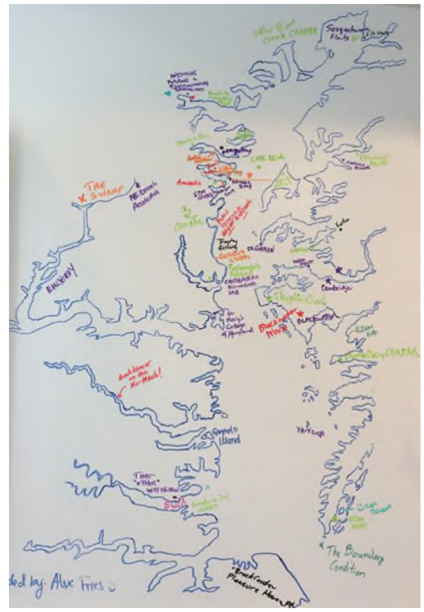
2nd Workshop Summary

Climate Smart Habitat Restoration Workshop: Toxic Contaminants Workgroup
A workshop in support of the CBT Project: Cross-Goal Climate Resiliency Analysis and Decision-Making Matrix and Implementation Methodology



UMCES Annapolis Office
429 4th Street
Annapolis, MD 21403
July 31 - August 1, 2017

Introduction

Project Background

A goal of the Climate Resiliency workgroup is to develop a structured, science-based framework through which the principles of climate-smart adaptation planning can be effectively applied to management strategies in the Watershed Agreement. To further this goal, this project was initiated to work toward developing an analysis & decision-making matrix and implementation methodology (framework) for the Chesapeake Bay Program (CBP) (see Acronym table below for this and all other acronyms used in this report) that utilizes climate smart principles and can be applied to all Chesapeake Bay Agreement Goals and Outcomes. In implementing the project, the team utilized the Adaptation Design Tool (West et al. 2017) developed by EPA's Exposure Analysis and Risk Characterization Group (EARCG) scientists with NOAA and Tetra Tech, as an ecosystem-specific application of the generic climate smart approach. This Tool was originally developed in the context of coral reef management, and is highly applicable for incorporating climate change vulnerability considerations into other ecosystem types and resource management contexts. This project applies this tool to the CBP for the purposes of developing a tailored, CBP-specific climate-smart framework and associated set of climate change adaptation decision matrices. Objectives of this project are to:

- Advance climate resilience objectives for Chesapeake Bay Agreement, including application of Climate-Smart restoration and conservation.
- Use a regionally developed framework/methods to integrate climate change into CBP management strategies and actions.
- Engage with selected GITs/workgroups to pilot implementation of the tool.
- Work toward development of a matrix methodology that will work across all Chesapeake Bay Agreement Goals and Outcomes through implementation by select CBP GITs & workgroups.

Development and testing of the framework and decision matrices started through interactions with two 'pilot' goal Implementation teams (GITs) or workgroups which were identified during initial phases of the project – the SAV Workgroup and the Black Duck Action Team/Wetlands Workgroup. A workshop held with these groups on November 15-16, 2016 provided a forum for piloting the draft framework and decision matrices through several example management actions relevant to each group, and thereby observe and discuss the strengths and weakness of the draft approach in a realistic CBP application. Revision and further development of the CBP framework was implemented based on outcomes from this first workshop, and was again piloted and tested in a second workshop focusing on the CBP Toxic Contaminants workgroup. This report is a summary of the key outcomes from this second workshop.

Workshop

A $1^1/_2$-day workshop was convened at the UMCES Annapolis Office in Annapolis, MD on July 31 – August 1, 2017, the second of two workshops in the process of developing a CBP matrix methodology. The objectives of this second workshop were to have participating experts:

- Apply the revised climate-smart adaptation framework and decision matrices to CBP Toxic Contaminant example management decisions and restoration activities.
- Progress toward providing a structured but easily applied process to make Toxic Contaminant management decisions 'climate smart'.
- Further the process of refining the framework and matrices for applicability to all GITs/workgroups in the CBP context.

Workshop participants included members of the CBP's Toxic Contaminants workgroup, as well as interested participants from the Climate Change workgroup, the CRC, CBP staff, and representatives of partnering agencies including DOEE, UMCES/CBL, MDE, MDH, PA DEP, the US EPA, NOAA, USGS, and Tetra Tech. A list of workshop participants with contact information is provided in Attachment 1.

The goal of the project is to support the integration of climate smart principles throughout the CBP at multiple levels, from place-based management actions to restoration strategies and development of partnerships. The desire for specific guidance for implementing climate smart adaptation at 'higher' decision levels (e.g., strategies, approaches, goals/outcomes) was made clear at the first workshop, and became a focus of subsequent decision matrix revisions. Thus, at this second workshop, we specifically included case study examples at different levels, from a hypothetical 'strawman' on-the-ground action that incorporated common BMPs that might be used to implement PCB load reductions in a tributary of the Potomac River, to an example of a TMDL (the Potomac River PCB TMD) representing one of the most common approaches the Toxic Contaminants workgroup uses to achieve its goals. We also included a third case study representing a high-level strategic approach, using GIS overlays to assess future contaminant source vulnerabilities to SLR due to climate change. This afforded the opportunity to pilot the draft decision matrices at multiple levels and incorporate revisions and emerging insights regarding application. The inputs and insights we gained through this process at the workshop are summarized in this report. We will use the information from this exercise to further revise the framework and decision matrices for application in the CBP context.

Day one of the workshop started with an overview presentation on the approach and general principles of climate-smart conservation, and the process of utilizing the climate smart framework and decision matrices. Because of the central importance of the TMDL process to the goals of the Toxic Contaminants workgroup, there also was a presentation reviewing the TMDL process and its potential intersections with climate change effects. This was followed in the subsequent morning and afternoon sessions with a facilitator leading the participants through 3 example 'case studies' (see Attachment 4), taking each strawman management action or strategy through the steps of the appropriate decision matrix. On the second day of the workshop, further facilitation was used to explore some of the insights gained on Day 1, such as new/emerging vulnerabilities, insights on BMP adaptations, points of potential adaptations for TMDLs and other programs (such as MS4 permits), and messaging. Subsequent discussions included data gaps and needs, related guidance documents that might be produced by the workgroup in response to needed climate change adaptations, synergies or other interactions among projects and approaches, and collaborations needed with other workgroups. Finally, there was discussion on the synthetic issues of potential uses of this tool, its levels of applicability, what might be missing in terms of process or questions addressed, and applicability to other workgroups, including perceived roadblocks or issues. The workshop agenda is included for reference as Attachment 2. Presentations made at the workshop are included for reference in this summary (Attachment 3). The descriptions of the 3 example 'case studies' to put through the draft climate smart decision support tool are presented in Attachment 4, and the completed decision tables as revised based on inputs at and following the workshop are presented in Attachment 5. Discussion notes from the workshop are summarized below. Acronyms used in this summary are defined in the following table.

Acronyms used in this summary report.

BMP	Best Management Practice
CBL	Chesapeake Bay Laboratory
CBP	Chesapeake Bay Program
CRC	Chesapeake Research Consortium
CSO	Combined Sewer Overflow
DMR	Discharge Monitoring Report
DOEE	District Office of Energy and the Environment
EARCG	Exposure Analysis and Risk Characterization Group
EJ	Environmental Justice
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FCA	Fish Consumption Advisory
GIT	Goal Implementation Team
GW	Groundwater
MD DNR	Maryland Department of Natural Resource
NOAA	National Oceanographic and Atmospheric Administration
ORD	Office of Research & Development
PA DEP	Pennsylvania Department of Environmental Protection
PCB	Polychlorinated BiPhenyl
SAV	Submerged Aquatic Vegetation
SLR	Sea Level Rise
SRS	Strategy Review System
SW	Stormwater
TCW	Toxic Contaminants Workgroup
TMDL	Total Maximum Daily Load
UMCES	University of Maryland Center for Environmental Science
U.S. EPA	United States Environmental Protection Agency
USFWS	United States Fish & Wildlife Service
USGS	United States Geologic Survey
USACE	United States Army Corp of Engineers
VA DGIF	Virginia Department of Game & Inland Fisheries
WG	Workgroup
WIP	Watershed Implementation Plan

WQ	Water Quality
WW	Waste water

Workshop Discussion Notes

Discussion of the Case Studies

The first example management activity (case study) was the most site- and method-specific example explored, the 'Coan River PCB Remediation'. It is a hypothetical, site-specific action that incorporated common BMPs that might be used to implement PCB load reductions in a tributary of the Potomac River, where reductions to achieve PCB TMDL targets are (hypothetically) needed. PCB contamination in this tributary has been identified as coming primarily from non-point sources of contaminated sediments and atmospheric deposition; and potential remediations that might be implemented in this case could include vegetated filter strips, stormwater collection and treatment, pumping and treatment of contaminated groundwater, and/or sediment capping of hot spots (see Attachment 4 for more detailed descriptions of this and the other 2 case studies). The second example is a higher-level strategy, the Potomac River PCB TMDL. PCBs have been identified by the Toxic Contaminant Workgroup as a primary work plan focus, and total maximum daily loads (TMDLs) are a key mechanism through which the Toxic Contaminant Workgroup goals will be implemented.

There are numerous steps that represent different aspects of 'implementing' this TMDL that include, for example, filling data/information gaps and initiating remediation investigations. The linkages between this higher-level strategy and climate change considerations are more numerous and complex, and are summarized as part of the more detailed description in Attachment 4. The third case study was a high-level strategic approach, using GIS overlays to assess future contaminant source vulnerabilities to SLR due to climate change, 'Vulnerability of Virginia Waste Sites to SLR'. This represented a large-scale (regional) examination of climate change effects of sea level rise (SLR), storm surge, and associated frequencies of flooding in the Hampton Roads/Norfolk area, and how they might impact existing waste or industrial facilities, potentially leading to an increasing number of such facilities becoming source concerns.

The facilitator guided the workshop participants through each case study, starting with a brief description of the hypothetical action or strategy, and the working through each question in each step of the applicable decision matrix to draw out discussion on relevant stressor considerations, climate change effects and concerns, interactions between climate change and the stressors, actions, or strategies, and how these would impact potential action or strategy effectiveness.

Stressor Effects, Sources, and Interactions

The first substantive question from the climate-smart decision matrix is 'What stressor(s) need to be addressed by or accounted for in the action'. Discussion among the workshop participants contributed some ideas about a more workgroup-relevant way to present this information, and in particular that while the singular stressor in this case was PCBs, it would be more useful to present the stressor in tandem with its sources. Subsequent discussion revealed additional stressor-source combinations, as well as richer detail about stressor-sources that had been included in the draft case study matrix (Attachment 5).

- Include wastewater (WW) (particularly industrial wastewater) as a source (of PCB's), which can be susceptible to flooding and overflow under conditions of increased precipitation or flooding due to climate change, in addition to soil (industrial sites, legacy contaminated soils), SW (regulated/point sources, and unregulated/non-point sources), and air sources.
- PCB loadings from soil sources (industrial sites, legacy contaminated soils):
  - Could be increased by soil mobilization, spillage; enhanced by SLR through direct inundation, nuisance flooding, storm surge.
  - When contaminant sources at regulated facilities become flooded due to SLR and are abandoned, they could become unregulated sources.
  - If a contaminated site is newly inundated, or in catastrophic flooding events, it may become a new PCB source. Under conditions of a natural disaster (e.g., another Superstorm Sandy), FEMA may cover costs (e.g., for site remediation); however there was concern that as facilities might become inundated due to SLR with storm surge resulting from climate change, those longer-term consequences might not covered.
  - With some preparation (proactive planning), disaster recovery funding could be used to implement practices on the ground that would reduce future risks.
- Air sources (atmospheric deposition):
  - Both wet and dry air deposition contribute and should probably be accounted separately as associated with effects of changing rainfall.
  - Dust may be increased by drought, result in more NPS air pollution.
  - Don't have a lot of information about air sources (last attempt at modeling atmospheric PCB's happened in the '90's); makes predictions about management and implementation difficult.
- Green infrastructure (GI), including various BMPs to capture sediments from runoff, could become sources of contaminated sediments (instead of sinks) if climate changes result in increased sediment loads that exceed the original design capacity of the GI, and increased precipitation as well as increased frequency and severity of storms result in erosion of previously trapped sediments.
- Climate change extremes may put more demand/load on the electric grid, could lead to more stress on the equipment, which then fails, potentially resulting in more PCB contamination.
- Can also have behavioral/economic effects on sources that could impact loadings.
- Increasing temperature could either increase or decrease effects on the metabolism of PCB-degrading bacteria.
- Increasing temperatures might also change the composition of fish species, thus affecting pathways of bioaccumulation of PCB's.

Climate Change Vulnerabilities and Effects on Stressors-Sources, Including Timing

The discussion on how various climate changes (e.g., temperature, precipitation and storm changes, SLR) could influence PCB contamination of the Bay focused separately on the types of PCB sources.

- Climate change effects on stormwater (SW):

    - Changes in SW may affect both point and non-point sources (regulated and unregulated); may alter loading of PCBs to the Bay.
    - For regulated SW, increased precipitation and storms may change PCB concentrations at and loadings from various facilities, including CSOs, due to infiltration.
    - Higher runoff from increasing precipitation and more frequent and intense storms may also lead to increased non-point source (unregulated) runoff and erosion of sediments, including PCB-contaminated sediments.
        - Preliminary estimates from the Bay-wide WQ model is that sediment loading may increase 4% over next 7 years due to climate change, so we might expect similar effects on PCBs.
    - Unintended consequence – more dredging could lead to more land application, which will be subject to erosion and re-introduction back to the bay.
- Increased frequency of flooding may also impact PCB loadings through episodic runoff and erosion (non-point source), as well as increased infiltration and flooding of various facilities, including CSOs.
- Consider implications of precipitation changes to level of the water table, with implications to PCBs in groundwater (GW); but these (and other responses) may also be different across the Chesapeake Bay watershed.
- Air and water temperature impacts should be evaluated separately.
    - Increasing air temperature may affect volatilization of toxics.
    - Increasing water temperature could impact toxicity, bioavailability, microbial degradation, biodiversity.
    - Consider temperature effects on what species will persist and on biodiversity, as these affect the pathways and processes of bioaccumulation.
- There is some indication that SLR is changing Bay circulation patterns and salinity, and changes in salinity can affect the biogeochemistry of PCBs in the environment, which can be expected to impact loading and toxicity.
    - Do any of these biogeochemical effects change the targets we set for these contaminants in water?
    - How do these vulnerabilities affect setting WQ standards?
- Similarly, changes in CO_2 concentrations along with other climate changes (e.g., in temperature) could alter pH, acidity, and other patterns of biogeochemical changes, including timing, which again can be expected to impact PCB loading and toxicity.
- Climate changes such as SLR and precipitation changes will differ across the Chesapeake Bay watershed.
- Changes in precipitation is not limited to winter months; have tropical storms as well increasing intensity.
- Increasing frequency of wildfire could impact erosion rates, reduce evapotranspiration, affect availability, mobilization, and fate of PCBs. Toxics could be transformed by the fire process, pH changes as well.

- Increasing temperature could either increase or decrease effects on the metabolism of PCB-degrading bacteria; bacteria activity can affect fate and toxicity of PCBs, but can also potentially be considered with respect to BMPs.

Uncertainty

- There is uncertainty in the magnitude/direction of climate change effects. Projections of precipitation are in particular uncertain/highly variable; not uniform across watersheds; not uniform in relationship between precipitation and discharge.
- There is more confidence in continuation of current trends, with decadal oscillations. Precipitation is one of the major climate drivers, but with the most uncertainty. There are techniques that help deal with such uncertainty in planning. Climate is changing, but planners should be realistic about what we know (and don't know), and about how soon in the future we may know more, especially about the more uncertain projections such as precipitation.

Broad Discussion of 'Climate Smart' and the TMDL Process

- Consideration of climate change questions could be integrated directly into the TMDL sequence of activities that build to a plan to determine effectiveness. Key questions from the climate smart process could be integrated into the TMDL creation process.
- It is important in the climate-smart review process at the TMDL level to revisit load allocations and implementation, assess where you can get the most reductions, maybe even in loading capacity (the baseline load allocations and the reductions needed to meet specified targets).
    - Climate change could result in a shifting baseload.
    - It is possible that total capacity (in context of the TMDL) might change if volume of the system changes (e.g., due to SLR), but precipitation and storms would also impact loads.
    - Endpoints might change under climate change; e.g., TMDL also affected via the fish tissue (bioaccumulation) endpoint.
    - Changes in load due to climate change could also influence the margin of safety estimate.
    - Each component of a TMDL implementation plan (i.e. each action/project) should be run through the climate smart process.
- Increasing temperatures could change the composition of fish species, thus affecting pathways of bioaccumulation of PCB's, and fish tissue concentrations and associated risks are an important endpoint in developing TMDLs.
- To aid in better continuity and collaboration among programs and states, there should be more involvement in the implementation; better continuity between EPA and the states.
- Consider developing guidance for making TMDLs climate smart.
    - Need to break down silos for TMDLs to be more effective (e.g., to effectively respond to multiple stressors), therefore the guidance should help to bring different divisions into the TMDL process.
    - Environmental justice issues may elevate toxics as a priority.
- Guidance on making TMDLs climate smart would represent application of the framework at a higher decision-level, where responses to the systematic questions take the uncertainty, risk,

and mechanism of impacts of expected climate change effects on the TMDL target stressor to help managers see how to change the formulation or implementation of the TMDL, or otherwise revise the TMDL to make it more effective in light of climate change.

