Input To The Independent Fiscal Office of Pennsylvania

Comments in connection with the economic impact study of any regulation of "single-use plastics, reusable plastics, auxiliary containers, wrappings or polystyrene containers."

To be sent by email to the IFO at: contact@ifo.state.pa.us by March 31.

Collaborated Input From Sierra Club of Pennsylvania. Approved by the PA Chapter Executive Committee on March 16, 2020 and posted to www.SierraClub.org/pennsylvania

Executive Summary

The Commonwealth of Pennsylvania has adopted an environmental amendment to its Constitution. In order to give the environmental amendment meaning, the Commonwealth and all its agencies (including municipalities) must take an active role in reducing pollution. Active measures to reduce pollution can mean reducing the sources of pollution.

In regard to plastics, Pennsylvania municipalities currently have the authority to limit the amount of one-use plastics in many ways. However, SB 712, enacted by the General Assembly last year, imposed a moratorium on taxing or restricting the use, distribution, or sale of plastic bags and containers until July 2, 2020 on municipalities and other Commonwealth agencies.

The provisions of SB 712 were directed at municipalities which were considering regulation of single-use plastics. Many municipalities are exploring ways to limit the use of single-use plastic bags in ways that will help consumers and businesses to reduce unnecessary, expensive, and toxic litter and waste. So-called "free" plastic bags, wraps, and containers have quantifiable environmental and economic costs. Many of these costs are "hidden" in the sense that taxpayers do not see the costs because they are part of larger municipal services. Landfill disposal fees are among the largest of these costs. But the costs of cleaning up plastic waste from streets, roadsides, waterways and water intake pipes are among the hidden costs that taxpayers pay from the convenience of disposable plastics. There exist less quantifiable, but real, costs from the damage plastics do to wildlife, aquatic habitat and natural landscapes.

The Pennsylvania Chapter of the Sierra Club requests that the Independent Fiscal Office take seriously the mandates of Article I, Section 27 of the Pennsylvania Constitution, and ensure that the Commonwealth "consider in advance of proceeding the environmental effect of any proposed action on the constitutionally protected features."[1] To date, the Independent Fiscal

[1] *Robinson Township, Delaware Riverkeeper Network, et al. v. Commonwealth*, 83 A.3d 901, 952 (Pa. 2013) (plurality) [hereinafter "*Robinson Twp*."].

Office has not acknowledged that Article I, Section 27 applies to Commonwealth actions concerning the plastic bag legislation, let alone that such actions cannot proceed without the constitutionally required environmental review. As we discuss below, compliance with the environmental amendment must start—but certainly does not end—with such a review. Both the review and the substantive decisions informed by that review must comply with the mandates.

Article I, Section 27 provides:

> The people have a right to clean air, pure water, and to the preservation of the natural, scenic, historic and esthetic values of the environment. Pennsylvania's public natural resources are the common property of all the people, including generations yet to come. As trustee of these resources, the Commonwealth shall conserve and maintain them for the benefit of all the people.

The location of Section 27 in the Commonwealth's Declaration of Rights signifies a particular constraint on Commonwealth actions because this portion of our charter "delineates the terms of the social contract between government and the people that are of such 'general, great and essential' quality as to be ensconced as 'inviolate.'"[2] Pennsylvania courts have made clear that Section 27 thus constrains every entity within the Commonwealth government[3]—including the Governor and any state or local government entity.[4]

The following sections, researched by our knowledgeable volunteers, compile facts and costs about the economic impacts of single-use plastics in our lives. Including:

- Problems with landfill capacity
- Highway cleanup
- Waterway cleanup

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[2] *Robinson Twp.*, 83 A.3d at 947 (citing Pa. Const. art. I, Preamble & § 25).

[3] *See*, *e.g.*, *id.* at 950; *see also id*. at 952 ("[T]he constitutional obligation [in Section 27, clause 1] binds all government, state or local, concurrently." [citations omitted]); *id*. at 977-78 ("With respect to the public trust, Article I, Section 27 of the Pennsylvania Constitution names not the General Assembly but 'the Commonwealth' as trustee. We have explained that, as a result, all existing branches and levels of government derive constitutional duties and obligations with respect to the people."); *accord Pennsylvania Environmental Defense Foundation v. Commonwealth*, 108 A.3d 140, 156-57, 160 (Pa. Cmwlth. 2015) ("PEDF I") (quoting *Robinson Twp.*)

[4] "Commonwealth" refers to all entities of the Commonwealth government. As noted below, any legislation limiting the authority of municipalities to control or regulate single-use plastics, reusable plastics, auxiliary containers, wrappings or polystyrene containers would interfere with municipal obligation to protect clean air, pure water, and the preservation of the natural, scenic, historic and esthetic values of the environment.

- Water treatment plants
- Terrestrial life
- Human health
- Recycling machinery
- Tourism
- Recreation
- Invasive species
- Illegal dumping
- Fishing
- Plastics recycling
- Climate change
- Hazardous materials
- Industrial pollution
- Underserved communities

INTRODUCTION:

Municipalities face all kinds of problems as the result of the pervasive use of single-use plastics in everyday life - from trash disposal, to littering, to removal of plastics from drinking water sources. Single-use plastics are commonly used for bags, in plastic packaging, and utensils. They are items intended to be used only once before they are thrown away or recycled. Although they are convenient, the pervasive use of these plastics has a large impact on the costs of municipal services.

Microplastic pollution may be one of the most widespread and long-lasting anthropogenic changes on earth (Barnes et al., Philosoph Transact Royal Society-Biolog Sci, 2009). Plastics are stressors for all forms of life that prevent beneficial uses of waters, degrade habitats and harm wildlife, and endanger people's health (EPA, https://www.epa.gov/trash-free-waters/clean-water-act-and-trash-free-waters).

Plastics have a significantly low life cycle, less than one month for a high fraction of plastics (Achilias and Antonakou, 2015). From 1950 to 2017, only 9% of plastics were recycled worldwide. Some current estimates are that 20% might be recycled, though this has changed since Asian countries no longer take mixed American plastics. Plastics are projected to take between 15 to 1000 years to biodegrade, along with their toxic chemical additives and adsorbed contaminants. Some plastics practically never biodegrade (such as foam buoys and Styrofoam cups), and some of the contaminants that adsorb onto the plastics also never break down. A review concludes that biodegradable plastics also are more prone to disintegrate into microplastics and leach chemicals, than to biodegrade (Whitacre, 2014). The process of manufacturing plastics not only requires extraction of fossil fuels, but creates hazardous waste. Recycling of plastics produced 25% less carbon dioxide, but still creates hazardous waste (D'Ambriere, 2019). There are other limitations to recycling. Products can only be recycled economically if (Cannon, 2019, personal communication):

- Recycling is built into their design,
- There are sufficient quantities in waste streams
- Manufacturers can meet the technical challenges involved in increasing the amount of recycled materials in their products,
- There is no problematic odor or color,
- Plastics can only be reused a limited number of times before they are too degraded for further use. For example, discoloration occurs, elasticity and strength are lost.

