Statewide Microplastics Strategy

Understanding and Addressing Impacts to Protect Coastal and Ocean Health

DRAFT

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EXECUTIVE SUMMARY

Plastics are a global threat to ocean health. Worldwide, an estimated 11 million metric tons of plastic enter the ocean each year, with this amount expected to triple by 2040 if no intervention takes place. Microplastics, defined by the State Water Resources Control Board as synthetic particles with at least three dimensions ranging from 1 nm to 5 mm in size, are considered pervasive global pollutants, with microplastics increasingly observed even in remote environments. The California Legislature recognized the need for a comprehensive plan to address this environmental challenge with the adoption of Senate Bill 1263 (Portantino) in 2018, requiring the California Ocean Protection Council to adopt a statewide research strategy and identify early actions to reduce microplastic pollution in California's marine environment.

This Statewide Microplastic Strategy provides a multi-year roadmap for California to take a national and global leadership role in managing microplastics pollution. Multiple state agencies and external partners will work together to combat the introduction and spread of microplastics in California's coastal ocean and other aquatic systems. Foundational to this Strategy is a recognition that the state must take decisive, precautionary action to curb microplastic pollution, while scientific knowledge and understanding of microplastics sources, impacts, and successful reduction measures continue to grow.

The Strategy outlines a two-track approach to comprehensively manage microplastics in California. The first track (**Chapter 2A**: **Solutions**) outlines immediate, 'no regrets' actions and multi-benefit solutions to reduce and manage microplastic pollution, while the second track (**Chapter 2B**: **Science to Inform Future Action**) outlines a comprehensive research strategy to enhance the scientific foundation for microplastic monitoring, source identification, risk assessment, and development of management solutions.

Solutions

multi-benefit solutions the state can act upon now while the scientific knowledge of microplastics further develops.

- **Pollution Prevention**
  to eliminate plastic waste at the source (products or materials from which microplastics originate)
- **Pathway Interventions**
  to intervene within specific pathways that mobilize microplastics from a specific source into California waters
- **Education**
  to inform the public and industries of microplastics sources, impacts, and solutions

Science to Inform Future Action

research priorities to advance scientific knowledge of microplastics to develop and refine future solutions.

- **Monitoring**
  to understand and identify trends of microplastic pollution statewide
- **Risk**
  to improve understanding of critical thresholds at which aquatic life and humans are adversely impacted by microplastic exposure
- **Sources & Pathways Prioritization**
  to idenitfy and prioritize future management solutions based on predominant ways microplastics enter California waters
- **Evaluating New Solutions**
  to develop and implement potential future solutions

Within the immediately implementable **Solutions** track, short-term management actions focus on eliminating plastic waste at its points of origin to prevent introduction into the environment (**Pollution Prevention**), implementing multi-benefit management interventions that both reduce plastics loading and improve overall ecosystem health (**Pathway Interventions**). Also, **Solutions** include working to alter public behaviors, attitudes, and priorities around plastics use and waste reduction (**Education**). Immediate actions California can take to curb microplastic pollution include elimination of products that are among the highest contributors of both plastic and microplastic pollution, engagement with industry to identify alternative material sources and product designs, and advancement of improved stormwater management.

The research-focused **Science to Inform Future Action** track focuses on standardizing measurement approaches and building monitoring capacity to comprehensively assess the scale of, and trends in, California's microplastic pollution (**Monitoring**), and implementing a risk assessment approach that identifies the types of microplastics having the greatest effect on aquatic life. In addition, the **Science to Inform Future Action** track quantifies critical thresholds at which microplastics effects manifest, and quantifies the extent to which aquatic life are being affected now and into the future (**Risk**), enhancing understanding of the predominant pathways by which the most toxic types of microplastics are entering aquatic environments (**Source and Pathways Prioritization**). Future actions include developing targeted engineering and management solutions (**Evaluating New Solutions**). California will specifically prioritize the development of a statewide microplastic monitoring program, creation of a source emission inventory, and advancement of existing risk thresholds that can inform future regulatory action by 2025.

This Strategy will adapt solutions to new science, as new information and approaches become available, through OPC's facilitation of the feedback loop between plastic pollution reduction and intervention strategies (**Chapter 2A**: **Solutions**) and research (**Chapter 2B**: **Science to Inform Future Action**). To implement these research priorities, evaluate the efficacy of early actions, and inform future solutions, California will collaborate with scientific experts across academic institutions, federal and state agencies, and other organizations.

Over the next four years, California can achieve substantial reductions in microplastic pollution and catalyze increased scientific understanding by implementing the 19 individual recommendations and 12 research priorities outlined in the two tracks of this Strategy. As policy recommendations are implemented and scientific understanding advances, the California Ocean Protection Council (OPC), alongside state agency partners, will evaluate the findings and lessons-learned to provide additional recommendations to the California Legislature by December 2025 – to ultimately ensure that California's management of microplastics is informed by the best available science to curtail this complex and pervasive pollutant.

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ACRONYMS

CalRecycle	California Department of Resources Recycling and Recovery
CCC	California Coastal Commission
CDFW	California Department of Fish and Wildlife
CTCP/CDPH	California Tobacco Control Program: Department of Public Health
DGS	California Department of General Services
DOE	California Department of Education
DTSC	California Department of Toxic Substances Control
EPR	Extended Producer Responsibility
FGC	California Fish and Game Commission
LCP	Local Coastal Program
LID	Low Impact Development
mm	millimeter
nm	nanometer
NOAA	National Oceanic and Atmospheric Administration
OEHHA	California Office of Environmental Health Hazard Assessment
OPC	California Ocean Protection Council
OPC SAT	California Ocean Protection Council, Science Advisory Team
PPSC	Plastic Pollution Steering Committee
RWQCB	Regional Water Quality Control Board.
SPD	California State Parks Department
SFEI	San Francisco Estuary Institute
SLC	California State Lands Commission
SWRCB	California State Water Resources Control Board
SCCWRP	Southern California Coastal Water Research Project Authority
TMDL	Total Maximum Daily Load

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1. BACKGROUND

Plastics are ubiquitous in both Californians' daily lives and in the environment. Worldwide, an estimated 11 million metric tons of plastic enter the ocean each year, and without any intervention, this amount is anticipated to triple by 2040.[1] Plastics are the recognized globally as the most harmful and persistent fraction of marine litter, accounting for at least 85 percent of total marine waste.[2] Over time, plastics break down in aquatic environments into pieces of ever-decreasing size, with those less than 5 mm in size known as microplastics.

Microplastics fall into two general categories: primary microplastics manufactured at a small size (e.g., preproduction plastic pellets used in manufacturing or microbeads in personal care products) or secondary microplastics that result from the breakdown of larger plastics. Microplastics have a range of polymer types, sizes, shapes, and associated chemicals, with irregular shapes and fibers found increasingly in marine organisms, including mammals, fish, mollusks, and crustacea.[3] In toxicity studies, microplastic exposures have been shown to cause adverse effects, including tissue inflammation, impaired growth, developmental anomalies, and reproductive difficulties.[4]

Microplastics Definition.

In this Strategy, microplastics are defined as "solid polymeric materials to which chemical additives or other substances may have been added" and which have "at least three dimensions that range from 1 nm to 5 mm in size" consistent with the definition adopted by the State Water Resources Control Board in 2020. Polymers that are derived in nature that have not been chemically modified (other than by hydrolysis) are excluded. Further, plastic particles larger than 5 mm in size are considered macroplastics.

