Climate Change Indicator Implementation Plans: Note to Reviewers

March 7, 2018

Thank you for reviewing one or more of our indicator implementation plans and providing your feedback. We appreciate your contributions!

This note provides some context that may be helpful as you begin your review. It includes background information about the project, our working definition of "indicator," and an explanation of what the implementation plan is (and is not) intended to be. It concludes with some suggested areas of emphasis for your review.

Project Purpose and Background

In 2016, the Chesapeake Bay Program Office (CBPO) began an effort to identify a suite of indicators that can be used to track and analyze trends, impacts, and progress towards advancing "climate resiliency." The chief aim of this initiative is to track progress toward the climate resiliency goal and outcomes in the 2014 Watershed Agreement:

- **Goal:** Increase the resiliency of the Chesapeake Bay watershed, including its living resources, habitats, public infrastructure, and communities, to withstand adverse impacts from changing environmental and climate conditions.
    - **Monitoring and Assessment outcome:** Continually monitor and assess the trends and likely impacts of changing climatic and sea level conditions on the Chesapeake Bay ecosystem, including the effectiveness of restoration and protection policies, programs and projects.
    - **Adaptation outcome:** Continually pursue, design, and construct restoration and protection projects to enhance the resiliency of Bay and aquatic ecosystems from the impacts of coastal erosion, coastal flooding, more intense and more frequent storms and sea-level rise.

To address all facets of the climate resiliency goal and outcomes, the CBPO sought a balance of indicators across three categories:

- Indicators of ***physical climate trends*** based on measurements of physical or chemical attributes of the environment.
- Indicators of ***ecological and societal impact*** that measure a) attributes of ecological systems, particularly attributes that may be influenced by physical climate trends, or b) impacts on society, such as health or economic outcomes.
- Indicators of ***programmatic progress toward resilience*** that quantify resilience or show evidence of learning or adaptation over time. Resilience is the ability to anticipate, prepare for, and adapt to changing conditions and to withstand, respond to, and recover rapidly from disruptions. Responses include management actions such as designating wetland migration corridors, as well as physical actions such as constructing living shorelines in place of hard shoreline structures (e.g., bulkheads) in coastal environments.

The CBPO contracted with Eastern Research Group, Inc. (ERG) to conduct research and lead a systematic, participatory process to identify candidate indicator topics; prioritize topics to include as part of a manageable, cohesive suite of indicators; and lay out an approach to develop each of the proposed indicators. The CBPO has

expressed an interest in developing a suite of indicators that is large enough to cover a wide range of important climate-related issues, yet small enough that it will be feasible to maintain all the indicators with periodic (in many cases, annual) data updates for the foreseeable future. After careful consideration of the scope, ERG recommended a target number of approximately 20 indicators.

What Is an Indicator?

Scientists and policymakers define the term "indicator" in various ways. For the sake of establishing common nomenclature, this project defines an indicator as follows:

- An indicator presents one or more numerical values derived from actual measurements of a state or ambient condition, ecological or societal response, or programmatic action, whose trends over time represent or draw attention to underlying trends in the condition of the environment or measure progress towards a desirable state or condition.

- An indicator as defined here may consist of multiple metrics. In some cases, underlying metrics may be aggregated to create a multi-metric index—for example, an index of biological integrity, which combines several distinct measurements into a single variable. However, this project will not require every indicator to be boiled down to a single variable. An indicator might present two or more variables that characterize different dimensions of a complex issue, possibly in the form of two or more distinct maps or graphs. This is especially true in cases where the variables are not easily combined, or where they provide more explanatory value on their own. For example, the proposed "precipitation" indicator could have one metric that tracks total annual precipitation and another separate metric that tracks the incidence of heavy precipitation events.