Bioplastics are not 'low-hanging fruit': they require special conditions to biodegrade or compost, such as high temperatures, moisture, and oxygen, and in a landfill they are like any other plastic. The demand for biodegradable polymers (plastics) is less than 0.1% of the market share for total plastic production due to their lower performances, higher price, and limited legislative attention in respect to the traditional materials. However, in order to reduce dependency on petroleum resources, its demand could accelerate in the future, yet the production processes do not guarantee minimal environmental impact. Ultimate disposal remains a problem. (Siracusa, Polymers (Basel), 2019)

We address the following discrete categories to analyze the economic costs of plastics in the environment.

1) Problems of landfill capacity for plastic waste, and increasing reliance on incineration with its side effects of air, land, and water pollution if incinerators scrubbers are not updated and enforced.

The Pennsylvania Waste Industries Association (PWIA) reports that as of 2016, Pennsylvanians generated approximately 8.7 million tons of municipal waste annually, or 1,360 pounds per person/year. Plastics often weigh less than other types of solid waste, and the PWIA does not categorize plastics as a subcategory except for film plastic (4.7% by weight). Although hazardous chemicals are known to attach to plastics, and hazardous chemicals used in the production of plastics easily leach into the air and water they come into contact with, plastics are not categorized in PA as "hazardous waste", and thus it is placed in landfills.

More than 75% of plastics after use end in landfills and the natural environment (Geyer et al., 2017, American Association for the Advancement of Science). By weight, 26% of landfills are plastics (Geyer 2017). If current trends continue, the authors projected that plastic waste will and exceed 25 Billion tons by 2050. About 60% of all plastics ever produced have been discarded and are accumulating in landfills or in the natural environment including all waterways and marine environments. The U. S. Environmental Protection Agency (EPA) reported in 2018 that 75.4% of plastics by weight go to landfills or the environment, 15.5% are incinerated, and only 9.1% are recycled. Some cities in PA have greatly increased their incineration of solid waste, for example, Harrisburg burns 100% of their plastics and trash. Municipal landfills in PA have an estimated 27 years left, according to DEP calculations, though production of plastic trash is increasing - globally, a compound annual growth rate of 8.4% - and industry estimates are an increase of >4% more plastics created each year. Barriers to emerging plastics conversions technologies to reduce their non-recyled waste are that there are few commercially operating facilities in North America, they are in the demonstration stage of development, feedstocks vary for different 'burn' methods making estimations of cost and performance difficult, different technologies/vendors/facilities have specific variations on the process, and there is a high level of uncertainty associated with the effects of the technologies on the environment and their costs (RTI International for the Am Chemistry Council, 2012). Thus far, there are still few commercial conversion facilities being used globally, though incineration continues with reliance on adequate and well maintained scrubbers to reduce pollution emissions and no enforcement of this.

Landfill tipping fees are estimated by the EPA in 2017 dollars as $74.75 per ton, a cost that typically increases as landfill capacity decreases (https://www.epa.gov/sites/production/files/2019-11/documents/2017_facts_and_figures_fact_sheet_final.pdf), which is similar to fees we were able to find. Based on the PWIA 2016 estimate of municipal waste in PA per year, and if 26% of landfills are plastic by weight, then the estimated cost of landfill tipping fees for plastics in PA is $169,084,500 per year. Fees are likely to increase, and as plastic production will be four fold in the next 30 years, this annual cost is likely to increase. Pennsylvania also imposes a $2/ton recycling fee (1988), a $4/ton disposal fee (2002), and a $0.25/ton Environmental Stewardship fee (1999).

More jobs are associated with a recycling plant than a landfill, incineration, or the petrochemical industry synthesis of virgin resins (D'Ambriere, 2019), and supports local industry.

2) Highway Cleanup - cost of highway and landscape clean up of plastic debris.

According to the PA Statewide Litter Research Study of 2009, $11.5 Billion dollars were spent each year in the U.S. on picking up litter on roadways, which does not reflect the cost of legions of volunteers whose time is not monetized into these government costs for road and highway clean up. PennDOT alone spends $13.9 million/year, uses 5,100 volunteer groups who cover 10,000 miles of roads.

The proportion of plastics in litter has grown significantly and was over 67% of the items (including cigarette butts which are 98% plastic) according to the 2019 PA Statewide Litter Research Study that was produced from a partnership with the PA Department of Environmental Protection (DEP), the PA Department of Transportation (PennDOT), and Keep

Pennsylvania Beautiful. The sources of this litter are motorists, pedestrians, improperly secured loads (still frequently observed on roads today), overflowing trash containers, vehicle debris, illegal dumping, and other unknown methods of wasting and littering. More than 90% of plastic littered items are produced from petrochemical companies. Plastic waste on our roads is all Pennsylvanians' problem, as it comes similarly from urban and rural areas; the 2019 PA Statewide Litter Research Study showed: 51.7% were from urban settings, and 48.3% were from rural settings. Of this waste, the largest component was food packaging film. PennDOT alone spent about $13.9 million each year between 2014 and 2018.

This problem has reached a crisis point, as the DEP, PennDOT, Department of Conservation and Environmental Resources, and cities across PA all report that no matter how much they spend, they are not able to keep up with the waste. Many of these plastic items were used once, and then became waste showing that in addition to the costs of cleaning them up, their brief lifespan before becoming waste is a problematic economic loss. Another major economic problem is the end of life disposition of these plastics, which cause problems 'downstream' for generations as landfills age, incinerators leak chemicals into the air, and microplastics and their chemical additives and adsorbed contaminants enter our waterways. This degradation of the environment over decades and hundreds of years is difficult to estimate realistically in costs, as the problems are accumulating over time.

Some examples are that Allentown reported (Keep Pennsylvania Beautiful Litter Summit) spending over $11,000,000 per year on their road cleanups. Philadelphia commits major resources and has a city wide coordinated plan including public and private local and state partners, but stated that the cleanups are not sustainable. Anyone who has participated in a street or roadside clean up can attest that the largest category of wasted items is made of synthetic materials – polymer resins, synthetic fibers, and chemical additives – that is, plastics. These are among the hidden costs of plastic wastes.

Plastics also interfere with our clean water. Plastics in our water require cleanup and removal.

<u>3) Waterway Cleanup</u> - Plastic debris - macroplastics and microplastics - are pollutants that find their way into our waters, even some ground waters that provide a significant proportion of drinking water sources (plastics in karst groundwater, Panno et al., Ground Water, 2019). About 8,300 Million Tons of plastic have been produced since 1950, of which 6,300 Million Tons are waste. These numbers are too large to be imagined. In the next 30 years, Pennsylvania will be a major contributor to four times more plastic than ever before (Guglielmi, Science, 2017). By 2050, we will have produced 25-27 Billion tons of plastic <u>waste</u>. On shorelines, 50-80% of debris are plastics including fragments broken down from large debris. Contaminants that are hydrophobic - fail to mix with water - adsorb and attach onto plastics in water environments.

