BIENNIAL STRATEGY REVIEW SYSTEM
Chesapeake Bay Program

Narrative Analysis

TOXIC CONTAMINAT RESEARCH OUTCOME: CONTINUALLY INCREASE OUR UNDERSTANDING OF THE IMPACTS AND MITIGATION OPTIONS FOR TOXIC CONTAMINANTS. DEVELOP A RESEARCH AGENDA AND FURTHER CHARACTERIZE THE OCCURRENCE, CONCENTRATIONS, SOURCES AND EFFECTS OF MERCURY, POLYCHLORINATED BIPHENYLS (PCBS) AND OTHER CONTAMINANTS OF EMERGING AND WIDESPREAD CONCERN. IN ADDITION, IDENTIFY WHICH BEST MANAGEMENT PRACTICES MIGHT PROVIDE MULTIPLE BENEFITS OF REDUCING NUTRIENT AND SEDIMENT POLLUTION AS WELL AS TOXIC CONTAMINANTS IN WATERWAYS.

FINAL: JULY 30, 2020

FOR AUGUST MB REVIEW

The narrative analysis summarizes the findings of the logic and action plan and serves as the bridge between the logic and action plan and the quarterly progress meeting presentation. Based on what you learned over the past two years from your successes and challenges, you will describe whether the partnership should make adaptations or change course.

Use your completed pre-quarterly logic and action plan to answer the questions below. After the quarterly progress meeting, your responses to these questions will guide your updates to your logic and action plan. Additional guidance can be found on ChesapeakeDecisions.

QUESTION 1: EXAMINE YOUR RED/YELLOW/GREEN ANALYSIS OF YOUR MANAGEMENT ACTIONS. WHAT LESSONS HAVE YOU LEARNED OVER THE PAST TWO YEARS OF IMPLEMENTATION?

Summarize what you have learned about what worked and what didn't. For example, have you identified additional factors to consider or filled an information gap?

The action plan has 5 primary management approaches that were reviewed, which are:

- MA 1: Supply information to make fish and shellfish safe for human consumption
- MA 2: Understanding the influence of contaminants in degrading the health, and contributing to mortality, of fish and wildlife
- MA 3: Document the occurrence, concentrations, and sources of contaminants in different landscape settings
- MA 4: Science to help prioritize options for mitigation to inform policy and prevention
- MA 5: Gather information on issues of emerging concern

Based on the analysis of the actions taken over the past 2 years (provided below) we will be maintaining current factors in the logic table and the five management approaches that address them. We have organized the answers for this question around each management approach, with successes and challenges.

<u>**MA1: Supply information to make fish and shellfish safe for human consumption.**</u>

Some of the key lessons learned were related to (1) producing a story maps showing PCB and mercury impairments across the watershed (2) results from a STAC workshop, and (3) findings from mercury study that was published in 2020 by the USGS.

<u>Success:</u> The findings from all three efforts highlighted **that fish consumption advisories continue to be widespread across the watershed, largely due to PCBs, mercury, and to a lesser extent organochlorine pesticide.** Visualizing the impairments and associated management plans is an effective way to communicate and impacts across the watershed in the absence of watershed-wide TMDLs for these compounds. The impairments for both mercury and PBC are shown below and the story maps are available for mercury https://gis.chesapeakebay.net/mercury/, and for PCBs http://chesbay.maps.arcgis.com/apps/MapSeries/index.html?appid=704ecbbb9f5943eca87d59b349edf1ab.

