Appendix 1. Comments on the *Final Science Assessment of Plastic Pollution*, released on October 9th, 2020.

Dow Chemical Canada ULC ("Dow"), as a Responsible Care® company and as an organization that actively participates and contributes to public policy discussions, has reviewed the recently published *Science Assessment of Plastic Pollution (the Science Assessment)*, released on October 9th, 2020. Our review was completed by Global Dow toxicology and environmental expertise, most of whom had reviewed and commented on the *draft Science Assessment*.

The comments provided below incorporate both our global and local Canadian expertise in Environmental, Health and Safety. While our review identifies a number of critical issues, we offer our thoughts, observations and comments in the spirit of continuous improvement with the hope the Government of Canada will embrace these ideas to strive for the best possible scientific outcomes. As such we offer the following for consideration.

Summary of our Review

A proper science assessment is difficult without sufficient information and credible studies. We challenge the assertion made at the conclusion of the Executive Summary. Contrary to what is stated, there is a lack of scientific basis for invoking the precautionary principle for microplastics.

The *Science Assessment* openly states that its purpose is to serve as a literature survey and that "*it is not intended to quantify the risks of plastic pollution on the environment or human health*." [page 8, paragraph 2]. Therefore, the *Science Assessment* should not be construed as a document intended to have either scientific conclusions, or recommendations beyond what science or data is needed or required for assessment. Hypothesizing on speculation and stretching conclusions under the guise of quality science can lead to errors, faulty decisions, or myths being perpetuated.

An example of speculation in the guise of science is found in Executive Summary, page 9, paragraph 5. The Executive Summary states a conclusion that "*While there are no Canadian data available on the occurrence of microplastics in air, limited data from other parts of the world suggest that concentrations may be higher in indoor air than in outdoor air. Indoors, microplastics are also found in settled house dust*". Yet in Section 9 of the Science Assessment, it states that "*There are currently no validated or recognized methods for the collection or analysis of microplastic samples in air, and little information is available on the partitioning of microplastic particles between air and dust.*"[p.77, paragraph 5]. It brings into question the scientific voracity of the conclusion presented in the Executive Summary when there are no validated or recognized methods to arrive at this conclusion.

Comments related to Microplastics

Adverse effects of microplastics to environmental organisms at environmental relevant conditions have not been demonstrated.

The Scientific Assessment itself pointed out in Section 6.2 that "*Currently, concentrations of microplastics used in effect studies are much higher than those measured in the environment* "(Burns and Boxall 2018).

Furthermore, effects studies focus on particle sizes much smaller than those currently sampled for in the environment (SAPEA 2019). Particle concentration can also influence toxicity, as higher concentrations are expected to overwhelm biological clearance mechanisms and cause responses that are not otherwise observed at lower doses (WHO 2019)." Furthermore, a new study published by de Ruijter et al. (2020) critically reviewed 105 microplastic effect studies with aquatic biota and found in far too many instances studies suggest and speculate mechanisms that are poorly supported by the design and reporting of data in the study. De Ruijter et al (2020) concluded that based on the current state-of-the-science, the weight of evidence for ecological effects of microplastics is very limited. The Scientific Assessment failed to point out the critical lack of environmental relevance and the critical lack of quality studies, regarding current available ecological effects studies on microplastics, in the Executive Summary.

Microplastics do not bioaccumulate or biomagnify.
A new study published by Gouin (2020) critically reviewed 421 studies on ingestion, bioaccumulation and trophic transfer of microplastics, including data for >800 species representing approximately 87 000 individual organisms. It is concluded that although strong evidence exists for the biological ingestion of microplastics, they do not bioaccumulate and do not appear to be subject to biomagnification as a result of trophic transfer through food webs. This study was listed in Appendix A: New information published or received through public consultation. However, it was not taken into consideration when the final Science Assessment was developed. This study was not referenced or discussed in the main text, nor was it been taken into consideration for the Executive Summary, in the Science Assessment.

Risk of microplastics to the environment has not been demonstrated.
Adam et al. (2019) reviewed 391 exposure measurements and 53 ecotoxicity values for microplastics in freshwaters and performed a preliminary probabilistic risk assessment. The calculated risk characterization ratios (RCRs) for North America was 1.3 × 10-6, indicating no immediate risk to the environment. Furthermore, SAPEA (2019) also concluded that the best available evidence suggests that microplastics do not pose a widespread risk to the environment or to humans. Similarly, a new GESAMP (2020) report recently published concluded that risks of microplastics to the environment are likely to be rare at present.

Risk of microplastics to human health has not been demonstrated.
As stated in the Executive Summary, p.10 and 11, current scientific literature does not identify a concern for human health. We specifically agree with the report authors reiteration that "recent international reviews indicate that there is likely a low health concern for human exposure to chemicals from ingestion of microplastics from food or drinking water (EFSA 2016; FAO 2017; WHO 2019)." Regarding the potential for biofilm exposure to human associated with microplastics, we agree with the report authors that "There is currently no indication that microplastic-associated biofilms would impact human health. In addition, despite very limited data, it is anticipated that drinking water treatment would inactivate biofilm-associated microorganisms."

While the best available evidence suggests that microplastics do not pose a widespread risk to the environment or to humans, we do agree that there is a critical lack of quality and credible studies to allow robust environmental and human health risk assessment of microplastics, as highlighted in credible international organizations such as WHO (2019), SAPEA (2019) and GESAMP (2020), and as also acknowledged in Section 9 Knowledge gaps and considerations for future research. This critical lack of quality and credible studies should be the highest priority to be addressed.