The Philadelphia Water Department spends $500,000 each year on filtering plastics out of some of its waters, likely those near the inputs. Many cities report spending millions of dollars/year on installing storm drain catchment devices, storm drain cleaning and maintenance, and manual water cleanups (e.g., Monroe, Waste in Our Waterways, NRDC Issue Brief, 2013), which does not monetize volunteer time. The Heinz National Wildlife Refuge at Tinicum has the problem of constant streams of primarily plastic debris washing downstream into the wetlands at the Refuge, and continuing to the Delaware River, Estuary, and Atlantic Ocean. The Fish & Wildlife Services state it is the top environmental problem at the Refuge (with the exception of continuing development surrounding the Refuge).

Plastic pollution is the most serious problem affecting the marine environment. Much of this comes from the land by air and by streams and rivers, and enters our freshwaters of Pennsylvania from wastewater treatment plants, trash bins, stormwater drains, sewage sludge, road and highways, atmospheric deposition, human hands, and the break up of larger plastics. Pennsylvania is the most water rich state in the U.S. aside from Alaska, estimated as almost 87,000 miles of streams. Therefore, we are a significant source of marine plastic waste. Once in the water, plastics break down into microplastics. Scientists recognize that our Pennsylvania streams all contain microplastics, and the macroplastics are visibly ubiquitous in a riparian area. Lake Erie was found to have 47,000 microplastics per square kilometer. All riverine studies have found plastics, and they have been found locally in Chester County streams and of course in the Delaware River in massive amounts. The extent of the plastics floating through the John Heinz National Wildlife Refuge at Tinnicum is so great that the Fish and Wildlife Service conduct their own clean-ups monthly with their volunteer groups, and other volunteer groups contribute additional cleanups, with a massive clean up in April. Yet, it is not possible to catch up to all the plastics. See below a tidal island at low tide at the Refuge, with the plastics embedded in the soil marked with red dots (photo credit: Armstrong, 2019).

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Plastics are in most tap water samples (Kosuth et al., PLOS One, 2018) . The types of microplastics that are abundant in our waters are microbeads (polyethylene, acrylates, e.g.), pellets/nurdles, lines, films, foams (polyurethane, polycarbonate, polyphenylene oxide, e.g.), and the most common, microfibers (polyester, acrylic, nylon).

When plastics were manufactured, we did not expect the reality of massive amounts of plastics in our waterways, a reality that cannot be reversed. Scientists can predict that stream bed sediments will exceed 5% of microplastics by mass by 2050 (Browne et al., Current Biology, 2013), which changes their understanding of how aquatic life will survive on the microorganisms in the sediment. The longer we promote the production of plastics for non essential things, the sooner this will permanently damage plankton, the beginning of the food chain, preventing plankton and necessary microorganisms on the bottoms of streams from reproducing and feeding aquatic and marine species of all kinds, from insects to fish to birds.

Plastics provide a hard substrate that adsorbs persistent pollutants, microbes and pathogens (that become attached to the plastic, even causing indentations), and leach toxic chemicals (see EPA Tox Town for long list of leached toxic, gene-altering chemicals). These microplastics are an abundant and distinct habitat in our fresh waters, termed plastispheres (McCormick et al, Env Sci&Tech, 2014, among many other papers).

The EPA estimated in 2012 that a state’s cost of plastic waste removal was $13 per person, which adds up to $166,530,000 each year in PA based on a 2018 population estimate. Costs are likely underestimated.

4) Water Treatment Plants - Costs of removing macro and microplastics from water treatment plants

According to the American Society of Civil Engineers, Pennsylvania's wastewater infrastructure is aging and in need of replacement, as the oldest have exceeded their intended lifespan. These plants were never designed to filter out microplastics. Andy Kricun, Exec. Dir and Chief Engineer of the Camden County Municipal Utilities Authority (CCMUA) reported at the Rutgers University conference, "Impacts of Microplastics in the Urban Environment" 2019, that more microplastics were found coming out of the wastewater treatment plant (WTP) than were measured going into the plant. He speculated that the plastic machine parts, which give off microplastic particles, might account for this. Note that the CCMUA is a leader in implementing green infrastructure and adapting to climate change. Water treatment plants are not able to filter out all microplastics, and all lead to an increase in microplastics in freshwater streams and rivers (Kay et al., Env Sci Pollut Res, 2018) because the intake sources are endemic with plastics. Both humans and aquatic life consume these microplastics, and physically and chemically pass them down to their progeny.

Just installing a membrane bioreactor to filter many microplastics (filters particles greater than 0.04 micrometers) from effluents in 2008 cost one Michigan city (Traverse City) $30,000,000. These bioreactors also have a higher energy cost compared to traditional filtration methods that do not reduce microplastics (Beljanski et al., Proc Nat Conf on Undergrad Res, 2016, Univ. No. Carolina, Asheville). Though new applications are being developed, it takes many years and extensive research and development costs to complete testing of a design, its feasibility in a WTP, adequate backflushing, long-term durability so that microplastics do not escape through tears, etc. There are no designs near readiness for use.

5) Impact on terrestrial life: Pervasive microplastic contamination of terrestrial systems is potentially changing terrestrial systems. Deposition of microplastics on land, especially agricultural soils, may be 4 to 23 times greater than in the ocean (Horton et al., Sci Total Env 2017). In large part, this is because environmental regulations are permissive in the levels of microplastics allowed in effluents of industrial plants and sewage treatment sludge that are often sprayed on soils. Even after treatment, sludge contains microplastics, but is considered biosolids that are applied as fertilizer to soils, where microplastics remain longer than the intended nutrients. Microplastics have been found up to 15 years after sludge was used to amend soil, and still retained their original properties (Zubris and Richards, 2005). Landfills may also contribute to the leaching of microplastics to land through accidental loss of particles, improper handling of waste, and generation of contaminated soils and aerosols (Nizzetto et al., 2016).

Studies of air deposition of microplastics are increasing (Dris et al., Env Pollut 2017; Dris et al., Freshwater Microplastics, 2018; Catarino et al., PEARL, 2018; Allen et al., Nature Geosci 2019), even being reported by the USGS as unintended, incidental findings in a remote part of the Rocky Mountains (Wetherbee et al., 2019, USGS). Topsoils near roads and industrial areas may contain high percentages of microplastics by weight (Huerta Lwanga et al., 2017, Fuller and Gautam, 2016). Leaching of pesticides (organochlorines) and PVC (polyvinyl chloride) cause geochemical changes in soils (Fuller and Gautam, 2016). Due to low light and oxygen conditions in soils, microplastics are likely to persist for a very long time.