In California, microplastics have increasingly been observed in Monterey Bay, San Francisco Bay, the Greater Farallones National Marine Sanctuary, Lake Tahoe, and in Southern California waterways, including preproduction plastic pellets ('nurdles') that spill from manufacturing facilities and reach California's beaches.

Microplastics are not only a marine pollution problem. Microplastics have been found nearly everywhere scientists have investigated, from pristine mountain streams to agricultural soil, and within human placenta, stool samples, and lung tissue.[5]

In 2018, in response to rising concerns over the potential impacts of microplastics to ocean and human health in California, the California Legislature adopted Senate Bill 1263, calling for the

[1] Lebreton & Andrady, 2020; Lau et al., 2020.
[2] United Nations Environment Programme, 2021.
[3] Barrows et al., 2018; Bucci et al., 2020; Sequeira et al., 2020.
[4] Gall & Thompson, 2015; Ziajahromi et al., 2017; Wilcox et al., 2018; Jacob et al., 2020.
[5] Amato-Lourenço et al., 2021; Ragusa et al., 2021; Schwabl et al., 2019; Rahman et al., 2021.

development of the Statewide Microplastics Strategy. This Strategy, developed by the California Ocean Protection Council (OPC) in coordination with state agency and external partners, provides a comprehensive and coordinated approach to identify early actions California can take to address microplastic pollution and advance existing microplastic research.

The recommended actions outlined in the Statewide Microplastics Strategy are organized into two basic categories: management actions that California can begin immediately implementing (**Chapter 2A**), and research priorities to inform future actions (**Chapter 2B**). The organizing framework and support infrastructure that California will employ to coordinate and guide this work are described in the final chapter (**Chapter 3**). Finally, this Strategy provides the recommended actions provided in Chapters 2A (Solutions) & 2B (Science), state partners that are be best suited to advance specific actions, and a timeline to implement these actions within the **Appendices**.

California has already taken action to curb plastic pollution and to invest in foundational research to identify the major sources and pathways of microplastics and how this ubiquitous contamination harms both humans and aquatic life. California is poised to take a global leadership role in developing the next era of science-informed solutions to manage microplastic pollution. With a diverse array of management agencies, municipalities, academics, nongovernmental organizations, and industry trade organizations combating microplastics, this cohesive, comprehensive strategy provides a common vision and framework for these parties to work together to optimally and expeditiously advance microplastics science and management in California.

Senate Bill 1263 (Portantino, 2018)

The California Legislature directed the Ocean Protection Council, in close coordination with state agency partners, to develop the Statewide Microplastics Strategy, recognizing:

- Although substantial scientific research on microplastics exists, further research will complement and support continuing efforts to reduce microplastic pollution.
- Early actions to prevent and reduce known impacts of microplastics to the marine environment should be pursued.
- The need for a comprehensive prioritized research plan, including the development of risk assessments for microplastics in California.

Senate Bill 1263 requires the Ocean Protection Council to submit the Statewide Microplastics Strategy to the Legislature on or before December 31, 2021 and to report on the implementation of the Statewide Microplastics Strategy, the Council's findings, and recommendations to the Legislature on or before December 31, 2025.

Pub. Resources Code section 35635.

Completed Studies Informing the Statewide Microplastics Strategy

California is an emerging leader in microplastic research. Since the adoption of Senate Bill 1263 in 2018, the OPC has collaborated with partner agencies and research institutions to enhance the scientific foundation for effective, informed management of microplastics. This body of work, coupled with global microplastics research, provides the foundational knowledge necessary for California to implement this Strategy.

- Assessing the Risk of Microplastic Pollution in California. The OPC Science Advisory Team (OPC SAT) formed an interdisciplinary microplastics working group, convened by the Ocean Science Trust, that recommended precautionary management of microplastic pollution and emphasized upstream source reduction as the most effective response. The working group specifically identified high-priority and prevalent components of microplastic pollution (microfibers and road wear particles as dominant sources; stormwater runoff (urban, agricultural), aerial deposition, and wastewater as primary fate & transport pathways), priority endpoints, and recommended a particulate management approach to prevent the proliferation and risk of small particulates in the environment.

- Microplastic Risk Quantification Framework. The State Water Resources Control Board (SWRCB) and Southern California Coastal Water Research Project Authority (SCCWRP) subsequently convened an expert workshop to identity critical thresholds at which biological effects become pronounced. The workshop focused on prioritizing microplastic characteristics (size, shape, polymer) of greatest biological concern, and developed an initial, tentative set of thresholds for aquatic life.

- Understanding Microplastic Levels, Pathways, and Transport in the San Francisco Bay Region. The San Francisco Estuary Institute (SFEI) conducted a comprehensive monitoring study of microplastic contamination in the San Francisco Bay area, which found stormwater was the primary pathway for microplastics to enter receiving waters, with tire wear particles and fibers potentially from textiles and cigarettes important sources of microplastics. SFEI made major field monitoring method improvements addressing stormwater and receiving water sampling methods, as well as recommendations for future microplastic monitoring study designs.

- A Synthesis of Microplastic Sources and Pathways in Urban Runoff. SFEI developed conceptual models to inform source-specific management strategies for the most common particles in urban runoff – tires, textile and cigarette fibers, and fragments of single-use plastic foodware.

- Standardization of Microplastic Measurement Methods. SCCWRP conducted an international study to evaluate and standardize potential microplastic measurement methods. The State Water Resources Control Board used outcomes from that effort to develop a proposed standard method for measuring drinking water microplastics and laboratory accreditation procedures associated with the method, which will be the first of its kind worldwide. California can leverage outcomes from the SCCWRP study and SFEI's recommendations to develop standardized methods for measuring microplastics in ocean water, sediments and fish tissue, which will form the foundation of a statewide monitoring program.

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2. TWO-TRACK APPROACH

This Strategy takes a two-track approach to addressing microplastic pollution in California: (1) pursue solutions the state can take now while the scientific knowledge of microplastics further develops (**Chapter 2A**: **Solutions**); and (2) continue to invest in and advance scientific knowledge of microplastics to inform and refine future solutions (**Chapter 2B**: **Science**). These two paths, taken together, reinforce and enhance each other. Immediate actions allow the state to move with the urgency this moment calls for, while future solutions are made possible only by advancing scientific knowledge. Jointly, this two-track approach empowers California to address microplastic pollution and reduce particulate loading of microplastics in a comprehensive manner.

Two-Track Approach:

Solutions (Chapter 2A): pursue solutions the state will act upon now while the scientific knowledge of microplastics specific to California further develops.

Science to Inform Future Action (Chapter 2B): invest in and advance scientific knowledge of microplastics to develop and refine future solutions.

Underlying this Strategy is a recognition that California must take decisive, precautionary actions now. This Strategy specifically recognizes that once microplastics have entered the environment, it is difficult, if not impossible, to remove microplastics and action is needed to prevent microplastics from entering the environment in the first place. An OPC Science Advisory Team (OPC SAT) working group, convened by the California Ocean Science Trust, urged the state to take a precautionary approach to microplastics management in California – that is, to immediately curb the introduction of microplastics into the environment, as microplastics research continues to advance (See **Completed Studies** on page 7). To that end, the Strategy calls on California to take a series of immediate, 'no regrets' actions that will reduce microplastics as well as provide multiple environmental and societal benefits.

The OPC worked with state agency partners to identify actionable priorities and solutions to prevent the proliferation of microplastics in the environment. These solutions are grouped into two broad categories – pollution prevention and pathway interventions – both aimed at reducing plastic waste that fragments into microplastics and preventing microplastics from mobilizing into California waters. Specific actions and recommended policy solutions are outlined in **Chapter 2A**.

