays. The zero cost at point-of-sale that is common for such items routinely leads to their over-consumption, a matter clearly demonstrated by the dramatic impact on consumption which have been occasioned by relatively small levies. With a shift to reusable items, the retailer will avoid the upfront cost of purchasing the single use items, and thus has an opportunity to either increase revenue (if the saving is not passed on to the consumer) or share the savings with consumers (or indeed pass them on in full).

There can be a cost in having to provide reusable items for consumption on the premises, for example, in terms of washing, but these reusable items can be expected to 'pay for themselves' over time as long as breakages are not excessive. However, the shift to non-plastic single use alternatives may lead to an increase in costs to retailers if these are more expensive, and they cannot, or choose not to pass these costs on to consumers.

For other single use items such as wet wipes, sanitary towels, and cotton buds, that retailers sell on directly to customers (rather than use to contain the food or drink they are selling), the impacts will vary based on the difference between the wholesale price and the retail price of the non-plastic single use alternative. Where retailers sell multi-use alternatives, while the number of sales will be lower, the effect on revenue will depend on the per item margin that the retailer makes versus the margin on the current single use plastic items.

For retailers engaged in a deposit refund scheme, there will be costs. However, these are usually compensated for through the payment by system operators of handling fees for every used beverage container returned via the retailer.

The figures below, also show that retailer turnover will fall as a result of the measures.

The turnover of retailers falls in all of the options considered (reflecting the loss in producer sales also). These changes range from an estimated €3.7 billion in Option 2a to €10.1 billion in Option 2d. We have calculated commercial washing and refill costs separately, and these range from €0.34 million to €1.82 billion under the Options 2a and 2d. These might be expected to be internalised in retail sales prices, so the reduction in sales turnover may be overstated by the bare 'retails sales reduction' figures.

6.6.3 The impact on SMEs

Most plastic converters in the EU (who take plastic resin, in the form of pellets, powders and flakes and turn it into products and packaging) are SMEs. The effect upon them in terms of any reduction in demand will depend upon the extent to which their business is dependent upon such single use plastic items, and their ability to switch to manufacturing other plastic items.

Many retailers, especially those engaged in food service retail, are SMEs. As previously explained, they may be positively impacted where they avoid the need to purchase single use items that accompany, or contain, the food or drink they are selling. Indeed, in such cases, the per unit avoided costs may be biggest for the smallest retailers, such as independent cafes. The reason for this is that they will not have the purchasing power of large retailers, and will thus have to pay more for each single use plastic item (such as coffee cups) than their larger competitors.

6.6.4 The impacts on consumers

For consumers, the impacts will vary depending on their consumption habits and their own pre-existing preferences in respect of using reusable items, for example. Schemes such as Refill will expand consumer choice by making tap water a more viable alternative to purchasing bottled water.

When consumers decide to use their own MU items, they will need washing in order to keep them clean and usable. Therefore, there may be some additional costs from washing the items. However, as they are no longer purchasing many SU items, the overall cost of the items to them falls.

The analysis indicates that, in line with the loss in retail and producer sales, consumers would stand to reduce their financial outlay under all the Options. Even taking into account the additional costs of washing MU cups and bottles, the assessment indicates that there would be savings to consumers of between €3.7billion, under Option 2a, to €10 billion under Option 2d. In principle, these savings could lead to consumption elsewhere in the economy (not all of which might have environmentally beneficial outcomes). In principle, though, what retailers and producers lose through loss in sales, consumers may gain, and they may use the money they save to spend on other things.

6.6.5 The impacts on public authorities

Waste prevention through the use of reusables will mean lower costs of waste treatment for public authorities (where such costs are covered by public authorities). Reduced levels of litter (both in bins and on the ground) will also mean reduced costs of litter collection and management. For example, if there is a lower quantity of waste produced overall, there will be less waste to recycle and treat in mixed wastes. If litter prevention policies are effective the demand on municipal street cleansing services will fall.

6.7 Social impacts

In terms of social impacts one of the key impacts will be that of litter on beaches. As litter marine and beach litter reduce increase social welfare will be derived. This is set out in section 4 of the Annex. For example, given the association of littered environments with crime, and the fear of crime (and other anti-social activities), any

reduction in litter is likely to lead to wider social benefits and improve overall levels of societal wellbeing.

Some social benefits may occur if third sector organisations take part in various activities, particularly around the refill schemes, which often provide employment to those who are otherwise unable to work or unwanted by mainstream companies. Experience from GOBox in Oregon, for example, shows that public welfare can be generated by extending opportunities to take part in box washing activities to homeless people.

Assessment of measures to reduce marine litter from single use plastics - ANNEX

Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'

30 May 2018

Submitted to:

Company name	European Commission - DG ENV - Sustainable Production, Products and Consumption (ENV.B1)
Address details	Beaulieu 9 - 6/157 - BE-1049 Brussels

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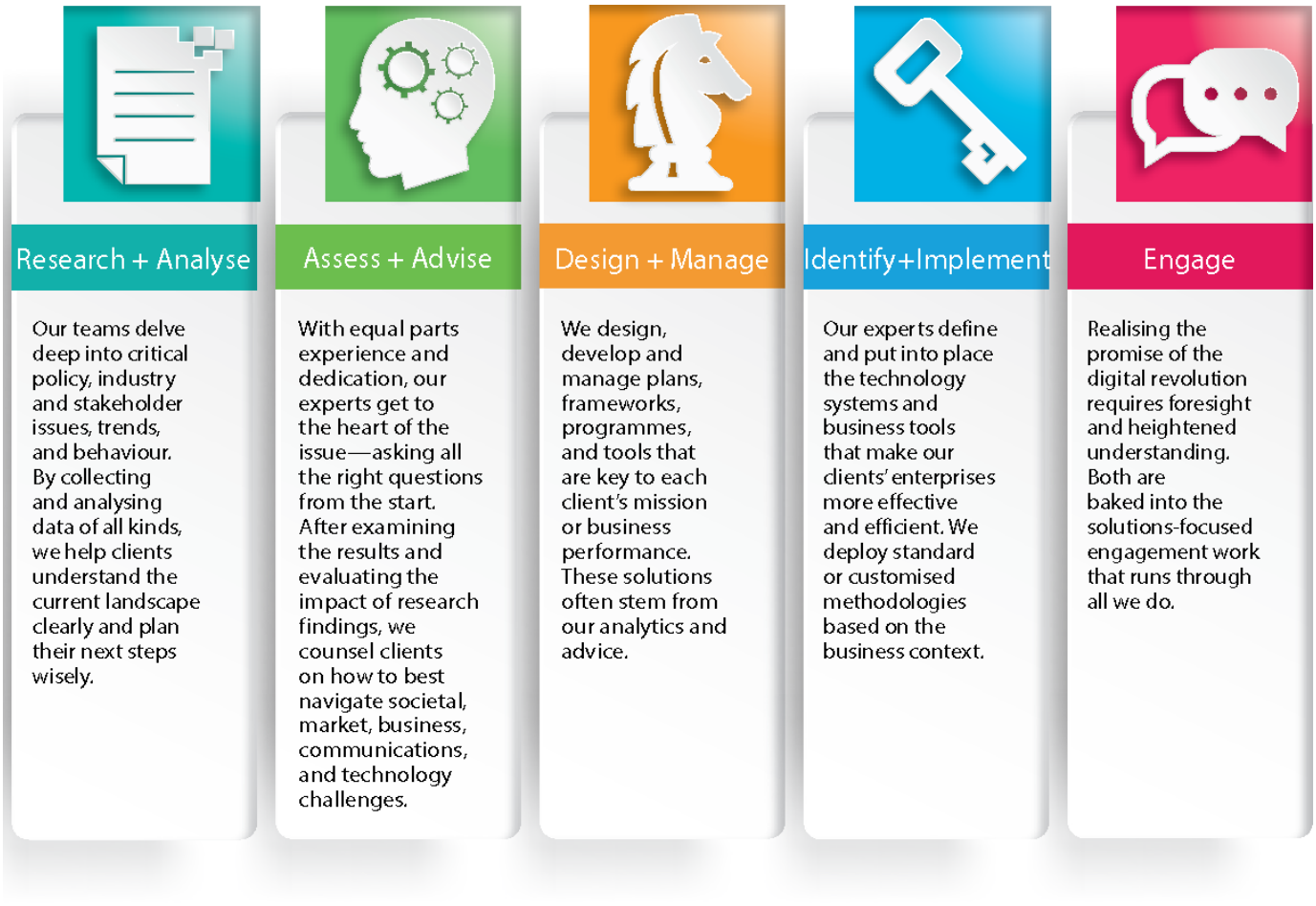

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Assessment of measures to reduce marine litter from single use plastics - ANNEX

Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'

A report submitted by ICF
in association with

Eunomia Research and Consulting Ltd (Eunomia)

Date: 30 May 2018

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Document Control

Document Title	Assessment of measures to reduce marine litter from single use plastics - ANNEX Part of European Commission Study Contract 'Plastics: Reuse, recycling and marine litter'
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Date	30 May 2018

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ANNEXES

Annex 1 Aggregation of Beach Litter Survey Categories

Table A1.1 details all of the single use plastic (SUP) items that were taken into account in the development of the top ten priority SUP items found littered in the marine environment.[1] "Items" are the classifications developed for this study, based on the categories provided in the JRC Technical Report, and the figures in brackets are the total number of units following the disaggregation and aggregation process. All of the data in the table is from the JRC study.

Where categories from the JRC report are included in the "Aggregated from" column, these have been allocated in full to the new classification; those listed under "Subclassification" have been split out between a number of further classifications, as set out in "Disaggregated by", as they comprised of multiple items not just the main item that was required under the 'Item (total count)' column. The total number for each item is the sum of the all the figures in green calculated under the relevant category. For example, Crisp packets / sweet wrappers (10,952) = the specific category Crisps packets / sweets wrappers (10,267) + the proportion of crisp packets / sweet wrappers in two categories that also included other items (Crisp/sweet packets and lolly sticks (593) and Food containers, candy wrappers, cups (147)) which were Crisps packets / sweets wrappers (581.4) and Crisps packets / sweets wrappers (103.4) respectively. 10,952 = 10,267 + 581.4 + 103.4. Decimal points simply reflect non-integer divisions.

[1] Addamo A.M., Laroche P., Hanke G., (in prep.) Top Marine Beach Litter Items in Europe: a review and synthesis based on beach litter data. JRC Technical Report JRC108181; http://mcc.jrc.ec.europa.eu/dev.py?N=41andO=441

Table A1.1 Aggregation of Beach Litter Survey Categories

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
Cigarette butts (21,854)	Cigarette butts and filters (21,854)		
Drinks bottles, caps and lids (24,541)	Beverage Bottles Plastic (3,776)		
	Plastic caps / lids drinks (2,605)	Lids Plastic (68)	Plastic caps / lids drinks (51.5) Plastic caps / lids chemicals, detergents (non-food) (1.4) Plastic caps / lids unidentified (11.4) Plastic rings from bottle caps / lids (3.7)
		Plastic caps and lids (drinks, chemicals, detergents (non-food),unidentified)/plastic rings from bottle caps/lids (14,064)	Plastic caps / lids drinks (10,656.4) Plastic caps / lids chemicals, detergents (non-food) (294.5) Plastic caps / lids unidentified (2,356.3) Plastic rings from bottle caps / lids (756.8)
		Caps/ lids (1,160)	Plastic caps / lids drinks (928.9) Plastic caps / lids chemicals, detergents (non-food) (25.7) Plastic caps / lids unidentified (205.4)
		Plastic caps / lids unidentified (576) + Lids Plastic (11.4) Plastic caps and lids (drinks, chemicals, detergents (non-food),unidentified)/plastic rings from bottle caps/lids (2,356.3) Caps/lids (205.4)	Plastic caps / lids drinks (3,064.4) Plastic caps / lids chemicals, detergents (non-food) (84.7)
		Plastic rings from bottle caps / lids (185)	Plastic caps / lids drinks (920) Plastic caps / lids chemicals, detergents (non-food) (25.4)

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
		+ Lids plastic (3.7) Plastic caps and lids (drinks, chemicals, detergents(non-food),unidentified)/plastic rings from bottle caps/lids (756.8)	
	Drink bottles <=0,5l (1,188)	Bottles < 2 L (99)	Drink bottles <=0,5l (23.4) Drink bottles >0,5l (22.3) Cleaner bottles and containers (22.7) Bottles and jars (6.4) Beach use related cosmetic bottles and containers, e.g. Sunblocks (8.3) beach use related cosmetic bottles and containers, e.g. Sunblocks/other cosmetics bottles andcontainers (0.12) Other cosmetic bottles and containers (3.8) Other bottles and containers (drums) (12.1)
		Bottles and jars (322) + Bottles > 2 L (6.1) Bottles < 2 L (6.3)	Drink bottles <=0,5l (75.3) (2.9)[2] Drink bottles >0,5l (71.7) (2.8) Cleaner bottles and containers (72.9) (2.8) Beach use related cosmetic bottles and containers, e.g. Sunblocks (26.8) (1) Beach use related cosmetic bottles and containers, e.g. Sunblocks/other cosmetics bottles and containers (0.38) (0.014) Other cosmetic bottles and containers (12) (0.47) Other bottles and containers (drums) (39.1) (1.5) Engine oil bottles and containers < 50 cm (8.9) (0.34) Engine oil bottles and containers > 50 cm (3.4)(0.13) Bottles, drums, jerry cans and buckets > 2 L (0.89) (0.034)

[2] In this case the double brackets relate to the two categories being disaggregated, firstly “Bottles and jars” and second “Bottles > 2 L and Bottles < 2 L”.

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
			Jerry cans (square plastic containers with handle) (10.8) (0.42)
	Drink bottles >0,5l (1,131)	Bottles < 2 L (99)	Drink bottles >0,5l (22.3) Drink bottles <=0,5l (23.4) Cleaner bottles and containers (22.7) Bottles and jars (6.4) Beach use related cosmetic bottles and containers, e.g. Sunblocks (8.3) Beach use related cosmetic bottles and containers, e.g. Sunblocks/ other cosmetics bottles andcontainers (0.12) Other cosmetic bottles and containers (3.8) Other bottles and containers (drums) (12.1)
		Bottles > 2 L (73)	Drink bottles >0,5l (21.5) Bottles and Jars (6.1) Cleaner bottles and containers (21.8) Beach use related cosmetic bottles and containers, e.g. Sunblocks (8) beach use related cosmetic bottles and containers, e.g. Sunblocks/ other cosmetics bottles and containers (0.11) Other cosmetic bottles and containers (3.6) Other bottles and containers (drums) (11.4)
		Bottles and jars (322) + Bottles > 2 L (6.1) Bottles < 2 L (6.3)	Drink bottles >0,5l (71.7) (2.8) Drink bottles <=0,5l (75.3) (2.9) Cleaner bottles and containers (72.9) (2.8) Beach use related cosmetic bottles and containers, e.g. Sunblocks (26.8) (1) Beach use related cosmetic bottles and containers, e.g. Sunblocks/ other cosmetics bottles andcontainers (0.38) (0.014) Other cosmetic bottles and containers (12) (0.47) Other bottles and containers (drums) (39.1) (1.5) Engine oil bottles and containers < 50 cm (8.9) (0.34) Engine oil bottles and containers > 50 cm (3.4)(0.13) Bottles, drums, jerry cans and buckets > 2 L (0.89) (0.034)

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
			Jerry cans (square plastic containers with handle) (10.8) (0.42)
Cotton bud sticks (13,616)	Cotton bud sticks (13,579)	Sanitary (nappies, cotton buds, tampon applicators, toothbrushes) (47)	Cotton bud sticks (36.8) Sanitary towels / panty liners / backing strips (7.8) Toilet fresheners (0.27) Diapers / nappies (0.057) Tampons and tampon applicators (2.1)
Crisp packets / sweet wrappers (10,952)	Crisps packets / sweets wrappers (10,267)	Crisp/sweet packets and lolly sticks (593)	Crisps packets / sweets wrappers (581.4) Lolly sticks, plastic (11.6)
		Food containers, candy wrappers, cups (147)	Crisps packets / sweets wrappers (103.4) Cups and cup lids (20.1) Food containers inc. fast food packaging (23.5)
Sanitary applications (9,493)	Sanitary towels / panty liners / backing strips (2,877)	Sanitary (nappies, cotton buds, tampon applicators, toothbrushes) (47)	Sanitary towels / panty liners / backing strips (7.8) Tampons and tampon applicators (2.1) Toilet fresheners (0.3) Nappies, sanitary (0.06) Cotton bud sticks (36.8) Other, identifiable, non-packaging, non-SUP, Plastic, Polystyrene, Rubber (0.3) Tampons and tampon applicators (2.1)
	Tampons and tampon applicators (789)		
	Other (eg diapers, toilet paper, tissue paper, shaving razors) (5,077)		
	Toilet fresheners (100)		
	Syringes / needles (160)		
	Condoms (incl. packaging) (480)		

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
Plastic bags (CBD + non-CBD) (6,410)	Shopping bags (2,520)	4/6-pack yokes, six-pack rings/bags/shopping bags incl. pieces/small plastic bags, e.g. freezer bags incl. pieces (37)	Plastic bags (34.5) 4/6 pack yokes, six-pack rings, plastic (2.5)
	Other Plastic Bags (34)		
	Plastic bags (opaque and clear) (1,093)		
	Small plastic bags, e.g., freezer bags (2,131)		
	Plastic bag collective role; what remains from rip-off plastic bags (420)		
	Dog faeces bag (178)		
Cutlery, straws and stirrers (4,769)	Knives, forks, spoons, straws, stirrers, (cutlery) (3666)		
	Straws and stirrers (566)		
	Cutlery and trays (537)		
Drinks cups and cup lids (3,232)	Cups and cup lids (1995)	Food containers, cups (362)	Cups and cup lids (167) Food containers inc. fast food containers (195)
		Cups and food packs (70)	Cups and cup lids (32.3) Food containers inc. fast food containers (37.7)
		Cups plates plastic (73)	Cups and cup lids (57.5) Food containers inc. fast food containers (15.5)
		Food containers, candy wrappers, cups (147)	Cups and cup lids (20.1) Food containers inc. fast food containers (23.5) Crisps packets / sweets wrappers (103.4)
	Cups, food trays, food wrappers, drink containers (956)[3]	Cups, food trays, food wrappers, cigarette packs, drink containers (15)	Cups, food trays, food wrappers, drink containers (4.1) Cartons/ tetra pack milk (0.6) Cartons / tetra pack (others) (1.9) Cigarette packets (8.4)

[3] Due to difficulties disaggregating, these have all been allocated to drinks.

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
Balloons and balloon sticks (2,706)	Balloons and balloon sticks (2,542)	Balloons, balls and toys (164)	Balloons and balloon sticks (163.7) Balls (0.3)
Food containers inc. fast food packaging (2,602)	Food containers incl. fast food containers (2,330)	Food containers, candy wrappers, cups (147)	Food containers inc. fast food containers (23.5) Cups and cup lids (20.1) Crisps packets / sweets wrappers (103.4)
		Food containers, cups (362)	Food containers inc. fast food containers (195) Cups and cup lids (167)
		Cups and food packs (70)	Food containers inc. fast food containers (37.7) Cups and cup lids (32.3)
		Cups plates plastic (73)	Food containers inc. fast food containers (15.5) Cups and cup lids (57.5)
Strapping bands, Plastic (2,239)	Strapping bands (2,239)		
Shotgun cartridges, plastic (2,263)	Shotgun cartridges (2,263)		
Cigarette lighters, Plastic (795)	Cigarette lighters (795)		
4/6 pack yokes, six-pack rings, plastic (372)	4/6-pack yokes, six-pack rings (369)	4/6-pack yokes, six-pack rings/bags/shopping bags incl. pieces/small plastic bags, e.g. freezer bags incl. pieces (37)	4/6-pack yokes, six-pack rings, Plastic (2.5) Shopping bags (17.1) Small plastic bags, e.g., freezer bags (14.5) Plastic bag collective role; what remains from rip-off plastic bags (2.9) 4/6 pack yokes, six-pack rings, plastic (2.5)
Lolly sticks, plastic (216)	Lolly sticks (204)	Crisp/sweet packets and lolly sticks (593)	Lolly sticks, plastic (11.6) Crisps packets / sweets wrappers (581.4)
Tobacco pouches/ plastic cigarette box packaging, plastic (148)	Tobacco pouches / plastic cigarette box packaging (147)	Tobacco Packaging Wrap (15)	Tobacco pouches/ plastic cigarette box packaging, plastic (1.1) Cigarette packets (13.9)

Item (total count)	Aggregated from	Includes these subclassifications	Disaggregated by
Nappies, sanitary (21)	Diapers/ nappies (21)	Sanitary (nappies, cotton buds, tampon applicators, toothbrushes) (47)	Nappies, sanitary (0.06) Cotton bud sticks (36.8) Sanitary towels / panty liners / backing strips (7.8) Toilet fresheners (0.3) Other, identifiable, non-packaging, non-SUP, Plastic, Polystyrene, Rubber (0.3) Tampons and tampon applicators (2.1)

Annex 2 Data

This annex provides the sources of data that were used to develop the Impact Assessment model.

A2.1 Levels of Consumption

Consumption levels were taken mainly from market research reports purchased for the study. Many market reports included consumption estimates for the major EU countries (e.g. UK, France, Germany, Italy, Spain etc). The smaller countries did not generally have specific forecasts, and were typically grouped in eastern Europe, western Europe and Nordic. Gross Domestic Product (GDP) data from Eurostat was used to pro-rate consumption levels for the aggregated categories across the countries within each category.

A2.1.1 Cigarette Filters

Data was sourced from the inception impact assessment: Implementing and delegated acts under Articles 15(11), 15(12) and 16(2) of the Tobacco Products Directive 2014/40/EU. It was assumed that the consumption of cigarettes would equate to the consumption of cigarette filters.

The current consumption of cigarette filters estimated to be around 500 billion per annum across the EU. The per capita consumption of cigarettes varies from around 500 to 3,500 per person per annum across the Member States.[4]

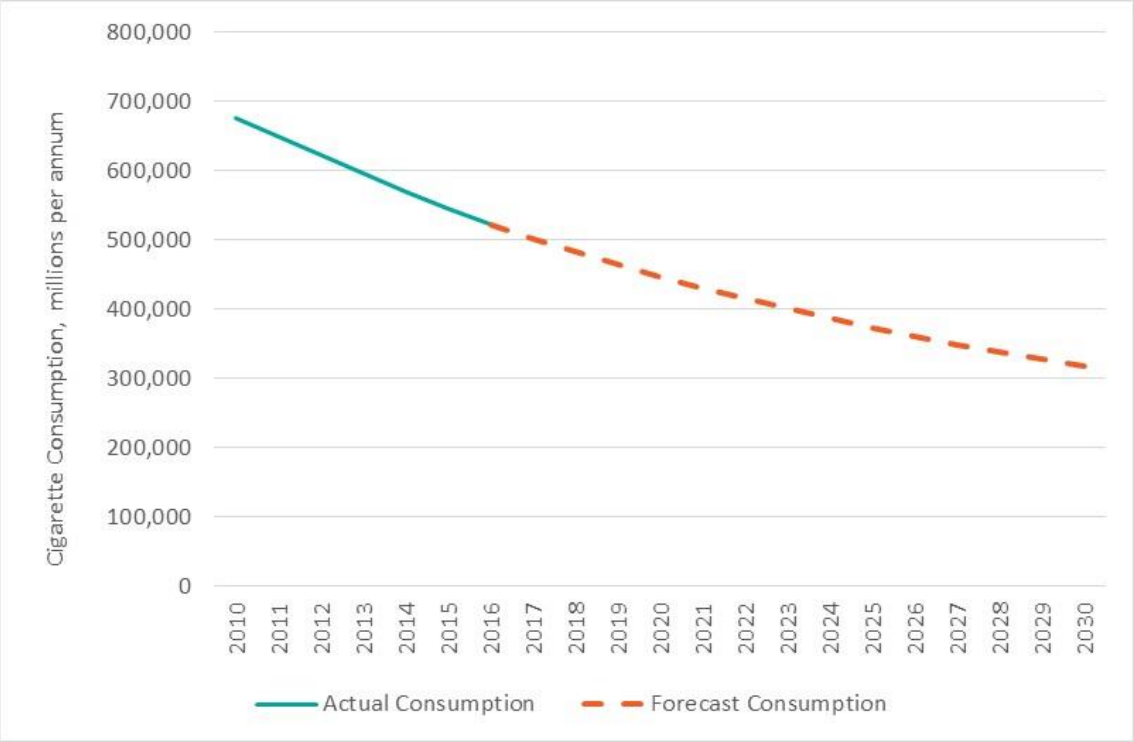
The compound annual growth rate (CAGR) of cigarette consumption (and hence cigarette filters) by Member State varied significantly across Member States over the period 2010-15.[5] The CAGR ranged from +0.4% in Belgium to -10.6% in Hungary, with all countries other than Belgium indicating a negative growth rate over the period.

Growth in consumption from 2015 to 2030 was assumed to be maintained at these current levels. As indicated in Figure A2.1, the total consumption of cigarette filters is therefore expected to continue to decline over time, to around 300 billion in 2030.

[4] Euromonitor cited in inception impact assessment: Implementing and delegated acts under Articles 15(11), 15(12) and 16(2) of the Tobacco Products Directive 2014/40/EU and Eurostat, population = demo_pjan

[5] Ibid.

Figure A2.1 Current and Forecast Consumption of Cigarette Sticks in the EU-28



Source: Euromonitor cited in inception impact assessment: Implementing and delegated acts under Articles 15(11), 15(12) and 16(2) of the Tobacco Products Directive 2014/40/EU

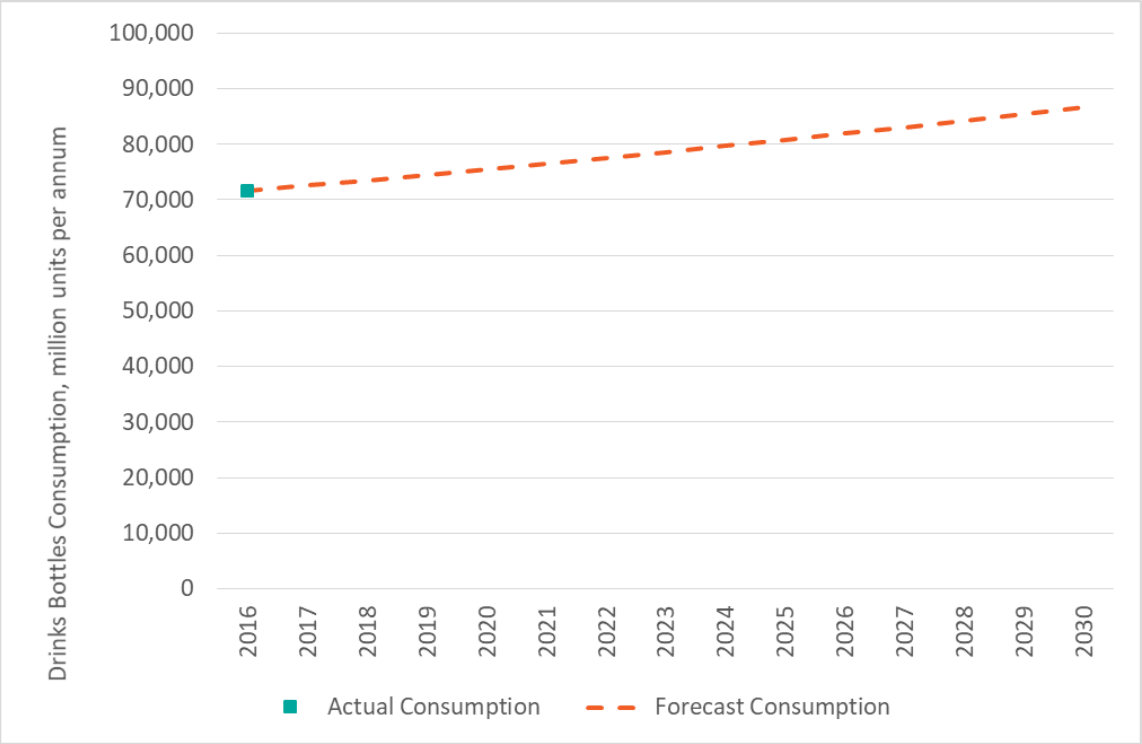
A2.1.2 Plastic Drinks Bottles

Data on the consumption of plastic drinks bottles was sourced from a Global Data market report.[6] Overall consumption of plastic drinks bottles was around 72 billion units in 2016 with an uneven distribution of this consumption across Member States. The per capita consumption, indicating relative levels of consumption of plastic drinks bottles, varies from around 56 to 389 bottles per person per annum across the Member States.

Figure A2.2 shows the forecast for demand for plastic drinks bottles. Growth rate projections were also provided in the market report out to 2021, then forecast to continue at the rate in the latest year. Growth in consumption from 2016 to 2030 projects an increase to consumption of over 85 billion units per annum in 2030. Total demand for plastic drinks bottles will continue to grow at a relatively steady rate at EU level. There is, however, variation at Member State level with a negative growth rate forecast for consumption of plastic bottles in Sweden, and Denmark – the precise reasons were not explained in the report.

[6] Global Data (2018) *Market report on the consumption of Plastic Bottles*. Prepared for Eunomia Research and Consulting

Figure A2.2 Current and Forecast Consumption of Plastic Drinks Bottles in the EU-28



Source: Global Data (2018) Market report on the consumption of Plastic Bottles. Prepared for Eunomia Research and Consulting.

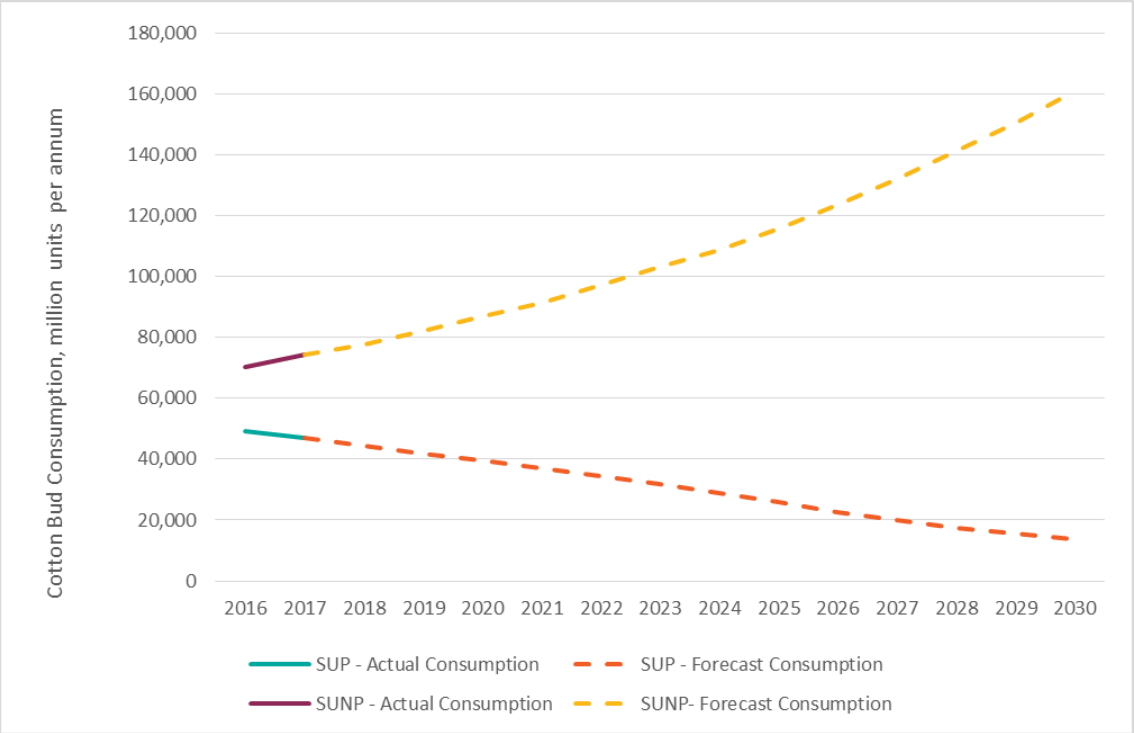
A2.1.3 Cotton Buds

Data for consumption of cotton buds, both single use-plastic (SUP) and single use non-plastic (SUNP), was sourced from a Global Data market report.[7] Overall consumption of SUP cotton buds across the EU-28 was 48.9 billion units in 2016. Consumption of the SUNP alternative was 69.9 billion units across the EU-28 in 2016, higher than that of plastic cotton buds. Per capita consumption of cotton buds varies with the United Kingdom consuming 218 SUP cotton buds per capita, and 314 SUNP cotton buds in 2016. Those Member States consuming the smallest quantity consume less than 10% of the quantities of the UK, with the lowest per capita consumption in Bulgaria at 15 SUP cotton buds per capita and 23 SUNP cotton buds per capita.

Figure A2.3 shows the forecast for the increase in demand for SUP and SUNP cotton buds. The projections for 2016-2030 show an increase in consumption of SUNP cotton buds, and a continued decline for SUP cotton buds. By 2030 it is forecast that consumption of SUP cotton buds will have fallen to 13.5 billion units per annum, from the 2016 baseline of 48.9 billion units. Simultaneously, demand for SUNP cotton buds will grow, reaching consumption of around 160 billion units per annum by 2030. CAGR projections were made in the market report for each year out to 2026, with the remaining 4 years assumed to grow at the rate projected in the final year.

[7] Global Data (2018) *Cotton Buds Market: Growth, Opportunities, Share and Competitive Analysis*, 2018-2026.

Figure A2.3 Current and Forecast Consumption of SUP and SUNP Cotton Buds in the EU-28



Source: Global Data (2018) Cotton Buds Market: Growth, Opportunities, Share and Competitive Analysis, 2018-2026.

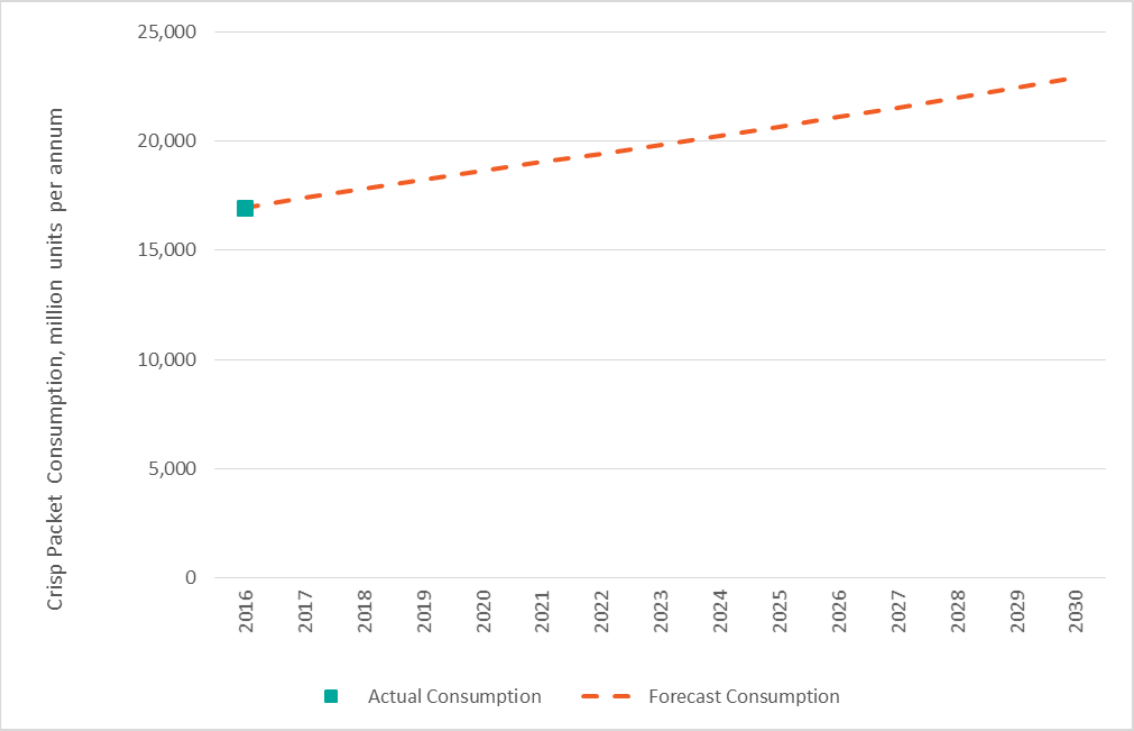
A2.1.4 Crisp Packets

Data was sourced from a Global Data market report which covered confectionary and savoury snacks.[8] Overall consumption of crisp packets across the EU-28 totalled 16.94 billion units in 2016. Twelve Member States have per-capita consumption rates of less than 20 units. Whilst others reached up to 150 units per capita per annum.

Consumption of crisp packets is forecast to grow between 2016 and 2030, as shown in Figure A2.4. Current (2016) consumption of crisp packets is close to 17 billion per annum, this is forecast to reach nearly 23 billion by 2030. The market report forecast annual consumption out to 2021, and for years thereafter the average annual growth rate over that period was maintained (this equated to around 2.7% per annum).

[8] Global Data (2018) *Market report on the consumption of confectionary and savoury snacks*. Prepared for Eunomia Research and Consulting.

Figure A2.4 Current and Forecast Consumption of Crisp Packets in the EU-28



Source: Global Data (2018) Market report on the consumption of confectionary and savoury snacks. Prepared for Eunomia Research and Consulting.

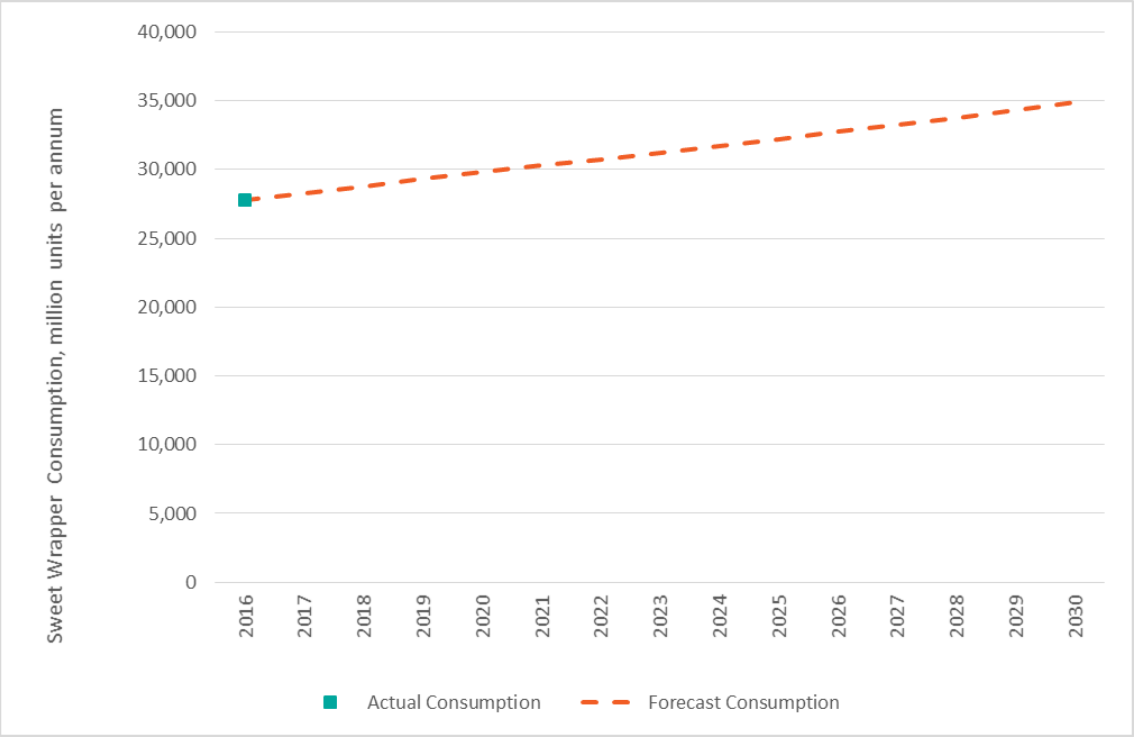
A2.1.5 Sweet Wrappers

Data was sourced from the Global Data market report covering confectionary and savoury snacks.[9] Overall EU consumption of sweet wrappers stood at 27.7 billion units per annum in 2016.

Figure A2.5 shows the forecast consumption for sweet wrappers between the current year (2016) and 2030. Growth in consumption of sweet wrappers is projected for the EU-28 as a whole with consumption rising from the 2016 level of 27.7 billion units up to around 35 billion units in 2030. The market report forecast annual consumption out to 2021, and for years thereafter the average annual growth rate over that period was maintained (this equated to around 2.0% per annum).

[9] Global Data (2018) *Market report on the consumption of confectionary and savoury snacks*. Prepared for Eunomia Research and Consulting.

Figure A2.5 Current and Forecast Consumption of Sweet Wrappers in the EU-28



Source: Global Data (2018) Market report on the consumption of confectionary and savoury snacks. Prepared for Eunomia Research and Consulting.

