Joint Climate Resiliency, Urban Stormwater,

and Modeling Workgroup Meeting

April 4, 2024

Meeting Minutes

Event webpage: Link

Meeting Purpose: 1) To support information transfer and facilitate a collective understanding in the opening discussion of the 2027-2028 climate assessment using the Phase 7 Suite of models. 2) Facilitate discussion and provide an opportunity for partners to offer feedback on priorities, remaining needs, and how best to coordinate efforts.

Follow-Up Actions
- Neil Ganju offered to present research on incorporating sea level rise, vegetative cover and elevation to estimate marsh degradation and loss over time to the Modeling and Climate Resiliency Workgroups.
- Climate Resiliency Workgroup can coordinate with Modeling Workgroup on cross-workgroup efforts on marsh migration modeling.
- Modeling Workgroup can coordinate with Water Quality Goal Implementation Team to review and identify priority Best Management Practices list for project to focus on.
- Modeling Workgroup can coordinate with respective workgroups to identify potential modeling test beds for assessing shallow water systems and living resource connections.

9:00   Announcements and Amendments to the Agenda – Mark Bennett (USGS), Jackie Specht (MD DNR), Norm Goulet (NVRC), and Dave Montali (Tetra Tech)

9:05   Introduction of the Workgroup Chairs
Workgroup chairs introduced themselves and shared the purpose of this meeting.

9:15   Meeting Context: Setting the stage for considerations of climate change in the Chesapeake Bay Program – Lew Linker (EPA-CBPO), Mark Bennett (USGS)
Lew Linker provided background on the Principals' Staff Committee charge to the CBP to assess climate change and how that influences current CBP efforts. Lew also outlined what the CBP learned from previous workshops including STAC Climate Change 1.0 and 2.0 Workshops, with particular attention to the knowledge gaps identified and subsequent reports. This presentation paid particular attention to the modeling components in the context of 2027-2028 climate assessment, such as expectations for modeling efforts. Mark then reviewed the draft agenda for the upcoming STAC climate change 3.0 workshop to demonstrate its scope and how it relates to this joint workgroup meeting.

Summary

Lew presented a review of lessons learned from the previous STAC Climate Change workshops, considerations for the upcoming Climate Change 3.0 workshop, including the modeling components and findings of the Phase 6 climate assessment and the expectations for Phase 7, and a rough agenda for the Climate Change 3.0 Workshop. Lessons learned from the previous workshops included creating a more sophisticated evaluation framework, continuing the development of climate-related watershed model capabilities with particular attention to best management practice (BMP) effectiveness, and developing a new estuarine model that extends onto the coastal shelf, has updated biogeochemistry, and includes a simulation of wetting, drying and waves. Lew reviewed the climate change elements that were included in the Phase 6 model and discussed what updates would be included in Phase 7 (e.g., better segmentation to assess at a finer scale. BMP effectiveness, phenology). He also drew conclusions for the Phase 6 assessment, stating that climate change is a multigenerational challenge for the Chesapeake Bay Program, however the partnership is working on management practices that are effective counters to climate change (e.g., designing and adopting stormwater BMPs to address the expected increases in rainfall volumes and intensities, examining top tier agriculture and stormwater BMPs that are most vulnerable to climate change, and quantifying the co-benefits of BMPs that mitigate future climate change risk).

Lew and Mark Bennett also reviewed the proposed agenda for the upcoming STAC 3.0 workshop. Day 1 will focus on management's motivation and next steps for Phase 7, reviewing the recommendations from the prior workshops, and climate management application of the Phase 7 models. Day 2 will focus on ecosystem, living resources, climate science, phenology, and holding breakout discussions. Day 3 will focus on report outs and writing a draft of the recommendations. Mark added that the workshop will be technical in nature and focus on modeling. He mentioned that there will be some policy discussion to help frame the discussions around the modeling. The result of the workshop will be technical recommendations.

Discussion
- Troy Bernier- asked to elaborate on slide 6 of Lew's presentation, specifically highlighting the point about evapotranspiration and the effect of carbon dioxide.
    o Lew responded that it does not make a large difference, but stomata helps with carbon fixing. When there is a lot of carbon dioxide the stomata do not have to be as open to fix carbon, which means there will be less evapotranspiration as carbon dioxide increases. He commented that its inclusion in the model is for completeness. Dave Montali added that the main effort is now how much additional watershed loads do we need to plan into our targets so that we can accommodate climate change in the future. He commented that conversations are now focused on whether or not they had the correct inputs for the Phase 6 models or will things be adjusted for Phase 7.
- Bhanu Paudel asked if the projected increase in phosphorus (P) in climate change scenarios is associated with sediment load increase. And if so could the increase in flow

compensate for sediment release of phosphorus (due to dilution effect). Bhanu wondered if that had been considered while projecting P increase.

- o Gary Shenk responded that it is partially true and the sensitives in models for P include sediment wash off for most land uses and also an increase in storm flow, so phosphorus is preferentially transported in storm flow rather than base flow. He commented that with flashier storms in the future, they expect that the balance between storm flow and base flow will change and that in turn drives sediment. He added that there's also an independent driver of phosphorus in the storm flow itself, leading to a compounded effect. He summarized that it's really about the load rather than the concentration, and there is a bit of a dilution effect which has some effect of pushing the blooms further out in space and perhaps further out in time. But the big picture is that it's all about the load rather than the concentration.
- Katie Brownson commented that the slide on the impacts of climate only versus climate and land use on loads is very interesting. She was assuming these estimates are for delivery to the Bay and asked if they are able to model this difference further up in the watershed. She commented that it seems like land use may be a more important driver in that context.
  - o Lew responded that yes and with phase 7 there will be finer inputs which will help and that land use will trump climate change in a local sense. Lew commented that scale is everything and they can look at both climate change and land-use impacts at a finer scale with Phase 7 than in Phase 6. Greg Sandi commented that they were able to determine the individual impacts of both factors at a jurisdictional level in Phase 6. Lew added that if there is a particular need in the program for this sort of information, it is only a matter of entering the data and pulling the results out.
- Katie Brownson asked if there was any information about understanding around BMP impacts to stormflow, such as reducing its intensity.
  - o Gary Shenk commented that there is no mechanistic modeling of BMP effects, as these impacts are determined by expert panels. The information these panels provide are the percent reduction in nutrients by these BMPs. He commented that some BMPs work through altering the hydrology, but they do not have hydrologic effects simulated within the watershed. He commented that they have an average effect partially simulated in some instances. An example he provided highlighted the effect that some BMPs have in preventing downstream erosion and not the actual restriction of flow from the upstream implementation. He also commented that if folks are interested in whether the streams would flood more or less, this information is not included in the model. Lew recaptured what Gary said, stating that when there is a flow restriction, for example in an ultra urban area and there's a great big tank under a parking lot and it releases water slowly, then the expert panel will look at efficiency for that kind of detention. Gary Shenk added a caveat that what he was thinking of when he responded earlier was focused on how to deal with pervious versus impervious land use in the urban area. So the urban impervious load is really dependent on downstream. He added that he does not know whether the BMP expert panels considered this overall effect. Norm

commented that the expert panels have mainly been looking at what are the reductions in nutrients and sediments. He added that the Bay Model in its current formulation does not have the ability to examine how hydrological regimes are altered by BMP implementation. He commented that to do so would take the development of a SWIM model for the entire Chesapeake Bay. Lew commented that the work that RAND will be doing will be similar to a SWIM model in different physiographic regimes (e.g., coastal plain, Piedmont, Ridge and Valley, Appalachian Highland) and will examine BMPs under future hydrology in urban areas within these regimes. He says the results could inform the BMP expert panel and their assessments. Norm commented that they have been trying to achieve something of this sort by using what they call the effective imperviousness.