This Strategy calls on California to simultaneously make strategic investments in scientific research to inform future management actions. The research priorities outlined in this Strategy will fill key knowledge gaps, thereby expanding the range of management solutions California can pursue in the future. Research priorities include the development of a statewide monitoring network, adaptation and implementation of the risk assessment framework as new data are

collected, and the use of monitoring data and risk thresholds to prioritize new microplastic management actions. These research priorities are outlined in further detail in **Chapter 2B**.

Through this Strategy, multiple state agencies and other partners across California will collaborate and coordinate to combat the introduction and spread of microplastics in the coastal ocean and other aquatic systems. Actions and investments will be prioritized based on the likelihood that they will lead to significant, rapid, sustained reductions to microplastics levels and the environmental threat they pose.

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The National Academies of Sciences, Engineering, and Medicine recently released a national report to Congress, on behalf of the National Oceanic and Atmospheric Administration (NOAA) in December 2021 highlighting the massive scale of the global plastics challenge impacting the ocean. The report concludes plastic waste in the United States is ubiquitous and increasing, with the United States having generated more plastic waste as of 2016 than any other country, exceeding that of all European Union member states combined. Recognizing no single solution will be sufficient to address the pervasive problem of plastic pollution, the report recommended a national strategy be created by the end of 2022 to employ a suite of interventions at every stage of plastics' flow into the ocean. The report also recommends the United States establish a nationally coordinated and expanded monitoring system to track plastic pollution in order to better understand the scale and sources of the United States plastic waste problem, set reduction and management priorities, and measure progress.

The national report specifically outlines six intervention strategies the United States should pursue: (1) reducing plastic production (with an emphasis on plastics that are not reusable or readily recyclable); (2) innovating design and materials to develop substitutes; (3) decreasing waste generation (including bans on specific products based on toxicity or necessity); (4) improving waste management (such as establishing regulatory limits for plastic or microplastic waste discharges into the ocean); (5) capturing waste in the environment (including ground litter and stormwater); and (6) minimizing at-sea disposal.

***Figure 1**. Conceptual diagram of plastic waste interventions. National Academies of Sciences, Engineering, and Medicine (2021).*

Not only does California's Statewide Microplastics Strategy embed these intervention recommendations within the two-track approach, but this Strategy also provides a framework to implement and advance the comprehensive recommendations of the national report. With a commitment to dramatically curb plastic pollution, especially single-use plastic waste reduction, and to advancing microplastic science, California is positioned to inform and integrate microplastics science in federal plastic pollution monitoring and management.

2A. SOLUTIONS

The diverse sources and pathways from which microplastics enter the environment requires a comprehensive and systemic approach to prevent and manage microplastic pollution. Microplastics are extremely challenging, if not impossible, to effectively remove once in the aquatic environment. This Strategy therefore focuses on solutions to prevent microplastics from entering the marine environment in the first place. These solutions are grouped into three broad categories:

- **Pollution prevention** to eliminate plastic waste at the source, defined as the product, material, or industry from which microplastics originate. Strategies to achieve pollution prevention can include the elimination of specific products and materials through financial incentives to encourage product innovation and waste reduction; identifying alternate product actions, including alternate sourcing and design; and, where necessary, product bans.
- **Pathway intervention** to intervene within specific pathways, such as stormwater or wastewater, that mobilize microplastics from a specific source into California waters. Pathway interventions should be pursued simultaneously and in addition to, not as substitutes for, pollution prevention actions that directly reduce plastic production and use.
- **Education** to raise awareness of microplastic pollution, and facilitate behavior, policy, systemic, and environmental change. Education campaigns and K-12 curriculum changes should be pursued as a targeted, strategic complement to other solutions that directly prevent and reduce plastic production, use, and waste.

Each of the recommended actions in this chapter address microplastic pollution in California as multi-benefit, 'no regrets' actions. 'No regrets' actions are identified based on a combination of factors, including feasibility, evidence to support those actions, and the overall benefit to our society and environment. These recommended actions are further consistent with the California Ocean Litter Prevention Strategy and build upon the Top 10 Recommendations to Address Plastic Pollution in California's Coastal and Marine Ecosystems, adopted by the OPC in February 2021. The philosophy and rationale behind these recommended actions are described in the sections that follow, while the individual recommended actions are presented as a single list at the end of this chapter (see **Solutions**: **Recommended Actions** on pages 18 - 19). The recommended actions can be undertaken immediately, as scientific research advances are simultaneously pursued.

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Pollution Prevention

Managing and preventing plastic pollution provides an important opportunity to prevent the proliferation of microplastics that fragment from larger plastics.[6] Microplastics are pervasive and persistent in the environment, with microplastics in the ocean anticipated to increase by almost 300% by 2030.[7] In the Southern California Bight alone, the majority of observed trash from 2013 to 2018 was comprised of plastic, with trash pervasive within watersheds and on the seafloor, according to Southern California Bight Regional Monitoring Program findings.

The OPC SAT working group, consistent with findings by national and international experts, has recommended source reduction of plastics as one of most effective precautionary strategies to reduce and prevent microplastics pollution, given the lack of feasible microplastics cleanup strategies, persistence of microplastics that enter the environment, and the need to prevent the internalization of microplastics by marine organisms. This Strategy outlines three approaches to prevent microplastic pollution: (1) product and material bans, (2) financial incentives, and (3) identification of alternate product actions.

> *"The United States should substantially reduce solid waste generation (absolute and per person) to reduce plastic waste in the environment and the environmental, economic, aesthetic, and health coasts of managing waste and litter."*
>
> *National Academies, Reckoning with the U.S. Role in Global Ocean Plastic Waste* (2021)

Product & Material Bans. Disincentivizing the production, sale, and use of plastic materials provides an opportunity to prevent the proliferation of microplastics in the environment. California already has moved aggressively on this front, passing a series of product and material bans and other laws aimed at reducing plastic waste (see box: Examples of Existing California Plastic Waste Reduction Laws). This Strategy calls on California to pursue multiple additional product and material bans to further curb the generation of plastic waste, advancing recommendations of the California Ocean Litter Prevention Strategy and Top 10 Recommendations to Address Plastic Pollution in California's Coastal and Marine Ecosystems.

As one example, a statewide prohibition of expanded polystyrene in foodware and packaging can prevent the persistence of expanded polystyrene in the environment, as it easily breaks apart, is easily transported by air, mixes with coastal sand and sediment, and is often unable to be recycled due to food contamination.[8] Additionally, prohibiting cigarette filters and tobacco plastic products that contribute to microplastic pollution can reduce presence of cellulose

[6] Kershaw & Rochman, 2016.
[7] Borelle et al., 2020.
[8] Sutton et al., 2019.

acetate fibers and other microplastics from tobacco products in the aquatic environment.[9] The recommendations in this Strategy further prioritize reusable products, rather than recyclable or compostable products due to lack of appropriate infrastructure and risk of contamination caused by the improper disposal of these products in the waste stream.