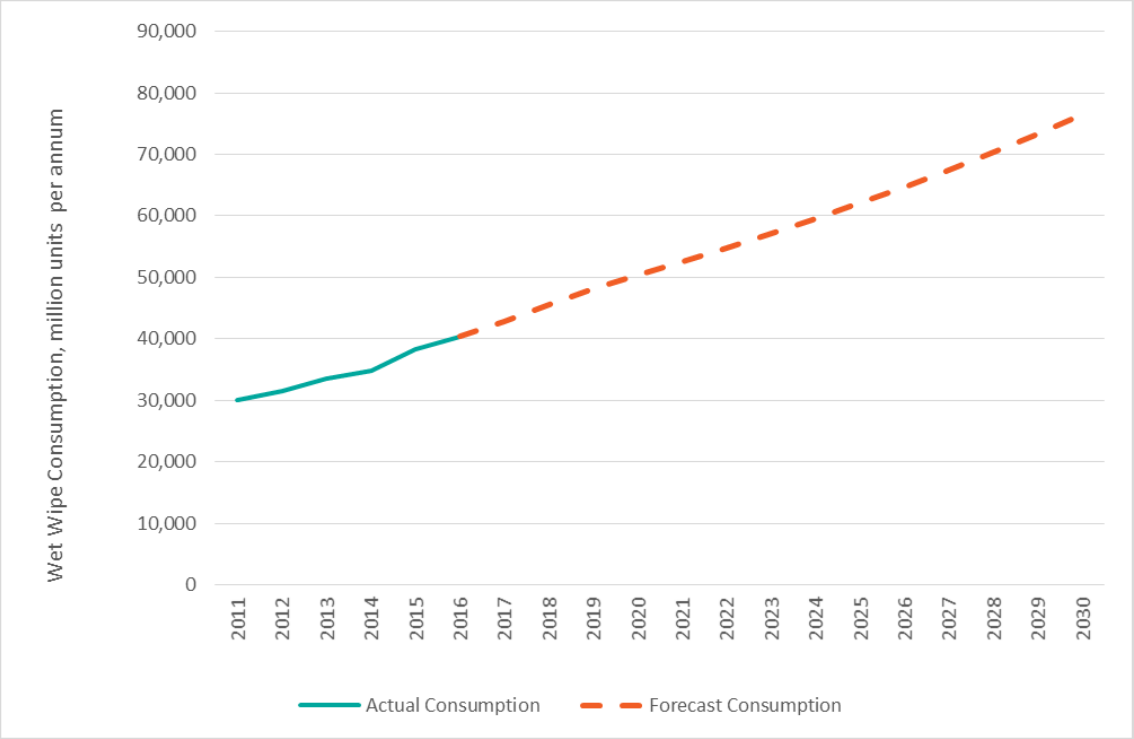
A2.1.6 Wet Wipes

Data was sourced from a market reports and analysis carried out for a previous study.[10] From these sources, only the data on consumption of baby and personal wipes was used as it is assumed that these are most likely to be flushed, which is what has been identified as the main pathway of these items to marine litter. Wipes classified as "home" or "industrial" were excluded. In 2016, overall EU consumption of baby and personal care wet wipes stood at 40.4 billion units per annum. Highest per capita consumption is in Ireland, where 207 wet wipes are estimated to be consumed per annum. The lowest levels of consumption in the EU-28 are between 10 and 20 units per capita, per annum in Bulgaria – in general the per capita consumption is much higher in northern European countries, and lower in central and eastern European countries.

[10] Eunomia (2017) *Single-use Plastics and the Marine Environment - Leverage Points for Reducing Single-use Plastics*, Final Report for Seas at Risk

Figure A2.6 details the historic change, from 2011 to 2016, in consumption of baby and personal care wet wipes across the EU-28 and forecasts the growth in consumption to 2030. Consumption has increased over the years recorded and is forecast to increase from the current (2016) 40.4 billion units per annum to around 76 billion units in 2030. The market report gave consumption forecasts in each year out to 2021, and thereafter the average growth over the period waste maintained out to 2030.

Figure A2.6 Current and Forecast Consumption of Wet Wipes in the EU-28



Source: various – see above.

A2.1.7 Sanitary Pads

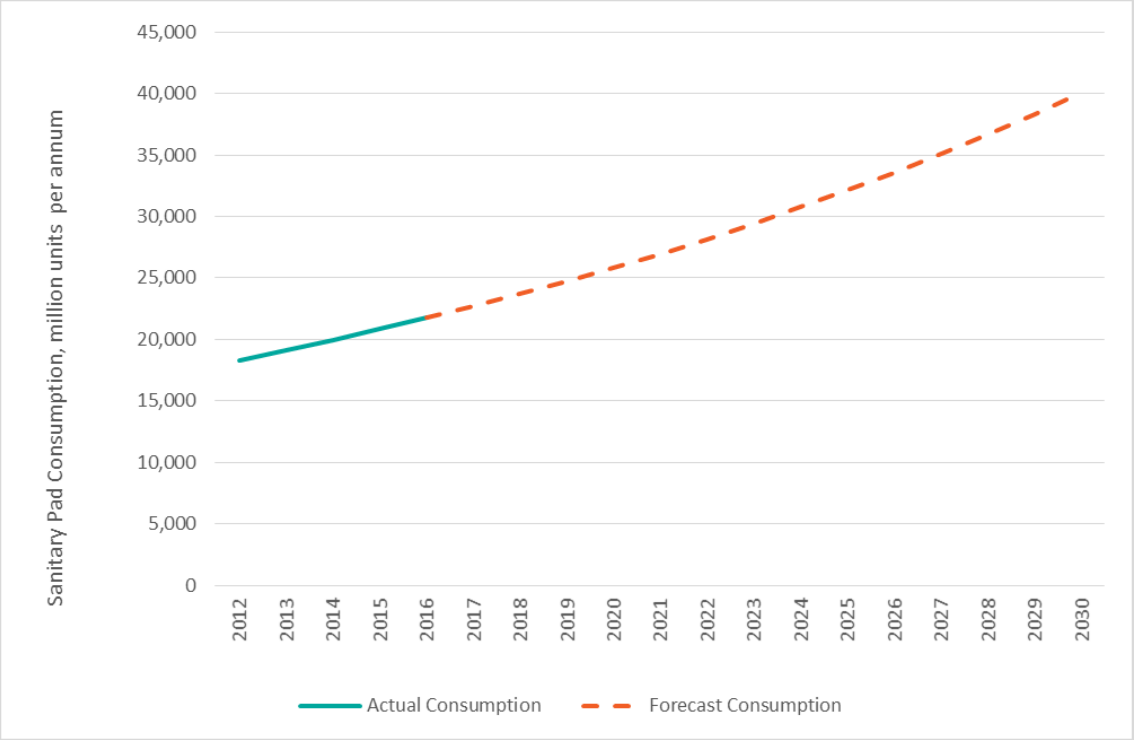
Data was sourced from a TechSci report on the global sanitary pads market, covering the years 2012-2022.[11] In the most recent year for which data is provided, consumption of sanitary pads stood at around 22 billion units per annum across the EU-28. Figure A2.7 details how this consumption breaks down between EU Member States in terms of per capita consumption. In terms of absolute consumption of sanitary pads, Germany, France and the United Kingdom are the greatest consumers. Each of these Member States consumed over 4 billion units in 2016. The highest per capita countries are those in the EU-15, whereas the lowest in the EU-12, ranging from around 10-70 per capita per year.

Figure A2.7 details the changes observed in the consumption of sanitary pads between 2012 and 2016, the latest year of observed data. It then forecasts the consumption of disposable sanitary pads between 2016 and 2030. As can be observed, consumption of sanitary pads is predicted to grow, with forecast for consumption of around 40 billion units per annum in 2030. The market report

[11] TechSci Research (2017) *Global Sanitary Pads Market by Product Type, By Sales Channel, Competition Forecast and Opportunities, 2012-2022.*

forecast consumption to 2022, and thereafter the average growth rate over the period was used to forecast out to 2030.

Figure A2.7 Current and Forecast Consumption of Sanitary Pads in the EU-28



Source: TechSci Research (2017) Global Sanitary Pads Market by Product Type, By Sales Channel, Competition Forecast and Opportunities, 2012-2022

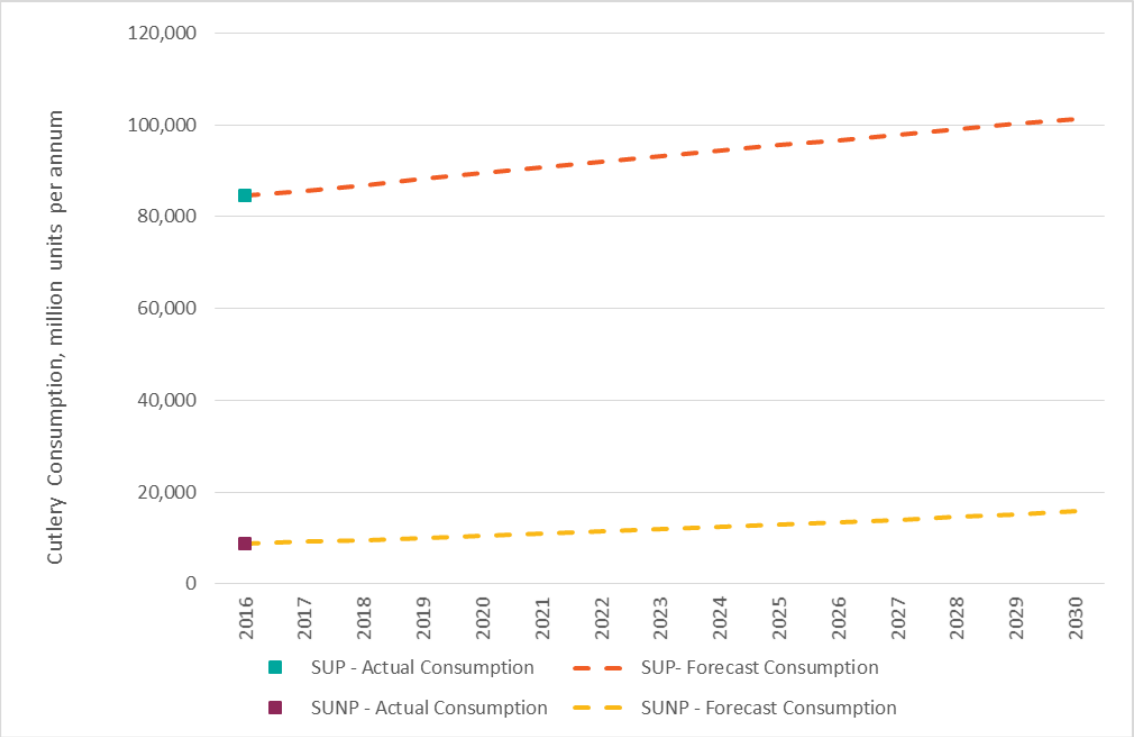
A2.1.8 Cutlery

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[12] Overall EU consumption was 84.5 billion units for SUP cutlery in 2016. Data was also obtained for the consumption of single use non-plastic alternatives (SUNP), in this case wooden cutlery. In 2016, EU consumption of wooden cutlery was around 8.9 billion units. Per capita, per annum consumption of SUP cutlery ranges from 266 units down to 16 units, and SUNP consumption ranges from 28 units down to 2 units per capita/per annum.

Figure A2.8 shows the current (2016) and forecast (to 2030) consumption of cutlery across the EU-28. Growth is anticipated in the consumption of SUP and SUNP cutlery. Consumption of SUP cutlery is expected to grow from 84.5 billion units in 2016 to over 100 billion units per annum in 2030. Whilst the absolute consumption of SUNP cutlery is lower, a faster rate of growth is observed, with consumption forecast to grow from around 9 billion units in 2016 to just under 16 billion units in 2030. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

[12] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.8 Current and Forecast Consumption of Cutlery in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

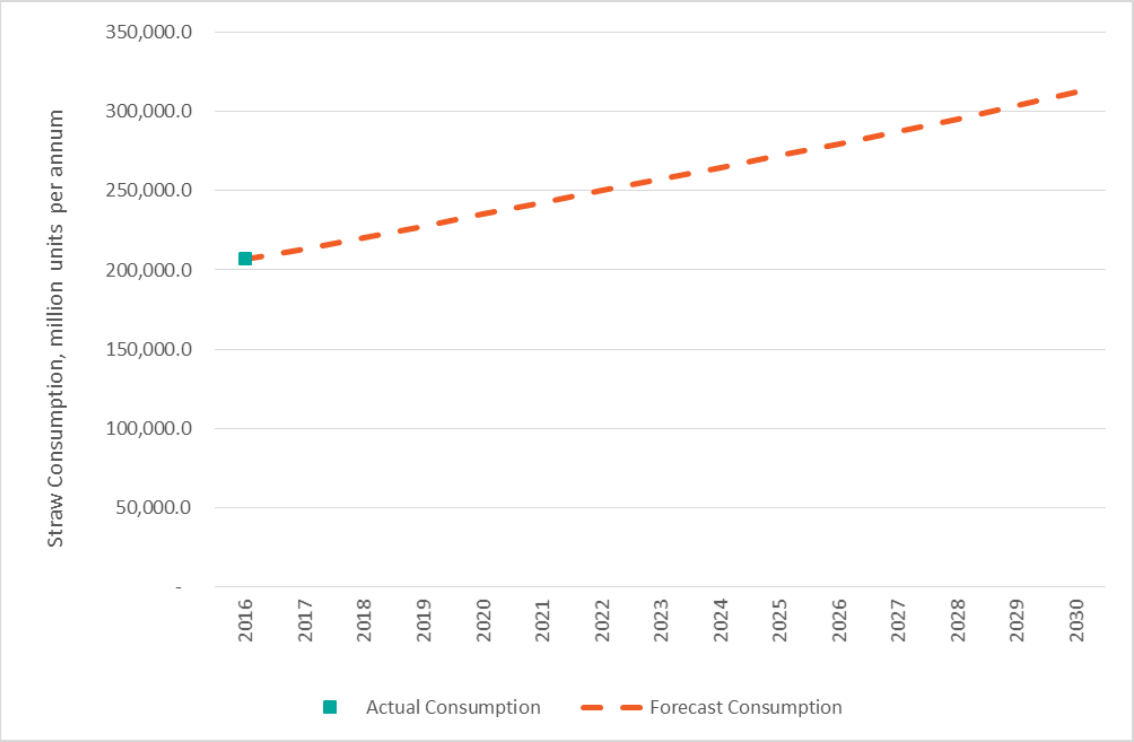
A2.1.9 Straws

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[13] Overall EU consumption was around 207 billion units for SUP straws in 2016. Figure A2.9 shows the current (2016) and forecast (to 2030) consumption of straws across the EU-28. Growth is anticipated in the consumption of straws. Consumption is expected to grow from around 203 billion units in 2016 to over 300 billion units per annum in 2030. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

Following submission of the initial Impact Assessment results, further forecasts were provided by the market research company. These, alongside other estimates suggested that there is a clear level of uncertainty in these market projections, particularly for straw and stirrers, but also other items. As no clear alternative data were available these figures were judged adequate and used in the modelling.

[13] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.9 Current and Forecast Consumption of Straws in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

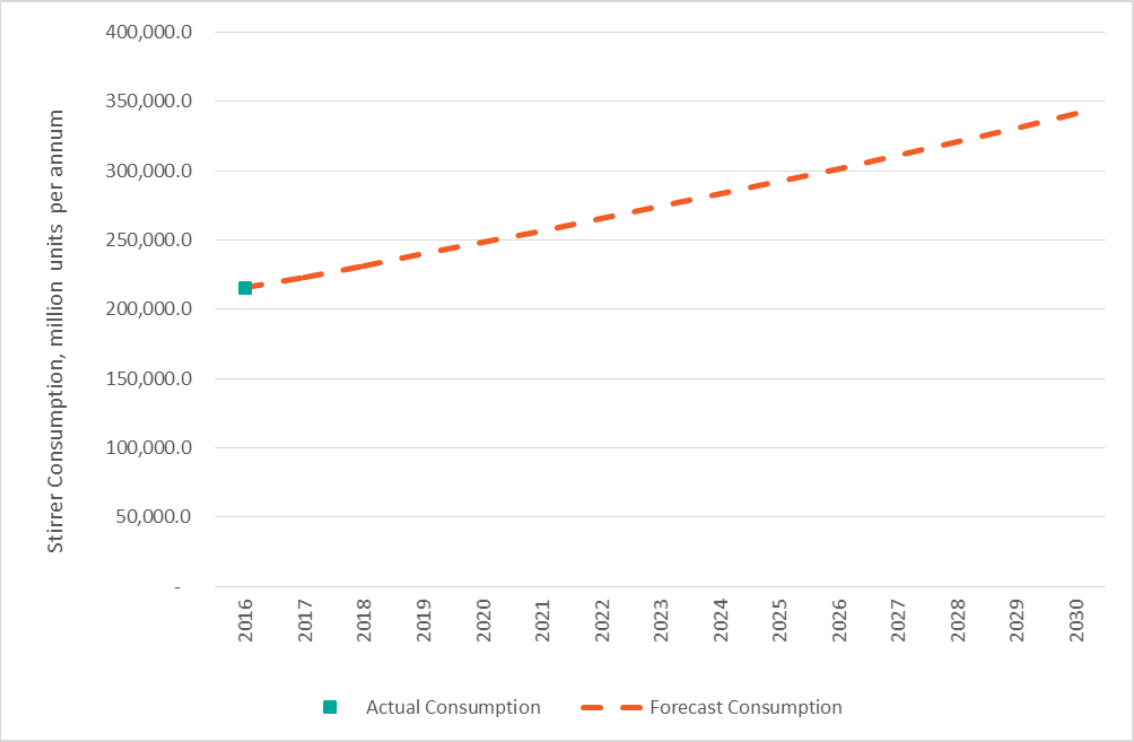
A2.1.10 Stirrers

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[14] Overall EU consumption was around 216 billion units for stirrers in 2016.

Figure A2.10 shows the current (2016) and forecast (to 2030) consumption of stirrers across the EU-28. Growth is anticipated in the consumption of stirrers. Consumption is expected to grow from around 216 billion units in 2016 to over 340 billion units per annum in 2030. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

[14] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.10 Current and Forecast Consumption of Stirrers in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

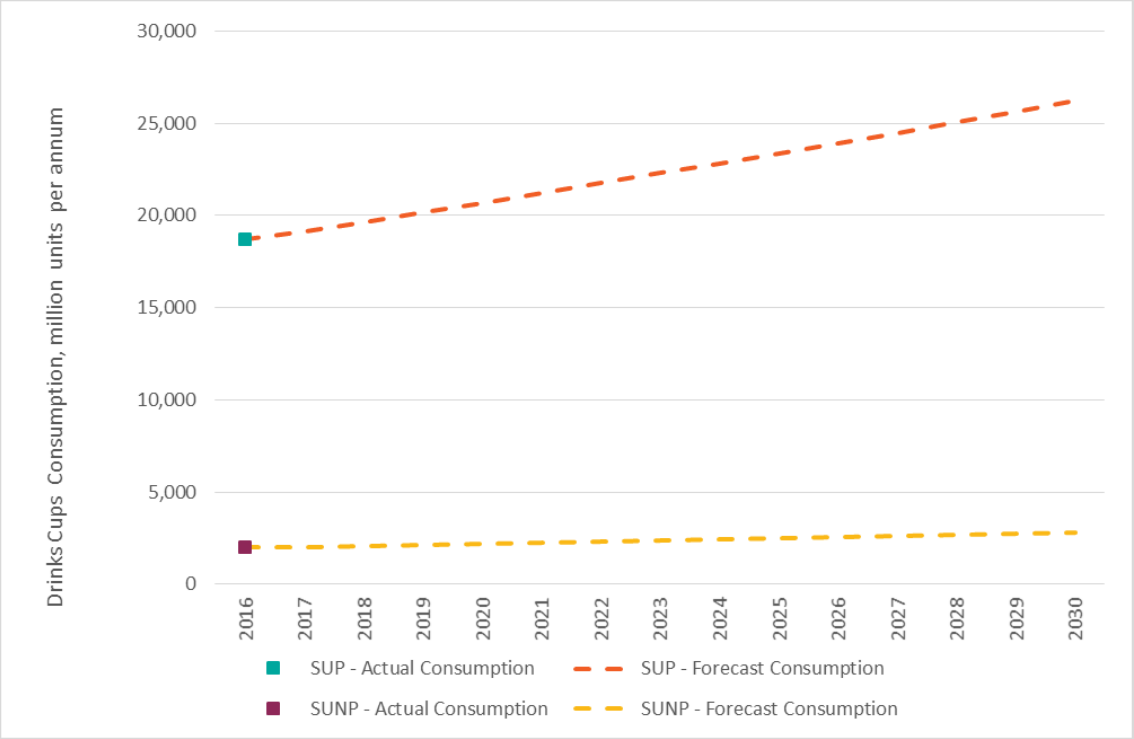
A2.1.11 Drinks Cups

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[15] Overall EU consumption was around 20.7 billion units for drinks cups in 2016. This number includes consumption of plastic drinks cups, those made from a mix of paper and plastic, and paper drinks cups. The per capita consumption across EU Member States, giving an indication of relative consumption, varies from 65 drinks cups down to 4 drinks cups, per capita per annum.

Figure A2.11 shows the current (2016) and forecast (to 2030) consumption of drinks cups across the EU-28. This is split into SUP drinks cups which includes those made only from plastic and those made from a mixture of paper and plastic, and SUNP drinks cups which are assumed to be made from paper. In 2016, EU consumption of SUP drinks cups was close to 19 billion units, with SUNP drink cup consumption at around 2 billion units – approximately 10% of total single use drink cups consumption. Growth is anticipated in consumption of both SUP and SUNP drinks cups. SUP drinks cup consumption is forecast to reach over 26 billion units per annum by 2030, and for SUNP drinks cups the figure for 2030 is ~2.8 billion units. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

[15] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.11 Current and Forecast Consumption of SUP and SUNP Drinks Cups in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

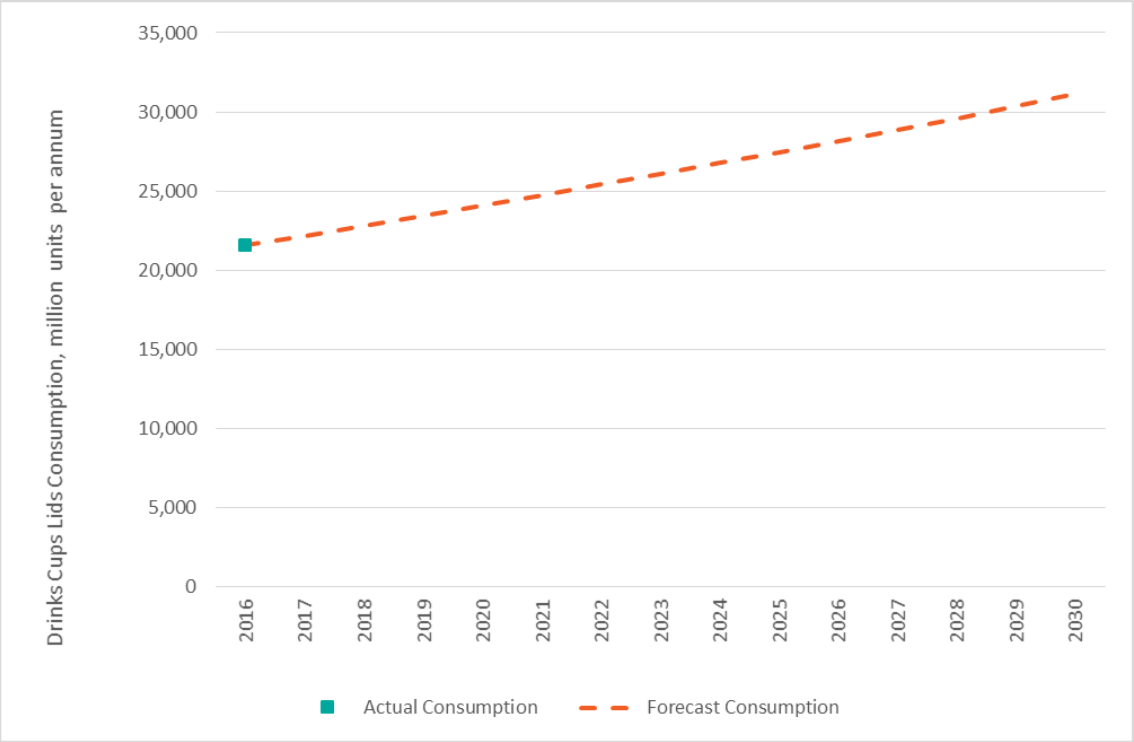
A2.1.12 Drinks Cups - Lids

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[16] Overall EU consumption was around 21.6 billion units for drinks cups lids in 2016. This number includes consumption of plastic drinks cups lids, and those made from a mix of paper and plastic.

Figure A2.12 shows the current (2016) and forecast (to 2030) consumption of drinks cups lids across the EU-28. In 2016, EU consumption of drinks cups lids was around 21.6 billion units. Growth is anticipated in consumption of drinks cups lids and consumption is forecast to reach over 30 billion units per annum by 2030. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

[16] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.12 Current and Forecast Consumption of Drinks Cups Lids in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

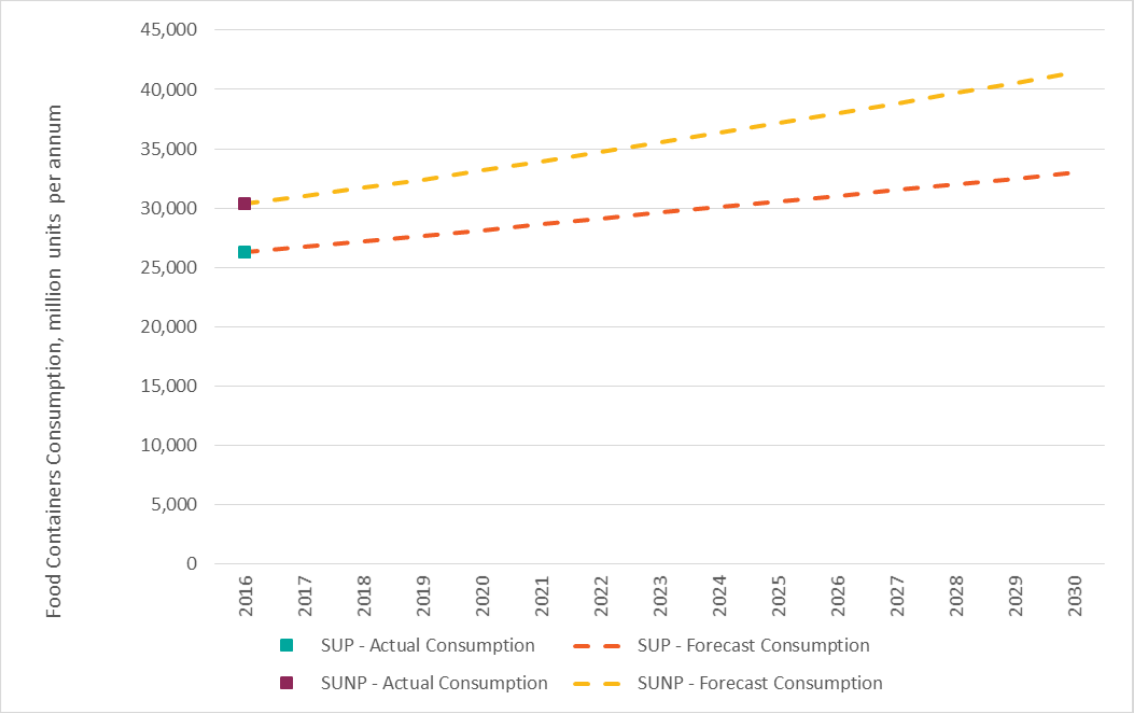
A2.1.13 Food Containers

Data was sourced from Transparency Market Research who provided a report on the food service packaging market.[17] Overall EU consumption was around 26.3 billion units for SUP food containers in 2016. In addition, consumption of around 30 billion SUNP (cardboard) food containers was recorded. Per capita consumption ranges were similar for SUP and SUNP options. SUP container consumption ranged from five to 83 units per capita, and SUNP container consumption was between six and 96 units per capita.

Figure A2.13 shows the current (2016) and forecast (to 2030) consumption of food containers across the EU-28. In 2016, EU consumption of SUNP food containers was around 26.3 billion units. Growth is anticipated and consumption of SUP food containers is forecast to reach around 33 billion units per annum by 2030. Consumption of SUNP food containers stood at around 30 billion units per annum in 2016 and is forecast to reach around 41.5 billion units per annum by 2030. The market report forecast consumption to 2025, and thereafter the growth rate in the final year was used to forecast out to 2030.

[17] Transparency Market Research (2018) *Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.*

Figure A2.13 Current and Forecast Consumption of SUP and SUNP Food Containers in the EU-28



Source: Transparency Market Research (2018) Food Service Packaging Market: Global Industry Analysis and Forecast 2017-2025.

A2.2 Material composition

Tables A2.1 and A2.2 set out the average weight and material composition of each individual unit for single use plastic items (SUP) in the top 10 priority list and their single use non-plastic (SUNP) counterparts. Table A.2.3 sets out these values for multiple use (MU) counterpart items.

Table A2.1 Weight and Composition – SUP

Item	Unit Weight (average), grammes	Composition
Cigarette filters	0.12[18]	Acetate tow 85% Plug wrap paper 9% Tipping paper 5%[19]
Drinks bottles	36.4[20]	Assumed 100% PET.
Cotton buds	0.23[21]	Plastic stick 74% Cotton 26%
Crisps / sweets	5.43[22]	15% of market by sales volume is Potato Chips, which are often laminated plastic and foil. Majority of remaining market (chocolate bars, sweet bags etc) are mostly mono material, so assume 100% Polypropylene.
Wet wipes	3.8[23] (wet) 1.1 (dry)	Dry weight 1.1g. Assume 2.7g is lotion. Sometimes 100% semi-synthetic (rayon); sometimes 80% polyester and 20% rayon, sometimes 100% polyester
Sanitary towels	6.2[24]	Paper 3% Adhesive 7% Superabsorbent polymer 6% Pulp 48% PE, PP, PET 36%
Cutlery	2.6 per item (knife, fork, spoon) on average.[25]	100% Polypropylene.
Straws	0.4[26]	100% Polystyrene.

[18] Mass of single filter using UK values (adjusted for tar) from O'Connor et al. (2008). *How do different cigarette design features influence the standard tar yields of popular cigarette brands sold in different countries?* doi:10.1136/tc.2006.019166

[19] Bin et al. (2017). Analysis of carbon footprint of cigarette based on life cycle assessment. Tobacco Science & Technology 50 (6) [in Chinese]

[20] Based upon a calculation of the average for all EU weighted by pack size. See Section above on Consumption data. Source weight data for 250ml, 500ml and 1,000ml pack sizes from https://allinpackaging.it.

[21] Weight of 10 cotton buds with/without the cotton. Total weight = 0.23g, just plastic stick = 0.17g, cotton = 6g.

[22] Based upon a calculation of the average for all EU weighted by pack size. See Section above on Consumption data. Source weight data from confidential industry sources.

[23] https://lotsafreshair.com/2014/07/07/lightweight-hiking-tip-wet-wipes/, corroborated by weighing of standard retail wipe: 3.46 (wet).

[24] 2006 pad, EDANA sustainability report 2008. – Ultra-thin sanitary towels account for the largest share of the market (~35%) so the average weights are based upon this product.

[25] ko-institut (2017). Comparative LCA on reusable and disposable crockery for mass catering in the USA.

[26] Average of three sources, 0.3g (https://allinpackaging.it/), 0.375g (https://en.wikipedia.org/wiki/Drinking_straw#Health_and_environment) and 0.5g from confidential industry source.

Item	Unit Weight (average), grammes	Composition
Stirrers	0.6[27]	100% Polypropylene.
Drinks cups	11	Plastics / Paper + lined / Paper only Market shares = 10% paper, 59% paper + plastic lined, 31% plastic only (for plastic lined – paper 94%/ Polyurethane 6%[28]) Resulting composition = 65% paper / 35% plastic.
Drinks cup lids	3[29]	100% Polystyrene.
Food containers	20*	100% Plastic.

** Estimate*

Table A2.2 Weight and Composition – SUNP

Item	Unit Weight (average), grammes	Composition
Cigarette filters	0.13[30]	100% fibre, 50% cotton and 50% hemp.
Drinks bottles (glass/aluminium)	287[31]	388g glass (72% of market) 26g cans (28% of market) Average = 287g
Cotton buds (paper)	0.23[32]	Paper stick 74% Cotton 26%
Crisps / sweets	n/a	
Wet wipes (cotton)	2.5[33]	100% cotton.
Sanitary towels	n/a	
Cutlery	2.6*	100% Wood.
Straws	0.8*	100% Paper.
Stirrers	1.9[34]	100% Wood.
Drinks cups	n/a	
Drinks cup lids	n/a	
Food containers	20*	100% Cardboard (plus minimal amount of wax)

** Estimate*

[27] Average of two sources, 0.3g (https://allinpackaging.it/) and 0.9g (Oko-institut (2017). Comparative LCA on reusable and disposable crockery for mass catering in the USA).

[28] 94%/6% paper/PE shares taken from OVAM, 2006. Comparative LCA of 4 types of drinking cups used at events

[29] Estimate from confidential industry source.

[30] Weight of fibre is 0.11g, plus the weight of the paper lining (see reference for SUP cigarette filters).

[31] ENT Environment and Management, Eunomia Research and Consulting Ltd and Jimenez de Parga (2017), Technical, environmental and economic viability of the implementation of a deposit-refund scheme (DRS) for single use beverage containers in Catalonia.

[32] Assuming weight of paper stick is the same as plastic stick.

[33] Weight of 4 small balls of cotton wool (about 0.6g/ball).

[34] IEEP.

Table A2.3 Weight and Composition – MU

Item	Unit Weight (average), grammes	Composition
Cigarette filters	n/a	
Drinks bottles (plastic/aluminium)	153	125g 100% Plastic. 180g 95% Aluminium / 5% Plastic. Average weight = 153g Average composition = 44% plastic / 56% aluminium
Cotton buds	3*	100% Plastic (MDPE)[35]
Crisps / sweets	n/a	
Wet wipes (cotton flannel / handkerchief)	6.7[36]	100% Cotton.
Sanitary towels	30[37]	100% Cotton.
Cutlery (steel)	31 per item (knife, fork, spoon)[38]	100% Steel.
Straws (steel/silicone)	11.05	Average value from weighing two types of reusable straws: 8.2g 100% Silicone 13.9g 100% Stainless steel
Stirrers (steel tea spoon)	20.1[39]	100% Steel.
Drinks cups	96[40]	Lid: 18g, synthetic rubber – thermoplastic olefin and high density polypropylene blend Lid over-mould: 9g, thermoplastic rubbers Plug: 6g, low density polyethylene Cup: 49g, polypropylene Band: 14g, silicone #7
Drinks cup lids		
Food containers (plastic)	156.2[41]	100% plastic

A2.3 Unit Costs

Table A2.4 shows the average unit cost in Euros for each of the top 10 priority SUP items. Tables A2.5 and A2.6 set out the average unit costs for their SUP and MU counterparts.

[35] https://utilitytip.com/

[36] Average value from weighing handkerchief and reusable wipes from Cheeky Wipes.

[37] Personal communication with Cheeky Wipes. Also on market but not modelled: 37.5g average weight for reusable towel made of bamboo fibre and PUL waterproof layer. Personal communication with Caring Panda and Cheeky Wipes.

[38] Oko-institut (2017). Comparative LCA on reusable and disposable crockery for mass catering in the USA

[39] Average value from weighing steel tea spoons.

[40] EDGE (2017). Reusable Coffee Cup Life Cycle Assessment and Benchmarking. Report for Keep Cup

[41] Average weight from reBOX and weighing Tupperware box. Personal communication with reCIRCLE about their reusable food container scheme. https://www.recircle.ch/what

Table A2.4 Unit Costs – SUP

Item	Unit Cost (average), €	Source
Cigarette filters	0.007	Average from online retailers in France (Smoking.fr), Germany (tabak-boerse24.de), Spain (amazon.es) and United Kingdom (Tesco).
Drinks bottles	0.726	Average from online retailers in France (E.Leclerc), Germany (Edeka), Spain (Carritus) and United Kingdom (Tesco).
Cotton buds	0.005	Average from online retailers in France (E.Leclerc), Germany (Edeka), Spain (Carrefour) and United Kingdom (Tesco).
Crisps / sweets	n/a	
Wet wipes	0.025	Average from online retailers in France (E.Leclerc), Germany (Edeka), Spain (Amazon).
Sanitary towels	0.317	Average from online retailers in France (E.Leclerc), Germany (Edeka), Spain (Amazon) and United Kindgom (Tesco).
Cutlery	0.053	Average from online retailers in France (E.Leclerc), Germany (Real), Spain (Carrefour) and United Kindgom (Tesco).
Straws	0.012	Average from online retailers in Germany (Edeka), Spain (Amazon) and United Kindgom (Tesco).
Stirrers	0.014	Average from online wholesalers in France (vaisellejetable.fr), Germany (otto-office.com, becher-onlineshop.de), Spain (Amazon) and United Kindgom (catering24.co.uk).
Drinks cups	0.1	Average from online wholesalers in France (vaisellejetable.fr), Germany (einwegbecher-onlineshop.de), Spain (Amazon) and United Kindgom (catering24.co.uk).
Drinks cup lids	0.029	Average from online wholesalers in France (vaisellejetable.fr), Germany (becher-onlineshop.de), Spain (complementosdelcafe.com) and United Kindgom (catering24.co.uk).
Food containers	0.118	Average from online wholesalers in France (smlfoodplastic.fr), Germany (pack4food24.de), Spain (puntoqpack.com) and United Kindgom (allianceonline.co.uk).

Table A2.5 Unit Costs – SUNP

Item	Unit Cost (average), €	Source
Cigarette filters	0.009	Average from online retailers in France (Smoking.fr), Germany (tabak-boerse24.de), Spain (todoella.es) and United Kingdom (rollingpapersexpress.com).
Drinks bottles (glass/aluminium)	0.726	Same sources as for SUP drinks bottles, assuming no differential in price with packaging change.

Item	Unit Cost (average), €	Source
Cotton buds (paper)	0.008	Average from online retailers in France (toutallandvert.com), Germany (dm.de), Spain (planetahuerto.es) and United Kingdom (rollingpapersexpress.com).
Crisps / sweets	n/a	
Wet wipes (cotton)	0.030	Average from online retailers in France (E.Leclerc), Germany (Edeka) and Spain (planetahuerto.es).
Sanitary towels	n/a	
Cutlery	0.098	Average from online retailers in France (cdsdiscount.com), Germany (kaufdichgruen.de) and Spain (planetahuerto.es).
Straws	0.092	Average from online retailers in France (Auchan), Spain (Amazon) and United Kingdom (nisbets.co.uk).
Stirrers	0.007	Average from online retailers in France (vaissellejetable.com), Germany (becher-onlineshop.de), Spain (Amazon) and United Kingdom (nisbets.co.uk).
Drinks cups	n/a	
Drinks cup lids	n/a	
Food containers	0.264	Average from online wholesalers in France (smlfoodplastic.fr), Germany (rausch-packaging.com), Spain (Amazon) and United Kingdom (catering24.co.uk).

Table A2.6 Unit costs – MU

Item	Unit Cost (average), €	Source
Cigarette filters	n/a	
Drinks bottles (plastic/aluminium)	8.392	Average from online wholesalers in France (pimp-my-bottle.com) and United Kingdom (Tesco).
Cotton buds	0.610	Utility Tip website.[42]
Crisps / sweets	n/a	
Wet wipes (cotton flannel / handkerchief)	0.856	Cheeky Wipes website.[43]
Sanitary towels	5.992	Personal communication with Cheeky Wipes and Caring Panda.
Cutlery (steel)	0.408	Average from online wholesalers in France (cdiscount.com) and United Kingdom (catering24.co.uk).
Straws (steel/silicone)	0.865	Average from online retailers in Spain (Amazon) and United Kingdom (ecostrawz.co.uk, Lakeland.co.uk).

[42] https://utilitytip.com/

[43] http://www.cheekywipes.com/

Item	Unit Cost (average), €	Source
Stirrers (steel tea spoon)	0.408	Same as for cutlery.
Drinks cups	7.403	Average from KeepCup[44], EcocoffeeCup[45] and Ebay[46].
Drinks cup lids		
Food containers (plastic)	7.586	Average from online retailers in France (rueducommerce.fr), Germany (tupperware.de), Spain (Amazon) and United Kingdom (Tesco).

A2.3.2 Multi-use number of uses before waste

The number of uses for each MU item was estimated by benchmarking current consumption data against estimated lifetime in years of a product. Some input from industry sources was also gathered. The approach is outlined in Table A2.7 below with the estimates made and calculated figures.

