REVISITING PLASTIC WASTE IN L.A. COUNTY, OCT 2021

TRENDS IN PLASTIC WASTE, ALTERNATIVES, AND REGULATION AND IMPACTS OF THE COVID-19 PANDEMIC

DANIEL COFFEE
UCLA LUSKIN CENTER FOR INNOVATION

EXECUTIVE SUMMARY

In this update to the UCLA Luskin Center for Innovation's January 2020 report *Plastic Waste in L.A. County*, we revisit the issue of plastics to identify the impacts of the COVID-19 pandemic and other ongoing trends on the plastic waste landscape. In doing so, we hope to provide Los Angeles County with the most complete and up-to-date picture of how plastics continue to impact people and the environment on both the global and regional levels.

Although the world today is profoundly different in many ways compared to January 2020, nothing has altered the fundamental relationship between plastic and the negative environmental, economic, energy, and human health impacts it produces. If anything, the unprecedented rise in plastic waste generation from medical waste and disposable personal protective equipment (PPE) and a shift in consumer and business behavior resulting in greater use of plastic packaging has worsened these impacts, and plastic food service ware and some other single-use packaging continues to be essentially non-recyclable. Perhaps unsurprisingly, representatives of the plastics and fossil fuel industry have attempted to capitalize on public health concerns by casting single-use plastic as a tool to minimize COVID-19 transmission, despite no supporting evidence and much to the contrary. These efforts have been accompanied by an unfortunate number of decisions by policymakers to delay, suspend, or roll back measures to reduce plastic waste.

Workforce disruptions and market volatility have negatively impacted recycling operators who are still coping with the repercussions of China's 2018 National Sword policy. Though prices for recycled plastic are currently on an upward trend, the industry still faces insecurity and many challenges. More operators are upgrading to optical sorting technology—which enables economical recovery of polypropylene, in addition to boosting efficiency and minimizing contamination—but some facilities still face barriers to doing so in the form of cost and space constraints. PET (Code 1) bottles and HDPE (Code 2) continue to be the only reliably recyclable resins, and contaminated plastic food service ware is still *de facto* non-recyclable.

On the composting front, access to capacity is still relatively low for many cities, and stringent siting and permitting rules make creation of new capacity a slow process. Moreover, as in January 2020, compostable materials generally and especially bioplastics are still unattractive to commercial composters due to long breakdown times and difficulty distinguishing compostable products from non-compostable ones. However, progress has been made in removing harmful chemicals from compostable items and promoting field testing to verify breakdown timelines in real-world conditions.

For the first time we explored the available science on aluminum as an alternative to single-use plastic. The high recyclability of aluminum makes it attractive from a solid waste management perspective. However, aluminum production has a very high energy footprint compared to plastic, making its

preferability contingent on minimizing new material required under a best-case scenario. More research comparing the two materials life cycle impacts is called for.

Lastly, although the pandemic produced some paralysis and backsliding, regulatory action on plastics continues apace. In California this activity has occurred primarily at the municipal level, with new jurisdictions instituting "tried-and-true" measures to require reusable items in some contexts and reduce or eliminate usage of small plastic items and polystyrene products. There have also been additional instances of municipalities adopting "fee-for-disposable" models. The most ambitious recent action has occurred in other states—notably Oregon and Maine—in the form of extended producer responsibility models that shift recycling costs to product manufacturers and incentivize measures to boost recyclability.

INTRODUCTION

In January 2020, the UCLA Luskin Center for Innovation (LCI) produced our *Plastic Waste in L.A. County* report for the Los Angeles County Chief Sustainability Office (CSO). That document, intended to provide a knowledge foundation for action taken by the County to address issues related to single-use plastic and plastic waste, examined several facets of the plastics problem. We provided an overview of the materials science behind plastics; discussed the different types of environmental impacts created by their production, use, and disposal; detailed the challenges associated with recycling and disposal of plastics; and identified considerations for lower-impact alternative materials.

However, less than three months following the publication of our report, the COVID-19 pandemic swept the globe. Government resources—including those of L.A. County—were prioritized for public health measures, and numerous businesses experienced unprecedented economic disruption. As a result, the County's regulatory efforts on plastics were temporarily paused.

Now, nearly two years later, these efforts are once again underway. To ensure that policy strategy is informed by the most current and accurate information, the CSO has requested we produce this addendum to our January 2020 report. Herein we review and revisit the key findings of that report, finding that the major conclusions we reached at the time remain valid today. We discuss how COVID-19 has impacted trends in plastic waste and the waste industry generally, as well as how market conditions and other factors continue to evolve independent of the global public health crisis. This includes a discussion of developments and some supplementary information related to alternative materials for single-use items. Finally, we discuss the landscape for regulatory action to curb plastic waste, identifying a number of new developments that have occurred since January 2020.

This update draws from interviews or correspondence conducted with four waste industry professionals in firms serving the Los Angeles area, as well as one expert intimately familiar with policy action on plastics. We also reviewed dozens of academic studies, journalistic works, and other sources covering topics including the quantifiable impacts of COVID-19 on the waste stream, health and sterility concerns related to plastic and alternative materials, ongoing regulatory efforts, and life cycle impacts of alternatives.