- Consideration of climate changes in SLR and precipitation might suggest making changes to how the TMDL is formulated. With regard to the implementation plan, these climate change influences also require revised consideration of how the reductions needed to achieve the loading capacity would be achieved. The most effective thing to do is bring the climate-smart framework to the TMDL rather than bend the TMDL process to the framework.

BMPs and Implementation Issues

- A TMDL implementation plan, which is a key component of the TMDL process where climate change considerations could be integrated, must be developed within one year of completion of a TMDL; the question of how to meet waste load allocations, how to remediate in the context of additional climate change considerations would have to respect these required timelines. For implementation, there already exist some tools to bring to the table, but new/innovative BMPs may also be needed in light of climate change influences.
  - Need more engagement with land management companies.
  - Not enough funding to address every contaminated site to use for TMDL development.
  - Need better management from state agencies of contaminated sediments; communication across programmatic silos.
- Need more consideration of sublethal effects, and of combined risks across multiple pollutants, for ecological effects thresholds, in addition to combining these with consideration of increasing temperatures, changing pH, etc.
- Increasing sediment loads in stormwater have been discussed as a link between climate change effects and TMDL pollutant sources; efficacy of associated BMPs may change with consideration of climate change effects. For example, it is hard to capture sediments from stormwater with vegetated filter strips, so these may not be a BMP to consider under climate change; whereas it is easier to capture with wet detention ponds.
- Even though some of the climate change effects on nutrients, sediments and contaminants are through similar mechanisms, there are some nutrient/sediment BMPs that have different processes and goals than those for contaminants, which may lead to unintended consequences for contaminants of concern. For example, nutrient trading is a BMP utilized to address nutrient loading reduction goals, but there is no accounting in this process for any associated effects on PCB's or other contaminants.
- Potential BMP modifications in response to climate change influences:
  - The margin of safety planned into BMPs (based on model uncertainty) may accommodate climate change effects.
  - Can alter placement of BMPs.
  - Can alter size (width) filter strips, but this might be limited by the availability of real estate; are there also ways to alter management that would be effective?
  - In the future may be able to engineer filter strips with PCB-degrading microbes.

    - Alter plant taxa used in filter strips to include those less sensitive to increasing temperature, salinity, and/or altered soil conditions that may occur with climate change.
- Green infrastructure (GI) is generally considered beneficial and applicable to addressing climate change concerns; however, under certain climate change effects, the functioning of these types of BMPs may have to be examined with respect to unintended consequences for toxic contaminants:
    - GI design may have to be re-examined, especially if GI can only handle a certain storm return period, as increasing storm intensity with climate change could lead to GI acting as a source (for sediments, contaminants) instead of a sink (as originally intended).
    - Need to be proactive about redesign before implementation, including consideration of any needed changes in maintenance frequency or approach.
    - There are no tools for tracking GI performance; if turning into sources of contaminants, what/how would you monitor?
    - Need monitoring of transitions from sinks to sources; assessment of replacing GI more frequently to adjust to more frequent/intense storms, etc.
    - A related need is to prioritize placement of GI practices.
- Permit renewal periodicity (timeframe) is an issue related to BMP implementation that might affect when reviews that include integration of climate change considerations could be conducted; however, changing this might be difficult, and in some cases could hamper climate smart efforts.

MS4 Permits:

- Phase I MS4 implementation plans would be a place to incorporate climate change considerations, but it would be a policy decision to reopen (no current regulatory requirement to do so).
- MS4 permits could (and in light of climate change effects, perhaps should) be written to include PCB's in addition to nutrients, particularly in response to expected increases in contaminated stormwater with climate change; this would be utilizing secondary benefits of BMPs. MS4 doesn't require monitoring on most of the contaminants of interest to this group. This could be added to the next general permit requirement. Similarly, MS4 doesn't require monitoring of most contaminants; adding this to the next general permit requirements could inform on related climate change concerns.
- If the CBP develops guidance on climate smart BMPs (perhaps with review by a Bay-wide committee to determine what is acceptable), these could be incorporated into MS4 permits by reference.

Monitoring and Sampling Issues Related to the TCW Workplan and Climate Smart

- The TWC workplan relies on routine monitoring that the states already do, though there may be a few projects that might add monitoring related to climate change considerations.
- Will likely continue to collect fish tissue concentrations to track contaminant levels.

  - We know that PCBs are degrading slowly in the environment, and some sources are slowly moving out of the system. Looking at fish tissue may show long-term environmental flux, but may not reflect the load reduction focus of a TMDL.
  - With climate change, it is important to gain an understanding of timing (seasonality) of trends.
  - Can track and use the frequency of fish consumption advisories (FCA) as a metric of how successful PCB BMPs are.
  - However, targeted fish monitoring for consumption advisories is difficult to use to assess trends.
  - Fish tissue methods differ across state lines, creating issues for comparisons and evaluation of trends.
  - PCB sampling is very expensive, so additional sampling is hard to fund and implement.
- Wastewater is tracked through discharge monitoring reports (DMR's), which are conditioned by monitoring frequency; but inundation (flooding) events may not correspond with the set timing of monitoring, so need to introduce event triggers for event monitoring.
- Monitoring to document pre- and of post-event conditions (e.g., storm surge flooding, inundation) would be valuable, could inform on event-induced changes and then track post-event (natural) attenuation.
- Monitoring of BMPs can be labor and time intensive, therefore expensive.
- Consider potential for including volunteer monitoring/citizen science.
- Monitoring is currently geared towards discharge events, and storage of data is only required for around 10 years; the timeframe needed to look for climate change signals (trends) is greater than that.
- From a messaging standpoint, the Bay framework needs to communicate long-term climate needs that monitoring can help fill.

Paths and Impediments to using the Climate Smart Framework

How might workgroup members use the tool from the workshop? What is the decision making process of the WG? How are decisions made on priorities and passed down to partners?

- The TMDL process is one of the best methods for making progress on this.
- The TCW is working to maintain a process of communication and engagement to make project design and implementation better.
- Need more information on how do we bridge the gap between these climate smart principles and individual projects on the ground.
- EPA recommendations and guidance would help get the process incorporated by states and individual jurisdictions that are crafting implementation plans.
- The Toxics workgroup can learn from the process being implemented with the Bay TMDL to address climate change in Phase III WIPs; with a focus on concise, clear language with regard to climate, load allocations, MPA, phase III WIPs.
- The climate smart tool is a good starting point; the TCW is particularly looking for a checklist of options and considerations. The question is always, how much is it going to cost? Knowing this will help when making the case for a local project.

- Risk assessment is the crux of climate change management strategies - increasing cost now to offset a cost later (i.e. what will the risk cost you if you do take precautions vs doing nothing).
- What are the associated risk elements that can be characterized as low hanging fruit that can be addressed right away with climate change? One example might be risks from flooding. In the public space, there are tools to deal with flood related issues. Incorporating those tools in a risk assessment for climate change might be a good place to start.

Conclusions

Some key recommendations can be drawn from these workshop inputs. As TMDLs are perhaps the primary mechanism through which the TCW attempts to achieve its CBP goals, development of guidance that specifically addresses how this framework should be applied to the defined TMDL process to make it climate smart would be singularly useful tool to help the TCW introduce the framework's climate smart principles into their strategic-level decisions.

Possible Climate Related TCW Workplan Revisions/Activities

- During the next workplan revision or through the Strategy Review System (SRS) process, ask if there is some element in the TCW workplan, like monitoring, mapping, or TMDLs, that could be more climate smart. Does the climate smart discussion add to or change the monitoring needs and programs we have identified in the workplan? Could look at what's happening on the Nutrient and Sediment Bay TMDL process with climate change, and see if any of those insights are applicable to toxics.
- Develop written guidance for how to consider climate change when developing and implementing a TMDL; start with the TMDL process and build off that.
- Develop a written guidance document focusing on climate smart BMPs, in a way that it could be incorporated into MS4 permits; a permit writers' compendium.
- Undertake a mapping analysis that integrates climate change (e.g., by adding a climate vulnerability layer) with the EPA EJ Screening Tool with its Hotspot Analysis and Hotspot Desktop Tool (https://www.epa.gov/ejscreen).

Identified Research Needs

- Research on atmospheric deposition of PCB, including understanding sources (e.g., incineration, volatilization, urbanized areas) and atmospheric flux, so this can be related to climate changes in precipitation, storms.
- Research in biogeochemistry of PCBs in the environment, relevant at many points in the TMDL process, because this will also influence the impacts of climate changes on the loading and fate of PCBs in the Bay.
- Develop information on what effects increasing storm intensities will have on water table levels.
- Information on green infrastructure (GI) performance, including issues with increased sediment due to climate changes, and how to augment or adjust GI practices.
- Guidance for TMDLs in light of climate change, including where different physical and biogeochemical process that can be affected by climate change relate to different points in the TMDL process.

In addition, there are numerous interactions with other workgroups as possibility some outside entities that were recognized would help advance the TCW CBP goals through sharing and dissemination of critical cross-group information. Recommended interactions, include:

- The Sustainable Fisheries Goal Team, for information on changes in species composition, fish abundances, locations with temperature (and other climate changes), and concomitant changes in consumption. Need to know more about fish, including changes in species composition, abundance, locations with temperature (and other climate changes), and concomitant changes in consumption, so need interactions with the Sustainable Fisheries Goal Team.
- The Land Use work group to ascertain potential PCB (and other contaminant) sources.
- The modeling work group to discuss components of the water quality midpoint assessment, in particular outcomes of modeling revisions that would impact locations and/or magnitude of deliveries of contaminants, likely judged through effects on sediment and nutrient deliveries.
- The Integrated Monitoring Networks workgroup to coordinate on both monitoring activities that could inform needed TMDL or other Toxic Contaminants Workgroup determinations (including source identification), and also help track the effectiveness of any remediation.
- Various species- or habitat-specific workgroups (e.g., SAV, fish, oysters, wetlands, blue crabs, etc.) to share information about changes in invasive species or biodiversity that may be related to toxic contaminant effects.
- The Watershed Technical Workgroup to consult on stream health, because of the possibility of PCB impairment potential bioaccumulation, even in the freshwater parts of the system.
- State climate commissions to coordinate information related to TMDLs (or toxic contaminants in general), human health policies, and climate change.

Consultations with the TCW leading up to and during this workshop were particularly helpful for expanding our perception of how the matrices could be applied at the higher (strategies or goals) levels. We will use these inputs to slightly restructure the matrices, reflecting new insights, and also to clarify some of the matrix questions to be more clearly applicable across different workgroups while still capturing their unique needs. As a few examples, we will assure the final tool includes a slightly expanded set of notes sections that can be used to document newly recognized information gaps and research needs. We will refine the section on target stressors to differentiate among stressor media or sources, as these are likely to respond differently to climate change effects. And we will focus more on rectifying differences in terminology so that it can provide a more understandable and common basis for communicating across scientists, managers, planners, and decision makers.

Attachment 1

CBP Climate Smart Restoration 2nd Workshop

Participant List

CBP Climate Smart Restoration 2nd Workshop

Participant List

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Attachment 2

CBP Climate Smart Restoration 2nd Workshop

Agenda

Chesapeake Bay Program
Climate Smart Restoration Workshop:
Toxic Contaminants

Workshop in support of the CBT Project: Cross-Goal Climate Resiliency Analysis and Decision-Making Matrix and Implementation Methodology

UMCES Annapolis Office
429 4th Street
Annapolis, MD 21403

Day 1: Monday, July 31, 2017

9:30 – 10:00 AM	**Sign-in, Distribute Materials**	***Main Room***
	Welcome & Introduction to Workshop *Zoe Johnson (CBP/NOAA) & Anna Hamilton (Tetra Tech)* *Workshop Objectives*: A hands-on event, focused on applying the Climate Resiliency framework and decision matrix to Chesapeake Bay Program's Toxic Contaminants Management Strategy in order to pilot the approach for ultimate application to all CBP management strategies. *Project Goals*: To develop and provide a structured but easily applied process to make Toxic Contaminant management decisions 'climate smart'.	***Main Room***
10:15 – 10:45 AM	**Overview of Climate Smart, Adaptation Design Tool** *Anna Hamilton (Tetra Tech)*	***Main Room***
10:45-11:15 AM	**Linkages Between Climate Changes & TMDLs** *Hope Herron (Tetra Tech)*	***Main Room***
11:15-11:45 AM	**Introduction to Workshop Exercise & Strawmen** *Anna Hamilton (Tetra Tech)*	***Main Room***
11:45 AM – 1:15 PM	**LUNCH (on your own)**	
1:15 – 3:00 PM	**Breakout Groups: Work through the Climate Resiliency Decision Matrix for 3 example management activities[1] (expectation – work on first 2 example activities)** Example Management Activity 1[2]: Coan River PCB Remediation. Example Management Activity 2: Potomac River PCB TMDL. Example Management Activity 3: Hampton Roads/Norfolk Area Waste Site Facilities, Vulnerability to SLR. **Group 1 - Main Room** **Group 2 - CBP Fish Shack**	

[1] Example management activities are grounded in Toxic Contaminants Workgroup approaches (e.g., linking with the TMDL process, an initial focus on PCBs), but any specific projects or actions presented are examples only, not actually being considered or recommended.

[2] See descriptions of each example management activity appended to end of this agenda.

	Facilitators: Hope Heron (Tetra Tech) & David Gibbs (EPA)	
3:00 – 3:15 PM	**BREAK**	
3:15 – 4:15 PM	**Continue Breakout Group work (expectation – work on 3rd example activity, and consider/summarize information relevant to higher levels captured in the notes)** **Group 1 - Main Room** **Group 2 - CBP Fish Shack** *Facilitators: Hope Heron (Tetra Tech) & David Gibbs (EPA)*	
4:15 PM – 5:00 PM	**Reconvene, Brief Report-outs, Compare Key Outcomes** *Anna Hamilton & Hope Herron (Tetra Tech) & David Gibbs (EPA)*	***Main Room***

Day 2: Tuesday, August 1, 2017

9:00 – 9:15 AM	**Recap of Key Outcomes from Activity 1 Matrices** *Anna Hamilton (Tetra Tech)*	***Main Room***
9:15 – 10:15 AM	**Breakout Groups: Explore Activity 2 of the Design Tool, What are we missing?** **Group 1 - Main Room** **Group 2 - CBP Fish Shack** *Facilitators: Hope Heron (Tetra Tech) & David Gibbs (EPA)*	
10:15 – 10:30 AM	**BREAK**	
10:30 – 11:30 PM	**Breakout Groups: Decision context, applying results to decisions, emerging Insights** **Group 1 - Main Room** **Group 2 - CBP Fish Shack** *Facilitators: Hope Heron (Tetra Tech) & David Gibbs (EPA)*	
11:30 – 12:15 PM	**Reconvene: Group Comparisons, information gaps, successes/issues, applicability to workgroup process, applicability across different workgroups** *Anna Hamilton & Hope Herron (Tetra Tech) & David Gibbs (EPA*	***Main Room***
12:15 – 12:30 PM	**Wrap Up: Project Timeline & Next Steps** *Zoe Johnson (CBP/NOAA)*	

Attachment 3

Relative Wetland Vulnerabilities Workshop

Presentations

PRESENTATIONS INCLUDED:

Intro Workshop Overview 7.29.17.pdf

Herron_Presentation_TMDLs-CC.pdf

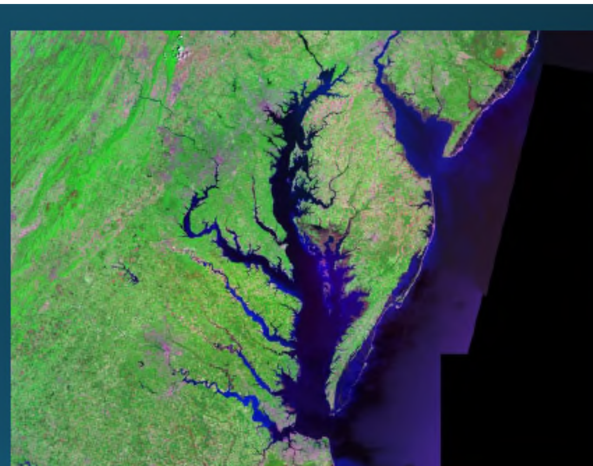
Day 2_8_1_17.pdf

Intro Workshop Overview 7.29.17.pdf

Climate Resiliency Decision-Making Matrix & Methodology

Climate Smart Restoration Workshop

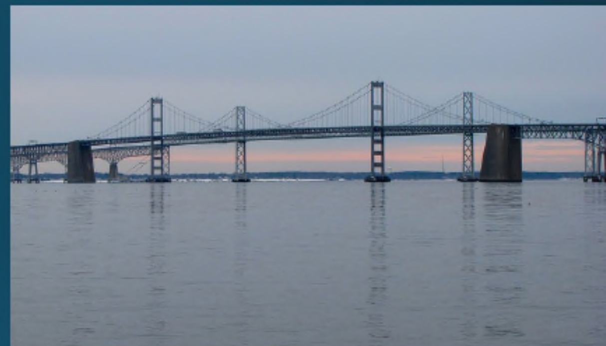
Toxic Contaminants Workgroup
July 31-August 1, 2017



Overview

Agenda

- Project goals
- Climate smart approach
- Overview of climate adaptation matrices
  - Applicability at multiple levels
  - Tailoring to different GITs/workgroups
- Workshop process & exercise



What are we doing and Why?

