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Dear Study Team:

We are natural scientists, social scientists, engineers, and urban planners who research sea-level change, coastal flooding, human responses to coastal flooding, and the use of coastal climate risk information to inform decision making. Many of us have extensive experience advising governments on these issues; several of us have served as (lead and coordinating lead) authors for the Intergovernmental Panel on Climate Change (IPCC) and the National Climate Assessment. We collaborate with one another on coastal climate research through the Megalopolitan Coastal Transformation Hub (MACH, coastalhub.org), a multi-institutional research collaborative funded by the National Science Foundation (NSF). We are, however, writing on our own behalf; the opinions and recommendations expressed are our own, and they do not necessarily reflect the views of the NSF or our institutions.

As a study examining a tens of billion dollar investment in the nation's densest urban megaregion, it is important that the NY & NJ Harbor & Tributaries Focus Area Feasibility Study (HATS) reflect the best available knowledge and approaches and not simply those prescribed by the standard practice. It is particularly important that such a large investment in a globally and economically important region avoid longer-term maladaptation to sea-level rise. As the recent IPCC Working Group 2 report notes (emphasis original) [1]:

> **Reliance on hard protection against sea level rise can lead to development intensification, which compounds risk and locks in exposure of people and assets as socioeconomic and governance barriers and technical limits are reached.** Avoiding maladaptive responses to sea level rise depends on immediate mitigation and application of adaptive planning that sets out near-term, low-regret actions while keeping open options to account for ongoing committed sea level rise (*very high confidence*). Such forward-looking adaptive pathway planning and iterative risk management can address the current path dependencies that lead to maladaptation and can enable timely adaptation alignment with long implementation lead times, as well as addressing uncertainty about rate and magnitude of local sea level rise, and ensuring that adaptation will be more effective (*medium confidence*). As sea level rise advances, only avoidance and relocation will eliminate coastal risks (*high confidence*). Other measures only delay impacts for a time, increasing residual risk, perpetuating risk and creating ongoing legacy

[1] H.-O. Pörtner et al., *Technical summary*, CLIMATE CHANGE 2022: IMPACTS, ADAPTATION AND VULNERABILITY (2022).

effects and inevitable property and ecosystem losses (*high confidence*). While relocation may in the near term appear socially unacceptable, economically inefficient or technically infeasible, it may become the only feasible option as protection costs become unaffordable and technical limits are reached (*medium confidence*).

Maladaptation can be reduced using the principles of recognitional, procedural and distributional justice in decision-making, responsibly evaluating who is regarded as vulnerable and at risk, who is part of decision-making, who is the beneficiary of adaptation measures and integrated and flexible governance mechanisms that account for long-term goals (*high confidence*).

Despite the risk of maladaptation, in places with high concentrations of people and property — including greater New York City — hard protective structures like those considered by the HATS are a necessary part of adaptation strategies. Given the importance of the HATS study region to the country and the real dangers posed by maladaptation, we therefore highlight a few areas relevant to our expertise where HATS could be improved by bringing it into alignment with the state of the art in science and practice.

Choice of sea level scenarios: Following standard Army Corps practice under ER 1100-2-8162 (2013), the draft HATS considers three sea-level scenarios: a 'low' scenario based on linear extrapolation of 20th century sea level trends (at rates already substantially exceeded by observed early 21st century sea level rise), an 'intermediate' scenario based on NRC (1987) Curve I and consistent with about 0.5 m of global-mean sea level rise over the 21st century, and a 'high' scenario based on NRC (1987) Curve III and consistent with about 1.5 m of global-mean sea-level rise over the 21st century. (It is our understanding that an update of the relevant guidance is currently under consideration. In the strongest possible terms, we advise against using such dated projections for major new investments).

Engineer Pamphlet 1100-2-1 (2019) emphasizes that considering these three scenarios are a minimum, and that "the analysis may also include additional intermediate or high rates, if the project team desires [e.g., from Parris et al. (2012)]." The Parris et al. (2012) study mentioned [2] was updated in 2022 by the most recent US government sea level rise scenarios published by the U.S. Sea Level Rise and Coastal Flood Hazard Scenarios and Tools Interagency Task Force [3]. One of us (Kopp) contributed to their development, and USACE (represented by Will Veatch, USACE's lead for climate preparedness and resilience) was among the agencies participating in the development of the scenarios. These new Interagency scenarios are consistent with the most recent sea level projections assessed by the IPCC [4].