REVISITING KEY FINDINGS FROM *PLASTIC WASTE IN L.A. COUNTY*

Our January 2020 report laid our several key findings related to the key areas of analysis we focused on therein. These areas included impacts of plastic, recyclability of plastics (especially food service ware), and alternative materials. In this section we revisit these findings, discussing additional considerations that have arisen since original publication and incorporating new information, where available. Generally, we find that the key takeaways of the original report remain valid, meaning this document should be viewed more as an informational update to our original report, rather than a revision. Though waste management and plastic alternative industries continue to evolve, the central conclusions reached nearly two years ago remain the same.

- Plastic continues to contribute to a variety of adverse environmental, economic, energy-related, and human health-related impacts. These have been increased by a worrisome uptick in medical waste and disposable personal protective equipment (PPE), as well as pandemic-related changes in consumer and retailer behavior that have led to greater use of plastic packaging.
- Factors like material properties, product size, contamination, and market conditions continue to make many single-use plastics items *de facto* non-recyclable.
- PET (Code 1) bottles and HDPE (Code 2) plastics continue to be the only reliably recyclable plastics in the Los Angeles area. However, recent market volatility has created challenges for operators, with recycled PET plastic prices dropping to almost zero at one point in the past year and a half, though they have since rebounded. Facilities continue to upgrade to optical sorting technology, enabling economical recovery of polypropylene (Code 5), but cost and space constraints present challenges for some operators.
- Single-use plastic food service ware is still highly problematic, though some regulatory actions taken at the municipal level constitute progress in reducing plastic waste generated by this sector. The fundamental challenges of these items—including small size and light weight and contamination with grease and other food residues—still make these items economically and practically infeasible to recycle. Although some progress has been made addressing plastic-related concerns at the State level through the enactment of several smaller bills, the legislature has yet to pass transformative, comprehensive legislation.
- Reusable food service ware continues to be the best option for reducing the negative impacts of plastic waste generated by the food service sector. Pandemic-related policies by both governments and businesses that have reduced reusable item usage are misguided or based on misinformation.
- Although some progress has been made in making compostable materials a more attractive alternative to single-use plastics (e.g. the banning of PFAS chemicals in the Biodegradable Products Institute standards) and instituting field testing for compostable products (i.e. via the Compostable Manufacturers Alliance certification standard) most of the major barriers to ideal disposal outcomes for such items persist. Longer-than-ideal breakdown times and ease of distinguishing compostable products from non-compostable ones continue to be major sources of concern for composting operators. However, as we noted in January 2020, there is evidence that the advantages compostables offer in recovery of food waste more than outweigh potential negatives.
- Aluminum may be another potential alternative to plastic in a food service context, given its high recyclability, but high energy costs associated with its processing warrant careful consideration of whether its net environmental impacts are lower than plastic counterparts. Further research comparing the two materials is called for.

- Evidence continues to mount that replacing single-use plastics with alternatives does not result in negative economic impacts for businesses or municipalities, with businesses typically saving money post-payback period for upfront investment. The increase in plastic packaging use and resulting litter may have imposed additional waste management costs on some cities during the pandemic.

PLASTIC TRENDS AND ISSUES RELATED TO THE COVID-19 PANDEMIC

The COVID-19 pandemic has drastically affected patterns of consumption across the globe, resulting in noticeable shifts in the composition of the waste stream. These shifts have exacerbated several of the adverse impacts created by the production and consumption of plastic waste we outlined in our January 2020 report, and have also created additional challenges for a waste industry still coping with the fallout of China's 2018 National Sword policy. Since March 2020, consumer response to the pandemic has also created second-order impacts on plastics via induced changes to market conditions and pricing of raw materials. Relatedly, public perception has been targeted by a concerted misinformation campaign by the plastics industry attempting to portray single-use plastics as a boon for public health, despite no supporting evidence.

CHANGES IN CONSUMPTION PATTERNS AND MARKET RESPONSES

The most pronounced direct impacts of COVID-19 on consumption related to plastic waste pertain to a few distinct categories: medical waste and personal protective equipment (PPE), food and other goods, and the residential-commercial waste divide.

Medical waste and PPE have, unsurprisingly, seen a massive uptick in waste stream prevalence since the beginning of the pandemic. However, it is hard to overstate the magnitude of this uptick, which has been truly breathtaking. International studies have identified numerous instances in which hospitals' medical waste production increased by hundreds of tons *per day*—a nearly five-fold increase in some cases.[1] This figure does not by any means represent a ceiling; other researchers have found waste generation increases in some areas to be as much as +370%, and an assessment of King Abdullah University Hospital in Jordan found the pandemic created a tenfold increase in medical waste production during its initial months.[2,3] To put in another perspective: data from the UK National Health Service showed that just one group, or trust, of four hospitals used approximately 72,000 PPE items per day in the early months of the pandemic.[4]

A substantial portion of this medical waste is plastic, both in the form of packaging (e.g. disposable plastic films for items like syringes and IV bags) and worker equipment (e.g. plastic gowns, gloves, and face masks).[5] For reasons discussed in our January 2020 report, small and lightweight plastic items are