- Julie Reichert-Nguyen was curious about the effects of sea level rise (SLR) in the model as it pertains to wetland loss. She commented that factors such as impacts to depth and temperature seem to be included already, but was wondering if wetland loss and landscape change associated with SLR are accounted for.
    o Lew responded that the model is unsophisticated, as they use a bathtub approach. He hopes that there will be more nuance with Phase 7 (e.g., blue sky flooding). With the bathtub approach they were able to look at the loss of wetland leading to the loss of attenuation. He said that they could potentially increase model sophistication if they had more granular detail about landscape changes associated with marsh migration and wetland loss. Mark commented that the wetland retreat issue is complicated as it's a matter of scale of the model. He added that if they had more information with regard to which wetlands that might keep pace with SLR, then they might be able to incorporate that information into the model. Pam Mason commented that the other potential problem is that the understanding of load reduction from wetlands is complicated as generally they are modeled as a sink, but there is uncertainty around the load reductions provided by wetlands. She added that right now keeping it at a higher level is the most honest way to approach it. Joel Carr commented that the SCHISM model should be better for this Julie.
    o In the chat, Neil Ganju commented that the increased load of sediment and carbon from marsh loss will be sizable, and spatiotemporally variable. USGS has some methods to address that, and he shared a link to a publication.
- Jim George asked Gary to elaborate on the load versus concentration concept in terms of dissolved oxygen. He added that he was thinking that the concept would be reversed, but he is more familiar with a steady state model.
    o Gary responded that when the annual load is plotted versus the annual hypoxia, there is typically a strong relationship. However, when plotting the annual concentration versus hypoxia, the relationship is not as strong. He commented that the Bay is a receiving area for these loads and the amount of water that comes along with the loads is a factor, but he added that it is important to focus on the amount of N (which gets used up over the year) and the amount of P, plus its storage (which gets used up over a decade). He added that if these nutrients come into the Bay with a lot of water or a little bit of water, it impacts the circulation to

some extent. So bottom line, it is more about the load than the concentration, unlike a steady state where concentration would be more important than the load.
-   Larry Sanford asked about the place of deep learning models in this effort. He asked if they were investigating how they might be used to improve estimates.
    o   Gary commented that the EPA has a grant with Penn State. This effort has two main objectives. The first thing they are investigating (which is being led by Kim Van Meter), will be taking all the new information about landforms and hydrography, which are at an extremely fine scale, to better understand what it means for delivery on the landscape. The second research question will focus on looking at whether or not there can be improvements to determining the concentration time series using deep learning approaches. This type of work has already been shown to be extremely successful, nationally. The accuracy of these deep learning models for concentration times series is better than other statistical approaches and better than process based models. While there is the ability to both assess delivery and generate a time series, this effort will have the possibility to give much better information that hopefully will be relevant to Phase 7. He also commented that there is research in the Gulf of Mexico, using deep learning approaches combined with hydrodynamic models to predict concentrations and other water quality parameters. He added that those types of methods could potentially be applied to the Chesapeake Bay.
    o   Larry followed up asking if deep learning could keep up with climate change. He added that the basis of the projection is changing. Gary responded that if the models use rainfall and temperature, then he would expect that the deep learning processes could keep pace.

10:30 Break

10:45 [Setting the stage for the Ecosystem Management Component of the Climate Workshop 3.0](#) – Julie Reichert-Nguyen (NOAA)
Julie provided a summary of projects supported by the Climate Resiliency Workgroup, in partnership with other workgroups, that can inform future climate modeling efforts by the Bay Program. The discussion included efforts involving marsh migration/adaptation, SAV climate model synthesis, and recommendations and follow-up research from the Rising Water Temperature STAC Workshop report in connection with living resources. This information will be shared to set the stage for the ecosystem management component of the STAC Climate Change 3.0 workshop in May 2024.

Summary
Julie Reichert-Nguyen and Katie Brownson presented on a number of efforts that have been supported by the Climate Resilience Workgroup that could be valuable for informing discussions at the STAC Climate Model 3.0 Workshop, which include the Rising Water Temperature STAC Workshop, the GIT-Funded Marsh Adaptation Project, and GIT-Funded Submerged Aquatic Vegetation (SAV) Climate Model Synthesis effort.

For the Rising Water Temperature STAC Workshop, the discussion focused on the ecological impacts of rising water temperatures, their management implications, and the development of watershed and tidal specific recommendations. Katie presented the watershed recommendations, which highlighted the need to prioritize cooler BMPs and provide information to local land-use decision makers to assist with land-use planning decisions, focus on stream restoration and develop BMP design recommendations to create or maintain thermal refugia and improve habitat connectivity, and focus on moderating and/or adapting to rising water temperatures. She also highlighted current efforts to support the recommendations such as the GIT-Funded Optimizing Riparian Forest Buffers project, the proposed project to assess heater and cooler BMPs, which includes expert elicitation, and the Beyond 2025 small group recommendations. Julie then reviewed the tidal recommendations, which addressed adapting to rising water temperatures, as they are driven by global climate change in the tidal waters. The recommendations focused on ecosystem-based management of fisheries, maximizing nearshore habitat benefits, tracking extreme stressors like marine heatwaves, and preparing for future climate conditions. Science needs to support these recommendations include synthesizing existing science to establish habitat condition thresholds for fisheries species, creating habitat suitability models, understanding the impacts of late winter loss of eelgrass, understanding the drivers of natural mortality in fishery species, and assessments for emerging fisheries. Current efforts to support the tidal recommendations include the development of a marine heatwave alert system related to key fishery species thresholds and the NOAA Chesapeake Bay Office's support of research on fish physiology and habitat suitability. She commented that warming water temperatures will make it more difficult to reach the 2025 goals in the Chesapeake Bay Watershed Agreement, and there is a need to think about how to incorporate water temperature considerations across partnership outcomes.

For the GIT-Funded Marsh Adaptation Project, Julie highlighted that this effort used data and metrics to inform targeting of regions for large scale marsh adaptation efforts. The project worked with two focus regions and engaged with state and local partners to understand priorities in the focus regions. She commented that the metrics used in the project could help inform the modeling effort for the Climate Model 3.0. She also added that the team is currently working with the CBP's GIS Team to get the data and mapping tool published on CBP sites.

For the GIT-Funded SAV Climate Model Synthesis project, the project team determined how climate change and nutrient loads impact SAV in the Bay. They looked at different nutrient and climate change scenarios to understand SAV coverage. The models predict that SAV will not reach the current Chesapeake Bay Watershed Agreement outcome without enhancements to the TMDL and that there is significant benefit to N and P reductions. The results also showed that eelgrass in the polyhaline will be most heavily impacted while widgeongrass is more heat tolerant. Lastly, there is still uncertainty around the overall trophic impacts from climate change.

Julie ended the presentation by stating that there is a need for more integration of temperature change across the partnership as well as the development of management scenarios to assess possible futures to living resource response. To assist with this, there needs to be better living resource modeling and monitoring, and currently there are a number of ongoing efforts within the partnership around living resource impacts and there should be a discussion about how to integrate this into the Climate Model 3.0.

