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.

DRAFT: AUGUST 31,2022

ABSTRACT: [Provide a concise paragraph summary, beginning with the outcome status (*e.g.,* on track, off track, ahead of schedule), your key findings, successes and challenges that are described in more detail below.]

<u>NOTE</u>: The narrative analysis summarizes the findings of the logic and action plan and serves as the bridge between the pre-quarterly logic and action plan and the quarterly progress meeting presentation. 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.](ChesapeakeDecisions)

1. Are we, as a partnership, making progress at a rate that is necessary to achieve this outcome? Would you define our **outlook** as on course, off course, uncertain, or completed? Upon what basis are you forecasting this outlook?

   How would you summarize your **recent progress** toward achieving your outcome (since your last QPM)? If you don't have an indicator, would you characterize this progress as an increase, decrease, no change, or completed? *If you have an indicator and it was updated since your last QPM, use your answer to question 16 from your Analysis and Methods document.*

The research outcome currently does not have specific measures of progress and given the large number of toxic contaminants in need to research understanding to transition to the policy and prevention outcome, the research outcome is considered off track. 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 recent progress, both of which can be considered to have increased:

- 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 continued to be made on mercury across the watershed and other contaminants of interest in local areas due to TMDL inclusion in the MS4 permits. Regional characterizations improved for agricultural chemicals in the Potomac and Susquehanna watersheds, and for PCBs related to restoration efforts in Anacostia watershed, and complex mixtures of contaminants in the Shenandoah watershed**.**

- Identify which best management practices might provide multiple benefits of reducing nutrient and sediment pollution as well as toxic contaminants in waterways.
    - **Progress: Fair.** Progress has been made to better understand reduction of specific contaminants in specific management actions (e.g., PCBs in gray infrastructure) and relevant response timelines from BMP implementation, but stormwater BMP removal efficiency studies continue to be limited. Additionally, jurisdictions WIPs don't have much emphasis on addressing co-benefits for contaminant reduction or have a way to quantify the reduction.

NOTE: Your responses related to outlook and recent progress will be used to update your outcome page on ChesapeakeProgress and the outcome status page.

2. Looking back over the last two or more years, describe any scientific (including the impacts of climate change), fiscal, and policy-related developments that impacted your progress or may influence your work over the next two years. Have these resulted in revised needs (*e.g.,* less, more) to achieve the outcome?

*To the extent feasible, describe your needs using the SPURR thought model, i.e., **S**pecific and actionable, **P**rogrammatic partner, **U**rgency of the needed action, **R**isk of not acting, **R**esources required.*

Over the last two years, developments in research and policy related to toxic contaminants will impact our work looking ahead to the next SRS cycle. In addition, fiscal developments may impact progress on some identified tasks in our logic and action plan. Specifically:

Research:

- PFAS studies: Jurisdictions, federal agencies, and academic partners have all initiated PFAS studies (including desktop, field, and laboratory) in the Chesapeake Bay watershed, as apparent from our PFAS Inventory and STAC Workshop (held May 2022). The sharp increase in science activity related to PFAS including fish consumption (and more Bay-specific consumption such as blue crabs), source identification, and other topics provides opportunity for TCW to coordinate and promote some consistency in the watershed.
- Microplastics: The CBP Pollution Prevention Action Team (PPAT) published several technical documents as part of their charge by the Management Board and identified that microplastics may pose a risk to striped bass in the Potomac, providing an opportunity to further refine this risk assessment through a GIT-funding proposal sponsored by the Research outcome.
- Endocrine Disrupting Compound study findings: Results of the multi-year, endocrine disrupting compound study on agricultural lands provide opportunity to work collaboratively with the agricultural workgroup to identify opportunities to reduce agricultural chemicals entering waterways of the watershed that are resulting in intersex occurrence in fish.

Policy:

- Some fish consumption advisories for specific PFAS have already been issued for waterways in the Chesapeake Bay watershed and assessments and advisories on a wider scale are expected to be forthcoming. Consistency between methods, approaches, and establishment of these advisories by jurisdictions will likely be a higher priority to the TCW than the ecological effects in the near-term.

- Interim updated health advisories for 2 PFAS were issued in 2022 and have impacts on jurisdictions actions at drinking water facilities. While drinking water is not of direct relevance to TCW, surface water intakes to supply drinking water are relevant and will provide extensive data on PFAS occurrence in the watershed.