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[1] Siming You, Christian Sonne, Yong Sik Ok (2020). COVID-19's unsustainable waste management. *Science* 368(6498), p. 1483. DOI: https://doi.org/10.1126/science.abc7778.
[2] Klemeš J.J., Fan Y.V., Tan R.R., Jiang P. Minimising the present and future plastic waste, energy and environmental footprints related to COVID-19. *Ren. Sustain. En. Rev.*127. DOI: 10.1016/j.rser.2020.109883.
[3] H.A. Abu-Qdais, M.A. Al-Ghazo, E.M. Al-Ghazo (2020). Statistical analysis and characteristics of hospital medical waste under novel Coronavirus outbreak. *Global J. Environ. Sci. Manage.* 6(SI), 21-30. DOI: 10.22034/GJESM.2019.06.SI.03.
[4] Faisal Islam (2020). Why a billion items of PPE is not enough. *BBC*. Accessed Sept. 20, 2021 at https://www.bbc.com/news/business-52362707.
[5] Tanveer M. Adyel (2020). Accumulation of plastic waste during COVID-19. *Science* 369(6509), p. 1314-1315. DOI: https://doi.org/10.1126/science.abd9925.

inherently difficult and inefficient to recycle, meaning most are not recovered and sent to landfill. In the medical context, this would include items like sterile packaging films and syringe caps. Many other types of items (discussed further below) are made of multiple types of plastics which are difficult to separate, again making recycling unlikely.[6] However, even if plastic medical waste was recyclable, it is subject to requirements for sterilization (e.g. incineration) to avoid exposing waste workers to potentially contaminated or hazardous items. The sheer volume of waste has overwhelmed available disposal infrastructure in many areas, leading to many instances of mismanagement.[7]

PPE has also been adopted broadly by members of the public outside of a healthcare context, adding to the volume of plastic waste generated and creating many opportunities for improper disposal of single-use plastic items. Masks, the most common item in use, are almost certainly being used in the billions, if not tens of billions, each month globally (based on maximum demand estimates).[8] Unfortunately these items are the quintessential non-recyclable single-use plastic good: small, lightweight, and commonly composed of mixed plastic polymers including polypropylene (PP), polyethylene, and polyethylene terephthalate (PET).[9,10]

Consumption of *food and other goods* has also changed in response to the pandemic, and given the uncertainty created by new virus variants and lack of vaccine uptake, it is possible these behaviors will persist for some time. Safety concerns from consumers and public health mandates for vendors have led to a pronounced increase in plastic packaging usage for food purchases. In a grocery context, shoppers have utilized more single-use plastic packaging (e.g. produce bags) and generally shown an increased preference for plastic-packaged fresh foods (e.g. produce), increasing single-use plastic consumption on a per-visit, per-customer, and per-item basis.[11,12] Moreover, closures of fresh meat vendors like delis and grocery store meat and fish counters during the pandemic created a downturn in sales of loose meat and other animal products, for which pre-packaged products were generally substituted.[13] More consumers have also turned to grocery delivery services during the pandemic, food from which is often heavily packaged.[14]

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[6] Joana C. Prata, Ana L.P. Silva, Tony R. Walker, Armando C. Duarte, Teresa Rocha-Santos (2020). COVID-19 Pandemic Repercussions on the Use and Management of Plastics. *Environmental Science & Technology* 54(13), 7760-7765. DOI: 10.1021/acs.est.0c02178.

[7] Siming You, Christian Sonne, Yong Sik Ok (2020). COVID-19's unsustainable waste management. *Science* 368(6498), p. 1483. DOI: https://doi.org/10.1126/science.abc7778.

[8] Joana C. Prata, Ana L.P. Silva, Tony R. Walker, Armando C. Duarte, Teresa Rocha-Santos (2020). COVID-19 Pandemic Repercussions on the Use and Management of Plastics. *Environmental Science & Technology* 54(13), 7760-7765. DOI: 10.1021/acs.est.0c02178.

[9] Ana L.P. Silva, Joana C. Prata, Tony R. Walker, Diana Campos, Armando C. Duarte, Amadeu M.V.M. Soares, Damiá Barcelò, Teresa Rocha-Santos (2020). Rethinking and optimizing plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of The Total Environment* 742. DOI: https://doi.org/10.1016/j.scitotenv.2020.140565.

[10] Joana C. Prata, Ana L.P. Silva, Tony R. Walker, Armando C. Duarte, Teresa Rocha-Santos (2020). COVID-19 Pandemic Repercussions on the Use and Management of Plastics. *Environmental Science & Technology* 54(13), 7760-7765. DOI: 10.1021/acs.est.0c02178.

[11] Ana L.P. Silva, Joana C. Prata, Tony R. Walker, Armando C. Duarte, Wei Ouyang, Damià Barcelò, Teresa Rocha-Santos (2021). Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations. *Chemical Engineering Journal* 405, 126683. DOI: https://doi.org/10.1016/j.cej.2020.126683.

[12] Carina Perkins (2020). Six ways coronavirus is threatening progress on single-use plastic. *The Grocer*. Accessed Sept 21, 2021 at https://www.thegrocer.co.uk/plastic/six-ways-coronavirus-is-threatening-progress-on-single-use-plastic/604507.article.

[13] Ibid.