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[2] Adam Parris et al., Global sea level rise scenarios for the US National Climate Assessment (2012).
[3] W. V. Sweet et al., *Global and regional sea level rise scenarios for the United States: Updated mean projections and extreme water level probabilities along U.S. coastlines*, 111 pp. (2022), https://oceanservice.noaa.gov/hazards/sealevelrise/noaa-nos-techrpt01-global-regional-SLR-scenarios-US.pdf.
[4] B. Fox-Kemper et al., *Ocean, cryosphere, and sea level change*, *in* Climate change 2021: The physical science basis 1211 (V. Masson-Delmotte et al. eds., 2021), https://doi.org/10.1017/9781009157896.011.

There are five Interagency scenarios, with 2050, 2100, and 2150 values shown in Sweet et al., (2022), Table 2.3, reproduced below:

Table 2.3: Global mean sea level and contiguous United States scenarios, in meters, relative to a 2000 baseline.

Global Mean Sea Level				Contiguous United States			
	2050	2100	2150		2050	2100	2150
Low	0.15	0.3	0.4	Low	0.31	0.6	0.8
Intermediate-Low	0.20	0.5	0.8	Intermediate-Low	0.36	0.7	1.2
Intermediate	0.28	1.0	1.9	Intermediate	0.40	1.2	2.2
Intermediate-High	0.37	1.5	2.7	Intermediate-High	0.46	1.7	2.8
High	0.43	2.0	3.7	High	0.52	2.2	3.9

Source: Sweet et al. (2022)

Each scenario is associated with local values at tide gauges and grid cells around the US. The 'intermediate' scenario considered by HATS is closest to the interagency Intermediate-Low scenario, and the 'high' scenario considered by HATS is closest to the interagency Intermediate-High scenario.

In light of the IPCC assessment of future sea-level rise[5], the Interagency Task Force interpreted its scenarios as follows (Sweet et al., 2022, Table 2.4):

- The Low scenario has at least a 92% chance of being exceeded, even in a world that limits warming to 1.5°C.
- The Intermediate-Low scenario corresponds to a median projection for a world in which warming is limited to 2°C, but has at least an 82% chance of being exceeded for a world in which warming is limited to 3°C.
- The Intermediate scenario has no more than a 5% chance of being exceeded in a world in which warming is limited to 3°C, unless rapid ice sheet loss processes that are an active topic of research and an area of limited scientific agreement come into play.
- The Intermediate-High scenario has less than a 1% chance of being exceeded in a 2°C world, even considering rapid ice sheet loss processes, but might have as high as 20% chance of being exceeded in a higher emissions future.
- The High scenario might have as high as a 8% chance of being exceeded in a higher emissions future with rapid ice sheet loss processes.

It is important to note that the IPCC found a basis in the literature to assess, even at low confidence, rapid ice sheet loss processes only under low and very high emissions; it is not clear from existing literature how much warming beyond 2°C is needed for these to become a considerable hazard. However, by interpolation it might be reasonable to estimate that, in a 3°C world with rapid ice-sheet

[5] *Id.*

processes, the probability of exceeding the Intermediate-High scenario would be less than about 10% and that of exceeding the High scenario would be less than about 4%.

In light of the Interagency and IPCC assessments [6], it is important to note that the current HATS 'intermediate' scenario, the focal point of the analysis, is as likely as not to be exceeded even in a world with low emissions, and likely to be exceeded under current emissions projections. At the same time, the HATS 'high' scenario is too high to be taken as a central scenario, but does not bound the full range of plausible scenarios considered in the Interagency report.

We therefore urge the consideration of the interagency scenarios, with the interagency Intermediate-Low (comparable to current 'intermediate' scenario) and Intermediate scenarios taken as bounding likely outcomes in the absence of rapid ice-sheet loss processes, and the High scenario used to evaluate the robustness of the alternatives to potential rapid ice-sheet losses. We recognize that US Army Corps procedure has not yet been updated for consistency with the Interagency scenarios, but such usage is consistent with the additional flexibility allowed by Engineer Pamphlet 1100-2-1.