Table A2.7 Approach to Estimating Number of Uses of MU Items before Waste

Summary	Per capita per day consumption	MU item	Lifetime, years	#Uses before waste
Cigarette filters	11.23	n/a		
Drinks bottles	0.77	Plastic/metal bottle	10	2,808
Cotton buds	1.01	U-Tip ear cleaner	2	734
Crisps / Sweet wrappers	0.18	n/a		
Wet wipes	0.87	Flannel	20	6,330
Sanitary towels	0.23	MU pad	5	426
Cutlery	0.60	Steel cutlery	20	4,416
Straws	1.48	Steel straw	10	5,412
Stirrers	1.54	Steel cutlery	20	11,274
Drinks cups and lids	0.15	Plastic/metal cup	10	564
Food containers	0.28	Plastic box	5	515

A2.3.3 Consumption switches under the measures

Table A2.8 outlines the key model inputs related to changes in consumption under the measures where consumption switches occur. The measure codes are as follows:

- Consumption levies 1
- Reduction targets (SUP) 2
- Reduction targets (all SU) 3

[44] https://uk.keepcup.com/?country=United%20Kingdom

[45] https://ecoffeecup.co.uk/

[46] https://www.ebay.co.uk/itm/60-150-250ML-Travel-Hiking-Folding-Collapsible-Cup-Telescopic-Stainless-Steel-J5-/202046993834?_trksid=p2385738.m2548.l4275

- Ban (of SUP items) 4
- Ban (of all SU items) 5

Table A2.8 Consumption switches by measure

Measure	Item	SUP Reduction			Diverted to…		Overall Demand Reduction
		2020	2025	2030	SUNP	MU	
1	Drinks bottles			-30%	10%	90%	0%
1	Wet wipes			-20%	75%	25%	0%
1	Sanitary towels			-10%	0%	100%	0%
1	Cutlery	-80%	-80%	-80%	50%	50%	0%
1	Straws	-80%	-80%	-80%	10%	90%	50%
1	Stirrers	-80%	-80%	-80%	50%	50%	50%
1	Drinks cups and lids		-30%	-30%	0%	100%	0%
1	Food containers		-30%	-30%	75%	25%	0%
1	Cigarette filters		-30%	-50%	100%	0%	0%
2	Drinks bottles			-50%	10%	90%	0%
2	Cotton buds	-90%	-90%	-90%	90%	10%	0%
2	Wet wipes		-30%	-50%	75%	25%	0%
2	Sanitary towels			-25%	0%	100%	0%
2	Cutlery		-30%	-50%	50%	50%	0%
2	Straws		-30%	-50%	10%	90%	50%
2	Stirrers		-30%	-50%	50%	50%	50%
2	Drinks cups and lids		-30%	-50%	0%	100%	0%
2	Food containers		-30%	-50%	75%	25%	0%
3	Drinks bottles			-20%	0%	100%	0%
3	Cotton buds	-90%	-90%	-90%	0%	100%	0%
3	Wet wipes		-30%	-50%	0%	100%	0%
3	Sanitary towels			-25%	0%	100%	0%
3	Cutlery		-50%	-80%	0%	100%	0%
3	Straws		-50%	-80%	0%	100%	50%
3	Stirrers		-50%	-80%	0%	100%	50%
3	Drinks cups and lids		-30%	-50%	0%	100%	0%
3	Food containers		-30%	-50%	0%	100%	0%
4	Cigarette filters			-100%	100%	0%	0%
4	Cotton buds		-100%	-100%	90%	10%	0%
4	Wet wipes			-100%	75%	25%	0%
4	Cutlery		-100%	-100%	50%	50%	0%
4	Straws		-100%	-100%	10%	90%	50%
4	Stirrers		-100%	-100%	50%	50%	50%
4	Drinks cups and lids			-100%	0%	100%	0%
4	Food containers			-100%	75%	25%	0%
5	Cotton buds			-100%	0%	100%	0%
5	Wet wipes			-100%	0%	100%	0%

Measure	Item	SUP Reduction			Diverted to…		Overall Demand Reduction
		2020	2025	2030	SUNP	MU	
5	Cutlery			-100%	0%	100%	0%
5	Straws			-100%	0%	100%	50%
5	Stirrers			-100%	0%	100%	50%
5	Drinks cups and lids			-100%	0%	100%	0%
5	Food containers			-100%	0%	100%	0%

Source: Eunomia

A2.4 Environmental Data

A2.4.1 Impacts from Waste Management

The model assesses the environmental impacts of changes in the quantity of waste generated and management destinations between the baseline and the policy options.

Two types of impacts are analysed:

1. Greenhouse gas (GHG) emissions: Climate change impacts are considered in isolation (as tonnes of CO_2 equivalent); and
2. Environmental externalities: The combined effect of both the climate change impacts together with those impacts associated with other emissions to air such as nitrogen oxides (NO_x), sulphur oxides (SO_x), and particulate matter (PM). Pollutant impacts are given a monetary value (€).

The unit GHG emissions and externalities were taken from values used in the European Reference Model on Municipal Waste Management (from here on referred to as the Municipal Waste Model). The Municipal Waste Model, which began development in 2012, was subsequently developed further and used to analyse policy scenarios for the Circular Economy Package, for both the proposal withdrawn in 2014 and the revised legislative proposal.[47,48]

The Municipal Waste Model requires a range of assumptions to quantify the unit GHG emissions and externalities. Table A2.9 lists the main assumptions used for modelling. The source of these data, as well as a more detailed description of the approach taken to environmental modelling, can be found in Appendix A6.0 of the technical documents associated with the Municipal Waste Model. [49]

[47] *Eunomia Research & Consulting, and Copenhagen Resource Institute (2014) Development of a Modelling Tool on Waste Generation and Management, Report for European Commission Directorate-General for the Environment, February 2014,* http://ec.europa.eu/environment/waste/pdf/waste-generation-management-model.zip

[48] Eunomia Research & Consulting (2015) *Further Development of the European Reference Model on Waste Generation and Management,* Report for European Commission Directorate-General for the Environment, May 2015, https://publications.europa.eu/en/publication-detail/-/publication/d188ce6e-9cac-11e5-b792-01aa75ed71a1/language-en

[49] *Appendix 6 in Eunomia Research & Consulting, and Copenhagen Resource Institute (2014) Development of a Modelling Tool on Waste Generation and Management, Report for European Commission Directorate-General for the Environment, February 2014,* http://ec.europa.eu/environment/waste/pdf/waste-generation-management-model.zip

Table A2.9 Environmental Assumptions

Environmental Impact	Assumption
Recycling	Avoided emissions through reduced use of raw materials
	Direct emissions from recycling process
Incineration	Type of energy recovery/incineration used in each Member State (electricity only, combined heat and power etc)
	Direct emissions from incineration process
	Emissions from energy used during incineration process
	Emissions avoided through energy generation (depends on the mix of energy sources in each Member States grid)
Landfill	Direct emissions from landfill process (not applicable for plastics as they are an inert material and do not release GHGs in landfill)
	Emissions avoided through energy generation (not applicable as plastics do not release methane)

Carbon and air quality damage costs are also key modelling assumptions. Carbon damage costs are taken from European Economic Area (EEA) values out to 2029. After this point, the price projections given in the EU Emissions Trading System (EUETS) and provided to us by DG Clima during the development of the Municipal Waste Model were used. These projections suggest the cost of each EU Allowance unit (EUA) to be €35 in 2030. The carbon damage costs used are shown in Table A2.10. The Member State specific monetary value of air quality impacts are based on those used in the Municipal Waste Model. These are based on modelling undertaken for the European Environment Agency. [50]

Table A2.10 Assumed Carbon Damage Costs, € per tonne $CO_{2\ eq}$[51]

Year	2014 - 2025	2026	2027	2028	2029	2030
Carbon Damage Cost	€ 32.0	€ 32.6	€ 33.2	€ 33.8	€ 34.4	€ 35.0

A2.4.2 Impacts from Manufacture and Washing

LCI data was provided as part of a study for DG Environment "Links between production, the environment and environmental policy", conducted by Cambridge Econometrics, IEEP and Denkstatt. Details of the approach will be available in the final report for this contract. In summary, manufacturing load factors per item, based upon the compositions given in Section A2.2, were derived from the lifecycle database Ecoinvent, and provided to the project team. Emissions such as GHGs, air pollutants, water use and land use were included.

[50] The methodology used is summarised in: European Environment Agency (2011) *Revealing the Costs of Air Pollution from Industrial Facilities in Europe*, EEA Technical Report No 15/2011, November 2011, https://www.eea.europa.eu/publications/cost-of-air-pollution

[51] *Section 2.1 of Appendix 6 in Eunomia Research & Consulting, and Copenhagen Resource Institute (2014) Development of a Modelling Tool on Waste Generation and Management, Report for European Commission Directorate-General for the Environment, February 2014,* http://ec.europa.eu/environment/waste/pdf/waste-generation-management-model.zip

A2.5 Analysis of Financial Costs

The options that we are considering may, in different Member States, be met through deployment of different policies. The policies could, in principle, be working on the supply-side, or the demand-side, to affect the consumption of the different SUP items.

The SUP items are typically being consumed in different ways, broadly classified as follows:

1. Directly purchased by consumers in shops, or online, in which case, they might be;
   a. Purchasing the SUP item itself (wet wipes, sanitary towels, cotton buds);
   b. Purchasing a product of the which the SUP item is either a part of, or is its packaging (pre-rolled cigarettes, drinks bottles, crisp packets / sweet wrappers, food containers); or
2. Indirectly purchased / used in cafes / fast-food outlets, restaurants etc. (the Hotel, Restaurant, Café – HoReCa – sector), in which case they might be:
   a. Typically given away free of charge at the point of use (cups / lidds, straws, stirrers, cutlery); or
   b. Be part of the packaging of a product being purchased (crisp packets / sweet wrappers, food containers).

Evidently, this is a simplified view. Many consumers will also purchase MU foodservice items through the retail route, such as drinks cups and food containers. However, for simplicity of the modelling, they have been dealt with under the approach taken for single use HoReCa sector items.

For SUPs falling under the different categories outlined above, different analytical approaches are required:

- Under 1a, the aim is to affect the consumption of an SUP item for which a purchase price already exists;
- Under 1b, the SUP item might not have a purchase price specifically attached to it: rather, the price of the SUP item is reflected in the wider purchase price, and typically forms only a small part of that price;
- Under 2a, the SUP item may appear free at the point of purchase, but the costs of free issue will be factored into the operation of the wider business;
- Under 2b, the situation resembles that under 1b.

This framework, undertaking analyses separately using different approaches for each of the different categories, can help understand the nature of the impacts on the different parts of the supply chain.

Because of the way the scenarios have been developed (related to changes in levels of consumption), we have traced the effects of such a change on consumers and then on the upstream supply chain.

A2.5.1 Costs Related to Retail Route to Sale

The following items are identified as those sold through the retail route, under 1a and 1b of the aforementioned categories:

- Cigarette filters
- Drinks bottles
- Cotton buds
- Crisps / sweet wrappers
- Wet wipes
- Sanitary towels

The costs were calculated as follows:

- **Consumers' Expenditure:** Consumers' expenditure on the items consumed is calculated in the baseline and under the modelled options in order to assess the change associated with the option. Unit costs for the different items were taken from a range of sources in order to calculate an average for all item types (SUP, SUNP and MU). The most representative product types and sales routes were chosen, and whilst it is recognised that prices will vary somewhat across Europe, the prices used are believed to be representative of the majority of sales in the EU-28, which mainly occur in the larger EU-15 countries. It should also be noted that the quality of some items, for example, MU cups, varies widely across suppliers (suggesting that it might make sense for some product standards in the case of some items, so as to minimise the risk that increased use of MU items does not increase environmental burdens unnecessarily). The unit prices on which the analysis was based are given in Tables A2.4 to A2.6 The total consumer expenditure for each option was calculated as the total number of items sold multiplied by the unit price.
- **Effect on Retailers**: the cost to the retailer is assumed to relate to the change in turnover of the business. This is assumed equivalent to the total value of consumer sales, i.e. the same value as the consumer cost indicated above (though one will be recorded as an upside and the other a downside). The gross value added from retail might be expected to change in line with this, with associated multiplier effects. Here, we have assumed the change in consumer expenditure translates into a change in retail sales. It might be expected that the extent to which SUNPs and MU items genuinely substitute for all use of SUNPs is influenced by the shift in relative prices across the options. Sales may decline more in the case of Items of type 1a since the SUP component of the price paid at the point of consumption will be higher: hence, if there are price changes related to the shift away from SUNPs, this is more likely to affect demand, and hence sales.
- **Effect on Producers**: as per the retail costs, the cost to the producer is assumed to relate to the change in turnover of the business. Retailers will mark-up items purchased from producers to cover their own costs and generate margin. A typical retail mark-up is 2.4 times.[52] Data on KeepCup retail and wholesale prices suggests a mark-up of 2 times. Mark-up is generally higher for luxury goods (4 times etc) but this would not apply to the items considered here. A mark-up of 2 times has been assumed to estimate the effect on producer sales based on the change in retail sales. This is calculated by dividing the change in retailer sales by 2.

A2.5.2 Costs Related to HoReCa Route to Sale

The following items relate to those sold through the HoReCa route:

- Cutlery
- Straws
- Stirrers
- Drinks cups
- Drinks cup lids
- Food containers

The costs were calculated as follows:

[52] https://www.ukbusinessforums.co.uk/threads/typical-retailer-mark-ups.231926/

- **Consumers' Expenditure**: As with the retail route to sale, consumers' expenditure on the items consumed is calculated in the baseline and under the modelled options in order to assess the change associated with the option. The total consumer expenditure, for each option, was calculated as the total number of items sold multiplied by the unit price.
- In some options where it is assumed that demand for specific categories of item falls strongly, and the level of usage declines on the whole (for example, where use of straws of all kinds is reduced), then there may be a loss in consumer surplus associated with the use of straws. On the other hand, the 'zero price' for most straws as given out in HoReCa establishments suggests that the loss might not be especially high, whilst there may be compensating increases through the resort to MU items. We have not modelled the changes in consumer surplus explicitly, but note here that where there is a significant decline in the function that items play, this would be a possible outcome.
- **Effect on HoReCa Sector**: To the extent that consumers spending on the items concerned changes, then in the case of items under categories 2a and 2b above, there will be an effect on them. The ways in which the effect is experienced by the HoReCa sectors.
- For the categories under 2a, the change in expenditure on SU items currently given away free of charge will translate into changes in expenditure on the part of the business. In the short term, this might translate into changes on the bottom line of the business, but in due course, the changes might be expected to be passed through in changes in the price of those products for which the sales revenue effectively had to cover the cost of items hitherto given away free of charge. For the purposes of this analysis, it is assumed that over the long-run the costs or savings are passed through to the consumer. To minimise negative pricing effects, HoReCa retailers might separate out the price of the product from the price of the SUP item (e.g. the coffee is priced independently of the cup).
- For the categories under 2b, the change in expenditure is deemed to translate in a change in sales revenue.
- **Effect on Producers**: The foodservice packaging items are assumed to be purchased directly from producers or distributors with no mark-up built into the sales price of the overall food or drink product. Therefore, the change in cost of purchasing the items, which is assumed to be passed through to the consumer, is taken to relate directly to the change in turnover of the producer. This is assumed equivalent to the total value of HoReCa purchases i.e. the same value as the consumer cost indicated above (though one will be recorded as an upside and the other a downside).

A2.5.3 Washing of Multi-Use Items

A2.5.3.1 Methodology and Key Process Assumptions

The switch from SU to MU items is likely to involve additional costs related to washing the MU items between uses. In this study, washing costs for the following MU product types have been assessed:

- Sanitary towels and tampons;
- Wet Wipes;
- Food containers including fast food;
- Cup and cup lids;
- Drink bottles, caps and lids;
- Straws and stirrers; and
- Cutlery.

Due to the wide prevalence of technologies and processes available for washing the above product types, a range of assumptions had to be made regarding those technologies that are most widely used across the EU, as well as those processes and settings that are likely to be used for the products in question. These assumptions are summarised in Table A2.11 below. It is noted that the product types have been grouped according to relevant washing technologies in order to avoid duplication of work. However, the assumptions regarding specific processes adopted for each technology will vary depending on the product.

Table A2.11 Assumptions for Washing Technologies and Processes

Product Types	Washing Method	Key Process Assumptions
Group 1: Sanitary towels and tampons, Wet Wipes	Washing Machine	i) Machines with an average capacity of 7 kg on a standard 60^0 cycle. ii) Purchase costs not included as the scale of additional items to be washed do not justify purchase of a machine. iii) Repair/ maintenance costs not included as these would be difficult to apportion to the additional MU items being studied. iv) Running costs include the cost of energy, water and detergent used per item. v) Running costs reduce by up to 50% if the cycle is at 40^0 instead of 60^0 (assumed to exclude detergent use).
	Hand Washing	i) Hand washing items either under a running tap or in a wash basin (of 20 L capacity, filled to 12 L). ii) Purchase, repair and maintenance costs not included. iii) Running costs include the cost of water, energy required to heat water, and detergent used per item.
	Tumble Dryer	i) Drying on 600 rpm and 1300 rpm spin cycles, 3.7 kg per load. ii) Purchase costs not included as the scale of additional items to be washed do not justify purchase of a machine. iii) Repair/ maintenance costs not included as these would be difficult to apportion to the additional reusable items being studied. iv) Running costs include the cost of energy per item.
	Air/ Line Drying	i) Assumed no costs associated with this process.
	Prewash	i) Soaking by hand and prewashing in machine (at 20^0). ii) Soaking by hand only using cold water and detergent ii) No purchase, maintenance or repair costs for machine prewash considered. iv) Machine prewash running costs include cost of energy, water and detergent per item. v) Machine prewash running costs reduce by 66% relative to a 40^0 cycle.
Group 2: Food containers, Cup and cup lids, Drink bottles, caps and lids; Straws and stirrers, Cutlery	Dishwasher (household)	i) Dishwashers with 10 PS and 13 PS capacity. ii) 1 PS consists of 10 items (dinner plate, soup plate, tumbler, cup, saucer, fork, knife, spoon, dessert spoon, teaspoon). iii) Purchase costs not included as the scale of additional items to be washed do not justify purchase of a machine. iv) Repair/ maintenance costs not included as these would be difficult to apportion to the additional reusable items being studied. v) Running costs include cost of energy, water and detergent per item.

Product Types	Washing Method	Key Process Assumptions
	Dishwasher (commercial)	i) Under-the-counter one tank system with single rack (capacity of 200 dishes per hour; 18 dishes per cycle). ii) Repair/ maintenance costs not included as these would be difficult to apportion to the additional reusable items being studied. iii) Purchase costs, running costs (energy, water, detergent) per item included.
	Hand Washing	i) 12 PS washed per cycle. ii) Running costs include energy, water and detergent costs per item. iii) For commercial washing, running costs also include costs of labour per item.
	Air Drying	i) Assumed no costs associated with this process.

A rapid evidence assessment was then undertaken to establish the costs, or key cost components (energy, water) associated with washing reusable items. Literature based on European, or EU markets were used with verified market studies taking preference over consumer survey methodologies. In addition, preference was given to the most recent data available, though older technical data was used where more recent estimates were not easily accessible (due to pay walls, broken links, etc.). For older cost data, prices were inflated to 2018 values. In addition, comparable data in terms of units of measurement were used where possible.

The key sources of data used in the assessment are listed below:

- Technical reports (primarily EC JRC Technical Reports and Preparatory Studies for Ecolabel/ Ecodesign Revisions);
- Private body market research papers (including those produced for industry/ trade bodies and associations, global market analytics companies, consumer associations); and
- Academic papers.

A2.5.3.2 Data Sources

A range of data was publicly available, using an assortment of assessment and sampling methodologies to determine the capacity, efficiency and cost of washing using various processes. As highlighted in Table A2.11 above, the following cost elements associated with washing have been disregarded in the analysis:

1. For household washing, the costs of repair associated with washing technologies and processes have not been considered. This is because it is not possible to apportion breakage and associated repair costs to marginal use of individual items. However, for commercial scale washing processes that are being used to specifically process MU items, such as a city-wide food box scheme, an average figure for annual maintenance costs of 10% of the capital costs are included in the modelling.
2. Purchase costs for washing technology have not been considered, except in the case of commercial dishwashers. In the latter case, purchase costs are included for those small foodservice businesses that are currently completely reliable on SUP food packaging, and for whom the adoption of reusable alternatives would necessitate the purchase of dishwashing technology.
3. For drying, no costs are assumed to be incurred as a result of air drying either on a line in the sun, or in a heated room. In reality, the latter is likely to involve

additional cost in terms of the additional energy required to heat the room on account of the change in humidity/ evaporation due to the wet clothes.

For each of the processes in Table A2.11, the unit inputs used in the estimation of cost per item are summarised in Table A2.121 below. The cost per unit input are summarised in Table A2.132. The sub-sections below then examine the applicability of these costs to the specific items under study.

Table A2.12 Summary of Input Units per Cycle/ Kg by Washing Process

Technology	Process Type	Cost Type	Category	Units
Dishwashing (per item)	Household BC1 (13 place settings), 60(w) x 60(d) x 85(h) cm[53]	Running Costs	Energy (kWh/ cycle)	1.04
			Water (l/ cycle)	10.90
			Detergent (g/ cycle)	20
	Household BC2 (10 place settings), 45 (w) x 60(d) x 85(h) cm[54]	Running Costs	Energy (kWh/ cycle)	0.97
			Water (l/ cycle)	12.10
			Detergent (g/ cycle)	20
	Professional (under-counter, one-tank) – per 100 dishes[55]	Purchase Costs	Purchase price (€/ 100 dishes)	0.033
		Running Costs	Energy (kWh/ 100 dishes)	2.21
			Water (l/ 100 dishes)	23.49
			Detergent (g/ 100 dishes)	79.12
	Hand-washing (12 place settings)[56]	Running Costs	Energy (kWh/ cycle)	2.50
			Water (l/ cycle)	103.00
			Time (work hours)	1.30
			Detergent (g/ cycle)	206
Laundry (per kg)	Washing machine - 60^0 cycle, 7 kg capacity, 3.3 kg loaded[57]	Running Costs	Energy (kWh/ kg)	0.195

[53] Boyano A., Moons H., Villanueva A., Graulich K., Rüdenauer I., Alborzi F., Hook I., Stamminger R., *Ecodesign and Energy Label for household dishwashers*, EUR 28645 EN, doi:10.2760/024232

[54] Ibid

[55] Öko-Institut e.V. *et al* (2011), Preparatory Studies for Eco-design Requirements of Energy-using Products Lot 24: Professional Washing Machines, Dryers and Dishwashers, Final Report Part: Dishwashers

[56] Stamminger, R. (2004), *Is a Machine More Efficient than the Hand?*, Published in Home Energy, May 2004

Technology	Process Type	Cost Type	Category	Units
			Water (l/ kg)	13.20
			Detergent (g/ kg)	23
	Washing machine - 40^0 cycle, 7 kg capacity, 3.3 kg loaded[58]	Running Costs	Energy (kWh/ kg)	0.098
			Water (l/ kg)	6.60
			Detergent (g/ kg)	23
	20^0 pre-wash cycle, 7 kg capacity, 3.3 kg loaded[59]	Running Costs	Energy (kWh/ kg)	0.043
			Water (l/ kg)	2.90
			Detergent (g/ kg)	23
	Hand-washing, running tap, hot water (using 2 min per item)[60]	Running Costs	Energy (kWh for heating water/ cycle)	1.104
			Water (l/ cycle)	12
			Detergent (g/ cycle)	36
	Hand-washing, filled sink, hot water (1 x 20 L sink, filled 12L)[61]	Running Costs	Energy (kWh for heating water/ cycle)	1.104
			Water (l/ cycle)	12
			Detergent (g/cycle)	36
Drying	Dishes – air-drying (rack)	No costs		

[57] Boyano Larriba, A., Cordella, M., Espinosa Martinez, M., Villanueva Krzyzaniak, A., Graulich, K., Rüdinauer, I., Alborzi, F., Hook, I. and Stamminger, R., *Ecodesign and Energy Label for household washing machines and washer dryers*, EUR 28809 EN, Publications Office of the European Union, Luxembourg, 2017, ISBN 978-92-79-74183-8, doi:10.2760/029939, JRC109033

[58] Ibid; Which.co.uk, Washing Machine Temperature Guide accessible at https://www.which.co.uk/reviews/washing-machines/article/washing-machine-temperature-guide

[59] Ibid.

[60] Kaps, R., Wolf, O., *Green Public Procurement for Sanitary Tapware - Technical Background Report* , EUR 26043 EN, Luxembourg: Publications Office of the European Union, 2013, ISBN 978-92-79-31485-8, doi:10.2788/57886, JRC 71117

[61] Ibid.

Technology	Process Type	Cost Type	Category	Units
	Dishes - dishwasher	Costs assumed to be included in washing costs above		
	Laundry – air-drying, either heated room or line	No costs		
	Laundry - Tumble dryer[62]	Running Costs	Energy (kWh/ kg)	0.60
	Laundry - Tumble dryer[63]	Running Costs	Energy (kWh/ kg)	1.046

[62] Schmitz, A., Stamminger, R., *Usage behaviour and related energy consumption of European consumers for washing and drying*, Energy Efficiency, June 2014 DOI 10.1007/s12053-014-9268-4

[63] Ibid.

Table A2.13 Unit Costs Applied

Unit	Cost € per unit	Data Year
Energy (kWh)	0.208	2014
Water (l)	0.004	2014
Detergent (g)	0.004	2014
Purchase price (prof. dishwasher)	3,500	2011
Staff time (work hour)	10	2015

Sanitary Towels and Tampons

Manufacturer guidance on washing MU alternatives to sanitary towels typically indicates that soaking, followed by washing in lukewarm/ warm water is advisable. As a result, either soaking by hand or in a machine prewash cycle (20 degrees), followed by handwashing or machine cycles at 40 degrees or the standard 60 degrees, are all feasible processes for washing this product.

Reusable pads could also either be dried in a tumble-dryer, or air/ towel dried.

While it has been assumed that such items will be washed at the individual household level, it is possible that in the future, more commercial systems for collection and centralised cleaning of these items will be established (e.g. as is the case for reusable nappies). In addition, washing such items at commercial laundromats might become popular among consumers. However, in the absence of any indication as to the scale of use and processes that such systems might use, commercial and industrial scale washing costs of these items was not considered for this analysis.

Wet Wipes

It has been assumed that MU alternatives to wet wipes require no special instructions for washing, and as such will be washed in either a washing machine at 60 or 40 degrees (the “standard” cycle in JRC analysis of household washing machines), or by hand. Drying in either a tumble dryer, or air drying are both feasible.

As in the case of MU sanitary towels, it has been assumed that these items will be washed in households rather than the commercial/ industrial scale.

Food Containers, Drinks cups, Cutlery

Switching to MU food containers, cutlery and cups will require washing at both the household and commercial level. At the household scale, washing and drying via the existing system (either dishwasher or by hand) is likely to continue, with additional costs incurred due to the added energy, water and detergent used to wash the additional items relative to the baseline. It is unlikely that additional reusable cutlery will be used/ washed at the household level (households are assumed to stock reusable cutlery at present).

MU stirrers are assumed to be teaspoons, and so are considered to undergo similar washing/ drying processes to other cutlery.

At the commercial scale, however, it is likely that the existing method of washing might change – particularly in small establishments that are completely reliant on SUP packaging at present. This is because a large volume of items that were once

disposed of may need to be collected and cleaned regularly. Depending on the volume of sales/ items to be cleaned, investment either in the form of additional staff time to wash dishes by hand, or in cleaning infrastructure in the form of a commercial dishwasher, or a combination of both are likely.

It is also feasible that centralised washing facilities will be provided for businesses within a certain radius in a closed system, such as at events, on campuses, or in reverse vending schemes in which consumers can purchase items in packaging at one location, and drop off at another after use. Or through the presence of city-wide refill schemes which may remove the necessity for on-site washing, with MU food containers being collected by logistics and washing operators. Such washing facilities may function at a larger scale than those of a single business, using dishwashers with a greater capacity and different technical specifications. However, information from GOBox in Portland Oregon, suggests that commercial scale dishwashers are used in this scheme.[64] Therefore, the same processes as on-site washing are modelled.

It is noted that the reference studies used to establish the input units for dishwashers in Table A2.12 Table A2.12 specify a per place setting capacity for household dishwashers, and a per 100 dishes capacity for commercial ones. In the former case, a place setting is assumed to consist of ten items – a dinner plate, soup plate, dessert plate, glass tumbler, tea cup and saucer, knife, fork, soup spoon, dessert spoon and teaspoon (i.e. four-five dishes, two beverage containers, five pieces of cutlery).[65] In the latter, roughly 18 dishes, or 25 cups are assumed to be washed per cycle.

Drinks Bottles

It is assumed that at the household level, reusable bottles would be washed by hand and air-dried, rather than placed in the dishwasher, in which washing is unlikely to be effective due to the shape of the item. At the commercial level, reusable bottles would be washed by dedicated bottle washing machines.

Straws

Similar to drinks bottles, reusable straws are assumed to be washed by hand in the household. This is likely to be the case not only because of the small likelihood that a domestic dishwasher would effectively be able to wash such items, but also because reusable straws are usually sold alongside a specified manual cleaning brush.

It is assumed that straws would be washed when a sink was already being filled for washing other kitchenware and so no additional cost is modelled.

Commercial / Household Split

As noted above, some items will be owned and washed by either the consumer or the commercial establishment selling a food or drink product. The splits shown in Table A2.13 have been assumed to weight both in order to derive a single unit cost figure for the analysis.

[64] Interview with GOBox, Portland, Oregon

[65] https://www.which.co.uk/reviews/dishwashers/article/dishwashers-jargon-buster - Which?

Table A2.14 Share of Consumer versus Commercial Led MU Washing Processes

Item	Consumer	Commercial
Sanitary towels	100%	0%
Wet wipes	100%	0%
Food containers, drinks cups, cutlery and stirrers	50%	50%
Drinks bottles	50%	50%
Straws	50%	50%

Source: Eunomia

Items per Load

Finally, to produce per item impacts for the modelling, assumptions have to be made regarding the number of items per wash as the process costs relate to a whole washing cycle. These are given Table A2.15 below.

Table A2.15 Number of Items Washed per Cycle

Item	Number per Wash Cycle	Rationale
Sanitary towels	12	3 pads used per day over 4 days washed at the same time, not with other laundry items.
Wet wipes	300	Average load of 2kgs @ 6.7 grammes = around 300
Food containers	12	Average number of place settings per washing machine, assume a box is equivalent to a place setting (12)
Drinks cups	60	Assume 5 cups is equivalent to a place setting (5x12)
Cutlery / stirrers	180	Assume 15 cutlery items are equivalent to a place setting (15x12)

Source: Eunomia

A2.5.4 Other Operational Costs of Refill Schemes

The costs of washing containers or drinks cups is considered in section A2.5.3. There would be additional costs from setting up and running refill schemes. Consultation was carried out with GOBox in Portland, Oregon, and reCIRCLE in Switzerland. However, detailed costs on the operation of the schemes was not available. Key characteristics of the schemes were discussed, along with the key cost elements. A representative refill scheme was developed based upon these interviews to derive a per box use cost. This is described as follows:

- A city wide multi use food container scheme was assumed to cover an average sized city of 500,000 inhabitants, with 50,000 using the scheme on a regular basis.

- It was assumed each person used two boxes per week on average, either for a lunch of evening meal. This equates to around 15,000 box uses per day.
- GOBox indicated that a reasonably significant element of the cost to the scheme was the development of the mobile and web application used to administer the scheme. The IT development cost was estimated at €100,000, and amortised over a period of 5 years.
- The labour cost of the washing was included, as the dishwashing costs just included capital and energy / water costs. It was assumed each load could contain 12 boxes and a load in a commercial dish washer would take 2 minutes. This would be equivalent to 40 hours of washing per day, which was assumed to relate to 5 staff.
- In terms of logistics costs, it was assumed that 50% of the boxes are managed by the consumers themselves, and cleaned at home and taken back to refill when needed, and 50% are collected by logistics operators. Assuming each operative can collect 200 boxes per day on a cycle carrier, this relates to 36 collection staff per day.
- 3 full time administrative staff were assumed to be required to manage the operation, marketing and sales for the system.
- At a wage rate of €80 per day this equates to around €1.3 million per annum.
- €5,000 per year for IT maintenance was assumed.
- An addition 5% of labour costs was calculated to equate to insurances, administrative costs, consumables etc.
- A €100,000 per year marketing and advertising budget was assumed.
- The total annual cost calculates around €1.5 million.
- On a per unit basis this relates to €0.28 per box used. This cost was included in the modelling.
- In addition, a per unit labour rate was included to estimate employment effects.

A2.5.5 Administrative Costs for Businesses

Administrative costs would depend on the measures that are implemented. The key measures that would require some ongoing administrative effort by businesses are:

1. EPR;
2. Levies; and
3. Reduction targets.

Firstly, regarding EPR schemes, producers would need to subscribe to compliance schemes which would carry out the obligated activities. Administrative effort in respect of reporting relevant data would place a burden on industry. Costs of compliance can be high depending on the nature of the system. The EPR schemes considered here related to flushable products and littering. The mechanisms would only cover a proportion of the market, and should be straightforward to administer. No cost estimate was possible.

Secondly, the implementation of levies on SU items will require businesses to implement an additional charge for sale of these items. Some reconfiguration of stock keeping systems to display the levy and account for it in sales databases will be required. Depending on how levy revenue is collected, this would also require some additional administration.

Thirdly, for reduction targets companies would have to report the consumption of each item on an annual basis, in order for national governments to monitor progress against any target. The marginal cost would relate to additional reporting burden. To

assess the change in cost, the current level of reporting burdens must be considered.

There are no PRODCOM categories that relate solely to the items being assessed in the study. According to Eurostat, more detailed codes are used at the national level, but these vary by Member State, and to understand them in detail has not been possible within this study. The approach to assessing administrative burden on retailers related to potential carrier bag reduction targets in Wales was as follows: [66]

> *"In respect of the charge on single use bags, it is proposed that all those who sell goods in the course of trade or business to customers in Wales will be required to keep records and provide returns relating to the number of bags sold annually. This requirement will impose an administrative burden on businesses which would otherwise not necessarily have existed in the absence of the charge; although, it is likely that retailers already keep a record of the number of bags given out, for stock-take purposes. Small businesses operating below a certain threshold and selling fewer than 100 bags per annum are likely to be exempt from the requirement to publish records, so could be less affected by this additional administrative burden.*
>
> *It is estimated that the total annual administrative cost of recording and reporting the number of bags sold each year in Wales will amount to around £0.9 million for all businesses combined. In 2005 prices, the additional administrative burden on retailers is estimated to amount to £0.8 million (although this figure could be lower, since a portion of this admin burden will be accounted for by those businesses already recording the number of SUCBs given out as part of their normal stock control)."*

Administration costs for reduction targets are therefore estimated based upon the costs of compliance modelled in the Welsh Impact Assessment. The cost was £0.8 million in 2005 prices (~€0.9 million). This is related to a total of 445 million carrier bags. Assuming the administrative burden can be related to the number of items, a per unit cost of €0.0022 per item consumed. The Welsh study does note that:

> *"this figure could be lower, since a portion of this admin burden will be accounted for by those businesses already recording the number of SUCBs given out as part of their normal stock control"*

It is likely that many businesses, especially larger retailers would have stock control systems which would allow for easy transfer of data to a central data portal. Taking this into account, it was assumed half of the unit figure would apply. The unit costs modelled, therefore, was €0.0011 per item consumed.

A2.5.6 Costs of Municipal Waste Management

A2.5.6.1 Recycling Costs

For plastic bottles and food containers, the route to recycling will be through the packaging EPR collection schemes that are assumed to be in place in the baseline to meet the revised packaging targets. It is, therefore, assumed that the avoided costs of recycling for these items relate to current high performing EPR schemes in

[66] http://gov.wales/docs/desh/publications/100604carrier-bag-charge-regulatory-impact-assessment-en.pdf

the EU: the most recent plastic packaging producer fee from Fost Plus was used: €328 per tonne placed on the market.[67]

For other items we argue that any recycling that might take place would be through automated sorting plants for recyclables or mixed wastes, but that the amounts captured would be very low given the nature of the items. Given the low tonnages of the remaining relatively small and light items, it does not seem likely that there would be any changes in the cost of collecting wastes. Therefore, the avoided cost of collection in source segregated or mixed wastes is assumed to be zero.

In combination, the total amount of items in a load might amount to a kg or so, and so may have some, albeit small, effect on input tonnages to treatment plants where gate fees are charged. Therefore, the avoided costs of recycling for these items are approximated to the avoided cost of treatment at a mixed waste sorting facility. An average per tonne gate fee was taken from a review of plant costs undertaken to update the European Reference Model on Municipal Waste Management, and assumed to be €100 per tonne.[68]

A2.5.6.2 Deposit Refund System Operational Costs

To model the scenario in which deposit refund systems (DRS) for one-way beverage bottles are setup, the costs of operation are required. In addition to the initial set-up costs, a DRS incurs on-going operational costs associated with the main areas outlined below:

- Reverse Vending Machines (RVMs)
  In European systems, the majority of beverage containers are returned via RVM, with larger retailers installing a number of machines in their stores. As well as the capital costs of a compacting RVM, there are subsequent ongoing maintenance costs. In many systems, retailers buy, or lease, one or multiple RVMs at their own expense. In countries such as Denmark and Lithuania, however, the central system operators supply and fund the RVMs.
- Retailer handling fees
  These are paid to retailers for each container they take back (in addition to reimbursing them for the refunded deposits). The fees are intended to compensate retailers for the costs they incur, including (to varying degrees): RVM installation; staff time (wages); and shop space (for any RVMs and for storing the containers awaiting collection).
- Transport and Processing
  Once beverage containers have been returned to retailers, they need to be collected and transported to either a counting centre first or directly to a reprocessor to be recycled. There are, therefore, driver wages, vehicle purchase and maintenance and fuel costs to be paid in addition to the recycling costs. The transport costs can be reduced by, for instance, compacting the containers beforehand or by using reverse logistics (backhauling by distributors delivering beverages for sale) to avoid unnecessary and superfluous journeys.
  Systems that do not rely on RVMs, which both compact the containers and provide reports on the number and type of containers returned, additionally pay for counting centres to sort the containers.

[67] https://www.fostplus.be/en/enterprises/your-declaration/rates

[68] Eunomia, on behalf of the European Commission, 'Study to Identify Member States at Risk of Non-Compliance with the 2020 Target of the Waste Framework Directive and to Follow-up Phase 1 and 2 of the Compliance Promotion Exercise', Final Report, February 2018.

- Fraud
  A DRS can potentially be defrauded (inadvertently or deliberately) by:
  - Consumers claiming a refund on a deposit that was not originally paid;
  - Retailers over-claiming handling fees; or
  - Beverage producers/ distributors under-reporting the number of containers placed on the market, meaning the deposit is not initiated in the first place.
- These all contribute to the costs of a DRS and system operators tend to balance the expected losses from fraud against the cost of fraud prevention measures. Such measures include more stringent auditing and compliance checks, more expensive labelling requirements (read by a higher-specification RVM), CCTV, installing signs in shops and criminal or civil prosecutions. As discussed below, some European systems specify that distributors must use country-specific barcodes, or pay higher fees to reflect the risk that beverage containers may be bought outside the country – and the remit of the DRS – will be returned for a refund.
- Administration
  These are the further costs associated with a centralised system operator that oversees the system, registers products, organises the logistics and manages the data and financial flows. Similarly, any DRS will require an auditing process. Beverage containers will additionally require new labelling to indicate to consumers that a deposit has been paid and can be refunded.

The scheme also generates revenues that help reduce the overall cost of scheme operation. In addition, where a central system operates the scheme, the unclaimed deposits will support the costs of scheme operation. The sum of all the costs, net of revenues, gives rise to the fees that producers must pay. Producers are generally required to pay a fee per container sold. The approaches in various European systems to the producers are explored below.

The net producer fee was taken as the additional cost for operating DRS in countries which do not already have them implemented. The average from existing schemes was used: a summary of the fees for PET bottles is given in Table A2.16. The majority of the market in terms of the size of plastics bottles sold will fall under the smaller category. An average figure of €0.025 per container was chosen as an average cost to apply to other countries currently without DRS as a means to meet the 90% beverage container recycling rate.

Table A2.16 Summary of Producer Fees for PET Bottles, EUR

Country	Small clear	Larger clear	Small coloured	Larger coloured	International barcode
Sweden	0.0220	0.0520	0.027	0.057	
Norway		0.0198	0.0286; 0.0363*		+0.0033
Finland	0.0172	0.0344	0.02459	0.03934	
Estonia	0.002	0.007	0.002	0.007	+0.005
Denmark	0.0234 – 0.0286	0.0299 – 0.0403	0.0234 – 0.0286	0.0299 – 0.0403	
Lithuania				0.03	

Source(s): DRS operators in the respective countries

A2.5.6.3 Avoided Direct Litter Costs

Until recently there has been very little research undertaken to quantify the direct costs of litter. The studies that do exist generally estimate costs per capita, rather than per tonne of litter. However, a 2013 Eunomia study for Zero Waste Scotland estimated a cost associated with dealing with all litter by local authorities and duty bodies of £42.6 million (€48.7 million) per annum.[69] The Eunomia study also estimated that 27,000 tonnes of litter is collected very year in Scotland.

It is difficult to estimate the cost savings from reduced effort spent on litter picking or a reduction in the use of litter bins. If it was assumed that there was a linear relationship between the tonnage of material recovered from litter bins and street cleaning, the unit financial costs for litter clean up could be estimated at €1.8 thousand per tonne of litter.

It is recognised that collection costs are not, generally, scalable on a linear basis according to weight, and therefore, the figure potentially over states the savings that would be generated at the margin. As a result, and recognising that the scope for reducing collection costs is limited for small changes, but also, that the changes considered here are not marginal ones, a saving of 65% of the figure has been used. It should also be noted that, in reality, this cost will vary by Member State depending on the type of waste management infrastructure, and the approach to litter collection. However, we have not adjusted this cost as due to a lack of data required to make these adjustments, e.g. on local authority budgets for litter collection.

A2.5.6.4 Avoided Mixed Waste Treatment and Disposal Costs

Costs of avoided treatment and disposal of mixed wastes are modelled using unit costs by Member State from the EU waste model.

As above, given the low tonnages of the remaining relatively small and light items, it does not seem likely that there would be any changes in the cost of collecting wastes. Therefore, the avoided cost of collection in mixed wastes is zero.

A2.5.7 Installing Screens at Discharge Points in Waste Water Treatment Systems

The costs of installing screens to capture flushed items within the waste water treatment system are challenging to estimate. Not least, as many combined sewer overflows (CSOs) are not even known about.[70] Moreover, the current level of installation of CSOs across the Member States varies significantly. A specific study on this issue from 2016 made estimates of the length of separated or combined sewers in each Member State.[71] Several averaging assumptions were needed; the figures derived are shown in Table A2.16

[69] Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping, 2013*

[70] Interview with confidential industry source.

[71] https://circabc.europa.eu/sd/a/f3c0cbde-3f4a-4b6f-8953-0eaec6a6ffd0/Task%203%20Occurrence%20of%20storm%20water%20over%20flows%20in%20the%20EU.pdf

Table A2.17 Proportion of combined sewers in each Member State

Member State	Proportion of Combined Sewers	Methodological Notes	Total Cost, € millions
Austria	29%		213
Belgium	95%	Est avg of 3 regions	924
Bulgaria	90%	Est says majority	554
Croatia	50%		180
Cyprus	0%		0
Czech Republic	70%	Est avg.	636
Denmark	50%		246
Estonia	0%		0
Finland	20%	Est avg. city / other	94
France	32%		1,838
Germany	55%	Est avg.	3,888
Greece	15%	Est avg.	139
Hungary	30%	Est avg.	254
Ireland	16%		65
Italy	90%	'Majority'	4,697
Latvia	20%		34
Lithuania	50%		124
Luxembourg	90%		45
Malta	0%		0
Netherlands	68%		993
Poland	80%	Est avg.	2,613
Portugal	33%		294
Romania	100%		1,700
Slovakia	8%		35
Slovenia	59%		105
Spain	10%		400
Sweden	12%		102
United Kingdom	70%		3,938
Austria	29%		213

Weighting these figures by population gives an overall figure of 55% for the whole of the EU. This is a significant figure given that the pathway for many flushed items is from combined sewer overflows during storm overflow events. Data received from water companies on a confidential basis provided an estimated cost of installed screens on CSOs across the UK. This included the installation of tens of thousands of CSO screens across the country at a cost of around a quarter of a million Euros per installation. This figure was then pro-rated across all Member States using both population and the proportion of combined sewers in the network in each country.