[14] Manuel A. Zambrano-Monserrate, María A. Ruano, Luis Sanchez-Alcalde (2020). Indirect effects of COVID-19 on the environment. *Science of The Total Environment* 728, 138813. DOI: https://doi.org/10.1016/j.scitotenv.2020.138813.

Outside of a grocery context, public health measures barring in-person dining at food vendor locations have translated to an increase in demand for take-out and delivery food.[15,16,17] Packaging intensity is often high in such cases, with food and beverages being supplied in plastic or plastic-lined containers and accompanied by plastic utensils, straws, and other accessories. Some vendors have also suspended policies that previously permitted customers to supply their own reusable items for takeout beverages, further increasing the generation of single-use plastic waste.[18] There is anecdotal evidence that these responses have led to a noticeable increase in plastic trash and litter in some Southern California areas, forcing municipalities to incur additional costs for waste cleanup.[19]

The increased use of plastic packaging is not confined to food consumption. Demand for hygienic supplies besides PPE (e.g. cleaning solutions, disposable wipes)—goods that are often fully or partially packaged in plastic—has also risen substantially.[20] Additionally, there has been a shift in favor of e-commerce for consumer goods generally, creating even more waste from delivery of packaged items.[21]

The result of these changes in consumption patterns is a marked increase in residential waste volume and an accompanying downturn in commercial waste volume.[22] Two of the four waste industry professionals spoken to for this update confirmed these trends have been observed in the Los Angeles area.[23,24] This can create additional fiscal challenges for waste operators, as commercial contracts generally subsidize less profitable processing of residential waste.[25]

Although none of the four waste industry professionals spoken to could attest to an observable uptick in plastic waste at material recovery facilities (MRFs) operated by their employers, it seems credulous to believe that Los Angeles is immune to the plastic waste-related impacts of COVID-19 demonstrably experienced by myriad countries, regions, and cities across the globe. One professional indicated that a more observable change is the increase in residential food waste, which is more noticeable than a correlated increase in food packaging.[26] Other trends—one professional stated their facility is taking in a significantly greater amount of cardboard compared to pre-pandemic, for instance—may also be masking

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[15] Tanveer M. Adyel (2020). Accumulation of plastic waste during COVID-19. *Science* 369(6509), p. 1314-1315. DOI: https://doi.org/10.1126/science.abd9925.

[16] Carina Perkins (2020). Six ways coronavirus is threatening progress on single-use plastic. *The Grocer*. Accessed Sept 21, 2021 at https://www.thegrocer.co.uk/plastic/six-ways-coronavirus-is-threatening-progress-on-single-use-plastic/604507.article.

[17] Shashank Bengali (2020). The COVID-19 pandemic is unleashing a tidal wave of plastic waste. *Los Angeles Times*. Accessed Sept 21, 2021 at https://www.latimes.com/world-nation/story/2020-06-13/coronavirus-pandemic-plastic-waste-recycling.

[18] Ibid.

[19] Plastics regulatory expert, personal communication, August 6, 2021.

[20] Daiane Scaraboto, Alison M. Joubert, Claudia Gonzalez-Arcos (2020). Using lots of plastic packaging during the coronavirus crisis? You're not alone. *The Conversation*. Accessed Sept 21, 2021 at https://theconversation.com/using-lots-of-plastic-packaging-during-the-coronavirus-crisis-youre-not-alone-135553.

[21] Kumar Raja Vanapalli, Hari Bhakta Sharma, Ved Prakash Ranjan, Biswajit Samal, Jayanta Bhattacharya, Brajesh K. Dubey, Sudha Goel (2021). Challenges and strategies for effective plastic waste management during and post COVID-19 pandemic. *Science of The Total Environment* 750, 141514. DOI: https://doi.org/10.1016/j.scitotenv.2020.141514.

[22] Scott Horsley (2020). 'Hard, Dirty Job': Cities Struggle to Clear Garbage Glut In Stay-At-Home World. *NPR*. Accessed Sept 21, 2021 at https://www.npr.org/2020/09/21/914029452/hard-dirty-job-cities-struggle-to-clear-garbage-glut-in-stay-at-home-world.

[23] Waste industry professional #2, personal communication, September 3, 2021.

[24] Waste industry professional #3, personal communication, September 3, 2021.

[25] Ibid.

[26] Waste industry professional #1, personal communication, August 31, 2021.

fluctuations in plastic waste.[27] Some portion of COVID-related plastic waste may also simply be bypassing recovery facilities and going straight to landfills if residents are discarding packaging items in trash bins, the contents of which may not be sent to a recovery facility.[28] In some cases waste may be being diverted to landfills and incinerators due to public health concerns (i.e. exposing workers to items contaminated with virus particles).[29]

Decreased demand for fossil fuels during the pandemic—attributable in large part to a decline in commuting and travel—has also affected the plastic waste landscape. The resulting drop in oil prices led to increased manufacturing of virgin plastic and a decline in demand for recycled plastic, creating additional fiscal strain on recycling operators.[30,31] The price of recycled PET (Code 1)—the most common plastic resin recycled by volume—dropped to just above $0 in September 2020, according to one waste industry professional.[32] However, prices of recycled plastics, including PET and polypropylene (Code 5) have trended upwards in recent months, and HDPE (Code 2) prices have drastically increased over the last year and a half for reasons that are unclear.[33]