Examples of Existing California Plastic Waste Reduction Laws

- **Microplastic Bead Ban**. Chapter 594 of 2015 (AB 888, Bloom) prohibits the sale of personal care products with plastic microbeads.
- **Single-Use Plastic Bag Ban**. Chapter 850 of 2014 (SB 270, Padilla) and Proposition 67 (2016) established a statewide single-use carryout bag ban, requiring a fee for paper and reusable bag in grocery stores, food marts, liquor stores, and retail stores with a pharmacy.
- **State Foodware Requirements**. Chapter 610 of 2018 (SB 1335, Allen) requires a food service facility located in a state-owned facility, operating on state-owned property, or otherwise contracted by the state to use reusable, recyclable, or compostable food service packaging.
- **Single-Use Plastic Straws Upon Request.** Chapter 576 of 2018 (AB 1884, Calderon) requires full- service restaurants to only provide single-use plastic straws upon request of the customer.
- **Single-Use Foodware Upon Request**. Chapter 505 of 2021 (AB 1276, Carrillo) expands the plastic straws upon request law to other single-use foodware items, such as utensils, straws, and condiments, requiring that these items only be provided upon request of the customer.
- **Local Ordinances.** The Berkeley Single-Use Foodware and Litter Reduction Ordinance, enacted in 2019, is designed to reduce single-use foodware, including cups, lids, straws, and other disposable items that contribute to street litter, marine pollution, and waste sent to landfills. Similar ordinances have been initiated in San Diego, Santa Monica, and other cities throughout California.

Implementing Pollution Prevention Strategies:
Reusable California Policy Playbook

The Reusable California Policy Playbook is an OPC-funded project by UPSTREAM, launched in November 2021 as part of a toolkit and resource hub to inform and help local governments, policymakers, and businesses develop foodware ordinances to reduce single-use plastics and achieve reuse goals in food service operations. Elements included in the Playbook are:

- Policy tools & key provisions
- Sample model policies and language (where available)
- Real-world examples to guide implementation

The guidance provided in the Reusable California Policy Playbook and resource hub can help local governments pursue more comprehensive reuse and reduction strategies – rather than continuing to address single-use plastics on an item-by-item basis.

[9] Miller et al., 2019; Sutton et al., 2019; Wright et al., 2015; Sutton et al., 2019; Belzagui et al., 2021.

Financial Incentives. Financial incentives and programs, by both state and federal partners, can drive innovation in product design and materials, incentivize consumer habits, and improve the overall life-cycle management of products that contribute to microplastic pollution. Financial incentives may include the use of taxes, subsidies, consumer incentives, or extended producer responsibility to drive innovation and improve management. This Strategy calls on California to develop and employ specific programs, such as extended producer responsibility (EPR), to promote principles for a circular economy, assign producers responsibility for the end-life of specific products, and provide an incentive for plastic producers to prevent or reduce plastic use and waste. Financial incentives can target specific consumer products, such as fibers from textiles, to reduce microplastic pollution caused by textile shedding by reducing the mobilization of synthetic fibers through aerial transport and by preventing microplastics from entering wastewater treatment plants.[10]

Identifying Alternative Product Actions. Prevention strategies require diverse stakeholders and specific industries to identify alternative products and pilot plastic waste reduction solutions. This Strategy calls for advancements in technological innovation to identify alternative products, sourcing, design, and plastic reduction strategies that may be voluntarily taken by targeted industries – and influence domestic and global markets with alternative products, design, or materials.

Targeted workshops to identify alternate product sources and design, and to facilitate the use of these alternatives can elevate and advance California's plastic reduction and microplastic reduction goals. Priority industries and products to investigate and reduce microplastic contributions to the marine environment include: (1) vehicle tires, (2) textiles, (3) foodware, (4) agriculture, and (5) fisheries & aquaculture.[11] Alternative materials and design of pre-production plastics, granules of plastic less than 5 mm in size known as 'nurdles,' should also be explored. Alternative product considerations include life cycle assessments that incorporate climate, social, and food security impacts, and chemical additive safety to avoid regrettable substitutes, in addition to recommendations and immediate actions to enact plastic pollution prevention strategies.

Pathway Interventions

This Strategy calls on California to prioritize management solutions that intercept macro and microplastic pollution before it reaches the marine environment. Trash and marine debris, which largely comprise of plastic, have become a policy focus throughout California, with several policies and management actions implemented to reduce the amount of trash that reach state waters. These existing policies include local bans of specific items that contribute to plastic

[10] De Falco et al., 2019.
[11] Verschoor et al., 2016; Boucher & Friot, 2017; Parker et al., 2020; Brander et al., 2021; Tian et al., 2021.

pollution, establishing Total Maximum Daily Loads (TMDLs) in specific watersheds, and implementation of Statewide Trash Amendments and the California Ocean Litter Prevention Strategy to mitigate plastic trash and debris.

Pathway intervention solutions are important to pursue simultaneously with pollution prevention solutions to intervene with the transport of pollutants into the environment. As research advances to identify the full range of pathways by which microplastics enter the environment, California should pursue immediate, recommended actions that have multiple benefits for water quality and the overall management of California's water system.

Stormwater. In many California urban areas, rainfall washes particles into stormwater collection systems that discharge directly to receiving waters, such as California's rivers, estuaries, and ocean.[12] Comprehensive studies of microplastics in California urban runoff outside of the San Francisco Bay area have not been conducted, although the relatively high microplastic concentrations measured in San Francisco Bay stormwater are generally consistent with limited observations of microplastics in stormwater in international locations.[13] The importance and prevalence of microplastics in urban stormwater runoff observed in the San Francisco Bay should be confirmed as a predominant source in other urban areas in the state; however, existing studies demonstrate improved stormwater management as a viable and available management strategy to manage the flow of microplastic pollution from municipalities into the marine environment.

Low impact development (LID), such as bioretention rain gardens, infiltration trenches, and additional types of green infrastructure, offer opportunities to capture both macro- and microplastics and provide additional pollution reduction benefits, stormwater capture and, augmentation of groundwater. California additionally has existing requirements to prevent the discharge of preproduction plastics ('nurdles') and to manage trash larger than 5 mm that mobilizes in stormwater runoff through the statewide Trash Provisions adopted by the State Water Resources Control Board in 2015. The Trash Provisions further established a water quality objective of zero trash in state waters by 2030. Timely implementation of the Trash Provisions and achievement of this implementation deadline is a priority to reduce the amount of plastic that enters California rivers, lakes and ocean, prevent impacts to aquatic life and public health, and prevent the fragmentation of plastic into microplastics.

Wastewater. Wastewater is a known pathway of microplastic and microfiber pollution into the aquatic environment, both directly through wastewater effluent and as indirect discharge through the land application of biosolids. Available data indicate that microplastic concentrations and loads from wastewater are significantly smaller than those in urban runoff in San Francisco Bay, however comparison data for other locations in California are absent.[14]

[12] Moore et al., 2011.
[13] Moran, K. et al., 2021.
[14] Id.; Zhu et al., 2019.

Additional research is needed, however, to determine the consistency of these findings in other California regions. OPC initiated a study in 2020 to assess the efficacy of microplastic removal in California wastewater treatment plants, with anticipated completion by the end of 2022. Numerous studies demonstrate that wastewater treatment plants with only primary and secondary treatment levels release higher concentrations of microplastics than wastewater treatment plants with tertiary or advanced levels of treatment, which release negligible levels of microplastics.[15]