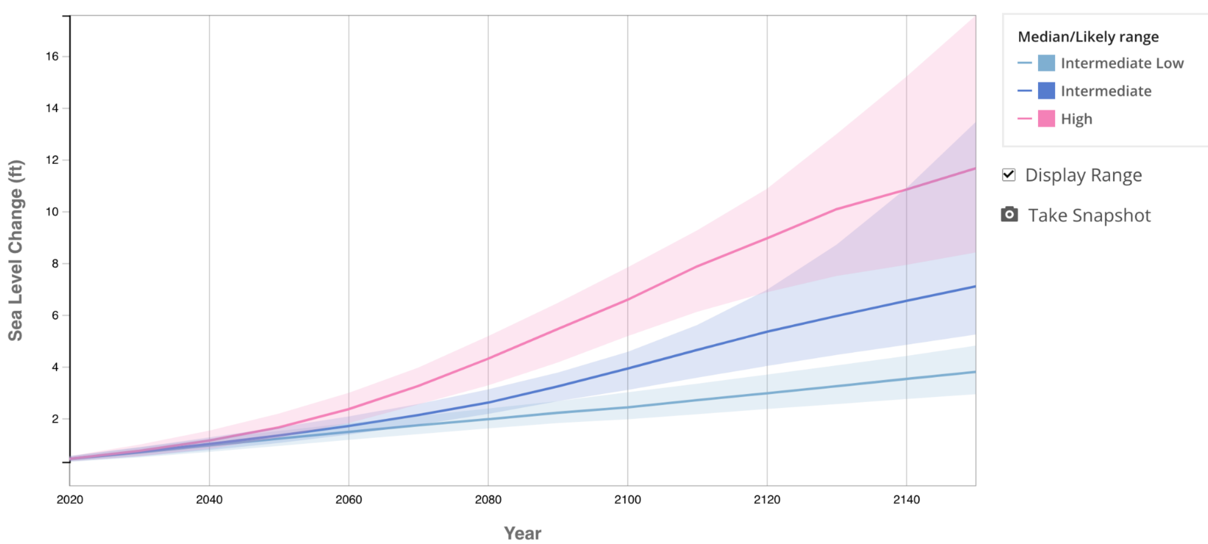

Figure 1. *Interagency Intermediate-Low, Intermediate, and Intermediate-High scenarios for the Battery tide gauge (relative to a year 2000 baseline). Note that the local projections associated with each scenario come with low, median, and high variants (median shown as line, and low-high range as shading around each line) that reflect different physical pathways consistent with the same global-mean sea-level outcome in 2100. Source: https://sealevel.nasa.gov/task-force-scenario-tool?psmsl_id=12*

Consideration of compound riverine and coastal flooding: The NY/NJ Harbor and Tributaries Region faces compound climate impacts from sea level rise, more intense precipitation and more significant

[6] *Id.*; SWEET ET AL., *supra* note 3.

tropical and extratropical coastal storms [7]. These hazards do not act alone and can interact, and modeling flooding without considering interactions can substantially bias outcomes. A hurricane or Nor'easter that also has intense precipitation has combined impacts of riverine flooding and coastal surge. Flood risk impact analyses that fail to consider these compound events would provide poor guidance. **While the field of compound flood modeling is computationally challenging and evolving, we suggest consideration and acknowledgement that these flood factors do not act independently.**

Another uncertainty and added complication to factor into a compound flood model is the impact that closure of inlet storm surge gates will have on stormwater/riverine flooding which may "pile up" behind the closed barriers. Understanding the impact of restricting the normal riverine flow into the Atlantic Ocean is another facet of understanding the dynamic changes that the proposed options will have both on flood reduction, and in this case, potential stormwater induced flood increases, and the resulting geographic redistribution of the hazard.

More rigorous analysis of adaptive approaches: Engineer Pamphlet 1100-2-1 states that, "Alternative plan selection should explicitly provide a way to address uncertainty,
describing a sequence of decisions allowing for adaptation based on evidence as the future unfolds" and encourages consideration of adaptive management that "uses sequential decisions and implementation based on learning and new knowledge."

The IPCC Working Group 2 report [8] points to the value of adaptive approaches, noting that responses to sea-level rise "are more effective if combined and/or sequenced, planned well ahead, aligned with sociocultural values and development priorities, and underpinned by inclusive community engagement processes (*high confidence*)."

The draft HATS (section 5.5.5) gives some consideration to adaptive approaches, focusing on changes to the closure criterion for the proposed storm surge barrier. It also gives a very cursory and schematic nod to adaptive approaches involving Risk Management Features and nonstructural measures, but does not provide any details, noting: "Even under the high RSLC projection, the current conceptual storm surge barrier designs could be adapted to maintain project performance over a 100-year planning horizon. Adaptation may include the modification or construction of additional structural and nonstructural measures, and natural and nature-based features to maintain the plan's level of risk management. Because the TSP's design level has not been optimized, the quantitative triggers for adaptation and quantitative data to define the potential adaptation measures have not been defined yet. A better definition of the possible triggers for adaptation and adaptation options will be established after optimization of the TSP, which will be documented in the final report."