Discussion
- Lew asked about the scope of the marine heatwave analysis and if it was examining impacts to fishing or swimming and recreation as well.
    - Julie replied that currently the effort is to connect with current fisheries thresholds, using the climatological definition of marine heatwaves (i.e., using a 15-30 year climatology to detect marine heatwave occurrence when temperatures exceed the 90th percentile based on that climatology for 5 days). She added that from a fish physiology perspective, the fisheries can be experiencing thermal stress events that do not meet the climatological definition, so there will be the potential to define it differently depending on species.
- Lew then asked if there was a real time model of tidal water temperature of the Bay, would that be helpful for forecasting. He commented that something with real-time tracking and forecasting could be envisioned as a Beyond 2025 product.
    - Julie commented that conversations have indicated that stakeholders would find value in such a product. She added that there will need to be consensus on the living resource thresholds that people would find most helpful. With forecasting, she highlighted current research that could be helpful in indicating the potential onset of a marine heatwave event through initial heat spikes preceding the event. Marjy Friedrichs added that there is a real-time short-term (2-3 day) forecast system for the Bay at VIMS. They provide alerts (prototype currently) when various thresholds are exceeded (low oxygen, low pH, high temperature, etc...). She added that if anyone is interested in testing out the alert system or helping develop the appropriate thresholds, please let her know. Julie replied that Marjy is on the CRWG's list to reach out to for the second round of conversations on the marine heatwave analysis/alert system.
- Katie Brownson highlighted a publication on aquatic heatwaves in rivers and streams and liked the idea of applying an alert system in the watershed.
- In the chat, Kevin Du Bois asked if the buoy system differentiates between bottom and surface water temperature for CBIBS data.
    - Jamileh responded that currently the effort is only using surface temperatures, as that is what the buoy system collects. Though there is research at VIMS around bottom temperatures as well.
- Richard Tian asked about marsh migration under future SLR scenarios since the project looked at different SLR scenarios. He was wondering if the methods can incorporate finer SLR projects beyond the 2ft and 4ft projections.

- Julie responded that this project focused on 2 ft and 4 ft since they are looking at short and long term decisions, and the two projections reflect mid-century and end of century conditions. The project was a scoping framework to target focus areas and help inform near term and long term strategies, so not as fine a scale as Richard was asking about. She added that there is data that incorporate different levels. She added the caveat that every model approaches SLR differently though. Pam Mason added that given the uncertainty, any effort to project precise locations at a particular time is problematic. The use of the projection should be considered as Julie said: For higher level persistence and migration, this works.
- Lew asked a follow up question about SLR and tidal marsh loss. He was wondering if wetlands vulnerable to SLR could be identified, as then there could be some determination about where wetland loss may occur. Currently the climate assessment model uses a bathtub approach which is more general when it comes to wetland loss. He commented that where wetland loss is occurring could be useful for decision making at the Bay program.
    - Neil Ganju said yes, there are ways to incorporate SLR, vegetative cover, and elevation to estimate degradation and loss with time. He would be able to present that to Modeling group and CRWG in the future.
    - Julie also highlighted the GIT-Funded Wetland Workgroup and Land-Use Workgroup project which is using remote sensing and AI to estimate marsh condition. She also added that currently there is a joint effort being led by the Status and Trends Workgroup alongside the Climate Resiliency Workgroup, Wetland Workgroup, and Land-Use workgroup to scope out a framework for a SLR Tidal Wetland Impact indicator.
    - Richard commented that in the past the CRWG has assisted with SLR projections for the model and was wondering if there could be similar coordination around marsh migration for the future model. Julie agreed and added that there are other groups that can be brought in around this topic as well (e.g., USGS and VIMS).

11:15 **[Most Implemented Agricultural and Urban Stormwater BMPs](#)** – **Olivia Devereux (Devereux Consulting) and Auston Smith (EPA-CBPO)**
Olivia presented the methodology and data used to show the percent contribution of each BMP to the total Phase III Watershed Implementation Plan (WIP) reductions. This creates a ranking of the most important BMPs to the states in their planning efforts. Auston presented on the context for this effort, the RAND Climate Resilient Stormwater Support project (see next agenda item).

Summary
Auston Smith began with an overview of the RAND Climate Resilient Stormwater Support project, including the overarching purpose, desired outcome, and timeline of the effort. Auston highlighted the four major activities of the award, including number four which will be the focus of this presentation: "Providing analysis on the impact of future

hydrology on a range of widely used best management practices (BMPs) in the Chesapeake Bay watershed."

Olivia Devereux then outlined the non-point source BMPs that the RAND team may be asked to review as part of this project. Olivia selected BMPs for this conversation from the Phase III WIPs that have the highest impact and the greatest implementation. This was calculated by running a series of scenarios, each with one BMP removed at a time as this isolates the load reduced from each BMP, includes interaction effects of other BMPs, and assesses the relative difference among BMPs. Olivia walked through a few examples of how this was run for BMPs by Jessica Rigleman. Olivia then described how the total implementation for reductions in each nutrient for all BMPs was calculated. The results showed forest buffers were the most impactful and tillage management was the most implemented. Olivia visualized the results of this quick analysis here.

Olivia concluded with some caveats for the results presented today, which are outlined on slide 10.

Discussion
- Lew Linker said the joint workgroup may want to consider developing an ordered, prioritized draft list of BMPs for RAND to review as part of this project. The list would be a working document that the workgroup chairs could start on and then send to the workgroups for comment and review. Given the rapidly approaching deadline of December 2025 for the completion of Phase 7 model development, it is critical we move this forward quickly.
    - Mark agreed this should be a large component of the discussion.
- Norm Goulet commented that WIPs don't always reflect the actual on-the-ground implementation, especially in the developed sector.
    - Olivia said we can instead use all BMPs available or those which are submitted via annual progress reports. This information is available in CAST and was sent directly to Norm (contact Olivia at olivia@devereuxconsulting.com if interested in getting a copy), but this is not what we were asked to do by the modeling workgroup.
    - Jeremy Hanson said he was wondering the same thing and asked if any of the top rankings change when applying progress instead of WIP. Jeremy noted the planning BMPs would drop out, but he asked if the relative effectiveness doesn't change except when there are the biggest implementation gaps between WIP and progress.
    - Olivia said yes, the top ranking BMPs change because the WIP is a limited set of BMPs.
- Pam Mason commented that wetland restoration has a high impact, but no implementation.
- Katie Brownson asked why the efficacy of the BMP depends on geography, specifically if that is because of variable loading rates.
    - Olivia said yes, variable loading rates as well as delivery factors are the cause.

- Mark Symborski said neither this link nor the link to your presentation have all of the bar charts that were in your presentation today. Also, Mark didn't see a way to access tabular data. Mark asked how he could access the complete data presented in graphic and tabular form.
    - Olivia said the download link is the box at this link with a downward pointing arrow.
    - Jeremy Hanson said he had to use the one slider to adjust which BMPs appeared for him and to see everything Olivia displayed as it only shows a filtered list at first.
    - Mark asked how to access the slide function.
        - Jeremy said when clicking on the TN, TP, or TSS tabs in Tableau, it is in the upper right hand corner.

11:25 **Methodologies and Tools to Support Climate-Resilient Stormwater Best Management Practices Project - RAND led team (Michelle Miro and Krista Romita Grocholski)**
Michelle and Krista provided an overview of each of the five activities described in the project scope and presented a brief outline of work plans and timelines. The assembled workgroups were asked to provide feedback and participate in a discussion of how the CBP can incorporate this information into the Phase 7 Suite of Models.

Summary
Krista began with an overview of the project objective, team, and timeline. Michelle then walked through the objectives, research steps, and outputs from each of the five activities.

Discussion
- Kevin Du Bois said the Vulnerability Assessment Tool sounds like it would also be useful to DoD installations that act like small cities.
- Fernando Pasquel said in the Activity 1 slide, it says the assessment tool will help "residential communities" understand vulnerabilities. Who is the planned audience for this activity? Does it include homeowner associations?
    - Michelle said the focus is local jurisdictions, but the team is looking to make it useful for local developers as well. Unless guided otherwise, the focus will be on local jurisdictions.
- Regarding Activity 1, the vulnerability assessment tool, Lew asked if the scope of work will include stormwater management impacts resulting from sea level rise or flooding vulnerability.
    - Michelle responded yes, there are specifics of the implementation of a vulnerability approach that are unique to a given climate hazard. Sea level rise versus flooding are often generalizable approaches that can be applied to different hazards, so we might discuss that part of the decision process also in the tool. This way people could think about what their priority hazards are and then apply an approach that's most relevant to those hazards and the infrastructure.

