Thank you for joining our fourth Crisfield/EPA ORD Technical Working Group (TWG) providing technical feedback on proposed nature-based solutions (NBS) and co-benefits for Crisfield’s coastal resilience!

AGENDA for April 1:

* Introduce new Technical Working Group members from Maryland Department of Planning (MDP), Maryland Department of Natural Resources (MDNR), and EPA Chesapeake Bay Program Office (CBPO) and Office of Water (OW)
* Share updates on upcoming community engagements, contingency planning, and Crisfield/MDNR funding application process and implementation planning
* Review and provide feedback on draft results and in progress research exploring:
  + Calculation of NBS co-benefits
  + Climate-smart vulnerability assessment
* Discuss and interpret first batch of Crisfield NBS storm attenuation model results

Attendees:

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| **Organization** | **Expertise** |
| City of Crisfield, climate resilience projects | Local knowledge, funding |
| National Oceanic and Air Administration (NOAA) Fisheries, Habitat and Ecosystem Services Division | Local fisheries regulatory considerations, fish habitat consultations, and co-benefits |
| National Oceanic and Air Administration (NOAA) Fisheries, Restoration Center | Local fisheries habitat and restoration |
| Virginia Institute of Marine Science, Center for Coastal Resources Management | Estuaries and salt marshes, nature-based features |
| Virginia Institute of Marine Science, Center for Coastal Resources Management | Urban and environmental coastal planning, sustainability |
| Maryland Department of Planning | Local planning and zoning |
| Eastern Shore Regional GIS Cooperative | Local mapping, spatial data |
| University of Maryland, Environmental Finance Center | Finance and green infrastructure, coastal resilience |
| Sustainable Science, LLC | Salt marsh restoration |
| EPA Region 3, Wetland regulatory | Wetlands ecology and permitting |
| Tetra Tech (contracted by EPA) | Coastal engineering |
| Tetra Tech (contracted by EPA) | Hydrodynamic modeling |
| EPA Office of Research and Development | Project Navigator |
| EPA Office of Research and Development | Ecosystem co-benefits |
| EPA Office of Research and Development | Community engagement |
| EPA Office of Research and Development | Evaluation, community capacity |

Upcoming planned community engagements include:

* Crisfield Resilience Academy initiated Community Resilience Day (04/26/2025)
* Crisfield community oral histories project presentations through environmental studies capstone class at Salisbury University (05/03/2025)
* Crisfield City Council NBS storm modeling results update (06/11/2025)
* Technical Working Group meeting followed by public meeting about storm results (06/12/2025)
* NBS research results summary public meeting (09/20/2025)

City of Crisfield is working on NOAA grant application for transformational habitats (due 04/16/2025), applying for funds ($4-$6 million) for a feasibility study and pilot project implementation for the living breakwater off Great Point at the north end of Cedar Island (on MDNR property, with their support). Crisfield is interested in collaborating with those with expertise in designing monitoring for this project.

EPA ORD shared draft research material with the TWG and provided updates, including:

* NBS co-benefit calculations [Crisfield NBS Co-benefit Assessment Plan 03 11 2025.pdf]
  + Proposed methods involve using land cover changes caused by NBS (such as increased marsh acreage, seagrass acreage, conversion of open water to artificial oyster reef) as inputs to calculate impacts to metrics of desired co-benefits (such as striped bass density, blue crab density, water quality, marsh condition, black duck density) based on quantified models in the literature relating landcover to ecological endpoint change
* Climate-smart assessment [Crisfield\_NBS Vuln Asess\_3.17.25.pdf and NBS Vulnerability Assessment\_3.18.25.pdf]
  + Evaluate different possible climate threats to NBS coastal ecosystems (such as increases in sea level, temperature, wave energy), historical trends in those metrics from data available in the Crisfield area, projected future trends and expected impacts (such as greater likelihood of marshes inundating more frequently and drowning), and what types of modifications can be made to NBS design given expected climate changes and impacts (such as more frequent marsh edge maintenance, use of different plants, etc.)
* NBS scoping report draft [Task3\_NBS\_Scoping\_Report\_Draft\_For\_TWG\_3\_31\_2025.pdf]
* Storm modeling plan report draft [Task\_3C\_Report\_1\_31\_2025\_V1.pdf]
* <https://www.epa.gov/water-research/coastal-community-resilience-research-project-updates>