Comments on Additives and Polymers

Inaccurate description or oversimplification of polymers and polymer structural relationships
A single reference is inadequate to describe polymers and polymer behavior. The Sperling 2006 reference is more to the types and methods of production. It does not tie these materials to microplastics specifically. Verschoor reference is not intended to be a fundamentals of polymer science, it is directed towards microplastics. It is unusual to link two references as is done in the Executive Summary, p15, paragraph 4, where both Sperling 2006 and Verschoor 2015 are linked to a comment on physical properties of plastic, when the Verschoor reference is not intended to be a fundamentals of polymer science. In fact, there is no evidence to support that referenced statement came, in whole or in part, from Verschoor 2015.

A single variable is not appropriate to describe or characterize polymers. Materials with similar molecular weights and dissimilar chemical backbones will have different properties. Mechanical performance, for example, is influenced by the supermolecular organization of the polymer chains into a structural hierarchy around which many papers have been written. A single polymer may be a blend of molecules with different chain lengths which impact the thermal, rheological (flow), and mechanical properties of the polymer, contrary to what is implied in Section 2 on p.15.
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Lack of Specificity on Composition, properties, uses.

- The use of a single reference to describe polymers, their structure, chemical makeup and additives avoids the complexity that is critical to understanding the relevance to microplastics and the understanding of any environmental impact. For example, molecular weight or chain length, is one of five structural factors that impact the performance of polyethylene; the remainder being the type and number of comonomer units, the molecular weight distribution (accounts for long and short chains in a single polymer).

- Absence of any studies or methods that enable identification of microplastics composition does not allow us to understand material concerns, only articles. This limits the type of work that can be done to focus on the materials of interest. Similarly, it is better to separate studies on the additives or chemicals of concern from the polymers. The quantity of monomers migrating through the bulk of the polymer and to the surface of the materials has been quantified through food contact compliance testing in order to establish the safety of the materials. Assumptions that these small molecules as a classification are negative or equally likely to migrate does not consider the process efficiency nor the differences in chemical composition.

- Contrary to how it is presented on page 73, paragraph 1, the persistence of plastic particles and the persistence of certain chemicals of concern need to be separate areas of study. This is due to the lack of a single type of plastic and its associated additives being assigned as the sole source of micro or macroplastics.

- The characterization of thermoplastics and thermosets on p.15 is not accurate and can be misleading. Polymers are processed typically in the molten (melt) or semi-molten state and formed into articles such as films, bottles, bumpers, closures, and non-wovens. Non-linear and linear polymers can be processed in this manner and are called thermoplastics. If a polymer, either through processing or through the use of certain chemistries becomes cross-linked whereby one chain is connected to another, the article may not be re-processed typically in the melt state. This is call a thermoset. Examples of this type of material include epoxy glues of even rubber hoses for use in automotive applications. Thermosets have a very high heat resistance and exhibit good dimensional stability in many environments.

- Page 16, paragraph 2's leading statement is inaccurate. Historically, polymers have been produced with fossil-fuel derived materials such as naphtha or natural gas. Recently, companies have demonstrated that bio-sources, or sources derived from recycled plastic, may also be used to produce polymers.

- LDPE/LLDPE blends are used in flexible packaging to the greatest extent, not in squeeze bottles or toys. (p.17) It is best not to tie applications and/or recycling classifications together. In the example used, films are harder to recycle as compared to squeeze bottles and should not be grouped together.

- Improper characterization. Polyamides are also commonly used in the automotive market. PC is used as a composite in many automotive parts but is not used to replace glass, as stated in the report, p.18, paragraph 2. Further information can be found at; https://www.nexant.com/resources/plastics-automotive-industry-which-materials-will-be-winners-and-losers

- The use of the word feedstocks in paragraph 1 of p.19 is not appropriate. "Sources" is a better word than "feedstocks". Feedstock implies the materials that are used to produce other materials, not articles.

Over-Generalization of findings

Studies which do not conclusively make a tie between various applications using plastics may overly inflate the concerns rather than enable the community to focus on the materials of greatest concern. The mechanisms by which these materials can actually enter the air differ based on the authors' already established correlation between the density and size of particles leading to different routes to the environment. (p.24, section 3.2.3)

Degradation to monomers is rare in the environment due to the strong chemical bonds that exist in polymers. None of the studies have demonstrated that oligomers were detected, and it is unlikely that the methods used to quantify the amount of micro or macroplastics were designed to look at oligomers of polymers. (p.75)

Concluding Remarks

Our review concurs with the *Science Assessment* assertion that its purpose is to serve as a literature survey and that "*it is not intended to quantify the risks of plastic pollution on the environment or human health*." [page 8, paragraph 2]. Our review of the *Science Assessment of Plastic Pollution* has raised a number of issues and concerns.

We agree and support the proposition in the *Science Assessment* that more research in the following areas be carried out to fill data gaps so credible and robust risk assessments can be made to inform science-based policy and regulatory decisions;

- Developing standardized methods for sampling, quantifying, characterizing, and evaluating the effects of macroplastics and microplastics
- Furthering the understanding of human exposure to microplastics
- Furthering the understanding of the ecotoxicological effects of microplastics
- Furthering the understanding of the effects of microplastics on human health
- Expanding and developing consistent monitoring efforts to include poorly characterized environmental compartments such as soil.

We must move forward on a data and knowledge-based path without public policy interference. Historically in Canada, public policy has been governed by data and scientifically valid knowledge.

References

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