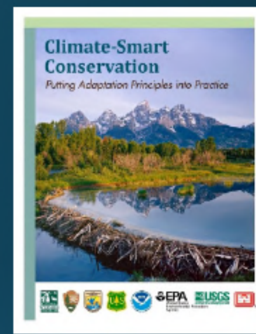
Climate Resiliency Goals

Increase the resiliency of the Chesapeake Bay watershed to adverse impacts from changing environmental & climate conditions

- Monitor:
  - Impacts of climate changes & sea level conditions
  - Effectiveness of restoration programs and projects
- Implement restoration &protection projects
  - Enhance resiliency
  - Address erosion, flooding, more intense & frequent storms & sea level rise

Project Goals

- Advance climate resilience objectives, including application of Climate-Smart conservation
- Develop a matrix methodology that will work across the GITs/workgroups
- Use a regionally developed framework/methods to integrate climate change into CBP management strategies and actions
- Engage with selected GITs/workgroups as case studies



Stein et al. (2014)
http://www.nwf.orgClimateSmartGuide

What is climate smart?

- Comprehensive review and synthesis of adaptation principles for ecosystem management
- Framework for integrating climate change information into every step of the management planning cycle
- General adaptation strategies to aid in brainstorming specific actions
- Rules for designing management actions to be "climate-smart"

Why 'Climate Smart' & This Process?

- Climate Smart planning– resiliency comes in at many points in the cycle
- Assessment & adaptation to climate change influences success ('effectiveness') of Chesapeake Bay restoration work
- Builds resiliency of living resources, habitats and communities
- Will require changes in policies, programs & projects → multiple scales of application

Climate adaptation matrices

Vulnerability Assessment as Input

Step 2: Assess Climate Impacts & Vulnerabilities

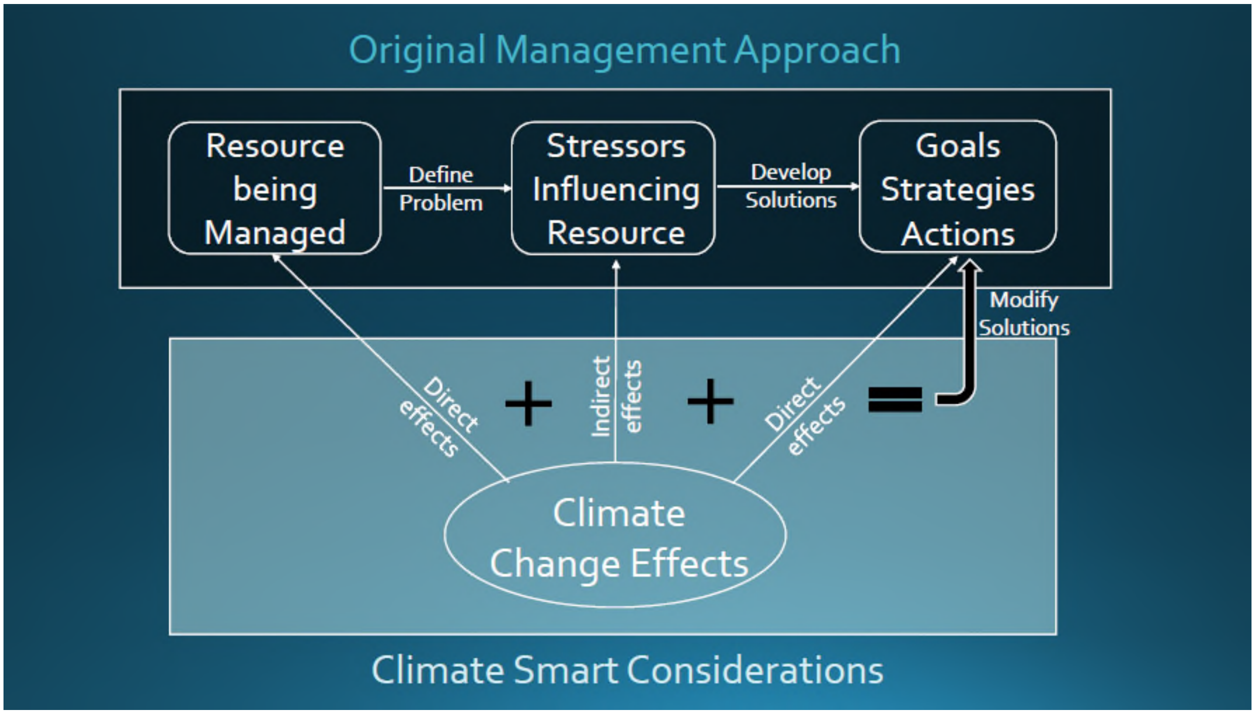
COMMUNITY NAME: West Maui

INDICATORS OF A CHANGING CLIMATE

	Climate Threat		Impacts
Indicator	Magnitude and direction of change over time based on community knowledge and latest climate science	Changes in environmental conditions (Climate Stressors)	Potential impacts to natural and social resources
Air temperature	Air temperature has increased and is projected to continue to increase in the Main Hawaiian Islands. Historical: In the Main Hawaiian Islands, from 1919 to 2006, average temperature for all stations increased by 0.04°C (0.08°F) per decade with natural variability. The rate of warming accelerated to 0.16°C (0.30°F) per decade from 1975 to 2006. The rate of increasing temperature from 1975 to 2006 is greater at high-elevation stations (0.27°C or 0.48°F per decade at greater than 800 meters above sea level). The annual number of below-freezing days has decreased between 1958 and 2009. An increase in the frequency of occurrence of the Trade Wind Inversion over Hawai'i since the late 1970s (Cao et al., 2007) is consistent with continued warming and drying trends throughout Hawai'i, especially for high elevations. Projected: In the Central North Pacific region, under the B1 and A2 scenarios, mean annual air temperature will continue to increase compared to 1971 to 2000. For 2055, B1 values range from 1.5° to 2.5°F, and A2 values range from 3° to 3.5°F higher.	Warmer temperatures, higher rates of evapotranspiration, changes in rainfall patterns with potential increase in drought conditions	Shifts in composition and distribution of native and non-native species, leading to losses of soil-stabilizing vegetative cover that could result in increased soil erosion
Sea-surface temperature	Water temperature has increased and is projected to continue to increase in the Main Hawaiian Islands. Historical: Pacific Ocean temperatures exhibit strong inter-annual and decadal fluctuations, and since the 1950s also exhibit a warming trend from surface to 200 m depth by as much as 3.6°F. Projected: In the Central North Pacific region, projected increases in SST range from 1.8° to 2.3°F by 2055 under B1 and A2 emission scenarios (compared to 1990 levels).	Warming seas, changes in ocean stratification	Coral bleaching and potential loss of reef structure and associated fish; shifts in marine species distribution and migration patterns; impacts to fishing sector
Sea level	Sea level has risen and is projected to continue to rise in the Main Hawaiian Islands. Historical: Global average sea level has risen by about 8 inches since 1900. Since the early 1990s, the rate of globally averaged sea level rise has been estimated to be 0.134 ± 0.016 inches per year based on satellite altimeter measurements. This is twice the estimated rate for the 20th century as a whole based on tide gauge reconstructions. Regional sea level trends may differ significantly from the globally averaged rate over multi-year to multi-decadal time scales. Maui had a island-wide average shoreline change rate at – 0.13 ± 0.05 m/yr over the last century due to multiple factors. Projections: In the Central North Pacific region, sea level over this century is expected to rise at about the same rate as the projected increase in global mean sea level, with regional variations. Climate model predictions estimate approximately 6 to 24 inch rise in global sea level by 2100. Including potential contributions due to changes in the dynamics of ice-sheet discharge results in an additional 4 to 8 inches of rise. So-called "semi-empirical models" yield higher estimates of global sea level rise, ranging from approximately3 to 5 feet by 2100. Why semi-empirical models yield higher values than estimates based on climate models is not understood.	Increased storm surges and king tides, more frequent coastal inundation, larger areas of inundation, greater rates of coastal erosion	Damage to key infrastructure, homes, and culturally important areas; decreased near-coastal water quality, coastal flooding and drainage issues

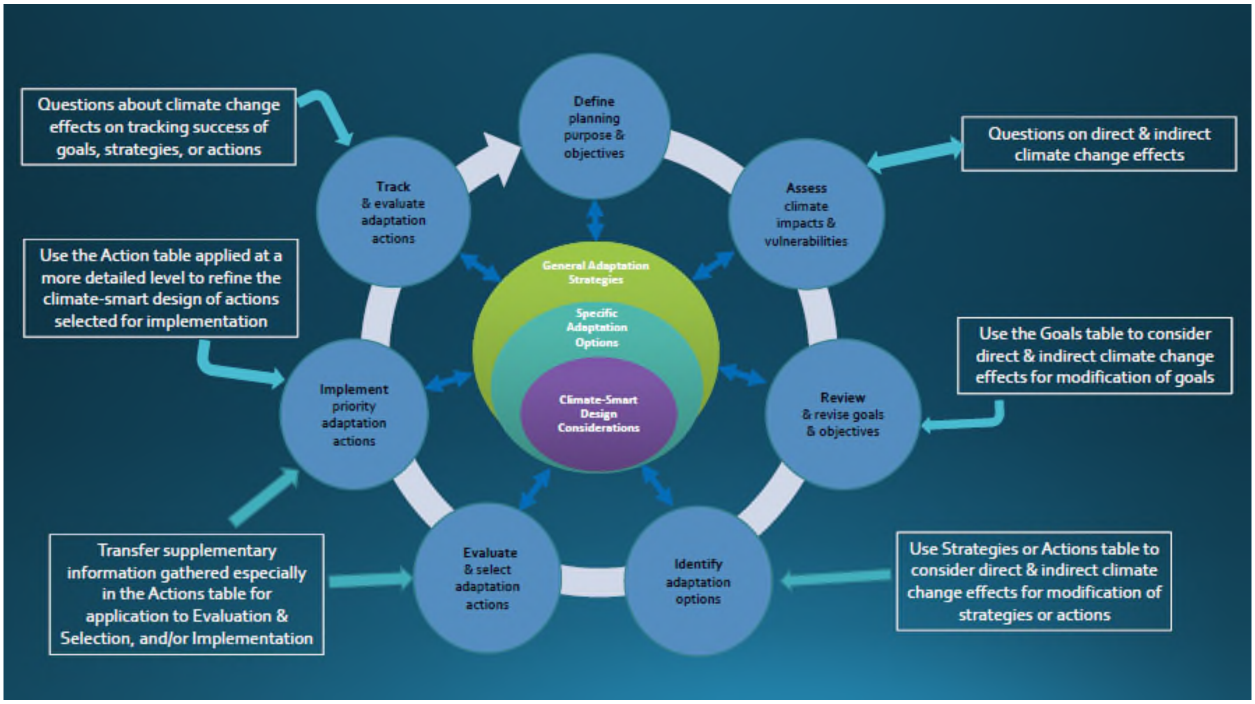
Format of Decision Matrices

- Step 1 – Screening
- Step 2 – Category 1 Climate Smart Considerations
  - Climate change effects on the stressors and systems
- Step 3 – Category 2 Climate Smart Considerations
  - Climate change implications for functionality/effectiveness
- Step4 – Climate Smart Re-Design
- Other
  - Notes on needed interactions with other groups
  - Notes that inform climate questions at higher levels
  - Consideration of what is missing



Decision Matrices

- Need to make decisions 'climate smart' at multiple levels
  - Project design to realistic goals/outcomes
- Currently have 3 levels
  - Actions/work plans (most specific – the 'bottom' of bottom-up
  - Strategies/approaches
  - Goals/outcomes
- Pigeon-holing by level not important
- Questions become qualitatively different
  - Site- & method-specific at action level, applicability to design
  - Consider broader spatial & temporal scales at higher levels, applicability to planning
- Need inputs from the 'bottom' to assure higher levels incorporation meaningful climate vulnerabilities
  - **Bottom-up**



Tailor Applicability to all GITs/WGs

- Different decisions
  - Toxics focus different from habit or organism-based groups, etc.
- Mechanisms of implementation differ
  - Often 'opportunistic'
  - Can apply to assess the value of opportunities

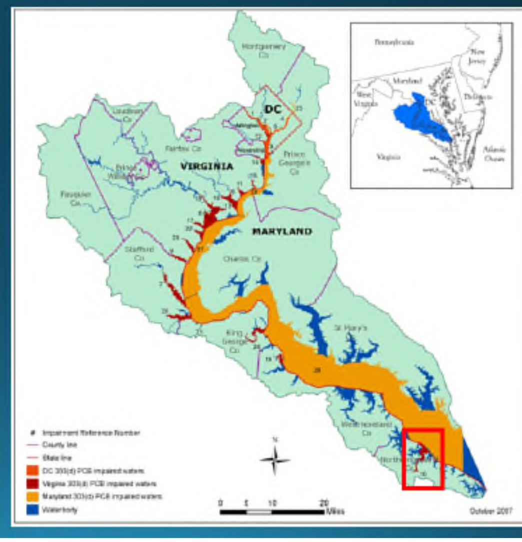
Workshop

Workshop Goals & Process

- Progress toward providing a structured but easily applied process to make Toxic Contaminant management decisions 'climate smart'
- Introductory information
- Work through 3 exercises to
  - Understand how the matrices work
  - Find strengths & weaknesses when applied to Toxics elements
  - Develop information specifically relevant to the Toxic Contaminants WG
- Breakouts
  - If enough participants, get multiple points of view on same questions

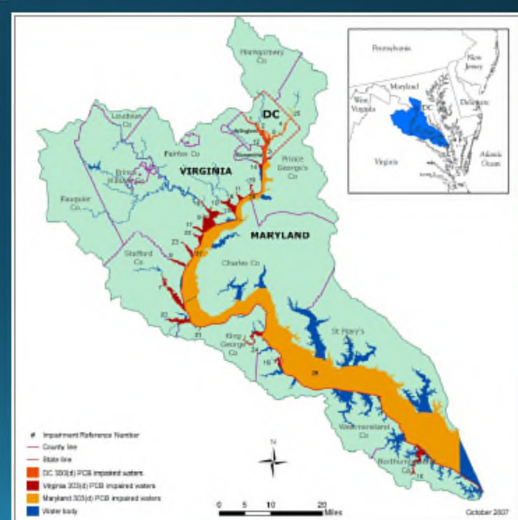
Exercise 1
Coan River PCB Remediation

- A hypothetical project, but grounded in the real TMDL
- Pilot most specific level (implementable actions)
- Inputs for work plan revisions
- Uses BMPs that might commonly be utilized to remediate PCB contamination



Exercise 2
Potomac River PCB TMDL

- TMDLs one approach that drives implementation of Toxic Workgroup goals
- Are critical components or assumptions of the TMDL vulnerable to climate change, and what could be done about it?
- Got background from Hope's presentation to help frame discussion



Exercise 3
Vulnerability of Virginia Waste Sites to SLR

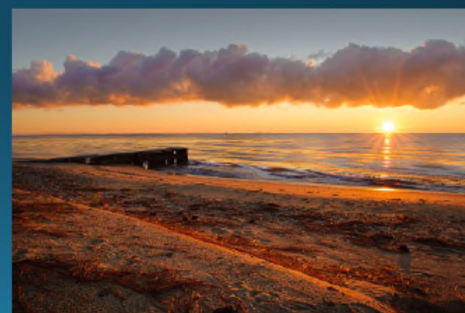
- Over larger spatial scales, will climate changes, e.g., SLR & storm surge, change the picture of toxic inputs/ exposures in the Bay?
- How could such information affect strategy formulation?

Synthetic Questions

- Decision context
- Applying results to decisions
- Emerging insights
- Group comparisons, information gap, successes/issues
  - Will help revision of matrices
- Applicability to workgroup process
- Applicability across different workgroups

Expectations

- Work through first 2 exercises during first session (~1 ¾ hours)
- Work through 3rd exercise & issues in application at higher levels during second session (~1 hour)
- Lots of honest inputs!



Herron_Presentation_TMDLs-CC.pdf

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Climate Change and TMDL's

July 31, 2017

Hope Herron, Climate Change Lead

Objectives and Outline of the Presentation

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Objectives

- Provide a brief overview of how climate change has been integrated in TMDLs to date, including drivers, to promote thoughtful engagement on today's exercise on the Potomac River PCB TMDL

Photo credit: The Potomac Conservancy (left) and Global Justice (right)

Outline of the Presentation

Presentation Overview

- Provide a conceptual overview of the linkages between the climate change assessment process and the TMDL process
- Present a brief overview of drivers of climate change and TMDL integration
- Discuss 3 example TMDLs that have incorporated climate change

Photo credit: The Potomac Conservancy

Conceptual Overview – Climate Change and TMDLs

A TMDL -

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- Is a calculation of the **maximum amount of a pollutant** that a water body can receive and still safely meet applicable water quality standards, and an allocation of that amount to the pollutant's point (wasteload allocation) and nonpoint (load allocation) sources
- Approved wasteload allocations for **point sources** must be incorporated into applicable National Pollutant Discharge Elimination System (NPDES) permits
- Load allocations for **nonpoint sources** are implemented through a wide variety of state, local, and federal programs, which are primarily voluntary or incentive-based
- Implementation plans describe how a TMDL will be implemented but are not required by Section 303(d)

The strength of a TMDL is the ability to support development of information-based water quality management strategies.