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[7] Hamed R. Moftakhari et al., *Compounding effects of sea level rise and fluvial flooding*, 114 PNAS 9785 (2017); P. M. Orton et al., *Flood hazard assessment from storm tides, rain and sea level rise for a tidal river estuary*, 102 Nat Hazards 729 (2020); Thomas Wahl et al., *Increasing risk of compound flooding from storm surge and rainfall for major US cities*, 5 Nature Clim. Change 1093 (2015).
[8] IPCC, *Summary for policymakers*, Climate change 2022: Impacts, adaptation and vulnerability (2022).

The HATS' consideration of adaptive approaches is highlighted in Figure 58, showing how changes in the closure criteria might affect the frequency of closing events, and Figure 59, illustrating adaptations (mostly changes to closure height) using the subway-map-style diagram commonly used to illustrate adaptation pathways. We reproduce these figures below.

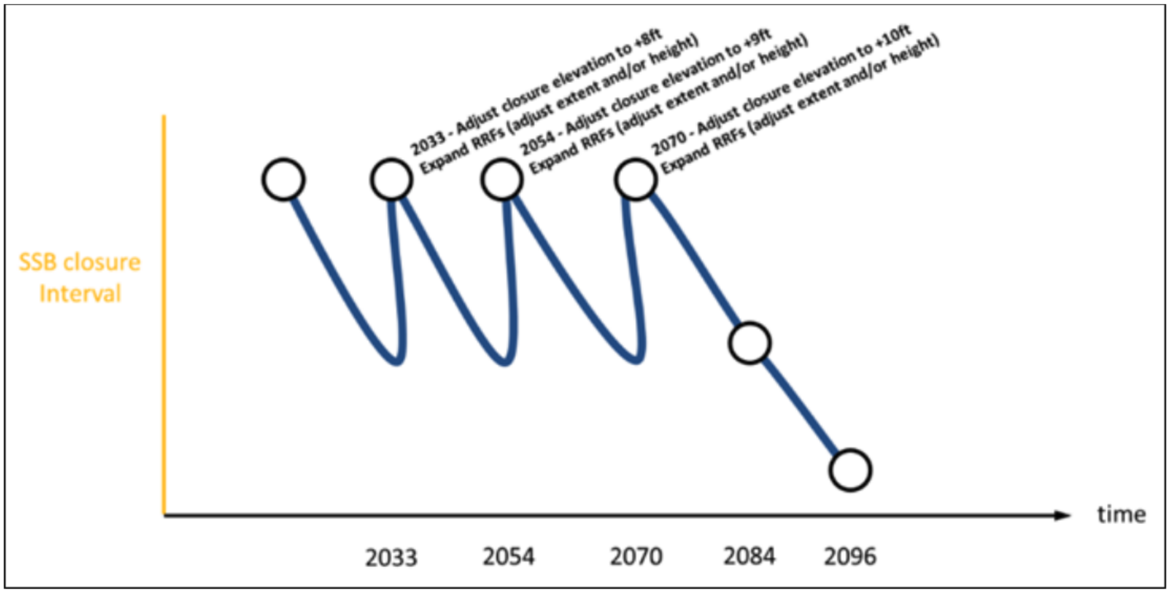

Figure 58: Adaptive management considering closure criteria (high RSLC scenario).

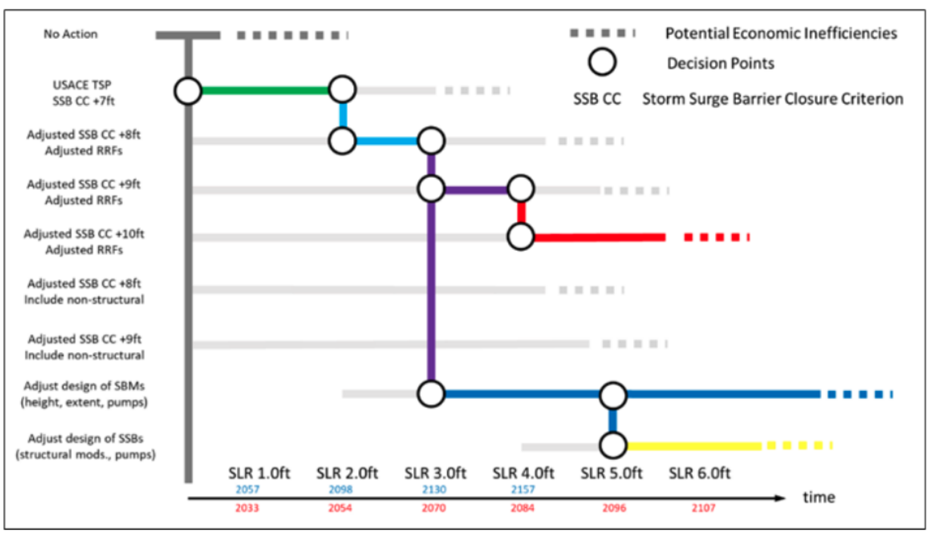

Figure 59: Adaptive management pathways with a focus on Risk Management Features.