Fiscal:

- The science and policy development needs of PFAS are requiring at least some jurisdictions to re-prioritize monitoring of other toxic contaminants, such as PCBs.
- The focus on human health effects of PFAS (drinking water and fish consumption) will likely restrict the ability of jurisdictions to consider ecological effects in the near-term, reinforcing the need for collaborative, cost-sharing efforts within the watershed.

3. Based on the red/yellow/green analysis of the actions described in your logic and action plan, summarize what you have learned over the past two years of implementation.

Summarize overall (not per action) what you have learned about what worked and what didn't work. For example, have you identified additional factors to consider or filled an information gap?

<u>MA1: Synthesize information to make fish and shellfish safer for human consumption</u>

Updates to the PCB TMDL story map indicate that more than 80 percent of tidal waters in the CB watershed is impaired for PCBs. Target WLA in these TMDLs is based on fish consumption/human health protection. During 2022, the workgroup facilitated a roundtable of PCB TMDL implementation status and developed a document to catalog current status. Similarly, as part of the enhanced monitoring effort, monitoring methods, techniques, frequency etc. was cataloged for PCB efforts in the watershed. From these efforts, follow on tasks were prioritized by the workgroup and were able to be included in the updated LAP.

PCB TMDLs in the watershed are driven by risk to humans due to fish consumption. A study conducted in the Back River (Baltimore, Maryland) provided insight into primary drivers of PCB input to an urban, impaired river with a TMDL. Mass loading estimates were conducted from nontidal streams under lowflow conditions, during a storm event, and into and out of wastewater treatment plant. Wastewater effluent and transport of PCBs on suspended solids during storms dominated PCB input, estimated an order of magnitude higher than targeted WLAs. The study also highlighted the need to address land-application of biosolids, containing 2-orders of magnitude higher loading than wastewater effluent and non-tidal streams.

- Passive samplers/freely dissolved concentrations can provide clues to areas of the sanitary sewer system that require further investigation. This sewershed trackdown to refine source should be considered as the watershed source trackdown.

- Evidence for considerable reductions in WW system with ENR and capital improvements and maintenance, suggesting that additional reductions may be observed with continued efforts.

Opportunities for further reduction are likely within the sanitary sewer system itself prior to reaching the plant influent.

(Majcher, E., Ghosh, U., Needham, T., Lombard, N., Foss, E., Bokare, M., Joshee, S., Cheung, L., Damond, J., and Lorah, M., 2022, Refining sources of polychlorinated biphenyls in the Back River watershed, Baltimore, Maryland, 2018–2020: U.S. Geological Survey Scientific Investigations Report 2022–5012, 58 p., https://doi.org/10.3133/ sir20225012)

<u>MA2: Understand the influence of contaminants in degrading the health, and contributing to mortality of fish and wildlife</u>

Results of a multi-year study on the influence of EDCs and other factors degrading the health and contributing to the mortality of fish were synthesized in a geonarrative and discussed with the joint members of the agricultural workgroup and CBP NRCS staff. Several publications were released and briefed during this two-year period and include:

(Vicki S. Blazer, Stephanie Gordon, Daniel K. Jones, Luke R. Iwanowicz, Heather L. Walsh, Adam J. Sperry, Kelly L. Smalling, Retrospective analysis of estrogenic endocrine disruption and land-use influences in the Chesapeake Bay watershed, Chemosphere, Volume 266, 2021, 129009, ISSN 0045-6535, https://doi.org/10.1016/j.chemosphere.2020.129009.)

Major findings included:

- Intersex or vitellogenin was observed in all five major river systems sampled.
- Testicular oocyte prevalence in largemouth bass ranged from 22 to 100% at 12 of the 14 sites collected during the late season (June - December). Vitellogenin ranged from 0 to 100% across all sites.
- Smallmouth bass testicular oocytes prevalence ranged from 25 to 100% in the late season, and 56 to 100% during the early season (January - May).
- Vitellogenin prevalence in smallmouth bass ranged from 0 to 75% in the 26/40 sites sampled in the early season sampled, and 0 to 100% in the 23/34 late season sampled sites.

A population-level ecological risk model was developed to evaluate effects of environmental stress and bioactive chemicals, and subsequently used to model the impacts of changing water temperature, stream flow, and exposure to estrogenic endocrine disrupting compounds (EEDC) on smallmouth bass populations in the Chesapeake Bay Watershed.