Microorganisms and macroinvertebrates in soils are changed by microplastics that alter their gut microflora and have deleterious effects on growth and reproduction. Ingestion of microplastics have been documented in earthworms to reduce their growth (Lwanga et al., 2016). The presence of microplastics in honey suggests that pollinators might transfer them to flower ovules as they can fit through pollen tubes (Liebezeit and Liebezeit, 2013). Studies are being initiated to determine if plant growth is impacted by microplastics because microplastics alter soil structure, can transport to soils substances that are toxic to plants, nanoparticles could be uptaken by some roots,and can change the microbial community and connection with roots (Rillig et al., New Phytologist, 2019).

There is growing evidence that microplastics' interaction with terrestrial organisms are damaging the essential ecosystem services and functions that we have become accustomed to: soil dwelling macroinvertebrates, terrestrial fungi, and plant-pollinators. Therefore, there are significant potential economic impacts of plastics and microplastics on Pennsylvania's leading industry, agriculture, that will accumulate over time. The inability of scientific technologies to measure the effects at this time do not prevent the accumulating damage in the future.

6) Human Health Impacts -

The connection between chemicals associated with plastics and health effects comes from epidemiological and case studies. Although plastic monomer molecules are too large to pass through the cell wall of animals, the chemicals added to their production that easily leach under many conditions, are small enough to pass through cell membranes. These chemicals disrupt the endocrine signaling (it interacts with hormones) and other communication signaling in cells needed for functioning of the immune system. Some of the main categories of chemicals used in plastics are considered here.

A very widely used additive in the production of plastics that disrupts the endocrine signaling within cells of many animals is bisphenol A (BPA). It also modulates thyroid hormones. It is used in some beverage containers, plastic dinnerware, toys, and many other products. As such, the Center for Disease Control reported repeatedly that it is ubiquitous in the bodies of Americans (CDC, Fourth National Report on Human Exposure to Environmental Chemicals, 2019). However, accumulating evidence indicates BPA and other bisphenol substitutes for BPA are detrimental to neurological development and contribute to other chronic diseases such as cardiovascular disease and diabetes II (Smith et al., Curr Env Health Rep, 2018) . BPA causes neuropsychiatric disorders: prenatal BPA exposure is linked to increased risk of ADHD (Casas et al., Env Res, 2015), to behavioral problems of self-control in boys, and to emotional problems and executive dysfunction in girls (Roen et al., Env Res 2015; Harley et al., Env Res 2013, Braun et al., Pediatrics 2011; Braun et al., Env Health Persp 2009). BPA can also disrupt gene expression through epigenetic mechanisms, affecting the development of the central nervous system in future generations (Yeo, et al., Proc of Nat Acad of Sci of U.S.A., 2013). The problem has become a major public health issue due to its adverse effects (Inadera, Int J Med Sci, 2015; https://www.cdc.gov/biomonitoring/BisphenolA_BiomonitoringSummary.html).

The CDC reported that BPA was found in over 40% of our streams. Aquatic male species have been found to produce eggs as a result of their exposure to chemicals; assigning the relationship of which chemicals from plastics versus other chemicals humans are consuming is difficult, as scientists find over 200 synthetic chemicals in the water that affect the male fish to feminize.

It is important to recognize that even after a chemical used in plastic production is found to be too toxic for human and environmental exposure and is banned, its legacy continues as most of discarded plastic remains in the environment and leaches chemicals into surface and ground water, such as PCBs (polychlorinated biphenyls) that were used in plastic production until they were banned in 1979 due to damage to liver, skin, immune system, neurological system including the brain, reproduction, hormones, and our genes. Fish, meat, and dairy contribute the greatest dietary exposure to PCBs (Agency for Toxic Substances and Disease Registry, 2015). In the U.S., annual per capita food consumption is over 7 kg/year.

Polybrominated diphenyl ethers (PBDEs) are used in plastic products. These chemicals are absorbed by fat tissue and easily accumulate in the environment (Meghal 2018). They are found in many settings including indoors. They were banned in Europe in 2004, but despite the ban there, its levels are increasing in Europe. Deca-PBDE was phased out by the end of 2013 in the U.S. except for certain uses, and the entire American population has detectable levels of at least one PDBE in their blood, also found in significant amounts in placenta, fetal blood, and breast milk. Early exposure to PBDEs is linked to decreased IQ, learning disabilities, hyperactivity and inattention, and poor executive function in children (Zhang et al., Env Health Persp 2017; Braun et al., Neurotoxicology, 2017; Vuong et al., Env Res 2017; Sagiv et al., Neurotoxicology Teratology 2015; Chen et al., Env Health Persp 2014; Eskenazi et al., Env Health Persp 2013; Cowell et al., Neurotoxicology Teratology 2015; Ding et al., Env Res 2015; Herbstman and Mall, Curr Env Health Rep 2014).

Phthalates are another commonly used plasticizer, used in toys, medical products, food packaging, pvc pipe recycling, and many other commercial products. It is highly volatile and found in high concentrations in enclosed spaces where air conditioning is used, such as in vehicles. It has a high rate of absorption into foods and into fat, which makes it a major concern for the vulnerable populations in contact with toys and medical devices. Phthalates do not bioaccumulate but are ubiquitous in our daily lives, and high levels are found in the general population. When found in mothers, there are higher risks of neurodevelopmental and behavioral disorders in their offspring. Other abnormal sexual phenotype behaviors have been observed from prenatal exposure to phthalates such as ‘reduced masculine play’, lower mental development scores, reduced IQ, and attention deficit/hyperactivity disorder (Tellez-Rojo et al., Sci Tot Env, 2013; Whyatt et al., Env Health Persp 2012; Minatoya et al., Sci Tot Env 2016; Swan et al., Int J Andrology 2010; Miodovnik et al., Neurotoxicology 2011; Cho et al., Env Health Persp 2010; Chopra et al., Env Res 2014).

PFCs (perfluorinated chemicals) are used in the manufacture of teflon, carpets, fabrics, and other fluorinated synthetic polymers (plastics), and bioaccumulate, are extremely persistent, and toxic. The CDC reported it was in the serum of nearly all the people tested. It is also found in wildlife.Though this group of chemicals was discontinued between 2000 and 2002, and a decrease in human serum levels were observed, they are still found in significant levels in drinking water or may be consumed in food (Domingo, Env Int, 2012). PFCs have become a current health crisis (PFOS, PFOA, PFHxS, PFNA). It affects thyroid hormone levels, and affects liver function (Mughal et al., End Connections: Review, 2018).

Persistent organic pollutants are found on plastic debris, such as PAHs (polycyclic aromatic hydrocarbons) in water environments, and cause short-term and long-term health effects. Sources are water, and air from plastics burning in municipal solid waste (Verma et al., Pro Env Sci, 2016). The burnings of the pollutants contributes to climate change. Long-term health effects found are cataracts, kidney damage, liver damage, inflammation of the skin, reproductive disruption, and neurodevelopmental damage. These PAHs form whenever substances are burned, and are found at coal-gasification sites (Illinois Dept of Public Health). They become attached to plastics.