The costs shown in Table A2.17 are applied to the model for the relevant WWTW scenarios only as the total net change in cost required by 2030.

A.2.5.8 Extended Producer Responsibility for Litter Costs

The extended producer responsibility (EPR) for litter costs in the model were calculated in the following way:

- For flushed items, the costs of EPR do not relate to improvements to the sewerage network, as it was highlighted by the European Commission that this was out of scope for the current impact assessment (IA) as upcoming reviews of legislation on waste water treatment would cover this aspect.
  - Therefore, for flushed items the costs relate to collection of the items from beaches.
  - It was assumed that collection from beaches would capture half of the items not captured through the waste water treatment works (WWTWs), with the remaining either sinking to the sea bed or floating out into global sea currents.
  - The cost per tonne for beach litter collection was estimated at around €24,000 from a variety of sources.[72]
  - No other administrative costs of running the schemes were included.
- For ground litter (cigarette filters and crisp packets), it was assumed that to half the remaining uncollected litter would see a doubling in the per tonne cost of managing that litter on land.
  - However, around 5% of the items end up in the marine environment, and was therefore assumed to be collected on beaches.
  - Therefore, the total cost of halving the remaining littering (from 8% to 4%) was estimated as follows:
    - The cost of collecting 95% of the additional litter was assumed to be double the current per tonne cost of €4k (so €8k).[73]
    - For the remaining 5% the cost was assumed to be related to beach litter clearance, at €24,000 per tonne.
    - It was specified by the commission that 80% of the costs should be covered by the measure, to be in line with the WFD revisions on EPR
  - So a cost of €7,040 per tonne of cigarette butts and crisp packets was used to estimate the overall costs of the EPR scheme for these items.
  - No other administrative costs of running the schemes were included.

As a caveat, the litter costs were modelled on a per tonne basis, but in reality this may underestimate the costs for collecting cigarette filters which are light and frequently found. It was not possible in the scope of this study to develop a more complicated and accurate litter cost collection methodology.

[72] Assumed 300 kgs of marine litter per km at a cost of €8,000 per km. 10x higher than ICC report as these figures were a large under estimate, for a discussion of this issue see Eunomia (2016) *Study to support the development of measures to combat a range of marine litter sources*, Final Report for DG Environment, and for the costs IEEP (2016), Marine Litter: Socio-economic study

[73] ICF and Eunomia (2018). 'Plastics: Reuse, recycling and marine litter, Final Report', 30th May 2018

Annex 3 Material flow of SUPs and their alternatives

A3.1 Littering rates

The type of data ideally required in order to understand what proportion of a particular item is littered is:

- Consumption per capita of each item (annual)
  - By weight or count (converted to weight using standard conversion factors)
- Total ground litter collected per unit area with defined population (annual)
  - By weight and count
  - This is as opposed to bin litter which is effectively waste collected or managed 'correctly'.
- Amount of litter escaping waste management (i.e. persisting in the environment despite cleaning efforts or where cleaning is ineffective). This would require information on litter collected, in terms of weight and item count;
- Composition of ground litter, with % prevalence of each item
  - By weight and count

This collection of statistics would enable the calculation of both what tonnage and subsequently, what percentage of a particular item consumed is littered, in the following way:

Box 1.1 Calculation of item littering rate

$$\%\ littering\ rate\ for\ item = \frac{\%\ item\ in\ litter\ by\ weight \times Total\ litter\ in\ MS/EU\text{-}28\ (tonnes)}{MS/EU\text{-}28\ consumption\ for\ item\ (tonnes)}$$

Because of the scarcity of these types of data, it is expected that availability only extends to a few data points for one or a few countries, on each count. To understand how these quantities might change between Member States, we would ideally also be able to factor in Member State-specific values for:

- Propensity of a population to drop litter
  - e.g. according to behaviour surveys of what % of respondents drop litter
- Propensity of litter to be cleaned up effectively
  - e.g. according to comparable indicators of cleanliness
  - e.g. according to cleaning effort measured in labour (time) or costs in comparable units

- The presence of deposit return schemes in a country - A 2005 peer review of a study for Defra, highlighted examples from the United States, where reductions in beverage container litter in excess of 80% occurred once a DRS was implemented.

In addition, for sanitary items, the 'littering rate' is primarily derived from incorrect disposal of the items at home or other premises, down the toilet, treated as a 'wet bin'. In order to understand the number of items disposed of this way (a different 'pathway' for 'littering'), either:

- Estimates of the number of items flushed per capita could be derived from surveys of disposal behaviour, or,
- The amount of material of different types intercepted by waste water treatment plants per capita could be estimated;

And assessed together with:

- An estimate of the proportion of items that escape interception by waste water treatment, because of combined sewage overflows, or other aspects of the waste water treatment system.

In the following sections, we assess the availability of these different types of information.

A3.1.1 Review of litter tonnage data

We have conducted a review of the limited data available on the total amount of material littered in various locations. Most of the data derives, ultimately, from municipal reporting of litter collected. The most important elements to understand when appraising this type of data are whether the data refers to:

- **'Ground litter' versus 'bin litter'.** For the purpose of this study, litter is defined as that which is 'in the environment' – i.e. on the ground or waterways. It excludes 'litter' deposited in 'litter bins' (other studies have termed this 'avoided litter' for clarity), as waste is *meant* to be in bins. Although we would ideally like to know how much litter is *dropped in the environment*, in reality, data mainly report on collected litter, which, if it excludes that found in bins, reflects what is *dropped first, but then picked up, by waste operatives*.
- **'Manually picked litter' versus other waste streams.** Because of the way street cleansing teams are organised, operatives may also be picking up fly-tipping, side-waste (household waste which does not fit into bins under a restricted volume collection regime), detritus such as leaves, or conducting mechanical street sweepers, which as well as a small amount of litter, will also collect a large quantity of soil and detritus. It is important to understand which streams of waste are included in the data and that figures from different sources have a consistent scope.
- **Litter collected by municipal street-picking teams versus other groups.** In a given area, different teams from different organisations may be involved in litter clearance. They could be within a municipality's organisation (e.g. green space or beach maintenance teams versus those conducting street litter picking); or they could represent groups with different 'jurisdictions' such as commercial waste operators who deal with litter in pedestrian precincts, or other 'privately-owned public spaces', national or regional organisations that spend time clearing

highways or waterways, some of which may fall within urban boundaries. It is important to understand whether a significant proportion of the litter generated in one specific area is likely to be excluded from the data source presented, and that data sources should be comparable in terms of what fraction of litter or physical area is included and excluded.

- **Well-defined geographical area and associated population.** In order for the estimated litter amounts to be of use, they must be linked to a defined unit of area with defined population, else it is not possible to pro-rate the amounts in a sensible way. Population data have been obtained which is as close in year to the date of the litter tonnage estimates, and which match the defined geographic area to which the data applies.
- **Well-defined time period**. Some estimates have been made on a daily basis, others, an annual basis. These have been standardised.

After having evaluated sources of information from the small collection of European cities, regions and Member States for which we were able to find them, a selection of statistics which are distributed around a range that appears realistic was obtained (Table A3.1). Only those statistics whose scope could be evaluated according to the above considerations have been reported. Some variation is likely to reflect in part the urban or rural nature of the locality, or the general propensity to litter in different places. None of the data sources are peer-reviewed literature, however they represent the best estimates currently available on litter generation. Taking an average, including only the countries within the EU-28, equals a 3.76kg per capita per year.

Table A3.1 Review of available data on tonnes of ground litter generated and collected per capita.

Geographical Scope	Date	Method	Tonnes per year	Population	Per capita kg per year	Reference
Bristol, UK	Approx 2016	Waste contractor's estimate of tonnages collected by municipal cleaning teams. 3650t (streets) plus 700t (green spaces) – includes both bin and ground litter; excludes a small fraction of litter collected via mechanical sweepers (most of which material however will be fines and detritus); tonnage from green spaces confirmed to exclude 'garden' type waste such as leaves or grass. Of this total of 4,350t, approximate estimate of 50% attributed to collected ground litter.	2,175	454,200[1]	4.8	Bristol Waste Company website, further details and scope clarification by personal communication with Operations Manager. http://www.bristolwastecompany.co.uk/clean-streets/bristols-litter-pile/
Scotland, UK	Approx 2012	Derived from WasteDataFlow (WDF) national reporting system for municipal waste treatment according to the following formula: WDF "Street Cleaning" category *minus* WDF "Flytipping" category *minus* "Mechanical Sweeping not recycled" *minus* "Bin litter". Mechanical sweeping that is recycled should be reported in a different WDF category. In order to complete the calculation as indicated, local authorities were asked to estimate the proportion of street cleansing waste that was mechanical sweeping vs litter; as well as how much of their street sweepings were recycled; and the proportion of bin:ground litter. Lower bound assumes no recycling of mechanical streets sweeping. Upper bound takes into account a level of recycling. The figure arrived at is the midpoint. The estimate is therefore for collected ground litter alone.	17,787	5,313,600[2]	3.3	Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping*, 2013,
East Lothian, Scotland, UK	Approx 2012	Local Authority's estimate of litter collected through litter picking, so 100% ground litter.	480	100,831[3]	4.8	Unpublished; obtained by personal communication during research for Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping*, 2013.

Geographical Scope	Date	Method	Tonnes per year	Population	Per capita kg per year	Reference
Oslo, Norway	2013	Estimate made by Oslo Council's organization dedicated to keeping Oslo tidy.[4] Only includes ground litter collected. No flytipping included. Only includes waste collected by municipality but businesses and other state departments will also be doing some litter picking/waste management - so may be an underestimate.	730	626,488[5]	1.17	Used in print campaigns (no reference available); obtained by direct personal communication.
Flanders, Belgium	2013	Litter quantities based on municipalities' direct reporting/estimate. Survey of a sample of local authorities, pro-rated to the whole of Flanders on a per capita basis. Tonnage reported here refers to ground litter only. Tonnage reported here inclusive of litter collected by agencies responsible for highways and waterways etc.	17,500	6,444,127[6]	2.72	KplusV, and Indevuilbak (2014) *Studie kostprijs en hoeveelheid zwerfvuil in 2013*, Report for OVAM, 2014
Flanders, Belgium	2015	Litter quantities based on municipality's direct reporting/estimate. Survey of a sample of local authorities, pro-rated to the whole of Flanders based on a model taking into account how at risk authority considered to be for littering. Tonnage reported here refers to ground litter only. Tonnage reported here inclusive of litter collected by agencies responsible for highways and waterways etc.	20,426	6,444,127[6]	3.17	Idea Consult (2017) *Onderzoek naar de hoeveelheden en de beleidskosten van zwerfvuil in Vlaanderen 2015 - Theoretisch model, clusteranalyse, steek proef*, Report for OVAM, 2017

[1]2016, ONS; [2]2012, NRS;[3]2012, ONS; [3]Rusken: https://rusken.no/; [5] Average 2012 and 2014/UNdata - Oslo municipality;[6]2015, Statbel.

A3.1.2 Review of data sources on litter escaping waste management

In order to understand what proportion of litter evades waste management and remains in the environment ('unmanaged litter'), both in terms of what is deposited and remains on land in a given period, and what makes its way into the sea, the sort of data ideally required would be:

- Estimates of annual litter load – terrestrial
  - An estimate of the tonnage of litter deposited on land that evades cleansing effort, in a geographical area with defined population, in a defined period of time.
- Estimates of annual litter load – riverine
  - The amount of litter contributed to a waterway by a catchment of defined population, in a defined period of time.
  - The amount of litter deposited by a river into the sea (the minimum requirement would be that this is representative of macro-litter, though ideally should report on macro and micro -litter), from a catchment of defined population, in a defined period of time.
  - The likelihood of land-based litter moving to a waterway, (i.e. as estimated by a mark, release, recapture-type experiment)
- Estimates of annual litter input to the sea – from coastal areas

In the following sections, estimates of each of these litter flows are reviewed.

A3.1.2.1 Review of estimates of terrestrial litter load

It was not possible to find any estimates of terrestrial litter load.

To our knowledge, the only estimates of littering tonnages apply, as reviewed in Section A3.1.1, to estimates of litter that is, ultimately, *collected*. An example was also found where collected litter tonnages (covering bin and ground litter and flytipping) were used as an approximation of both managed *and* unmanaged terrestrial litter.[74]

While litter is sitting on the ground there is potential for it to move into an area that is not cleaned, including a waterway. Street-cleansing teams may work to guidelines as to (for example):

- The frequency of cleaning, or
- The standard to which a street must be maintained and a timescale within which the standard must be restored.

In both cases, the timeframe is likely to be varied according to the land-usage – e.g. high footfall retail area, residential street, or inter-city roadway.

[74] 4.17 million metric tonnes litter and flytipping collected in US = ~2% of US waste generation; used as littering rate for all countries in Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015) Plastic waste inputs from land into the ocean, *Science*, Vol.347, No.6223, pp.768–771,MSW Consultants (2009) *2009 National Visible Litter Survey and Litter Cost Study*, Report for Keep America Beautiful inc., 2009

For example, in Italy, a report that surveyed the frequency of manual and mechanical sweeping found that the average interval was 5 times a week for manual sweeping, and 4 times a week for mechanised sweeping, although the minimum and maximum for both ranged between once a week and every day.[75] Further, more detailed regional reports reported that some municipalities only cleared litter "once a month from residential areas of medium density".[76]

Under the Code of Practice on Litter and Refuse, in the UK, the guidance states that:

> *"It is expected that managers of land should, through monitoring and the appropriate use of resources, keep their land clear of litter and refuse so that it does not fall below a grade B ("Predominantly free of litter and refuse apart from some small items") and is cleansed to an A (no litter or refuse) on a regular basis."*[77]

If an area falls below grade B, an area with high intensity of use (such as a shopping area) should be restored within half a day (in practice, a maximum of 8 hours if reported in the morning and 24 hours if reported in the afternoon). An area of medium intensity of use (such as a residential area) should be restored within 36 hours maximum; and an area of low intensity of use within 14 days (such as a roads with little traffic) and 28 days or more if there are special safety circumstances that mean the area can't be accessed easily (such as a railway embankment or motorway verge).

Of particular interest is the following statement made in the US, where a Los Angeles study stated that:

> *"It is generally accepted that commercial land uses tend to contribute larger loads of gross pollutants per area compared to residential and mixed land-use areas. This is in spite of daily street sweeping in the commercial sub-catchment compared to once every two weeks in residential and mixed land use areas."*[78]

There is plenty of opportunity, therefore, for a vector such as wind or rain to move litter in between cleaning times, whether in areas of low footfall or traffic, because of the (potentially longer) time between cleaning, or in areas of high footfall or traffic, because of the volume of litter in question.

There is a further illustration of the issue of unmanaged litter provided by a citizen researcher in the Netherlands. On inspecting a cycle path, it is observed that the path appears clean and is known to be cleaned regularly; however, the researcher then maps each beverage container that is found in the area on the litter pick immediately conducted (Figure A3.1), to show a large amount of 'concealed' litter.

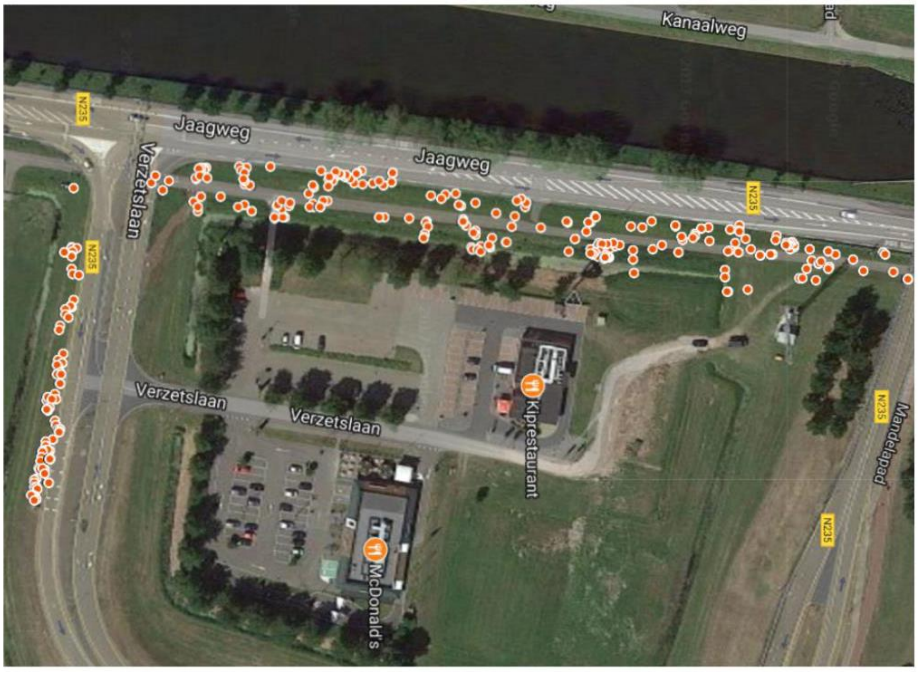
[75] ANPA (2001) *Definizione di standard tecnici di igiene urbana*, 2001, http://www.isprambiente.gov.it/contentfiles/00003500/3528-manuali-2001-06.pdf

[76] Autoridsru (2007) I servizi di spazzamento e pulizia nel contesto del servizio gestione rifiuti urbani: analisi, valutazioni & strategie

[77] Defra (2006) *Code of Practice on Litter and Refuse*, April 2006

[78] "It is generally accepted that commercial land uses tend to contribute larger loads of gross pollutants per area compared to residential and mixed land-use areas. This is in spite of daily street sweeping in the commercial sub-catchment compared to once every two weeks in residential and mixed land use areas."

Figure A3.1 Unmanaged terrestrial litter. Upper panel: Photograph taken before litter pick. Lower panel: Location of each piece of litter subsequently found mapped using GIS.



"Another example to show how difficult it is to determine in advance where in an area the most waste lies and from which it emerges that the most waste is on the unpaved part is the measurement … on the Jaagweg past the McDonalds in Purmerend on June 11, 2017. In the photo that I took before I started you can hardly see litter. In the 570 meters that I traveled, I eventually found 410 pieces of litter. The cycle path was neatly swept, the verges with the grass to ankle height and the ditches were full.

Source: Groot, D. (2017) 20.000 redenen voor statiegeld

This particular example highlights an often-observed phenomenon – that areas with vegetation, 'permeable' backlines, etc. are resistant to cleansing and can accumulate litter.[79] In addition, the locality of Purmerend is especially relevant as it is within an extensive polder.[80] Waterways line many streets – including in the example above. Once litter is within a waterway, it will move, and even in an enclosed system of water like a polder, where a path to the sea is not immediate, waterways are not cleaned as regularly or as easily as a street, and so the litter is likely to remain unremoved. Ultraviolet (UV) light mitigated degradation over time will produce smaller and smaller fragments of plastic, which will not be so easily constrained within the polder.

The distribution of litter at every level is characterized by extreme spatial and temporal variability and the story of unmanaged terrestrial litter is no different. It is expected that there will be some locations, because of their nature, that are sinks for disproportionate quantities of this type of litter, and others that are, whether additionally or instead, the source of disproportionate quantities of litter transitioning over the land-water boundary. However, mapping the distribution and extent of these locations is not possible with current data availability; it would additionally require an extensive geospatial mapping exercise.

It is not currently possible to base an estimate of unmanaged terrestrial litter load on empirical data.

A3.1.2.2 Review of estimates of riverine litter load

There are several types of study that aim to understand riverine litter loads. Most, however, fail to provide robust estimates of the total annual litter load of a river, or the amount of litter produced by a city, or catchment, that makes its way into rivers in a certain time period.

The main issues are:

- **Litter size being sampled does not adequately capture macro litter.** Many of the studies rely on water surface or water column sampling using suspended nets such as manta nets. These often have small mesh sizes such as 0.333 mm, or a few mm at the most. These mesh sizes are susceptible to clogging and so are typically only deployed for 30-60 minutes. This sampling strategy is unable to account for the extreme temporal and spatial heterogeneity of macro-litter across a river cross-section over days, weeks and months: it seems reasonable to conclude that these studies capture a very small proportion of a river's macro-litter load.
- **The models' reliance on assumptions from other studies and riverine data that does not adequately represent macro-litter load.** There are two large-scale models of riverine litter currently available; both have used estimates of littering rate, and a marine litter conversion rate derived from Jambeck et al. (2015).[81] (reviewed in Section A3.1.2.3). They also use the riverine data which,

[79] MSW Consultants (2009) *2009 National Visible Litter Survey and Litter Cost Study*, Report for Keep America Beautiful inc., 2009

[80] Drained area of land where water level is carefully managed

[81] Ibid.

as mentioned immediately above, probably fails to capture the macro-litter element, and understates the riverine load.[82]

- **Accounting for detritus in riverine litter tonnages**. For studies that sample waste collected in booms, waste collected from waterbodies by waste clearance vessels or opportunistically in structures such as dams, typically an enormous amount of detritus is collected, ranging anywhere from 60% to 98% of what is collected. In some studies, the composition of waste has not been recorded, and there is a further difficulty which has to be considered when considering measured proportions between studies as these are heavily influenced by whether the composition was determined by wet, or dry matter content – the differences are likely to be large since the method used for reporting will enormously affect the weight of detritus, as well as of paper, or other absorbent elements of litter.
- **Capture efficiency unknown.** For these more 'macro' focussed studies, the capture efficiency of the waste capture method, as % of annual load is often entirely unknown. Booms – even if they are an array - may still have a low rate of capture unless they block the entire river, which is often avoided, for navigation purposes.[83] Booms may also not capture submerged litter at all well. Given the massive spatial and temporal variability of riverine litter, this reduces the utility of such studies for estimating per capita waste loads.
- **Estimating catchment and its population correctly.** For some of the studies, the catchment area and population has not been determined, making it difficult to estimate per capita waste loads. For others, it has been possible to make an approximate estimate but the quality of this limits the quality of any derived estimate.
- **Inability to take into account local variation in unmanaged terrestrial litter per capita.** Especially where data comes from the US, with a per capita national waste generation 53% higher than that of the EU-28, and a more pronounced culture of eating out and on-the-go, using the per capita riverine waste loads will probably overestimate the proportion of riverine litter compared to our estimates of all litter.

There are however, a few sources of information which have been found to be useful.

One source comes from those of the US which have implemented Total Maximum Daily Loads for litter in particular rivers. To support the target of a zero daily load, a few catchments have estimated the total input of litter via CSOs and storm-drains in the catchment by sampling outflow in different seasons, in locations representing different land-use, and prorated for the whole catchment, taking into account both land-use types and annual rainfall in the catchment. In all cases, importantly, detritus was excluded from the estimate. Samples were also variously confirmed to have been drip-dried or dried, and with liquids also removed from beverage

[82] Lebreton, L.C.M., van der Zwet, J., Damsteeg, J.-W., Slat, B., Andrady, A., and Reisser, J. (2017) River plastic emissions to the world's oceans, *Nature Communications*, Vol.8, p.15611,Schmidt, C., Krauth, T., and Wagner, S. (2017) Export of Plastic Debris by Rivers into the Sea, *Environmental Science and Technology*, Vol.51, No.21, pp.12246–12253

[83] Gasperi, J., Dris, R., Bonin, T., Rocher, V., and Tassin, B. (2014) Assessment of floating plastic debris in surface water along the Seine River, *Environmental Pollution*, Vol.195, pp.163–166

packaging.[84,85,86] In each case, the population of the catchment was known, or was possible to estimate, with reasonable accuracy.

A second source of information comes from case studies of the deployment of a litter collecting vessel, a "Water Witch", in various UK locations. Not all of these case studies provide tonnages which are a reflection of litter alone, since some of the craft are also able to winch up heavy items of detritus, or litter, such as shopping trolleys, or carry out clearance of weeds, algae and silt. There is one example where the nature of the craft (a light craft for litter-clearing only) and the nature of the water body it clears, gives better insight as to the litter load for a small catchment. The example given is that of the harbour in Bristol, UK, which is an area of water crossing the centre of the city, bounded by a lock at both ends. At the upstream end, a weir diverts most of the flow of the River Avon, including most detritus, through a channel that flows parallel to the harbour. The water in the harbour flows slowly, and so it seems safe to assume that most litter is likely to remain within it. Although the 'catchment' will be smaller than the population of the city, as there are two other waterways which can be expected to receive a significant amount of storm overflow and direct litter input, leading to an underestimate of the per capita waste load, the harbour likely receives a large quantity of direct input because of the surrounding land-use (high-footfall retail, night-life and other recreational use), which will be a positive driver of the per capita waste load.

The population of the various catchments was determined to the extent possible, and per capita litter loads were estimated.

A3.1.2.3 Review of estimates of coastal litter load

We are aware of studies that have attributed a nominal percentage to the amount of litter reaching the marine environment. For example, in a study quantifying the impacts of plastics worldwide, it was assumed that 100% of littered packaging and 100% of littered cigarette butts reached the marine environment, while only 50% of other products did.[87] The amount of littered items was therefore retrospectively derived from an estimate of marine litter input of 20m tonnes from Vannela (2012) which derived the estimate very crudely from its assumption that an estimated 10% of around 200m tons of plastic produced annually ends up in the oceans.[88] A second iteration of the study adopted assumptions made in Jambeck et al.(2015)[89] – i.e. that

[84] District of Columbia Deparment of the Environment, and Maryland Department of the Environment (2010) Total Maximum Daily Loads of Trash for the Anacostia River Watershed

[85] California Regional Water Quality Control Board (2007) *Trash Total Maximum Daily Loads for the Los Angeles River Watershed*, 2007, http://www.epa.gov/waters/tmdldocs/34863-RevisedStaffReport2v2.pdf

[86] Maryland Department of the Environment (2014) Total Maximum Daily Loads of Trash and Debris for the Middle Branch and Northwest Branch Portions of the Patapsco River Mesohaline Tidal Chesapeake Bay Segment

[87] UNEP, Trucost, and The Plastic Disclosure Project (2014) *Valuing Plastic. The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry*, accessed 30 June 2014, http://www.trucost.com/_uploads/publishedResearch/Valuing%20plastics%20final%20report.pdf

[88] Vannela, R. (2012) Are We 'Digging Our Own Grave' Under the Oceans?: Biosphere-Level Effects and Global Policy Challenge from Plastic(s) in Oceans, *Environmental Science and Technology*, Vol.46, No.15, pp.7932–7933

[89] Jambeck, J.R., Geyer, R., Wilcox, C., et al. (2015) Plastic waste inputs from land into the ocean, *Science*, Vol.347, No.6223, pp.768–771

2% of items were littered, and 40% of these items (i.e. the upper bound) made their way into the sea.[90]

These two important assumptions – 2% of items are littered, and 40% make their way to sea - made in the widely reported work by Jambeck et al. (2015), are not, given the quality of data available, well-grounded in empirical data. Reflecting this fact, the proportion of items making their way into the sea were modelled in the study using low, mid and high range (15%-25%-40%) estimates, to give an idea of the sensitivity of the estimate to this assumption. It is not obvious, though, whether even the full range of these values covers the true figure. Therefore, the mid-range estimate reported by the study for the EU-28 input of litter from coastal areas, at 102,038 tonnes in 2015, is highly sensitive to these assumptions and should be treated as an order of magnitude estimate only.

A3.1.3 Review of litter composition data

There are two main sources for this sort of data:

- Litter counts, conducted as part of land-based litter monitoring; and
- Compositional analysis of waste, usually reporting categories based on weight.

Litter counts, as the name suggests, primarily rely on analysis *in situ* of the number of items collected. By its very nature, it refers exclusively to ground litter (rather than e.g. bin litter). In terms of how representative it is of actual litter, it is important to understand that some items, such as chewing gum 'stains' (i.e. chewing gum stuck to the ground) are likely to be overrepresented because they represent an *accumulation* over time as opposed to items that are more easily removed by street cleansing services, for which the figures may reflect a flow of litter since the previous cleaning event. There may also be a tendency for cigarette butts to be over-represented for similar reasons; they are small and not easy to pick up with a litter picker. However, the extent of over-representation will be less than for chewing gum because they can still be removed effectively by a number of routine cleansing practices such as manual or mechanical sweeping. Typically these studies, as they never actually collect the litter, do not report a total weight for the sample. Converting % counts to % weights for particular items therefore would require assigning weight conversion factors to every item monitored; a small proportion of items will fall in catch-all categories, e.g. 'other packaging' and hence factors cannot be estimated robustly.

Compositional analysis of collected litter (e.g. on the basis of samples provided by a municipality, or as collected by the study team) is reported as either count, volume or weight, depending on context and method chosen, as well as precedent. Typically weight is the most popular choice. It is very rare to find analyses broken down by volume. For litter, this is significant because, especially on land, but also with respect to river-bank and beach litter, volume may be one of the metrics most correlated to litter impacts with respect to disamenity.[91] Because it samples collected litter, any items that are difficult or less likely to be collected will be under-

[90] Trucost (2016) *Plastics and Sustainability: A Valuation of Environmental Benefits, Costs and Opportunities for Continuous Improvement*, Report for American Chemistry Council, 2016, https://plastics.americanchemistry.com/Plastics-and-Sustainability.pdf

[91] Once at sea, weight, as a measure of plastic load, for example in terms of potential for secondary microplastic generation, will become more important; however in both contexts, shape and size are important and these are not consistently approximated well by count, weight or volume.

represented (e.g. small, light items such as cigarette butts or film). Food waste, which can be a heavy fraction of e.g. bin litter, may additionally have a tendency to 'disappear' from the equation, eaten by wildlife). Compositional analysis may be conducted on ground litter, bin litter or mechanical sweepings, and it is important to understand what the scope of a particular study refers to for comparability and an understanding of what the analysis actually reflects.

In addition, a third option has been considered. Analysis of river-bank litter data and beach litter data could also be used to shed light on litter composition. It is considered that river-bank litter has already undergone transport within freshwater before high water and its descent causes items to be caught on vegetation and mud or other features in the waterway. Beach litter, integrating both what has been in the sea for some time as well as newly deposited items, will have had time for there to be more influences on its composition. We can expect that different items will have different transfer rates from the terrestrial to the riverine environments, and also that different items will have different propensities to find themselves in different riverine and marine compartments (e.g. floating, water column, sea or river -bed, beached on the riverbank or beach. There will be additional sources contributing to the litter in riverine and marine environments, such as those from sewage, as well as flytipping and commercial and household waste escaping from waste management – this would lead to an underestimate of the littering rate for particular items in comparison with inland litter analysis. Therefore, they are not ideal sources of data; but in the absence of any other information about particular items, could be used as a very rough approximation.

Finally, it is expected that the time of year in which a study conducted will influence the litter amount and composition of litter, which is likely to undergo marked seasonality. When the weather is better, especially in summer months in more northern countries, people spend more time outside and consume more items on-the-go. There may similarly be trends in tourism that lead to greater footfall in, often. summer. It will not be possible to take this into account (it is rare to find studies that sample in each season or once a month, to produce a seasonal trend for waste generation that can be used to weight other data), but at least, it should be borne in mind as a source of variation.

In addition, water saturation (of items such as cigarette butts, paper, card, sanitary products), items of packaging which are not empty (i.e. a food waste fraction not properly separated and accounted for), and packaging contaminated with soil, mud or sand, can all work to increase the error and decrease the comparability and accuracy of composition statistics. Again, this must be borne in mind that this is a potential source of error but it is not possible to retrospectively 'correct' each dataset for this.

The datasets reviewed are summarised in Table A3.2. The general characteristics of the data found is summarised as follows:

- For some of the waste compositional analyses, the scope is uncertain. The waste, sent as samples by municipalities, is derived in some cases from a mixture of sources which is not disaggregated or specified; therefore, the composition can be expected to differ from litter from street-pickings alone. However, there are five examples where it is certain that the data apply to street litter.
- For most of the land-based litter monitoring counts, not only is the weight of each fraction not recorded, but also, total weight is not recorded. It is considered too inaccurate to convert percentage counts to percentage by weight in these

instances, as explained above. Only one *in situ* count based study collected the waste and weighed it, as well as counting it. Therefore, most of these studies cannot be used for our purposes.

- There are no beach litter studies, to our knowledge, where the prevalence of items are recorded in terms of weight. There is one example of river-bank monitoring that measured composition by weight as well as by count.
- There are very few examples of beach litter data where the total weight of litter samples are recorded; and one example where, for riverine data, the total weight of litter samples are recorded. Beach litter is likely to be the farthest removed, in terms of the source, and hence, the composition, from general land-based litter, so it is less than ideal to use as a means to gap-fill the land-based street data.
- Categories are often not adequate to report on all items of interest. *In situ* counts are likely to be categorized in a more disaggregated way than more typical waste characterization studies; however, they each have their pros and cons. For example, waste composition analysis is likely to have a better disaggregation by materials, and is good at distinguishing recyclable from non-recyclable material – as this is often the primary reason this sort of analysis is commissioned. However, they tend to have poor disaggregation by particular item types. For example, confectionery and snack wrappers are typically included within a broad category like 'other plastic packaging' or 'other flexible plastic'. Straws, stirrers and cutlery are usually not distinguished at all and are also likely to be appearing in general categories like 'other dense plastic items', 'other paper items' or 'other combustibles. There is only one example where cups were included as a category. *In situ* counts are likely to have categories more based on functional items – but may have a poor materials breakdown; for example, 'takeaway containers' is likely to fail to distinguish between plastic, plasticized card, card or foil containers. Most of the categorisation schema, whether for *in situ* counts or waste composition analysis do not include 'cutlery' or 'stirrers' as an item.
- With respect to sanitary items such as wet wipes, cotton buds and sanitary towels and tampons, we do not expect to find cotton buds or particularly wet wipes disposed of as street litter. Many of the studies evaluated do have a category like "absorbent hygiene products". This will include nappies and incontinence wear, and it is not possible to make a further disaggregation of the items. We assume that the main pathway for these items to reach the wider environment is through the sewage system.
- There were two examples where 'takeaway associated litter' represented a much higher proportion of litter than other studies (i.e. 20, 30% - these data points were excluded as it was deemed likely that they included food waste, which tends to arise in these proportions for some litter samples).
- Sampling period – these vary considerably between the studies, with spring and autumn months predominant, followed by winter then summer months.

In conclusion, there are very few data points for estimating the percentage by weight share of particular single use plastic and non-plastic items in litter that has been dropped on the ground. The data points that have been deemed usable are summarised in Section A3.1.5.1 and Table A3.4.

Table A3.2 Review of data on the composition of litter in the environment

Location, year	Time of year	Method - including whether count or weight recorded. If count, is total weight estimated?	Scope	Item types covered - in relation to top ten list and alternatives	Reference
Scotland, UK, 2010	April and September	Samples sent to consultants, sorted and weighed.	"Litter and street sweepings", "Parks and gardens", "Beaches". No gully waste analysed. Could be ground or bin litter - undetermined.	PET and HDPE plastic bottles, glass packaging, alu cans, packaging plastic film (separately from bags), other plastic packaging, other recyclable/non-recyclable paper, thin card packaging, absorbent hygiene products.	AEA, and WastesWork (2010) *The composition of municipal solid waste in Scotland*, Report for Zero Waste Scotland.
England, UK, 2010/11	Mostly spring and autumn	Samples sent to consultants, sorted and weighed.	Street sweepings, cleansing and litter residual; also street bins recycling. Likely to be a mixture of bins and ground litter.	Card packaging, glass packaging, Alu drinks cans, plastic film, plastic bottles. Any other splits applied from kerbside residual data from same study.	Resource Futures (2013) Updated Compositional Estimates for Local Authority Collected Waste and Recycling in England, 2010/11, Report for DEFRA.
Wales, UK, 2017	March	Samples sent to consultants, sorted and weighed; counts were also taken for selected categories (e.g. coffee cups).	Litter bins, recycling on the go bins and ground litter, disaggregated.	Coffee cups, plastic bottles, glass bottles and jars (together), ferrous cans and tins, non ferrous cans, takeaway packaging (branded and not coffee cups), cigarette butts, chewing gum. Sanitary products and nappies - together.	Unpublished - Resource Futures (2017) *Litter composition study - Wales*, Report for WRAP, March 2017
East Lindsey, UK, 2005	August	Samples sent to consultants, sorted and weighed.	Litter bins and pickings both in town, beach and on foreshore, disaggregated.	Cans, PET bottles, glass bottles and jars (together), "fast food related litter", "smoking related litter".	Community Recycling Services (2005) *Waste compositional analysis of street litter*, Report for East Lindsey District Council.
England,	Dec-March	In situ count. No	Ground litter	All except - SRD, cutlery or stirrers. No	INCPEN, and Keep Britain Tidy (2014)

Location, year	Time of year	Method - including whether count or weight recorded. If count, is total weight estimated?	Scope	Item types covered - in relation to top ten list and alternatives	Reference
UK, 2014		total weight recorded.		material breakdown aside from where material linked explicitly to item type (e.g. can). Issues around smoking and chewing gum litter. 25% 'other', not further subdivided.	*Litter Composition 2014*
Scotland, UK, 2014	Dec-Feb	In situ count. No total weight recorded.	Ground litter	All except - SRD, cutlery or stirrers; but do have 'other' broken down into food and, separately, drink related items. though are small categories anyway. No material breakdown. Issues around smoking and chewing gum litter.	INCPEN (2014) *Composition of Litter in Scotland*, 2014
Republic of Ireland, UK, 2016	March-December	In situ count. No total weight recorded.	Ground litter	Has most categories, except stirrers, cutlery, cotton buds and wet wipes; limited material breakdown.	Tobin (2016) *National Litter Pollution Monitoring System, System Results 2016*, Report for Department of Communications, Climate Action and Environment
Netherlands, 2008-2014	Sample taken every month, April-Oct	In situ litter counts converted to weights using conversion factors	Ground litter	Cigarette butts, cups, trays, other take-away (material unclear), plastic bottle, glass bottle, cans, candy wrappers, plastic packaging and plastic non-packaging	KplusV (2015) *Kosten en omvang zwerfafval*
Mol, Belgium, 2012	Sample taken every month, April-Oct	Samples collected, sorted, counted; total sample weighed, some fractions weighed and volume estimated.	Ground litter - by highways	Bags of PMD (cans, plastic bottles and cartons) (19%) vs residual (81%) weighed; volume (40%:60%); PMD split by count (for cans, plastic bottles and cartons) and then weight (for cans only).	Indevuilbak (2012) *Voorstelling Cijfers Mol*
Flanders, Belgium, 2006	Spring and summer	Litter collected from test locations of 32 land-use types;	Ground litter	Paper food packaging, glass bottles, metal cans, plastic bottles, other packaging plastic items, plastic non beverage packaging,	OVAM (2006) Zwerfvuil rapport tellingen proefstroken 2006

Location, year	Time of year	Method - including whether count or weight recorded. If count, is total weight estimated?	Scope	Item types covered - in relation to top ten list and alternatives	Reference
		results extrapolated to Flanders; weight and count recorded.		cigarette butts, "hygienic waste".	
Vienna, Germany, 2014	October	Samples collected, sorted, counted and weighed.	Litter collected from river bank a month post-flood by volunteers. Site downstream of Vienna.	PET bottles, food containers, other bottles and containers, caps and lids, "dishes, cutlery straws, cups" (as one category), sanitary waste (all together), other plastic packaging, glass drink bottles, beverage cans.	Schüttpelz, N.S. (2014) *Measuring Marine Litter density, mass and composition – including a case study on land-based litter along the Danube*, dissertation submitted at BOKU, 2014
Berville-sur-Seine, France, 2013	Unknown	Samples collected, sorted, counted; total sample weighed	Litter collected from Seine river bank post-flood; downstream of Rouen	OSPAR protocol used. Includes: Plastic drinks bottle; food containers inc fast food, caps and lids, sweet wrappers, balloons, cigarette filters, metal cans, glass bottles, cotton buds, sanitary towels, tampons.	http://maldeseine.free.fr/OSPAR.html

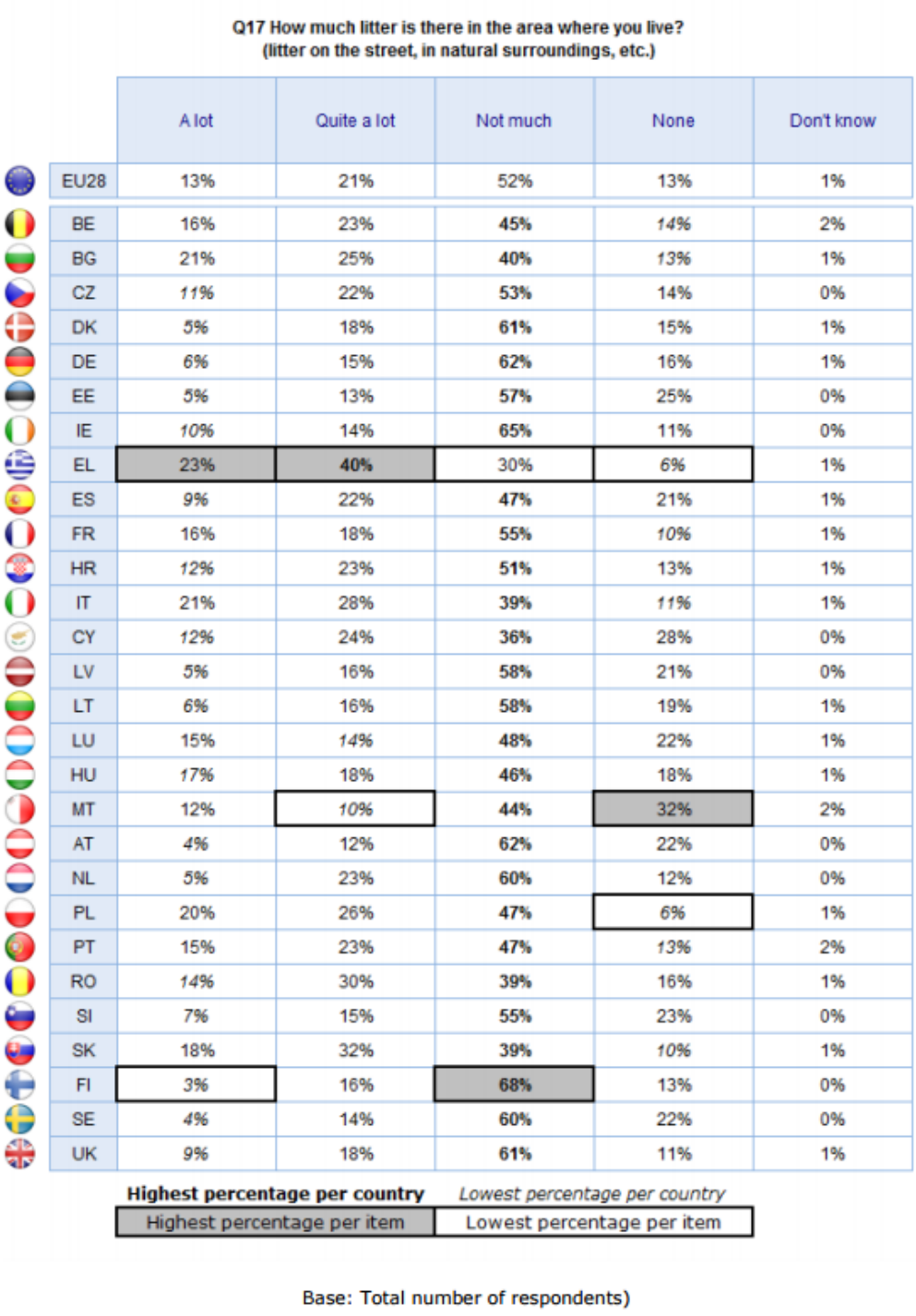
A3.1.4 Review of other data sources on littering rates

The European Commission conducted a survey to understand citizens' perceptions and attitudes towards litter and waste management across Member States, and highlights the differences between countries.