In addition to the challenges created by fluctuating prices for recycled plastic, pandemic-related disruptions—including concerns of workers being exposed to contaminated waste items—have led to throughput reductions or complete shutdowns of recycling operations in many parts of the country.[34]

Misinformation Regarding Plastics and Public Health

Another worrisome phenomenon observed during the pandemic was a wave of misinformation regarding the public health impacts of single-use plastics versus alternatives. In the early stages of COVID-19's global spread, the plastics industry capitalized on public concern regarding virus transmissibility by claiming that single-use plastic items—especially those used in food service and grocery contexts, such as bags and food and beverage containers—were safer than reusable alternatives.[35,36] These claims were made with no supporting scientific evidence or empirical data, but were nevertheless accompanied by a slew of public sector actions to temporarily suspend, delay, or roll back policies meant to curb harmful

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[27] Waste industry professional #4, personal communication, September 9, 2021.
[28] Waste industry professional #2, personal communication, September 3, 2021.
[29] Rachel A. Meidl (2020). Pandemic, Plastics and the Continuing Quest for Sustainability. *Forbes*. Accessed Sept 22, 2021 at https://www.forbes.com/sites/thebakersinstitute/2020/04/14/pandemic-plastics-and-the-continuing-quest-for-sustainability/?sh=382b71a077b4.
[30] Ana L.P. Silva, Joana C. Prata, Tony R. Walker, Diana Campos, Armando C. Duarte, Amadeu M.V.M. Soares, Damiá Barcelò, Teresa Rocha-Santos (2020). Rethinking and optimizing plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of The Total Environment* 742. DOI: https://doi.org/10.1016/j.scitotenv.2020.140565.
[31] DeAnne Toto (2020). Challenges of the unknown. *Waste Today*. Accessed Sept 22, 201 at https://www.wastetodaymagazine.com/article/covid-19-recycling-industry-survey-responses/.
[32] Waste industry professional #2, personal communication, September 3, 2021.
[33] Ibid.
[34] Colin Staub (2020). Coronavirus pandemic disrupts recycling sector. *Resource Recycling*. Accessed Sept 22, 2021 at https://resource-recycling.com/recycling/2020/03/17/coronavirus-pandemic-disrupts-recycling-sector/.
[35] Caroline Griffith (2020). Contrary to What the Plastics Industry Says, Single-Use Isn't Safer. *The Northcoast Environmental Center*. Accessed Sept 22, 2021 at https://www.yournec.org/contrary-to-what-the-plastics-industry-says-single-use-isnt-safer/.
[36] Jasmin Malik Chua (2020). Plastic bags were finally being banned. Then came the pandemic. *Vox.* Accessed Sept 22, 2021 at https://www.vox.com/the-goods/2020/5/20/21254630/plastic-bags-single-use-cups-coronavirus-covid-19-delivery-recycling.

consumption of extraneous single-use plastics.[37,38,39] In addition to the short-term harms created by these regressive policy actions through permitting more consumption of single-use plastic and the generation of a commensurate amount of plastic waste, such actions threaten to erode hard-won progress shaping consumer habits.[40]

Since the claims of single-use plastics' public health advantages were made, new research has shown that the reality is likely the opposite. To begin with, the likelihood of surface transmission of COVID-19 is extremely low.[41] Even if an appreciable risk of surface transmission existed, multiple studies have confirmed that COVID-19 virus particles persist and remain viable on plastic much longer than alternative materials like paper and cotton.[42,43] Therefore, while one could justify actions taken by policymakers and businesses early in the pandemic to not use reusable items out of an abundance of caution when information on surface transmission was not available, there is no scientific justification for these policies to persist, nor to delay further action to reduce single-use plastic usage.

Overall Impacts of COVID-19 on the Plastic Waste Landscape

Given the trends and issues discussed above, impacts from the COVID-19 pandemic are likely manifesting in a number of ways:

- *Increased negative environmental, economic, and energy-related impacts* resulting from an increase in usage of single-use plastics (and therefore, increased manufacturing and usage of fossil fuel feedstocks), particularly for medical items and PPE and packaging for food and consumer goods. For reasons discussed above or in our original report, many of these items are not recyclable for practical and/or public health reasons, meaning they are typically landfilled or incinerated. PPE items are also contributing significantly to plastic litter, creating a new type of pervasive plastic pollution with negative environmental and economic effects.[44,45]
- *Fiscal strain and other disruptions* for the recycling and waste management industry resulting from volatile market conditions, public health concerns, and a significant shift from commercial