- Krista said [this report](#) summarizes our findings from our conversations with folks in the region about what they need to operationalize the climate-informed IDF curves. Krista also has hard copies of the report if anyone is interested.
    - Kevin Du Bois said he would be interested in a hard copy (kevin.r.dubois.civ@us.navy.mil).
- Lew said this project will need to look at BMPs in different physiographic regions, like the Appalachian Highlands, Coastal Plain and everything in between. Lew said a question the group will need to consider is if a unit area of urbanness should be used, or if a small urban watershed is used. The advantage of investigating a small, ultra-urban watershed is that a flow reduction BMP, like a big pipe with a sand filter and grease trap for slow release, doesn't really do a whole lot for the impervious area, but it could do a whole lot for the stream. We want to include a watershed that has heavy, impervious components and lighter, imperious residential areas and how they interface with the stream network. Lew asked if the team wants to sandbox this sort of approach for both urban and agricultural watersheds on a land use per acre basis.
- Marina Metes said USGS led a [study that was recently published](#) where we heavily monitored small urban watersheds with both high percentages of impervious cover, and a high density of stormwater BMPs (infiltration-focused, and most set up as treatment trains). We saw mitigation of runoff and storm flows with small and medium sized storms, but not with the larger storms.
- Julie said she is not sure if urban stormwater BMPs are limited to structural BMPs or if they include nature-based BMPs (riparian forest buffers and wetlands) within the scope of this project. Considering the previous presentation, there is concern that natural BMPs' effectiveness may be variable under changing climate conditions, such as wetlands becoming a source of pollutants, not a sink as they often function.
    - Lew said this is an entirely appropriate question that these workgroups should address.
    - Mark noted there are limitations as to what we can do with the suite of models. For example, the loss of sediment due to wetland loss may be beyond what this project is capable of doing.
    - Lew agreed and caveated that while we should consider natural BMPs in this project, we should do so with discernment.
    - Pam Mason commented that sediment loss (loading) from wetlands could be incorporated as bank erosion. The complicated factor is the additional loss of efficiency. Like wetland restoration, there are two accounting processes- land-use change and load reduction.
- Katie Brownson said this discussion speaks to a question she raised earlier: in the BMP climate sensitivity modeling, the focus will be on estimating the impact of future hydrology on BMPs. Katie asked if there would be an opportunity to also consider the reciprocal impacts of BMPs on hydrology (where relevant)? This could influence pollutant removal efficiencies given the projected impacts of increased storm intensity and stormflow on loading. There was no answer to this question due to time constraints.

- Lily Cheng asked if the RAND team plans on looking into stormwater infrastructure scaled for flood mitigation. As a flood planner with DC DOEE, Lily is interested in how that can inform the design guide manual.
    - Michelle said part of initial scoping would be to gather feedback on what should be included, so if this is an area of interest, this feedback is relevant and we will try to include it if possible. Michelle said they are flexible to the needs of the workgroup.

11:55 Lunch

12:45 Discussion Session

The afternoon portion of the meeting was split into a series of discussions aimed at providing feedback on the morning presentations, identifying remaining needs, and establishing next steps. With five key questions, the group spent approximately 20-25 minutes on each question. Responses submitted via mentimeter to the five questions are available here. Verbal or chat comments are listed below.

Key Questions Session 1-3:

1. **What gaps still exist that have not been addressed by the projects discussed in the morning, and what options should we explore to fill them - funding mechanisms, partners, venues, etc.?**
    - o Lew explained that we didn't have the capacity to deal with shallow waters and model support for higher trophic levels in Phase 6, but we will in Phase 7. He elaborated that there has been interest from multiple workgroups in dealing with shallow water habitat and living resources, and asked if those present see a reason to expand the work in that direction.
        - ▪ Julie expressed that she wasn't entirely certain about the capacity of this new scale and what we can do with it. She said that there's a lot of interest and that we'll be dealing with the challenge of warming temperatures and how to create thermal refugia for living resources, especially sensitive species. Julie wondered about whether with the finer scale we would have the ability to get a better understanding of where heater and cooler BMPs were placed in the watershed, and how they could connect to create thermal refugia. This might also involve selecting the right BMPs for critical habitat areas. She said that we may not have the capacity to do it now, but if we could it would be great, since it would give us the sense of where the most vulnerable areas are that would be amenable to management strategies versus not. Understanding the management practices put in place via modeling of their influence on heating and cooling of water would be interesting and useful for CRWG.

- o Lew said that it could be good to look at a smaller scale than the whole watershed. Lew provided suggestions on what we could do if we had the correct inputs. He explained that Larry Sanford suggested looking at wave action on shoreline erosion, which would impact tidal wetlands. The amount of potential erosion from wave action is a connection with the CRWG. Lew said that the refugia idea could be a small scale test but there were other connections as well.
  - ● Pam Mason (in chat): Too much focus on water quality leaves habitat, flood benefits, and other co-benefits behind.
- o Larry discussed the importance of recognizing the aspects of living resource habitat that aren't captured by the model. This might include the character of the bottom sediments, the nature of the edge between the land and water (hardened or living shoreline), adjacent land use, and other factors. Larry said that these aspects may need to be included in future models of resource recovery. He also explained that there was a whole slew of things that could be implemented with relative ease at a local scale.
  - ▪ Lew mentioned the Corsica test bed where a very fine scale was useful. He also talked about understanding benthic algae and the importance of tidal wetlands and small scale hydrodynamics. Lew suggested that Larry was pointing to the need for more test beds like Corsica to look at armored vs unarmored shorelines, influences of adjacent land use, presence of SAV, etc. Tests that would give us insight along with research and monitoring that would be concurrent.
  - ▪ Larry brought up that Kenny Rose and Mark Monaco are working with a small group to explore what we need beyond water quality for specific living resources. He explained that the needs are different depending on the specific resource, and that another influence to consider could be flooding, which in major events can increase local delivery in both the watershed and the estuary. Larry explained that Margie Mulholland and others at ODU had shown that sunny day flooding which comes up through sewers can have a huge impact on nutrient delivery.
  - ▪ Norm Goulet (in chat): We've already asked Gary to look at the impact of sunny day flooding.
  - ▪ Lew said that to the extent Margie can launch a broader effort to monitor these events we will get a lot of good data.
- o Richard said that his comments had a lot of overlap with Larry, and in fact his first one was going to be on shoreline erosion and its impact. Richard explained that the team was able to simulate shoreline erosion. He noted that substrate is a bigger deal in terms of habitat and that it's in both the 56 and 58 model but more information is needed. Richard brought up the interface between land and water, the impacts of saltwater intrusion and sea level rise. If we're talking about the shallow coastal ecosystem, we need a tool to look into it as well. Richard's third

point was that it would be good to have an inventory of shallow ecosystems in terms of what species live where. Additionally, seasonality should be incorporated. This information could be used to project what would happen under future climate change scenarios, but first we would need the baseline information. Richard mentioned that the mechanistic model can do some of this, but that tools like machine learning and AI can do the job a lot better. Richard said he's been looking at a platform called SDM. He ended by mentioning that SAV management will be a challenge going forward, but that tools like SDM will be useful.

- ▪ Lew noted that potential test beds shouldn't be as large as the Choptank or Rapahannock, more like the Corisca. He urged the group to think about where we may want small test beds for shallow water systems and living resource connections. It would also be good to consider salinity. Lew mentioned potentially proposing something at the STAC Climate Change 3.0 workshop.
- ▪ Julie-Reichert-Nguyen (in chat): Mobjack Bay may be a good test bed. A lot of work happening there from living shorelines, SAV recovery, oysters, etc.
- ▪ Mark Bennet (in chat): Is there enough temperature data in the shallowsto accurately calibrate a model in those areas?

o Dave said that with respect to Julie and refugia, he assumed our MTM outputs were at a fine enough resolution to do temperature for the shallow water areas. He thus believes that there is no gap in the modeling ability, just in data. Dave spoke to issues with IDing heaters and coolers. Dave had other questions about thermal impacts, but wanted to point out what Larry said about habitat needs for living resources. Dave said that when people say habitat is DO and temperature it makes him think water quality instead which can cause confusion. The idea that temperature and DO are water quality needs of living resources, what are the other needs we aren't considering.