In our opinion, this approach – deferring consideration of adaptive management until after selection of the TSP – is inadequate. Numerous studies have shown that adaptive approaches can considerably improve benefits, costs, and tradeoffs involved in selecting alternative adaptation pathways.

Deep uncertainty is often defined as a situation in which "analysts do not know, or the parties to a decision cannot agree on, (1) the appropriate models to describe the interactions among a system's variables, (2) the probability distributions to represent uncertainty about key variables and parameters in the models, and/or (3) how to value the desirability of alternative outcomes" [9]. The selection of the appropriate adaptation strategy is characterized by deep uncertainty not only with respect to physical changes (e.g., the potential for rapid ice sheet loss processes), but also with respect to the multiple and sometimes conflicting values held by relevant stakeholders. We note the public contentiousness surrounding the HATS process, which is unlikely to be resolved by the current round of comments. We suggest that adaptive management may provide an approach for dealing with this uncertainty, allowing greater time for a public discussion of options without deferring action indefinitely. In particular, we emphasize the finding of the IPCC [10], quoted previously, that "Avoiding maladaptive responses to sea level rise depends on … application of adaptive planning that sets out near-term, low-regret actions while keeping open options to account for ongoing committed sea level rise (*very high confidence*)."

For example, we note that many of the elements of Alternative 5 are embedded in other alternatives, and that these elements are substantially faster and lower cost to implement than many of the additional elements in other alternatives; one adaptive approach might include embarking on some of these elements while greater time is allowed to resolve both physical uncertainty and societal dissensus regarding these other elements. We do not endorse such an approach without analysis, simply point to it as an exampl e of the way that adaptive approaches that start with low-regret actions while keeping longer-term options open could be integrated into the alternative selection process.

Evaluation of costs and benefits along multiple dimensions, including values beyond efficiency with respect to capital protection: The benefit-cost calculations in HATS are narrowly scoped with respect to the priorities stated throughout the study. These priorities include environmental, economic, and social goals. Yet, the only costs included in benefit-cost calculations are construction costs; the only economic benefits included are avoided property damages. While the study includes some metrics for environmental and social benefits, these are not incorporated into the benefit-cost calculations. Limiting these calculations in scope to just property damage undermines these other project goals. For example, this limited scope inherently prioritizes protection of high-value property areas because benefits appear higher [11]. A benefit-cost analysis that corresponds more closely to how benefits are conceived of within the communities receiving investment will more comprehensively account for factors outside the report's limited scope. This is especially important in the context of HATS because nearly all considered alternatives exhibit benefit-cost ratios that exceed one, and the ratios are similar to each other. Benefit-cost analyses that more comprehensively account for other prioritized factors may indicate substantially

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[9] Robert J. Lempert, Steven W. Popper & Steven C. Bankes, Shaping the next one hundred years: new methods for quantitative, long-term policy analysis (2003).
[10] Pörtner et al., *supra* note 1.
[11] A. R. Siders, *Social justice implications of US managed retreat buyout programs*, 152 Climatic Change 239 (2019).

different benefit implications, and shift the recommended option [12]. Furthermore, many of the affected communities are victims of historical and current patterns of bias (e.g., redlining) and are also foci of efforts to account for these in ongoing agency decision-making across the US government (e.g., Executive Orders 13985 and 14091). Instead, by ignoring the need to account for such factors in its BCA and relegating related considerations to the other social effects account, USACE positions itself as contrary to US policy.

Multi-objective approaches is one class of strategies to improve upon these benefit-cost analyses. While the report's benefit-cost analyses are focused on economic efficiency in a limited scope, individuals and communities have a range of values affected by risk management decisions: for example, biodiversity, sense of place, quality of life, empowerment, and safety [13]. While many of these can be represented in a single-objective benefit-cost analysis (for example, through contingent valuation or revealed preference approaches [14]) there is considerable ambiguity and substantial challenges in translating these to a dollar scale [15]. In contrast to the current way these values are treated, multi-objective approaches are a practical method for directly evaluating these considerations as objectives instead of as ancillary, non decision-relevant criteria in the other social effects account. Thus explicitly multi-objective approaches can foster more fruitful civic dialogues about alternative choices.