Hoellein et al. reported that the average person may ingest over 5,800 particles of plastic debris from water sources each year (tap water, sea salt, bottled water, beer). We also consume microplastics from seafood including PCBs, PAH, DDT, BPA, and PBDEs (Smith et al., Curr Env Health Rep, 2018).   Detection of nanoplastic contamination is not possible as yet.

A review of the scientific literature on all the environmental exposure to these classes of chemicals and their associations with neurological impairments was conducted by Zeliger (Toxicology, 2013). The evidence for these associations lead the author to state that these chemicals “are known to cause neurological diseases” (p. 105). The possible mechanisms are oxidative stress, epigenetic effects, endocrine disruption, and lipophile-dependent mechanism. Other diseases associated are immunological disorders, reproductive interferences, autoimmune diseases, and periodontal disease, as well as cancers and neurological and neurodevelopmental diseases and disorders. There are many sources of chemicals in our environment, but they include chemicals adsorbed onto plastics, added to plastics, or made when plastics are burned (e.g., toxic metals, pesticides, flame retardants, particulate matter) are thought responsible for 30% of risk for Alzheimer's disease that has doubled in incidence and may have contributed to the 75% increase in Parkinsonism from 1990-2010 (Manivannan et al., Curr Alzh Res, 2015; Caudle et al., Neurotoxicol 2013; Zeliger, Interdiscip Toxicol 2013).

Elevated health risks for in workers in settings that produce or work with plastics, include but are not limited to neoplasms and other cancers, diseases of the circulatory system, severe chronic respiratory conditions, diseases of the genitourinary system, kidney diseases, and psychiatric problems. Questions are also being raised about whether pre-natal or fetal exposure to endocrine-disrupting chemicals associated with plastics alter sex and gender phenotypes (Hood, Env Health Persp, 2005). BPA is of greatest concern for its affects on loss of sex differentiation in brain structures and behavior.

The CDC offers the methodology to estimate the economic cost of illness, which include the costs of mortality, morbidity, reduced life expectancy, loss of quality of life, decreased life expectancy, disability-adjusted life expectancy, and changes in the activities of daily living and vocational productivity. The estimated total costs are incurred because of:

- The costs of medical resources to treat the disease
- The costs of non-medical resources to treat the disease.
- The loss in productivity over the life time.

The ability to measure these costs in relation to the classes of chemicals used in plastic production in this review are beyond our scope and skill. However, the problems found in this review are all chronic conditions that do not reverse, and many onset in early childhood. Thus the economic costs of plastics on our health must be enormous. Scientists concur that the impact of microplastics on human health presents one justification to decrease the increasing flux of plastic into the environment.

<u>7) Recycling Machinery</u> - cost of removing plastic bags and plastic packaging that gum up machinery.

Recycling sorting equipment use magnets, optical sorters, crushers, shakers, blowers, and other methods to find recyclable material. It is well publicized that non-recyclable material can jam the equipment or cause it to break down. Even today these items continue to interfere and even damage equipment include plastic bags, as well as other large or stringy items. The unrecyclable materials go to the landfill or are incinerated. A 2017 report by Closed Loop reported that 4% of plastic films (packaging and bags) accrued by American households are recycled, leaving 96% to be trash even if put out for recycling services to remove where they go to landfills.

The city of Portland OR sought to focus on recycling bags instead of banning them, but local plastics recycling operations managers reported to the Portland Mercury that they are a “plague” in the recycling business as they become stuck in giant sorting machines, and gum up the work so badly that four to six people had to stop the machine to clean it four times a day, taking 30 min. for each repair, bring the cost of just cleaning bags out of the machine to $60,000/month in 2010 dollars for this one recycling plant. A report by SP Recycling cited that though plastic bags were 0.1% of material going through recycling, the bags cost 20-30 % of labor costs. In 2017, the Monroe County Recycling Center in NY had a very ambitious landfill diversion rate for trash and achieved 39%, compared to a national average of 16%. They also cause damage and high labor costs to their recycling efforts. They reported to the local paper that they were closing the machines at least once/day to clean out the bags that catch up in the gears and other machine parts. The plant manager cited the plastic bags as the #1 cause of operational down time. Phoenix AZ reported in 2018 to Waste 360 that plastic bags cost the city about $1,000,000/year in lost time, causing them to shut down one-to-two times/day again due to machine jams and related contamination. Other plastic films such as packaging are also jamming sorting machines around the country - see photo below from Hartford Courant, CT), as reported in 2019 by the LA Times.

In Pennsylvania, the Borough of West Chester reports that:

> Borough residents discard approximately six million plastic bags per year. At a weight of 6 grams per bag this equates to 39 tons of solid waste annually, which the Borough collects and pays about $95/ton to collect, transport, and tip at a landfill. Therefore eliminating just plastic bags could save Borough taxpayers approximately $3,705 per year, though we also acknowledge that many bags are not disposed of properly.
>
> Single-use items are not recyclable curbside but nonetheless end up improperly recycled, where they become a leading source of recycling contamination. This contamination devalues post-consumer recycling materials, directly leading to increased costs that are today undermining recycling programs in every municipality in Pennsylvania. These added costs must be passed along to taxpayers.

Pennsylvania municipalities have recognized the high cost of single-use plastics. They are focused on common sense solutions that minimize plastic waste and the inconvenience to consumers and merchants. Many innovative solutions are on the horizon. The Sierra Club supports the multiple efforts to encourage innovation and reduce waste.

Therefore, the problem of plastic bags jamming equipment, costing lost processing time, and adding to labor costs has not been solved in the past 10 years. Consumers are not instructed or directed to the need to recycle bags and packaging separately, nor are encouraged to bring these plastics for recycling to various corporate shopping businesses. When a paper address or other label is affixed to the packaging, the label must be removed before it can be recycled.

8) Tourism - visible plastics along waterway shores that have negative impact on recreational use and tourism.

Tourism is an important part of Pennsylvania's economy. The PA Department of Community and Economic Development reports that tourists in Pennsylvania spend $41 Billion dollars each year. This amount of spending provides $4.3 billion of tax income and employees 490,000 Pennsylvanians. Of those tourists, 40 million visit our State Parks and Forests. Their reasons are to enjoy various activities, including the natural sights and sounds of nature, fishing, hunting, viewing wildlife, boating, and white water rafting. In fact the Audubon Society has designated several special areas of Pennsylvania's forests as Important Birding Areas.

Litter, especially plastic litter, is not only visually offensive, but also a detriment to the functions of our forests. Our forest trees sequester 4.7 million tons of CO_2 and other air pollutants. They provide two thirds of the water that feed our streams and replenish the ground water.   Pollution, especially the toxins present in plastic, break down and negatively affect the forest plants and animals, upsetting the delicate balance of nature.