- ▪ Breck Sullivan (in chat): With this question of needing data on heaters and coolers, is there a way we can elevate the GIT Funding request Katie mentioned about addressing this question? It is being submitted to EPA management soon.
  - ● Katie Brownson (in chat): Thanks Breck. The WQGIT is still deciding which proposals to put forward to EPA.
  - ● Jeremy Hanson (in chat): We'll submit the full list and highlight the top three items from the WQGIT members' prioritization. I don't know what else might help make the case in the decision process.

o Jian had a question about the MBM. He likes the mechanistic model for the waves and tides, but when it gets to the TMDL he backs up a bit. Jian had questions about the wind pattern and storm frequency to use for 1990-2000 data. Jian explained that for things like habitat erosion there isn't enough data. One approach would be to use a mechanistic model but not directly coupled into the

3D model. Based on the erosion and other characteristics the mechanistic model would calculate erosion and give it to the 3D model. This would be much more controllable. Jian also spoke highly of machine learning and his efforts on the 5 and 10 year models with wind and other data. He expressed optimism about using machine learning to tackle the questions Larry and Lew brought up earlier.

- Lew explained the timeline for putting the models together and how they are around for a decade or so which means that there will be opportunities to test different ideas.

o Peter asked if within the watershed model steam temperature was being modeled. If it is being modeled, Peter also asked about incorporating the impact of ponds and impoundments, which USGS had done research on. The research showed that in areas where Brook Trout are, small impoundments contribute thermal pollution to those waterways.

- Gary said that temperature was being modeled but only for the larger scale rivers and the effects that Peter was referring to happened below the NHD 100K scale in many instances. He said that getting to the scale to model those effects was on the wish list for future models but wouldn't be worked on at this time.
- Peter said that an easy thing to do would be to design impoundments that are near cold water fisheries in such a way that they wouldn't pose as much of a thermal threat, which could be incorporated into the engineering criteria.
- Julie Reichert-Nguyen (in chat): Out West, there are efforts to redirect cool groundwater to a restored wetland site within a tidal tributary given the warming of the Columbia river. It was an interesting approach to create thermal refugia for salmon that utilize the wetland habitat.
- Katie Brownson (in chat): There are some BMPs where we have high confidence about temperature impacts. We know riparian forest buffers provide cooling benefits. For other BMPs there is less certainty or situations where temperature impacts will depend on BMP design and site characteristics.
- Pam Mason (in chat): Minimum thresholds for temp and DO for species are life stage dependent as well. These limits are more like "boundary" conditions. The habitat structure (veg strata, density, composition, edge/ interior ratio, surface micro-topography, sediment size, organic content and more) defines the suitability for species.
- Norm Goulet (in chat): When it comes to heaters/coolers for the most part it's not a science problem, it's a policy problem.

2. **How should the RAND team prioritize their work - which BMPs are most important, are some tools needed before others, what sites/regions should be assessed?**
    - o Norm said that he understands Olivia was given the direction to look at what was in the WIPs but that he thinks we need to recast that to look at what's in CAST. Specifically, what have been the most implemented BMPs since we started tracking this? There are significant differences between what is actually in the ground and what states put in their WIPs, and why are we trying to worry about these unachievable numbers when the policy is something different? Norm then reiterated his comment from earlier about heaters and coolers being a policy, rather than a science problem. He said that prioritization should stop looking at what's on the ground currently to what would be best to put in if we had the opportunity and how do we shift policy to get there.
        - ▪ Julie Reichert-Nguyen (in chat): I agree with Norm; what we should be putting in the ground to maximize multiple benefits around water quality, habitat, and living resources.
        - ▪ Greg agreed that what was in the WIPs versus on the ground was an important area to be thinking about. He noted that a lot of the implementation that's being done is through permits which are being implemented by localities. We should be interested in what practices these localities are interested in and that should play a big role in us prioritizing what RAND should look at. Greg also brought up other tools and congratulated Norm on the grant for design standards. He said that the decision support tools for localities and other jurisdictions which can tell them things like how to adjust IDF curves or other projections which can be critical. Greg explained that the key thing he and his team is thinking about is how do we provide guidance to localities so that their decisions meet the expectations set by their stakeholders regarding the performance of BMPs over time? The important thing on the ground level is making the connection between what we're planning for and what we get. Although co-benefits are critical, for localities it's about how they manage the water, so that there aren't conditions like ponding on the eastern shore (route 13). Being able to align decision making tools with future expectations will be very important.
    - o Lew explained that we would have to be careful with the priority ordering given how long the list was.
    - o Jeremy asked if anyone knew whether when it came to site selection for modeling there was a boundary to be aware of.
        - ▪ Dave said that RAND should look at the BMP expert panel reports. He elaborated that if there are BMPs where expert panels came up with a single value for the entire watershed, RAND should look at these effects versus the ones where they broke the values, which merit even more scrutiny.
            - ● Lew wondered about how many 'broken out' BMPs there were.

- Gary said there were eight regions.
- Dave asked for clarification that some BMP Expert Panels don't have different numbers for different regions, and Lew replied that he was correct.
- Lew said that it would be good to carry on the breakouts when needed but obviously combining all the regions when there is reason to would be good for efficiency.
- Greg explained that there were other complications to consider including stream restoration protocols, shoreline control, the overlap between stormwater performance BMPs and traditional infiltration and retention practices, all of which would make the process messy.
- Dave brought up the fact that the design for certain stormwater BMPs are outdated, meaning that as climate change hits their performance will take a hit.
- Lew explained that this has implications for decision makers because they may decide to leave off the climate adjustments if they negatively impact load projections; how will it fit into target assessments?
- Dave reiterated that each BMP had its own nuances.
- Norm Goulet (in chat): Modeled assessments will depend on the availability of information. Putting together a SWIMM model for an urbanized area is no small feat.
  - Fernando Pasquel (in chat): Norm, RAND may be able to leverage models that are already developed by the municipalities. As you know, many of the VA, MD and some in PA have models available for their watersheds and BMPs.
  - Norm Goulet (in chat): Yes, we are already trying to set up a call with Michelle to discuss that.
- Julie mentioned the regulatory aspect with regards to the TMDL, which leads people to focus narrowly on their N, P, and S targets rather than things like co-benefits. She wondered if we need a policy shift to consider temperature as co-equal with N, P, and S as a selection/targeting criteria for BMPs. This echoed Norms comment on it being a policy issue and not a science issue.
  - Dave observed that the things that give us the most co-benefits tend to be the ones that are the most climate resilient (i.e. buffers and GI). He echoed Norm's point on policy and said it would be helpful to see which of the impacts of climate change are the worst for thermal impact and how to deemphasize those things. Put another way, perhaps RAND should come up with a list of the BMPs least affected by climate change.
  - Lew said that he was impressed with RAND's collegiality and our ability in CAST as it is to account for co-benefits. He brought up carbon mitigation co-benefits of some BMPs which are a data limitation problem

regarding the value of carbon sequestration in different ecosystems. It would be valuable to have a monetized value for the carbon co-benefits of some of these BMPs.