Overview of the TMDL Process

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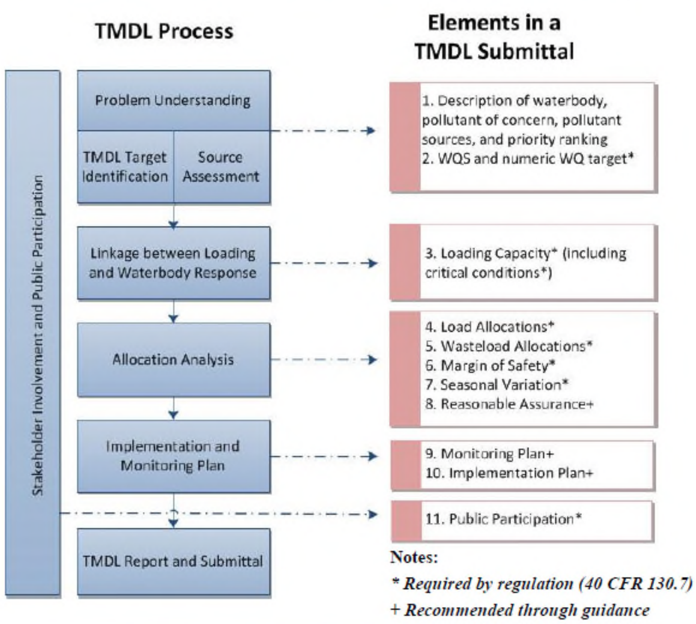

Adapted from *Guidelines for Reviewing TMDLs under Existing Regulations issued in 1992* (USEPA 2002)

Overview of the Climate Change Assessment Process

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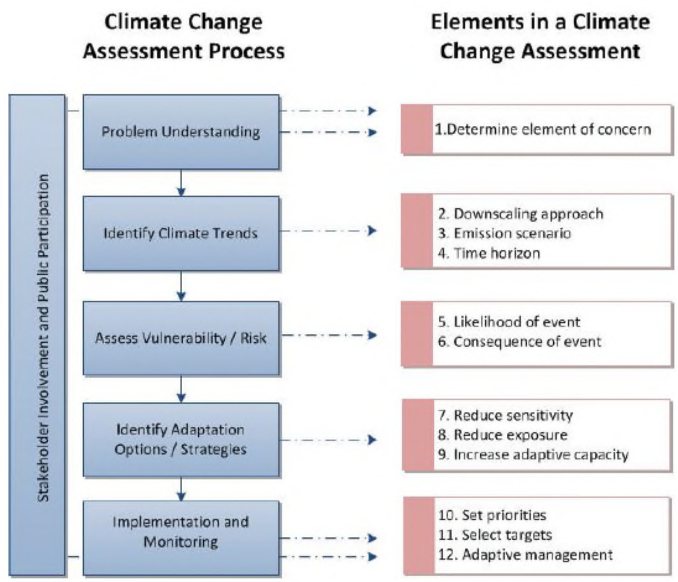

Adapted from *Scanning the Conservation Horizon, A Guide to Climate Change Vulnerability Assessment (Glick et al. 2011)*

TMDL and Climate Change Assessment Process Linkages

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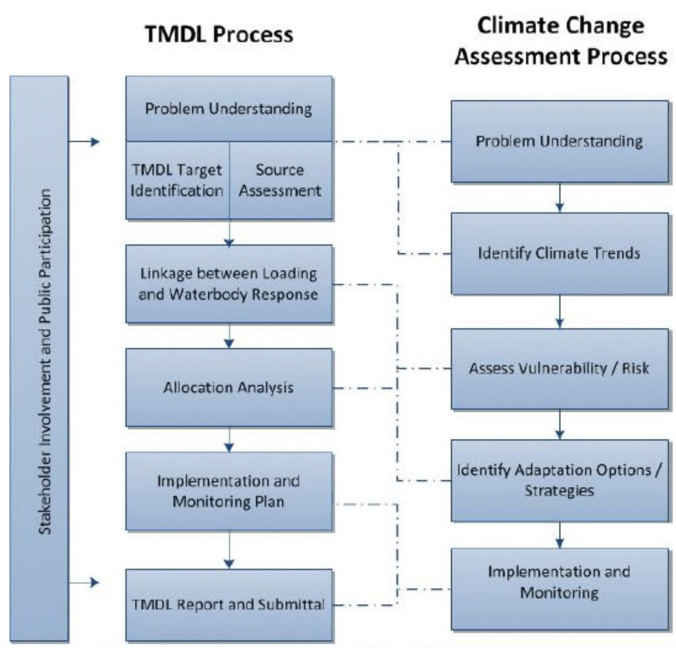

Key Challenges

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- TMDL development is complex and resource-intensive
  - Requires significant technical information and modeling
  - *Climate change presents an extra resource/technical requirement and may alter attainability of some designated uses and parameters related to water quality standards*
- Implementation is a major uncertainty
  - Section 303(d) does not require implementation, and states' strategies for implementation vary widely.
  - Often insufficient funding.
  - Require support from wide variety of actors.
  - *Climate change requires reassessing priorities with short- and long-term considerations in mind*

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Drivers to Integrate Climate Change into TMDLs

Why Include Climate Change in TMDLs?

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There is no regulatory requirement* to include climate change in a TMDL, but, some TMDLs have included climate change –

- Litigation
- Proactive states/parties

Photo credit: Herzing University (left) and https://coastalamerica.wordpress.com (right)

Except for the Chesapeake Bay TMDL!

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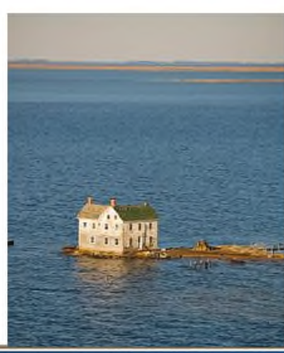
* Executive Order 13508 - assess impacts of climate change on the Bay's water quality

- Specifically cited nutrient and sediment loading as a specific concern
- Development of models to better understand climate change impacts – but, will this impact load allocations?



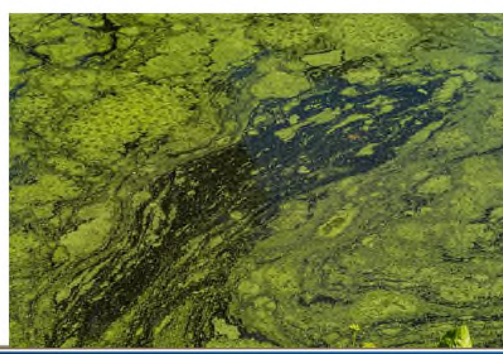


Photo credits: Chesapeake Bay Program

Illustrative Case Law

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- Conservation Law Foundation v. U.S. Environmental Protection Agency, filed 2010, settled
  - Alleges - EPA's approval of the TMDL challenged, including for failure to consider water resource effects associated with documented and predicted climate change
  - Settlement - EPA conducted a study of potential effects of climate change and phosphorus loads to Lake Champlain.
- Conservation Law Foundation v. EPA, filed 2013, settled
  - Alleges - EPA's approvals of TMDLs for Cape Code and Nantucket embayment "ignored entirely an important aspect of the water problem facing the embayments: the actual and potential impacts of climate change on the attainment of water quality standards."
  - Settlement – EPA to encourage Mass to incorporate climate change in future nitrogen TMDLs

Illustrative Case Law, continued

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- American Farm Bureau v. EPA, filed 2011 (Supreme Court of the United States denied certiorari)
  - EPA has the authority to issue the Chesapeake Bay TMDL and take certain enforcement measures to ensure the completion of TMDL goals
  - *Thus - EPA has the requisite authority and enforcement tools to modify the TMDL if the impact of climate change makes it necessary to do so.*
- United States v. Metropolitan Water Reclamation District of Greater Chicago, filed 2015, court approved permit as is
  - Enforcement suit alleging violations of Clean Water Act related to combined sewer overflows in Chicago area in violation of NPDES permits
- Columbia Riverkeeper v. Pruitt, filed 2017
  - Alleges - EPA violated the CWA by failing to issue a TMDL for temperature pollution in the Columbia and Snake Rivers in Oregon and Washington....and that high water temperatures were expected to worsen due to continuing climate change

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Illustrative Cases of TMDLs Addressing Climate Change

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South Fork Nooksack River TMDL

- Location: Washington State
- Driver: Proactive stakeholder engagement (Nooksack Indian Tribe, Washington Department of Ecology, EPA R10 and OW) and funding (EPA ORD)
- Linkage: TMDL Implementation Plan
- Key finding: Attainment of WQS already difficult, more so under climate change; added impetus to implementation plan (Nooksack Tribe)

SFNR TMDL Scenario: 7Q10, Critical August Week

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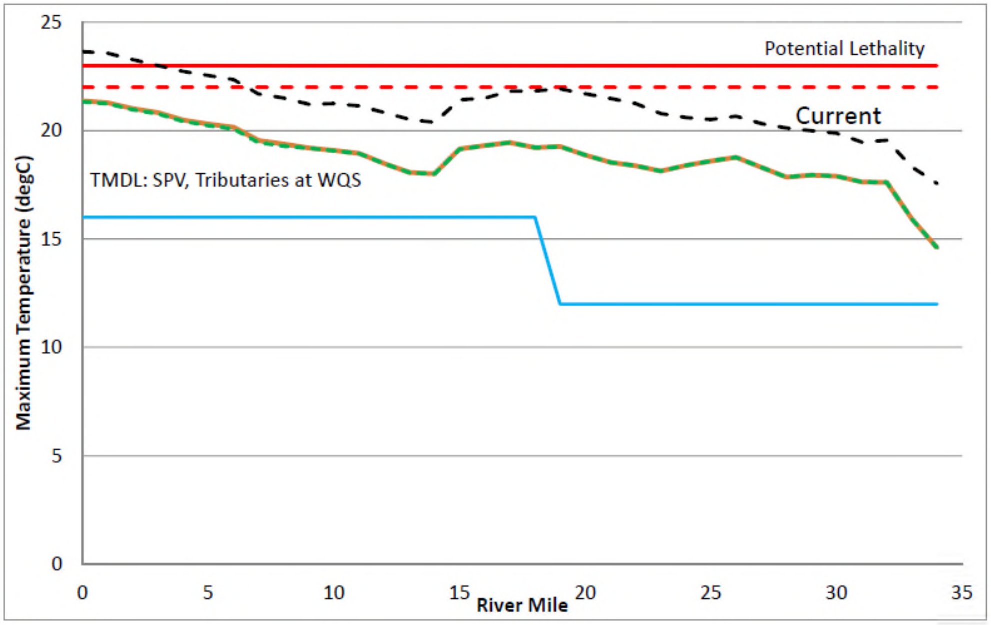

Lake Champlain TMDL Revision

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- Location: Vermont
- Driver: Litigation
  - Phosphorus TMDL approved in 2002
  - CLF litigation in 2008
  - EPA disapproval in 2011
  - TMDL revision from 2011 to present
- TMDL Revision Approach
  - Funded and led by EPA Region 1
  - Developed phosphorus load estimates from subwatersheds and key sources
  - Estimated potential phosphorus reductions from implementation of management practices (reasonable assurance)
  - Revised lake model to reflect recent conditions
  - Evaluated effects of climate change

Lake Champlain TMDL Revision

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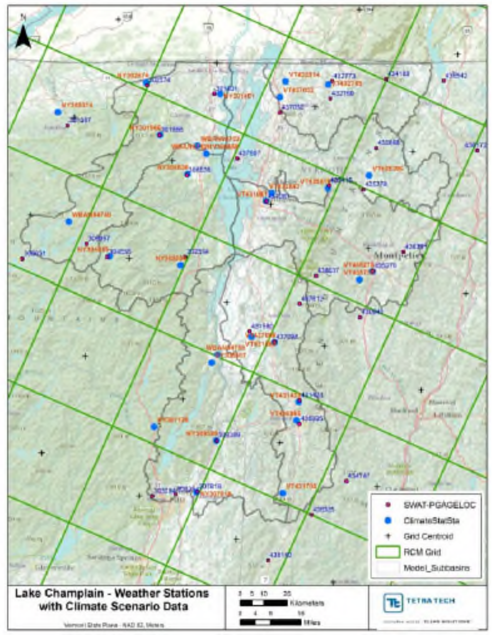
- Used existing EPA approach
  - ORD-NCEA 20 Watersheds
  - Ran SWAT for predicted future conditions
- 6 climate scenarios
  - 2040-2070 horizon



Lake Tahoe TMDL

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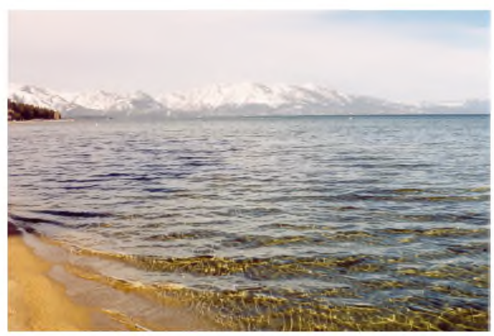
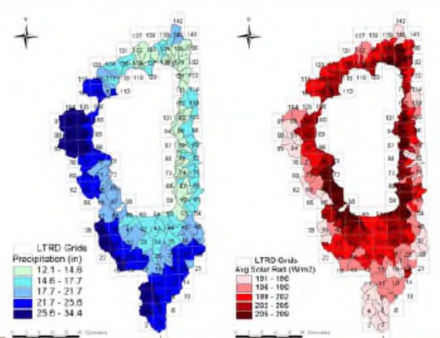
- Location: Nevada
- Driver: Concern about reduced snowpack
- Evaluated flow and pollutant loading distribution spatially and temporally
- Identified key sources and tested implementation strategies
- Evaluated potential climate change impacts – included as the adaptive management approach for the TMDL Implementation Plan





Lake Tahoe TMDL

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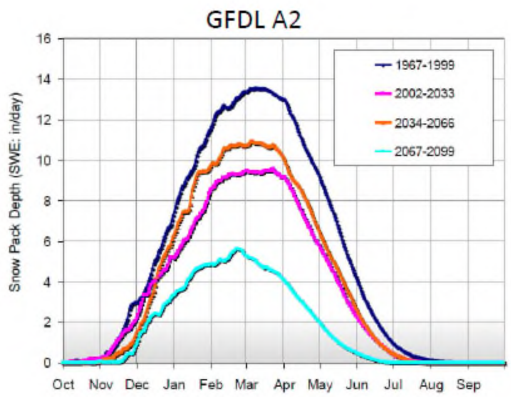
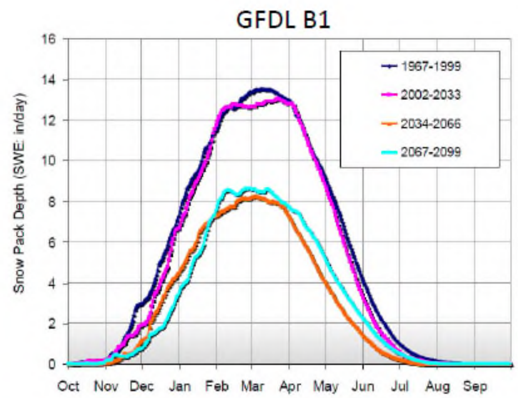
- Model Baseline: GFDL Historical (1967 – 1999)
- Scenario 1: GFDL A2 (2002 – 2099)
- Scenario 2: GFDL B1 (2002 – 2099)





From: The Effects of Climate Change on Lake Tahoe in the 21st Century: Meteorology, Hydrology, Loading and Lake Response (http://terc.ucdavis.edu/publications/documents/climate_change_2010.pdf)

Comparison of Modeling Approaches for TMDLs Considering Climate Change

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Element	South Fork Nooksack River	Lake Champlain	Lake Tahoe
Model	QUAL2Kw	SWAT	LSPC
Model Type	River (quasi-steady state)	Watershed	Watershed
Climate Change Scenarios	3 (low, med, high)	6 (model-based)	11 (sensitivity analysis); 2 (emissions-based)*
Time Horizon	2080	2040 - 2070	2050; 2002-2099*

*Separate from TMDL analysis

Take-Away Messages

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- In all Tt pilot cases, there was an increase in both flow and pollutant loads under the average of the climate change scenarios
- TMDL technical analyses that evaluate climate change scenarios will thus likely suggest revising loading capacities, etc; however, these are policy decisions that can be very contentious
- Including climate change as part of the Implementation Plan can be less contentious and also be very meaningful (prioritization, timing, and scale of actions).

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Thanks!