(Yan Li, Vicki S. Blazer, Luke R. Iwanowicz, Megan Kepler Schall, Kelly Smalling, Donald E. Tillitt, Tyler Wagner, Ecological risk assessment of environmental stress and bioactive chemicals to riverine fish populations: An individual-based model of smallmouth bass Micropterus dolomieu, Ecological Modelling, Volume 438, 2020, 109322, ISSN 0304-3800, https://doi.org/10.1016/j.ecolmodel.2020.109322.)

Model results include four fish health population metrics: population size, abundance of spawning and recruit (portion of the population achieving adulthood) fish, and the proportion of fish within a size (quality-length) range.

- Flow and temperature increases demonstrated the most severe effects on all four population measures.
- An increase in exposure level to EEDCs, both year-round and in summer months, substantially reduced population size as well as spawner and recruit abundance, and the proportion of quality-length individuals.
- Acute exposure to EEDCs was more detrimental to the population than chronic exposure.
- Acute exposure during spawning season had the most severe impacts.

Opportunities for collaboration with agricultural workgroup have been ongoing and continue as an action item for the workgroup to address meaningful ways to integrate these findings into actions in the watershed's agricultural land.

MA3: Document occurrence, concentrations, and sources of contaminants in different landscape settings

Long-term monitoring sites in agricultural watersheds across the Chesapeake Bay Watershed were assessed to document the effects of stream flow and landscape variables on contaminant concentrations and co-occurrence patterns.

(Kelly L. Smalling, Olivia H. Devereux, Stephanie E. Gordon, Patrick J. Phillips, Vicki S. Blazer, Michelle L. Hladik, Dana W. Kolpin, Michael T. Meyer, Adam J. Sperry, Tyler Wagner, Environmental and anthropogenic drivers of contaminants in agricultural watersheds with implications for land management, Science of The Total Environment, Volume 774, 2021, 145687, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.145687.)

Results

- Contaminant concentrations were often positively correlated with seasonal stream flow, although the magnitude of this effect varied by contaminant across seasons and sites. However, contaminant co-occurrence patterns were not affected by seasonal flow or proportion of agricultural land-use near the sampling locations.
- Land-use and other less utilized landscape variables including biosolids, manure and pesticide applications, and percent phytoestrogen producing crop cover were inversely related with site average contaminant concentrations.

Long-term monitoring sites in five agricultural watersheds across the Chesapeake Bay Watershed were established and sampled monthly from 2013 to 2018 to understand relationships between flow, contaminants, and landscape variables, as well as assess the effects of land management actions (also known as Best Management Practices (BMPs)) on contaminants in streams.

(Catherine M. McClure, Kelly L. Smalling, Vicki S. Blazer, Adam J. Sperry, Megan K. Schall, Dana W. Kolpin, Patrick J. Phillips, Michelle L. Hladik, Tyler Wagner, Spatiotemporal variation in occurrence and co-occurrence of pesticides, hormones, and other organic contaminants in rivers in the Chesapeake Bay Watershed, United States, Science of The Total Environment, Volume 728, 2020, 138765, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2020.138765.

Results

- Of the 301 compounds analyzed in 370 surface-water samples, 109 (36%) were observed at least once. The compounds detected included eight hormones, 27 pesticides, 25 pharmaceuticals, 38 organic waste indicator compounds, and 11 phytoestrogens and mycotoxins.
- The highest probability of contaminant occurrence occurred in the spring and summer.
- Four pesticides (atrazine, metolachlor, fipronil and simazine) co-occurred frequently in surface water across sites. These findings provide baseline information on patterns of contaminant occurrence within agricultural watersheds of Chesapeake Bay Watershed.

Groundwater discharge zones could be a unique exposure pathway of chemicals to surface water systems and are a potential pathway for phytoestrogens entering streams.

In preparation for the STAC Workshop, an inventory of efforts underway to assess PFAS was conducted in the watershed and will be included in the forthcoming workshop report.

<u>MA4: Synthesize and promote science to help prioritize options for mitigation to inform policy and prevention</u>

Further investigation into the potential co-benefits of BMPs included both agricultural and urban landscapes. Site comparisons between treated (with BMPs) and untreated agricultural and urbanized watersheds, wastewater treatment plants and combined sewer overflows allow for direct measurement of nutrient management techniques as a potential strategy to reduce estrogens in environmental waters.