- Julie said that she doesn't have a complete understanding of how jurisdictions select BMPs for their WIPs. Do co-benefits influence that or is it just the N, P, and S math?
- Norm and KC's answer suggested that the answer to her question is likely the latter.
- Greg said that jurisdictions can't litigate things beyond the WIP/TMDL targets (N, P, and S) into their permits because they would get sued. In a legal setting if you can't prove something there's no reason to put it in a permit and that's a fight that the state wouldn't be willing to take on.
- Katie Brownson (in chat): If there is a standardized system for quantifying some of these co-benefits, we could then look at what policy/programmatic options could help incentivize WQ practices that deliver some of these other co-benefits. This reflects recommendations from the recent STAC ecosystem services report.
  - Olivia Devereux (in chat): Here is a standard system on co benefits - CAST Ecosystem Benefits Browser.
  - Katie Brownson (in chat): Thanks. I think what is missing is a partnership-approved system for quantifying specific co-benefits.

o Gary brought up nuances in climate effects on BMPs and how they could affect evaluation. For example, there are the regional differences in BMP efficiency, which Dave brought up, but there are also differences based on different climate projection scenarios. Do we use the most optimistic, pessimistic, or median scenario? Do we focus on change in precipitation, temperature, two year storm intensity, or something else? Will we need to evaluate each BMP under multiple regional and climate scenarios, and do we have the capacity to do so?

- Lew agreed with Gary, and added that mechanistic models may be able to pick up some of the impacts to efficiency caused by climate change.
- Norm Goulet (in chat): Vulnerability to climate change for a BMP is a science problem; there is little research and more SAG's.

o Richard said that the big picture was trying to figure out the impact of climate change writ large. Given that, he supported a ranking of BMPs in terms of vulnerability to climate change based on factors like precipitation and temperature. It would have to be comprehensive.

- Lew agreed with Richard and emphasized that we need to think about issues like sunk costs (i.e. concrete with a design life of 30 years) and transparency.

o Dave said that there may be BMPs which normally function effectively but fail during extreme events. These need to be counted as vulnerable as well, for purposes including insurance.

- Lew agreed and said it might not be task four but it might be part of activity one or two in terms of climate resiliency in communities. The

consequences of a stormwater pond failing would be part of those sections. He mentioned that USWG would be the lead on this.

- o Lew explained that the thing to keep in mind about this list is that it doesn't have to be absolutely correct when we give it to RAND, just 'right-ish.' This is because they have to get their models together, and we have to continue to consider and evaluate if we have the first ten right, or how else to change the rankings. Our goal is to get to 'right-ish.'

3. **How can the CBP better incorporate living resources and landscape change into the Climate 3.0 workshop?**
   - o Julie said that they wanted people to start thinking about how the program could do a better job incorporating living resources and landscape change, which brings habitat change with it, into the conversations that are being had around the STAC Climate Change 3.0 Workshop. Julie explained that she had heard things in talking about modeling thermal refugia regarding data limitations, and that made clear the importance of knowing things like whether or not a given management strategy is heating or cooling the water. Julie brought up Larry's comments on going beyond strictly water quality parameters into things like habitat loss, SAV loss, wetland loss, and stream degradation. USGS has done a lot of research on changes in flow and the effects that has on stream health and living resources. Julie ended by asking about how we get from point A to point B, what kind of data we may need, and whether there's a way to structure this conversation so that we can get to an action item for the workshop.
     - ▪ Jeremy Hanson (in chat): I suggest synthesizing Table 2, page 20 from the 'A Systematic Review of Chesapeake Bay Climate Change Impacts and Uncertainty: Watershed Processes, Pollutant Delivery, and BMP Performance' report along with the updated analysis from Olivia and Auston, and then adjusting with input from there. I think the list could reasonably get to ~10 BMPs? Which leads me back to my earlier question about any upper bounds for the SWMM and SWAT modeling efforts.
     - ▪ Greg Sandi (in chat): Also, it might not hurt to get some input from our larger MS4 jurisdictions on their priorities to get a better sense of the types of BMPs that will be implemented in the future.
   - o Lew brought up phenology; what happens when we have less snowpack, freshet, timing of inflows, less eelgrass and more gulf shrimp? What role does phenology play in terms of living resources support? Lew said he didn't know if we had information on that phenological change and whether it could influence things like juvenile fish in shallow waters. Is this data limited or resource limited (time, expertise)?
     - ▪ Julie agreed and said that there were definitely bins, including water column habitat which has the low DO/warmer temperature habitat squeeze, shallow water habitats losing features like SAV and undergoing

species community shifts, and wetlands in general. Julie added that some of the bins would have data and some wouldn't so it would be a question of how to integrate that.

- ▪ Lew emphasized that there's always the Phase after Phase 7, the change, concern, and response are unstoppable. If the answer to some of those bins, in terms of data or expertise, is not available yet it can still happen in the future (the distinction between 'no' and 'not yet).'

o Richard said that the strength of the Bay Program is the data abundance, in terms of water quality and the environment. We have monitoring stations, interpolated data, modeling, but what's lacking to link to living resources is data on the living resources themselves. This doesn't only concern the target species, but also abundance of prey and predator, since they are the living food web. Richard said that this is related to Dave's question on what we need, and emphasized that data on living species is lacking.

- ▪ Julie concurred with Richard, and mentioned the Rising Water Temperatures STAC Workshop, where predator prey dynamics and the lack of robust zooplankton monitoring came up. She brought up the importance of understanding the shifts that may happen with those dynamics as the climate changes, and trying to figure out how to integrate that information, since it will have ramifications for how well certain species or populations will do.
- ▪ Alex Gunnerson (in chat): Regarding Julie's comment about zooplankton monitoring, Hongsheng Bi at UMCES recently presented his research in that area at STAR. If you missed the presentation, you can access it here.
- ▪ Richard suggested that machine learning or AI could help make the link to include living resources in the model we have.
- ▪ Julie brought up NOAA funded programs like the fisheries research grant program which are doing just that. Mary Fabrizio and Marjy Freidrichs are trying to make those links with fisheries and climate change. Julie wondered if there was a way to utilize the partnership's different grant programs to build the knowledge base and make those connections. Julie said that at NOAA they purposefully integrated effects on living resources into their NOFO related to changing environmental conditions and climate change, and asked whether that was something we could look into through STAR or another program. She asked how we can boost knowledge and model design which can then be coupled or inform the climate model for the TMDL to determine which direction we're moving in.
- ▪ Richard made the point that if we're talking about living resources, we don't need to only focus on shallow waters, but that the model can provide information on other areas in the watershed as well.
- ▪ Pam Mason (in chat): Trophic cascades….Ecosystem builders shifts

o Norm moved to climate change and the STAC Climate Change 3.0 Workshop. He said that his office is currently redoing their model for the Accotink Watershed, and one stakeholder brought up a question about how they were taking into

account the shift in climate change with respect to our understanding of seasonality. Summers are getting longer, springs are getting warmer, winters are getting shorter. Norm explained how they've started looking at some of their calibration knobs such as PET and they're starting to look at cluster analysis of the last 15 years worth of monitoring data. He said they've noticed that there does seem to be a shift in some of those statistics, and asked Lew and Gary if they've looked at this yet since it could have a major impact on the models and how they're represented.