Respondents were asked to assess the amount of litter in the area where they live (Figure A3.2). However, because it cannot distinguish between amount of litter and relative 'acceptability' of litter in different places, it does not necessarily function as a reflection of littered amounts in different Member States. It could be compared to actual observations of litter to see how accurate perceptions are, and the relative 'acceptability' of particular amounts of litter in different countries, once comparable indicators of cleanliness are available. [92]

[92] European Commission (2014) *Attitudes of Europeans Towards Waste Management and Resource Efficiency*, accessed 4 April 2017, http://ec.europa.eu/public_opinion/flash/fl_388_en.pdf

Figure A3.2 Assessment of Litter in Respondents' Areas



Q17 How much litter is there in the area where you live?
(litter on the street, in natural surroundings, etc.)

	A lot	Quite a lot	Not much	None	Don't know
EU28	13%	21%	52%	13%	1%
BE	16%	23%	**45%**	*14%*	2%
BG	21%	25%	**40%**	*13%*	1%
CZ	*11%*	22%	**53%**	14%	0%
DK	*5%*	18%	**61%**	15%	1%
DE	*6%*	15%	**62%**	16%	1%
EE	*5%*	13%	**57%**	25%	0%
IE	*10%*	14%	**65%**	11%	0%
EL	**23%**	**40%**	30%	*6%*	1%
ES	*9%*	22%	**47%**	21%	1%
FR	16%	18%	**55%**	*10%*	1%
HR	*12%*	23%	**51%**	13%	1%
IT	21%	28%	**39%**	*11%*	1%
CY	*12%*	24%	**36%**	28%	0%
LV	*5%*	16%	**58%**	21%	0%
LT	*6%*	16%	**58%**	19%	1%
LU	15%	*14%*	**48%**	22%	1%
HU	*17%*	18%	**46%**	18%	1%
MT	12%	*10%*	**44%**	**32%**	2%
AT	*4%*	12%	**62%**	22%	0%
NL	*5%*	23%	**60%**	12%	0%
PL	20%	26%	**47%**	*6%*	1%
PT	15%	23%	**47%**	*13%*	2%
RO	*14%*	30%	**39%**	16%	1%
SI	*7%*	15%	**55%**	23%	0%
SK	18%	32%	**39%**	*10%*	1%
FI	*3%*	16%	**68%**	13%	0%
SE	*4%*	14%	**60%**	22%	0%
UK	*9%*	18%	**61%**	11%	1%

Highest percentage per country *Lowest percentage per country*

Highest percentage per item | Lowest percentage per item

Base: Total number of respondents)

Source: European Commission, 2014

A3.1.5 Review of data on sanitary waste disposal

There are a few examples of surveys where the behaviours of respondents around sanitary waste disposal down toilets have been interrogated. Many of these however have been conducted as part of public awareness campaigns and the methods are not published. Issues that the resulting data typically raise are:

- The exact nature of the question asked is unclear or varies. Respondents might be asked:
  - if they flush certain or any sanitary items down the toilet
  - if they have ever flushed certain or any sanitary items down the toilet
  - how many items they flushed in a defined time period

The types of items flushed may or may not be determined.

Ideally, the number of items flushed in a defined period of time would be determined. There are, however, only two studies which made this type of estimate: both specify what items for which flush frequencies are being estimated, but one does not cover all the item types under consideration here.

For the other surveys, it is not really possible to understand whether the result refers to occasional, or habitual, disposal. By assuming the answer indicates habitual disposal (a highest value of 100% of the items or item type disposed in the toilet), this could overestimate the proportion of items disposed of in this way by a large margin. For example, if respondents who said they did dispose of items this way only did so for on average of e.g. 10% of items used, but it was assumed that the respondents were actually referring to all items, the proportion of items flushed down the toilet would be wrongly predicted by a factor 10.

- Whether the survey question uses item users as a base or the general population

Determining this is of vital importance when assessing the meaning of the percentages reported. For example, if the user base is a much smaller proportion of the survey population, the proportion of respondents stating they dispose of particular items down the toilet would enormously underestimate the proportion of items of that are disposed of in this way. For example, if the survey population is representative of the adult population over 18 years of age in a country, for some items such as menstrual products, only a proportion of those people could be expected to be users of these products. This would be primarily women between the age of 18 (as the survey does not cover women below the age of 18; even though the average age of the onset of menses is around 12) and the age of 51 (the average age for menopause). In the EU, women between 18 and 51 years of age constitute 28% of the total population over the age of 18. Therefore, the corresponding 72% of the sample population who would never be users of menstrual products would invariably respond that they did not flush that item type. To illustrate; if it was reported that 6% of the survey population disposed of sanitary towels in the toilet, and the survey population was representative of the general population over 18, this would be better expressed, in terms of numbers of *users*, to the proportion of the 28% of potential item users represented by the 6% of respondents (or 6 divided by 28, which equals 21%).

In some examples, it is not specified what the base population is. In these cases, it is held most likely that a general population is used, as the types of surveys conducted for generating content for awareness campaigns tend to be quite simple, without many layers of questions, so as to increase engagement.

In some examples, it is clear that the base population is representative of the general population, rather than item users. In this case, the proportion of people who dispose of particular items down the toilet underestimates the proportion of items of that are disposed of in this way. In two studies, the number of items flushed in a given time period is determined, so this issue is circumnavigated. For one of these studies, it was explicitly stated that the gender and age of respondents was taken

into account when making these quantitative, absolute measurements, so they should be more accurate; however, the complete method is not given in the publication.

Because so few studies have been conducted into this question, we have no basis upon which to understand how flush rates may vary between Member States. For example, some places have sewage systems that do not even cope well with toilet paper, and people are accustomed to dispose of this paper in bins. In this scenario, it is unlikely that citizens would dispose of almost any other sanitary item in the toilet. General attitudes and awareness towards the environment in a Member State might be another proxy indicator of how likely this disposal behaviour is, but it is not quite specific enough to gauge awareness of this issue, the issues associated with which are not widely understood (for example, in one UK survey, 41% of respondents did not know that sanitary items could not be disposed of in the toilet).[93]

A3.1.5.1 Assessment of capture rate of sanitary items

The capture of flushed sanitary items is very difficult to assess as it depends on the presence of combined sewers (see Section A2.5.7), the number of CSOs, the number already screened and those not, rainfall patterns and other factors that result in CSOs discharging to watercourses. For the purposes of this modelling it was assumed the capture rate was similar to the litter collection rate, of around 90%.

A3.1.6 Approach

The average litter tonnage for the studies deemed of reasonably certain scope – i.e., where the estimate applied to the amount of litter dropped and collected, rather than bin litter – was used to generate an estimate for the EU. Only the data points for EU-28 countries were included. This generated a figure of 3.76kg per capita per year. For the purpose of this study, we have assumed this as an overall average for the EU-28, although it will, clearly, vary by Member State (see Figure A3.2 above).

We have further assumed that around 5% of total items littered make their way into the freshwater and. subsequently, the marine environment; this figure being supported by the studies summarised in Table A3.3. We assume that the same proportion of items remain littered on land.

This gives a total littering rate of 4.18 kg per capita.

[93] https://www.fablittlebag.com/tampon-research/

Table A3.3 Riverine litter loads per capita, selected studies

Location	Per capita riverine litter load Kg/capita	Per capita managed terrestrial litter Kg/capita	% of per capita managed terrestrial litter	Source
Washington DC, USA	0.43	5.75[1]	7.55%	Total Maximum Daily Load (TMDL) catchment estimation, Anacostia River
Baltimore, USA	0.22	5.75	3.79%	TMDL catchment estimation, Baltimore Harbour
Los Angeles, USA	0.29	5.75	4.96%	TMDL catchment estimation, Los Angeles River
Average			5.4%	

[1]General per capita littering rate of 3.76 increased by 53% to reflect US levels of waste generation compared to EU; US = 729kg/cap/yr; EU-28= 477gk/cap/yr

The composition of litter in terms of percentage by weight was determined for a selection of items based on the few data points available. The figure and rationale for each item is explained in Table A3.4. It is very important to bear in mind that owing to the paucity of data, these figures cannot be taken to represent an accurate picture of the true situation, but we believe they are as reasonable an estimate as can be made without much greater time and effort being expended on data gathering. Litter composition can be expected to vary considerably between places and seasons, whereas these estimates are made based on mainly one or two datapoints. For some items (e.g. cutlery, and stirrers), judgement has been applied based on related, broader categories. For one item (straws), an additional datapoint was sourced by converting percent by count to percentage by weight data. For several items, data are derived from riverine studies as there was not the appropriate percentage by weight data available for street litter.

Table A3.4 Summary of % weight litter contribution of specific items to litter in the environment

Item	%wt	Source
Cigarette butts	0.34%	Average, street pickings data, Wales and Flanders
Plastic drinks bottles, caps and lids	8.79%	Average, street pickings data, Wales, Louth, Skegness, Flanders
Glass bottles	*7.45%*	*Average, street pickings data, Wales, Louth, Skegness, Flanders, all category ("bottles and jars") apportioned to bottles as was street pickings*
Cans	*9.79%*	*Average, street pickings data, Wales, Louth, Skegness, Flanders, all category ("ferrous tins and cans") apportioned to drink cans as was street pickings*
Crisps packets / sweets wrappers	0.41%	Street pickings data, Wales – "Recyclable plastic film+other plastic film" = 4.1%. This excludes carrier bags, but may include other

Item	%wt	Source
		flexible packaging and e.g. black bin bags. Therefore a small, indicative amount, 10%, has been apportioned to snack wrappers. No other acceptable data, by weight, was found for this item type.
Cutlery	0.045%	In the Danube river-bank study, "Dishes, cutlery, straws, cups" were 0.09% by weight. Given that some items start to become over and under-represented during transit, and that there are more sources for riverine litter, and the proportion of unidentifiable fragments also increases significantly, we have posited that this is an underestimate of the category, and apportioned a small, indicative amount to each of the items of interest. No other data, by weight, or disaggregated by material, was found for this item type.
Straws	0.13%	Average of values from Danube (0.045% - small indicative amount) and Seine (0.13% wt). No other source of data by weight was available for this item type.
Stirrers	0.045%	Small indicative amount apportioned on basis of Danube study. No other source of data by weight was available for this item type.
Cup and cup lids	3.74%	Street pickings; Wales. Unsure if lids included or not.
Food containers including fast food - Plastic	2.61%	Street pickings, Wales
Food containers including fast food - Paper and card	*5.07%*	*Street pickings, Wales*
Food containers including fast food - Aluminium	*0.63%*	*Street pickings, Wales*
"Single use plastic items" (Subtotal)	16.11%	

Sources: Unpublished - Resource Futures (2017) Litter composition study - Wales, Report for WRAP, March 2017, Unpublished, Community Recycling Services (2005) Waste compositional analysis of street litter, Report for Report prepared for East Lindsey District Council., OVAM (2006) Zwerfvuil rapport tellingen proefstroken 2006, Schüttpelz, N.S. (2014) Measuring Marine Litter density, mass and composition – including a case study on land-based litter along the Danube, dissertation submitted at BOKU, 2014

For some items such as cups, food containers and cigarette butts, the initial littering rate calculated in Section A3.1.7 was considered too high to be realistic, suggesting that the above composition by weight was overestimated for these items, perhaps owing to waterlogging of items. Therefore, a compensation factor was input that reduced the litter composition by a factor of three for cigarette butts and two for cups and food containers (often part paper). The assumption is that a third and a half of their weight is attributed to water. An adjustment was also made for crisp packets and wrappers, on the basis of contamination and over-representation in the

environment owing to their shape and nature. The compensation factor reduced the litter composition by a factor of two.

For cans and bottles, for Member States which have a DRS system in place, the littering rate is assumed to be 80% lower than the other countries. Rates have therefore been adjusted to reflect this for countries with DRS.

For sanitary items, as they are considered predominantly to find their way to the environment by a different pathway – i.e. disposal down the toilet in the home or other premises, a % 'littering rate' has been based on a synthesis of the available survey-based studies as well as consultation with relevant stakeholders.

For the studies where the number of items flushed over a defined period of time was estimated, the % flush rate was determined in conjunction with the market data on consumption. No weighting was made for behaviour in different MS as no data was available to base this on. These rates are presented in Table A3.5.

Table A3.5 Summary of flush rates for sanitary items under consideration

Item	Flush rate	Source
Wet wipes	31%	*Average of* - Gouda et al (2014) (Baby wipes) - Think Before You Flush campaign – (2017) (Baby wipes adjusted on basis of % parents, Facial wipes adjusted on basis of gender) - EDANA estimate - United utilities survey (baby wipes and cleaning wipes)
Cotton buds	14%	*Average of* - Gouda et al (2014) - Think Before You Flush campaign – (2017)
Sanitary towels	21%	- Think Before You Flush campaign – (2017)

For multi-use items, the standard number of uses was defined and the littering rate divided by this. The standard number of uses defined is shown in Table A2.7.

A3.1.7 Results

As described in Section A3.1, littering rates of specific items have been estimated by combining consumption data (see Section A2.1) with data on total litter dropped and litter composition. For the 'flushables' only the flush rate defines the littering rate. The results are summarised in Table A3.6.

Table A3.6 Littering rates of different items

Item	kg/capita littered	Tonnes littered	Consumption, EU-28, tonnes	SUP littering rate	SUNP littering rate	MU littering rate
Cigarette filters	0.01	2,174	7,531	29%	29%	-
Drinks bottles	0.33	168,578	2,703,641	6%	6%	0.002%
Cotton buds	-	-	9,547	14%	14%	0.02%
Crisp packets	0.02	7,866	117,045	7%	7%	-
Sweet wrappers	0.02	7,866	138,965	6%	6%	-
Wet wipes	-	-	47,720	31%	31%	0.01%
Sanitary towels	-	-	122,698	21%	21%	0.05%
Cutlery	0.002	959	206,605	1%	1%	0.000%
Straws	0.003	1,660	88,450	2%	2%	0.000%
Stirrers	0.00	192	139,252	0.1%	0.1%	0.000%
Drinks cups and lids	0.14	35,920	302,417	12%	12%	0.02%
Food containers	0.10	25,029	544,382	5%	5%	0.01%

For the single use plastic items considered here, the total tonnage of items dropped as litter is estimated to be 237,000 tonnes, while the tonnage of items flushed sums to 42,000 tonnes. Of a total of 280,000 tonnes of items, the amount then entering the marine environment is calculated to be around 15,000 tonnes. This takes into account the proportion of “flushables” removed during waste water treatment.

A3.2 Recycling rates

Ideally the recycling rates for different single use plastic items would be monitored and reported. However, usually recycling rates are published on the base of a group of products (such as “packaging” or “municipal”) or material type (e.g. “plastic”) with little other disaggregation that helps to understand the fate of specific items. This is especially problematic for establishing recycling rates of smaller items.

In order to understand the proportion of a particular item that is effectively recycled, the type of information that is required, as a starting point, is:

- An assessment of the typical composition of the item – which plastic(s) is it made of?
- Recycling rates for packaging (for packaging items only)
- Recycling rates for specific material streams (e.g. PP, bottle PET, PS)
- Other item specific information about recycling rates
- Consideration of the options for collecting and sorting the material in such a way that it might be recycled.

Recycling rates are generally reported in terms of the quantity of material that was collected or sorted for recycling, as a proportion of the total in the waste stream. Therefore, in addition, it is important to take into account not only the amount collected / sorted for recycling, but also, the actual quantity that is ultimately recycled. Material is lost from the recycling stream for a variety of reasons, at several junctures. Several types of single use plastic items under consideration are particularly susceptible to this loss because of their characteristics. The relationship between the amount collected for recycling versus the actual recycling rate is dependent on:

- Type of item – is it collected for recycling by municipalities or commercial contractors, and if so, through what type of collection scheme?
- Size, shape and colour of item
- Nature of the material of which the item is made (is there a market for this material?)

Quality, and appropriateness, of collection and sorting infrastructure to ensure recycling of the specified item

All of these factors will influence the quantity collected for recycling and the extent to which losses occur in the recycling process.

In the next sections, the available data on recycling rates and reject rates is reviewed.

A3.2.1 Review of recycling data

Packaging waste and recycling tonnages are reported to Eurostat under Member State reporting obligations under the Packaging and Packaging Waste Directive (PPWD). Data on plastic waste by sector was obtained from PlasticsEurope.

Recycling data of relevance to this study is available by waste stream according to the following breakdown:

- For packaging by major material stream – i.e. plastic, metal, glass etc (both for household waste, as well as commercial and industrial (C&I)),
- By major material stream (for all sectors/product groups as a whole),
- For plastics alone (for packaging household waste, for non-packaging household waste, as well as industrial packaging).

The data are summarized in Table A3.7, Table A3.8 and Table A3.9, for the baseline year, 2014, in order to give an idea of the figures that can be used as starting points to understand the recycling rates of particular single use items.

The Eurostat data are broadly aligned with data provided by PlasticsEurope. The total generation of plastic packaging waste for the EU-28 in 2014 (the latest data

available at the time of download) was 15.4m tonnes. This figure is very similar to that estimated by PlasticsEurope, in its annual plastics waste report, of 15.5m tonnes.[94]

PlasticsEurope estimates that around two thirds are household packaging wastes with the remainder arising from businesses. However, there is some evidence that the waste arising figures may be too low when comparisons are made with municipal waste statistics and compositions. Furthermore, packaging is generally believed to be consumed within a year of being placed on the market, and the consumption figure from EU production is around 20 million tonnes, over 4 million higher than the estimate figure for waste generation – furthermore, this does not include any packaging imported from outside the EU, or the quantity of secondary plastic on the EU market. This suggests that the arisings of plastic packaging waste reported by Eurostat are under reported. This would lead to an overestimate of recycling rates, which have been derived here by dividing the amount of packaging waste collected for recycling by the waste arisings estimate.

As a starting point, we have previously assumed that patterns of treatment of the packaging single use items within the group are assumed to be the same as for packaging items generally. For the non-packaging single use plastic items, these could be assumed, in the first instance, to be treated in line with the 'other non-household' plastic fractions (3% - see Table A3.8).[95]

The recycling rates by total material stream (all sectors) presented in Table A3.9 have the disadvantage that it is not possible to split them by sector – i.e. households, or the service sector for example, which would be more suitable for the items under consideration; the figures include the construction, manufacturing and agricultural sectors. This is because although waste generation for each material type can be disaggregated in this way, waste treatment for each material type is not disaggregated in this way. Where recycling rates for municipal solid waste are calculated and reported as per COM DEC 2011/753,[96] they are not disaggregated by material.

In terms of the tonnages of material recycled used to calculate the recycling rate, Eurostat metadata states that for the packaging recycling rate,

> *"'Recycling rate' means the total quantity of **recycled** packaging waste, divided by the total quantity of generated packaging waste."*
>
> *"The weight of recovered or recycled packaging waste shall be the input of packaging waste to an effective recovery or recycling process. If the output of a sorting plant is sent to effective recycling or recovery processes **without significant losses,** it is acceptable to consider this output to be the weight of recovered or recycled packaging waste."*[97]

For the data set on waste generation and treatment in all sectors, the Waste Framework Directive is referred to, which states

[94] Consultic (2014) *Post-Consumer Plastic Waste Management in European Countries 2014*, Report for PlasticsEurope, 15th October 2015

[95] The alternative would be to assume a rate similar to the total recycling rate for plastic for all sectors (60%) as given in the Eurostat data. However this is held to overstate the recycling rate of single use plastic non-packaging items because it will include a high proportion of pre-consumer waste from a commercial context; as well as all the household plastic packaging, which pushes up the rate.

[96] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011D0753

[97] http://ec.europa.eu/eurostat/cache/metadata/en/env_waspac_esms.htm

"'Recovery' means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function"[98]

From this it is understood that the tonnage, and hence the recycling rate, should be a 'real recycling rate' rather than the percentage *collected* for recycling. However, in practice, loss rates are not usually monitored and even more rarely reported. Therefore, it is not generally possible for a Member State to verify that their data satisfies these requirements. In practice, the statistics will be a widely varying scope.[99]

Table A3.7 Recycling rates for packaging by material, EU-28 (unless otherwise indicated), 2014

Packaging material type	Recycling rate
Paper and cardboard packaging	82%
Plastic packaging	40%
Wooden packaging	39%
Metallic packaging	75%
Aluminium packaging (average of 8 countries)	*62%*
Steel packaging (average of 8 countries)	*89%*
Glass packaging	74%

Source: Packaging waste by waste operations and waste flow [env_waspac]
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_waspacandlang=en

Table A3.8 Recycling rates for plastics deriving from different sectors, EU-28, 2014

Sector and item type	Recycling rate
Household plastic packaging	38%
Industrial plastic packaging	43%
Household, plastic non-packaging	3%

Source: Plastics Europe

[98] http://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX:32008L0098

[99] Eunomia Research & Consulting (2016) *Support to the Waste Targets Review*, Report for DG Environment, 2016

Table A3.9 Recycling rates for different material streams, for all sectors, EU-28, 2014

Material type	Recycling rate
Paper and card	76%
Plastic	60%
Wood	41%
Metal	92%
Glass	86%

Source: Category RCV_O (Treatment of waste by waste category, hazardousness and waste operations [env_wastrt]
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wastrtandlang=en

Generation of waste by waste category, hazardousness and NACE Rev. 2 activity [env_wasgen]
http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_wasgenandlang=en

However, the plastics waste stream is made up of many different polymers. Each single use plastic item is associated with one or more of them. Each polymer has a different market in terms of recovered materials, with some very saleable and others with little or no demand, either because of technical, quantity or quality issues.

There are very few sources of data on recycling rates reported associated with different polymer types. In order to give a general understanding of the issues affecting the recycling rates of different polymer types, stakeholders with relevant experience were consulted on the different markets for different polymers in the EU, to give an indication of how recycling rates might vary between polymers. A 2016 report on the plastics market in the UK and the EU was also used to corroborate this information.[100] Other relevant considerations are summarised in the following paragraphs. The overall results of the assessment of polymer-specific recycling rates are summarized in Table A3.10.

For cups, representing the material type of 'paper lined with PE', an isolated example of an item-specific recycling rate is that in the UK, 1 in 400 plastic lined paper cups were reported to be recycled, in a statement during a parliamentary debate; a rate equivalent to 0.25%.[101] Only two facilities in the UK were known to have the right equipment to do so.

PET used to make bottles is distinguished from that used to make pots, tubs and trays and other items by the manufacturing method (injection and blow moulding). The manufacturing method gives bottle PET particular chemical properties that make it more widely suitable for recycling. Bottle PET can be used to make new bottles. However, the primary market for bottle PET is to make thermoformed PET items. This is because an additional processing step is required to make bottles out

[100]WRAP (2016) Plastics Market Situation Report
http://www.wrap.org.uk/sites/files/wrap/Plastics_Market_Situation_Report.pdf

[101] http://www.independent.co.uk/news/uk/politics/disposable-coffee-cups-could-be-taxed-like-plastic-bags-environment-minister-says-a6938126.html?utm_content=buffer5a9ae&utm_medium=social&utm_source=twitter.com&utm_campaign=buffer

of bottle PET; with associated extra cost.[102] Because of its maximal range of applications, this is the polymer type with the highest recycling rate. The trade association PETCore estimated a 59% collection rate for bottles Europe-wide in 2015.[103] The number of bottles places on the market was given as 3.1m tonnes.

PET used to make pots, tubs and trays, including entirely plastic (generally cold-use) cups, and potentially some take-away containers (e.g. salad boxes), is made by thermoforming. Thermoformed PET has a much weaker market because its intrinsic viscosity is lowered each time it is recycled to make similar products, unless an additional processing step is carried out, which raises costs. The market for thermoformed PET was estimated by PETCore to be around 1.05m tonnes in 2016.[104] Thermoformed plastic is therefore estimated to make up around a third of the PET market.

Polypropylene (PP), also used to make pots, tubs and trays, as well as cold-use cups and various types of take-away containers, does have a market in the EU. In the UK the collection rate for pots, tubs and trays was reported to be 32% in the UK in 2016; this will include a proportion of thermoformed PET which is not currently recycled in great amounts.[105] PP packaging demand is estimated to be around 2.8m tonnes in the EU in 2014.[106]

[102] http://www.packagingdigest.com/sustainable-packaging/how-to-expand-recycling-of-pet-thermoform-packaging-in-europe-2017-11-14

[103] http://www.petcore-europe.org/news/growth-pet-collection-and-recycling-europe-continues-over-18-million-tonnes-pet-bottles

[104] http://www.petcore-europe.org/news/new-developments-recycling-pet-thermoforms-europe

[105] Recoup, 2017 UK Household Plastics Collection Survey
http://www.bpf.co.uk/sustainability/plastics_recycling.aspx

[106] European PP demand ~8.8m tonnes; global breakdown of polypropylene by application 32% packaging by application. Ecosphere (2014) A European Plastics Market and Trend Study
http://ptfplus.com/onewebmedia/A%20European%20Plastics%20Market%20and%20Trend%20Study.pdf

Table A3.10 Markets for different polymers and implications for recycling rate

Polymer	Notes on market	Recycling rate assumption
Polypropylene (PP)	Strong market	Collection rate of pots, tubs and trays reported to be 32% in the UK; this will include a proportion of thermoformed PET which is not currently recycled in great amounts. Assume overall rate of 20% collected for recycling.
Injection moulded Polyethylene terephthalate (PET) i.e. bottle PET	Strong market - Mostly used to manufacture thermoformed PET items	At or higher than the reported average; generous estimate of 59% collected and recycled rate.
Thermoformed Polyethylene terephthalate (PET)	Little to no market: - Chemical structure differs from bottle PET; needs additional processing step to maintain adequate properties.	Lower than reported average for plastic: - For municipal solid waste (MSW)-derived material close to zero - Mostly incinerated
Polystyrene (PS)	Little to no market for MSW-derived material: - Low quantity	Lower than reported average for plastic: - For MSW-derived material close to zero - Mostly incinerated
Expanded Polystyrene (EPS)	Little to no market for for MSW-derived : - Material not compatible with most plastics recycling plant - Low quantity	Lower than reported average for plastic: - For MSW-derived material close to zero - Mostly incinerated
Polyethylene (PE) film	Little to no market for for MSW-derived material: - Quality poor, contaminated with labels and food - Low quantity - Market only for clean, clear, unprinted, unlabelled film in large quantities	Lower than reported average for plastic: - For MSW-derived material close to zero - Mostly incinerated
Paper lined with PE	Little to no market for for MSW-derived material: - Material is not compatible with most cardboard recycling plant - Carton recyclers are not generally interested in taking it: o different material composition o concerns around quality o low quantity	UK – 0.25%. Other Member States – for many, rate likely to be zero; a generous estimate would assume around half with similar recycling rate of 0.25%.
Metallized PE film (PE and Al)	This type of film is not currently recyclable.	Assume recycling rate zero.

Source: Stakeholder interviews, WRAP (2016) Plastics Market Situation Report

A3.2.2 Evaluation of collection rate and reject rate

Collection rates as applied to each item

Item fate was discussed with stakeholders who have detailed knowledge of waste collection and sorting processes and the associated technologies and their performance.

There are a set of items which are not generally collected for recycling across the EU. There are no, or next to no, facilities that are either able to, or willing to, deal with them.

This may be because of technological barriers (existing plant is unable to deal with the material), or economic issues (e.g. the waste stream is not large enough to be sorted profitably, the material has no onward market, or the material is just considered to contaminate other, more valuable waste streams). These factors can lead to a tension between some who seek to ensure more waste is collected for recycling, and others who have to sort such material, and for whom, some materials are best considered as rejects (or potentially worse, as contaminants). These items are:.

- **Menstrual products** – although it is technically possible to recycle absorbent hygiene products (AHPs), one of the few companies offering such a service has been unable to maintain a presence in the UK so far, citing lack of onward market for the materials recovered.[107] There is one UK plant offering composting of absorbent hygiene products, although the recovered plastic is intended to be incinerated.[108] Another UK plant has developed a process to turn the AHPs into refuse-derived fuel (RDF).[109] In Italy, a pilot plant was established, Fater, to recycle the AHPs. The pathways for processing this type of product are in the very early stages of development. There are very few collections services in operation for this type of material.
- **Wet wipes** – to our knowledge, there are no possibilities of developing pathways for the collection or recycling of wet wipes.
- **Cigarette butts** – some specialist firms do offer cigarette butt recycling but we do not know of any municipality or commercial contractor who makes use of this service, which operates by post,[110] more widely.

Constituting a second 'set' of items, a brief assessment of guidance from municipalities across the EU[111] suggests that typically, plastic items accepted for recycling are:

[107] The company made pet litter, insulation and waste containers out of the waste https://www.letsrecycle.com/news/latest-news/knowaste-appeal-nappy-recycling-plant-dismissed/; https://www.theguardian.com/sustainable-business/2016/sep/06/billions-dirty-nappies-diapers-recycled-pet-litter-insulation-compost-waste-landfill

[108] https://www.letsrecycle.com/news/latest-news/ocs-group-opens-nappy-recycling-plant-in-kent/

[109] https://resource.co/article/phs-facility-turns-absorbent-hygiene-products-rdf-11755

[110] https://www.terracycle.co.uk/en-UK/zero_waste_boxes/cigarette-waste

[111] E.g. Milan, Italy http://www.amsa.it/gruppo/cms/amsa/cittadini/milano/documenti/2_PlasticaMetallo.pdf, Naples, Italy https://www.asianapoli.it/raccolta-differenziata/come-si-fa-la-raccolta-differenziata/plastica-e-metalli.html

Bristol, UK https://www.bristol.gov.uk/bins-recycling/green-recycling-box, Edinburgh UK http://www.edinburgh.gov.uk/info/20001/bins_and_recycling/1618/individual_kerbside_collections

Cologne, Germany https://www.awbkoeln.de/tonnen/wertstofftonne/

- Bottles – drinks bottles
- Bottles – other household bottles
- Bottle tops, lids and caps
- Pots, trays and tubs – in some places
- Cutlery – in some exceptional cases
- Plastic cups – in some exceptional cases

Items explicitly excluded tend to be:

- Film – with some exceptions, where it is explicitly included
- Expanded polystyrene – with some exceptions, where it is explicitly included

Therefore we conclude that:

- **Bottles** are the most widely collected item where plastics recycling is offered; collection and recycling rates in the EU have been estimated at 59% EU-wide.
- **Food containers including fast food containers** are likely to be grouped, at least in the mind of some citizens, in 'pots tubs and trays'. In the UK, the collection rate was reported as 32% in 2016.
- **Cutlery** is included very rarely in the 'items accepted' list
- **Film** is also included very rarely in the 'items accepted' list

A third set of items is considered to have little targeted collection by municipalities or commercial contractors. They are usually unmentioned, or excluded from items accepted for recycling. Some may make their way into the material stream anyway because householders may consider the items to be of a polymer type that is recyclable, even if the item does not appear in the lists of acceptable items provided by municipalities (they are 'misthrows'). A few exceptions may be found if a high volume, high quality stream is accessible – e.g. from a commercial premises or pre-consumer waste. We briefly discuss each in turn:

- **Cotton buds** – The fact that these are not explicitly collected by municipalities, associated with their mixed material nature (plastic and cotton), as well as the location of use (bathroom) leads to an assumption that most users are unlikely to be separating out the plastic from the soiled cotton wadding. It seems unlikely that these are recycled.
- **Cutlery, straws and stirrers** – Not as likely to be used at home; it is possible that some householders would chance putting these items in their recycling bin. There is a slim chance commercial or institutional premises may end up putting these in their plastic recycling stream. If disposed of on the go, they are unlikely to end up in recycling streams. Public litter bins do not always offer opportunities for separating materials for recycling; material collected through this route may also be too contaminated to send for recycling.[112, 113]

Paris, France https://www.api-site.paris.fr/mairies/public/assets/2017%2F5%2FGuide%20to%20waste%20sorting.pdf

Warsaw, Poland https://czysta.um.warszawa.pl/documents/10181/0/plakat140800_A3_v04_ENG.pdf

Barcelona, Spain http://ajuntament.barcelona.cat/ecologiaurbana/es/servicios/la-ciudad-funciona/mantenimiento-del-espacio-publico/gestion-de-limpieza-y-residuos/recogida-de-residuos-domiciliarios

[112] "The total composition presented is based on the average composition of all samples. The litter collected in recycling bins was also included within the average composition. Due to heavy contamination, it is unlikely that the Council would have treated the recycling separately to the other litter waste." Resource Futures (2017) *Litter composition study - Wales*, Report for WRAP, March 2017

[113] "Litter and flytipping result in resources being wasted – even once rubbish on the ground has been cleared up, it is typically dirty mixed waste, and recyclate within it is not seperable or of poor quality. Almost all of it ends up in

- **Cups (plastic-lined paper) and cup lids** – only a very few commercial or institutional premises with high throughput may have a collection arrangement for these. Again, these are unlikely to be recycled through household collections, and if they end up in public litter bins, they are unlikely to be recycled.

Quality of material stream and location of disposal

It is worth noting at this point that some of the issues endemic to particular types of item are more pronounced dependent on the origin of material. Depending on the item, single use plastic waste is most likely to come from:

- Street sweeping (manual/mechanic);
- Litter bins;
- C&I waste; and
- Household waste.

This will affect e.g. the contamination of materials with food, dirt, or other material streams. For example, as mentioned above, litter from litter bins, whether disposed of in recycling on-the-go bins or residual waste litter bins, has been reported to be so contaminated with food or non-target materials, it cannot be sent for any recycling other than that available for the municipal solid waste (MSW) residual waste stream.[114] The best material streams in terms of quality and quantity may be provided by some institutional high through-put catering arrangements; however no information is available to make an estimate.

As we are unable to apportion fractions of many of the material streams for an individual item to the different origins, we have not made any further apportionment for this, aside the considerations arising from assessing the general collection issues around each item detailed in the previous section.

Size and shape

Once waste has been collected, whether separately collected for recycling or whether it is residual waste, where it is sent to a material recovery facility, there are a number of sorting stages that rely on a mixture of technologies that separate out material based on a variety of characteristics. They can be briefly described as follows:

Early sorting stages involve using either a trommel screen to remove small items, or a ballistic separator, which both removes small items and separates mixed recyclables into 2D and 3D streams (i.e. separates out film, flat paper and card that 'float' from bottles, tubs and other items that 'bounce' or 'roll'). An 'air classification system' may also be used upstream to split 'lights' (loose paper and film) from other fragments.

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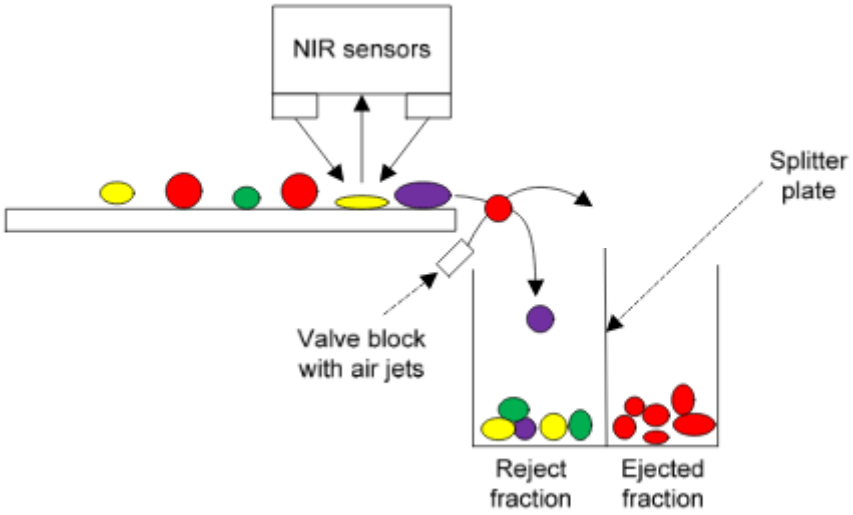
landfill." Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping*, 2013, http://www.zerowastescotland.org.uk/sites/default/files/Scotland's%20Litter%20Problem%20-%20Full%20Final%20Report.pdf

[114] Resource Futures (2017) *Litter composition study - Wales*, Report for WRAP, Zero Waste Scotland (2013) *Scotland's Litter Problem: Quantifying the scale and cost of litter and flytipping*.

Later sorting stages involve a near-infrared (NIR) detector to conduct a series of two-way or three-way sorts (i.e. target one or two materials respectively. The material, carried along a fast-moving conveyor belt (2.5–4.0 m/s), is detected by a beam of NIR and its position logged; based on the belt speed and detected location, the timing of the item reaching the end of the conveyor belt is calculated, where upon an 'air knife' or valve block with air jets, blows the material into different hoppers, separated by a 'splitter plate' (See Figure A3.3). Every material is associated with a success rate and ejected, or rejected; A value of above 90% is considered to be very good, between 80-90% is good, between 70-80% is acceptable, whilst below 70% indicates a poor separation.[115]

Figure A3.3 Diagram of NIR sorter



Source: WRAP, 2010

The early screening stages described are such that small items are therefore removed. For MSW, a stakeholder relays that a screen opening would be in the region of 60-80mm, while for packaging it would be in the region of 40mm. If an item is much less than this in any dimension, it is very unlikely to reach the infra-red unit. The fine fraction goes out as residue and is incinerated or landfilled. Very few plants have equipment to recover the small plastic items. Newer plants may invest in an additional 10-15mm screen, but these are currently rare. Therefore 80-90% of items that have at least one dimension much smaller than the generally used screens are considered to be lost.

This is considered to apply therefore to:

- **Straws**
- **Stirrers**
- **Cutlery**
- **Cotton bud sticks**

[115] WRAP, 2010, Near infrared sorting of household plastic packaging http://www.wrap.org.uk/sites/files/wrap/NIR%20Good%20practice%20guidance%20for%20existing%20NIR%20users%20Final.pdf

- **Bottle caps if separated from their bottles**
- **Confectionary and snack wrappers**

Secondly, the shape of an item will influence the reject rate in the ballistic separator; for example, while a very obviously 3D item will have a small reject rate (i.e. a 'pass rate' of around 95%) in the ballistic separator, an ambiguous item that is relatively flat like a coffee cup lid or a takeaway container lid might have a greater reject rate (equivalent to a 'pass rate' of 75-85%).

Thirdly, the shape and size of an item will influence how it moves on the NIR conveyor belt. For example, if the items is very light, or if it rolls, the predicted location of the item may change by the time it reaches the end of the conveyor and the "air knives" will not fire at the right time, leading to mis-sorting or rejection.

Fourthly, the item must be capable of being blown directionally by the "air knives" at the end of NIR screening conveyor. A very light, small item, or one with a high large length/width ratio (i.e. something long and thin), may be difficult to manoeuvre in this way, leading it to be mis-sorted into a reject stream.

And lastly, if the item is of a shape and size where it might cover other items or be covered by other items, this can also lead to mis-sorting or rejection, where an item is erroneously attributed to another material type, or while trying to directionally blow two items at once, are mis-sorted.

The types of items that maybe susceptible to these sorts of losses are likely to be:

- **Straws**
- **Stirrers**
- **Coffee cup lids**
- **Takeaway container lids**
- **Confectionary and snack wrappers**

Note that we have already identified a low probability of cutlery, film and especially straws, stirrers, and cotton bud sticks of finding their way into the fraction of material collected for recycling in the first place; it is additionally likely that many of these items will be removed from the recycling process at the size and 2D/3D screening stage.

Colour

It is also worth bearing in mind that NIR is unable to detect the material type of black items, as black items do not reflect light. The types of items that may be made out of black plastic are:

- **Straws**
- **Cutlery**
- **Cup lids**
- **Bottle tops, where separated from bottles**
- **Food containers (e.g. sushi trays)**

These items are rejected in the sort and will be sent to incineration or landfill. We are unable to account for the exact proportion of these. We have applied a nominal figure to these.