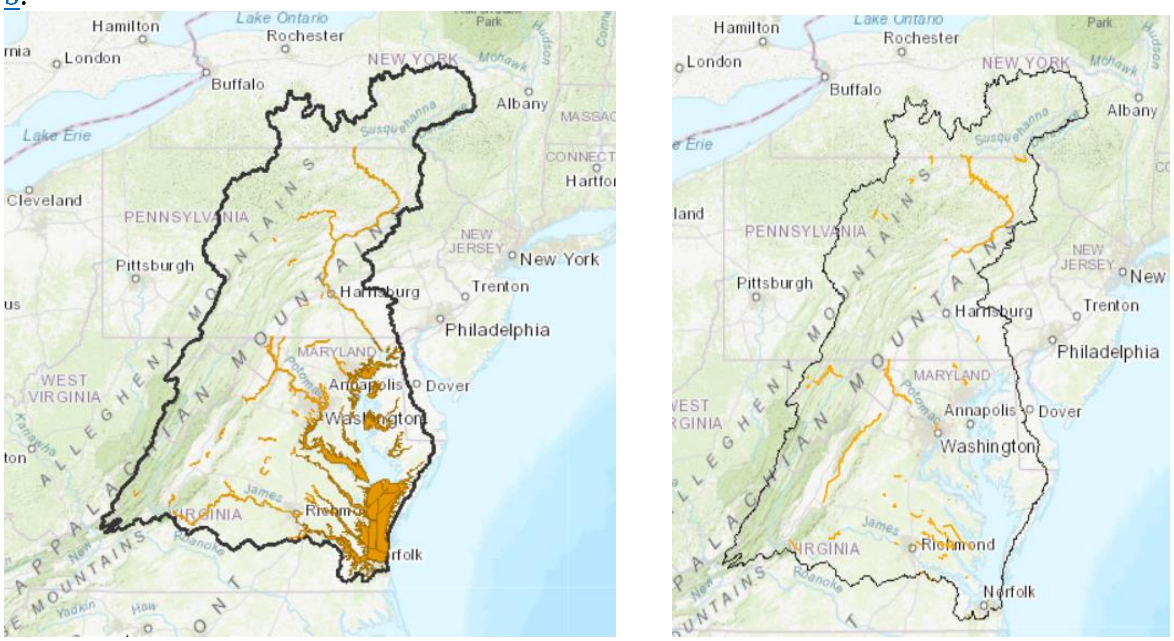

Figure 1. 2017 Impairments for PCBs (left) and mercury (right).

<u>Challenge:</u> **Most emerging contaminants do not have thresholds to identify impaired waters or set fish consumption advisories**. Therefore, the extent of impacts to waterways due to contaminants are likely more extensive than shown on the story maps.

<u>Success</u>: The findings from a USGS study showed that **mercury concentrations in fish were widespread** but variable among across areas and among species within the freshwater portions of the watershed (see figure below), (Willacker and others, 2020 https://doi.org/10.1007/s10646-020-02193-5). Some highlights include:

- Mean concentrations of mercury in all fish species was 0.22 micrograms per gram, with a range that spanned four orders of magnitude.

- For individual fish species residing in the freshwater portion of the watershed, the highest concentrations of mercury were found in: Striped Bass (landlocked individuals not migratory estuarine individuals), Bowfin, Walleye, Largemouth Bass, Flathead Catfish, and Smallmouth Bass. The lowest concentrations were found in several trout species (including Brook Trout) and the Creek Chub. (see figure below from Willacker and others, 2020)
- Mean concentrations of mercury were highest in the Susquehanna watershed followed by the Potomac watershed and Coastal drainages, with lowest average concentrations in the York, Rappahannock and James watersheds.
- Forty-five, 48, and 35 percent of fish mercury concentrations in the present study exceeded benchmarks for human, avian piscivore, and fish health risks, respectively