Offsetting the $4.3 billion dollars of tax revenue is the cost of Penn Dot and DCNR clean up. Penn DOT spends $40 Million dollars per year cleaning up litter along our roads and highways.   30%-40% of that litter is plastic, much of it single use such as plastic bags and bottles.

The Commonwealth cannot recycle our way out of the plastic problem. Nor can the Commonwealth solve the litter problem with continuous clean ups. The cheap accessibility of single use plastic bags and bottles is not worth the costs -- not the financial costs, not the health costs, and not the environmental costs. The only way to get out of the plastic problem is to reduce the presence of plastics in our environment.

9) Invasive Species - plastics are vectors for transporting invasive species which have an impact on PA heritage assets and recreational opportunities.

Description of Pennsylvania's waterways:

The Commonwealth of Pennsylvania is located in the mid-Atlantic region, with New York State to the north, New Jersey to the east, Delaware, Maryland and West Virginia to the south, and West Virginia and Ohio to the west. The Commonwealth's varied geology and topography contribute to the large variety of aquatic and estuarine habitats.The Commonwealth hosts more than 84,000 miles of streams and shares five major watersheds with other states and Canada. The Delaware River begins in New York and forms the Commonwealth's eastern boundary, draining about 6,422 square miles of eastern Pennsylvania. Roughly 50 miles of the river in Pennsylvania are freshwater tidal. The river's main stem in Pennsylvania contains no dams impassable to fish. Philadelphia, located at the southeastern corner of the state where the Schuylkill River flows into the Delaware Estuary, is a major port city. The Susquehanna River begins in New York and flows into Pennsylvania, draining 21,000 square miles of Pennsylvania to the Chesapeake Bay, which is roughly 20 miles downstream of the Pennsylvania/Maryland border.

The Potomac River watershed's 1,570 square mile area within Pennsylvania consists mostly of first to third order headwaters streams in the south central region. The Monongahela and Allegheny Rivers join at Pittsburgh to form the Ohio River. Together, these rivers drain 15,614 square miles of western Pennsylvania. The Ohio River system supports extensive commercial barge traffic. The Allegheny, which flows through the Allegheny National Forest, has eight locks and dams in Pennsylvania; the Monongahela has six, and the Ohio three. The Lake Erie watershed has a six hundred and ten square mile area, and the Commonwealth owns approximately 740 square miles of submerged lands to the middle of the lake and the border with Canada. The headwaters of the Genesee River watershed encompass 94 square miles in north central Pennsylvania along the New York border and are a tributary to Lake Ontario. Pennsylvania has more than 1,200 lakes, many of which are impoundments, although this number does not include run-of-river impoundments (Lathrop, 2006). Major lakes and impoundments include Pymatuning Lake in the northwest (shared with Ohio), Allegheny Reservoir (an impoundment on the Pennsylvania/New York line) in the northwestern part of the state, Raystown Lake (an impoundment) in the south central part of the state, and Lake Wallenpaupack (an impoundment) in the northeast. Glacial lakes located across the northern part of the state are of special ecological interest because of the rare species they support.

Pennsylvania has a large variety and number of wetlands (Pennsylvania Game Commission, 2005). According to the National Wetland Inventory, there are a total of 729,535 wetland acres found in more than 160,000 wetlands across the state. Of this, 146,816 acres are lacustrine (lakes and ponds primarily) and 410,009 acres are palustrine habitat (marshes, etc.). An additional 643 acres of estuarine habitat are located in the southeastern region along the Delaware River. The majority of Pennsylvania's wetlands are palustrine (bogs, fens, swamps, shallow pools). Emergent wetlands (marshes, meadows) and shrub swamps comprise 10 to 20 percent of state wetlands.

Cost of Invasive Species:

Invasive species in the United States cause annual economic losses exceeding $137 billion (Pimentel et. al. 2000) Fisheries in Pennsylvania support both recreational activities and commercial enterprises, and represent one sector that could be impacted economically by aquatic invasive species. The 2001 National Hunting and Fishing Survey reported that 1.3 million state residents and nonresidents 16 years old and older fished in Pennsylvania, spending $580 million on fishing. In 2005, the Pennsylvania Fish and Boat Commission sold 817,894 fishing stamps and licenses, generating $18,581,999.00 in revenue.

Aquatic invasive species represent a challenge to state agencies in how they manage lands and waters to meet a stated mission. For example, DCNR has the mission of providing recreational uses in state parks and forests while demonstrating good natural resource stewardship. The Bureau of State Parks spends $40,000 to $50,000 annually on herbicides, which are mainly used for AIS treatment in park lakes in order to maintain recreational activities. Pennsylvania has 117 state parks and 20 forest districts that together manage about 2.5 million acres of state lands. DCNR park and forest district managers spent approximately $215,000 in fiscal year 2004-2005 for invasive plant control efforts statewide. Current available funding, which comes mostly from operating budgets, is inadequate to meet the challenge of aquatic invasive species.

https://www.anstaskforce.gov/State%20Plans/PA_AISMP.pdf

Definition of Invasive Species:

Whereas no definition to date is perfect, the federal government has defined the concept of "invasive species" in two different ways. The following definition of "invasive species" was defined in Executive Order 13112 (1999). Invasive Species: "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health (Executive Order No. 13112, 1999; NISC, 2006)."

A white paper (NISC, 2006) produced by the National Invasive Species Council provides a nonregulatory policy interpretation of the concept of invasive species (in Executive Order No. 13122, 1999) by identifying what is meant, and just as important, what is not meant by the concept. Prior to that, the NANPCA, as amended by the NISA, defined the concept as follows: Aquatic Nuisance Species: "a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters."

There are a number of ways that aquatic invasive species can make their way into Pennsylvania's aquatic ecosystems. Pathways are the means by which species are transported from one location to another. Natural pathways include wind, water, and other forms of dispersal where a specific species has developed morphological and behavioral characteristics enabling movement. Human pathways are those pathways which are enhanced or created by human activity, generally falling into categories of intentional or unintentional introductions.

One method is through the contamination of products in channels of trade: Shipments of organisms may contain other organisms, included intentionally (for example, as packing material) or accidentally. Improper disposal of packing material has the potential to introduce invasive species into new environments. Shipments of approved organisms also may contain similar species that are difficult to distinguish with the naked eye, and accurate identification becomes critical.
https://marinedebris.noaa.gov/sites/default/files/publications-files/2017_Invasive_Species_Topic_Paper.pdf

Plastic Pollution:

Plastic pollution in the oceans is known to endanger marine wildlife and degrade habitats. Floating plastics can also transport marine animals, plants, and microbes long distances across the oceans through 'ocean rafting'. While floating in nearshore environments, local marine species, such as mussels, amphipods, and barnacles, can settle on plastic litter. Because plastics are exceptionally buoyant and slow to degrade, floating plastics in coastal waters can be carried out to sea by offshore ocean currents, where the debris and the attached organisms can circulate for years, in some cases, traveling far enough to reach new shores. Marine organisms hitchhiking on plastics can thus be deposited hundreds of miles from their native ranges, increasing opportunities for non-native species introductions.