[37] Ibid.
[38] Ana L.P. Silva, Joana C. Prata, Tony R. Walker, Diana Campos, Armando C. Duarte, Amadeu M.V.M. Soares, Damiá Barcelò, Teresa Rocha-Santos (2020). Rethinking and optimizing plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of The Total Environment* 742. DOI: https://doi.org/10.1016/j.scitotenv.2020.140565.
[39] Daiane Scaraboto, Alison M. Joubert, Claudia Gonzalez-Arcos (2020). Using lots of plastic packaging during the coronavirus crisis? You're not alone. *The Conversation*. Accessed Sept 21, 2021 at https://theconversation.com/using-lots-of-plastic-packaging-during-the-coronavirus-crisis-youre-not-alone-135553.
[40] Ibid.
[41] Dyani Lewis (2021). COVID-19 rarely spreads through surfaces. So why are we still deep cleaning? *Nature* 590, 26-28. DOI: https://doi.org/10.1038/d41586-021-00251-4.
[42] Denis E. Corpet (2021). Why does SARS-CoV-2 survive longer on plastic than on paper? *Medical Hypotheses* 146, 110429. DOI: https://doi.org/10.1016/j.mehy.2020.110429.
[43] Neeltje van Doremalen, Dylan H. Morris, Myndi G. Holbrook (2020). Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. *The New England Journal of Medicine* 382, 1564-1567. DOI: 10.1056/NEJMc2004973.
[44] Justine Ammendolia, Jacquelyn Saturno, Amy L. Brooks, Shoshanah Jacobs, Jenna R. Jambeck (2021). An emerging source of plastic pollution: Environmental presence of plastic personal protective equipment (PPE) debris related to COVID-19 in a metropolitan city. *Environmental Pollution* 269, 116160. DOI: https://doi.org/10.1016/j.envpol.2020.116160.
[45] Gurusamy Kutralam-Muniasamy, Fermín Pérez-Guevara, V.C. Shruti (2022). A critical synthesis of current peer-reviewed literature on the environmental and human health impacts of COVID-19 PPE litter: New findings and next steps. *Journal of Hazardous Materials* 422, 126945. DOI: https://doi.org/10.1016/j.jhazmat.2021.126945.

waste to relatively less profitable residential waste. However, trends are currently positive in this area, as recycled plastic prices have recently been on an upward trend and commercial waste volume is beginning to rebound.[46]

Other Trends and Issues Related to Plastic Waste and Alternatives

In addition to developments since January 2020 that are attributable to the COVID-19 pandemic, the plastics landscape continues to evolve independent of the ongoing public health crisis. Below, we discuss a few noteworthy developments and trends. Presented in no particular order, these include retooling within the recycling industry, long-term market conditions affecting plastic, and activity and new information regarding alternative materials.

The recycling industry continues to retool in response to conditions precipitated by China's 2018 National Sword policy. The primary driving factor continues to be the new, stringent contamination standards the policy *de facto* instituted for the global recycling market. Achieving these new standards essentially mandates recycling operators to adopt optical sorting technology, which—as we discussed in our January 2020 report—offers significant advantages not only in terms of limiting contamination, but also in throughput volume and efficiency.[47] One waste industry professional interviewed for this update noted that their operator recently installed a new sort line with optical technology, and noted that it is likely other operators are pursuing similar upgrades.[48] A key feature of optical sorting is that it enables economical recovery of polypropylene (Code 5), meaning that as more operators integrate optical technology polypropylene will become more realistically recyclable. However, without a comprehensive overview of facilities serving the Los Angeles area, we cannot definitively say whether polypropylene can yet be characterized as truly recyclable.

Barriers and challenges still exist pertaining to optical sorting, though. As we discussed in our original report, though highly advantageous, optical technology has difficulty capturing many types of single-use plastic products (e.g. thin films, small and lightweight items, greasy or otherwise contaminated items). Additionally, cost and space continue to make widespread adoption by operators difficult. The aforementioned new sort line installed by one operator constituted a $25 million investment, and another waste industry professional interviewed noted that the small physical size of their facility is hamstringing their ability to retool operations.[49,50]

Long-term trends in the plastics market are subject to significant uncertainty, but the short-term disruptions caused by COVID-19 (discussed above) and forecasts from the fossil fuel industry create reasons for concern. As aforementioned, a short-term drop in demand for fossil fuels accompanying the onset of the pandemic produced lower oil prices, resulting in increased production of cheaper virgin plastics. Should national and international efforts to achieve widespread decarbonization make progress in the coming years—perhaps aided by long-term changes to patterns of work and travel spurred by COVID-19—this phenomenon may repeat itself in a more significant and long-lasting fashion. Worrisomely, projections from the fossil fuel industry are making increased production and consumption of plastic a foundational pillar of their future business model. Industry projections count on plastic to be the major driver of new oil demand in the coming decades, to the extent that plastics would account for

[46] Waste industry professional #3, personal communication, September 3, 2021.
[47] Waste industry professional #2, personal communication, September 3, 2021.
[48] Ibid.
[49] Ibid.
[50] Waste industry professional #4, personal communication, September 9, 2021.

20% of global oil consumption (and 15% of the global carbon allowance under a 2ºC scenario) by 2050.[51,52] Such a scenario would be disastrous for global efforts to combat climate change, and underscores the importance of regulatory action to both reduce plastic consumption and new exploitation of fossil fuel resources.