Material types

For the items that are considered to be collected for recycling to any extent, a brief survey was conducted of the typical plastics items are made of using a variety of sources, such as manufacturer's websites, online catalogues for catering supplies, and environmental assessments for particular items. The findings are presented in Table A3.11. This can then be used in conjunction with the information obtained on recycling rates by polymer type presented in Table A3.10 to understand the implication for each type of item.

Table A3.11 Polymers typically used for the manufacture of single use items in the recycling stream

Item	Material	Examples, notes
Cotton bud sticks	PP	
Cutlery	PS, PP	
Straws and stirrers	PP, PS	Now PP becoming most popular; in past mostly PS
Stirrers	PS	
Cup lids	PS, thermoformed PET	PS - hot and cold drinks, opaque. PE - clear, cold drinks
Cups	Thermoformed PET, PP, expanded polystyrene (EPS), PS, Paper and PE lining	PP - cheaper, more haze; PS - some flexible, some more durable, high-end disposables
Food containers including fast food containers	EPS, PP, thermoformed PET, PS, Paper with PE lining	EPS - e.g. trays/clamshells PP - e.g. typical rectangular/ round microwaveable tubs Thermoformed PET, PS - e.g. salad containers
Crisps packets / sweets wrappers	PET, PET metallized with Al	
Drinks bottles **Bottle caps**	Bottles - injection moulded PET Caps - PP	

A3.2.3 Approach for item-specific recycling baseline

Following the assessment of collection rates for each item as to whether they are typically collected by municipalities or commercial contractors:

- Items such as menstrual products, wet wipes and cigarette butts are assumed to have close enough to zero collection for recycling for the items to be allocated a 0% collection rate.

- Plastic bottles have been allocated a basic collection rate of 59% based on an EU-wide estimate. Their non-plastic alternatives (cans and glass bottles) have been assigned collection rates based on the proxy of the glass and aluminium packaging recycling rates (74% and 62% respectively).
- Coffee cups (paper lined with PE) have each been allocated a collection rate of 0.125% based on a rough assumption that half EU MS have a recycling rate similar to that cited for the UK, (0.25%).
- Pots, tubs and trays have been allocated a collection rate of 32% based on the UK recycling rate for these items.
- Other cups and cup lids (made of PET, PS or PP) have been allocated a collection rate of 20% based on the fact that some consumers may try and recycle them together with pots, tubs and trays, even though they are not generally requested as dry recyclables. Expanded polystyrene (EPS) cups have been assigned a collection rate of 0% because EPS is very rarely accepted with household recycling, and if it is it usually refers to trays. Their potentially biodegradable alternatives (i.e. made of bagasse, leaves or wax-lined paper,for cold-use applications only) have been allocated collection rates of 10% based on the fact that food-contaminated items are not the target of any dry recyclables collection and that the alternative disposal pathway, food waste collection, is not yet very prevalent in EU MS.
- Take-away containers have been allocated a collection rate of 32% for PP, PET and PS, based on the assumption that citizens would generally try to recycle them together with pots, tubs and trays. Containers lined with PE have been assigned a 0% collection rate based on no authorities offering collection for those items; EPS take-away containers have also been allocated a collection rate of 0%. Their potentially biodegradable alternatives (i.e. made of bagasse, wheatstraw leaves or wax-lined paper) have been allocated collection rates of 10% based on the fact that food-contaminated items are not the target of any dry recyclables collection and that food waste collection is not yet very prevalent in EU MS.
- Cotton bud sticks have been assigned a collection rate of 10% to account for a small proportion of items that might be placed in dry recyclables by citizens, even though they are not target items.
- Plastic cutlery, straws and stirrers have been each been allocated a collection rate of 15% based on the assumption that citizens might put a small proportion of these together with other plastic recycling, even though they are not normally target items. Additionally, because a proportion of these will be disposed of on the go, this is a further negative driver of recycling collection rate. Their potentially biodegradable alternatives (i.e. made of paper or wood) have been allocated collection rates of 10% based on the fact that food-contaminated items are not the target of any dry recyclables collection and that food waste collection is not yet very prevalent in EU MS.
- Items such as snack/confectionary packets have been allocated a collection rate of 5% for PET film and 0% for metallized PET film, on the basis that no collection system targets that type of mixed material and very few accept film at all. Their non-plastic alternatives (for part of the market only – i.e. foil and paper) have been assigned collection rates based on the proxy of the aluminium and paper packaging recycling rates.

Following the survey of typical polymer types used to make specific items, material specific 'real recycling' rates were applied to the following items:

- For any item made out of PS or EPS, the material-specific recycling rate was taken down to 0%, as there is no market for this material. This includes therefore, a proportion of straws, cutlery, cup lids, cups and food containers.
- For any item made out of thermoformed PET, the material-specific recycling rate was assigned as 0%, as there is no market for this material. This includes, therefore, the remainder of the plastic cup lids, a proportion of cups and food containers.

A consideration of fate of specific items within a materials recovery facility lead to the following assumptions being determined:

- Plastic bottles, cans, glass bottles, and cups would have a 'very good' 'pass rate' throughout each stage of the sorting process at 95%; plastic bottle tops (made out of PP) were assumed to be detached from the bottle and taken out of the process during the early screening stages due to small size 25% of the time, leading to a pass rate of 75% for the caps. Additionally, it was assumed that in 10% of cases, the bottle tops were black and also rejected from the recycling process.
- Cotton bud sticks, cutlery, straws and stirrers were assigned a very poor 'pass rate' in the early sorting stages of 15%, due to their size and shape. Cotton bud sticks, straws and stirrers were also assigned a very poor 'pass rate' – 55% - in the later sorting stages, owing to the likelihood that they were going to be difficult to directionally blow with accuracy. Cutlery were assigned a 'good' pass rate – 85% - at this stage owing to greater average weight and larger size. However, for cutlery and straws it was also assumed that in 10% of cases, the bottle tops were black and also rejected from the recycling process.
- For take away containers, a 'pass rate' of 90% was assigned in both the early and late phases of sorting, to account for the fact that a proportion of lids might be erroneously removed in the 2D/3D sort; and that they might be prone to being double layers and being obscured. It was also assumed that in 10% of cases, the food containers/trays were black and also rejected from the recycling process.
- For film, a low 'pass rate' of 30% was assigned in the early phase of sorting, to account for the fact that most of the items would probably be removed through size screening and only some would be large enough to continue through the process. The retained fraction would be recoverable at a good rate – 95%. However, it was also assumed that in 10% of cases, the film would be black and rejected from the recycling process as unsortable. The paper and foil alternatives were assumed to be even smaller items and most lost in the early stages of sorting – with a pass rate of only 15% for paper and 10% for foil. Anything making it through the early screen was assigned a 'very good' pass rate of 95% for the later sorting stages.

In order to account for the different polymers used to make specific items, and their different fates owing to the market considerations; unless information was available to the contrary, the market was split evenly between the different polymers. This applied to cutlery, straws, cup lids, food containers and snack/sweet wrappers. The exception was PE lined paper cups and EPS cups, which were estimated to have a proportionally greater market share (42%) and smaller market share (8%)

respectively, owing to the wide use of paper-lined PE cups in both cold and hot applications, and the relative decline in use of EPS cups.

A3.2.4 Results

The item specific recycling rates estimated are presented in Table A3.12. In general, it can be seen that single use non-plastic items suffer from many of the same issues as single use plastic items in terms of recovery for recycling, because of characteristics around their size and shape; improvements in recycling between single use plastic items and single use non-plastic items are most evident where *truly* compostable materials are used, because food waste does not undergo the same kind of sorting processes. To be clear, we are not considering industrially compostable plastics, because it is not possible for waste contractors then to distinguish between 'real' plastic contamination and compostable plastics, reducing the quality of the output.

This systematic approach has identified many of the hurdles associated with the plastics recycling chain which could be dealt with by better, co-ordinated design of items and infrastructure for end-of-life around clear principles such as:

- Limit number of types of materials in use;
- Limit use of multi-layer materials;
- Invest in infrastructure with smaller screening thresholds or tether items together;
- Develop markets and collection pathways for materials in parallel; and
- Create economic stimulus to return items where there is no market (whether internalising externalities or deposits).

Table A3.12 Baseline recycling assumptions for specific single use items

Item	Item class	Final Recycling Rate
Cigarette butts	SUP	0%
	SUNP	0%
Drinks bottles, Caps and lids	SUP	52%
	SUNP	61%
Cotton bud sticks	SUP	1%
	SUNP	1%
Crisps packets / sweets wrappers	SUP	0%
	SUNP	9%
Wet wipes	SUP	0%
	SUNP	39%
Sanitary towels and tampons	SUP	0%
	SUNP	-
Cutlery	SUP	1%
	SUNP	10%
Straws	SUP	0.6%
	SUNP	10%
Stirrers	SUP	0%
	SUNP	10%
Drinks cups and cup lids	SUP	1.5%
	SUNP	10%
Food containers including fast food packaging	SUP	5%
	SUNP	10%

Annex 4 Valuing External Impacts

In this section we identify the extent to which monetary values can be placed on the various impacts that result from the single use plastic items of relevance when littered. The section is laid out as follows:

- Section A4.1 briefly considers the relationship between littered tonnages and litter prevalence;
- Section A4.2 describes the types of impacts thought likely to be amenable to valuation in monetary terms;
- Section A4.3 considers the impact of litter on land in the EU, and how this might be valued;
- Section A4.4 discusses the problem of litter in European rivers;
- Section A4.5 looks at litter on European beaches and the valuation that can be placed on this;
- Section A4.6 explores impacts on marine fauna;
- Section A4.7 considers impacts on specific high value ecosystems including coral reefs and seagrass beds; and
- Section A4.8 looks at the impacts on European beach tourism.

A4.1 The Relationship between Littered Tonnages and Litter Prevalence in terms of both Stocks and Flows

It is challenging to try and place a value on each tonne of plastics prevented from entering, as litter, the terrestrial and marine environments.

On land, where regular - if not necessarily always (sufficiently) frequent - litter clearance takes place, the litter that citizens perceive around them in their daily lives will relatively closely approximate to the 'flow' of litter over the period between clean-ups.[116] Therefore, any reductions in littering of these items will fairly rapidly translate to a reduction in the prevalence of such items, meaning an overall reduction in the number and overall volume of littered items. However, the literature on disamenity of terrestrial litter typically explores the visual impact of a littered environment, which does not readily translate into tonnage terms. It is, therefore, necessary to translate tonnage reductions in litter into quantifiable differences in the prevalence of littered items on a day to day basis.

The same applies to litter that is dropped directly onto European beaches, or arrives by other means directly from land. Reduction of land-based littering will translate relatively rapidly through to reductions in the prevalence of littered items that arrive on beaches in this way.

However, some litter on beaches arrives from the sea (a proportion of which will have been transported there from inland locations via rivers). Indeed, there can be a 'flux' between the beach and the sea, with litter being both washed on, and washed off, of a beach over time. Due to an inevitable time lag, any litter arriving in this way will not decline as rapidly - following implementation of specific measures that

[116] This is especially true for higher volume items such as plastic bottles, single use takeaway cups, expanded polystyrene food containers etc. For cigarette butts, which are more difficult to pick up, what citizens observe may more closely approximate a 'stock' rather than a flow.

reduce the amount of litter produced – as, for example, litter that is directly dropped onto a beach.

In the freshwater environment, the same applies, to an extent, since a reduction in plastics littered along the course of the river should translate reasonably quickly to a reduction in prevalence. All else being equal, one might expect a reduction in prevalence to be more apparent, more quickly, the closer one is to the source of the river. The closer one moves towards the river mouth, the more likely it becomes that there will be a time-lag in the effect as items littered upstream prior to reduction measures being implemented may simply be continuing a journey towards the sea begun at an earlier time.

In the marine environment, the flows of littered plastic from land (and from shipping and fishing) contribute to the *stock* of littered plastic. Therefore, any reductions in the flow of littered plastics will not actually reduce the amount of plastic in the marine environment, but will rather reduce the rate at which the stock increases (relative to the counterfactual).

However, given that the vast majority of plastics already in the marine environment are to be found on the seabed, and that even neutrally buoyant plastics will tend to sink over time due to biofouling, it can be expected that a reduction in the flow of littered plastic into the marine environment will lead, over time, to a reduction in the amount floating at the surface. Given that this is what citizens will perceive in terms of visual disamenity, especially close to coastal areas, then what happens in coastal areas, and in particular what is visible at the surface, is most likely have the greatest impact for the majority of coastal users.

A4.2 Types of Impacts Amenable to Valuation

The broad categories of impacts considered potentially amenable to valuation are presented below:

- European litter on land
  - Disamenity impact
- European litter in European rivers
  - Disamenity impact
- Litter on European beaches
  - Disamenity impact
- Impacts on Marine Fauna
  - As macro-plastic litter and microplastic
    - Ingestion
  - As microplastics
    - Potential impacts on shellfisheries for human consumption
    - Potential impacts on plankton growth and subsequent food chain
    - Potential impacts on lugworms and subsequent food chain
- Impacts on Specific High Value Ecosystems
  - Impacts on coral reefs
  - Impacts on seagrass
- Impacts on European beach tourism
  - Potential for displacement to other locations

A4.3 European Litter on Land

A number of studies have sought to quantify, in monetary terms, the 'welfare loss' - i.e. the extent to which citizens are negatively impacted – from the existence of littered items in their local neighbourhood. This welfare loss is often referred to as the 'disamenity' arising from litter – much of which is considered to be due to the 'visual disamenity' which is understandable given that litter can transform the look and feel of a place.[117] The studies have typically sought to place a monetary value on this disamenity through determining the amount that respondents would be willing to pay for a marginal improvement from the current situation, in terms of a proportional reduction in the levels of litter.

While it is possible to measure litter by weight, number of items, and volume, it is likely that visual disamenity is most closely related to the overall volume of litter, which depends both on the number and unit volume of littered items, rather than the weight, or only the number. While litter is composed of a number of different materials and items, of which single use plastics will comprise a proportion, there is no research available, to the best of our knowledge, on how the impact varies by material and item type.

In the following sections, we work through the process of identifying an appropriate figure for the disamenity arising from littered single use plastic items on land. The approach used first identifies the disamenity associated with all littered items, and then attributes a proportion of this value to the single use plastic items that are being considered within this impact assessment.

A4.3.1 Relevant Studies

The most detailed study reviewed, which included, alongside litter, a range of other attributes that affect local environmental quality, was undertaken in the UK in 2011.[118] The study, funded by Defra sought to establish the willingness to pay, in terms of an increase in the tax paid to the municipality, for a number of improvements in a range of local environmental factors, namely:

- Urban quiet areas;
- Flytipping;
- Litter;
- Flyposting;
- Graffiti;
- Dog-fouling;
- Discarded chewing gum;
- Trees;

[117] The association between a littered environment and perception of public safety / fear of crime is an example.

[118] Mark Wardman, Abigail Bristow, Jeremy Shires, Phani Chintakayala and John Nellthorp (2013) Estimating the Value of a Range of Local Environmental Impacts, Report for Dept. for Environment, Food and Rural Affairs, 1 April 2011, available at http://randd.defra.gov.uk/Document.aspx?Document=9854_LEQFinal.pdf

- Light pollution (obscuring the stars);
- Light intrusion (into the home); and
- Odour.

The emphasis was on local, or neighbourhood, effects, by which the authors mean individuals' willingness to pay (WTP) for improved conditions, as experienced in their locality. The study does not cover the benefits of improved environmental factors for those who are visitors to another area, or the respondents' experience of these environmental factors in places other than their locality.

Surveys were carried out in late January and early February 2011 in Manchester, Coventry and London, providing a representative mix of 561 respondents across England. Within each city, surveys were conducted in three specific locations that covered inner-city, suburban and rural/semi-rural areas.

Prior to questions being asked in relation to WTP, respondents were asked to identify local environmental quality in relation to the relevant factors, with a value of 1 denoting the worst condition offered, and either 3, 4 or 5 denoting the best condition depending on the number of levels offered. The results of this are shown in Table A4.1 , from which it can be seen that chewing gum and litter score poorly.

Table A4.1 Respondents' Current Situation for Each Local Environmental Factor

Attribute	Scale	Inner	Suburban	Rural	Total
Light Pollution	1-3	2.20	2.23	2.72	2.33
Discarded Chewing Gum	1-3	1.95	2.20	2.64	2.21
Litter	1-4	2.31	2.86	3.18	2.74
Light Intrusion at Night	1-4	3.02	3.01	3.25	3.07
Trees	1-4	2.29	2.54	3.06	2.57
Fly Tipping	1-4	3.16	3.54	3.59	3.42
Access to Quiet Areas	1-5	2.92	3.53	4.32	3.49
Graffiti	1-5	2.76	3.53	4.14	3.40
Odour	1-5	3.76	4.17	3.76	3.93
Fly-posting	1-5	3.42	3.86	4.16	3.77
Dog Fouling Occurs	1-5	2.78	3.60	3.86	3.37

Source: Wardman et al., 2011

In terms of the willingness to pay for improvements in local environmental factors, expressed on a common 0-10 scale from bad to good, the monetary values shown in Table A4.2 were obtained. These again show that litter and flytipping are the factors for which respondents indicate the highest level of willingness to pay for 'unit' improvements (on a scale of 1 to 10). The average WTP (per person per month) for a unit improvement is £3.95 for litter, £3.71 for flytipping, £2.17 for chewing gum and £1.89 for dog fouling. Multiplying these unit valuations by ten to establish an average monthly WTP for a move from the worst to best situation, the values are £39.50 (~€44) for litter, £37.10 (~€41) for flytipping, £21.70 (~€24) for chewing gum and £18.90 (~€21) for dog fouling.

However, it is important to note that not everyone will rate the worst level offered by the researchers as zero and the best level offered as 10. Accordingly, the use of this valuation would overstate the benefit of moving from existing levels to the best level.

Table A4.2 Willingness to Pay Valuations (£s per person per month) and Ranking of Importance

	Value of a Unit Rating Change	Value of a Move from Worst to Best	Stated Preference Rank	Importance Rating Rank
Chewing Gum	2.17 (1.96 – 2.38)	21.7	4	7
Dog Fouling	1.89 (1.69 – 2.09)	18.9	6	3
Fly Posting	-	-	-	11
Fly Tipping	3.71 (3.39 – 4.03)	37.1	2	2
Graffiti	0.56 (0.42 – 0.71)	5.6	9	8
Light Intrusion	0.34 (0.02 – 0.65)	3.4	10	9
Litter	3.95 (3.59 – 4.31)	39.5	1	1
Light Pollution	0.63 (0.29 – 0.98)	6.3	8	10
Odour	1.91 (1.72 – 2.10)	19.1	5	6
Quiet	1.37 (1.20 – 1.53)	13.7	7	4
Trees	2.33 (2.07 – 2.59)	23.3	3	5

Source: Wardman et al., 2011

Further analysis was undertaken, to identify differences in the valuations of local environmental factors according to socio-economic, attitudinal and location factors. Rather than using the 11 point scale (0-10), this was based on four photographs showing different levels of littering. The valuations therefore represent 'one-level' shifts on a four level scale. The results were used to demonstrate how willingness to pay (in £s per person per month) varies across circumstances. The results, by area type, are presented in Table A4.3. It is worth noting that this is an average value for the whole sample so may include some who are already at the best level, and so place a zero value on any improvements.

Table A4.3 Valuations (£s per person per month) by Area Type

	Inner-City		Suburban		Rural	
	One Level	To Best	One Level	To Best	One Level	To Best
GUM	1.99	2.10	0.83	0.78	0.08	0.08
LITTER	9.75	15.81	12.85	16.20	11.33	12.54
TREES	0.61	1.82	3.11	4.46	2.15	2.95
FLY-TIP	8.43	8.70	5.84	6.18	5.02	5.02
GRAFFITI	1.12	2.78	0.83	1.55	0.21	0.29
FLY-POST	-	-	-	-	-	-
QUIET	0.27	0.58	1.03	1.91	0.53	0.60
DOG FOUL	4.16	8.87	5.12	7.79	1.20	2.72
ODOUR	0.87	1.69	2.25	2.70	2.45	4.05
INTRUSION	0.02	0.03	1.58	2.25	0.55	0.57
POLLUTION	-0.23	-0.26	2.37	2.40	0.07	0.07

Source: Wardman et al., 2011

It can be seen that the difference between the valuations placed on the 'One Level' improvements and 'To Best', diminish as one moves from Inner-City, to Suburban,

to Rural. This would suggest that the pre-existing level of litter is highest in inner city areas, and lowest in rural areas, which would seem plausible.

Arguably a particular strength of the Wardman et al. (2011) study is that it places litter in the context of a wide range of factors that impact on local environmental quality rather than focusing solely on litter. This means that participants are having to consider a range of different local environmental attributes, and the relative importance they place on each in their responses. While the WTP figures are higher than in the other studies reviewed, when set against the scale of the internalised indirect costs of litter in terms of effects of a littered environment on wellbeing, house prices, and even crime, the values seem eminently plausible.[119] The study was reviewed by UK Government economists who noted that:[120]

> *The results of this research can usefully inform national decisions where [local bespoke evidence] is not available*.

However, they go on to highlight that in using these values, it is important that uncertainties and sensitivities of these results are considered, some key areas being:

- The survey undertaken for this research was undertaken based on a representative, but relatively small, number of observations.
- Values derived from this approach only reflect the amenity that the public are aware of. Therefore, wider impacts such as the impact on health of air pollution are unlikely to be reflected in these values.
- It is unlikely that value changes in a linear manner with the status of the area. The law of diminishing marginal returns suggests that the use of a fixed value would overstate the benefits of significant improvements and underestimate the cost of significant deteriorations.

Given that single use plastics comprise perhaps 30% by volume of all litter on land in the EU, any reduction resulting from measures taken by Member States would reduce overall litter from current levels by less than this amount. This suggests that diminishing returns should not be a reason for these figures not to be used for the current impact assessment.

It is of course important that the survey was of a representative sample and while the number of observations is relatively small, there have been no follow-on surveys with a larger number of respondents. In the absence of more locally specific data, transferring these values across the EU (with appropriate adjustments by Member State) would be appropriate.

The comment about values deriving from disamenity that the public is aware of is important. The point made by the Defra reviewers here is that air pollution is undervalued – if people knew the damage being caused to their own health they would offer a higher WTP to tackle this issue. The same point could be made as to public knowledge and concern about litter, and by extension marine litter, which has grown in the seven years since the Wardman et al. (2011) study was published.

[119] See Eunomia Research & Consulting Ltd (2013) 'Exploring the Indirect Costs of Litter in Scotland', Report to Zero Waste Scotland, available at http://www.zerowastescotland.org.uk/litter-flytipping/exploring-indirect-costs

[120] Defra (2013) Local Environmental Quality: Valuing the Neighbourhood in which we live. Department for Environment, Food & Rural Affairs, August 2013. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/226561/pb14015-valuing-local-environment.pdf

Furthermore, it seems likely that the attributes associated with different fractions of litter will be perceived in different ways, and thus the disamenity will vary based on the type of item and material (and knowledge of its potential fate and impacts). Unfortunately, there are no studies that allow for a full comparison across item and material types. However, given the increased public concern about single use plastic items, driven in large part by knowledge that a significant proportion of what is in the sea derives initially from land, it would seem reasonable to expect that the single use plastic fraction of litter might account for a disproportionate amount of the disamenity. Accordingly, using the WTP for marginal reductions in *all* types of litter in order to value marginal reductions in single use plastic litter might well mean under-estimating the welfare gains that could be realised.

Another study, from 2011 in Wallonia, Belgium, sought to elicit the willingness to pay (WTP) for the removal of beverage can related litter. The WTP approach used images of areas with litter including cans, and excluding cans. The results were that the WTP for removal of cans from litter were €9 - €22 per household per year. The study also sought to understand the benefits of eliminating all litter, the results being a range from €34 - €39 per household per year.[121] However, this study was far less comprehensive in approach than the one undertaken by Wardman et al. (2011) and in focusing in beverage cans (which comprised a significant proportion of litter in the photographs shown to participants) arguably identified values that are qualitatively different from those associated with single use plastics. Part-whole bias might also explain the relatively low valuation for the removal of all litter compared with the removal of beverage cans alone.

A further study to determine the value householders place on a less-littered local environment was carried out in Australia by Pricewaterhouse Coopers (PwC) during 2010.[122] Over 3,000 people were surveyed from 15 different regions across Australia. Householders stated they were willing to pay $41.5 per annum for every 10% reduction in litter. To put this into context the householders were advised that a 10% reduction would be a 'noticeable improvement' in litter whereas a 20% reduction corresponded to a 'significant improvement'. Inflated and converted to €2018 values this is approximately €29 per year per household for every 10% reduction in litter. When it comes to local litter, it is possible that there may be diminishing returns, in that citizens value the first 10% reduction more highly than the subsequent 10% reduction and so on. However, this is not known for certain. As an illustrative example, if using this figure to determine the total WTP to have no litter, this would lead to an estimate of €290 per household per year.

A4.3.2 Estimating Willingness to Pay for Reduced Litter on Land at the European Level

In order to translate these findings into WTP at the European level, we follow a number of steps:

[121] Rdc environment (2011) Évaluation contingente du coût des désagréments visuels causés par les canettes dans les déchets sauvages en Wallonie, Raport Final, Etude pour l'Office Wallon des Dechets, Décembre 2011, http://environnement.wallonie.be/rapports/owd/pwd/canettes.pdf

[122] PricewaterhouseCoopers (2010) Estimating Consumers' Willingness to Pay for Improvements to Packaging and Beverage Container Waste Management, Report for Environmental Protection and Heritage Council of Australia, June 2010, http://www.ephc.gov.au/taxonomy/term/53

From the Wardman et al. (2011) study, in order to establish the overall disamenity associated with local land-based litter across the EU, we first take the unweighted average of a 'to best' improvement across the area types (inner-city, suburban, rural). This equates to £14.85 (~€16.50) per adult per month in 2011. Inflated to 2018 values, this is equivalent to £16.54 (€18.62) per month in 2018 values, or €244 per adult per year.[123,124]

We then scale this figure across each Member State based on per capita GDP adjusted by purchasing power parity. Ideally, we would have detailed analyses of litter composition and prevalence across all EU Member States to use in scaling the disamenity values. However, there are very few composition analyses and those available are not readily comparable. Accordingly, it is appropriate to simply scale by PPP-adjusted GDP, noting that the figure may lead to a slight overestimate in some less-littered locations, and an under-estimate in other more-heavily littered locations.

This gives a total disamenity associated with neighbourhood litter in EU Member States of €93.8 billion per annum. In terms of modelling these impacts, the disamenity figure is adjusted downwards to account for the fact that these items are only a proportion of total neighbourhood litter. The total contribution of the items in total litter is estimated, arguably conservatively, to be 30%, and thus the total neighbourhood disamenity associated with the SUP items of relevance is estimated to be €31.3 billion per annum

However, it's important to note that this relates only to neighbourhood disamenity, and doesn't cover the impact of litter than might be found on journeys to areas beyond one's neighbourhood, such as on walking excursions for example. Therefore, these estimates do not provide a complete picture of the total land-based disamenity associated with single use plastic items. Indeed, in terms of neighbourhood litter, citizens may to an extent start to see this as somehow 'normal' (while still having a strong preference for it not to be there). However, for litter encountered on a walking trip in a beautiful area, for example, the sense of upset, and indeed potentially anger, that might be experienced when littered single use plastics are encountered, might be proportionally higher than when it is seen in a day-to-day context.

Proportional reductions in disamenity will be calculated linearly based on anticipated reductions in volume. In respect of land-based litter, to assume a linear reduction (given the argument of diminishing returns) could well be to underestimate the benefit of such reductions – especially given that they will be of single use plastics. However, we take this approach in order to derive a conservative estimate.

There's a further question as to how a shift from single use plastics to single use non-plastics might affect neighbourhood disamenity. While the overall *amount* of litter may not change, in the shift away from plastic, the *nature* of the litter changes in qualitative terms. By way of example, it would seem reasonable to expect that most observers will perceive a littered wooden stirrer differently to a littered plastic stirrer, and indeed a littered paper straw differently to a littered plastic straw. This is because of widespread knowledge of the possible fate of such plastics both on land and in aquatic environments. Wooden stirrers and paper straws that would

[123] UK GDP deflators at market prices, and money GDP December 2017 https://www.gov.uk/government/statistics/gdp-deflators-at-market-prices-and-money-gdp-december-2017-quarterly-national-accounts

[124] Converted from Sterling to Euros at an exchange rate of €1.13:£1

decompose in time might be expected to be viewed differently in terms of their fate, and would likely be considered as more environmentally benign by members of the public.

Accordingly, a reduction in disamenity would likely be experienced, even if it's not to the same extent as when the number of littered items reduces. In the absence of evidence on the size of the reduction in disamenity, we cautiously suggest that a shift towards non-plastic single use items be valued at 30% of the value of a shift away from littering entirely.

A4.4 European Litter in Rivers

In respect of plastics, and indeed other types of litter, the freshwater environment has, to date, received far less attention from academics and policymakers than the marine environment. However, this does not mean that there is not public concern about single use plastic items within European rivers. Indeed, as an illustration of public concern, a number of organisations already arrange litter clean-up activities on rivers across Europe.[125] For those in European countries who live far from the coast, their main direct experience of plastics in the aquatic environment will more likely be from observation of riverine litter, either floating in the river or washed up on the riverbank after times of flood. Given the number and extent of rivers across Europe, and the proximity of many centres of population to such watercourses, the number of people in the EU who visit or otherwise 'experience' rivers in the course of their daily lives may well be greater than those who experience beaches in the same way.

The existence of littered plastic in the rivers, or washed up on the riverbanks, can be expected to have a negative impact on amenity. Unfortunately, there are, to the best of our knowledge, no studies that seek to capture, in monetary terms, the disamenity associated with litter in European rivers. It is clear that the level of disamenity is non-zero, but primary research is required in order to determine the scale of this.

A4.5 Litter on European Beaches

A wide-ranging study undertaken in 2012 for the Dutch Government included a detailed review of the available literature on public preferences for reductions in litter on beaches.[126] The headline recommendation was that a range of €0.60 to €1.60 per trip be used for the value of moving from partly littered to fully clean beaches. This value was based on academic research that was considered to provide the most useful source of potential value transfer results. The academic research, by Dugald Tinch and Nick Hanley of the University of Stirling, collected data from individuals visiting beaches in the Republic of Ireland, Northern Ireland, and Scotland in order to identify preferences for beach management.

[125] See for example https://www.letsdoitworld.org/2015/07/over-20400-romanians-were-involved-in-education-and-cleanup-actions-to-protect-the-danube-river/ ; https://www.bnt.bg/en/a/volunteers-are-cleaning-danube-islands-near-bulgaria-s-rousse ; https://pl.usembassy.gov/world/ ; https://www.rte.ie/news/2015/0403/691843-limerick-clean-up/

[126] eftec, Enveco & Intersus (2012) Recreational Benefits of Reductions of Litter in the Marine Environment, Final Report for Rijkswaterstaat Waterdienst, 15th November 2012.

Within the sample in the Republic of Ireland only active recreational users (those entering the water) were sampled, while in Northern Ireland and Scotland, samples also included what the authors termed 'non-active' recreational users (those not entering the water). A sample of the general public in Scotland was also taken to identify the 'non-use' value of improvements to beach quality. The results of the study are shown in Table A4.4. For the Northern Ireland, Republic of Ireland, and Scotland: Onsite columns, the figures represent willingness to pay per person, per visit. For the Scotland: Gen. Public column, the figure represents an increased annual expenditure on water rates (i.e. the payment made by households for domestic water supply and waste water services).

Table A4.4 Results of UK and Eire Choice Experiments

Willingness to pay	Northern Ireland	Republic of Ireland	Scotland: Onsite	Scotland: Gen. Public
Benthic Health - small increase	£4.67*** (±£1.03) (€5.66) (±€1.25)	€4.77***	£6.77*** (€8.20)	£23.84*** (€28.87)
Benthic Health - large increase	£5.97*** (±£1.03) (€7.23) (±€1.25)	€4.84***	£12.00*** (€14.53)	£29.32*** (€35.51)
Health Risk 5%	£5.36*** (±£1.42) (€6.49) (±€1.72)	€4.08***	£13.13*** (€15.90)	£30.38*** (€36.79)
Health Risk - very little	£7.22*** (±£1.31) (€8.74) (±€1.59)	€9.03***	£15.72*** (€19.04)	£54.09*** (€65.51)
Debris - Prevention (A)	£7.37*** (±£1.01) (€8.93) (±€1.22)	€6.60***	£9.91*** (€12)	£52.97*** (€64.15)
Debris - Collection & Prevention (B)	£8.72*** (±£1.19) (€10.56) (±€1.44)	€7.20***	£13.19*** (€15.97)	£65.36*** (€79.16)
Collection only (B-A)	£1.35 (€1.64)	€0.60	£3.28 (€3.97)	£12.39 (€15.01)

Note *** = significant at the 1% level. 'Collection only' row: own calculations based on results in Tinch and Hanley.

Source: Tinch and Hanley reported in eftec et al 2012

The specific debris scenarios are 'prevention', which would reduce the levels of sewage related debris such as sanitary products and cotton bud sticks, and other debris such as cans, bottles, and plastic bags, as well as 'collection and prevention', which also includes collection of general waste from the beach. Eftec et al. (2012) make what they consider to be a conservative assumption for transfer to the Netherlands that the additional WTP for collection relates to the WTP for moving from a somewhat littered situation to a litter-free situation, focusing specifically on beach litter, and excluding reductions in sewage related debris. Eftec et al. (2012) consider this to be conservative because some part of the WTP for debris prevention will also relate to reducing beach litter. On this basis the authors suggest

that the range of €0.60 (drawn from the collection-only WTP for the Republic of Ireland) to €1.60 per trip (drawn from the collection-only WTP for Northern Ireland) be used for the value of moving from partly littered to fully clean beaches.

The authors note that WTP values were lower in the Republic of Ireland, which they suggest was not surprising given the prevailing economic difficulties of the time. Growth has since rebounded in Ireland and thus the WTP values in the study, even in inflated to 2018 values, may not be representative of the present day situation.

However, given the focus of the European Commission on measures to reduce the level of consumption and littering of single use plastic items, it would seem appropriate to account for a proportion of the 'prevention' valuations in considering the value of changes in the amount of single use plastics that will be found on beaches. Given that the prevention values identified by Tinch and Hanley also account for prevention of sewage related debris, there may be a specific health concern associated with this type of item (which includes wet wipes, cotton buds and sanitary towels), as their presence is indicative of inadequately managed sewage including spills from combined sewer overflows (CSOs). The remainder of the prevention values will be associated with prevention of items that become littered on the beaches through other means (such as being directly dropped by visitors).

For the purposes of the present Impact Assessment, it thus seems justifiable to consider the prevention values as well as the collection values. These are shown in Table A4.5.

Table A4.5 Results of Choice Experiments – Debris Prevention and Collection

Willingness to Pay	Northern Ireland	Republic of Ireland	Scotland: Onsite	Scotland: General Public
Debris – Prevention (A)	€8.93	€6.60	€12	€64.15
Debris – Collection and Prevention (B)	€10.56	€7.20	€15.97	€79.16
Collection only (B-A)	€1.64	€0.60	€3.97	€15.01

Taking the collection and prevention values together, we first take the average of the Debris - Collection and Prevention values for Scotland and Northern Ireland (acknowledging that the Republic of Ireland figures represented WTP values at a time of significant economic difficulty, and thus may not be relevant to the present day). This gives a value of €13.27 per visit for a beach that is clear of debris. However, this full value will not be realised simply through removal from beaches of the single use plastic items considered in this impact assessment. Other items, such as metal cans, glass bottles, and fishing gear also contribute to beach litter. It is therefore necessary to make an assumption as to the proportion of this value that can be attributed to the removal of specific types of items.

Given the specific health concerns associated with sewage related debris, this could well account for a disproportionate amount of the disamenity relative to the overall number/volume of items. On the other hand, other single use plastics that are not sewage-related can often be much more brightly coloured, of higher volume, and thus more noticeable on beaches than sewage related debris, albeit without the specific health concerns.

In the absence of appropriate academic research to attribute the relative contribution to disamenity, we make the following assumptions:

We assume that 50% of the value is attributable to litter associated with sewage (i.e. cotton buds, wet wipes, sanitary towels), and of the remaining 50%, half (i.e. 25% of the overall value) is attributable to single use plastic items that have arrived in ways other than via the sewage system (i.e. plastic bottles, cups, straws, stirrers etc.) with the remainder attributable to other items such as metal cans, glass bottles, and fishing gear.

This leads to the following WTP estimates for complete removal of specific items from beaches:

- €6.63 per visit for a beach clear of sewage related debris such as wet wipes, cotton buds and sanitary towels
- €3.32 per visit for a beach clear of single use plastic items such as plastic bottles, cups, straws, stirrers etc.

However, a difficulty in applying these figures is a lack of understanding of the number of visits made to beaches across EU Member States that have a coastline.

An alternative approach, and one that more appropriately captures values across the EU as a whole is to consider the combined use and non-use values that apply to clean beaches. As shown in Table A4.5 the WTP among the Scottish public for a beach free of both sewage related litter and other litter is €79.61 per year (2012 values), equivalent to €82 per year in 2018 prices.

We then apply the same assumption as previously described, i.e. 50% of this value is attributable to litter associated with sewage (i.e. cotton buds, wet wipes, sanitary towels), and of the remaining 50%, half (i.e. 25% of the overall value) is attributable to single use plastic items that have arrived in ways other than via the sewage system (i.e. plastic bottles, cups, straws, stirrers etc.) with the remainder attributable to other items such as metal cans, glass bottles, and fishing gear.

This leads to the following WTP estimates, for combined use and non-use value, for complete removal of specific items from beaches:

- €41 per household per year for beaches clear of sewage related debris such as wet wipes, cotton buds and sanitary towels
- €20.50 per household per year for beaches clear of single use plastic items such as plastic bottles, cups, straws, stirrers etc.

Given strong public concern about the issue of marine litter (as illustrated by a Eurobarometer Report from 2014 which identifies that 94% of respondents support the development of an EU-level target to reduce the amount of litter entering oceans), and single use plastics in particular, a per-household Willingness to Pay of €3.42 per month and €1.71 per month for beaches to be clear of SRD-related and other single use plastic items respectively seems entirely credible.[127]

These values can then be applied across EU Member States by PPP-adjusted GDP.

This then gives a current total willingness to pay across the EU of:

[127] European Commission (2014) Attitudes of Europeans Towards Waste Management and Resource Efficiency, Flash Eurobarometer Report 388, June 2014

- €8.5 billion per year for beaches clear of sewage related debris such as wet wipes, cotton buds and sanitary towels
- €4.25 billion per year for beaches clear of single use plastic items such as plastic bottles, cups, straws, stirrers etc.

In terms of the modelling, both figures are divided by the total material flushed and entering the sea respectively, to create a per tonne disamenity figure. The change in disamenity is therefore calculated based upon the per tonne figure and the change in tonnes calculated in the model.

A4.6 Impacts on Marine Fauna

In this section, we consider a number of impacts on marine fauna, and seek to determine whether a monetary valuation of these impacts is possible. The impacts considered relate to:

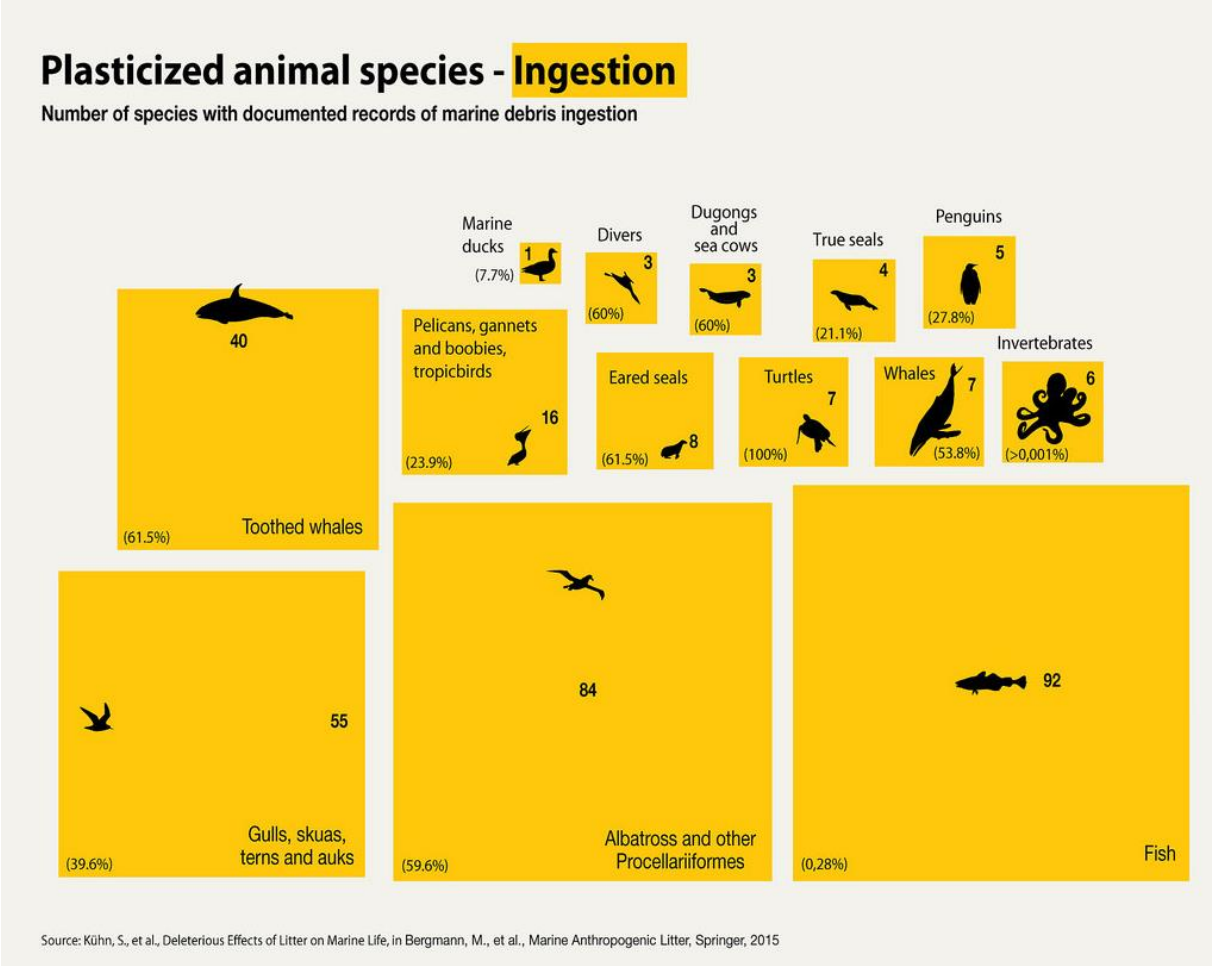
- Ingestion of plastics (both micro- and macro-) by large marine fauna; and
- Ingestion of microplastics by other marine fauna, with a focus on shellfish, plankton, and lugworms.