Contact:
Hope.herron@tetratech.com

Additional Messages

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- Climate change scenarios could:
  - set potential upper and lower allocation bounds
  - be used to define MOS
  - inform implementation
- Data perturbation methodology could be applied in absence of modeling to develop TMDLs
  - for example, apply new regime to load duration curves
- Factors to consider relative to the effects of climate change on TMDLs and water quality management strategies include:
  - Variation between climate change scenarios
  - Appropriate scale of watershed analysis
  - Choice of watershed model
  - Role of land use
  - TMDL development considerations
  - Implementation planning

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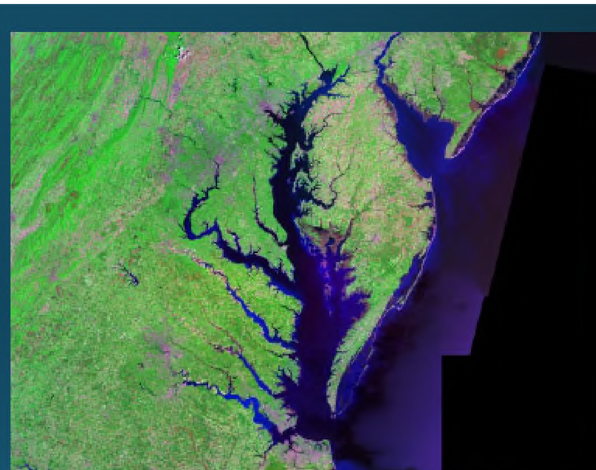
Climate Resiliency Decision-Making Matrix & Methodology

Climate Smart Restoration Workshop

Toxic Contaminants Workgroup
July 31-August 1, 2017



Welcome – Day 2!

What are some of the new/emerging vulnerabilities that we identified from Day 1?

Round Robin –

Are new management actions needed to address these vulnerabilities?

What ideas do you have to adapt workgroup actions? And/or for your own professional position (day job!)

Focus on BMPs from Exercise 1

Illustrative BMPs

- Install vegetated filter strips along the river and for stormwater treatment.
- Install groundwater wells to pump and remove, and then treat, contaminated GW.
- Add a sediment cap to the contaminant 'hot spot'.

Discussion points –

- Need for innovative filter strips
- Need to focus/prioritize BMP placement and ME efforts (resource constraints)
- Link efforts to fish advisory services

Focus on BMPs from Exercise 2

Illustrative BMPs

- Evaluate need to include climate change in TMDL via:
  - Modeling and analysis of associated PCB loads
  - Margin of Safety calculation
  - Critical conditions

Discussion Points -

- Develop/explore sector specific BMPs (easier to scale)
- Baseline load and adaptive management framework
- End point species and adaptive management framework
- MS4 Permit Guidance and climate smart BMPs
- Evaluate Implementation Plan for climate smart BMPs

Focus on BMPs from Exercise 3

Discussion Points

- Inundation may not track with permit monitoring
- Need for pre- and post- event monitoring
  - Flow event monitoring
  - Natural attenuation
  - Explore issues of contractual responsibilities
  - Compare BMP effectiveness
  - Understand and message what is possible over time

What are key Data Gaps/Needs?

- New modeling for atmospheric deposition
- Better source tracking
- Biogeochemical interactions
- Water table data
- Temperature impacts on fish species
- No information on GI performance – explore use of microbials for toxics? Adaptive management (ME)?
- TMDL and climate change guidance
- BMP and climate change guidance
- pH effects on loading and toxicity

Other Challenges?

- Multi-jurisdictional
- Higher focus given to Bay TMDL (nutrients)
- Difficult making argument for stakeholders to care about PCBs (make better link to fish advisories)
- Policy issues with TMDL and WQ standards

What are Synergies or Dependencies with the new actions we have identified?

Collaboration with other WGs?

- Fisheries – water temperature; fish species and consumption; toxicity
- Landuse – changing sources; PCB TMDL
- Stormwater – linkages to sediment and toxics
- Stream health – PCB impairments start with benthic gaps; health of population/microbial activity
- Modeling WG – inputs to WQ

Reflections on Decision Making – this working group

- Potential uses of this Tool (what level of decision-making?)

Focus on the Tool Questions and Format

- What are we missing?
- How useful do you think it may be for your WG? Other WGs? Your day job?
- What about some of the information you learned through this workshop?

Attachment 4

CBT Project: Cross-Goal Climate Resiliency Analysis and Decision-Making Matrix and Implementation Methodology

3 Example Management Activities for the Toxic Contaminants Workgroup

Toxic Contaminants Work Group
Example Management Activities[3]

Example Management Activity 1: Coan River PCB Remediation.

The Potomac River PCB TMDL (Hayward and Buchanan, 2007) identifies a variety of sources contributing to PCB loads, some of which will require substantial load reductions in order to achieve TMDL targets. On-the-ground actions that might be implemented to achieve Potomac River PCB TMDL targets will be determined through ongoing and future TMDL processes, but may include BMPs such as sediment trapping/remediation BMPs that have been evaluated for co-benefits of contaminant reduction. These types of actions represent the most specific level (in terms of location and method) of activity that would be implemented through the auspices of the Toxic Contaminants Workgroup for which potential climate change effects can be assessed and accounted for. From information in Hayward and Buchanan (2007) on the general types of PCB sources that contribute to observed environmental concentrations, a fictitious example 'project' is presented that includes an arbitrarily selected, fictitious site on the Potomac River (a real location but not an actual facility or otherwise identified contaminated site), and presents a set of BMPs that might commonly be utilized to remediate PCB contamination, such as erosion and runoff of contaminated sediments, and groundwater (GW) contamination through leaching.

Example Activity

The Coan River on the lower Potomac in Virginia (identified as segment 10 in the PCB TMDL; Figure 1) has PCB contamination primarily from non-point sources of contaminated sediments, and atmospheric deposition (Hayward and Buchanan, 2007). No specific contaminated sites are identified in the TMDL, but for the purposes of this example activity, we are going to also say there is a (fictitious) 'hotspot' of legacy PCB sediment contamination near the bank of the river that has not be previously treated. Such a site could contribute eroded PCB-contaminated sediments, and also leach PCBs to groundwater (GW).

This example focuses on a combination of remediation BMPs:

- Install vegetated filter strips along the river and in particular adjacent to the 'hotspot' legacy contaminated site to reduce the load of contaminated sediment in the runoff before it enters the river.
- If there are stormwater collection and discharge, install vegetated filter strips for stormwater treatment.
- Install groundwater wells to pump and remove, and then treat, contaminated GW.
- There may be additional benefit from adding a sediment cap to the contaminant 'hot spot'.

[3] Example management activities are grounded in Toxic Contaminants Workgroup approaches (e.g., linking with the TMDL process, an initial focus on PCBs), and the background information presented represents this factual basis. But any specific projects or actions presented are examples only, not actually being considered or recommended.

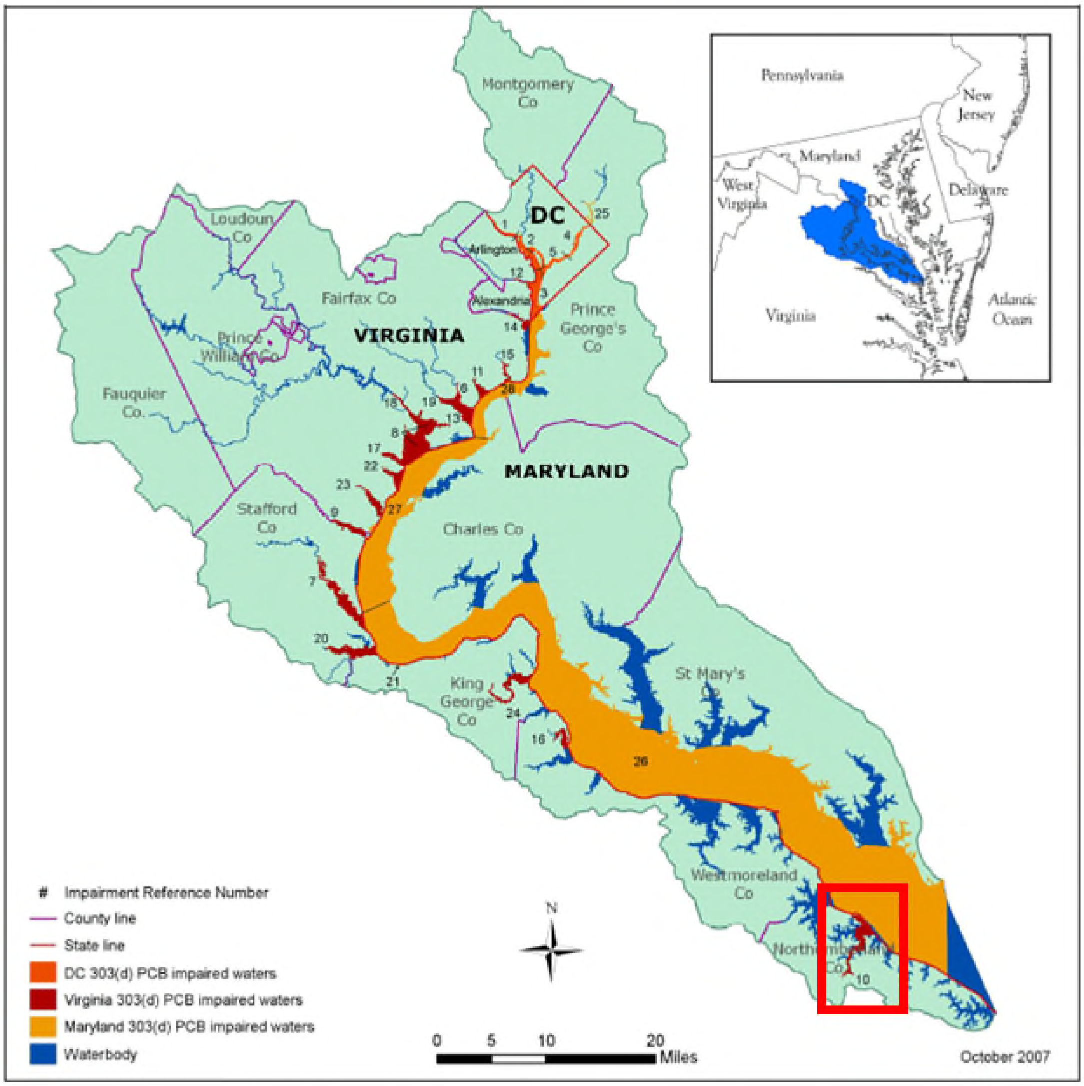


FIGURE 1. Potential contaminant (PCB) sites on the Potomac River, showing Coan River (segment 10) on the lower Potomac.

Additional Supporting Information

In general, contaminants may enter the river from any contaminated sites that border the river, as well as from other river segments or tributaries (Hayward and Buchanan, 2007). Contaminant entry pathways include erosion and transport of contaminated soil, contaminated runoff, and seepage of contaminated groundwater. The Coan River has an estimated PCB baseload of 15 grams/year total PCBs, and a TMDL load of 6.98 g/yr, representing a needed load reduction of 53.5%. Modeling in support of TMDL development showed that in addition to direct load reduction, meeting water column and sediment targets in the tidal Coan River would also require that the PCB concentration at the boundary with the Chesapeake Bay be reduced by 33% from the Baseline 0.108 ng/l to 0.072 ng/l PCB (Hayward and Buchanan, 2007). Meeting these targets also assume a 93% reduction in atmospheric deposition everywhere.

Example Management Activity 2: Potomac River PCB TMDL.

Example Activity

PCBs have been identified by the Toxic Contaminant Workgroup as a primary work plan focus, and total maximum daily loads (TMDLs) are a key mechanism through which Toxic Contaminant Workgroup goals will be implemented. The Potomac River PCB TMDL (Figure 2) has been published (Interstate Commission on the Potomac River Basin, 2007) and various recommended next steps are underway for filling data/information gaps and initiating remediation investigations. This TMDL will be used as a strawman for exploring where critical components or assumptions of the TMDL may be vulnerable to climate change (e.g., the assumptions regarding seasonality and critical flow conditions), and how they might be reviewed/revised. There are numerous potential intersections between the TMDL process and climate change assessment, which can be explored with regard to the Potomac River PCB TMDL. To help think about these, Figure 3 summarizes key elements of the TMDL process.

BMPs that might commonly be utilized to remediate PCB contamination

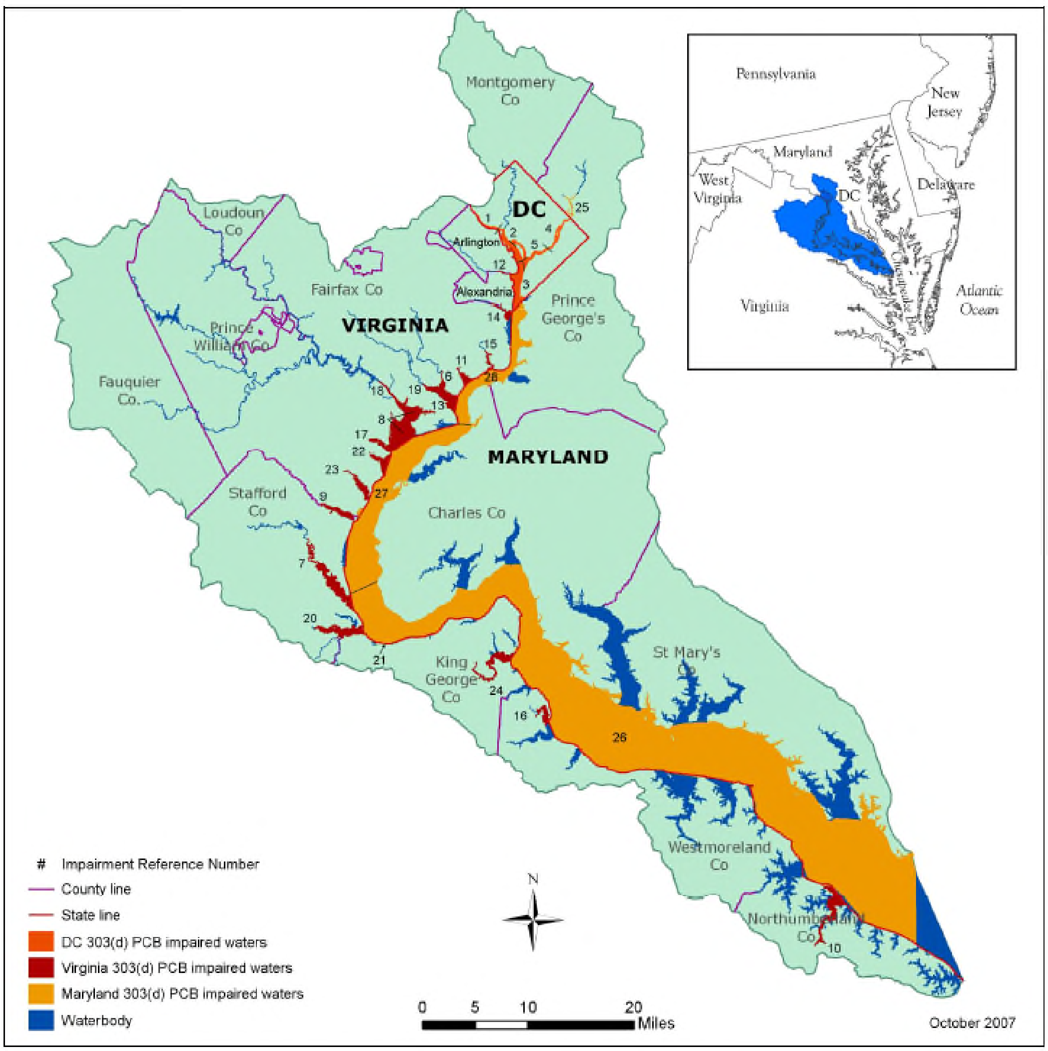


FIGURE 2. PCB impaired waterbodies in the lower Potomac River Basin (from Hayward and Buchanan, 2007).

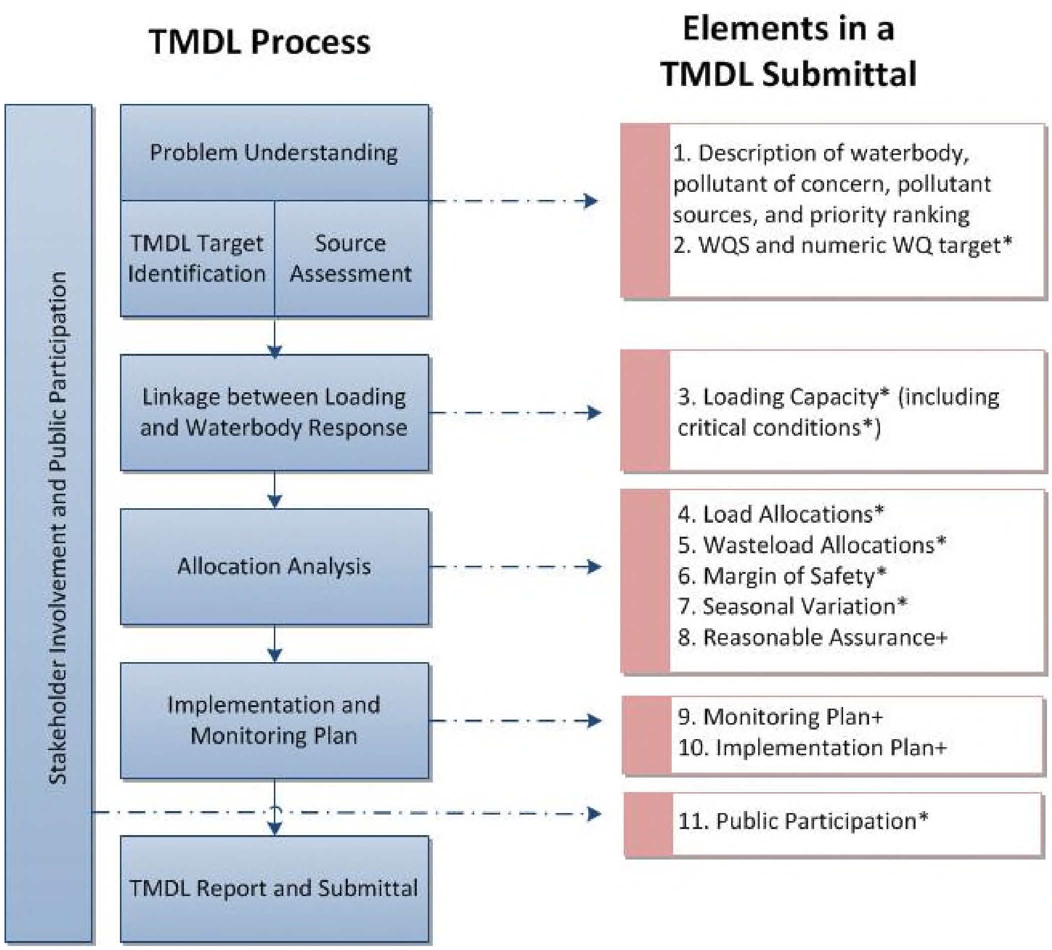


FIGURE 3. TMDL process and elements (from Tetra Tech, 2015).