- ▪ Lew agreed that PET is very important, since half of the precipitation that comes down onto the watershed departs as PET. He emphasized the importance of timing; the summers are deeper in terms of low flow, and the winters will be evened out due to lack of snowpack and freshet, and more precipitation (more water in the atmosphere). Lew said he thought a cluster analysis was a great idea, and asked Gary for his thoughts.
- ▪ Gary said that cluster analysis was incorporated into the way they did climate previously. Previously they used climate models which had a monthly adjustment for temperature and precipitation, reflecting less snowfall, earlier spring. It's incorporated into a fully process based model, albeit not perfectly. It's a good point and we have some of it. Gary said that how to deal with PET will be a topic at the STAC Climate Change 3.0 Workshop.
- ▪ Lew asked Norm if we were looking at measured ET from gauge equipment or modeled PET.
    - ● Norm said they were looking at gauged data, and Lew clarified that this meant pan evaporation, which Norm agreed with. Norm elaborated that PET isn't the only seasonally influenced coefficient in the models and so if the understanding of seasonality is changing it needs to change in the models as well.
- ▪ Lew mentioned that to the extent we can incorporate these things we should and we will. He also briefly mentioned longer growing seasons.
- ▪ Julie agreed that seasonality was important since shifts in season affect different life stages of living resources.
- o Katie summarized her thoughts from the previous discussion regarding whether we had a model problem, science problem, or policy problem. Katie said she sees all three of these problems as intelinked, since the model does drive policy and decision making in some ways, meaning that we need to be really intentional about what goes into the model. Katie brought up the vulnerability of habitats and ecosystems to climate impacts and how the way our model works now doesn't incentivize conservation or management activities that are needed to reduce that vulnerability. Katie used the example of forest management, but said there were things on the aquatic side as well, but that we don't have any mechanism for crediting these practices which not only reduce the vulnerability of ecosystems and strengthen living resources, but also provide water quality benefits. A bigger conversation about whether there are opportunities to do that through the model or

other policy mechanisms could be worth it, especially since there's a lot of interest in incorporating vulnerability into the model in some way.

- Lew agreed with Katie, and said that it came down to fundamental questions that were still unresolved. For example, if we have higher temperatures (and precipitation) that drive decay rates in forests, the science is still out on whether they become leakier or more attentive with more biomass, productivity, and CO_2 sequestration. Lew expressed that it would be helpful to have confidence in that but we don't right now.

o Gary prefaced his comment with the warning that it ignores the watershed part which is a good argument not to do it. He said that the TMDL is based on the needs of living resources like SAV and their oxygen requirements; it's not ignoring those needs but it is focusing on certain ones. Gary noted that moving forward, in keeping with 'the Bay of the future is not the Bay of the past' (which will be mentioned by Bruce Voigt at the STAC Climate Change 3.0 Workshop) the living resources in the future won't be those of the past. This means we may need different criteria in the TMDL and so that conversation will take place, although it's strictly estuarine.

- Julie concurred with Gary and brought up the question of putting practices in place which both serve current species but also recognize that there will be a shift in the structure of our communities and the Bay itself. She mentioned that there may be legal issues with how water quality standards are written and the possible effects on the TMDL.

1:45 Break

2:00 Discussion Session (continued)

Key Questions Session 4-5

4. **How do these efforts align with projects going on in each state (stormwater manual updates, re-issued MS4 permits, Resilience Plans, etc.), both in terms of timing and/or overlapping products.**
   o David provided context on the question, that they want to hear from states and localities about their work and whether it related to anything that had come up earlier in the meeting.
   o Lew brought up NOAA's ATLAS 15 which will have many of the same features that RAND is providing us now. We're benefitting from getting this information early and we're a national example for moving from stationarity with managing and implementing stormwater, but what's the vision for now that RAND project 1 is done, project 2 is getting underway, and what do you see as the sequence with those and ATLAS 15?
      - David said that they haven't met as a group but he has had conversations with his team on coordinating with the folks at NOAA working on

ATLAS 15 because they hope that their work on IDF curves and MARISA as well as this upcoming progress can help inform some of the ATLAS 15 work. This will make sure there aren't two products out there saying two totally different things which could add confusion about projections to the confusion that already exists with these types of tools and projections. David said that he didn't know what the collaboration would look like yet but the opportunity is there and it's definitely something they've thought about.

- Lew said he was surprised in a good way that NOAA's ATLAS 15 work for the entire country could look a lot like what RAND is doing in their project 2.0.
  - David clarified that he wasn't entirely sure on that, and it was more that there was communication happening to coordinate methods and to avoid reinventing the wheel. David said he wasn't trying to overpromise and that it was more of a 'hey wouldn't this be great' conversation.
- Dave asked when ATLAS 15 was coming out and Greg said that it was supposed to be done by the end of 2026 for the continental US.
- Lew said that if ATLAS 15 was out by the end of 2026 and was seamless it would fit in well going forward with our products.
- Dave brought up the fact that once ATLAS 15 comes out it will be used by many jurisdictions.
- Lew asked what the big players like FHA would be using; the interim product RAND is producing (RAND 1.0 or 2.0), or ATLAS 15?
  - Ben said that he didn't know what FHA was looking at, but that VA had adopted, in different parts of its transportation manuals, guidance that said to look at sea level rise and rainfall. He doesn't know whether other states have done it, but FHA didn't say no. Greg said he hoped there would be discussion between NOAA and the RAND team since all are involved in the Bay program, and this could provide warning whether the final product will be very different.

o Julie brought up the question about similar efforts which could be redundant/opportunities for collaboration, and said that the CRWG at their March meeting heard a presentation from Amy Freitag at NOAA's National Center for Coastal Ocean Science about the Baltimore Area Climate Vulnerability Assessment. They've initiated the assessment and are focusing on Baltimore City and the surrounding counties and are doing indicator development, assessment of vulnerability hazards, risk assessment and a place based approach. Julie said she mentioned their presentation because it had stormwater as a gap to be decided how they're going to approach vulnerability from that perspective. They will be reaching out to jurisdictions and the Chesapeake Conservancy and there's a potential opportunity from the RAND funding and what NOAA NCCOS is doing to have a conversation. That way instead of being redundant each group could talk

about assessing climate vulnerability around storm surge, sea level rise, and increased precipitation and flooding. Julie mentioned that NCCOS is looking at combined flooding including sunny day flooding, storm surge from extreme storm events, and they have some ideas of approaches to use.

- ▪ Christina Lyerly (in chat): I'm not directly involved in this effort, but for information related to Maryland's work on stormwater resiliency, visit this link.
- ▪ Julie Reichert-Nguyen (in chat): Here's the presentation on the Baltimore Area Climate Vulnerability Assessment.

o Ben mentioned a couple other things in terms of opportunities to engage with related efforts. He said that in VA they had a couple of studies underway with the Army Corps of Engineers (the coastal storm risk management studies). Ben explained that one thing to keep in mind regarding the implementation of BMPs or large scale projects that would have an effect on the watershed is that a lot of that is driven either by local requirements for permits on the stormwater side (localities putting in place BMPs) but also federal investment in storm risk management infrastructure (landscape buyouts, storm surge barriers, seawalls) that shifts where the water goes. There are opportunities to engage in those processes. Ben mentioned a project underway in the city of Virginia Beach, and one that's just starting up for the Lower Peninsula in Virginia. These projects span from Williamsburg to Hampton and that's just in Virginia. Ben added that there's another study underway somewhere in the DC metro area that Norm may know about and others will happen in the future. Another thing that drives development patterns are floodplain management regulations and where FEMA is in the process of developing local flood insurance rate maps and the models/data they're using. Ben expressed that it would be wonderful to see coordination between what we're doing at the Bay Program and what FEMA is using for its mapping purposes, since the latter are used for decision making by public and private parties (building houses, infrastructure, etc). Ben said that FEMA had an advisory committee which was advising them to adopt two separate floodplains. The first one would be for insurance requirements and the second would be for floodplain management and include things like climate change and future development. Ben noted that having similar assumptions would be helpful so localities weren't looking in two directions when they're trying to make decisions. Ben didn't know how involved FEMA had been in these discussions but that there's a lot of discussion underway with their groups to figure out how they're going to do this work moving forward. Some of that work has been funded to do additional mapping as part of the budget extension and BIL and other funding streams.

- ▪ Greg Sandi (in chat): Maryland Department of the Environment - Digital Flood Insurance Rate Maps.
- ▪ Lew said that he didn't know what the right answer here was and asked if annual flood risk was implemented everywhere or state by state.
- ▪ Ben replied that it depends on the product. The 1st Street Foundation has a nationwide product, but FEMA may not say it's good. The quality of flood

risk data varies widely from place to palace and even within states and localities. Ben said that in Hampton Roads, the model used for storm surge risk is much more advanced than the models for the interior flooding areas. The riverine areas there can be decades old, so there's room to improve.