As a qualitative example of a multi-objective approach, consider this dynamic adaptation pathways scorecard for Surf Drive in Falmouth, Massachusetts, highlighted in the Application Guide for the 2022 Interagency Sea Level Rise Technical Report:

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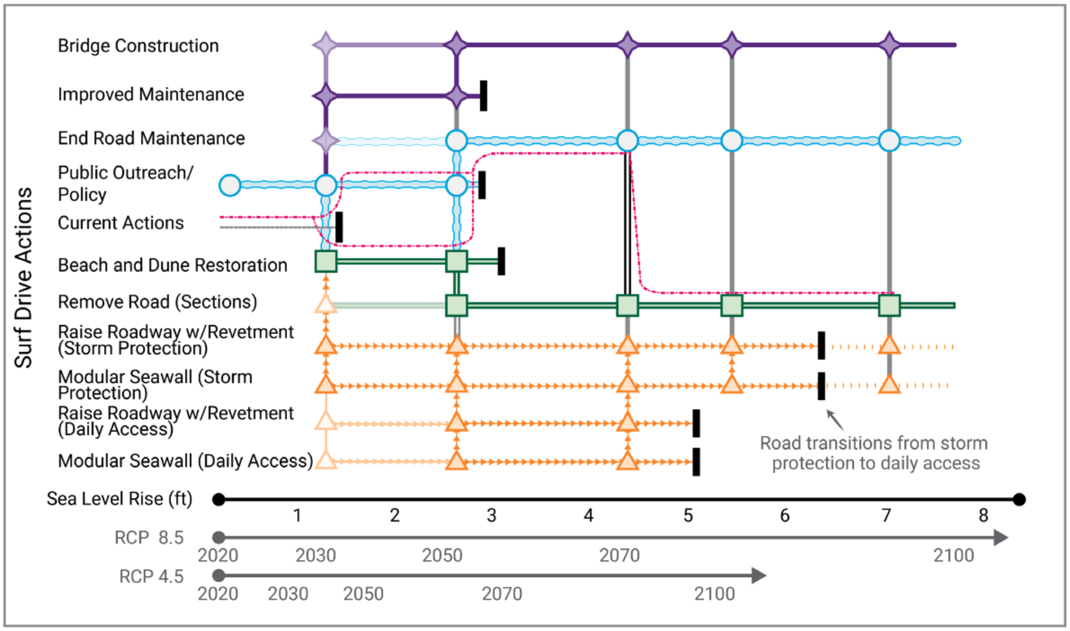
[12] Guangtao Fu et al., *Optimal Design of Water Distribution Systems Using Many-Objective Visual Analytics*, 139 JOURNAL OF WATER RESOURCES PLANNING AND MANAGEMENT 624 (2013); Gregory Garner, Patrick Reed & Klaus Keller, *Climate risk management requires explicit representation of societal trade-offs*, 134 CLIMATIC CHANGE 713 (2016); Mahkameh Zarekarizi, Vivek Srikrishnan & Klaus Keller, *Neglecting uncertainties biases house-elevation decisions to manage riverine flood risks*, 11 NAT COMMUN 5361 (2020).

[13] Douglas L. Bessette et al., *Building a Values-Informed Mental Model for New Orleans Climate Risk Management*, 37 RISK ANALYSIS 1993 (2017); Polina K. Dineva et al., *Promoting Spatial Coordination in Flood Buyouts in the United States: Four Strategies and Four Challenges from the Economics of Land Preservation Literature*, 24 NATURAL HAZARDS REVIEW 05022013 (2023); Ellen M. Douglas et al., *Coastal flooding, climate change and environmental justice: identifying obstacles and incentives for adaptation in two metropolitan Boston Massachusetts communities*, 17 MITIG ADAPT STRATEG GLOB CHANGE 537 (2012); Sébastien Foudi et al., *The impact of multipurpose dams on the values of nature's contributions to people under a water-energy-food nexus framing*, 206 ECOLOGICAL ECONOMICS 107758 (2023); Clare Johnson, Edmund Penning-Rowsell & Dennis Parker, *Natural and Imposed Injustices: The Challenges in Implementing "Fair" Flood Risk Management Policy in England*, 173 THE GEOGRAPHICAL JOURNAL 374 (2007); Caroline M. Kraan et al., *Promoting equity in retreat through voluntary property buyout programs*, 11 J ENVIRON STUD SCI 481 (2021); Hannah M. Stroud, Paul H. Kirshen & David Timmons, *Monetary evaluation of co-benefits of nature-based flood risk reduction infrastructure to promote climate justice*, 28 MITIG ADAPT STRATEG GLOB CHANGE 5 (2022); Erik C. van Berchum et al., *Evaluation of flood risk reduction strategies through combinations of interventions*, 12 JOURNAL OF FLOOD RISK MANAGEMENT e12506 (2019).