Promising developments regarding alternatives to plastic have occurred since *Plastic Waste in L.A. County* was completed, but many challenges remain related to end-of-life disposal for non-plastic single-use materials. The most notable point of progress is that the certifying body for compostable products in the United States, the Biodegradable Products Institute (BPI), implemented new standards in January 2020 addressing the issue of fluorinated chemicals (i.e. PFAS).[53] As we noted in our original report, presence of PFAS chemicals in ostensibly compostable fiber-based items was one of several notable concerns for composting operators, given the numerous health hazards associated with them. However, the most important barrier to commercial composting—the fact that compostable materials simply take too long to break down—persists.[54] Progress is being made in this area via an increased emphasis on field testing (i.e. through the Compostable Manufacturing Alliance certification standard), which is crucial to ensuring products break down as expected even when real-world conditions like oxygenation and moisture levels vary. However, these standards continue benchmark using ASTM D64000/D6868 guidelines, which stipulate biodegradation occurring within 180 days—significantly longer than the typical commercial composter turnover period. Ideal disposal outcomes for compostables also continue to be hindered by a lack of clear and consistent labeling schemes and low nutrient content, along with difficulties associated with siting and permitting for composting facilities generally.[55]

For jurisdictions deciding what compostable alternatives to permit for use by food vendors in place of single-use plastics, the ideal items would have the following traits:

- Primarily composed of *fiber-based materials* with no or minimal bioplastic coatings.
- Devoid of toxic fluorinated chemicals (i.e. PFAS).
- Design that maximizes surface area-to-volume ratio while minimizing product mass.
- Field-tested and certified to biodegrade in <90 days (which may be infeasible); OR certified compostable in home or community composter settings.
- Consistently labeled and clearly distinguishable from non-compostable analogues by both consumers and composting operators.
- Uses material inputs that do not create additional environmental or climatological impacts (e.g. agricultural post-processing waste).
- Accompanied by waste receptacles and systems that maximize co-capture of compostable packaging and food waste.

A topic left unaddressed in our first report is the attractiveness of aluminum as an alternative material to plastic in a food service context. Aluminum offers significant advantages over plastic with regards to recyclability. The current national recycling rate for aluminum beverage cans—the most ubiquitous single-use aluminum product—is much higher than plastic (approximately 50%), with about 82% of

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[51] David Roberts (2020). Big Oil's hopes are pinned on plastics. It won't end well. *Vox*. Accessed Sept 23, 2021 at https://www.vox.com/energy-and-environment/21419505/oil-gas-price-plastics-peak-climate-change.
[52] World Economic Forum (2016). The New Plastics Economy: Rethinking the future of plastics. Accessible at http://www3.weforum.org/docs/WEF_The_New_Plastics_Economy.pdf.
[53] Biodegradable Products Institute (2020). Fluorinated Chemicals. Accessed Sept 24, 2021 at https://bpiworld.org/Fluorinated-Chemicals.
[54] Waste industry professional #3, personal communication, September 3, 2021.
[55] Ibid.

aluminum being recovered from a can that is properly disposed of.[56] Similar advantages can be observed with respect to recycled content, as domestically produced aluminum cans are composed of 73% recycled material on average.[57]

Unfortunately, other aspects of aluminum limit its overall attractiveness as an alternative to plastic in single-use contexts. Several studies have used life cycle assessment (LCA) to examine the overall environmental impact of two comparable items: plastic PET beverage bottles and aluminum beverage cans. The four studies reviewed for this update conclude that PET bottles have a lower overall environmental impact on both a one-to-one and per-volume basis.[58,59,60,61] The primary driving factors behind aluminum's poor performance in these studies are its very high associated energy inputs and, to a smaller degree, its greater water use. Single-use aluminum items are also heavier and bulkier than their plastic counterparts, intensifying transportation fuel costs and upping their global warming potential in comparison to plastic.[62,63] However, aluminum's huge advantages in in recyclability potential essentially put it at parity with PET plastic when sufficiently high recycled content (~80%) is achieved, though there is no consensus on which material edges out the other in such a scenario. This suggests that, if implemented with high minimum recycled content standards for single-use food service ware (>80%) and very high recovery rates, aluminum could be a lower-impact alternative to plastic in such use cases.

One key piece of highly relevant information needed to properly compare aluminum and plastics is missing. As with many of the LCA studies we reviewed for our original report that compared single-use plastics and compostable materials, the studies assessed for this update do not address the impact of solid waste pollution and resulting ecological harms. Given that this is one of the most important and salient negative impacts of plastic waste, as well as the existence of additional uncertainties (e.g. whether the aluminum supply chain could provide enough material to substitute for even a fraction of single-use plastics[64]), we cannot definitively recommend for or against policy action to encourage adoption of single-use aluminum items in place of plastic ones. Further study is urgently needed in this area, ideally in the form of an LCA that examines multiple types of plastic, compostable, and aluminum items and incorporates impact categories for ecological and wildlife impacts.