Activities conducted for the Potomac River PCB TMDL which might be considered in terms of their vulnerability to various climate changes include (but are not limited to):

- Identification of PCB sources and modeling and analysis of associated PCB loads.
- Development and calibration of the linked hydrodynamic and PCB transport and fate model (POTPCB).
- Calculation of new water column PCB concentrations that would be protective of fish tissue concentrations.
- Calculation of PCB loads and load allocations (i.e. running of the POTPCB model with a series of loading scenarios to identify the impacts of individual sources, and then with an iterative series of input load adjustments to characterize a set of loads (the TMDL scenario) that would meet water column targets in all model segments.

- Selection, calculation, and utilization in modeling of various critical flows. For example, it is necessary to account for seasonality and critical conditions related to stream flow, loading, and water quality parameters. Seasonality and critical conditions are captured in the Potomac PCB TMDL using 2005 as the hydrologic design year. Baseline conditions for daily surface flows and loads of total suspended solids and particulate carbon come from 2005. During the period 2002 to 2007 from which flow data were available, Potomac River flows in calendar year 2005 most closely matched the river's long-term harmonic mean flow (the flow condition recommended by EPA as the critical condition for TMDLs for substances whose human health impact is derived from lifetime exposure).
- The relative influences of flows and loading from one modeled river segment to another.
- Accounting for uncertainty in load estimates through calculation of a margin of safety (MOS).

Additional Supporting Information

Figure 4 shows how key steps in the TMDL process are linked to climate change assessment steps. Some key points of linkage include target identification and source assessment, characterization of pathways, assessment and modeling of loading and load reduction options, assessment of water body and ecological responses (risk assessment), remedial investigations and consideration of implementation options for remedial actions. In addition, determinations of waste load allocation are, in part, influenced by the responses of affected organisms/communities. Thus, climate change effects on and relative vulnerabilities of the various river resources identified in the Potomac River/Tributaries (e.g., surface & ground water, sediments, benthic invertebrates, fish tissue (bioaccumulation), birds & mammals, human health) are another linkage of interest.

From the PCB TMDL document (Hayward and Buchanan, 2007): "It is clear that progress toward achieving the Potomac PCB TMDL described in this report will require *significant reductions from point, nonpoint, and atmospheric sources of PCBs to the estuary*. The jurisdictions have agreed to proceed with an adaptive implementation approach using additional data collected concurrently with activities to reduce PCB loadings. New data and information will not necessarily re-open the TMDL, but the *TMDL and allocation scenarios can be changed if warranted by new data and information*."

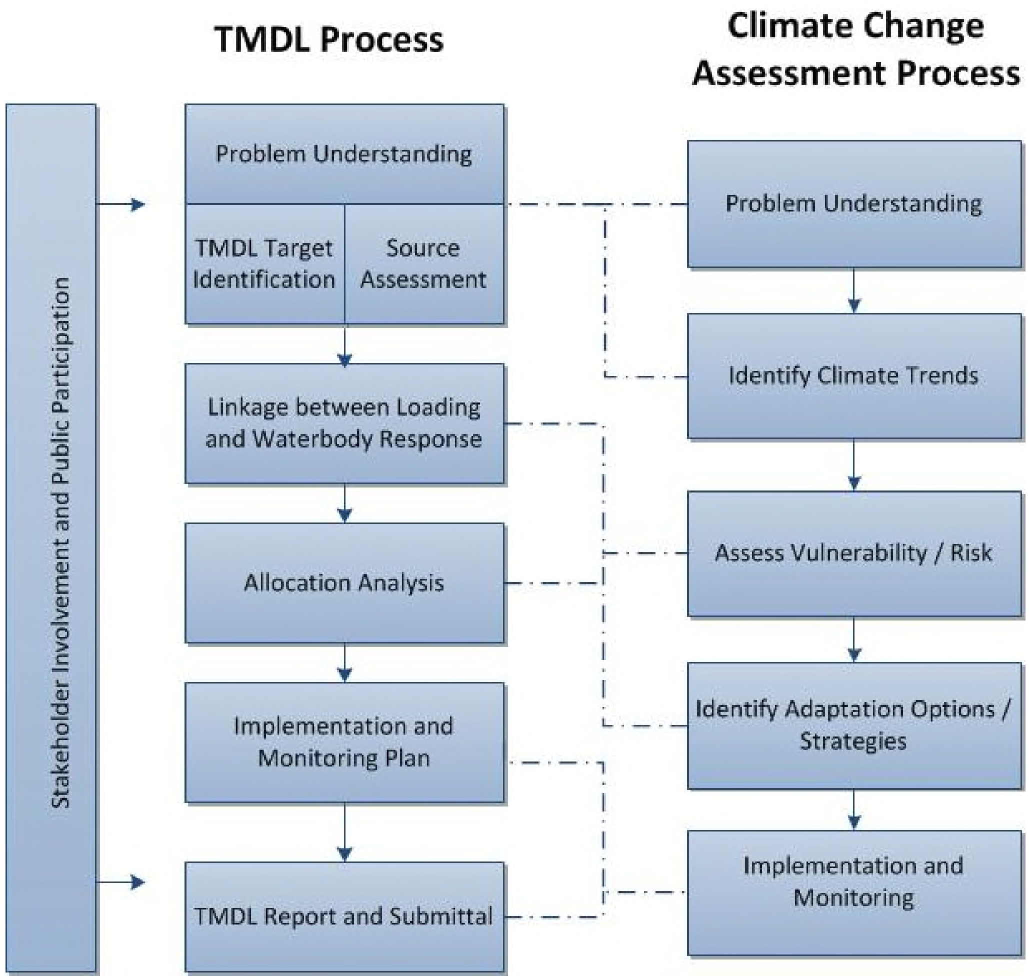


FIGURE 4. Linkages between TMDL and climate change assessment processes (from Tetra Tech, 2015).

Example Management Activity 3: Vulnerability of Virginia Waste Sites to SLR

Supporting Example: Hampton Roads/Norfolk Area Waste Site Facilities, Vulnerability to SLR.

Example Activity

Overarching questions regarding the locations and nature of key sources of contaminants to the Chesapeake Bay help drive the formulation of approaches (or strategies) and objectives for remediation. Ongoing and future climate changes, including sea level rise (SLR), storm surge, and associated frequencies of flooding, can impact land-based industrial or waste facilities and contaminated sediment sites, potentially increasing releases from already identified sources, or placing new sources at risk of contaminant release. This represents a large spatial scale (e.g., Bay-wide) of impact, with the potential of altering assumptions about the processes and pathways that contribute loadings to the Bay, and thus affecting strategy/approach-level decisions.

The example being considered is to examine the future risk of inundation of low-lying lands in the Hampton Roads/Norfolk, VA area of the lower Bay due to SLR and storm surge, and the associated threats to various types of waste facilities. This will be done using information from the Climate Central Surging Seas Risk Finder on the numbers of various types of waste-associated facilities in Virginia under future risk of inundation with SLR. In particular we will focus on EPA-listed waste sites (as well as some other facilities, structures, roads, etc.) that would be inundated at 5-feet above local high tide as a starting point for considering the potential additional exposure risks. This example provides an avenue for considering the implications of the vulnerabilities of these facilities, and how such information could affect strategies for meeting work group goals of reducing contaminant loading and effects in the Bay.

As an additional example, we present outputs from an EPA effort (by the Exposure Analysis and Risk Characterization Group, EPA Office of Research and Development) that identified and mapped waste facilities in the Norfolk, VA/Hampton Roads area of the southern Chesapeake Bay, as well as associated mapping of hurricane storm surge projections. The original objective for use of these results was to consider on a regional, rather than a single-site basis, how to sustain the functionality of municipal waste management across a system of sites that supports a large population, under the risk of a storm that could take out a few to several of the contributing units within the regional waste management system. This example provides an additional picture of how climate changes in SLR and storm surge can spatial pattern and number of waste facilities that may be at risk in the future.

Additional Supporting Information

Figure 5 maps areas of risk by category (low/medium/high) for inundation in the Hampton Roads/Norfolk area of Virginia based on SLR that would inundate 5 ft above mean high water (from the Climate Central Surging Seas Risk Finder (http://riskfinder.climatecentral.org/state/virginia.us?comparisonType=county&forecastType=NOAA2017_int_p50&impact=EPA&impactGroup=Contamination+Risks&level=5&unit=ft).

FIGURE 5. .Map of relative risk levels for inundation in the Hampton Roads/Norfolk area of Virginia based on SLR that would inundate 5 ft above mean high water (from the Surging Seas Risk Finder).

This website and associated report (Strauss et al. 2014) also gives results on number of facilities, structures, roads, etc. that would be inundated at 5-feet above local high tide (as well as for other increments of SLR). Some examples of infrastructure in Virginia on land less than 5 feet above the local high tide line include:

- 54,000 homes ($17.4 billion in property value, 107,000 residents, 1/3 in Virginia Beach).
- 1 power plant.
- 148 EPA-listed sites, screened to include mostly hazardous waste sites, facilities with significant hazardous materials, and wastewater generators.
- 32% of Norfolk Naval Shipyard, with one quarter of that area apparently protected or isolated.
- 13% of Naval Station Norfolk.

For context, in Delmarva as a whole on unprotected land below 5 feet there are:

- 183,000 people, 116,000 homes, $42 billion in property value.
- 401 EPA-listed sites.

Using enumeration of sites below 5 feet, as a moderate future SLR projection, Figure 6 maps a categorical summary of risk levels along Bay coastal counties in Virginia. The increasing risk (% likelihood) of flooding >5 feet in Virginia from 2016 through 2200 is shown in Figure 7.

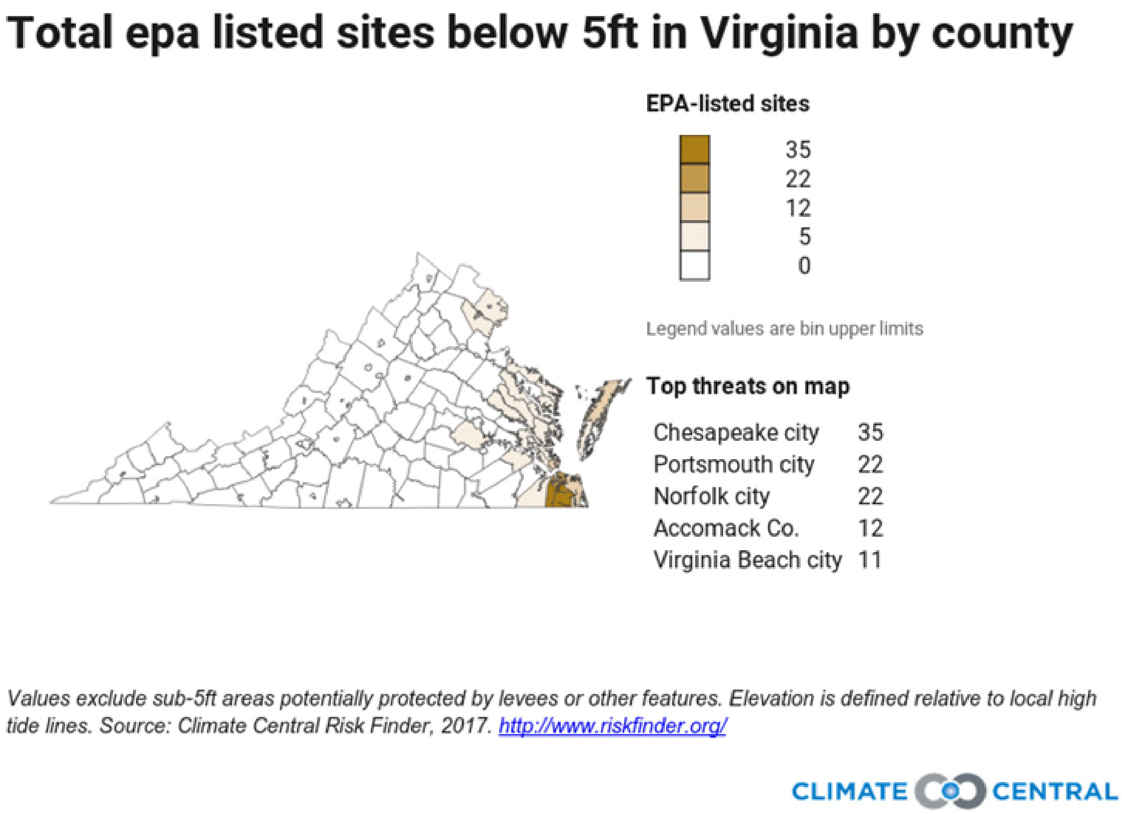


FIGURE 6. Threats to EPA-listed sites in Virginia based on SLR that would inundate 5 ft above mean high water (from the Surging Seas Risk Finder).

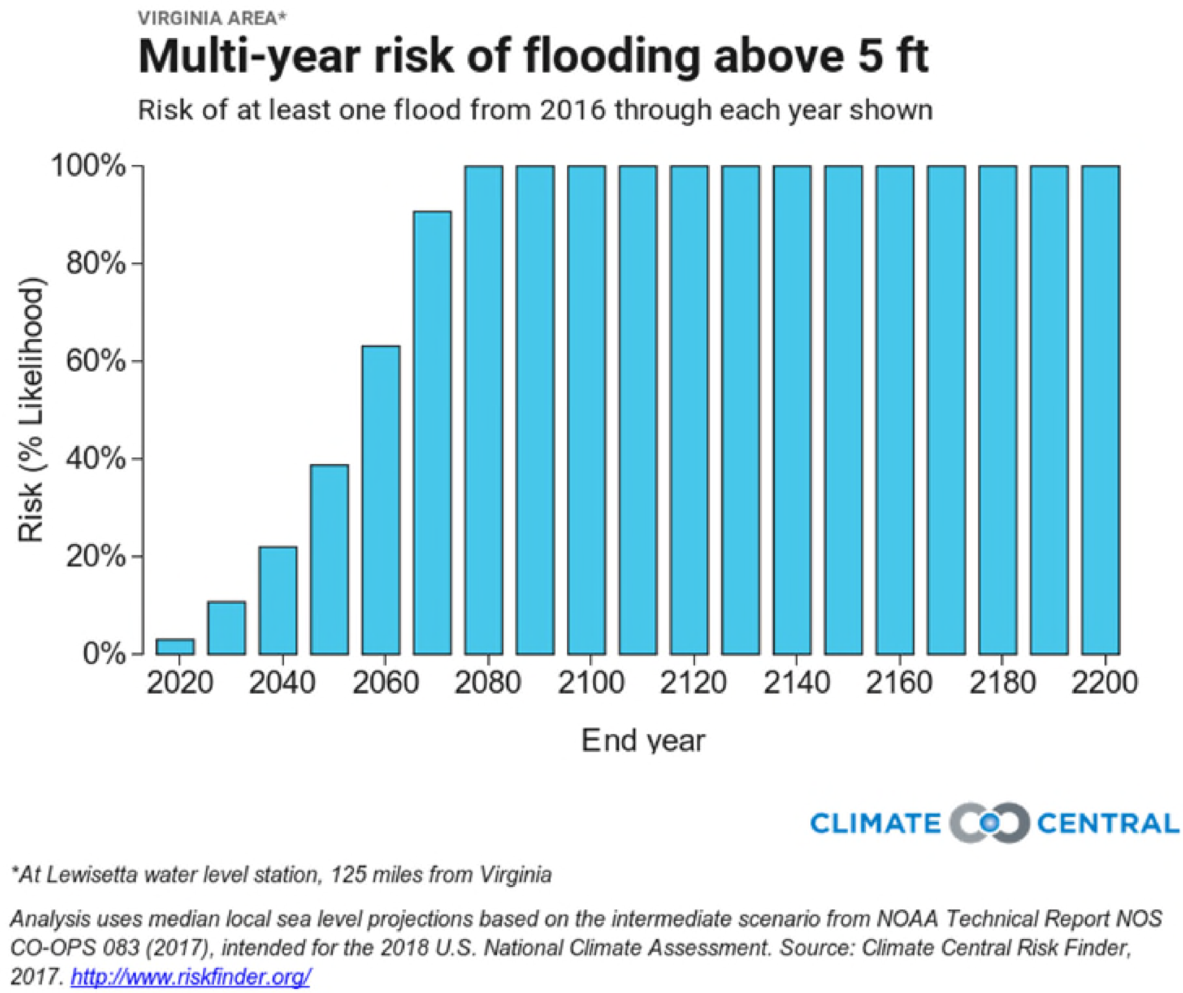


FIGURE 7. Multi-year risk of flooding above 5 feet in Virginia (from the Surging Seas Risk Finder, http://riskfinder.climatecentral.org/state/virginia.us?comparisonType=county&forecastType=NOAA2017_int_p50&impact=EPA&impactGroup=Contamination+Risks&level=5&unit=ft).