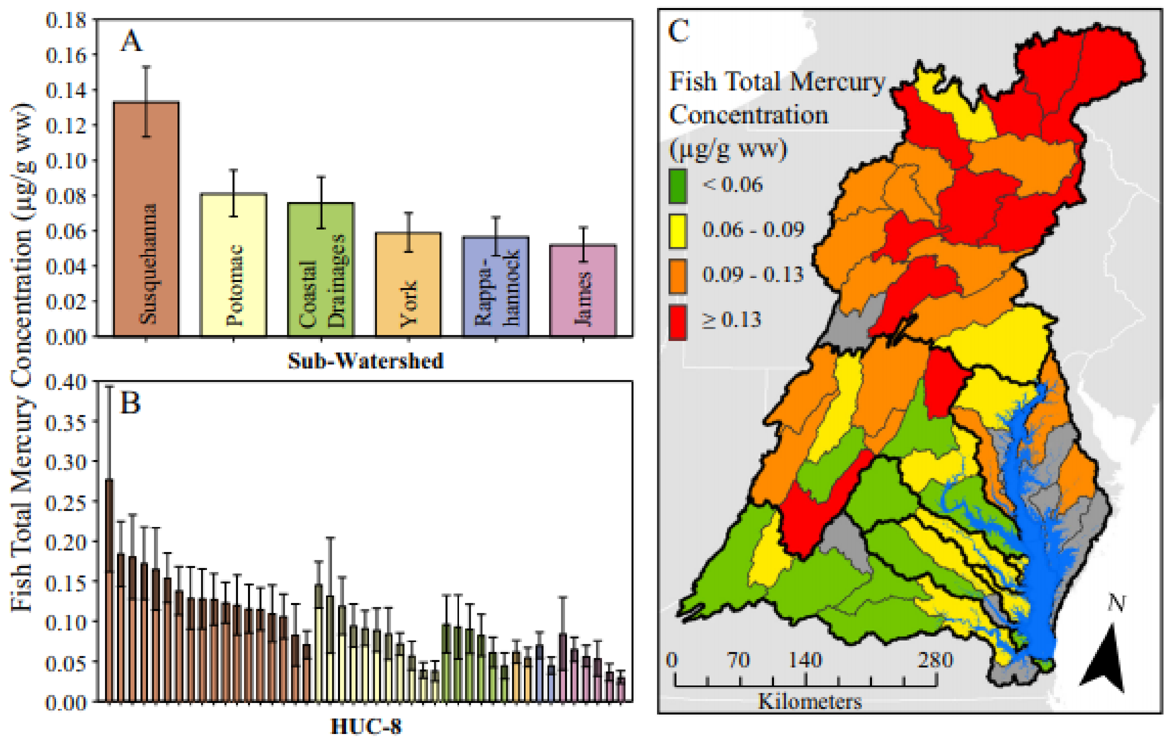

Fig. 2 Least-squares mean fillet total mercury (THg) concentrations (µg/g wet weight) in fish sampled from freshwater habitats of the Chesapeake Bay Watershed. **a** Least-square mean fillet THg concentrations (±standard error) in the major sub-watersheds of the Chesapeake Bay Watershed accounting for the effects of species, hydrologic unit (8-digit HUC; nested within sub-watershed), and year. **b** Least-square mean fillet THg concentrations (±standard error) in HUCs comprising each major sub-watershed accounting for the effects of species, location within HUCs, and year. Bar colors correspond to major sub-watersheds in **a**. **c** Map of least-squares mean fillet THg concentrations by HUC accounting for the effects of species, location within HUCs, and year. Gray HUCs lacked sufficient data to estimate mercury concentrations. Heavy black lines delineate major sub-watersheds of the Chesapeake Bay Watershed

Challenges: **The pattern of fish mercury concentrations was not consistent with regional patterns in atmospheric mercury wet deposition**; for example, mercury deposition is highest in the southern portions of the watershed and lowest in the north, whereas fish mercury concentrations displayed the opposite pattern. This apparent disconnect supports findings elsewhere that biogeochemical and ecological drivers are important determinants for fish mercury bioaccumulation, confounding the linkage with inorganic mercury loading from the atmosphere.

There are limitations with the data for answering broader questions about the factors driving differences in mercury concentrations. The existing data sets were generated by different to address the unique program scopes and goals of each organization. In this context, the authors discuss the limitations of the current data and provide a roadmap for different monitoring program structures that would provide more comparable data among agencies in the watershed. The data from such a monitoring program would better allow agencies to

- assess changes in mercury due to reductions in air emission,
- improve the ability to compare risk of mercury to fisheries and humans through fish consumption advisories
- Understand the factors that drive spatial differences in mercury concentrations

These efforts would help inform if additional mitigation actions are needed to minimize exposures and health risks.

MA 2: Understanding the influence of contaminants in degrading the health, and contributing to mortality, of fish and wildlife

Success: The TCW worked with STAC to have a workshop in May 2019 on *Integrating Science and Developing Approaches to Inform Management for Contaminants of Concern in Agricultural and Urban Settings*. The workshop included participants from the Bay watershed but also had speakers from other important ecosystems around the Nation. The workshop and associated report summarized some key findings about fish health in urban and agricultural areas. https://www.chesapeake.org/stac/document-library/integrating-science-and-developing-approaches-to-inform-management-for-contaminants-of-concern-in-agricultural-and-urban-settings/