An extreme example of plastics' efficacy in transporting coastal organisms across oceans followed the 2011 Japan tsunami when 5 million tons of debris washed offshore. One year later, some of these derelict objects (for example, vessels, docks, buoys, household items) began floating ashore on the west coast of North America and Hawaii. Researchers from SERC and other institutions as well as over 100 volunteers tracked the arriving tsunami debris for the next six years, collecting over 600 items. They found 289 Japanese marine species living on the debris, thirty of which were known invasive species. Their discoveries, published in Science, were unprecedented given the length of time that the coastal hitchhikers floated at sea (over 5 years in some cases) and the extraordinary distance traveled before landing on North American shores.

https://serc.si.edu/research/projects/invasive-species-rafting-ocean-plastics

It is estimated that mismanagement of U.S. landfills release 0.04-0.11 million tons of plastic waste into the oceans yearly. Worldwide release is 8 million tons per year.

10) Illegal Dumping - cost of state agencies to prevent illegal dumping of debris including synthetics and cost of their cleanups in state parks and forest lands.

DCNR Deputy Secretary for Administration, Michael Walsh, reported to The Litter Summit that illegal dumping remains a chronic problem in some state forests and state parks throughout the state. Managers of Michaux State Forest, in the south central section of the state, are actively deploying surveillance cameras in an attempt to deter roadside dumping, which often leaves the district facing high disposal costs. Thus far, DCNR has spend $40,000 on cameras to catch illegal dumping, and gave 142 citations.

11) Fishing - Impacts on fish destined for human consumption in Lake Erie and rivers.

When an animal eats fish, plankton, or larvae that has eaten plastic, the toxic chemicals are absorbed and are capable of crossing cell membranes and disrupting the communicating and endocrine functions of the cells. This is the source of the endocrine disrupting features of plastics, that have received some public notice. Plastic is a *stressor* to all life forms, and affects growth, reproduction, and species interactions (Scherer et al., Handbook of Environmental

Chemistry, 2017). These disruptions have an impact on human health, as reviewed in another section of these comments.

Studies vary as to the prominence of fish ingestion. One study by Penn State University found that 40% of fish had ingested plastic, but a more recent and comprehensive study of fish in reservoirs found that 100% of the fish had microplastics in them (Hurt et al., Limn Oceanogr, 2020). Plastics have been found in greater proportion in fish in agriculturally dominated watersheds than in forested watersheds, and are common in river food webs (McNeish et al., Sci Rep, 2018) Microplastics are also found in greater proportion in farmed fish than in wild caught, even though farmed fish have shorter life spans than wild (Van Cauwenberghe and Janssen, Env Pollut, 2014). A UN report of 2016 documented over 800 sea animal species that were contaminated with plastics, including many of our sources of food. Microplastics are found in many species intended for human consumption: plastics first enter digestive tracts, so that small fish and bivalves that are consumed whole are more likely to expose microplastics to human tissue and systems. Microplastics are found even in dried fish species. In fish, as in humans, microplastics particles are transferred from digestive tracts to other systems such as the circulatory, liver, spleen, and immune system. Scientists do not exclude the likelihood that nanoplastics can cross the blood-brain-barrier and be found in the brain. We have no evaluations yet of human tolerance for plastic consumption.

Microplastic exposure can confer exposure to associated chemicals, and few studies have assessed exposure to chemicals from microplastics versus other exposure pathways. There is yet insufficient information to assess the true amount of microplastics humans may be exposed to in their food. However, the toxic pathways in the body are both physical and chemical. The human excretory system can eliminate some micro- and nanoplastics in feces. Retention of microplastics in the body are due to the size, shape, polymer type, and additive chemicals of microplastics that are ingested by humans (Lusher et al., FAO Fisheries and Aquaculture Technical Paper, 2017). The severity of the health effects from exposure depend on the nature of the toxic chemical, exposure characteristics, individual susceptibility, and hazard controls (Smith et al., Curr Env Health Rep, 2018). Initial findings are that potential impacts are inducing inflammatory responses, size-related toxicity of plastic particles, chemical transfer of adsorbed chemical pollutants, and disruption of the gut microbiome (Wright and Kelly, Env Sci Technol 2017). Chronic exposure that produces an cumulative effect is of greater concern than localized microplastic particle toxicity. The true adverse effects of microplastic consumption through our food requires further work to estimate the dose of chemicals to humans from microplastics in seafood.

The potential loss of the value of fishing in Pennsylvania due to increasing public awareness of the health risks they expose themselves to from eating fish would have economic consequences for both the recreational and seafood industries.

<u>12) Plastics Recycling</u> - costs of recycling plastics.

Recycling plastic films/packaging/bags must be processed at slower speeds to produce the same output, and the economic profit margins are not yet there, according to Pete Keller, the VP of Recycling for Republic Services, as he was quoted as saying in the 2/13/2019 Los Angeles Times article. Mr. Keller also said that separate plastic packaging and bad recycling was labor- and maintenance-intensive on a daily basis, and thus expensive (see #7: Recycling machinery). An internet search revealed 20 Pennsylvania companies engaged in recycling of plastics. As of the 2019 Litter Summit sponsored by Keep Pennsylvania Beautiful, only a very limited number of plastic feedstocks were profitable, and plastic films and bags are not.

Plastics Today reported in 2018 an article in which James Warner, CEO of the Solid Waste Management Authority in Lancaster County, PA stated “Recycling as we know it isn’t working”, and that mixed plastics were not worth processing. Many who will not be quoted state that a great deal of plastic actually goes to landfill. This industry media reported that we are a long way from making plastics recycling feasible. This was also voiced by representatives of recycling industries in the Rutgers University’s 2019, “Impacts of Microplastics in the Urban Environment Conference”.

A thorough examination of recycling of plastics shows how complex it is (Achilias and Antonakou, Chemical and Thermochemical Recycling of Polymers from Waste Electrical and Electronic Equipment, 2015). Plastics are simple monomer molecules that form strong chains - polymers. There are four methods of recycling, each with its disadvantages and costs. <u>Primary</u> recycling for non-useful or problematic plastics that were not used by consumers, were not deteriorated, but cannot be turned back into useable products. <u>Secondary</u> recycling refers to recycling of consumer products, which requires cleaning, decrease in size, separation into the mixture components, melting, and reforming. The final product is lower in quality because macromolecular chains are broken during the processes just described. <u>Tertiary</u> recycling, chemically or with the use of heat, breaks the polymer bonds leading to either the initial monomers or fractions of the repeating monomers. BPA is recycled this way and requires severe conditions such as long reaction times, high temperature, high pressures, and a large amount of concentrated bases or acids (Watanabe et al., Polymer Degrad Stability, 2009). Highly toxic organic solvents are used, for which there are high costs and safety issues, and environmental consequences. High pressure and high temperature water can be used for part of this process. It produces higher quality products with more chemical and heat costs and toxicities. <u>Quaternary</u> recycling is mainly incineration. It causes dangerous byproducts to be emitted, such as dioxins. There is no enforcement of scrubbers used to control some of these toxic byproducts, which still require disposal. Plastics used in electronic equipment such as televisions, refrigerators, washing machines, usually contain metals that are incorporated into their structures, and separating and recycling them involves a series of technical and economic challenges (DeMarco et al., J Analyt Appl Pyrolysis, 2008).