RECENT AND ONGOING REGULATORY ACTION

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[56] James Souder, Benjamin Elizalde, Jochem van der Zaeg, Eva Gladek (2020). Recycling Unpacked: Assessing the Circular Potential of Beverage Containers in the United States. *Metabolic*. Accessible at https://www.metabolic.nl/publications/recycling-unpacked/.
[57] Ibid.
[58] Yahya Saleh (2016). Comparative life cycle assessment of beverages packages in Palestine. *Journal of Cleaner Production* 131, 28-42. DOI: https://doi.org/10.1016/j.jclepro.2016.05.080.
[59] C.M.V.B. Almeida, A.J.M. Rodrigues, S.H. Bonilla, B.F. Gianetti (2010). Energy as a tool for Ecodesign: evaluating materials selection for beverage packages in Brazil. *Journal of Cleaner Production* 18, 32-43. DOI: 10.1016/j.jclepro.2009.03.019.
[60] David Amienyo, Haruna Gujba, Heinz Stichnothe, Adisa Azapagic (2013). Life cycle environmental impacts of carbonated soft drinks. *The International Journal of Life Cycle Assessment* 18, 77-92. DOI: 10.1007/s11367-012-0459-y.
[61] Sphera (2020). Beverage Packaging: A Comparative Life Cycle Assessment. *Ball Corporation*. Summary accessible at https://www.ball.com/Ball/media/Ball/Global/Sustainability/LCA-presentation-US.pdf.
[62] Ibid.
[63] Jesse Klein (2021). Should you swap plastic for aluminum packaging? It's complicated. *GreenBiz*. Accessed Sept 24, 2021 at https://www.greenbiz.com/article/should-you-swap-plastic-aluminum-packaging-its-complicated.
[64] Ibid.

Putting aside the aforementioned delays and suspensions of single-use plastics regulations resulting from the COVID-19 pandemic, progress on addressing the plastic waste issue has continued since January 2020. The State legislature has enacted several smaller, focused pieces of legislation addressing topics like accurate labeling of recyclables and compostables and how exports of mixed plastic are reported, but has yet to enact comprehensive legislation such as the California Circular Economy Act. Thus, the lion's share of impactful regulatory progress in California continues to be at the municipal level. A number of cities, including Culver City, Palm Springs, Beverly Hills, Pasadena, Burbank, and the County and City of Los Angeles have taken or are considering action to curb plastic waste in some form.[65] These actions can generally be characterized as focusing on tried-and-true approaches, such as instituting "upon-request" measures for food service accessories, bans on expanded polystyrene products, and restrictions on single-use plastic items at public facilities and events.[66] Somewhat more ambitiously, some municipalities—Culver City being one notable example—have passed ordinances that will require reusable items to be used for dine-in food service and ban many non-recyclable single-use plastic items (e.g. straws and utensils).[67,68] The "fee-for-disposable" model has also expanded in usage; a number of jurisdictions in Sonoma County, for instance, have adopted an ordinance allowing (though not requiring) vendors to charge $0.25 for disposable item usage.[69] Such measures continue to be viewed cautiously due to potential regressive impacts on low-income consumers.[70]

Relatedly, efforts by non-governmental organizations are helping reduce barriers to reusable adoption for food vendors. Although mostly limited to Northern California at this time, a nascent business model is emerging focused providing reusable food service ware and hub dishwashing services to vendors that face capital and/or space constraints.[71] Such services could be crucial to expanding reusable usage to non-dine-in settings and small, independent vendors like food trucks. Additionally, non-profit groups like Plastic Free Restaurants and ReThink Disposable continue to be active in helping vendors transition to a reusable model through consultative support and grants to assist with capital costs.[72,73] These efforts also provide an expanding database showcasing the fiscal benefits of reusable adoption for vendors.[74]

Some of the most promising activity is occurring outside of California as other State legislatures take bold steps to address the plastic waste and recycling crises. In particular, both Oregon and Maine recently enacted a form of extended producer responsibility model in which plastics manufacturers pay for the cost of recycling their products.[75,76] These measures bring to the United States a model that has been highly successful internationally in fostering a healthy recycling system; Oregon will require producers to pay

[65] Plastics regulatory expert, personal communication, August 6, 2021.
[66] Ibid.
[67] Ibid.
[68] City of Culver City (2021). City Ban On Single-Use Plastics. Accessed Sept 27, 2021 at https://www.culvercity.org/City-Hall/Reports-policies-local-laws/City-Ban-On-Single-Use-Plastics#section-1.
[69] Zero Waste Sonoma (n.d.). Disposable Food Service Ware and Polystyrene Foam Ban Model Ordinance. Accessed Sept 27, 2021 at https://zerowastesonoma.gov/reduce/commercial/model-ordinance.
[70] Plastics regulatory expert, personal communication, August 6, 2021.
[71] Ibid.
[72] Ibid.
[73] ReThink Disposable (2020). Businesses. *Clean Water Action and Clean Water Fund*. Accessed Sept 27, 2021 at https://www.rethinkdisposable.org/businesses.
[74] Ibid.
[75] Monica Samayoa (2021). Oregon's recycling system is getting an update. Packaging makers will help pay for it. *OPB*. Accessed Sept 27, 2021 at https://www.opb.org/article/2021/08/13/oregons-recycling-system-is-getting-an-update-packaging-makers-will-help-pay-for-it/.
[76] Winston Choi-Schagrin (2021). Maine Will Make Companies Pay for Recycling. Here's How It Works. *The New York Times*. Accessed Sept 27, 2021 at https://www.nytimes.com/2021/07/21/climate/maine-recycling-law-EPR.html.

for approximately 28% of recycling costs incurred by local governments, while Maine's measure makes manufacturers responsible for funding 100% of such costs—a commendable approach.[77] Such models are expected to stabilize struggling recycling operators and municipal programs and create fiscal incentives for manufacturers to make products that are easier to recycle.[78]

[77] Ibid.
[78] Ibid.