In urban areas, fish exhibited abnormal tissue growth and reduced reproductive success. Bullhead catfish in the tidal Potomac had liver tumors, with the prevalence in Anacostia some of the highest in N. America and were attributed to contaminants such as PAHs and PCBs (See figure 2, Pinkney and others, 2019: https://www.chesapeakebay.net/channel_files/27647/bullhead_fact_sheet_2018.pdf). The findings did reveal that a monitoring of this species can detect changes in tumors over time. The reduced reproductive success of yellow perch, which is believed related to combined exposures to legacy (e.g., PCBs) and emerging contaminants, was observed with increased urbanization (Blazer

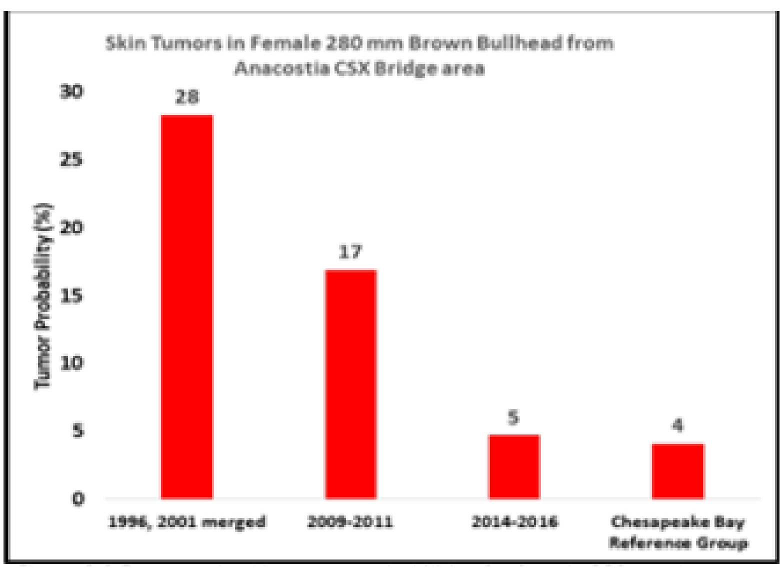

Figure 2. Decrease in skin tumor prevalence Brown Bullhead, Anacostia River (Pinkney 2019)

In agricultural settings, there have been fish kills and a variety of indicators for poor fish health including low chronic mortality, skin lesions, and reproductive endocrine

disruption. We learned there is no one culprit for these conditions but exposure to contaminants make the populations more susceptible to infectious agents, parasites, virus, and bacteria.

A study of UV filters, hormones, antibiotics in 14 sites along the eastern shore of the Chesapeake Bay showed ubiquitous presence of UV filters in water, sediment and oyster tissue and long-range transport of contaminants of emerging concern (He and others, 2019; *link* https://www.sciencedirect.com/science/article/pii/S0048969718338944?via%3Dihub). The study demonstrated bioaccumulation of UV filters in oysters and suggests the need for improved CEC removal during municipal wastewater treatment and agricultural waste management within the Chesapeake Bay watershed (He and others, 2019).

Challenge: **One challenge is to gather information on the effects of toxic contaminants on wildlife.** State wildlife agencies do not participate, and the workgroup didn't establish connection with them during the past cycle. With stakeholder interest focus on mainly on fish, we must discern how much effort should be put into information on wildlife for the next cycle.

MA 3: Document the occurrence, concentrations, and sources of contaminants in different landscape settings

Success: The STAC workshop also contributed to this management approach with selected findings including:
For urban areas, the report concluded that the fate and transport of contaminants with suspected fish health effects and their transformation products are largely unknown in urban areas, including degradation characteristics and partitioning (water, sediment preference) of these contaminants under different environmental conditions. For contaminants with known and unknown fish health effects, sources of the contaminants that are the primary risk drivers are largely unknown making selection of appropriate management actions difficult.

For agricultural areas, the sources of contaminants are relatively well defined but detailed information on many CECs is currently limited. Primary sources include pesticide use, manure storage/application, biosolid application, irrigation treated wastewater, and septic systems.