Polystyrene (Styrofoam, e.g.) which never biodegrades can be recycled, and is a common component of waste electrical and electronic equipment, construction, packaging materials, storage bottles, appliance parts, housewares, and interior parts in household electronics. Polystyrene is recycled through a combination of mechanical, chemical, and thermal methods, but most of it goes to landfill or the environment (as seen by anyone spending any time near water). Most communities exclude polystyrene from recycle collections, while a few communities will only accept dense polystyrene.

Much of currently recycled plastics end up in incinerators instead. China limited the quantity and quality of recycled materials that it was willing to accept in 2018. As a result, 200 tons of recycled material from the City of Philadelphia is burned at the Coventa incinerator in Chester, the Guardian reports.
https://www.wired.com/story/since-chinas-ban-recycling-in-the-us-has-gone-up-in-flames/ This diversion of recycled material has air pollution consequences for our local communities.

Currently, only 9.2 % of plastic is recycled, and 9.9 % is incinerated. The rest is landfilled. Only PET and HDPE plastics are significantly recycled. Even under optimal conditions, it is estimated that recycling PET from a single stream recycling program will not be profitable, with a net loss of approximately $10.00/ton. Dual stream recycling models increase profit to about $14.00/ton. However, recycled PET currently does not compete well with production costs for virgin polymer due to low crude prices. It is estimated that the required oil price per barrel for break-even recycled PET is about $59.00/barrel.

13) Climate Change - costs of extracting virgin fossil fuels for new plastics, orphan gases

Production of plastics is 90% dependent on virgin fossil feedstock - both natural gas and oil. Serpil Guran of Rutgers University's EcoComplex related that greenhouse gas emissions from plastics were estimated to be 390 million tons of CO_2 in 2012. Our freshwater drinking supplies are required, and it takes approximately 22 gallons of water to make 1 pound of plastic. Land degradation, water contamination, and impacts to food systems are extreme. The United Nations estimated that the natural capital cost of plastics, environmental degradation from plastics, climate change, and health risks are about $75 billion globally each year. According to D'Ambrieres (Field Action Sci Rep, 2019), 18% of virgin plastics are made in North America. As Pennsylvania is positioning itself to be a major producer of plastics in the country, we will conservatively estimate that Pennsylvania is a producer of 5% of the plastics in North America, which leads to a UN estimated cost of $650,000,000/year in Pennsylvania

Estimates of CO_2 production (in tons) per ton of virgin plastic:

Process energy - HDPE/1.56 tons LDPE/1.91 tons PET/1.80 tons

Transport energy - HDPE/.04 tons LDPE/.04 tons PET/.04 tons

Process non-energy - HDPE/.17 tons LDPE/.17 tons PET/.10 tons

Savings with recycled - HDPE/1.61 tons LDPE/1.95 tons PET/1.77 tons

14) Hazardous Materials - costs of safe disposal of chemicals used in recycling and in creation of new plastics.

Toxic chemicals are required to dissolve plastics from packaging and products, such as dichloromethane, toluene, chloroform, and acetone. Other chemicals and chemicals under high heat are used to recover the monomers that make up the base plastic (before other chemicals are added for features such as color, flexibility, and fire resistance) (Achilias and Antonakou, 2015).

15) Industrial Pollution - costs of air and water pollution from plastics industries

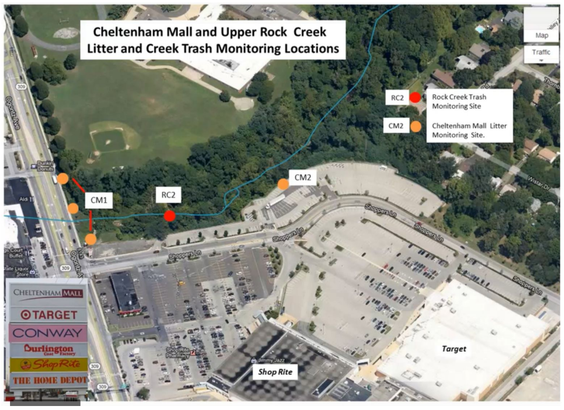
Ethane cracker plants create virgin plastics. These plants release many hazardous air pollutants, including benzene, toluene, and formaldehyde, as well as conventional pollutants such as fine particulate. These pollutants are not only harmful to human health, but affect the natural landscape.

16) Impact to Underserved Communities -

It is hard to imagine resolving the plastic litter pollution problems in urban neighborhoods, including streets and waterways, without considering municipal regulations of the single-use plastic products that end up collecting in streams, vegetation along stream banks, street trees, community open spaces and common alleyways where lightweight materials escape from trash bins and are blown by the wind.

Without unsightly plastics pollution in neighborhoods property values would increase and community pride would be boosted.

Please review the photos, videos and data collected by Kelly O'Day in Philadelphia about plastic pollution in the northeast neighborhoods. Particularly the video analysing Tookany-Tacony Creeks (https://mtairy.me/ttf-creek-trash-documents/ttf-trash-videos/).



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References

Raynaud, J., 2014. Valuing plastics: the business case for measuring. Managing and Disclosing Plastic Use in the Consumer Goods Industry. Retrieved from. www.unep.org/pdf/ValuingPlastic/.

Hardesty, B.D., Good, TP., Wilcox, C., 2015. Novel methods, new results and science-based solutions to tackle marine debris impacts on wildlife. Ocean Coast. Manag. 115:4–9. http://dx.doi.org/101016/j.ocecoaman.2015.04.004.

Jang, Y.C., Hong, S., Lee, J., Lee, M.J., Shim, W.J., 2014. Estimation of lost tourism revenue in Geoje Island from the 2011 marine debris pollution event in South Korea. Mar. Pollut. Bull. 81 (1), 49–54.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S., 2011. Microplastics as contaminants in the marine environment: a review. Mar. Pollut. Bull. 62 (12):2588–2597. http://dx.doi.org/10.1016/j.marpolbul.2011.09.025.

Sivan, A., 2011. New perspectives in plastic biodegradation. Curr. Opin. Biotechnol. 22 (3):

422–426. http://dx.doi.org/10.1016/j.copbio.2011.01.013.