For the example of waste facilities in the Norfolk/Hampton Roads area that serve the large regional population for municipal waste disposal, Table 1 lists the related waste facilities and they are mapped in Figure 8. Projections of the portions of land in this area that would be inundated by storm surges associated with hurricanes of different categories is shown as an overlay on the waste facilities map in Figure 9. This information gives some perspective on risks of waste facility inundation.

TABLE 1. List of Waste Facilities in the Norfolk, VA Region from I-WASTE

Name	Type
Hampton-NASA Steam Plant	Combustion/MSW Combustion Facilities
Wheelabrator Portsmouth Inc.	Combustion/MSW Combustion Facilities
Wheelabrator Portsmouth Inc.	Combustion/MSW Combustion Facilities
York County Transfer Station	Compost Facility

Marpol	Decontaminated Wastewater/Centralized Waste Treatment
Petrochem Recovery Services Inc.	Decontaminated Wastewater/Centralized Waste Treatment
HRSD – Army Base Sewage Treatment	Decontaminated Wastewater/POTW
HRSD – Boat Harbor Sewage Treatment	Decontaminated Wastewater/POTW
HRSD – Nansemond Sewage Treatment Plant	Decontaminated Wastewater/POTW
HRSD – Virginia Initiative STP	Decontaminated Wastewater/POTW
HRSD – York River Sewage Treatment	Decontaminated Wastewater/POTW
VDOT Interstate 64 Goochland Rest Area	Decontaminated Wastewater/POTW
Naval Base Norfolk	Government-Owned Land/Facilities
Portsmouth City - Craney Island Landfill	Landfills/Inert or Construction & Demolition (C & D) Landfills
Virginia Beach Landfill No. 2	Landfills/Inert or Construction & Demolition (C & D) Landfills
USA Waste Of Virginia Landfills - Bethel Landfill	Landfills/MSW Landfills
Virginia Beach Landfill No. 2	Landfills/MSW Landfills
Huntington Ingalls Incorporated-NN Shipbldg Div	Other/Electric Arc Furnaces
HRSD - James River Sewage Treatment	POTW; Other/Electric Arc Furnaces
Area Container Services Inc	Transfer Station
WMI / Recycle America Hampton Rds	Transfer Station
BFI / Chesapeake Transcyclery	Transfer Station
Craney Island Mat Rec Fac	Transfer Station
Newport News Materials Recovery	Transfer Station
Safety-Kleen / Chesapeake County	Transfer Station
SPSA / Chesapeake Transfer Station	Transfer Station
SPSA / Landstown Transfer Station	Transfer Station
VPPSA - King William County Transfer Station	Transfer Station

FIGURE 8. Map of Waste Facilities in the Norfolk, VA Region from I-WASTE.

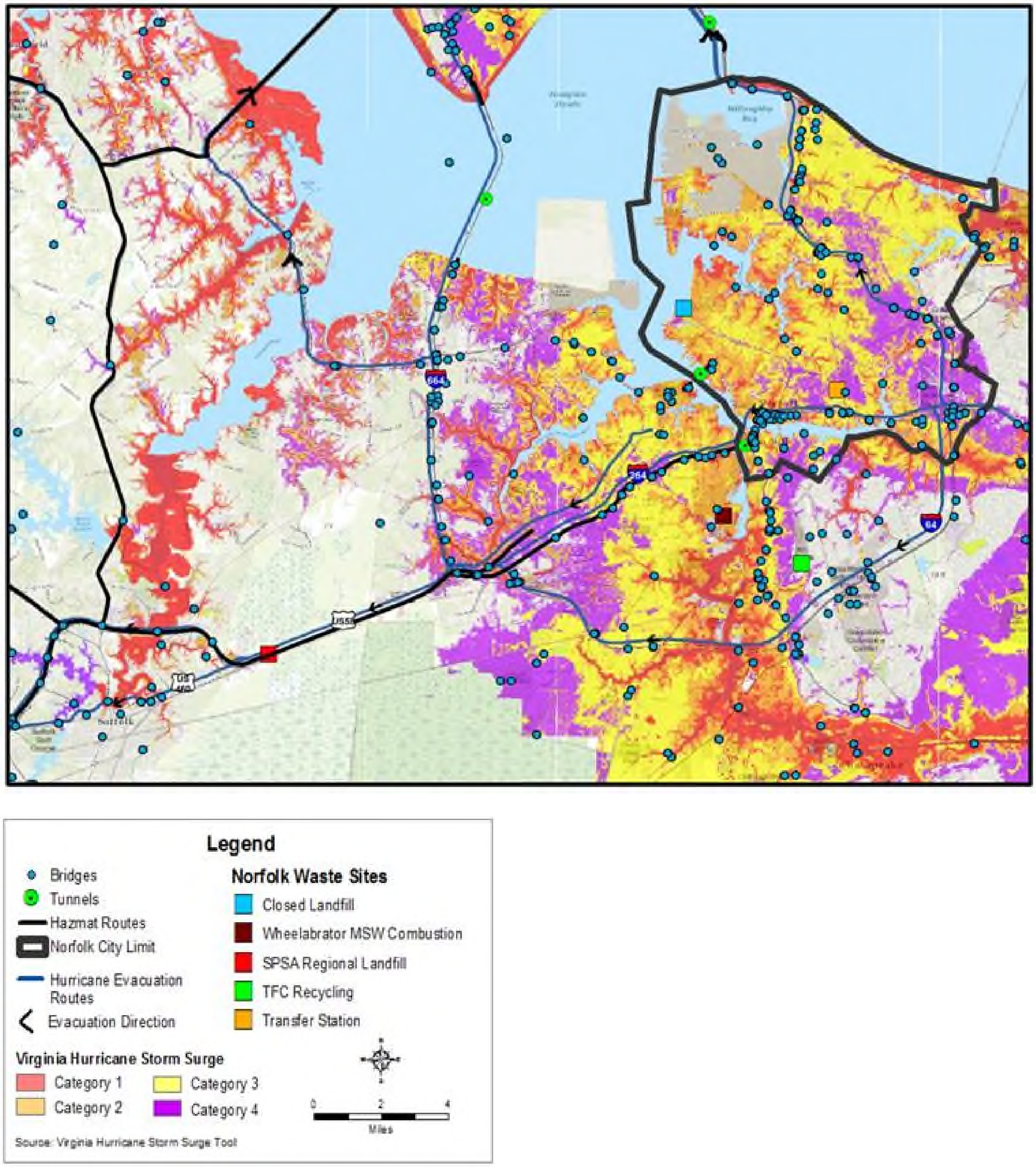


FIGURE 9. Overlap of Waste Facilities in the Norfolk, VA Region from I-WASTE with Hurricane Storm Surge Categories (from the Virginia Storm Surge Tool, http://www.vaemergency.gov/prepare-recover/threats/hurricane-storm-surge-maps/). From the Virginia Storm Surge Tool website – "'Storm surge" is an abnormal and potentially dangerous rise of water pushed to the shore by strong winds from a hurricane or tropical storm. It is also the main reason that evacuations are ordered. The storm surge zones of this map indicate the maximum area that may be inundated by a hurricane of a given value. This map is provided by the Virginia Department of Emergency Management (VDEM).

References

Haywood, H. C. and C. Buchanan. 2007. Total maximum daily loads of polychlorinated biphenyls (PCBs) for tidal portions of the Potomac and Anacostia rivers in the District of Columbia, Maryland, and Virginia. Interstate Commission on the Potomac River Basin. ICPRB Report 07-7. Rockville, MD.

Strauss, B., C. Tebaldi, S. Kulp, S. Cutter, C. Emrich, D. Rizza, and D. Yawitz. 2014. Virginia and the Surging Sea: A Vulnerability Assessment with Projections for Sea Level Rise and Coastal Flood Risk. Climate Central Research Report. 31 pp. www.climatecentral.org.

Tetra Tech. 2015. EPA Region 10 Climate Change and TMDL Pilot Process Roadmap: Conceptual Framework and Procedures. 13 pp.

Attachment 5

CBT Project: Cross-Goal Climate Resiliency Analysis and Decision-Making Matrix and Implementation Methodology

Decision Matrices Completed for the Toxic Contaminants Workgroup

CLIMATE-SMART ADAPTATION DESIGN – CBP WORK PLAN/KEY ACTIONS

Fill this out last

Climate-informed actions and performance targets – Documentation of Results *Check the appropriate box*	
☐	Keep existing actions and performance targets without modification. *If yes, provide reasoning.*
X	Use existing actions and performance targets but with minor modifications *If yes, note modifications and the reasoning behind them.*
☐	Use new actions/performance targets or significantly adjust existing ones. *If yes, provide the reasoning.*

Climate-Smart Adaptation Design at the CBP Work Plan/Key Actions Level

Current Action	*What is the CBP action being considered?*	
	Current key action or specific performance target	Coan River PCB Remediation (see case study description for details)
Step 1: Screening for Actions	*Will the action be substantially influenced by climate change?*	
	Screening for actions.[4] If yes (influenced by climate change), proceed; if no, set aside the action (check the first box in the check list below).	Yes, potentially (proceed with subsequent questions).

[4] This is a screening question to identify and set aside (not proceed with climate-smart revision) actions not likely to be affected by climate change. For example, model improvement efforts will not themselves be directly influenced by climate change, although it would be important to include climate change into CBP models used for planning purposes.

<table>
<tr><td rowspan="6">Step 2: Category 1 Considerations:
Climate change effects on the stressors and systems</td><td colspan="2">What stressor(s), characterized by source if appropriate, are addressed by or accounted for in the action?</td></tr>
<tr><td>Specific stressor(s) and source(s). [List separately, include uncertainty and relative sensitivity (low, medium, high.]</td><td>• PCB contamination of soils with erosion and transport of contaminated sediments to the river.
• PCB contamination of GW by leaching from overlying contaminated soils; with mobility of the GW to the Coan River.
• Air deposition of PCB, creating diffuse ground contamination with PCB. Note – insufficient information on air deposition of PCB (a data gap).
• PCB contamination of stormwater runoff (differentiate between point and nonpoint source (which are regulated differently).
• Wastewater.</td></tr>
<tr><td colspan="2">What are the key climate change impacts (direction, magnitude, mechanism, uncertainty) on the stressor(s)/source(s)?</td></tr>
<tr><td>Key climate influences on stressor(s)/sources(s)</td><td>• The high and accelerating rate of SLR in Chesapeake Bay will increase inundation/flooding of land adjacent to the river, though flooding effects are not likely to be uniform across the landscape; new or increased flooding of contaminated areas including ‘hot spots’ of legacy soil contamination potentially, may increase direct transfer (leaching) of PCB contaminants to the river. Unknown magnitude, medium to high uncertainty.
• Higher water levels from accelerated SLR combined with increased frequency and severity of storms will increase delivery of shoreline energy, and will therefore likely increase erosion of potentially contaminated soils. Medium magnitude, medium uncertainty.
• Increased rainfall (applies throughout all seasons) and increased frequency and severity of storms will increase runoff, results in more contaminated runoff to the river. Medium magnitude, medium uncertainty.
• Increased flooding, along with increased rainfall during winter, is likely to increase infiltration and leaching of PCBs from contaminated soils to the GW. Uncertain magnitude, undefined uncertainty.
• Accelerated SLR will alter Bay salinity patterns, which in combination with increasing temperatures and altered patterns of flooding will impact PCB biogeochemistry, which may affect mobility, transport, toxicity, and treatment options. Moderate magnitude, high uncertainty.
• Decreased precipitation during the summer and increases during the winter will alter seasonal patterns of contaminant delivery; this influence may differ between dry and wet deposition of PCB.
• Impacts of climate change such as increased precipitation and more frequent and severe storms, may exceed capacities of BMPs or green infrastructure such as containment structures, etc. and thereby change into sources rather than sinks of contaminates. Low magnitude, medium uncertainty.
• Increasingly frequent wildfires may increase the availability of PCB.</td></tr>
<tr><td colspan="2">What is the expected timing of climate change impacts on the action? This could include seasonal patterns or temporal trends of the climate change effects of concern.</td></tr>
</table>

	Timing of climate change effects	• Accelerated SLR is already occurring, there is evidence that it is accelerating, and will continue to increase. • More intense storms are already occurring and are likely to increase, though confidence in ability to project these changes is low. • Seasonal timing of rainfall/runoff is already changing, with increased rainfall in winter, decreased in summer. • Increasing temperatures, as well as altered estuarine and ocean acidity, are already occurring and will continue to increase. • The effects of climate changes (SLR, temperature) that may alter the biogeochemistry of PCBs and its resulting toxicity, as well as impact the metabolism of organisms impacted by PCBs, are likely to be long term and cumulative.
	Implications for how effectiveness of actions or progress towards performance targets is measured.	
	How is implementation being tracked (e.g. indicators, metrics)?	• As part of TMDL implementation, PCB concentrations (ng/l) will be measured at various points in the river, and presumably in runoff, and loads calculated; also fish tissue concentrations (ppb) will be measured. However, there are many current sources of PCBs, and authorized uses, so source tracking is complicated for regulation. This makes tracking and measuring progress hard. • Decadal scale is used to achieve PCB goals, anticipate up to 100 years to fully remove the toxin. • Fish tissue used for tracking, but this is long term monitoring. Also very different methods of measurements across states. • Frequency of Fish Consumption advisories.
	How will climate change alter the ability to carry out progress measurements or monitoring protocols?	Given climate change effects discussed above, it is possible that the timing (e.g., season), and/or locations of sampling may have to be reconsidered. • PCB availability, affected by seasonality, will need to be taken into account, as this may change with climate change.

Step 3: Category 2 Considerations: **CC** implications for functionality of actions		
	How will climate change impacts on the stressor(s)/source(s) impact effectiveness of the action?	
	Indirect effects on action	• Greater erosion and runoff of contaminated sediments could exceed filter strip filtering capacity. • Increased stormwater and runoff volumes could exceed previously planned filter strip capacity. • Greater volumes of contaminated GW could exceed otherwise planned pumping/treatment capacities. • Possible biogeochemical changes due to increasing temperatures, altered salinity, may impact treatment efficacy, and may have to be revised. • Stormwater effluent concentrations may change over time, requiring modified treatment plans.
	How will climate change impacts directly on the action impact effectiveness of the action?	
	Direct effects on action	• Filter strips placed adjacent to the river would become inundated over time due to SLR, and become dysfunctional. • More frequent and intense storms may directly damage buffer strips. • The potentially increased infiltration (from inundation, more frequent flooding, increased rainfall) and resulting greater volumes of contaminated GW may overwhelm previously expected pumping/treatment volumes. • If sediment capping at the hot spot site is included, inundation during more frequent floods, or from SLR, may degrade the sediment caps.
	What are climate change-related time frame considerations or constraints on achieving or implementing the action [e.g., urgency, synergies or dependencies on other actions /work plans]?	
	Time frame considerations	• Though the timing of implementation of this action would be linked to the TMDL process, the accelerating pace of SLR suggests a moderate urgency to this action. • Frequency of permit turnover may constrain the timeline of implementation.
	What changes are needed to adapt the action to accommodate the combination of direct and indirect climate change effects over the target periods for implementing the action? Or are there other ideas for actions suggested by these results?	
	Climate-driven adaptations needed	• Review and revise, as needed, the GW treatment process to assure efficacy in the future under increasing temperatures and changing biogeochemistry. • Increase the width of filter strips, and/or consider other modifications (e.g., composition of the vegetation?) to accommodate the greater runoff volumes. • Review and resize, as needed, the GW pumping and treatment facilities to accommodate the larger volumes of contaminated GW • Review the proposed location(s) of GW pumping/treatment facilities to avoid flooding/inundation from SLR. • Consider strip placement, and/or plan for need to move/renew the strips as SLR inundates the leading edges. • If sediment capping is used, redesign to withstand flooding, inundation. • Dredge sediment of retention ponds to mitigate potential releases, if any occur at the site.

Step 4: Climate-Designed Action	***Climate-Smart Work Plan/Action***	
	Description	• [discuss]

Notes: What are the information/data gaps and research needs to better understand climate impacts or uncertainties, social or ecological effects, design needs, etc.
• More information on air deposition of PCB. • Additional clarification of dry or wet deposition.

Notes: What issues, lessons, or spatial or temporal considerations emerged that might be common across other sites, or Bay-wide? How might these affect higher levels of planning (strategies, approaches)?