The USGS project to assess endocrine-disrupting compounds (EDCs) also provided results on the occurrence of contaminants in the watershed. A paper by McClure and others (2020; link https://www.sciencedirect.com/science/article/pii/S0048969720322828?via%3Dihub) looked for patterns of 28 compounds and estrogenicity in an attempt to better understand the spatiotemporal dynamics of contaminants in surface water. Study highlights include:

- Highest probabilities of occurrence were in the spring and summer months.
- Occurrence of most compounds not strongly linked to stream flow or land use
- Atrazine, simazine, fipronil and metolachlor co-occurred most often across sites

Challenge: **Even with these studies, there has been a lack of progress by the TCW for inventorying and assessing data watershed-wide and comparing them with the co-occurrence of nutrients and sediment.** Currently, the TCW does not have the capacity to conduct such a watershed-wide effort. Our lessons learned are to have more of a targeting geographical effort, or find additional resources, for inventorying and assessing co-occurrence of contaminants, nutrients, and sediment.

<u>MA 4: Science to help prioritize options for mitigation to inform policy and prevention</u>
Progress on this management approach also came mostly through STAC workshop on urban and agricultural areas.

<u>Success:</u> **<u>In agricultural areas</u>, several BMPs appeared promising**, including

- Adding activated carbon or biochar to established BMPs effectively reduces contaminant transport.
- Retention ponds and vegetative treatment are shown to reduce pesticide loading.
- Finally, manure management (including composting, subsurface application) and buffer strips, were shown to reduce antibiotics.

<u>Challenge:</u> From the workshop we learned that to prioritize BMP implementation, it is important to better define the types of contaminants that require reduction (exposure), define desired outcome (e.g., improved fish health) and establish how the BMP functions in relation to this outcome. Further the understanding of the co-benefits of nutrient and sediment BMPs is needed to improve water quality (reduce toxic contaminants) and habitat quality and preserve aquatic resources. We need to further develop tools for the management community to identify areas/populations that would benefit from improved BMP implementation and/or monitoring. Finally, we need to build qualitative frameworks to answer questions related to co-benefits for toxic contaminants.

<u>Success: In urban areas</u>, **there were several examples at the workshop of studies demonstrating effective management.** These included:

- Sediment capture and reactive filter BMPs reduce concentration and toxicity related to urban stormwater runoff
- Iron-enhanced sand filtration reduces concentrations of pesticides and wastewater indicators
- In stream innovative treatment using activated carbon with and without bioamendments immobilizes and degrades PCBs

<u>Challenge:</u> **There is a need to improve information on removal efficiencies for certain BMPs, particularly in urban areas to assess reduction in tools such as CAST**. The workgroup was challenged to establish this approach over the last two years. A GIT funding project was proposed to assess the literature and propose approaches to incorporate reductions into management tools. This project will be critical for any progress on these items over the next two years.

<u>MA 5: Gather information on issues of emerging concern</u>

<u>Success:</u> **The TCW addressed 6 different emerging concerns in 2018-19 which were microplastics, harmful algal blooms, PFAS, road salts, discharge from coal storage, and personal care products**. PFAS was a common priority for all the jurisdictions for needing more information, followed by HABs and road salts.

<u>Challenge:</u> **The workgroup was challenged by the number of emerging issues in the workplan.** Going forward, the TCW would benefit from having less items every two years to focus in more detail on select issues.

QUESTION 2: REGARDLESS OF HOW SUCCESSFUL YOUR SHORT-TERM PROGRESS HAS BEEN OVER THE PAST TWO YEARS, INDICATE WHETHER WE ARE MAKING PROGRESS AT A RATE THAT IS NECESSARY TO ACHIEVE THE OUTCOME YOU ARE WORKING TOWARD.

The research outcome currently does not have specific measures of progress. The overarching topic is to "Continually increase our understanding of the impacts and mitigation options for toxic contaminants". There are two supporting items in the outcome to provide a qualitative assessment of progress:

- Further characterize the occurrence, concentrations, sources and effects of mercury, polychlorinated biphenyls (PCBs) and other contaminants of emerging and widespread concern.
  - **Progress: Good,** progress has been made on mercury across the watershed and contaminants in local areas, but ability characterize more regional occurrence and concentrations of contaminants has been limited.
- Identify which best management practices might provide multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways.
  - **Progress: Fair.** A STAC workshop provided insights of a limited number of BMPs to have co-benefits between nutrient, sediment, and contaminant reductions. However, getting information into CBP decision tools, such as CAST, does not have a clear path forward. Additionally, jurisdictions WIPs don't have much emphasis on addressing co-benefits for contaminant reduction

QUESTION 3: WHAT SCIENTIFIC, FISCAL AND POLICY-RELATED DEVELOPMENTS WILL INFLUENCE YOUR WORK OVER THE NEXT TWO YEARS?