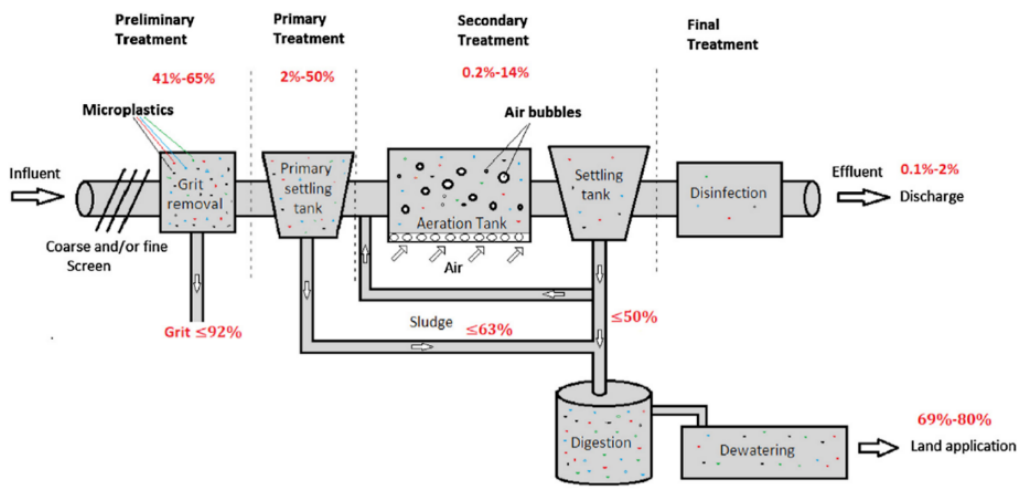

***Figure 1**. Representation of microplastic removal at various treatment stages within a wastewater treatment plant. (Sun et al., 2019).*

While tertiary and advanced treatment have demonstrated efficacy in preventing microplastic pollution from entering receiving waters, microplastics may be applied to land and impact soils through the biosolid byproduct of wastewater treatment plants.[16] Preventing microplastics from entering wastewater treatment systems reduces the risk of direct or indirect discharges of microplastics.[17]

Aerial Transport. Atmospheric transport drives the widespread distribution of microplastics in the global environment, particularly in remote regions.[18] Microplastics have been found to transport from distances of up to 95 km away,[19] with approximately 34 percent of emitted tire wear particles worldwide are estimated to be transported through the air before being deposited in

[15] Hou et al., 2021.
[16] Liu et al., 2020; Koutnik et al., 2021; Food and Agriculture Organization of the United Nations, 2021.
[17] Fendall et al., 2009.
[18] Zhang et al., 2019; Hernández-Arenas et al., 2021.
[19] Allen et al., 2019.

the ocean.[20] Deposition of aerial microplastics, such as those from tires, are a significant source of microplastics in urban stormwater in San Francisco Bay. Aerial transport is a potentially significant pathway of microplastics,[21] and further research is needed to understand the full implications of the transport, deposition, and exposure to both human and marine health is from microplastics in air.

Dryers are further identified as a potentially significant source of textile fiber emissions in outdoor air.[22] Improving lint capture technology on dryers provides an opportunity to intervene with microparticles and microfibers and prevent these particles from becoming airborne. Moving toward the capture of microfibers from dryers and encouraging use of alternatives such as hanging textiles to dry can abate one source of microplastic pollution, while research is pursued to advance understanding of emissions from this pathway (see **Chapter 2B**: **Science**).

Education

Coordinated education campaigns are an important and overarching component of the Statewide Microplastic Strategy to raise awareness about microplastic pollution and facilitate behavior, policy, systemic, and environmental change.

Raising public awareness of microplastic pollution complements the other solutions presented in the Strategy. Education campaigns can reduce desirability, accessibility, and acceptability of plastic products, increase consumer demand for plastic alternatives or reuse, and improve understanding of microplastic impacts on human and environmental health. This Strategy calls on California to develop and advance a strategic public awareness campaign that educates the public to recognize and understand the sources, impacts, and available solutions to reduce macro and microplastic pollution, and ultimately builds awareness and support of the actions outlined in the Statewide Microplastic Strategy. Campaigns may include but are not limited to working with the California Air Resources Board to elevate public awareness of the tire wear pollution benefits associated with vehicle miles traveled reduction; and working with the California Tobacco Control Program, Department of Public Health to develop messaging on toxic tobacco waste and strategies for reducing tobacco plastic waste in the environment. In addition, the OPC will work with CalRecycle in its capacity as lead of the California Education and the Environment Initiative and the Department of Education to update pertinent environmental principles and concepts, standards, teacher training efforts, and/or curricula to educate K-12 students.

[20] Evangeliou et al., 2020.
[21] Dris et al., 2016.
[22] Kapp K. J. & Miller, R. Z., 2020.

SOLUTIONS: RECOMMENDED ACTIONS

Each of the recommended actions presented below address microplastic pollution in California as multi-benefit, 'no regrets' actions.

Pollution Prevention

Product & Material Bans

- Implement the statewide requirement that single-use foodware and condiments be provided only upon request, consistent with Assembly Bill 1276 (Carrillo, 2021). (2022)
- Encourage state purchasing and service contracts to require reusable foodware whenever feasible and reduce the state's reliance on single-use foodware. (2022)
- Prohibit expanded polystyrene foodware and packaging. (2023)
- Expand the statewide microbead ban enacted by Assembly Bill 888 (Bloom, 2015) to include microplastics that are intentionally added to consumer products, such as cosmetics, household and industrial detergents, and cleaning products. (2023)
- Prohibit the sale of single-use tobacco products, that demonstrably contribute to tobacco product plastic pollution, including but not limited to cigarette filters, electronic cigarettes plastic cigar tips, and unrecyclable tobacco product packaging. (2022)

Financial Incentives

- Identify Extended Producer Responsibility (EPR) strategies for recycling or disposal of plastic packaging and foodware. (2022)
- Develop and implement a program to incentivize, or otherwise require, the sale and use of ENERGY STAR condenser dryers through rebates and other mechanisms. (2024)
- Develop and implement a program to incentivize, or otherwise require, the sale and use of washing machine filters with a screen size of 100 microns or smaller through rebates and other mechanisms. (2024)

Identifying Alternative Product Actions

- Convene experts from targeted industries (e.g., vehicle tires, textiles, agriculture, foodware, and/or fisheries & aquaculture) and scientific experts to identify alternative products and other sector-specific plastic pollution prevention strategies. (2023)

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Pathway Interventions

Stormwater

- Evaluate efficacy of microplastic removal in LID structural Best Management Practices and identify sites where LID implementation should be required based on environmental characteristics and available co-benefits. (2023)
- Include LID requirements for new and redevelopment projects in municipal, industrial, construction, and highway water quality permits and in Local Coastal Programs (LCPs) and coastal development permits for new and redevelopment projects that may contribute to microplastic loading in receiving waters. (2024)
- Prioritize LID retrofit projects for existing development that generate or have the potential to generate large microplastic loading in receiving waters. (2023)
- Prioritize compliance assurance for preproduction plastic pellets ('nurdles') discharge prohibitions consistent with the Trash Provisions and local Trash TMDLs. (2022)
- Implement the statewide Trash Provisions and final compliance deadline of zero trash in state surface waters by 2030.