- Dave asked what the effect of that was. If you're building a house and the model has negative results, would that preclude them from building?
    - Amy Freitag confirmed that that was how official FEMA maps work.
    - Ben replied that there's an elevation requirement (using fill, pilings, etc) and a lot of things that go into that.
    - Amy Freitag brought up 30 year mortgages, which have banks caring and that can impact people's ability to get insurance. This means there's both a market and regulatory side to the story. The Gulf of Mexico has a regional modeling initiative which is academic-led.
- Lew emphasized the complexity and speed of change and the need to figure things out as we move forward.
- Dave asked how we can coordinate with ATLAS 15 since more and more entities will use it and it's within our time zone of 2025-2035.
    - Ben said that his team has been looking at ways to turn the RAND tool into local policy guidance. Norm's group will be doing something similar in NOVA. Ben said he's had conversations with the RAND team and will be reaching out to them again. Being able to take what he and NOVA have been doing and what other communities are doing to make sure no one is reinventing the wheel. Ben brought up key questions localities have when they're trying to use these products. VA has a coastal resilience masterplan and they picked a number to use by looking at various climate scenarios. The other thing about ATLAS 15 is whether it will stay on schedule or not. There's an update going on now for the Mid-Atlantic states for ATLAS 14 that's a year and a half behind schedule. There's a natural inclination to wait for someone else to make the decision for you, but then you may not get where you need to be at the right time.
    - Dave said that we have the information, but political or legal constraints are the question.
    - Ben noted that in VA ATLAS 14 (as opposed to 15) is literally codified in the law in some cases, so they have had to work around it by saying a locality can use a higher standard than the state baseline. Localities will have to decide whether or not to adopt higher standards if the state doesn't mandate it.
- David brought up that ATLAS 15 is a two volume product; one is updated historic data and the other is climate projections. More progressive

localities and states will use projections in guidance but others may just use volume one. There will be communication needs around the differences in those tools.

- o Labeeb Ahmed (in chat): MDE reached out to USGS and Andy Miller and Matt Baker (UMBC) to map frequently flooded areas (e.g., pluvial flooding) and mapping multiple annual exceedance probabilities (e.g., 5, 10, 25, 50, 100 AEP) in riverine systems using lidar and remote sensing and calibrating with USGS high water mark data and other field measurements. This is work in progress but it would potentially expand floodplain mapping in many headwater channels with no FEMA flood maps.
- o Ben McFarlane (in chat): NOAA ATLAS 15 Flyer.

5. **How do the workgroup members want to engage with these efforts moving forward?**
    - o Julie asked if the question was in reference to the RAND RFA.
        - ▪ David replied that it could be and was what he had in mind but that people could also speak to the projects they presented on and that the modeling workgroup may have opportunities for further input and discussion through their efforts.
    - o Julie said that earlier in the meeting she heard from MWG members that they were interested in the datasets that Wetlands, CRWG, and LUWG are using to look at marsh migration and so that's an action item to connect those MWG representatives and have them come to the sea level rise tidal wetlands meetings with status and trends. In regards to the RFA, Julie said she imagined that depending on the subject they could put a request out to the CRWG membership and they may be able to serve on steering committees (assuming those exist).
    - o David explained that part of the thought process was to maximize the time of the project team; there are so many work groups that want to be involved or kept up to date but the contracts are not even underway yet and Michelle and Krista have already participated in multiple Bay Program meetings. He emphasized that we need to be conscious of time in terms of going in front of many workgroups for updates.
    - o Julie brought up the idea of having a representative who interfaces with RAND and then comes back to the workgroup to update them, so that RAND is not the one doing the work of presenting to the workgroup. The representative would sit on a committee, provide advisory support, and then report back with the project status.
    - o Lew mentioned the idea of it being a two way street in terms of how we rely on others and what we should step up with. He said that with regards to the MWG, they expect to have four quarterly reviews with RAND in order to make sure we're on track until December 2025. The MWG would work closely with RAND for the BMP efficiency under climate change conditions work. With the stormwater BMPs, Lew said the MWG would do what they can but they will rely on the USWG's expertise. Lew brought up questions that were raised and that they may not be able to get to setting up a shallow water testbed to deal with

higher trophic levels and living resource finfish support in 2024 and maybe not even in 2025. However, at some point they will be ready. Lew said the way to look at how we're going forward over the next several years is with mutual reliance.

- o Dave expressed concern that BMPs were mostly a GIT and GIT workgroup issue rather than a MWG issue. Although the MWG will be helpful, the drive for BMP crediting lies with the WQGIT.
    - ▪ Lew agreed and said that the MWG would follow the EC and PSC but more on the technical end but that they don't provide guidance on how to then apply that work.
- o Dave told people interested in what the MWG is doing that they should tune into the MWG's quarterly meetings.
- o Alex Gunnerson (in chat): Keep up with the USWG here.
- o Fernando Pasquel (in chat): Great meeting! Thank you for the opportunity to participate. Your work will help prepare the Bay to adapt to climate change.

2:45   Wrap up and Next Steps

3:00   ADJOURN

Participants: Aaron Fisher, Alana Hartman, Alex Gunnerson, Alisha Mulkey, Amanda Poskaitis, Amy Freitag, Andrea Krug, Anna Kasko, Arianna Johns, Ashley Hullinger, August Goldfischer, Auston Smith, Bailey Robertory, Ben McFarlane, Bhanu Paudel, Bill Keeling, Breck Sullivan, Brenda Morgan, Brock Reggi, Caitlin Bolton, Camille Liebnitzky, Carl Friedrichs, Carlington Wallace, Carol Wong, Cassandra Davis, Cecilia Lane, Christina Lyerly, Chris Guy, Chuck Schadel, Clint Gill, Dave Montali, David Wood, Deborah Herr Cornwell, Dinorah Dalmasy, Douglas Austin, Elaine Webb, Eli Podyma, Emma Corbitt, Eric Hughes, Erin McNally, Fernando Pasquel, Gary Shenk, George Doumit, George Onyullo, Ginger Ellis, Gopal Bhatt, Greg Sandi, Guido Yactayo, Heidi Bonnaffon, Helen Golimowski, Holly Walker, Ho-Ching Fong, Jackie Specht, James Dunbar, Jamie Eberl, Jamileh Soueidan, Jeff Sweeney, Jeff Yang, Jeremy Hanson, Jesse Bash, Jesse Maines, Jian Shen, Jillian Seagraves, Jim George, Joel Carr, John Seitz, Joseph Schell, Jonathan Leiman, Joseph Delesantro, Joseph Zhang, Julie Reichert-Nguyen, Karinna Nunez, Katherine Dyer, Katherine Rainone, Katie Brownson, Kevin Du Bois, Kevin Mclean, Krista Romita Grocholski, Labeeb Ahmed, Larry Sanford, Lee McDonnell, Len Schugam, Lew Linker, Lily Cheng, Lori Maloney, Marisa Baldine, Marjy Friedrichs, Mark Bennett, Mark Hoffman, Mark Symborski, Marina Metes, Martin Hurd, Matthew Konfirst, Matthew Meyers, Michelle Berry, Michelle Miro, Neil Ganju, Nora Jackson, Normand Goulet, Olivia Devereux, Pamela Mason, Peter Claggett, Richard Tian, Robert Goo, Sam Merrill, Samuel Canfield, Scott Bass, Scott Crafton, Scott Heidel, Sean Emmons, Sophia Grossweiler, Steven Bieber, Susan Larcher, Taylor Woods, Thomas Cronin, Thomas Johnson, Tom Butler, Tyler Trostle, Troy Bernier, Zhengui Wang.