This may include information learned at the previous biennial SRS meeting or more specific information about your outcome such as an increase or decrease in funding, new programs that address gaps, and new scientific data or research. Describe how these developments are likely to impact your recommended measure(s) of progress, the factors you believe impact your ability to succeed, and newly created or filled gaps. These changes should be reflected in the first three columns of your revised logic and action plan after your quarterly progress meeting.

<u>Scientific Developments</u>

There will be numerous science developments that will influence our work over the next two years, including:

- **Learning from existing and new mitigation studies**, both in the watershed and in other areas of the nation, **to reduce PCBs**. Studies by several state partners in the watershed should provide results over the next two years as well as studies required by EPA for remediation of hazardous-waste sites.
- **EPA approval of passive sampling methods for PCBs** streamlining the collection of data and states **taking advantage of methods with lower detection limits** will enhance available of data for analyses.
- **Communicating the conclusions from the USGS EDC project, which focused on agricultural settings.** The project will be producing new papers on factors affecting fish health in agricultural areas, sources and occurrence EDCs, and relation of their changes to selected BMPs. The results from USGS mercury study will also be further shared, and opportunities for more integrated monitoring program to assess response to management

approaches. Finally, USGS will begin additional studies on contaminants in selected river systems and landscape settings.

- **A growing number of PFAS investigations** are underway in different CBP jurisdictions, and there are enhanced efforts by federal agencies. These efforts will increase the understanding of these contaminants.

<u>Policy Developments</u>

- **Development of PFAS water-quality, health-based thresholds** will help with assessing risk to humans, fish, and wildlife.
- **Risk assessment of microplastics on striped bass** could provide thresholds for policy options.
- **Evolving regulations on reductions of mercury emissions** could affect management approaches and increase need for coordination monitoring network.
- Implement STAC Workshop outcome recommendations (see next question)

<u>Fiscal Developments</u>

- **COVID-19 impacts on state budgets will likely reduce funding** for contaminant monitoring and studies. Federal funding impacts not well known at this time.

QUESTION 4: BASED ON YOUR RESPONSE TO THE QUESTIONS ABOVE, HOW WILL YOUR WORK CHANGE OVER THE NEXT TWO YEARS?

Describe the adaptations that will be necessary to more efficiently achieve your outcome and explain how these changes will lead you to adjust your management strategy or the actions described in column four of your logic and action plan. Changes that the workgroup, GIT or Management Board consider significant should be reflected in your management strategy.

Based on what we learned, the following changes are being considered for our five management approaches.

MA1: Supply information to make fish and shellfish safe for human consumption

- Interact with the jurisdictions on the opportunity for integrated monitoring of mercury given lack of data to assess effects of atmospheric reductions and other management approaches. The data from such a monitoring program would better allow agencies to
    - assess changes in mercury due to reductions in air emission,
    - improve the ability to compare risk of mercury to fisheries and humans through fish consumption advisories
    - Understand the factors that drive spatial differences in mercury concentrations
- Take advantage of existing studies to enhance information on the sources of PCBs in environment. Examples include the Baltimore Areas study (UMBC-USGS) and several studies in the Anacostia and DC. These projects are also looking at sources of PCBs and relation to potential stormwater controls or stream remediation.

MA 2: Understanding the influence of contaminants in degrading the health, and contributing to mortality, of fish and wildlife

- Use results from soon to be completed USGS EDC project and other planned efforts to better understand effects on fish health in agricultural areas
- PFAS- Nature and extent of watershed surface waters and fish to better assess resource impacts.
- Continued studies of known and emerging contaminants in mussels and oysters

MA 3: Document the occurrence, concentrations, and sources of contaminants in different landscape settings

- Use results from soon to be completed USGS EDC project and other planned efforts to better understand sources and occurrence of toxic contaminants in targeted agricultural and urban areas. This will be done since watershed-wide assessments even of selected contaminants are not feasible with current TCW resources. More specific targeted assessments in subwatersheds that may have approaches, methods, lessons learned can be communicated and replicated elsewhere may be more manageable.