Notes: interactions needed with other GITs/Workgroups that are key to the actions

*Are there any key actions missing?**

* *Actions that may be needed to more comprehensively address the climate change impacts identified. The purpose is to identify any key vulnerabilities that are not sufficiently addressed in the existing plan and to craft additional actions to fill those gaps. The ecologically-oriented list of general adaptation strategies from the Climate-Smart guide can be used to help in brainstorming these, though actions relevant to implementing those strategies/approaches in your specific management/ecosystem context may need to be brainstormed and/or researched in the literature. Start by listing any new actions listed in the last question of Step 3.*

CLIMATE-SMART ADAPTATION DESIGN – CBP STRATEGIES/MANAGEMENT APPROACHES OR GOALS/OUTCOMES

Fill this out last

Climate-informed strategies/mgmt. approaches (or goal/outcome) – Documentation of Results *Check the appropriate box*	
☐	Keep existing strategies/approaches (or goal/outcome) without modification *If yes, provide reasoning*
X	Use existing strategies/approaches (or goal/outcome) but with minor modifications *If yes, note modifications and the reasoning behind them*
☐	Use new strategies/approaches (or goal/outcome) or significantly adjust existing ones. *If yes, provide the reasoning*

Climate Smart Adaptation Design at the CBP Strategy/Mgmt. Approach (or Goals/Outcomes) Level

Current Strategy	*What is the CBP strategy/ (or goal/outcome) being considered?*	
	Current strategy/mgmt. approach (or goal/outcome)	Potomac River PCB TMDL
Step 1 Screening	*Will the strategy (or goal) be influenced by climate change?*	
	Screening for strategies (or goals)[5]. If yes (influenced by climate change), proceed; if no, set aside the strategy (check the first box in the check list above).	Yes, potentially (proceed with subsequent questions).

[5] This is a screening question to identify and set aside (not proceed with climate smart revision) strategies/approaches (or goals/outcomes) not likely to be affected by climate change. For example, education or outreach efforts will not themselves be directly influenced by climate change, although it would be desirable to include climate change information into these types of efforts. Therefore, it would not be necessary to apply this process directly to revision of such strategies. It should be noted that strategies such as development of energetic, system, planning, or other models also are not directly impacted by climate change; however, if climate change effects have not heretofore been considered in the model, then redesign of the model would be recommended.

<table>
<tr><td rowspan="10">Step 2: Category 1 Considerations:
Climate change effects on the stressors and systems</td><td colspan="2">What stressor(s), characterized by source if appropriate, are addressed by or accounted for in the strategy?</td></tr>
<tr><td>Specific stressor(s) and source(s). [List separately, include uncertainty and relative sensitivity (low, medium, high.]</td><td>• Water, sediment, and fish tissue (bioaccumulation) contamination with PCBs in 28 impaired (under CWA) water body segments in the Potomac Rivers & tributaries from a variety of sources. Objective of the Potomac PCB TMDL is “… to ensure that the fish consumption use is protected in each of the impaired waterbodies”.</td></tr>
<tr><td colspan="2">What are the key climate change impacts (direction, magnitude, mechanism, uncertainty) on the stressor(s)/source(s), relevant to the resource?[6]</td></tr>
<tr><td>Key climate influences on stressor(s)/sources(s)</td><td>A variety of sources/pathways for PCBs entering the environment include primary sources such as electrical equipment, secondary sources such as wastewater treatment by-products, and pathways such as stormwater runoff contaminated by air deposition or contaminated sites. From this, key climate change influences on these sources include:
• SLR (a high and accelerating rate in Chesapeake Bay) leading to more frequent flooding and/or continuous inundation over greater portions of low-lying coastal areas of the Bay, such that more waste facilities and/or legacy PCB contaminated sites, as well as land area contaminated by air deposition, will become PCB sources of concern.
• Greater erosion (of contaminated soils) and stormwater runoff from increases in rainfall and increased frequency and severity of (winter) storms.
• Greater runoff of untreated stormwater contaminated from non-point and diffuse sources (e.g., electrical equipment, contaminated sites, air deposition) due to increases in rainfall and increased frequency and severity of storms.
• Episodic wastewater treatment plant overflows due to increased inundation/flooding of shoreline waste facilities from SLR, more precipitation, and increased frequency/severity of storms.
• Decreased precipitation during the summer and increases during the winter may alter seasonal patterns of contaminant delivery.</td></tr>
<tr><td colspan="2">What are the key climate change impacts directly affecting the resource (direction, magnitude, mechanism, uncertainty)?</td></tr>
<tr><td>Key climate influences on target resource(s)</td><td>• [In this case the target ‘resource’ for this strategy is a stressor, so this question can be skipped and climate change impacts addressed under the previous question.]</td></tr>
<tr><td colspan="2">Over what timeframe will key climate change impacts affect targeted resources? Are there seasonal patterns or other short- or long-term temporal factors of the climate change effects of concern?</td></tr>
<tr><td>Timing of climate change effects</td><td>• Seasonal timing of rainfall/runoff is already changing, with increased rainfall in winter, decreased in summer.
• SLR is already occurring, there is evidence that it is accelerating, and will continue to increase.
• More intense storms are already occurring and are likely to increase, though confidence in ability to project these changes is low.</td></tr>
</table>

[6] Incorporate information from the notes section of any action-level climate smart decision matrices completed on issues, lessons, or spatial or temporal considerations emerged that might be common across other sites, or be relevant Bay-wide, and how these affect higher levels of planning (strategies, approaches).

	How is progress toward strategy/mgmt. approach (or goal/outcome) measured?	
	How is implementation being tracked (e.g. indicators, metrics?	• Primarily through TMDL implementation plans and associated load reduction modeling. • Secondarily, as part of TMDL implementation, PCB concentrations (ng/l) will be measured at various points in the river, and presumably in runoff, and loads calculated; also fish tissue concentrations (ppb) will be measured.
	How will climate change alter the ability to carry out progress measurement or monitoring protocols?	• Climate change will not impair the ability to model, but will certainly impact the parameters of the modeling. • Climate change may not directly impair ability to monitor for PCBs in water, sediment and fish tissue, but may impact the timing (e.g., season), and/or locations of sampling needed.

<table>
<tr><td rowspan="12">Step 3: Category 2 Considerations:
CC implications for strategies</td><td colspan="2">How will climate change impacts on the resource itself change the condition (affect the quality or quantity) of and/or trends in the target resource?</td></tr>
<tr><td>Direct effects on resource condition</td><td>• n/a</td></tr>
<tr><td colspan="2">How will climate change impacts on the stressor(s) impact the strategy/approach (or goal/outcome)?</td></tr>
<tr><td>Indirect effects on strategy/approach (or goal/outcome)</td><td>• Climate change effects on various hydrologic parameters that are essential to TMDL modeling may be alter due to combined changes in temperature, precipitation patterns, and SLR, such as:
o Critical low, mean, and high flow conditions.
o Seasonality of flows.
o Daily surface flows;
o Total suspend solid and particulate carbon loads.
• Climate changes in temperature, water/sediment chemistry, and biological responses may impact the toxicity of PCBs to fish, invertebrates, and other targets of interest, potentially impacting the relationships between loading and waterbody responses.</td></tr>
<tr><td colspan="2">How will climate change impacts directly on the strategy/approach (or goal/outcome) impact how realistic, achievable, or effect the strategy/approach (or goal/outcome) is?</td></tr>
<tr><td>Direct effects on strategy/approach (or goal/outcome)</td><td>• Greater erosion and runoff of contaminated sediments will increase loadings to the Bay.
• Increased stormwater runoff from areas with various sources (electrical equipment, contaminated sediments, air deposition) will increase loadings to the Bay.
• Increased leaching (resulting from increases in rainfall and flooding) and contamination of GW may increase concerns of contaminated GW contributions to the Bay in contaminated areas with good GW connections.
• Possible biogeochemical changes of PCBs in Bay waters due to increasing temperatures, altered salinity, may impact mobility or toxicity of this contaminant.</td></tr>
<tr><td colspan="2">What are climate change-related time frame considerations or constraints on achieving or implementing the strategy/mgmt. approach (or goal/outcome) [e.g., urgency, synergies or dependencies on other strategies/mgmt.. approaches]?</td></tr>
<tr><td>Time frame considerations</td><td>• Several PCB (and potentially other) TMDLs exist or are under development for various areas around Chesapeake Bay (e.g., for the Potomac & Anacostia, James, Elizabeth rivers). They are in various stages of development or implementation. Progress on these are in part driven by regulatory requirements. As such, timely inclusion of climate change impacts on these TMDLs and associated implementation plans is needed.</td></tr>
<tr><td colspan="2">What changes are needed to modify the strategy/mgmt. approach (or goal/outcome) to accommodate the combination of direct and indirect climate change effects or the target periods for implementing the strategy? Or are there other ideas for strategies suggested by these results?</td></tr>
<tr><td>Climate-driven adaptations needed</td><td>• Review/revise hydrologic (and/or linked) models used in TMDL load allocation development.
• Include appropriate revisions to critical flows in models.</td></tr>
</table>

		• Identify additional PCB sources of concern based on vulnerability to flooding/inundation, and include in source assessments and TMDL models. • Review regions/locations where increases in GW contamination and/or volumes with climate change will be substantial, and include these new or increased GW sources in models and source assessments. • Review existing research (or encourage additional work to fill knowledge gaps) on changes in PCB toxicity or *in situ* chemical dynamics, and include in assessment of waterbody responses to loadings.

Step 4: Climate-Designed Strategy	***Climate Smart Strategy/Management Approach (or Outcome)***	
	Description	• [discuss]

Notes: What are the information/data gaps and research needs to better understand climate impacts or uncertainties, social or ecological effects, design needs, etc.

Notes on interactions needed with other GITs/Workgroups that are key to the planned strategies/approaches

*Are there any key strategies/approaches or (goal outcomes) missing?**

* *Strategies/approaches that may be needed to more comprehensively address the climate change impacts identified. The purpose is to identify any key vulnerabilities that are not sufficiently addressed in the existing plan and to craft additional strategies/approaches to fill those gaps. The ecologically-oriented list of general adaptation strategies from the Climate Smart guide can be used to help in brainstorming these. Start by listing any new strategies/management approaches listed in the last question of Step 3.*

CLIMATE-SMART ADAPTATION DESIGN – CBP STRATEGIES/MANAGEMENT APPROACHES OR GOALS/OUTCOMES

Fill this out last

Climate-informed strategies/mgmt. approaches (or goal/outcome) – Documentation of Results *Check the appropriate box*	
☐	Keep existing strategies/approaches (or goal/outcome) without modification *If yes, provide reasoning*
X	Use existing strategies/approaches (or goal/outcome) but with minor modifications *If yes, note modifications and the reasoning behind them*
☐	Use new strategies/approaches (or goal/outcome) or significantly adjust existing ones. *If yes, provide the reasoning*

Climate Smart Adaptation Design at the CBP Strategy/Mgmt. Approach (or Goals/Outcomes) Level

Current Strategy	*What is the CBP strategy/ (or goal/outcome) being considered?*	
	Current strategy/mgmt. approach (or goal/outcome)	Vulnerability of Virginia Waste Sites to SLR
Step 1 Screening	*Will the strategy (or goal) be influenced by climate change?*	
	Screening for strategies (or goals)[7]. If yes (influenced by climate change), proceed; if no, set aside the strategy (check the first box in the check list above).	Yes, potentially (proceed with subsequent questions).

[7] This is a screening question to identify and set aside (not proceed with climate smart revision) strategies/approaches (or goals/outcomes) not likely to be affected by climate change. For example, education or outreach efforts will not themselves be directly influenced by climate change, although it would be desirable to include climate change information into these types of efforts. Therefore, it would not be necessary to apply this process directly to revision of such strategies. It should be noted that strategies such as development of energetic, system, planning, or other models also are not directly impacted by climate change; however, if climate change effects have not heretofore been considered in the model, then redesign of the model would be recommended.

Step 2: Category 1 Considerations: Climate change effects on the stressors and systems	*What stressor(s), characterized by source if appropriate, are addressed by or accounted for in the strategy?*	
	Specific stressor(s) and source(s). [List separately, include uncertainty and relative sensitivity (low, medium, high.]	PCB (and possibly other) contaminant sources to Chesapeake Bay. Key sources include (from Schueler and Youngk, 2015; Toxic Contaminants Policy and Prevention Outcome Management Strategy, 2015–2025, v.1): • Leaking transformers (significant quantities of PCBs are still used in existing electrical transformers), capacitors in small appliances, & fluorescent light ballasts. • Atmospheric deposition, especially falling on impervious surfaces & washed off during storm events. • Eroded or re-suspended soil particles contaminated by PCBs in the past, gradually working their way through the watershed; especially in highly urban watersheds & especially with legacy industrial sites; strong association with impervious cover; brown fields. • Wastewater treatment by-products.
	What are the key climate change impacts (direction, magnitude, mechanism, uncertainty) on the stressor(s)/source(s), relevant to the resource?[8]	
	Key climate influences on stressor(s)/sources(s)	• [In this case the target 'resource' for this strategy is a stressor, so this question can be skipped and climate change impacts addressed under the next question.]
	What are the key climate change impacts directly affecting the resource (direction, magnitude, mechanism, uncertainty)?	
	Key climate influences on target resource(s)	• SLR (a high and accelerating rate in Chesapeake Bay) leading to more frequent flooding and/or continuous inundation over greater portions of low-lying coastal areas of the Bay, such that more waste facilities and/or legacy PCB contaminated sites, as well as land area contaminated by air deposition, will become PCB sources of concern.
	Over what timeframe will key climate change impacts affect targeted resources? Are there seasonal patterns or other short- or long-term temporal factors of the climate change effects of concern?	
	Timing of climate change effects	• SLR is already occurring, there is evidence that it is accelerating, and will continue to increase. • More severe storms are already occurring and are likely to increase, creating increasing concerns with respect to storm surge, though confidence in ability to project these changes is low.
	How is progress toward strategy/mgmt. approach (or goal/outcome) measured?	
	How is implementation being tracked (e.g. indicators, metrics?	• PCB sources are identified as part of the TMDL process, e.g., source tracking studies.
	How will climate change alter the ability to carry out progress	• n/a

[8] Incorporate information from the notes section of any action-level climate smart decision matrices completed on issues, lessons, or spatial or temporal considerations emerged that might be common across other sites, or be relevant Bay-wide, and how these affect higher levels of planning (strategies, approaches).

	measurement or monitoring protocols?	

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<tr><td>Direct effects on resource condition</td><td>• n/a</td></tr>
<tr><td colspan="2">How will climate change impacts on the stressor(s) impact the strategy/approach (or goal/outcome)?</td></tr>
<tr><td>Indirect effects on strategy/approach (or goal/outcome)</td><td>• Greater damage from increasingly severe storms may increase PCB leakage from source facilities, including electronic equipment.</td></tr>
<tr><td colspan="2">How will climate change impacts directly on the strategy/approach (or goal/outcome) impact how realistic, achievable, or effect the strategy/approach (or goal/outcome) is?</td></tr>
<tr><td>Direct effects on strategy/approach (or goal/outcome)</td><td>• SLR will expose increasing areas of flow-lying coastal land to inundation, and/or more frequent flooding associated with more severe storms and associated storm surge.
• Greater erosion and runoff of contaminated sediments will increase loadings to the Bay.</td></tr>
<tr><td colspan="2">What are climate change-related time frame considerations or constraints on achieving or implementing the strategy/mgmt. approach (or goal/outcome) [e.g., urgency, synergies or dependencies on other strategies/mgmt.. approaches]?</td></tr>
<tr><td>Time frame considerations</td><td>• SLR is already occurring, there is evidence that it is accelerating, and will continue to increase.
• More intense storms are already occurring and are likely to increase, though confidence in ability to project these changes is low.
• Given the large effort and relative long time it takes to develop and then implement a TMDL, any large scale (e.g., Bay-wide) revision of key PCB sources should probably be initiated quickly.</td></tr>
<tr><td colspan="2">What changes are needed to modify the strategy/mgmt. approach (or goal/outcome) to accommodate the combination of direct and indirect climate change effects or the target periods for implementing the strategy? Or are there other ideas for strategies suggested by these results?</td></tr>
<tr><td>Climate-driven adaptations needed</td><td>• For each Bay tributary or region for which a PCB TMDL is or has been developed, conduct a GIS mapping study that overlays maps of potential PCB source locations (including various existing or historic industrial sites, known landfill or contaminated sites, etc.) with climate change projections of SLR and storm surge exposure under a reasonable range of climate change scenarios.
• Collect data on/investigate newly identified potential PCB source sites to support estimation of the magnitude of contributed loads.
• Review/revise hydrologic (and/or linked) models used in TMDL load allocation development to incorporate newly identified sources.</td></tr>
</table>

<table>
<tr><td>Step 4: Clim ate-</td><td>Climate Smart Strategy/Management Approach (or Outcome)</td></tr>
</table>

	Description	• [discuss]

Notes: What are the information/data gaps and research needs to better understand climate impacts or uncertainties, social or ecological effects, design needs, etc.

Notes on interactions needed with other GITs/Workgroups that are key to the planned strategies/approaches

*Are there any key strategies/approaches or (goal outcomes) missing?**
Maybe a strategy/approaches is needed to identify, catalogue, and assess new or increasingly vulnerable PCB sources around the Bay, especially in low-lying areas vulnerable to SLR and storm surge.

* *Strategies/approaches that may be needed to more comprehensively address the climate change impacts identified. The purpose is to identify any key vulnerabilities that are not sufficiently addressed in the existing plan and to craft additional strategies/approaches to fill those gaps. The ecologically-oriented list of general adaptation strategies from the Climate Smart guide can be used to help in brainstorming these. Start by listing any new strategies/management approaches listed in the last question of Step 3.*