EPA ORD Contractor Tetra Tech discussed first round of storm attenuation modeling simulating water height and wave height during a 3-day, 1-in-50-year storm in Crisfield with and without all proposed nature-based strategies. The selected storm was Hurricane Dorian which passed through Crisfield on September 5-8, 2019. In the middle of the Lower Annemessex River, storm surge reached 2.5 feet above NAVD88 24 hours into the storm, 4.6 feet 48 hours (2 days) in, and decreased to 4.0 feet after 72 hours (3 days). Significant wave height on top of the surge was 1.3 feet 24 hours after the storm began, decreased to 1.1 feet 48 hours (2 days) in, and returned to 0 feet by 72 hours (3 days) during which the surge was still elevated. Surge levels were generally uniform across the entire submerged Crisfield area within each time step, while wave heights clearly decreased over the marshes compared to in the Bay.

First draft Batch 1 modeling showed water level reductions up to 0.5 feet with all NBS (compared to no NBS baseline) in some areas of Janes and Cedar Island marshes 12 hours into the storm, and significant wave height reductions up to 0.7 feet behind the Great Point living breakwater and 0.3 feet in Daugherty Creek at the same 12-hour time step. By 24 hours into the storm, little difference in surge water levels was detectable between all and no NBS, and wave height decreases no more than 0.2 feet were visible in some areas of Janes and Cedar Island marshes. Changes in water level and wave height were not observed between all and no NBS scenarios past 24 hours. After surge levels rise high enough to submerge marshes and NBS, little impact of NBS is expected due to the “bathtub effect” of raising water levels’ ability to flow around any raised infrastructure (unless the infrastructure completely surrounds a given area, which is the visible effect of Crisfield’s proposed hard infrastructure flood mitigation project).

Results for 2050 were not yet available. Model representation corrections are ongoing.

Questions, feedback and discussion:

***City of Crisfield:*** *One of the boating families locally pointed out to me that these projects could also impact the safety of the boats in the harbor. Because they may be impacted by waves before the land is. Does that sound correct?*

***EPA ORD:*** *So, you're saying when waves are reduced, there's going to be less waves hitting boats, so flooding is not the only end point of concern. Wave reduction is important.*

***VIMS:*** *What about reduction in energy? As opposed to a measurable change in water level, landward transgression of the water may be reduced by NBS.*

***Tetra Tech:*** *Yes, those are good points, and so far, we are only showing two output types: we could also show flow velocities, wave propagation that could help understand NBS ability to reduce wave energy. Especially in high priority areas for the community along Crisfield’s edge and harbors, and for boats traveling through Daugherty Creek.*

***Crisfield:*** *The city dock is being raised 18 inches because of the damage it sustained in storms, and we lost the American cruise lines that used to come there, because* *that's the only place where a boat of that size can come in as far as I know. So decreasing damage would be great.*

***VIMS:*** *Good point... maintenance of NBS could reduce increased adverse impacts. In other words, keeping a marsh and its services may be beneficial to losing it and its services.*

***EPA ORD:*** *I was going to ask in terms of [NAME]’s question. Is a reduction in wave height a good like surrogate like a direct approximation of reduction in energy? Like can we assume wherever waves are smaller that energy has dissipated?*

***Tetra Tech:*** *Yeah, basically the wave energy is a function of the wave height. The wave period also affects the energy, but since they they're always generated by the local wind from the hurricane, here, yes, the energy is basically from the wave height.*

***VIMS:*** *It may be that the more measurable benefit of NBS is an actual change in water level other than where you've increased the surface elevation by thin layer or thick layer. It may be more the reduction in transgression of water onto the land surface. In areas where water gets slowed (as opposed to stopped. So, the water transgression from floods may be lessened with the implementation of NBS, at least that's what some of the research is showing now. That could be an important piece. And we try not to conflate those two elements (vertical versus horizontal decrease in flood levels).*

***Tetra Tech:*** *Yes, the model domain extends quite far in the upland so any sort of change in landward transgression, we would be able to capture that. And it would be interesting to look at a smaller time step (than 12 hours) to look at the landward progression of water levels at a finer scale as the storm is passing through. Because you would be able to see slower timing of water movement across land for NBS scenarios compared to baseline (no NBS). I think that is important from a flooding and inundation perspective, but also from a disaster response perspective.*