MA 4: Science to help prioritize options for mitigation to inform policy and prevention

- Reduce scope of tasks associated with incorporating toxic contaminants into CAST until more information is gathered on removal in BMPs and gray infrastructure improvements, and approaches and information needed is determined.
- The GIT funding proposal to explore approaches for determining removal effectives for PCBs and similar contaminants will be needed to make progress on this topic.
- Implement recommendations to CBP response to the STAC CEC report. The response has been reviewed and approved by the TCW and WQ GIT and will be forwarded to the MB for their consideration. The proposed actions include:

CBP Action 1: Enhance Interaction with Stakeholders for Contaminant Information

The best opportunities are to interact with stakeholders who are implementing practices to reduce nutrients and sediment, so they can consider actions to also mitigate toxic contaminants. The TCW is will increase interaction with Jurisdictions: Water Quality Goal Implementation Team (GIT) & workgroups: and Local TMDL implementors:

CBP Action 2: Take advantage of Phase 3 implementation

The jurisdictions must develop updated lists of nutrient and sediment practices that will be implemented every two years for their WIPs. These 2-year milestones provide opportunities for the TCW to summarize new findings on the co-benefits of toxic contaminant reduction for selected nutrient and sediment BMPs and share them with jurisdictions to consider.

CBP Action 3: Enhance Communication Materials to Inform Decisions
The TCW will interact with stakeholders on the most useful approaches to provide new findings. In addition to presentations of results, the TCW will discuss opportunities to prepare Fact Sheets and other briefing materials to best communicate results to different stakeholder groups. Preparing communication materials will take additional resources, which could be supported through annual GIT funding proposals.

CBP Action 4: Compile results and expand BMP studies of contaminant mitigation and relation to nutrients and sediment reductions.

Studies of the effectiveness of BMPs designed for nutrient and sediment reduction to mitigate contaminants are currently limited, particularly within the Chesapeake Bay watershed (CBW). However, expanding information about fate of toxic contaminants in BMPs is critical to understand within the current CBP framework of management actions; therefore, several approaches will be emphasized.

CBP Action 5: Include selected BMP results into CBP tools
Currently management selection and contaminant reduction tools within CBP do not include evaluation of toxic contaminants so opportunities for decision making on co-benefits are extremely limited. Approaches to overcome these limitations include: Populating the Chesapeake Bay Watershed Data Dashboard with selected toxic contaminant monitoring, and proposed GIT project described under action 4 would develop approaches and information for selected BMPs and contaminants in urban areas that could be considered for CAST and other contaminant management models

MA 5: Gather information on issues of emerging concern

- Support the microplastics action team
- Expand focus on PFAS to better understand resource impacts but limit assessment of other Contaminants of Emerging Concern over the next 2 years.

QUESTION 5: WHAT, IF ANY, ACTIONS CAN THE MANAGEMENT BOARD TAKE TO HELP ENSURE SUCCESS IN ACHIEVING YOUR OUTCOME?

Please be as specific as possible. Do you need direct action by the Management Board? Or can the Management Board direct or facilitate action through other groups? Can you describe efforts the workgroup has already taken to address this issue? If this need is not met, how will progress toward your outcome be affected? This assistance may include support from within a Management Board member's jurisdiction or agency.

- Ask the jurisdictions to enhance consideration, and have EPA provide more technical support, for reducing contaminant as they develop 2-year milestones to carry out their Phase 3 WIPs. Approve the CBP responses to the STAC CEC report that will help achieve this request, which included:
  - CBP Action 1: Enhance Interaction with Stakeholders for Contaminant Information
  - CBP Action 2: Take advantage of Phase 3 implementation
  - CBP Action 3: Enhance Communication Materials to Inform Decisions
  - CBP Action 4: Compile results and expand BMP studies of contaminant mitigation and relation to nutrients and sediment reductions.
  - CBP Action 5: Include selected BMP results into CBP tools
- Support jurisdictions and federal agencies developing a plan for a coordinated monitoring network for mercury in the watershed, that will better assess effects of management actions. The data from such a monitoring program would better allow agencies to:
  - assess changes in mercury due to reductions in air emission,
  - improve the ability to compare risk of mercury to fisheries and humans through fish consumption advisories
  - Understand the factors that drive spatial differences in mercury concentrations
- Support jurisdiction and federal interaction to have a more coordinated science approach for PFAS that takes advantage of existing and planned studies.