{(Kelly L. Smalling, Olivia H. Devereux, Stephanie E. Gordon, Patrick J. Phillips, Vicki S. Blazer, Michelle L. Hladik, Dana W. Kolpin, Michael T. Meyer, Adam J. Sperry, Tyler Wagner, Environmental and anthropogenic drivers of contaminants in agricultural watersheds with implications for land management, Science of The Total Environment, Volume 774, 2021, 145687, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.145687.)

Results

- The natural hormone estrone (E1) was widely distributed and positively correlated with total estrogenicity (E2Eq), water temperature, and dissolved organic carbon (DOC).
- Among nonpoint sources, E2Eq, E1, soluble reactive phosphorus (SRP) and total dissolved nitrogen (TDN) decreased in urban and agricultural streams with best management practices (BMPs) relative to streams without BMPs.
- >94% of E1, estrone-3-sulfate (E1-3S), estriol (E3), total estrogenicity and TDN were removed while SRP increased during the nitrification/denitrification part of advanced wastewater treatment.
- Concentrations of estrone in WWTP effluents were comparable or even lower than those observed in the receiving stream or river water.
- Highest total estrogenicity values and concentrations of E1, E3, and TDN were detected in combined sewer overflow (CSO).

The ability (i.e., statistical power) to detect regional declines in chemical contaminant concentrations in streams and rivers is currently unknown. A study was conducted to explore the statistical power to detect regional temporal trends in river contaminant concentrations within the Chesapeake Bay Watershed as a result of BMP implementation.

(Tyler Wagner, Paul McLaughlin, Kelly Smalling, Sara Breitmeyer, Stephanie Gordon, Gregory B. Noe, The statistical power to detect regional temporal trends in riverine contaminants in the Chesapeake Bay Watershed, USA, Science of The Total Environment, Volume 812, 2022, 152435, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2021.152435.)

Results

- For herbicides atrazine and metolachlor, that have had 30 years of regular sampling across the Chesapeake watershed, there were significant declining regional temporal trends in river concentrations of approximately 4% per year. Temporal trends for total estrogenicity and total PCBs were also negative, but not statistically significant –

- Monitoring programs aimed at detecting small annual declines (< 5 to 7 % declines per year) are underpowered and unlikely to detect these small rates of decreasing contaminant concentrations, unless sampling has occurred at roughly 100 or more sites for at least 20 years
- Monitoring for short time periods (e.g., 5 years) is inadequate for detecting regional temporal trends, regardless of the number of sites sampled or the magnitude of the annual declines –
- Annual sampling frequency had little impact on the ability to detect regional trends for any monitoring scenario. This suggests that sampling all sites every year is not necessary –
- Overall, the ability to detect temporal trends was greatest for total estrogenicity, suggesting that this aggregate measure of estrogenic activity may be a useful indicator.

<u>MA5: Gather information on issues of emerging concern</u>

In 2021, the TCW submitted a proposal for a STAC workshop on PFAS, the co-chairs served on the steering committee, and it was held in May 2022. The objectives of the PFAS workshop were to:

- Summarize the current understanding and analyses of the sources, occurrence, and fate of PFAS,
- Identify current efforts and approaches to inform the potential effects on fish and wildlife, and their consumption, and
- Consider study designs, and comparable sampling and analysis methods, for a more coordinated PFAS science effort.

In preparation for the workshop, an inventory and literature review of desktop, field, and laboratory studies completed in the Chesapeake was compiled and will be a living document to expand and add to over time. This will be included in the workshop report, along with the identified needs and recommendations.

In 2021, the PPAT published a preliminary ERA for striped bass in the Potomac watershed and briefed the TCW. The study indicated that there could be significant impacts on the valuable Chesapeake resource, identifying 14 prey taxa as potential vectors for microplastics. Further refinement of the ERA is needed to provide more accurate estimate of the effects to the resource throughout the watershed.