***VIMS:*** *And, also because of the average salinity. The water transgression prevented means that there's less upland exposed to salinization, at least from storm salinization. Now, obviously there's still groundwater issues and groundwater salinization, but that could also be a valuable or monetizable benefit. That you're preventing conversion of some farmlands. Benefits to the producer of not having salty water on their fields.*

***EPA ORD:*** *Over what time frame does that usually happen? Because storm modeling is over 3 days basically, right? Would that happen over the course of three days, or is that like a lot longer after the storm?*

***Tetra Tech:*** *That's a good question. The way that we've presented the results here, even at that last time step towards the end of the storm, we're still seeing somewhat elevated water levels and inundation in the Crisfield area. So, it would be interesting to take a look a couple of time steps after to see the regression of any upland inundation.*

***EPA ORD:*** *Because the waves die down, but the surge is still there.*

***VIMS:*** *Exactly. So, it's the energy on top of the surge that nature-based solutions tend to be more beneficial for. The surge is this sort of just big slug of water and nothing's going to stop that other than a wall or elevating your land, you know? But the things that come with it, the debris that it carries can be trapped by nature-based strategies, so you could minimize some of the damage. Say you have a lot of damaged piers and the wood from those piers comes in and slams against other things. Well, if that wood and that debris gets caught up in a breakwater or a marsh system, then that's not being delivered into the community into the upland. So, there's other things like that. It's really the energy on top of the surge that a lot of the research has been focusing on lately.*

***EPA ORD:*** *Is there a possibility that lowered wave energy could help preserve the longevity of the FEMA wall? Not sure how vulnerable it is to destructive storm wave action (or not).*

***VIMS:*** *Yes, yes, wave energy reduction could help a wall last longer, absolutely.*

***EPA ORD:*** *Yeah, and I also keep thinking that the FEMA calculations were based on assuming the marsh is still there in the same condition. I think we asked them about that at some point and there was no incorporation of the issue that if nothing was done that the marsh would continue to be lower relative to the water levels and that would make wave energy higher.*

***Crisfield:*** *I don't think they have any modeling capabilities, so they partnered with some of the other organizations here and the TNC project to get some modeling. But I don't think they had a way to do that.*

***EPA ORD:*** *We want to be able to share all of this with designs for the on-land hard infrastructure, so no one has to reinvent the wheel.*

***EPA ORD:*** *Given the wave height reduction early in the storm by NBS, do we know if there is also wave height reduction pre-storm?*

***Tetra Tech:*** *Like a typical condition. Yeah, the NBS should provide a measurable benefit for wave attenuation under a typical 24-hour tidal cycle. I am not sure if the modelers looked at a standard, no storm condition as part of the calibration process, but that is one of the things we have talked about in our planning, to look at lower intensity storms like a typical nor’easter to see what the benefit would be under a higher probability storm that the community would face at least once a year, if not multiple times a year.*

***Crisfield:*** *That's going to be extremely beneficial because we do experience that so often.*

***UMD EFC:*** *Yeah, I was thinking that those higher-frequency, lower-depth flood events like we looked at in the TNC/GMU/EFC project would be great to look at more.*

***EPA ORD:*** *So, would that be preferable, from Crisfield’s perspective, to move towards potentially modeling more lower intensity storms than a higher intensity storm?*

***Crisfield:*** *I definitely do not have enough expertise to be comfortable answering that. I think whatever EPA and the working group and Tetra Tech thinks - it's all beneficial. We'll leave it up to you all in this group.*

***EPA ORD:*** *Yeah, because I think we initially wanted to match the FEMA storm, but that's a one in 50-year storm. So, it's pretty extreme and not that frequent. And if we want to get a better sense of more frequent benefits that Crisfield will experience with NBS, it might help to do one in 25 or similar - I don't know how we would decide a lower frequency - and isolate where the benefits are most beneficial.*

***Crisfield:*** *The Nature Conservancy's Citizens Advisory Committee chose to look at a 2.5-foot storm. If you decide to look at something lower, looking at how The Nature Conservancy chose that number could be helpful.*

***EPA ORD:*** *Since it seems like there isn't a lot of effect at higher water levels or wave heights, would doing a smaller storm show more detail?*