Wastewater

- Based on the results of previous studies regarding microplastic removal efficacy in wastewater treatment plants, further promote recycling of tertiary-treated wastewater that would otherwise be discharged to the ocean. (2022)
- Based on the results of previous studies and the following completion of the ongoing SCCWRP study on wastewater treatment plant process removal efficacy, further develop microplastics reduction strategies and monitoring recommendations based on each level of treatment, including primary, secondary, tertiary, and advanced treatment. (2023)
- Develop and implement a program to incentivize, or otherwise require, the purchase and use of washing machine filters through rebates and other mechanisms. (See Pollution Prevention: Financial Incentive solutions)
- Expand the microbead ban to include microplastics that are intentionally added to consumer products, such as cosmetics, household and industrial detergents, cleaning products, and paints. (See Pollution Prevention: Product and Material Ban solutions)

Pathway: Aerial Transport

- Develop and implement a program to incentivize, or otherwise require, the sale and use of ENERGY STAR condenser dryers through rebates and other mechanisms. (See Pollution Prevention: Financial Incentive solutions)

Education

- Develop a public awareness campaign to raise awareness of microplastic pollution, and facilitate behavior, policy, systemic, and environmental change. (2023)
- Update pertinent principles, concept, standards, teacher training efforts, and/or curricula to educate K-12 students of microplastic sources, impacts, and solutions. (2024)
- Promote industry engagement and outreach to advance sector-specific microplastic pollution prevention strategies. (2024)

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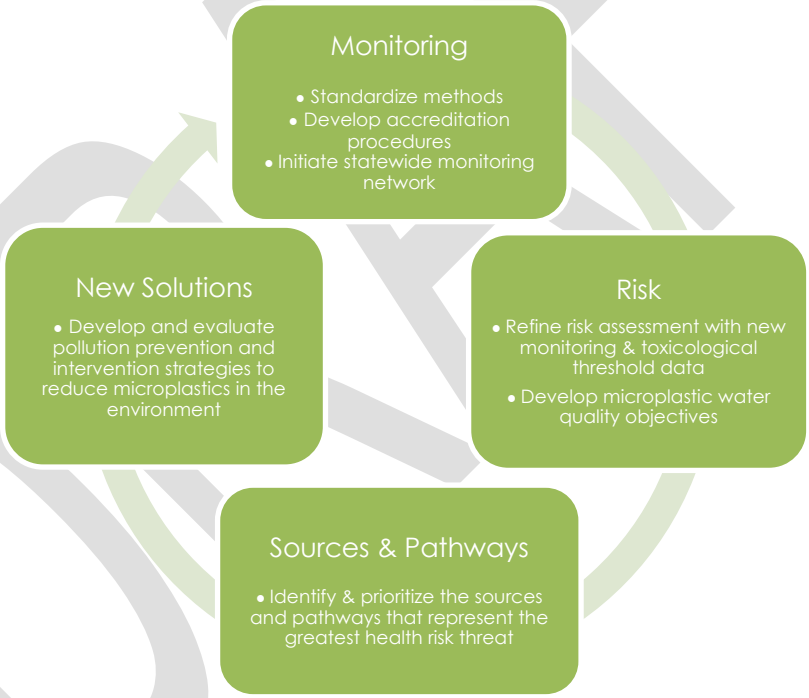
2B. SCIENCE TO INFORM FUTURE ACTION

This Strategy builds from recent advancements in microplastic science and details an overarching research strategy to advance proposed solutions (**Chapter 2A**) and shape the next generation of management solutions. The research priorities outlined in this chapter call for coordinated, simultaneous investments across four main areas: (1) Collect data on levels of microplastic contamination across the state (**Monitoring**); (2) Improve understanding of critical thresholds at which aquatic life and humans are adversely impacted by various microplastic exposures (**Risk**); (3) Identify and prioritize future management solutions based on the predominant ways; that microplastics enter California's marine ecosystems (**Sources and Pathways Prioritization**); and (4) Develop and evaluate new mitigation strategies (**Evaluating New Solutions**). The philosophy and rationale behind each of these investment areas are described in greater detail below; specific recommended research investments are summarized as a list at the end of this section (see **Science to Inform Future Action: Research Priorities** on page 25).



Monitoring

Effective management of microplastics begins with understanding the extent of microplastic pollution within the state. California has the opportunity to build from existing monitoring studies, including methods developed by SFEI to collect and identify microplastics from a variety of

environments, comprised of surface waters, sediments, stormwater runoff and treated wastewater effluent. SCCWRP has additionally conducted large-scale laboratory intercalibration studies that developed and quantified the effectiveness of laboratory measurement methods for processing water, sediment, and tissue samples. Priority research to advance microplastic monitoring include: (1) transitioning the foundational work performed by SFEI and SCCWRP into standardized methods; (2) developing laboratory accreditation procedures to ensure standardized monitoring methods are employed properly and to confirm that data submitted are of acceptable quality and comparable; and (3) creating a statewide monitoring network with willing partners to design, implement, and sustain long-term operations of the network.

Monitoring provides crucial information regarding how much and what types of microplastic (e.g., particle sizes, morphologies, polymer types) are in California waters, and provides the foundation for tracking future changes in response to management action. Monitoring information also provides context for exposure in various environmental matrices (e.g., water, air, sediment, biological tissue) and habitats (e.g., marine, estuary, freshwater), to directly inform which areas are most contaminated and which organisms and biological communities may be at greatest risk from microplastics.

California has several existing monitoring programs that may incorporate microplastic sampling, including the Surface Water Ambient Monitoring Program (SWAMP), the San Francisco Bay Regional Monitoring Program, and Southern California Bight Regional Monitoring Program. These programs, alongside potential microplastic monitoring requirements in permits, will be leveraged to form the foundation of a statewide monitoring network. The California Water Quality Monitoring Council is well positioned to engage these programs, as well as other willing partners, to develop an integrated monitoring network, develop a proposed monitoring plan, and determine the most appropriate means for collating and sharing data from the monitoring network. Additional data may be obtained by requiring microplastic monitoring of wastewater treatment plants following the completion of existing studies on the microplastics removal efficacy in various stages of wastewater treatment. The State and Regional Water Boards may additionally require microplastic monitoring in municipal stormwater permits, and monitoring efforts to measure microplastics in agricultural runoff.

Risk

Microplastics are ubiquitous in the California ocean, and determining the urgency for implementing specific management action requires a risk assessment to quantify the number and type of biota that are affected now, and are likely to be affected in the future, under different management scenarios. Senate Bill 1263 called for development of such a risk assessment, which was initiated through the OPC SAT working group and completed in Spring 2021 (See **Completed Studies** on page 7). The State Water Resources Control Board (SWRCB) and SCCWRP subsequently expanded on this through an expert workshop to identify critical

thresholds at which biological effects from microplastics exposure become pronounced. The expert workshop developed a framework for assessing risks of microplastics with confidence in its ability to assess risks based on available studies. Data availability to assess risk is increasing rapidly, which will only strengthen risk assessment outcomes in the future.

Using updated and strengthened thresholds to quantify both existing and future risks from microplastics exposure, including whether risks would change under a range of management scenarios (e.g., pathway interventions, source control, and/or no action), will help California identify the habitats and/or communities that may be most affected by plastic pollution, and provide insight as to which management actions are most needed to reduce microplastic exposure. Low-income and disadvantaged communities may be at greater risk from microplastic pollution due to disproportionate community exposure from a variety of possible pathways, such as consumption of food in plastic packaging, residential, or occupational exposures. Advancing and conducting risk assessments can evaluate the potential socioeconomic factors that magnify the risk of microplastic exposure.

California can support comprehensive risk assessments and inform future regulatory action by: (1) identifying ambient exposure concentrations generated through the statewide monitoring program; (2) applying risk thresholds; and (3) updating the risk assessment framework developed by the OPC SAT and SWRCB/SCCWRP microplastics working groups by incorporating new ambient concentration data and toxic effects data as they become available, and quantifying risk based on these new values.

Investing in and prioritizing additional research that advances the foundational advancements and recommendations made by the OPC SAT working group, SWRCB/SCCWRP and others will provide California with information needed to guide future management decisions. Advancing the research priorities of this Strategy will provide actionable risk thresholds and identify future source control actions needed to inform a water quality objective and program of implementation, to inform a key regulatory mechanism for controlling the prevalence of microplastics in California waters, and to ensure protection of aquatic life exposed to microplastics.