(Preliminary Conceptual Model for an ecological risk assessment for microplastics on striped bass in the Potomac River estuary [Microsoft Word - TO 20F0213_Microplastics QAPP_FINAL_RFM07202020_sal.docx (chesapeakebay.net)])

<u>Challenges Across Management Actions:</u>

Many of the topics that TCW addresses are interdisciplinary and cross-cut to other workgroups within WQGIT and beyond. TCW was deliberate about engaging with and inviting other workgroups to meetings where presentations included topics we believed were relevant their efforts. During the last two years this included the agricultural, wastewater treatment, urban stormwater, and stream health workgroups. We struggled to engage with these workgroups collaboratively beyond the presentations and have long-standing action items to do so. Similarly, we recognize benefits to working with sustainable fisheries goal team related to fish consumption and fish habitat assessments, but currently no one from SFGIT participates regularly in TCW not does TCW participate in SFGIT.

In addition, managers have little incentive (or the tools to quantify with any level of confidence) co-benefits of BMPs relative to specific toxic contaminants. While progress was made identifying specific actions that reduce contaminants such as PCBs, co-benefits from landscape BMPs installed for nutrient or sediment reduction have few explicit removal efficiencies documented in the literature. Further, management actions specific to toxic contaminants may be tracking behind implementation of nutrient and sediment BMPs, making optimal selection for co-benefits challenging.

4. Based on what you have learned through this process and any new developments or considerations described in response to question #2, how will your work change over the next two years? If we need to accelerate progress towards achieving our outcome, what steps are needed and, in particular, what specific actions or needs are beyond the ability of your group to meet and, therefore, you need the assistance of the Management Board to achieve?

Describe any adaptations that may be necessary to achieve your outcome more efficiently and explain how these changes might lead you to adjust your Management Strategy (if significant) or the actions described in column four of your Logic & Action Plan. What new science, fiscal, and policy-related information, could be recommended or pursued over the next two years to maintain or, if needed, accelerate progress? Use the SPURR model described in question #2, to provide detail to the needed steps and actions.

While we anticipate the general management strategy and management approaches under this strategy to remain consistent with the previous SRS cycle, we plan to integrate the following into the revised logic and action plan, based on recent science, policy, and fiscal developments:

- Based on workgroup prioritization, we expect to dedicate up to one-third of TCW meeting time in the next two years to PFFAS science knowledge transfer, sharing, and coordination. We expect to address STAC workshop report needs and recommendations and will identify how best to respond to the priorities raised in the workshop report.
- With less resources available for ongoing PCB TMDL implementation, we expect to continue to serve in a coordination role for synthesizing science and restoration advances with the workgroup. In addition, we will continue to explore the feasibility of PCB enhanced monitoring in regional, impaired areas to assess response to management actions, consistent with the enhanced monitoring outlined for the PSC.
- With the prioritization of microplastics and their potential effects on resources in the Chesapeake such as striped bass, TCW will take steps to integrate the PPAT into the workgroup, including the sponsoring of a GIT-funding proposal to further refine the ecological risk assessment.

The TCW may accelerate progress toward their outcome over the next two years from the following engagement by the Management Board:

- Support for jurisdictional and federal agency participation and engagement in PFAS-focused science and coordination efforts. This will include support to address needs and recommendations from the forthcoming STAC workshop report,
- Enhanced consideration by jurisdictions for reducing toxic contaminants when planning nutrient and sediment practices for their 2-year milestones,
- Identify and support opportunities to achieve multiple benefits of toxic contaminant reduction through collaborations with other CBP workgroups such as wastewater treatment, agriculture, stream health, and the sustainable fisheries Goal Team, and
- Support further exploration, including feasibility assessment and cost, of the PCB monitoring as proposed in the PSC monitoring report.
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5. What steps are you taking, or do you recommend, to ensure your actions and work will be equitably distributed and focused in geographic areas and communities that have been underserved in the past?

Many of the impairments for PCBs are in urban areas. Any implementation for PCB management, will likely occur in these areas.

TCW is fostering a closer working relationship with the Urban Waters Federal Partnerships within the watershed– including both Anacostia (near D.C.) and Patapsco (near Baltimore) to track efforts related to toxic contaminants in these watersheds. Similarly, there is a PCB source reduction partnership in the Anacostia on which several workgroup members participate. By fostering information exchange with these groups, we can better understand priorities related to toxic contaminants in areas of the watershed that may be in underserved areas. In addition, the TCW anticipates continuing efforts to communicate and educate the public about fish consumption and toxic contaminants. With the potential for new fish consumption advisories for PFAS, this could become increasingly important.