[14] PATRICIA A. CHAMP ET AL., A PRIMER ON NONMARKET VALUATION (2003); U.S. OFFICE OF MANAGEMENT AND BUDGET, *Circular A-4*, (2003).

[15] Kelly C. Bishop et al., *Best Practices for Using Hedonic Property Value Models to Measure Willingness to Pay for Environmental Quality*, 14 REVIEW OF ENVIRONMENTAL ECONOMICS AND POLICY 260 (2020).



Pathway Scorecard

	Path Actions	Relative Costs	Target Effects	Side Effects
1.	○ Managed Retreat	+	Balances present uses with increased costs and risks in the future through a multi-phase retreat plan	Loss of Homes No Connection via Surf Dr. Loss of Accessible Beach
2.	△ Protection	+++++	Protects operational capacity of existing infrastructure and features	Loss of Accessible Beach Aesthetics/Visuals
3.	□ Natural Resources	+++	Preserves and enhances coastal and marine ecosystem functions	Loss of Homes No Connection via Surf Dr.
4.	◆ Connection	++++++	Maintains important public access, utility connections, and transportation corridors	Loss of Homes
5.	□ ○ □ Preferred	+++	Balances present uses with increased costs and risks in the future through a multi-phase retreat plan, while enhancing ecosystems	Loss of Home No Connection via Surf Dr.
6.	◆ □	+++	Improved maintenance for short-term uses with a long-term focus on ecosystem restoration	Loss of Homes No Connection via Surf Dr.
7.	□ △	+++++	Coastal habitat restoration in the short-term, with protection of existing infrastructure in the long-term	Loss of Accessible Beach Aesthetics/Visuals

Note that the scorecard explicitly compares costs, desired non-monetized benefits, and non-monetized side effects. As a more quantitative, two-objective example, the 2023 Louisiana Comprehensive Master Plan explicitly evaluates alternatives with respect to both storm surge risk reduction and land loss reduction.[16]

Table 16 in the draft HATS nods in the direction of qualitative multi-objective assessment, but does not seriously consider the multiple values held by the affected people, nor even the differences in assessed costs and benefits. From this table, the only difference among the alternatives is the ability to support

[16] COASTAL PROTECTION AND RESTORATION AUTHORITY OF LOUISIANA, *Louisiana's Comprehensive Master Plan for a Sustainable Coast: 4th Edition - Draft Plan Release*, (2023), https://coastal.la.gov/wp-content/uploads/2023/01/230105_CPRA_MP-Draft_Final-for-web_spreads-main.pdf.

critical infrastructure during and after storm surge events. At the same time, “no alternative plans were screened for violating the planning constraints,” such as minimizing impacts to ecosystem restoration, resources within the Gateway National Restoration Airway, access for federal navigation channels, induced flooding, community access, airport operations, and critical habitat. A more rigorous multi-objective assessment would include such identifiable goals as part of the selection process.

The draft HATS does consider the contribution of the alternatives to four accounts: national economic development (reflected here based on flood damages), regional economic development (here based on induced economic output associated with construction), environmental quality and other social effects. However, the consideration of these four accounts does not necessarily all point in the same direction, based on the analysis included in the HATS: alternative 3A has the greatest reduction in flood damages, though net benefits are greater in the Intermediate-Low sea level scenario in 3B; induced economic activity is greatest in alternative 2 (because project costs are greatest); other social effects favor alternative 2 (though this alternative ranks lowest based on reflection of community priorities); and environmental effects favor alternative 5. We make this observation not to favor one alternative or another, simply to note that the draft HATS itself indicates that not all relevant metrics point in the same direction.

At a minimum, we suggest acknowledging this explicitly and pointing to the consideration that nevertheless led the draft HATS to favor Alternative 3B.

Consideration of the range of human responses to coastal climate hazards, including individual, household and community-planned relocation in evaluating the benefits of alternatives: While it is appropriate to consider the longer-term benefits of alternative plans, the economic analysis in the draft HATS assumes full benefits through 2094. It does this by assuming that the current distribution of structures (and by extension people) remains unchanged through this period. This assumption is questionable, and a more comprehensive representation of population, specifically including household level decision-making on mobility and migration and in response to these barriers, may highlight maladaptation risks and alter both the benefits as well as desirability of these interventions.