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Microplastic Water Quality Objectives

California's water quality regulatory framework relies on water quality objectives to protect and maintain beneficial uses of California waters and the health of aquatic ecosystems. Developing a water quality objective for microplastics will provide a key regulatory mechanism to monitor and control the prevalence of microplastics in California waters and in the organisms that ingest or otherwise are exposed to microplastics. Water quality objectives are an important precursor to many potential management actions and provide a target level for management action. Failure to achieve the objective can lead to listing of a water body as impaired under Section 303(d) of the Clean Water Act and adoption of Total Maximum Daily Load allocations (TMDLs).

In the absence of water quality objectives for microplastics, California has implemented preliminary regulations to control plastics and microplastics, including requirements to manage preproduction plastics (small, granular plastic less than 5 mm in size known as 'nurdles') and trash larger than 5 mm through the Trash Provisions adopted by the State Water Resources Control Board in 2015. California, however, will need specific microplastic water quality objectives to propel the development and implementation of future regulatory actions.

Source and Pathways Prioritization

To curb microplastic pollution in aquatic environments, management actions must target and prioritize the predominant sources and pathways by which microplastics accumulate and pose ecological and human health risks. Sources are the original products and manufacturing processes that can trigger the generation and initial release of microplastics; meanwhile, pathways are the transport mechanisms (e.g., runoff, air) through which microplastics reach aquatic environments. SFEI has conducted a comprehensive assessment of microplastics in the San Francisco Bay, finding average concentrations and estimated total annual discharge of microplastics in stormwater are approximately two orders of magnitude higher than those in treated wastewater effluent. This insight has helped focus local management activities on stormwater runoff and other solutions outlined in **Chapter 2A**.

California can build on this foundational work to assess pathways not yet fully studied (e.g., agricultural runoff, air deposition) and confirm the prominence of microplastic transport in stormwater in other regions of the state. Future research priorities may include an assessment of windborne microplastics and the quantification of macro and microplastic contributions from agriculture to the marine environment, including monitoring microplastics in agricultural soils, biosolids, and runoff.

For each pathway, particles should be characterized (according to size, morphology, polymer type) in addition to quantifying the total amount of microplastics present. Additionally, advancing source identification methods can provide insights to inform industry-specific source control measures. Research in California should focus on investigating sources for which viable

management remediation strategies can be readily developed. The OPC SAT microplastics working group has recommended focusing on discharges from tire and road wear, laundry and textiles, tobacco products, and agricultural runoff. The specific sources to be prioritized for investigation will be informed by the working group and other expert opinion. Based on the OPC SAT working group's recommendation, a source emissions inventory should be conducted – once pathways are better understood, and assuming availability of necessary data – to quantify the relative contribution of microplastic loading from all potential sources. A key consideration of this work should include selecting sources that may disproportionately affect marginalized or disadvantaged communities.

Investments in existing research to advance source identification and application of this technology, once proven successful, could allow California to identify and work with individual product manufacturers that are yielding the largest contributions and risk caused by microplastics in the environment.

Evaluating New Solutions

Once the occurrence, risks, priority sources and pathways associated with microplastics have been identified in specific localities in California, targeted solutions to mitigate microplastic contamination can be prioritized and implemented. Feasibility and efficacy studies, and future risk assessments, can inform future management actions as new innovations are identified and developed in California, nationally, and abroad. This Strategy will adapt solutions to new science, as new information and approaches become available, through OPC's facilitation of the feedback loop between plastic pollution reduction and intervention strategies (**Chapter 2A**: **Solutions**) and research (**Chapter 2B**: **Science to Inform Future Action**). To implement these research priorities, evaluate the efficacy of early actions, and inform future solutions, California will collaborate with scientific experts across academic institutions, federal and state agencies, and other organizations.

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SCIENCE TO INFORM FUTURE ACTION
RESEARCH PRIORITIES

Each research priority and action presented below are contingent upon available funding and personnel resources.

Monitoring

- Establish standardized microplastic monitoring methods (sampling and analysis of environmental samples, including marine, river, and estuarine waters, sediment, and fish tissue) with accreditation procedures. (2023)
- Develop a model microplastics monitoring program and establish an ongoing integrated statewide ambient monitoring network to quantify microplastic occurrence and effectiveness of management actions for microplastic pollution. (2024)
- Based on the results of existing studies regarding microplastic removal efficacy in wastewater treatment plants, require microplastic monitoring for California wastewater treatment plant permittees as needed as permits are renewed or revised. (2024)
- Require microplastic monitoring for municipal stormwater permittees as permits are renewed or revised. (2024)
- Implement a pilot monitoring program to evaluate microplastics in agricultural runoff. (2024)

Risk Thresholds & Assessment

- Develop toxicological studies that provide greater certainty of microplastics risk thresholds for marine life and human health, and determine recommended actions when thresholds are exceeded. (2024)
- Update the existing microplastics risk assessment framework and execute risk assessments that incorporate local environmental loads of microplastics and risk thresholds to quantify the risk of microplastics to marine life and human health. (2024)
- Conduct an assessment of microplastic pollution exposure and impacts on environmental justice communities in California to inform and prioritize future solutions. (2024)
- Prioritize the development of microplastic water quality objectives for state ocean waters, estuarine waters, and freshwaters. (2024)
- Identify water body impairments in the California Integrated Report based on best available science, known thresholds, and available data. (2024)

Sources & Pathways Prioritization

- Quantify and characterize relative inputs from the primary pathways (e.g., urban stormwater, agricultural runoff, wastewater, aerial deposition) of microplastics statewide to the ocean. (2023)
- Create a source emissions inventory to quantify the most prevalent California-specific sources (i.e., specific materials and products) contributing microplastics into the environment to inform future regulatory action. (2024)

Evaluating New Solutions

- Based on findings from actions completed under Science to Inform Future Action (**Chapter 2B**), provide additional policy recommendations consistent with subsection (g)(2) of Senate Bill 1263.

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3. IMPLEMENTATION

Implementation of the Statewide Microplastic Strategy requires a comprehensive and coordinated effort between California state agencies, local, and federal partners. Collaboration will help advance this Strategy, as well as other existing initiatives including the California Ocean Litter Prevention Strategy, the OPC Top 10 Actions to Reduce Plastic Pollution in California's Coastal and Marine Ecosystems, NOAA's Marine Debris Program, the proposed development of a national plastic strategy, and/or the development of the proposed United Nations' Treaty on Plastic Pollution.

The OPC will continue to work with designated partners and advance specific recommendations through California's interagency Plastic Pollution Steering Committee (PPSC), which consists of representatives from the OPC, California Tobacco Control Program: Department of Public Health (CTCP/CDPH), California Department of Resources Recycling and Recovery (CalRecycle), California Coastal Commission (CCC), Department of Fish and Wildlife (CDFW), Department of Toxic Substances Control: Safer Consumer Products Program (DTSC), Fish and Game Commission (FGC), Office of Environmental Health Hazard Assessment (OEHHA), State Lands Commission (SLC), and State Water Resources Control Board (SWRCB).

The California Water Quality Monitoring Council, Trash Monitoring Working Group additionally convened a subcommittee in November 2021 composed of scientific experts, local environmental managers, and interested stakeholders to elevate opportunities to advance microplastics monitoring. Continued statewide collaboration through both the Plastic Pollution Steering Committee and California Water Quality Monitoring Council, and convenings of interdisciplinary scientific experts through the OPC SAT, will facilitate information sharing that is needed to advance this Strategy, evaluate management strategies as new information is generated, and provide new recommendations to the California Legislature within four years, consistent with Public Resources Code section 35635, subsection (g)(2) (Senate Bill 1263).