A4.6.1 Ingestion of Plastics by Large Marine Fauna

Incidences of ingestion of marine debris across a range of species has been widely documented, as illustrated in Figure A4.1. Ingestion of both microplastics and macroplastics has been recorded, along with other kinds of harmful interactions, such as very high profile example where a turtle had to have a single use plastic drinking straw removed from its nasal cavity.[128] Photographs of turtles ingesting plastic bags, and indeed of autopsies of large cetaceans where considerable amounts of plastic have been found inside the stomach, have become increasingly widely shared on social media and in the formal press in recent years.

[128] See http://www.plasticpollutioncoalition.org/pft/2015/10/27/the-turtle-that-became-the-anti-plastic-straw-poster-child

Figure A4.1 Number of Species with Documented Records of Marine Debris Ingestion



Graphic sourced from https://www.grida.no/resources/6927 made from data in Kuhn et al. 2015. Percentages are percentage of species types to have been found with ingested plastic, e.g. 100% of the 7 turtle species.

Research recently completed has also identified impacts on certain types of megafauna that feed by filtering the water from microplastics. The estimated daily plastic ingestion rates for filter-feeding megafauna vary greatly, depending on location and feeding behaviour, and range from as low as 100 pieces for whale sharks in the Gulf of California to as high as thousands of pieces for fin whales in the Pelagos Sanctuary in the Mediterranean.[129]

The effects of ingesting in digestible particles include blocking adequate nutrient absorption and causing mechanical damage to the digestive tract. Microplastics can also harbour high levels of toxins and persistent organic pollutants (POPs), and introduce these toxins to organisms via ingestion.[130,131]

[129] Germanov et al (2018) Microplastics: No Small Problem for Filter-Feeding Megafauna, Trends in Ecology & Evolution (in press, corrected proof) Feb 2018

[130] Worm, B. et al. (2017) Plastic as a persistent marine pollutant. Annu. Rev.Environ.Resour. 42, 1–26

[131] Rochman, C.M. et al. (2014) Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment. Sci. Total Environ. 493, 656–661

In terms of placing a monetary value on these impacts (which will of course simply reflect a *human* preference for the avoidance of such impacts) there is, as yet, no study that focuses specifically on types of plastics and their negative interactions with marine fauna, and seeks to understand an associated willingness to pay for a reduction in such impacts.

However, there are numerous studies that gauge public preferences for preventing the species loss (or indeed a proportion of loss). One such study looked at public preference for avoiding a reduction in species richness at three locations – the Azores Islands (Portugal), Gulf of Gdansk (Poland) and Isles of Scilly (UK). The contingent valuation study sought to estimate public WTP to avoid reduction of species loss for different marine taxa.[132]

The mean WTP for residents in respect of preventing an up to 25% reduction in species richness for mammals was US$90, $70, $58 (in the form of a one-off payment to a charitable foundation) in the Azores, Scilly and Gdansk respectively. This is an average of $75 (circa €60). Simply sharing this value equally over the 12 year period of the current analysis (2018 to 2030), gives a WTP of €5 per person per year.

This value may be a reasonable proxy for public preferences in terms of preventing ingestion of plastics (and the associated impacts) by marine fauna. However, there is good reason to think that it could represent a significant underestimate. In the public's eye, the impacts of plastics on marine life are very evident, with many photographs and videos available online, and in the popular media, showing the acute and chronic negative impacts in a very graphic manner. The public response to this is thus likely to be very different to the arguably less emotive subject of a decline in species richness – the cause and manner of a decline may be more important from a public perspective.

Accordingly, while public preference for avoiding ingestion of plastics by large marine fauna could be reasonably high, there is as yet no number that can be used to convey this in monetary terms. However, it will be non-zero.

A4.6.2 Impacts of Microplastics on Other Marine Fauna

In this section we consider the impacts of microplastics in particular on a number of commercially important species of marine fauna. While the effects described have been documented, some of the possible impacts that may result are more theoretical (albeit plausible) in nature. Accordingly, in this section, while we are not able to identify values per se associated with these impacts, there is considerable value (in the broadest sense) that could be considered 'at risk'. This suggests that the precautionary principle should apply.

A4.6.2.1 Potential Impacts on Commercial Shellfisheries

Microplastics have been found in shellfish, including certain lobsters, crabs, oysters and mussels. A study conducted by V. Cauwenberghe and Janssen on oysters and mussels targeted two species (*Mytilus edulis* and *Crassostrea gigas*) which are grown for commercial use. They discerned that European shellfish consumers could

[132] Ressurreicao et al (2012) Different cultures, different values: The role of cultural variation in public's WTP for marine species conservation, Biological Conservation 145 (2012), 148-159

be ingesting as much as 11,000 microplastics annually as part of their diet. This figure was highly publicised, helping to raise awareness and potentially influence the consumer market.[133]

Whether this leads to a threat to human health is yet to be scientifically determined. However, microplastics are in commercially important marine fauna such as oysters and mussels, which are consumed whole, could negatively affect public opinion, leading to reduced consumption.

According to the European Market Observatory for Fisheries and Aquaculture Sector (EUMOFA)bivalves represent almost half of the volume of EU aquaculture production, with mussels alone equating to 38% of the total volume in 2015. In terms of value, however, oysters are more important, with a production value of €446 million in 2015.

Spain was the largest producer of mussels (46% of total volume) in 2015.
For oysters, France was the largest producer in 2015 and was responsible for an EU level increase in value. Other key countries within the oyster market are Ireland, the Netherlands, the United Kingdom, Portugal, and Spain.

All things being equal, reducing the amount of single use plastics entering the marine environment will lead to a future reduction in the extent to which such commercial shellfisheries might be negatively impacted (relative to the counterfactual). However, it is difficult to establish a monetary impact that is anything other than non-marginal. If public concern over microplastics reaches a point where consumers move away from mussels and oysters, it may well be a significant shift. Accordingly, we simply note that there is value here - including employment in some of the more peripheral regions of Europe – that is potentially at risk from flows of plastics into the marine environment.

A4.6.2.2 Potential Impacts on Plankton

Plankton are a collection of organisms, such as algae and crustaceans, which are a vital source of food to a variety of larger marine species, such as fish and whales. Not only do they represent the bottom levels of the food web, but they also have other important roles within their marine ecosystem, including the ocean carbon cycle.

Plankton, grouped as phytoplankton or zooplankton, have been studied in laboratory environments and have been proven to interact with microplastics. Videos have been published, such as the video by Plymouth Marine Laboratory, which captures plankton feasting on microbeads.[134]

It has been found that phytoplankton can interact with microplastics through absorption and adhesion, and zooplankton interact via adhesion and ingestion.

[133] Van Cauwenberghe, L., and Janssen, C.R. (2014) Microplastics in bivalves cultured for human consumption, *Environmental Pollution*, Vol.193, pp.65–70

[134] See https://www.newscientist.com/article/dn27849-plankton-snacking-on-plastic-caught-on-camera-for-the-first-time/

Although one study found no adverse effects on phytoplankton when exposed to microplastics, other studies produced conflicting results. Bhattachyra et al.[135] demonstrated absorption of charged microplastics (polystyrene) onto the surface of microalgae which inhibited the organism's photosynthesis. As a result, in a species of green algae (Scenedesmus obliquus), a reduction in the population growth and chlorophyll concentration was seen. Another study on microalgae conducted by Sjollema et al.[136] demonstrated uncharged polystyrene at high concentrations also negatively impacted growth, though it had no effect on the microalgal photosynthesis. Considering that it has been found that phytoplankton amount to only around 1-2% of the total global plant carbon but that they account for about 40% of the photosynthesis in biogeochemical cycles (fixing between 30 and 50 billion tons of carbon annually), the potential for microplastics to hinder the photosynthesis capacity of these organisms could be extremely significant.

Multiple studies on the effects of microplastics on zooplankton have found that microplastics can adhere to external and internal body parts, as well as be ingested and egested (excreted). It was found that these activities can lead to a decrease in feeding (activity, rate, and capacity), loss of energetic reserves, hepatic stress, and reduced fecundity and survival. Loss of energetic reserves and fecundity can lead to smaller zooplankton populations consisting of less nutritious, energy-poor organisms. As plankton in general are at the bottom levels of the food chain, such a change could leave the higher levels malnourished, which in turn could reduce plankton populations further until other species' populations decreased. The impact in an extreme scenario could be very severe.

The laboratory studies mentioned above were conducted with various types and size of microbeads, in concentrations that tend to be higher than those currently seen in the wild. Though in the ocean, there are also fibres, pellets, and other forms of non-spherical microplastics. The effects of consumption of those non-spherical microplastics is not widely known – but might be higher due to a higher surface area to mass ratio.

The aforementioned studies point to population decline as a major result of microplastics for plankton, which in turn could result in a population decline further up the food chain. The types of species that could directly or indirectly be affected via ingestion (or lack thereof) include bivalves (such as mussels and oysters), crustaceans, annelid worms, fish (demersal, mesopelagic, and pelagic), sea turtles, marine mammals and sea birds. If these species were to drop in population numbers, as the fishery and aquaculture trade is worth € billions, the commercial impact could be significant.

A4.6.2.3 Potential Impacts on Lugworms

Lugworms (Arenicola marina), also known as rock worms, can make up to 30% of the biomass of an average sandy beach, making them key in their habitats' food

[135] Bhattacharya, P., Lin, S., Turner, J.P., and Ke, P.C. (2010) Physical Adsorption of Charged Plastic Nanoparticles Affects Algal Photosynthesis, *The Journal of Physical Chemistry C*, Vol.114, No.39, pp.16556–16561

[136] Sjollema, S.B., Redondo-Hasselerharm, P., Leslie, H.A., Kraak, M.H.S., and Vethaak, A.D. (2016) Do plastic particles affect microalgal photosynthesis and growth?, *Aquatic Toxicology*, Vol.170, pp.259–261

web. Lugworms re-oxygenate the sand and are a food source for other animals such as certain types of fish and birds.

They have been shown to ingest an average of 1.2 (± 2.8) microplastic particles per gram of wet body weight. (Van Cauwenberghe et al. 2015).

A study on lugworms demonstrated that chemicals associated with microplastics can have negative effects, as they can be transferred to the gut, reducing certain biological functions and having a negative effect on feeding and survival. (Browne et al. 2013).[137] Another study showed ingestion of microplastics alone could also reduce feeding and total energy reserves. (Basseling 2013[138], Wright et al. 2013b[139]). This could have a negative on wading bird populations, including those that rely on mudflats as part of their migration routes. The impact on specific types of bird life could thus be relatively significant. Determining a value for any such change is not straightforward, but at the very least, there may be a reduced spend from birdwatchers in such locations. We thus again simply note this possible impact as a value that is at risk.

A4.7 Impacts on Specific High Value Ecosystems

In the sections below we consider possible impacts on coral reefs and seagrass beds.

A4.7.1 Impacts on Coral Reefs

Global coral reef related tourism is a significant example of nature-based tourism, with coral reefs attracting foreign and domestic visitors in over 100 countries and territories. An academic study from 2017 estimates reef tourism to be worth US$35.8 billion globally every year (~€30 billion), representing the total of within-country expenditure by international and domestic visitors that the authors believe can be attributed to the presence of coral reefs.[140]

However, a paper recently published in Science assessed the influence of plastic waste on disease risk in 124,000 reef-building corals from 159 reefs in the Asia Pacific region. The authors found that the likelihood of disease increases from 4% to 89% when corals are in contact with plastic, and estimate that 11.1 billion plastic items are entangled on coral reefs across the Asia-Pacific region.[141]

While corals clearly face a number of threats including increased sea-surface temperatures, and ocean acidification, it is clear that plastics play a contributory role in reducing the health of coral ecosystems.

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[137] Browne, M.A., Niven, S.J., Galloway, T.S., Rowland, S.J., and Thompson, R.C. (2013) Microplastic Moves Pollutants and Additives to Worms, Reducing Functions Linked to Health and Biodiversity, *Current Biology*, Vol.23, No.23, pp.2388–2392

[138] Besseling, E., Wegner, A., Foekema, E.M., van den Heuvel-Greve, M.J., and Koelmans, A.A. (2013) Effects of microplastic on fitness and PCB bioaccumulation by the lugworm Arenicola marina (L.), *Environmental Science & Technology*, Vol.47, No.1, pp.593–600

[139] Wright, S.L., Rowe, D., Thompson, R.C., and Galloway, T.S. (2013) Microplastic ingestion decreases energy reserves in marine worms, *Current Biology*, Vol.23, No.23, pp.R1031–R1033

[140] Spalding, M., Burke, L., Wood, S. A., Ashpole, J., Hutchison, J. and zu Ermgassen, P. (2017) Mapping the Global Value and Distribution of Coral Reef Tourism, Marine Policy 82 (2017) 104-133

[141] Lamb, J. B. et al. (2017) Plastic Waste Associated with Disease on Coral Reefs, Science, Vol 359, Issue 6374, pp. 460-462

Of course, attribution of any such impacts to plastics that enter the marine environment in Europe is tentative – specifically plastics that enter the Baltic, Black Sea or Mediterranean are very unlikely to contribute to impacts on coral reefs. Plastics that enter the North-West Atlantic may well travel further, but as Europe is thought to contribute to only c. 1% of plastics entering the marine environment globally, the direct effect of a reduction in emissions of plastics in Europe will be limited. However, indirectly, action taken in Europe may well spur action to be taken in other jurisdictions.

A4.7.2 Impacts on Seagrass Beds

Seagrass beds provide a number of important ecosystem services:

- providing nursery and habitat for fish and other marine species;
- a food source for marine organisms;
- erosion control and shoreline stabilisation;
- recreational and tourism value
- water filtration; and
- oxygen production and CO_2 absorption.

It is estimated that seagrass is worth €190 million per year to Mediterranean fishing, of which €78 million is to commercial fishing, and €112 million is to recreational fishing. [142]

However, plastics have been shown to negatively impact seagrass beds. Balestri et al. (2017) [143] found that plastic bags on the seafloor reduced sediment pore-water oxygen concentration and pH and changed the growth form of two Mediterranean seagrass species as well as the species interactions/coexistence (from neutral to competitive). A study of seagrass meadows in New South Wales, Australia, found that seagrass shaded by plastic films had a reduced leaf growth rate, shoot number and weight; also observed reduction in diversity of microfauna living on the leaves. 17 months after the plastic films were removed, no recovery was observed, suggesting the effects are long-lasting. [144]

Again, it is not straightforward to determine a marginal value for the benefit to seagrass beds associated with reduced levels of single use plastics entering the marine environment. However, all else being equal, any reduction relative to the counterfactual will likely be of benefit to seagrass habitats.

A4.8 Impacts on European and Global Beach Tourism

In 2011, coastal and maritime tourism employed 3.2 million people in the EU, generating €130bn in Gross Value Added (GVA). Coastal areas attract more than

[142] EU article/ Jackson, E.L., Rees, S.E., Wilding, C., and Attrill, M.J. (2015). Use of a seagrass residency index to apportion commercial fishery landing values and recreation fisheries expenditure to seagrass habitat service. Conservation Biology DOI:10.1111/cobi.12436

[143] Balestri E., Menicagli V., Vallerini F., and Lardicci C. (2017) Biodegradable plastic bags on the seafloor: A future threat for seagrass meadows?, *Science of The Total Environment*, Vol.605–606, pp.755–763

[144] https://www.blastic.eu/knowledge-bank/impacts/smothering/ ; Fitzpatrick, J., and Kirkman, H. (1995). Effects of prolonged shading stress on growth and survival of seagrass Posidonia australis in Jervis Bay, New South Wales, Australia. Marine Ecology Progress Series, 127, 279–289.

one third of all tourism business in the EU.[145] With 45% of people working in tourism aged between 16 and 35 years old, tourism in coastal areas is a significant source of employment for young people in areas that are often peripheral.[146]

The presence of litter in marine and coastal areas is reported to result in economic losses due to reductions in visitation rates and tourist spending, diminished net economic value to visitors through reduced satisfaction, and opportunity costs associated with beach cleanup.[147] Evidence from Sweden cited in a UNEP study from 2009 indicates that substantial accumulation of litter on the beach depresses tourism by between one and five per cent.[148]

In terms of tourist spend, it is possible to imagine that such an impact could easily occur at a local level, where visitors go to a cleaner beach in preference to a littered one. At the European level, the value of coastal tourism overall may be unaffected, while those areas that are more heavily littered lose out. Alternatively, tourists may shift to locations away from the coast. If, as suggested by the Swedish example, there were a reduction in tourist spend of 1% to 5% due to litter, this would suggest a loss in GVA to coastal areas of between €1.3 billion and €6.5 billion per year. Such a shift may not be experienced equally across all coastal Member States, and a greater negative impact could expect to be experienced by those Member States where tourist expenditure is predominantly in coastal areas.

[145] Ecorys (2013) Study in Support of Policy Measures for Maritime and Coastal Tourism at EU Level. Final Report to DG MARE, September 2013.

Available at https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/docs/body/study-maritime-and-coastal-tourism_en.pdf

[146] See EUROSTAT database (2012) - Employed persons by age groups (NACE Rev. 2)-

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database#

[147] Ofiara, D., D., Brown, B. (1999) Assessment of Economic Losses to Recreational Activities from 1988 Marine Pollution Events and Assessment of Economic Losses from Long-term Contamination of Fish within the New York Bight to New Jersey. Marine Pollution Bulletin 38 (11), 990-394.

[148] UNEP (2009) Guidelines on the Use of Market-based Instruments to Address the Problem of Marine Litter, available at http://minisites.ieep.eu/assets/477/Economic_Instruments_and_Marine_Litter.pdf

Annex 5 Model Results

The impacts of the 'Options' are presented in Tabular form in Table A5.1 to Table A5.4 below. The model outputs below are shown across two pages for each of the 4 Options. The first page presents the environmental impacts. The second page represents the economic impacts.

Following submission of the initial Impact Assessment results with 4 Options, 2a to 2d, a further option was defined for additional analysis. This was labelled Option 2c+, as is was based upon Option 2c but with some changes. The key changes from Option 2c were:

- The DRS measure for beverage containers included only in 2d in the first assessment was included in 2c+;
- The reduction targets for wet-wipes were removed; and

The obligation for EPR on litter collections was removed for sanitary towels/pads.

Table A5.5 below shows the detailed breakdown of the model results for Option 2c+ by measure. Note that for this analysis the costs of DRS were apportioned in a different way to the original Impact Assessment results. The key differences are a) consumers' lost deposits are recorded in the column "Change in consumer costs, € million", b) the change in producer fees related to the existing PRO schemes and the additional DRS, as well as c) revenues from the sale of material are accounted for in the column "Business compliance costs, € million", and d) the reduced revenues for the PROs, litter collection costs and avoided collection and treatment of mixed wastes are accounted for under the column "Change in waste management costs, € million".

In addition, the litter EPR compliance costs were pro-rated according to the relative compliance costs outlined in the next section, following further work after the initial Impact Assessment results were produced. The changes affect the distribution of the results rather than the total costs and benefits, therefore the Options are still comparable.

All impacts are measured relative to the Baseline (Option 1 in the Commission's IA).

Note, that some of the product-measure results are not the same as the figures in the Options results due to the combined effect, or additive, nature of the measures in the Options.

Finally, also note in the tables below, that '€ -' or '-' = zero as the output is not relevant for this item.

Table A5.1 Model Outputs (2030) – Option 2a

Item	Measure	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight*	Marine litter reduction - % of SUP by count*	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Cigarette filters	Info. campaign + voluntary action	-0.01	-692.77	-0.1%	-10.1%	0.00	-€ 18	€ 0.001	-€ 18	0.00	0
Drinks bottles	Info. campaign + voluntary action	-1.58	-42.85	-10.6%	-0.6%	-0.92	-€ 3,394	-€ 96	-€ 3,490	-2.97	-34.88
Cotton buds	Info. campaign + voluntary action + labelling	-0.00	-11.90	0.0%	-0.2%	-0.00	-€ 33	€ 0.01	-€ 33	-0.00	-0.01
Crisp packets and sweet wrappers	Info. campaign + voluntary action	-0.06	-10.76	-0.4%	-0.2%	-0.00	-€ 129	-€ 0.004	-€ 129	0.00	0
Wet wipes	Info. campaign + voluntary action + labelling	-0.13	-114.16	-0.8%	-1.7%	-0.00	-€ 655	-€ 1.7	-€ 657	13.25	2.55
Sanitary towels	Info. campaign + voluntary action + labelling	-0.19	-30.36	-1.3%	-0.4%	-0.01	-€ 967	-€ 1.1	-€ 968	-0.03	-3.87
Cutlery	Info. campaign + voluntary action	-0.01	-4.94	-0.1%	-0.1%	-0.06	-€ 31	€ 0.5	-€ 30	-0.13	-19.71
Straws	Info. campaign + voluntary action	-0.04	-101.51	-0.3%	-1.5%	-0.05	-€ 99	-€ 5	-€ 104	0.04	-14.89
Stirrers	Info. campaign + voluntary action	-0.00	-5.43	0.0%	-0.1%	-0.11	-€ 6	-€ 2.8	-€ 9	-0.21	17.97
Drinks cups and lids	Info. campaign + voluntary action	-0.38	-27.33	-2.6%	-0.4%	-0.03	-€ 875	-€ 8	-€ 883	-0.73	-20.07
Food containers	Info. campaign + voluntary action	-0.35	-17.51	-2.4%	-0.3%	-0.10	-€ 908	€ 1.6	-€ 907	3.27	-24.39
Total		-2.75	-1,060	-18.5%	-15.5%	-1.28	-€ 7,116	-€ 112	-€ 7,228	12.49	-97

**% reductions are calculated relative to the total marine litter of these 'top ten' items only.*

Item	Measure	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Cigarette filters	Info. campaign + voluntary action	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 0.001	0.0
Drinks bottles	Info. campaign + voluntary action	-€ 2,800	-€ 2,800	-€ 1,573	€ 167	€ 6	€ -	€ 102	€ -	€ 5	-7.1
Cotton buds	Info. campaign + voluntary action + labelling	€ 0.0	€ 0.0	-€ 1	€ 1	€ 0.024	€ -	€ 16	€ -	-€ 0.47	0.004
Crisp packets and sweet wrappers	Info. campaign + voluntary action	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 0.01	0.0001
Wet wipes	Info. campaign + voluntary action + labelling	-€ 8	-€ 8	-€ 41	€ 37	€ 0.06	€ -	€ 58	€ -	€ 2.50	-0.041
Sanitary towels	Info. campaign + voluntary action + labelling	-€ 185	-€ 192	-€ 100	€ -	€ 4	€ -	€ 28	€ -	-€ 0.27	-1.1
Cutlery	Info. campaign + voluntary action	-€ 49	-€ 49	-€ 414	€ 389	€ 0.35	€ -	€ 14	€ 26	-€ 0.60	0.69
Straws	Info. campaign + voluntary action	-€ 146	-€ 146	-€ 292	€ 215	€ 3.4	€ -	€ 42	€ -	-€ 0.71	0.04
Stirrers	Info. campaign + voluntary action	-€ 512	-€ 512	-€ 346	€ 89	€ 0.46	€ -	€ 46	€ 88	€ 1.09	-1.2
Drinks cups and lids	Info. campaign + voluntary action	-€ 127	-€ 127	-€ 73	€ -	€ 10	€ -	€ 102	€ 15	-€ 0.54	-0.5
Food containers	Info. campaign + voluntary action	€ 144	€ 144	-€ 291	€ 354	€ 9	€ -	€ 102	€ 209	€ 25	5.3
Total		-€ 3,682	-€ 3,689	-€ 3,130	€ 1,253	€ 33	€ -	€ 714	€ 338	€ 30	-3.8

Table A5.2 Model Outputs (2030) – Option 2b

Item	Measure	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight*	Marine litter reduction - % of SUP by count*	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Cigarette filters	EPR – full cost of litter	-0.03	-2,627.74	-0.2%	-38.4%	0.00	-€ 25	€ 0.003	-€ 25	0.00	0
Drinks bottles	EPR – full cost of litter + Specific design requirements	-1.07	-29.19	-7.2%	-0.4%	0.08	-€ 2,089	€ 44	-€ 2,046	1.78	63.73
Cotton buds	Ban (of SUP items)	-0.01	-59.66	-0.1%	-0.9%	-0.00	-€ 61	€ 0.88	-€ 60	-0.08	-0.26
Crisp packets and sweet wrappers	EPR – full cost of litter	-0.23	-40.80	-1.5%	-0.6%	-0.00	-€ 177	-€ 0.01	-€ 177	0.00	0.00
Wet wipes	EPR – full cost of litter	-0.13	-114.16	-0.8%	-1.7%	0.00	-€ 532	€ 0.006	-€ 532	0.00	0.00
Sanitary towels	EPR – full cost of litter	-0.23	-37.31	-1.6%	-0.5%	0.00	-€ 840	€ 0.02	-€ 840	0.00	0.00
Cutlery	EPR – full cost of litter + Reduction targets (SUP)	-0.04	-13.91	-0.2%	-0.2%	-0.26	-€ 70	-€ 2.3	-€ 73	-0.44	-65.69
Straws	EPR – full cost of litter + Reduction targets (SUP)	-0.13	-329.71	-0.9%	-4.8%	-0.35	-€ 332	-€ 33	-€ 365	-0.51	-87.22
Stirrers	EPR – full cost of litter + Reduction targets (SUP)	-0.01	-17.63	-0.1%	-0.3%	-0.56	-€ 24	-€ 43	-€ 67	-1.29	-72.49
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP)	-1.58	-112.83	-10.6%	-1.7%	-0.60	-€ 3,352	-€ 99	-€ 3,452	-7.31	-200.74
Food containers	EPR – full cost of litter + Reduction targets (SUP)	-0.99	-49.65	-6.7%	-0.7%	-0.33	-€ 1,976	€ 5	-€ 1,971	10.91	-81.31
Total		-4.45	-3,433	-30.0%	-50.2%	-2.02	-€ 9,477	-€ 127	-€ 9,605	3.06	-444

*% reductions are calculated relative to the total marine litter of these ‘top ten’ items only.

Item	Measure	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Cigarette filters	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 4	0.0
Drinks bottles	EPR – full cost of litter + Specific design requirements	€ 1,258	€ 1,258	€ 629	€ -	€ -	€ -	€ 102	€ -	€ 535	2.3
Cotton buds	Ban (of SUP items)	€ 0	€ 0	-€ 29	€ 29	€ 0.5	€ -	€ 16	€ -	€ 0.4	0.1
Crisp packets and sweet wrappers	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 30	0.0
Wet wipes	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 58	€ -	-€ 36.7	0.0
Sanitary towels	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 28	€ -	-€ 67.7	0.0
Cutlery	EPR – full cost of litter + Reduction targets (SUP)	-€ 197	-€ 197	-€ 1,360	€ 1,260	€ 1.2	€ -	€ 14	€ 87	-€ 4.1	2.4
Straws	EPR – full cost of litter + Reduction targets (SUP)	-€ 2,188	-€ 2,188	-€ 1,458	€ 359	€ 6	€ -	€ 42	€ -	-€ 13	-5.7
Stirrers	EPR – full cost of litter + Reduction targets (SUP)	-€ 3,159	-€ 3,159	-€ 1,730	€ 149	€ 0.8	€ -	€ 46	€ 147	-€ 6	-9.1
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP)	-€ 1,265	-€ 1,265	-€ 728	€ -	€ 95	€ -	€ 102	€ 150	-€ 24	-4.0
Food containers	EPR – full cost of litter + Reduction targets (SUP)	€ 480	€ 480	-€ 970	€ 1,179	€ 30	€ -	€ 102	€ 697	€ 26	17.8
Total		-€ 5,071	-€ 5,071	-€ 5,645	€ 2,976	€ 134	€ -	€ 714	€ 1,081	€ 445	3.8

Table A5.3 Model Outputs (2030) – Option 2c

Item	Measure	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight*	Marine litter reduction - % of SUP by count*	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Cigarette filters	EPR – full cost of litter	-0.03	-2,627.74	-0.2%	-38.4%	0.00	-€ 25	€ 0.003	-€ 25	0.00	0
Drinks bottles	EPR – full cost of litter + Specific design requirements	-1.07	-29.19	-7.2%	-0.4%	0.08	-€ 2,089	€ 44	-€ 2,046	1.78	63.73
Cotton buds	Ban (of SUP items)	-0.01	-59.66	-0.1%	-0.9%	-0.00	-€ 61	€ 0.9	-€ 60	-0.08	-0.26
Crisp packets and sweet wrappers	EPR – full cost of litter	-0.23	-40.80	-1.5%	-0.6%	-0.00	-€ 177	-€ 0.01	-€ 177	0.00	0
Wet wipes	Reduction targets (SUP)	-0.50	-450.72	-3.3%	-6.6%	-0.03	-€ 1,873	-€ 17	-€ 1,890	132.51	25.51
Sanitary towels	EPR – full cost of litter	-0.23	-37.31	-1.6%	-0.5%	0.00	-€ 840	€ 0.02	-€ 840	0.00	0
Cutlery	Ban (of SUP items)	-0.05	-17.94	-0.3%	-0.3%	-0.56	-€ 117	-€ 7	-€ 125	-0.88	-131.39
Straws	Ban (of SUP items)	-0.15	-371.50	-1.0%	-5.4%	-0.47	-€ 417	-€ 43	-€ 460	-0.44	-112.04
Stirrers	Ban (of SUP items)	-0.01	-19.87	-0.1%	-0.3%	-0.72	-€ 28	-€ 46	-€ 73	-1.64	-42.54
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP) - high	-1.58	-112.83	-10.6%	-1.7%	-0.60	-€ 3,352	-€ 99	-€ 3,452	-7.31	-200.74
Food containers	EPR – full cost of litter + Reduction targets (SUP) - high	-0.99	-49.65	-6.7%	-0.7%	-0.33	-€ 1,976	€ 5	-€ 1,971	10.91	-81.31
Total		-4.85	-3,817	-32.6%	-55.8%	-2.63	-€ 10,955	-€ 162	-€ 11,117	134.86	-479

*% reductions are calculated relative to the total marine litter of these ‘top ten’ items only.

Item	Measure	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Cigarette filters	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 4	0.0
Drinks bottles	EPR – full cost of litter + Specific design requirements	€ 1,258	€ 1,258	€ 629	€ -	€ -	€ -	€ 102	€ -	€ 535	2.3
Cotton buds	Ban (of SUP items)	€ 0	€ 0	-€ 29	€ 29	€ 0.5	€ -	€ 16	€ -	€ 0.4	0.1
Crisp packets and sweet wrappers	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 30	0.0
Wet wipes	Reduction targets (SUP)	-€ 79	-€ 79	-€ 408	€ 368	€ 0.6	€ 36	€ 58	€ -	€ 25	-0.4
Sanitary towels	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 28	€ -	-€ 67.7	0.0
Cutlery	Ban (of SUP items)	-€ 409	-€ 409	-€ 2,712	€ 2,505	€ 2.3	€ -	€ 14	€ 174	-€ 8	4.9
Straws	Ban (of SUP items)	-€ 2,431	-€ 2,431	-€ 1,944	€ 718	€ 11	€ -	€ 42	€ -	-€ 8	-5.5
Stirrers	Ban (of SUP items)	-€ 4,012	-€ 4,012	-€ 2,306	€ 298	€ 1.5	€ -	€ 46	€ 294	-€ 2.1	-11.2
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP)	-€ 1,265	-€ 1,265	-€ 728	€ -	€ 95	€ 16	€ 102	€ 150	-€ 24	-4.0
Food containers	EPR – full cost of litter + Reduction targets (SUP)	€ 480	€ 480	-€ 970	€ 1,179	€ 30	€ 18	€ 102	€ 697	€ 26	17.8
Total		-€ 6,457	-€ 6,457	-€ 8,468	€ 5,097	€ 142	€ 70	€ 714	€ 1,315	€ 511	4.0

Table A5.4 Model Outputs (2030) – Option 2d

Item	Measure	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight*	Marine litter reduction - % of SUP by count*	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Cigarette filters	Reduction targets (SUP) + labelling	-0.04	-3,702.73	-0.3%	-54.2%	-0.03	-€ 80	-€ 3.4	-€ 83	24.38	0
Drinks bottles	DRS for beverage containers	-7.55	-205.40	-50.8%	-3.0%	-0.59	-€ 19,578	-€ 33	-€ 19,611	0.00	0
Cotton buds	Ban (of SUP items)	-0.01	-59.66	-0.1%	-0.9%	-0.004	-€ 61	€ 0.9	-€ 60	-0.08	-0.26
Crisp packets and sweet wrappers	EPR – full cost of litter	-0.23	-40.80	-1.5%	-0.6%	-0.0004	-€ 177	-€ 0.014	-€ 177	0.00	0.00
Wet wipes	Standards for WWTW	-0.43	-393.64	-2.9%	-5.8%	0.0004	-€ 122	€ 0	-€ 122	0.00	0.00
Sanitary towels	Reduction targets (SUP)	-0.57	-92.31	-3.8%	-1.4%	-0.10	-€ 2,679	-€ 14	-€ 2,693	-0.41	-48.42
Cutlery	Ban (of SUP items)	-0.05	-17.94	-0.3%	-0.3%	-0.56	-€ 117	-€ 7	-€ 125	-0.88	-131.39
Straws	Ban (of SUP items)	-0.15	-371.50	-1.0%	-5.4%	-0.47	-€ 417	-€ 43	-€ 460	-0.44	-112.04
Stirrers	Ban (of SUP items)	-0.012	-19.867	-0.08%	-0.29%	-0.72	-€ 28	-€ 46	-€ 73	-1.64	-42.54
Drinks cups and lids	Reduction targets (SUP) - high	-1.85	-132.48	-12.5%	-1.9%	-0.97	-€ 4,862	-€ 160	-€ 5,022	-11.69	-321.19
Food containers	Reduction targets (SUP) - high	-1.17	-58.30	-7.8%	-0.9%	-0.52	-€ 2,747	€ 8	-€ 2,739	17.45	-130.09
Total		-12.07	-5,095	-81.2%	-74.5%	-3.97	-€ 30,868	-€ 297	-€ 31,165	26.70	-786

*% reductions are calculated relative to the total marine litter of these ‘top ten’ items only.

Item	Measure	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Cigarette filters	Reduction targets (SUP) + labelling	€ 381	€ 381	-€ 718	€ 908	€ -	€ 216	€ 102	€ -	€ 0.9	3.4
Drinks bottles	DRS for beverage containers	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 1,418	4.2*
Cotton buds	Ban (of SUP items)	€ 0.4	€ 0.4	-€ 29	€ 29	€ 0.5	€ -	€ 16	€ -	€ 0.4	0.1
Crisp packets and sweet wrappers	EPR – cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 30	0.0
Wet wipes	Standards for WWTW	€ -	€ -	€ -	€ -	€ -	€ -	€ 58	€ -	€ 7,733	0.0
Sanitary towels	Reduction targets (SUP)	-€ 2,316	-€ 2,396	-€ 1,254	€ -	€ 55	€ 26	€ 28	€ -	-€ 3.7	-13.2
Cutlery	Ban (of SUP items)	-€ 409	-€ 409	-€ 2,712	€ 2,505	€ 2.3	€ -	€ 14	€ 174	-€ 8	4.9
Straws	Ban (of SUP items)	-€ 2,431	-€ 2,431	-€ 1,944	€ 718	€ 11	€ -	€ 42	€ -	-€ 8	-5.5
Stirrers	Ban (of SUP items)	-€ 4,012	-€ 4,012	-€ 2,306	€ 298	€ 1.5	€ -	€ 46	€ 294	-€ 2.1	-11.2
Drinks cups and lids	Reduction targets (SUP) - high	-€ 2,025	-€ 2,025	-€ 1,165	€ -	€ 152	€ 16	€ 102	€ 239	-€ 23	-6.3
Food containers	Reduction targets (SUP) - high	€ 769	€ 769	-€ 1,551	€ 1,887	€ 49	€ 18	€ 102	€ 1,115	€ 38	28.5
Total		-€ 10,043	-€ 10,123	-€ 11,679	€ 6,345	€ 272	€ 276	€ 714	€ 1,823	€ 9,175	5.0*

* Note, following submission of the results to the Regulatory Scrutiny Board, additional DRS related jobs were added to the modelling, and are presented in the 2c+ results in Table A5.5 below – the additional jobs are in the order of 22 thousand FTEs.

Table A5.5 Model Outputs (2030) – Scenario 2c+

Item	Measure	Reduction in marine plastics, kt	Reduction in marine plastics, million items	Marine litter reduction - % of SUP by weight*	Marine litter reduction - % of SUP by count*	Change in GHGs, million tonnes	Change in external costs (litter), € million	Change in external costs (LCA), € million	Change in external costs (total), € million	Change in manufacturing related land use, km2	Change in material demand, kt
Cigarette filters	EPR – full cost of litter	-0.03	-2,628	-0.2%	-38.8%	0.00	-€ 27	€ 0.003	-€ 27	0.00	0.00
Drinks bottles	EPR – full cost of litter + Specific design requirements	-5.79	-157	-44.0%	-2.3%	-0.56	-€ 14,905	€ 4	-€ 14,902	1.78	63.73
Cotton buds	Ban (of SUP items)	-0.01	-61.8	-0.1%	-0.9%	-0.01	-€ 65	-€ 0.3	-€ 65	-0.08	-0.26
Crisp packets and sweet wrappers	EPR – full cost of litter	-0.23	-40.8	-1.7%	-0.6%	-0.00	-€ 191	-€ 0.03	-€ 191	0.00	0.00
Wet wipes	EPR – full cost of litter	-0.12	-112	-0.9%	-1.7%	0.00	-€ 537	€ 0	-€ 537	0.00	0.00
Sanitary towels	Info. campaign + labelling + voluntary action	-0.23	-36.6	-1.7%	-0.5%	0.00	-€ 843	€ 0.02	-€ 843	0.00	0.00
Cutlery	Ban (of SUP items)	-0.05	-17.9	-0.4%	-0.3%	-0.61	-€ 129	-€ 10	-€ 139	-0.88	-131.39
Straws	Ban (of SUP items)	-0.15	-372	-1.1%	-5.5%	-0.49	-€ 459	-€ 43	-€ 502	-0.44	-112.04
Stirrers	Ban (of SUP items)	-0.01	-19.9	-0.1%	-0.3%	-0.77	-€ 30	-€ 49	-€ 79	-1.64	-42.54
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP)	-1.58	-113	-12.0%	-1.7%	-0.61	-€ 3,689	-€ 100	-€ 3,790	-7.31	-200.74
Food containers	EPR – full cost of litter + Reduction targets (SUP)	-0.99	-49.7	-7.6%	-0.7%	-0.38	-€ 2,177	€ 3	-€ 2,174	10.91	-81.31

*% reductions are calculated relative to the total marine litter of these 'top ten' items only.

Item	Measure	Change in consumer costs, € million	Change in retailer turnover, € million	Change in producer turnover (SUP), € million	Change in producer turnover (SUNP), € million	Change in producer turnover (MU), € million	Business compliance costs, € million	Information costs, € million	Commercial washing and refill scheme costs, € million	Change in waste management costs, € million	Change in employment, Thousand FTEs
Cigarette filters	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 275	0.0
Drinks bottles	EPR – full cost of litter + Specific design requirements	€ 1,000	€ -	€ -	€ -	€ -	€ 414	€ 102	€ -	€ 180	27.1
Cotton buds	Ban (of SUP items)	€ 0	€ 0	-€ 29	€ 29	€ 0.5	€ -	€ 16	€ -	-€ 0.2	0.1
Crisp packets and sweet wrappers	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 102	€ -	€ 124	0.0
Wet wipes	EPR – full cost of litter	€ -	€ -	€ -	€ -	€ -	€ -	€ 58	€ -	€ 321	0.0
Sanitary towels	Info. campaign + labelling + voluntary action	€ -	€ -	€ -	€ -	€ -	€ -	€ 28	€ -	€ 0.1	0.0
Cutlery	Ban (of SUP items)	-€ 409	-€ 409	-€ 2,712	€ 2,505	€ 2.3	€ -	€ 14	€ 174	-€ 22	4.9
Straws	Ban (of SUP items)	-€ 2,431	-€ 2,431	-€ 1,944	€ 718	€ 11	€ -	€ 42	€ -	-€ 28	-5.5
Stirrers	Ban (of SUP items)	-€ 4,012	-€ 4,012	-€ 2,306	€ 298	€ 1.5	€ -	€ 46	€ 294	-€ 7.1	-11.2
Drinks cups and lids	EPR – full cost of litter + Reduction targets (SUP)	-€ 1,265	-€ 1,265	-€ 728	€ -	€ 95	€ 16	€ 102	€ 150	-€ 41	-4.0
Food containers	EPR – full cost of litter + Reduction targets (SUP)	€ 480	€ 480	-€ 970	€ 1,179	€ 30	€ 18	€ 102	€ 697	-€ 19	17.8

Note, '€ -' = zero cost as not relevant for this item

Annex 6 Response: Query regarding impacts of individual top ten single use plastic items

This Annex serves to address the following comment made by the Regulatory Scrutiny Board (RSB):

"The report makes it clear that the 10 most frequently found single use plastics are harmful as a group. This is not shown for each individual item, especially for those that are least frequently found."