***Tetra Tech:*** *I think there would definitely be a benefit in modeling lower intensity storms. I think it’s useful to figure out the upper extent of effectiveness and then roll it back to more common storms and* *really highlight the benefits under some of these typical storms. Up to a certain surge level and then we can use that to say we are only seeing a benefit up to, say, 3 feet surge level with these wave heights so let’s look at storms within that realm.*

***EPA ORD:*** *Would you already know that answer because you already modeled everything lower before you got that high?*

***Tetra Tech:*** *Well, every. Yeah. Every storm's a little different, right? And the model will perform differently based on the different progressions of water levels and wave heights that come from each unique storm's wind field as it winds up being represented in the model, particularly for the waves. If the storm incidence angle and forward movement speed is all the same, then you would expect the system to react similarly, but I think from a wave attenuation perspective you would see a difference depending on the relative wave height to the NBS elevations.*

***NOAA:*** *Could you model the 50-year storm in 2050, factoring estimate marsh loss in the interim to smaller storm events? That would highlight the benefits of measures to address marsh edge loss in the interim. Here's a paper that points to the effects of frequent-return storms on marsh edge.* [*https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019JF005200*](https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2019JF005200)

***EPA ORD:*** *Loss to smaller storms. I think in our “do nothing” scenarios we are only factoring in marsh loss due to sea level rise, no extra erosion or anything.* *So, we'd have to figure out how to estimate that, maybe from the current information.*

***VIMS:*** *That’s a hard one. Good luck with that. If you figure it out, let us know. It's because it's so stochastic, right? So, it's chronic and stochastic. So, if you attribute it to a particular series of storms, you have to know what storm direction but many other things. Some of those marsh retreat models try to make estimates of the leading edge loss, as opposed to just the back edge retreat (movement into the upland). So, you can poke around in the literature. It's just really tough. But you certainly don't want to ignore it. Even if it's just to note that it's there and you are not going to account for it, you know, just to be upfront about it. The Fagherazzi paper in the chat is useful. You just have to be able to attribute your common storm tracks, and even if you just say we have our storms from the North and West or whatever your sector is, you might be able to do something with that. That’s the thing about modeling a 50-year storm in 2050. The important thing is to remember to start from the projected water level at that time before you go out any further, because that changes everything and then it complicates it because you don't know if your marsh will have kept up.*

***EPA ORD:*** *I wonder if there's some way to estimate it from things like current and velocity - we keep saying we're doing erosion qualitatively/semi quantitatively. Maybe there's some way to designate areas or some kind of rough assumption.*

***Tetra Tech:*** *I think we can. We can come to some general conclusions about higher risk areas of marsh edge erosion. That's something that we're planning on doing already and it's how the NBS are structured right now - around protecting the marsh edge, either through restoring a healthy dune system on the sandy beaches or oyster reefs offshore. Doing the geomorphic and sediment transport modeling would better inform those sorts of conclusions. The good news is that is one of the reasons we wanted to go with the Delft3D model because it can incorporate that. Now that we have the model set up and calibrated, adding in that sediment transport component is something that is feasible. And something we would look to do for some of the design work for a particular NBS project. We would preferentially do some sediment transport modeling as part of the feasibility work to understand the sediment dynamics in the system with NBS. If you can design a breakwater of dune system to accrete sediment in the areas you want, that would be ideal.*

***EPA ORD:*** *Yeah, we are trying to design to prevent marsh edge erosion, but I think [NAME] is asking how bad would it be if you didn't design that way? Like, what's the benefit of designing against it? It sounds like it's complicated. SLAMM doesn't do that - It's just sea level rise, not erosion?*

***Tetra Tech:*** *Yeah, it's sea level rise and changing land use land cover relative to the typical habitats (relative elevation). We will look at the hydrodynamic stresses on the shoreline to try to determine where marsh edge erosion is higher probability, where smaller storms might have most effect.*

***EPA ORD:*** *Great, thank you so much, Tetra Tech, for all your help and we really, really appreciate everyone taking their time and providing feedback. Feel free to let us know anything else you think of whenever you think of it, and we will plan to keep you posted with updates as soon as they're available. And we'll hope for the best moving forward. Thank you.*

Questions?

**[END MEETING]**