This Strategy provides the recommended actions provided in Chapters 2A (Solutions) & 2B (Science to Inform Future Action), state partners that are be best suited to advance specific actions, and a timeline to implement these actions within the **Appendices**.

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APPENDIX 1

Recommended actions, partners, and timeline to advance **Chapter 2A**: **Solutions**. Each of the recommended actions presented below address microplastic pollution in California as multi-benefit, 'no regrets' actions.

Actions	Timeframe
Pollution Prevention	
Product & Material Bans	
Implement the statewide requirement that single-use foodware and condiments be provided only upon request, consistent with Assembly Bill 1276 (Carrillo, 2021). **Partners: Local Governments**	2022
Encourage state purchasing and service contracts to require reusable foodware whenever feasible and reduce the state's reliance on single-use foodware. **Partner: DGS**	2022
Prohibit the sale of single-use tobacco products, that demonstrably contribute to tobacco product plastic pollution, including but not limited to cigarette filters, electronic cigarettes plastic cigar tips, and unrecyclable tobacco product packaging.	2022
Prohibit expanded polystyrene foodware and packaging.	2023
Expand the statewide microbead ban enacted by Assembly Bill 888 (Bloom, 2015) to include microplastics that are intentionally added to consumer products, such as cosmetics, household and industrial detergents, and cleaning products.	2023
Financial Incentives	
Identify Extended Producer Responsibility (EPR) strategies for recycling or disposal of plastic packaging and foodware.	2022
Develop and implement a program to incentivize, or otherwise require, the sale and use of ENERGY STAR condenser dryers through rebates and other mechanisms	2024
Develop and implement a program to incentivize, or otherwise require, the sale and use of washing machine filters with a screen size of 100 microns or smaller through rebates and other mechanisms.	2024
Identifying Alternative Product Actions	
Convene experts from targeted industries (e.g., vehicle tires, textiles, agriculture, foodware, and/or fisheries & aquaculture) and scientific experts to identify alternative products and other sector-specific plastic pollution prevention strategies.	2023

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Pathway Interventions	
Stormwater	
Prioritize compliance assurance for preproduction plastic pellets ('nurdles') discharge prohibitions consistent with the Trash Provisions and local Trash TMDLs. **Partners: SWRCB, RWQCB**	2022
Prioritize LID retrofit projects for existing development that generate or have the potential to generate large microplastic loading in receiving waters. (2023) **Partners: SWRCB, RWRCB, CCC**	2023
Evaluate efficacy of microplastic removal in LID structural Best Management Practices and identify sites where LID implementation should be required based on environmental characteristics and available co-benefits. **Partners: SWRCB, RWQCB, CCC**	2023
Include LID requirements for new and redevelopment projects in municipal, industrial, construction, and highway water quality permits and in Local Coastal Programs (LCPs) and coastal development permits for new and redevelopment projects that may contribute to microplastic loading in receiving waters. **Partners: SWRCB, RWQCB, CCC**	2024
Implement the statewide Trash Provisions and final compliance deadline of zero trash in state surface waters by 2030. **Partners: SWRCB, RWQCB**	2030
Wastewater	
Based on the results of previous studies regarding microplastic removal efficacy in wastewater treatment plants, further promote recycling of tertiary-treated wastewater that would otherwise be discharged to the ocean. **Partners: SWRCB, RWQCB**	2022
Based on the results of previous studies and the following completion of the ongoing SCCWRP study on wastewater treatment plant process removal efficacy, further develop microplastics reduction strategies and monitoring recommendations based on each level of treatment, including primary, secondary, tertiary, and advanced treatment. **Partners: SWRCB, RWQCB**	2023

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Develop and implement a program to incentivize, or otherwise require, the purchase and use of washing machine filters through rebates and other mechanisms. (See Pollution Prevention: Financial Incentive solutions above)	2024
Expand the microbead ban to include microplastics that are intentionally added to consumer products, such as cosmetics, household and industrial detergents, cleaning products, and paints. (See Pollution Prevention: Product and Material Ban solutions above)	2024
Aerial Transport	
Develop and implement a program to incentivize, or otherwise require, the sale and use of ENERGY STAR condenser dryers through rebates and other mechanisms. (See Pollution Prevention: Financial Incentive solutions)	2024
Education	
Develop a public awareness campaign to raise awareness of microplastic pollution, and facilitate behavior, policy, systemic, and environmental change. **Partners: CCC, CDFW, CalRecycle, CTCP/CDPH, DTSC, OEHHA, SLC, SPD, SWRCB**	2023
Update pertinent principles, concept, standards, teacher training efforts, and/or curricula to educate K-12 students of microplastic sources, impacts, and solutions. **Partners: CCC, CDFW, CalRecycle, CTCP/CDPH, DOE, DTSC, OEHHA, SLC, SPD, SWRCB**	2024
Promote industry engagement and outreach to advance sector-specific microplastic pollution prevention strategies. **Partners: CCC, CDFW, CalRecycle, CTCP/CDPH, DTSC, OEHHA, SLC, SPD, SWRCB**	2024

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APPENDIX 2

Recommended actions, partners, and timeline to advance **Chapter 2B**: **Science to Inform Future Action**. Each research priority and action presented below are contingent upon available funding and personnel resources.

Actions	Timeframe
Monitoring	
Establish standardized microplastic monitoring methods (sampling and analysis of environmental samples, including marine, river, and estuarine waters, sediment, and fish tissue) with accreditation procedures. **Partner: SWRCB**	2023
Establish an ongoing integrated statewide ambient monitoring network to quantify microplastic occurrence and effectiveness of management actions for microplastic pollution. **Partners: SWRCB, NOAA**	2024
Based on the results of existing studies regarding microplastic removal efficacy in wastewater treatment plants, require microplastic monitoring for California wastewater treatment plant permittees as needed as permits are renewed or revised. **Partners: SWRCB, RWQCB**	2024
Require microplastic monitoring for municipal stormwater permittees as permits are renewed or revised. **Partners: SWRCB, RWQCB**	2024
Implement a pilot monitoring program to evaluate microplastics in agricultural runoff. **Partners: SWRCB, RWQCB**	2024
Risk	
Develop toxicological studies that reduce uncertainties of microplastics risk thresholds for marine life and human health, and determine recommended actions when thresholds are exceeded. **Partner: SWRCB, OEHHA**	2024
Update the existing microplastics risk assessment framework and execute risk assessments that incorporate local environmental loads of microplastics and risk thresholds to quantify the risk of microplastics to marine life and human health. **Partner: SWRCB, OEHHA**	2024

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Conduct an assessment of microplastic pollution exposure and impacts on environmental justice communities in California to inform and prioritize future solutions. **Partner: SWRCB, OEHHA**	2024
Prioritize the development of microplastic water quality objectives for state ocean waters, estuarine waters, and freshwaters. **Partner: SWRCB, RWQCB**	2024
Identify water body impairments in the California Integrated Report based on best available science, known thresholds, and available data. **Partners: SWRCB, RWQCB**	2024
Source & Pathways Prioritization	
Quantify and characterize relative inputs from the primary pathways (e.g., urban stormwater, agricultural runoff, wastewater, aerial deposition) of microplastics statewide to the ocean. (2023) **Partner: SWRCB**	2023
Create a source emissions inventory to quantify the most prevalent California-specific sources (i.e., specific materials and products) contributing microplastics into the environment to inform future regulatory action. **Partner: SWRCB**	2024
Evaluating New Solutions	
Based on findings from actions completed under Science to Inform Future Action (**Chapter 2B**), provide additional policy recommendations to consistent with subsection (g)(2) of Senate Bill 1263.	2025

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