Human responses to climate hazards such as sea level rise, are conditioned on the perceptions of risks, household resources, including assets and social capital, and policies [17]. Representing decisions about whether to remain or move requires a consideration and representation of the interactions and feedbacks of policy, population, and sea level. Neglecting this may have grave implications, especially with respect to environmental justice objectives. For example, protective barriers may lead to a climate gentrification effect where lower income households are displaced as the properties are now less risky. Conversely, these barriers could also lead to mobility traps where vulnerable populations who would otherwise move remain with the eventual need for more costly interventions. While it is difficult to

[17] e.g., D. Wrathall et al., *Meeting the challenge of future migration from global sea-level change*, 9 NATURE CLIMATE CHANGE 898 (2019).

know which dynamics will occur without modeling of both push and pull efforts, agent-based models (ABM) have shown a way forward in representing these interactions [18].

A more thorough examination of these socioeconomic futures could also engage communities with more challenging conversations on the possibility of complementing investments in structural and non-structural risk reduction plans with policies to encourage relocation out of high-risk areas, such as property acquisitions, relocation assistance, and the development of new affordable housing intended to facilitate relocation[19] . While such levers are not within the domain of the USACE, they are part of the available strategies for a comprehensive, intergovernmental adaptation plan for the region, and would affect the assessed benefits of the alternatives. (As an example of potential inefficiencies introduced by not considering protection and relocation strategies together, note that some of the areas protected by the under-construction South Shore of Staten Island Coastal Storm Risk Management Project were targets of post-Sandy state buyouts.[20]) Also, by neglecting these conversations now, communities may find any future relocation approaches less desirable and with larger detrimental effects on wellbeing than those that are planned for through ongoing and participatory processes.

Collaborative Governance Structure: Although governance of the currently suggested mitigation approaches is not explored at this stage in the HAT Study, we suggested a collaborative governance be discussed. Decisions that could benefit from this type of structure include (but are not limited to):

- Who decides the trigger for when surge gates are opened or closed?
- Who or what entity/entities(ies) is/are responsible for physically opening and closing, and
- Do these triggers take into account other ecological risks associated with possible changes to the dynamics of the estuarine flow?

Ensuring multiple perspectives and values are factored into the governance and decision making behind the planning and operations of the mitigation strategies will result in standard procedures that are reflective of the assets they are intended to protect.

In summary, given the magnitude of the proposed costs (assessed at $53 billion) and the scale of the project's impact on the nation's largest urban megaregion, the plan selection process should employ state-of-the-science approaches. In particular, this includes integrating the multiple objectives the analysis considers into a rigorous framework that does not simply prioritize the tradeoff between construction and operation costs, on the one hand, and residual property risk on the other. Other important social and environmental values are at stake in the selection process, but are not given equal

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[18] e.g., Koen de Koning & Tatiana Filatova, *Repetitive floods intensify outmigration and climate gentrification in coastal cities*, 15 ENVIRON. RES. LETT. 034008 (2020); A. R. Bell et al., *Migration towards Bangladesh coastlines projected to increase with sea-level rise through 2100*, 16 ENVIRON. RES. LETT. 024045 (2021).

[19] e.g., A.R. Siders, Miyuki Hino & Katharine J. Mach, *The case for strategic and managed climate retreat*, 365 SCIENCE 761 (2019).

[20] Nathan Kensinger, *Staten Island will build a barrier to protect against climate change—but is it already too late?*, CURBED NY (2019), https://ny.curbed.com/2019/4/25/18515213/staten-island-usace-seawall-climate-change-photo-essay (last visited Feb 24, 2023).

weight. Additionally, the broader consideration of environmental justice related to this plan over time is not given significant consideration, even though there is ample evidence that shows how these interventions can disproportionally affect these communities. Finally, households or communities are insufficiently equipped with the relevant range of socioeconomic futures by which to evaluate the desirability of these interventions or engage in more difficult long-term conversations about the need to relocate from risky areas, which may ultimately make these future decisions even more socially and politically challenging.

In addition, we argue that dynamic adaptive approaches have a first-order effect on the evaluation of tradeoffs, and that it is not appropriate to defer the detailed analysis of adaptive options until after the selection of the preferred alternative. While a more comprehensive analysis does require employing state-of-the-art approaches and will be therefore take longer than apply standard approaches, we believe that careful analysis of existing data could identify opportunities for staging alternatives, allowing progress to begin on lower-cost, less-impactful features that are common to multiple alternatives while both technical uncertainties are resolved and a greater degree of social consensus obtained.

Thank you for your consideration.

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