This Annex therefore discusses the harmful effects of the 10 most frequently found single use plastics as a group. It demonstrates that each of these items is sufficiently harmful to warrant the proposed measures (as set out in the main report). This is particularly relevant for those items that are found less frequently, in line with the request from the RSB.

Our response and observations are laid out in the sections below.

A6.1 Lack of disaggregation of individual item categories in the literature

Data on the aggregate impact of different SUP items on animals is not available. The available evidence is for broader groups of plastic items. Where impacts of specific items are evidenced, these are typically from case examples of individual instances.

The animals commonly monitored for plastic related impacts, e.g. ingestion impacts, such as fulmars, are generally small, and can only ingest very small items or fragments of larger items. Of the 10 target SUP items, one would not expect to find many, if any, of the items ingested whole and as identifiable items. This is because items, such as drinks bottles, cups and food containers, are generally too large to be swallowed whole by most bird and fish species.

Once items are fragmented, it can become very difficult to identify from which item the fragments originate. Hence most studies include broad categories of items in their analyses of impacts. This means that it is, in general, not feasible to establish an understanding of which SUP items are most prevalent in impacting animals.

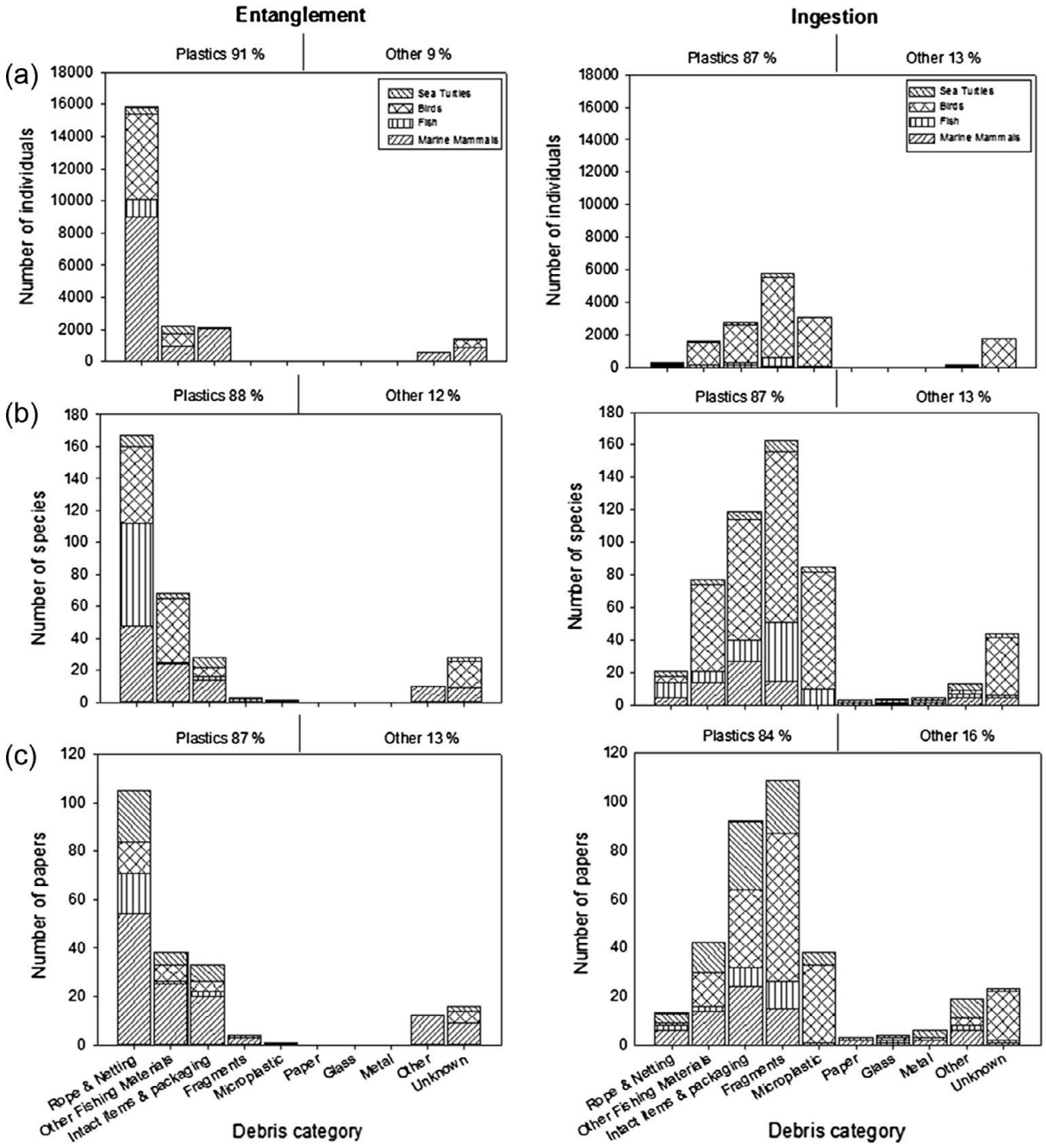
For example, Gall and Thompson's (2015) review of 340 papers produced a summary of impacts on 693 species, shown in Figure A1.1.149. The debris categories used in the study were:

- Plastic
  - Rope and netting
  - Other fishing materials
  - Intact Items and Packaging
  - Fragments
  - Microplastic
- Paper
- Glass
- Metal
- Other

[149] Gall, S.C., and Thompson, R.C. (2015) The impact of debris on marine life, *Marine Pollution Bulletin*, Vol.92, Nos.1–2, pp.170–179

- Unknown

Figure A6.1 Impact of debris on marine species



Source: Gall and Thompson, 2015

Similarly, another review of impact papers specific to ingestion by sea turtles (results shown in Figure A1.2), has the categories:[150]

- Plastic (general)
- Soft plastic
- Rope
- Styrofoam

[150] Schuyler, Q., Hardesty, B.D., Wilcox, C., and Townsend, K. (2013) Global Analysis of Anthropogenic Debris Ingestion by Sea Turtles, *Conservation Biology*, p.n/a–n/a

- Hard plastic
- Fishing line
- Rubber
- Fish hooks
- Tar/Oil
- Balloons
- Aluminium
- Other
- Cigarette Butts

Figure A6.2 Review of studies reporting marine debris ingested by sea turtles

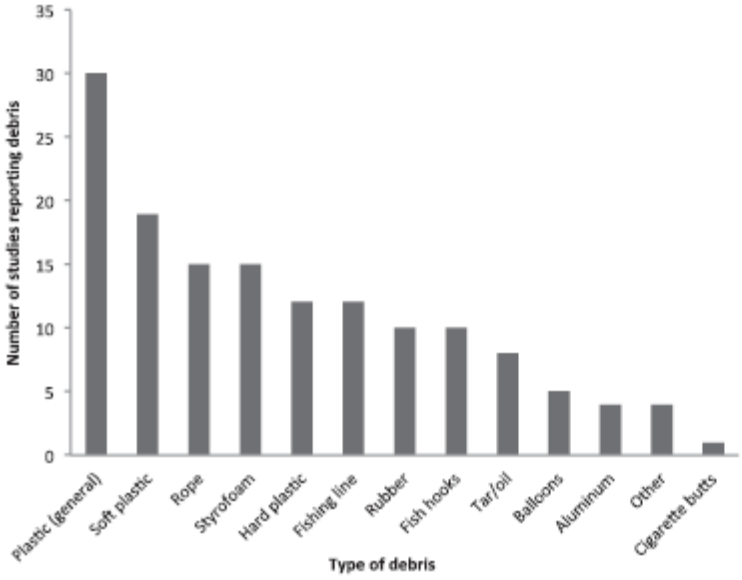


Figure 2. Total number of studies reporting on ingestion of particular types of marine debris by sea turtles. In many cases, multiple types of debris were found, so a study could be counted in more than one category.

Source: Schuyler, 2013

The scheme to monitor environmental quality in the OSPAR region by assessing fulmar stomachs uses the following categories:[151]

- Plastics
  - Industrial plastic pellets
  - User plastics
    - Sheet-like plastics
    - Threadlike plastics
    - Foamed plastics
    - Fragments
    - Other
- Rubbish
  - Paper
  - Kitchen food
  - Various
  - Fish hooks
- Pollutants (e.g. paraffin, slag)
- Natural food remains

[151] van Franeker, J.A., Blaize, C., Danielsen, J., et al. (2011) Monitoring plastic ingestion by the northern fulmar Fulmarus glacialis in the North Sea, *Environmental Pollution (Barking, Essex: 1987)*, Vol.159, No.10, pp.2609–2615

- Natural non-food remains

An informal publication from Jan Andries van Franeker illustrates the average stomach content of a fulmar in terms of plastics. At a body weight of 700g, the fulmar stomach is only a few centimetres across. Images of these fragments of debris can be seen in Figure A1.3.

Figure A6.3 Images from van Franeker's informal publication on the contents of fulmar stomachs

Dead Northern Fulmar on the beach.

Balloon remains from a fulmar stomach

An ± average stomach content

An extreme stomach content

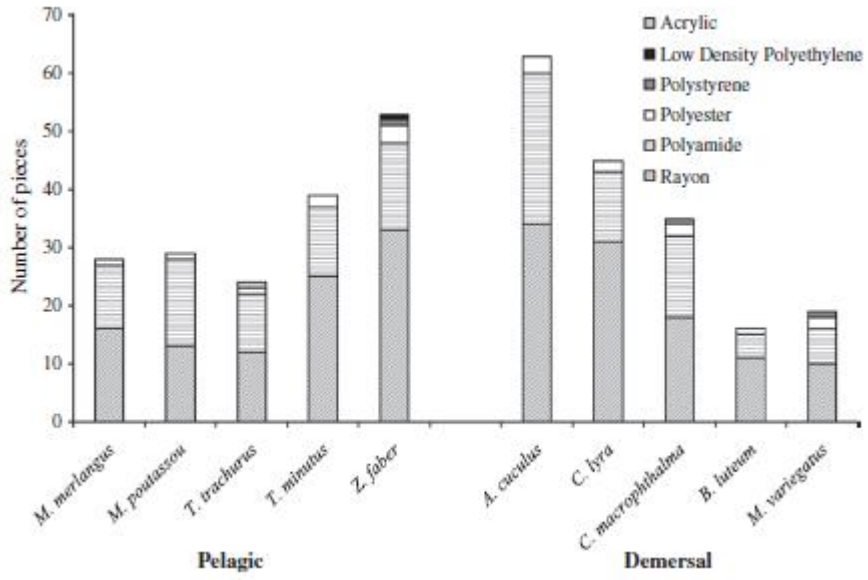
Source: van Franeker, J. Plastic Soup is Everywhere[152]

Papers reviewing ingestion in fish such as Foekema et al (2013) and Lusher (2013) only assess by size in mm, shape and polymer type. [153] The size of the fish stomach precludes that anything other than microplastics (i.e. <5mm) are the focus of the study. Results from their studies are shown in Figures A1.4 and A1.5.

[152] https://www.wur.nl/upload_mm/0/b/2/020f791b-3b58-4f39-9f08-09924fa9b15d_PLASTIC%20LUNCH-UK.pdf

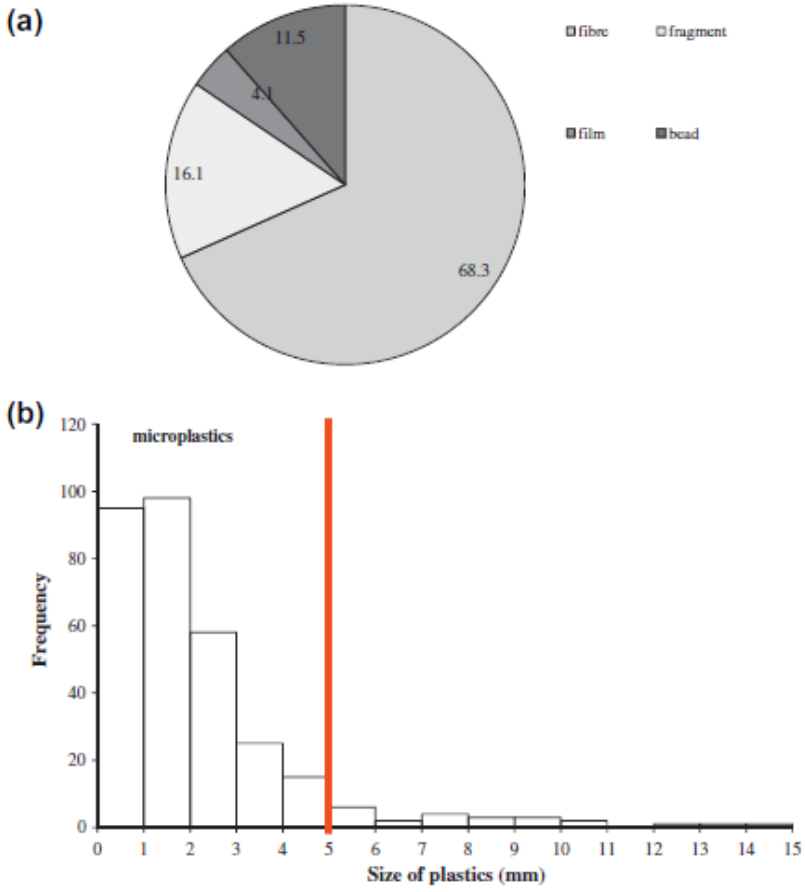
[153] Foekema, E.M., De Gruijter, C., Mergia, M.T., van Franeker, J.A., Murk, A.J., and Koelmans, A.A. (2013) Plastic in North Sea Fish, *Environmental Science & Technology*, p.130711150255009,Lusher, A.L., McHugh, M., and Thompson, R.C. (2013) Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel, *Marine Pollution Bulletin*, Vol.67, Nos.1–2, pp.94–99

Figure A6.4 Types of plastic polymers found in a range of fish species' stomachs



Source: Lusher, 2013

Figure A6.5 a) Form of plastics found in fish stomachs as a proportion, b) Frequency of plastics found in fish stomachs by size ("microplastics" to left of red line)



Source: Lusher, 2013

Even for larger animals such as dolphins and whales, it is not yet commonplace to use standardized item lists for categorisation (such as UNEP or TG ML lists). Even

where standardised lists are used, there are limitations to disaggregating impacts to items relevant to this study. Standardised lists currently have their own inherent limitations such as absence of a category for e.g. wet wipes, or absence of separate categories for straws and stirrers or cutlery, as covered in the main report. Similar limitations are found in any custom lists created for particular research studies.

However, there are individual high-profile cases (as listed in the paragraph below) where impacts have been demonstrated for specific items for these larger animals. These cases demonstrate that even larger items are directly ingested whole in some instances.

For example: a widely publicised case of a turtle having ingested a drinking straw which then became lodged in the animal's nostril[154]; a case of a plastic fork having been ingested by a turtle[155,156]; a review of items found in whale stomachs, including bags, drinks cups, plastic caps as well as a host of other items[157]; as well as the widely seen images of Midway Island albatross[158] with plastic caps easily identifiable amongst ingested items.

However, it is not possible to demonstrate the relative contribution of specific items in a systematic way, based on the body of research currently available.

A6.2 Making the case for item-specific actions

In response to the statement made by the RSB, that the relative contribution, by direct impact, of each top 10 SUP items, the authors assert that (regardless of the fact that given the state of available evidence, it is not feasible to do so), action on the identified items (via the proposed measures) is justifiable without demonstrating item-specific impacts. This is because the items together account for a high proportion of plastic items in the environment, and for a large part of their life-cycle in the marine environment there is no difference in their likely environmental effect (beyond that determined by their volume).

The case for action for this group of items stems from the fact that together they account for a large proportion of items found in the marine environment. By focussing on these top ten items, potentially 77% of the general plastic items found on beaches can be addressed by the measures proposed; while a full 86% of the single use plastic items that are found on beaches could be addressed. They share a commonality in terms of their use and function and represent a good trade-off between the number of items to be dealt with versus the potential environmental gains, owing to the ranking approach applied.

The description of the state of the current literature on impacts of marine plastics highlights the fact that many of the impacts of plastic items occur after they have fragmented. The impacts are item-specific for only a certain part of their life cycle. Once the items have fragmented, the impacts become ***common to all items***. It can be reasonably assumed that fragments derived from them are created, as a general

[154] https://news.nationalgeographic.com/2015/08/150817-sea-turtles-olive-ridley-marine-debris-ocean-animals-science/

[155] https://www.earthtouchnews.com/environmental-crime/pollution/first-a-straw-now-a-fork-turtles-are-choking-on-our-plastic-trash/

[156] The mouth cavity of turtles is lined with tough, backwards facing spines to inhibit the escape of prey; however it means that the animals can egest things only with great difficultly and for this reason, items get lodged in their nasal cavities. http://seaturtleexploration.com/inside-of-a-sea-turtles-mouth/

[157] de Stephanis, R., Giménez, J., Carpinelli, E., Gutierrez-Exposito, C., and Cañadas, A. (2013) As main meal for sperm whales: Plastics debris, *Marine Pollution Bulletin*, Vol.69, Nos.1–2, pp.206–214

[158] http://www.chrisjordan.com/gallery/midway/#CF000313%2018x24

rule, in direct proportion to their prevalence in the marine environment. For this reason, it is not necessary to attribute impact to specific items, but it is adequate to demonstrate the impacts caused by plastic generally at sea, which are applicable to *all of these items*.

For those items that are found less frequently, we make the point that any item category could be continuously disaggregated - by brand, polymer type, location of origin, or any other attribute, until the case for addressing any individual item is untenable owing to the increasingly small proportion of marine litter which it accounts for. We bring to the RSB's attention that the most detailed marine litter categorisation system in use at present (the JRC's Technical Group on Marine Litter list) contains ~165 categories, and this still isn't sufficient to capture all the detail that might be required about certain specific marine litter item types. With such a detailed categorisation system, there are very few categories which, alone, make up a large contribution to marine litter. The fact that marine litter is extremely varied is not a good reason for failing to take action on specific items.

A6.3 The number of items that can potentially be prevented from entering the marine environment is very large

This statement – that the number of items that can potentially be prevented from entering the marine environment is very large – is true for each individual item as well as the top ten priority group set out by the European Commission.

The JRC data on beach litter only covers a small proportion of coastline – 100m stretches of 276 beaches in 17 Member States. At around 28km of monitored coastline, this is a small proportion (0.04%) of the total EU coastline (which is 70,000km long)[159]. However, this study's single use plastic items mass flow model, provides a best estimate for the number of items that are currently entering the marine environment on an annual basis (summarised in the Table A1.1), of almost **12 billion items**. The smallest of the top ten items, stirrers, is still estimated to contribute **17 million items** a year to the marine environment. Option 2c is modelled to reduce that 12 billion item input by **3.8 billion items** (see Table A6.1).

Table A6.1 Change in marine plastics by item and by % total marine litter – by each scenario

Option	Change in SUP marine litter, million items	Change in SUP marine litter - % of top ten SUP items in marine litter
2a	-1,049	-15%
2b	-3,426	-50%
2c	-3,806	-56%
2c+	-3,609	-53%
2d	-5,041	-74%

[159] https://en.wikipedia.org/wiki/Geography_of_the_European_Union

Table A6.2 Estimated number of SUP items entering the marine environment, under each option in the model

			Change in marine litter by item, 2030				
Item	Marine litter, millions of items, **2018**	Marine litter, millions of items, **projection to 2030**	Option 2a	Option 2b	Option 2c	Option 2c+	Option 2d
Cigarette filters	9,916	4,778	-693	-2,628	-2,628	-2,628	-3,703
Wet wipes	662	775	-112	-112	-444	-112	-388
Straws	341	372	-102	-330	-372	-372	-372
Cotton buds	286	95	-12	-62	-95	-95	-95
Drinks bottles	215	182	-34	-23	-23	-157	-157
Sanitary towels	205	252	-30	-37	-37	-37	-90
Drinks cups and lids	140	146	-27	-113	-113	-113	-132
Crisp packets and sweet wrappers	77	74	-11	-41	-41	-41	-41
Food containers	68	64	-18	-50	-50	-50	-58
Cutlery	18	18	-5	-14	-18	-18	-18
Stirrers	17	20	-5	-18	-20	-20	-20
Grand Total	**11,948**	**6,776**	**-1,049**	**-3,426**	**-3,806**	**-3,609**	**-5,041**

Annex 7 Litter Extended Producer Responsibility (EPR) costs sensitivity and further literature review

This Annex outlines the methodology and results for the further estimates of potential costs of extended producer responsibility (EPR) requirements, which were requested following submission of the initial Impact Assessment results.

A7.1 Method

The litter EPR costs cover the following products, split into those predominantly littered on land or flushed down drains:

- Littered on land:
  - Food containers
  - Packets and wrappers
  - Beverage containers
  - Cups for beverages
  - Tobacco products with filters
  - Inflatable balloons for events and sticks[160]
- Flushed items:
  - Wet wipes
  - Sanitary towels (pads) and tampons and tampon applicators

EPR is anticipated to relate to the following measures:

- Awareness raising measures;
- Waste collection and treatment; and
- Litter clean up.

The total cost of awareness raising measures are calculated assuming a cost of €0.20 per inhabitant per year, pro-rated across the items according to the relative total cost of litter clean-up of each item.[161]

The costs of waste collection and treatment are calculated through the modelled changes in waste management and unit costs from the EU reference model on municipal waste management.

The litter clean-up costs are further described in the paragraphs below.

The measure should make reference to a standard of cleanliness for it to be effective. This is important because:

- The range of 'litter clean-up' activities that might be taken by a Member State is wide, and so the effectiveness of the instrument might be reduced if a limited range of activities are undertaken.

[160] an additional pathway for helium filled balloons is release into the atmosphere, unintentionally or intentionally, particularly through 'mass ascents', where the balloons and land and are washed into rivers or land directly in the sea.

[161] Cost based upon household waste information campaigns carried out by WRAP in the UK.

- A wide range of approaches could be taken by Member States, resulting in inconsistent application of the Directive, unharmonised policies and limited overall reductions in litter across the EU-28.

A standard would set the requirements for such activities to be carried out and set a level playing field across the different products and countries within the EU.

The Clean Europe Network made reference to litter cleanliness standards in its work to initiate the development of an EU standard for litter monitoring.[162,163] These litter grades were based on litter grading needs in the UK to monitor indicators on cleanliness.

The litter cleanliness indicators used by Keep Scotland Beautiful, are as follows:

> *Grades of cleanliness*[164]
>
> *Each area of study (site) was graded according to the standards outlined in the Code of Practice on Litter and Refuse (Scotland) 2006, which relates to Part IV of the Environmental Protection Act (EPA) 1990. An additional grade not defined within the code (B+) has been included for reporting quality.*
>
> *There are five grades of cleanliness, which are defined as:*
>
> - Grade A
> – No litter or refuse
> - Grade B+
> – Predominantly free from litter and refuse – up to three small items
> - Grade B
> – Predominantly free from litter and refuse
> - Grade C
> – Widespread distribution of litter and refuse with minor accumulations
> - Grade D
> – Heavily littered with significant accumulations
>
> *This grading system is based on research into standards of cleanliness which most people regard as being acceptable or unacceptable. Under this system, grades C and D are unacceptable and must be cleaned (in most cases to grade A condition) within a specified time (see below). Grade A is the standard which a thorough conventional sweeping/litter-picking should achieve. The overall aim, however, should be to operate a management system where acceptable standards of cleanliness (grades A, B+ and B) are maintained at all relevant times.*

The exact nature of the standard that would be required is not developed here. However, the standard chosen would have to be high enough to ensure significant reductions in litter entering the marine environment. Given the amounts of litter found on beaches, it is clear current grades of cleanliness used are not likely to be robust enough.

Standards could be developed through a delegated act referred to in the Directive. This may take time to develop, so the schemes obligated by the Directive cover the

[162] https://www.cleaneuropenetwork.eu/en/measuring-litter/aus/

[163] https://www.cleaneuropenetwork.eu/pdf/slns2016_Litter_measurement.pdf

[164] https://www.keepscotlandbeautiful.org/media/1561096/16_17-leams-benchmarking-report.pdf

costs of all existing services at the current level of cleanliness at the earliest opportunity – even this would have a significant benefit to stretched municipal budgets. Higher standards can then be fully developed, and practices changed, over time.

For the purposes of the modelling it was assumed half of the litter remaining uncollected in the Baseline could be captured as a result of measures taken to meet the increased standards. In terms of the costs of achieving these standards, the following approach was taken:

- The costs associated with the flushed items related solely to increased costs of beach cleaning – assuming that flushed items would enter the sea and become washed up on beaches.
- The costs of litter dropped in the terrestrial environment relate to increased pick up costs and increased beach cleaning costs, as a fraction of the terrestrial litter enter the marine environment.
- Of the uncollected terrestrial litter in the Baseline, 50% is assumed to remain on land and 50% enters the marine environment. It is assumed, therefore, that if the remaining uncollected litter is halved, 50% relates to pick-up on land and 50% to increased beach cleaning.
- The costs of beach cleaning were calculated as follows:
  - The total cost of cleaning beaches in the EU was estimated by Arcadis to be between €194 million and €630 million, with an average around €410 million per annum.[165] However, the average cost per km is low (€8k) compared to the cost of bathing beaches (up to €40k). Assuming the costs would need to increase significantly to capture an increased level of beach litter, we assume that 5 times the current level of funding would be needed – this assumes beaches would need to be cleaned much more regularly to stem the build up of litter, the Arcardis report suggests many non-bathing beaches are only cleaned once or twice a year. This would bring the total beach clean-up cost to around €2,000 million per annum.
  - The total cost of beach cleaning was then pro-rated across the different items based upon an average of the item count and weight within the total amount of beach litter that would be collected – i.e. it was assumed that the beach litter cleaning activities are not just for plastic items, but all items found on beaches.
- The costs of terrestrial litter clean up were calculated as follows:
  - The Clean Europe Network estimates that "the total cost of cleaning up litter on the land throughout the EU is somewhere in the range of €10-13 billion. Including the cost of marine litter would boost that cost even higher."[166]
  - Taking an alternative approach using the average litter rate of 3.76 kgs per capita of collected litter, 510 million people in the EU-28 and a cost per tonne to collect ground litter of €4,000, the total estimated cost for the EU is around €7.7 billion (see section 2 and 3 of this Annex for litter assumptions).
  - It was assumed that the current clean up estimates would need to double in order to achieve a higher grading of overall cleanliness – the increase is not as high for beach litter as more terrestrial litter clean up (in urban centres for example) is already occurring and the cost of clean up is less than for beaches which are less accessible.
  - A range was therefore used between €16 billion and €26 billion for the total cost of managing terrestrial litter in the EU.

[165] Arcardis (2015) *Marine Litter study to support the establishment of an initial quantitative headline reduction target - SFRA0025*, Final Report for DG Environment

[166] https://www.cleaneuropenetwork.eu/en/facts-and-costs/aup/

- The total cost of ground litter was then pro-rated across the different items based upon an average of the item count and weight within the total amount of ground litter that would be collected – i.e. it was assumed that the ground litter cleaning activities referred to above were not just for plastic items, but all items found in terrestrial environments.
- The litter compositions used in the model to date focused on compositions by weight. The most accessible composition with usable figures for counts was for litter in Flanders, Belgium (see section 3 of this Annex). However, not all categories were present in this dataset (such as packets and wrappers). Where count based compositions were not available, the weight based count only was used.

A7.2 Results

In Table A7.1 to Table A7.2 below, the results of the cost modelling sensitivities for litter EPR are presented.

The first table outlines the key components of the costs and uses an average cost for the litter clean up. The relative compliance cost per item sold is given in the far right column of the table.

The second table shows the outputs of the litter clean cost sensitivity. The low and high costs are calculated based upon low and high input costs respectively as well as using both weight and count based methodologies (i.e. the highest cost out of the two methods is presented in the high column as vice versa). For some items, such as cigarette filters, the difference in the apportioned cost is highly significant and mainly related to whether a count or weight based approach is used. This outlines the need for careful consideration of how the overall costs of cleaning up litter should be apportioned across the different items covered by the EPR obligations.

Table A7.1 Compliance Costs – Average

Item	Total litter clean-up costs, € million	Information costs, € million	Total disposal costs, € million	Total Compliance Costs, € million	Total Number of Items Sold, millions	Compliance Cost per Item, €	Unit Cost of Product, €	Relative Compliance Cost, %
Cigarette filters	3,012	76	0.67	3,088	709,994	0.004	0.20	2.2%
Drinks bottles	558	14	112	684	71,651	0.010	0.73	1.3%
Wet wipes	15	0	11	26	40,374	0.001	0.02	2.6%
Sanitary towels	10	0	29	40	18,791	0.002	0.32	0.7%
Drinks cups and lids	240	6	59	305	20,711	0.015	2.00	0.7%
Food containers	167	4	73	244	26,299	0.009	5.00	0.2%
Crisp packets and sweet wrappers	58	1	48	107	44,681	0.002	0.30	0.8%

Table A7.2 Relative Compliance Cost vs Unit price, % (high/low = range in total cost and selection of highest / lowest weight or count based costs)

Item	Low	Average	High
Cigarette filters	0.03%	2.2%	5.3%
Drinks bottles	0.5%	1.3%	2.7%
Wet wipes	1.1%	2.6%	6.6%
Sanitary towels	0.5%	0.7%	1.1%
Drinks cups and lids	0.3%	0.7%	1.4%
Food containers	0.1%	0.2%	0.3%
Crisp packets and sweet wrappers	0.7%	0.8%	1.2%

Annex 8 Analysis related to deposit refund systems (DRS)

This Annex outlines further work completed on assessing deposit refund systems (DRS), focusing on general costs and retailer costs (Section A4.1) and leasing of reverse vending machines (RVMs) (Section A4.2).

A8.1 General costs and retailer costs

The costs associated with the potential introduction of a DRS covering plastic bottles are set out in this section. The model excludes any Member States which have already implemented a comprehensive DRS for one-way beverage containers. These countries are:

- Denmark
- Estonia
- Finland
- Germany
- Lithuania
- Sweden

It is noted that normal convention is for DRSs to cover all beverage materials across product ranges. However, the costs of the other materials are not calculated here, as the focus is plastics.

Firstly, the costs of the potential DRS itself are considered. The costs to the system itself should equate to the revenues. The breakdown of the costs into the following categories were taken from the overall proportions of these costs reported by the Norwegian DRS, Infinitum:[167]

- Costs - Handling fee (inc. RVMs) 54%
- Costs - Container pickup / logistics 27%
- Costs - Counting centres 17%
- Costs - System administration 2%

In terms of the revenues, these include:

- Fees from beverage producers;
- Unclaimed deposits paid by consumers; and
- Value of the material collected and sold to reprocessors.

The net producer fee was discussed in section 2 of this Annex. An average fee for plastic bottles from the existing European schemes was around €0.025 per container. At an average plastic bottle weight of around 37g (see section 2), this equates to a producer fee of around €680 per tonne placed on the market. The remainder of the assumptions are set out in the Plastics Strategy report.[168] The return rate assumed in the model is 90%, therefore, 10% of the deposits are unclaimed and will contribute revenue to the operation of the system. The revenue was calculated assuming an average deposit value of €0.15 per container. In terms

[167] Infinitum (2018) *About Us*, Accessed 15th May 2018, https://infinitum.no/english/about-us

[168] ICF and Eunomia (2018). 'Plastics: Reuse, recycling and marine litter, Final Report', 30th May 2018

of the material sales, a value of €250 per tonne of plastic bottles sold (assuming they are mainly PET), was used in the calculations.

The total costs and revenues calculated according to the approach outlined above are shown in Table A4.1.

Table A8.1 Costs and revenues associated with DRS

Associated costs and revenues	Value (€ million)
Handling fee (including RVMs)	1,738
Container pickup / logistics	869
Counting centres	547
System administration	64
Material sales (PET) (Revenue)	-551
Unclaimed deposits @ 15 € cents deposit (Revenue)	-1,000
Producer fees (Revenue)	-1,667
Net Costs	**0**

The material sales are derived from the operation of the system itself. The additional financing of the system comes from consumers forgoing their deposit and the producer fees. Therefore, the total additional fees paid by beverage producers are considered to represent a net cost to society, at €1,667 million, with the costs to consumers at €1,000 million.

However, these beverage producers will not now be paying fees to the existing packaging producer responsibility obligations (PRO) schemes as the DRS will fulfil their obligations under the packaging and packaging waste directive (PPWD) to meeting the recycling targets. In fact, the beverage producers will contribute significantly more to the meeting of the 55% recycling target than the other plastics packaging manufacturers (as the beverage recycling rate will be 90%).

To estimate the savings to the beverage producers, one must consider that the savings will be made in the future over and above the baseline position where the 55% packaging target is achieved in 2025. Therefore, beverage producers will be paying the same as all other plastics packaging producers to ensure that the target is met. The method to produce this estimate is described below.

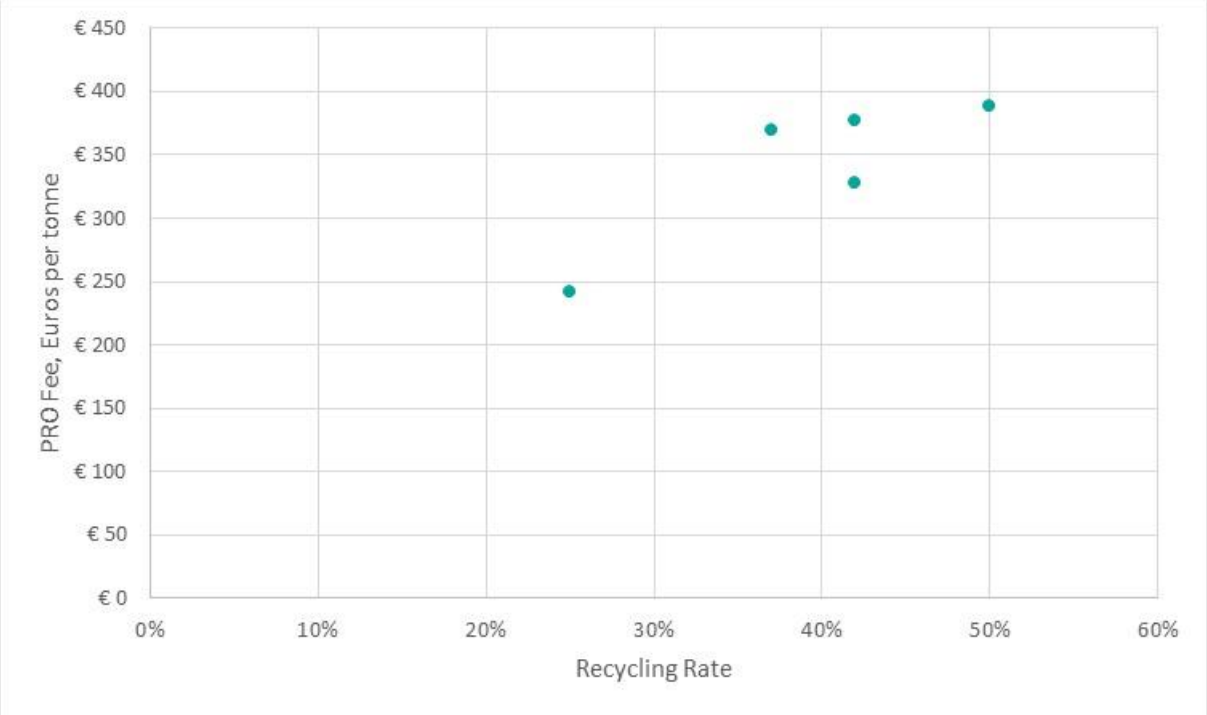
Firstly, data relating to the plastic packaging recycling rate and PRO fee for a range of higher performing countries were chosen, and outliers were removed from the data (see Figure A4.1 below).

These data suggest that the fee per tonne of material placed on the market at a recycling rate of 55% is likely to be in the region of €350/t. However, with eco-modulation of fees being implemented under the waste framework directive (WFD) requirements, and the fact that beverage bottles are eminently recyclable, it is likely that the fees for the beverage producers would be lower than for other packaging

producers. An additional figure of €250/t was used in a sensitivity analysis. For the purposes of calculating the overall results from the single use plastic (SUP) IA model, a figure of €300/t was used (i.e. the mid-point between the two per tonne estimates). This figure was then used to estimate the total avoided costs to beverage producers from implementing a DRS. In total, the savings to beverage producers amount to €858 million and €613 million respectively.

There is also a question of whether the reduction in beverage bottles collected by existing PRO schemes affects the fees for other plastic producers or producers of any other material covered by the scheme. There will be losses in revenue from the removal of the beverage containers, however, there will also be a reduced amount of material to collect and sort. If there is less material to collect this could potentially reduce the number of trucks and drivers on the road, which would result in cost savings. Plastic has a high volume and low bulk density, meaning it fills up collection vehicles more quickly than many other recyclables. High bulk density materials are generally more cost efficient to collect. In addition, sorting of plastics from other recyclables or by polymer is generally financed on a gate fee basis. Therefore, if there are fewer tonnes to sort the costs reduce. Finally, although not included in the scope of these calculations, if glass were removed from existing waste collection services, this is also likely to reduce costs as the material revenue is often low and glass is heavy. In addition, glass causes the most wear and tear in sorting plants, so maintenance costs would also reduce as a result of shifting the material to a DRS.

Figure A8.1 PRO Fee versus Plastic Packaging Recycling Rate



Source: Eurostat / PRO Schemes

A recent comprehensive study found that the reduced collection and sorting costs balanced out the reduced revenues, both as a result of removing beverage

containers from current municipal waste collection services.[169] There are a range of factors which would drive the net balance of collection and sorting costs and revenues, but it is clear that only including reduced revenues and not making any consideration of the logistics effects is inappropriate.

Given this evidence, it was assumed that the costs and benefits to the wider PRO schemes would balance out. Moreover, the increasing recyclability of plastics driven by the 2030 target in the plastics strategy may mean that collection systems operate more profitably in future. Also, due to the high performance of DRS, less effort and cost by the remaining plastic packaging producers will be required to meet the 55% target, as would otherwise have been under a case where beverage container recycling reaches a maximum of 70% rather than 90%. As a final point, even if no savings were taken into account the overall cost (which would be the value of the material, €551 million), this is a small fraction of the environmental savings from reduced external costs of around €22 billion.

Mixed waste treatment and disposal costs would also be saved as there would be less material in the mixed waste stream as recycling increases. The method to calculating these costs is set out in section 3. Savings amount to €53 million.

Finally, the remaining key service to be affected through the introduction of a DRS is 'street scene', i.e. litter sweeping. The direct costs of collecting litter have been previously estimated at around €1,500 per tonne. However, this also relates to collecting litter from on-street litter bins. The costs of street sweeping and litter picking are significantly higher as it is a highly manual task. The cost of this activity is estimated at €4,000 per tonne.[170] This is significantly lower, however, than the cost of collecting litter from beaches which is estimated at the high end to be around €25,000 per tonne (see section 3). The calculated saving from reduced litter collection is in the region of €470 million per annum.

In summary, Table A4.2 outlines the total net financial costs related to plastics from introduction of a DRS in all Member States that do not currently operate one.

Table A8.2 Total net financial costs related to plastic bottles in DRS

Item	Scenario 1 (PRO fees @ €350/t) - €Million	Scenario 2 (PRO fees @ €250/t) - €Million
Producer fees paid to DRS	1,667	1,667
Forgone deposits by consumers	1,000	1,000
Avoided PRO fees which beverage producers would otherwise pay (@€350/t)	-858	-613
Residual waste treatment / disposal	-53	-53
Litter collection	-470	-470
Net costs	**1,287**	**1,532**

[169] Eunomia (2017) Impacts of a Deposit Refund System for One-way Beverage Packaging on Local Authority Waste Services, Final Report for Keep Britain Tidy

[170] Average from Eunomia Scotland litter study and large litter study by OVAM collecting actual data from municipalities.

A8.2 Retailer Reverse Vending Machine (RVM) options

Retailers can be concerned about the introduction of a DRS due to the cost of RVMs. There are, however, a number of options intended to ensure that the use of RVMs is both affordable and practical.

Firstly, in some cases – notably Lithuania and Denmark – the RVMs are provided and paid for by the central system operator, which is also responsible for installation and on-going maintenance costs. As the system operator would be providing RVMs for the whole country, it is likely that they could negotiate better prices with the RVM manufacturer than if each retailer was responsible for purchasing RVMs.

Where retailers are responsible for providing RVMs, they may purchase or lease them.

When retailers purchase RVMs they would typically take out a loan, to be repaid over a number of years using their income from handling fees (the assumed life of an RVM is seven years but, in practice, they can last much longer than this).

Retailers can lease RVMs from the manufacturer and agree a service contract. Full service contracts are common in some North American deposit systems. In such cases, the RVM manufacturer retains responsibility for installing and maintaining the RVMs, and replacing the compactors (in the case of compacting RVMs) to extend the life of the RVM. A hire and service model is consistent with circular economy principles.

Which approach retailers opt for will depend on their circumstances and size (including whether they are a chain or independent), the availability of credit and whether they are willing to take on the risk of buying the machines.

In successful European systems, retailers are paid a handing fee for every container they take back. The handling fee is typically higher for retailers with a compacting-RVM than for retailers providing a manual service or non-compacting RVM. This is due to the higher costs the former incur and the efficiency savings they can generate for the system operator. (In Lithuania, retailers with an RVM funded by the system operator are still paid a higher fee, partly to recognise the retail space they have provided to accommodate the RVM. In contrast, Denmark is unusual in paying a higher handling fee to retailers providing a manual service).

When deciding whether to invest in an RVM or sign a lease agreement, retailers will estimate the handling fees they are likely to earn and whether this justifies the cost of the RVM or the monthly payments. As a general rule, it tends to make financial sense to install an RVM if the retailer takes back at least 5-600 containers each day, as the handling fees will then off-set the costs associated with the RVM. The average RVM density of the six main established DRSs in Europe is 1 per 1,900 people.[171]

[171] Eunomia (2015) *A Scottish Deposit Refund System*. Final Report to Zero Waste Scotland, May 2015.

KH-03-18-234-EN-N

Publications Office