Indicator Criteria

After soliciting input and compiling a list of more than 200 potential indicator topics, ERG worked with the Climate Resiliency Workgroup and other partners to screen and prioritize the topics according to four sets of criteria:

1. Fundamental data quality standards that every proposed indicator must be able to meet, either now or in the future

2. "Desirable" data quality considerations to help select the best data source or metric for a given topic, if multiple sources are available

3. "Value-added" criteria to prioritize indicators that will provide the most relevant and useful information for the CBPO and its mission

4. Considerations for assembling the overall suite

The introduction to the final implementation plan will provide a complete description of the criteria in each step. These criteria were designed to focus on indicators that will be useful and relevant to technical users, such as scientists and policy analysts involved in management and oversight. Where possible, the project team considered indicators that are also relevant to a public audience.

About the Implementation Plan

ERG developed this implementation plan to fulfill the following objectives:

- Lay out an initial vision for each indicator in the proposed suite.
- Describe a stepwise process that could be used to develop each indicator.

- For each step in the process, identify likely resource needs to the extent possible, in terms of tools, expertise, CBPO staff time, and funding to engage outside partners if needed.

For each indicator, this plan identifies the status of current development and describes actions or next steps for five general stages:

1. Defining the indicator
2. Collecting data
3. Developing methods to transform the data into an indicator
4. Processing the data
5. Developing a final indicator for the Chesapeake region

Timeframes and costs have been estimated based on available information and based on experience with similar indicator development projects. However, many of these estimates are just general approximations. At best, some of the cost estimates should be taken as an indication of the order of magnitude of the effort required. In some cases, information was insufficient to allow even a ballpark estimate to be generated, due to uncertainties in earlier stages of indicator development that have yet to be completed. These instances are noted as "TBD."

This plan focuses on incremental costs—that is, costs for additional tasks that are not already covered (and funded) as part of someone's job duties. For instance, if a proposed indicator relies on data that are already being collected, and funding for continued data collection is assumed to be in place from another source, this plan identifies no additional cost. Substantial new tasks that could require support from a contractor or an academic/research partner have been estimated in dollars. For substantial new tasks that likely can be performed by CBPO personnel, this plan identifies resource needs in terms of labor hours. This plan focuses on the cost to develop technical indicator content; it does not include additional labor to develop and disseminate communication products such as web graphics or summary text.

Considerations for Review

At the moment, each indicator's implementation plan exists as its own document. These plans will be combined into a single master file following expert review, and the combined plan will be presented to the Climate Resiliency Workgroup for further review.

Given that these plans are intended as a "living" resource, we do not expect them to be perfect documents representing complete consensus or worthy of any sort of official approval. We encourage reviewers not to worry about reviewing the documents at that level. However, we *are* quite interested in your thoughts on the following topics:

1. Does the plan lay out a reasonable approach to develop the suggested indicator?
2. Are you aware of additional data sources or resources (e.g., partnerships) that should be considered?
3. Do you have any major concerns about the proposed approach?
4. Do you have any other suggestions for improvement before this plan goes to workgroup review?

Next Steps

This plan is not set in stone. Rather, it is a "living" document, intended to provide guidance and ideas as a starting point for further discussion, development, and engagement with additional partners. As priorities evolve, new data sources emerge, and new analytical approaches are developed and published, the CBPO and its partners may find it useful to add or remove certain indicator topics or change the way the indicators are constructed.

From the outset, this project was intended to be the first step in a process to develop a suite of indicators, to be implemented over time, to measure and assess trends or "factors influencing" (i.e., physical climate drivers); ecological and societal response (i.e. impacts); and programmatic progress toward building an effective response (i.e., adaptation). Upon completion of this implementation plan, ERG will develop a small subset of indicators within the proposed suite and deliver them to the Climate Resiliency Workgroup for review and approval. This subset will likely include some of the following indicators: Air Temperature, Coastal Flooding, Precipitation, Restored Habitat, Sea Level Change, Stream Temperature, and Upstream Flooding.

This implementation plan presents a vision of an ideal suite of indicators; however, it is recognized that Climate Resiliency Workgroup priorities and available resources will determine which indicators are actually developed, and on what timeframe.