THE STATE OF NEW YORK

NATIONAL DISASTER RESILIENCE COMPETITION

PHASE 2 APPLICATION FOR PUBLIC COMMENT

ATTACHMENT F: BENEFIT COST ANALYSIS

REIMAGINING RESILIENCE

OCTOBER 25, 2015

Attachment F Benefit Cost Analysis
State of New York
AttFBenefitCostAnalysis_NYS.pdf

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Executive Summary

The State of New York worked closely and iteratively with its Partners to develop a holistic, systems-based approach to addressing the recovery and resiliency needs of its most impacted and distressed target areas. *Reimagining Resilience*, the State's Phase 2 application to the National Disaster Resiliency Competition (NDRC), aims to support a resilient recovery by enhancing the physical, economic, social, and environmental resilience of the Empire State's coastal and riverine communities.

The State proposes two projects and four programs, which enhance the resilience of vulnerable communities impacted by coastal and riverine flooding and further threatened by climate change. The first set of proposals will create protections for highly-vulnerable, low and moderate-income (LMI) residents of public housing and manufactured home communities:

- Manufactured Home Community Resiliency Pilot Program and
- Public Housing Resiliency Pilot Project.

The second group of proposals is aimed at modernizing infrastructure to accommodate changing conditions in riverine and coastal areas to increase resilience:

- Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program,
- Right-Sizing Bridges Resiliency Program,
- Right-Sizing Critical Dams Resiliency Project, and
- Nassau County Outfall Pipe and Bay Resiliency Project.

As part of the NDRC effort, the State engaged one consulting firm to independently evaluate the costs and benefits of all of its proposed programs and projects per the requirements described in Appendix H of the NOFA and OMB Circular A-94. Benefit Cost Analyses (BCAs) were developed using the Federal Emergency Management Agency (FEMA) BCA toolkit. The

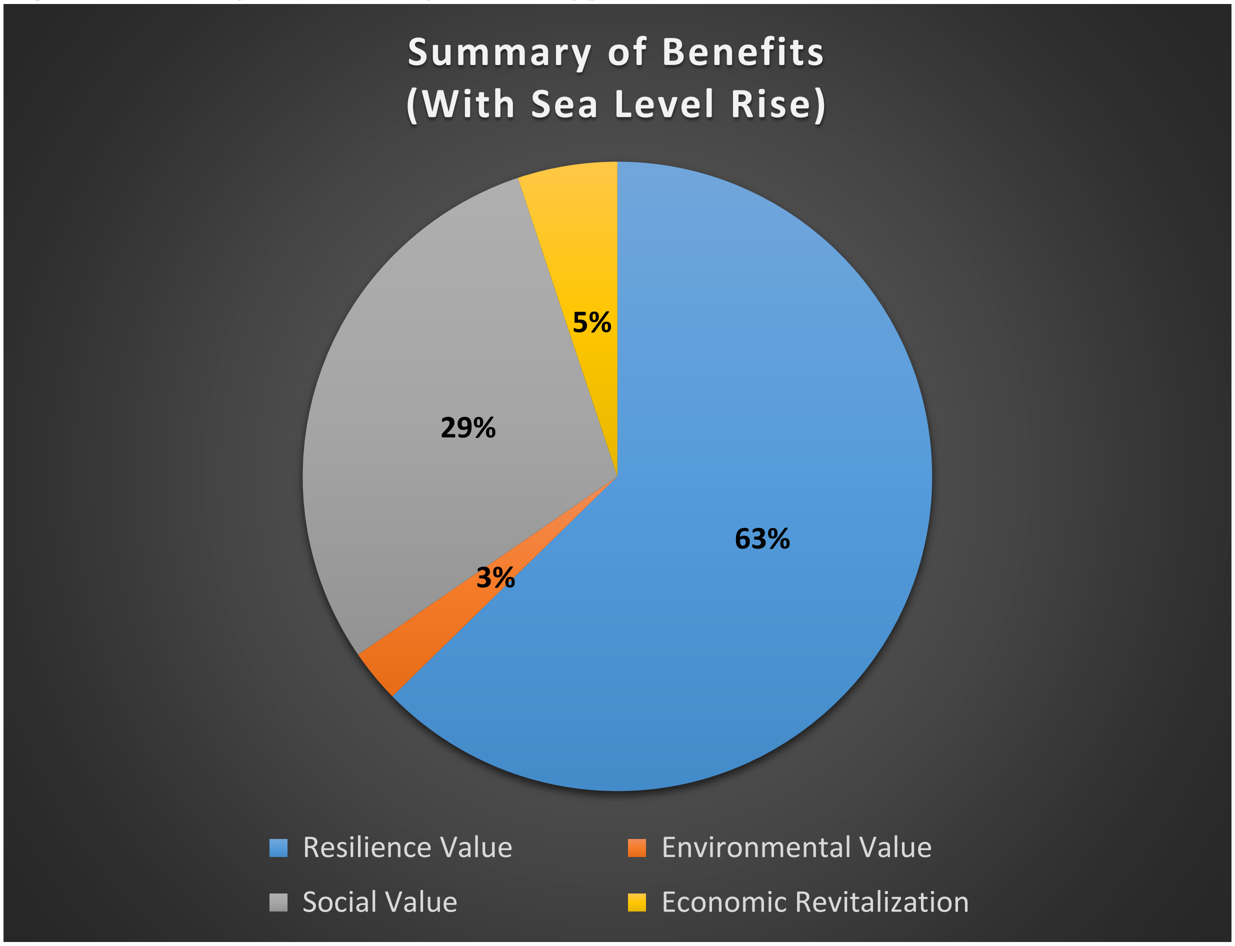
BCAs were completed for the proposed projects based on the most detailed information available for the project sites. The BCAs were completed for the proposed programs based on program-indicative interventions at exemplary sites. The monetized costs and benefits are used to calculate a benefit cost ratio (BCR). BCR measures a project's cost effectiveness by comparing the project's future benefits to its costs. BCRs were provided for every program and project, as well as for the overall portfolio of programs and projects. BCRs were calculated for a base case and a case in which the effects of sea level rise were incorporated.

Individual BCAs prepared for each project and program are combined together for an aggregate net present value of $2.044 billion and benefit cost ratio of 3.47. Accounting for the effects of sea level rise, the BCR increases to 3.82 for all proposed interventions. As such, the State's CDBG-NDR request for $470 million is both prudent and cost-effective.

Table 1: BCA Summary Table – Reimagining Resilience

SUMMARY OF BENEFIT COST ANALYSIS (BCA) **Cumulative Present Values, Monetized Intervention Program Elements** **GRAND TOTAL COMBINED PROGRAMS (1 - 6)**	**BASE CASE OR OTHER ALTERNATIVE EVALUATED**	**WITH SEA LEVEL RISE (ASSUMES HIGH CASE)**
MITIGATION COSTS	$828,146,445	$828,146,445
BENEFITS		
Resilience Value	$1,800,344,911	$2,076,585,883
Environmental Value	$78,665,528	$78,665,528
Social Value	$845,944,784	$864,085,160
Economic Revitalization	$147,289,875	$147,289,875
Total Benefits	$2,872,245,099	$3,166,626,446
Net Benefits (NPV)	$2,044,098,654	$2,338,480,001
Benefit Cost Ratio (BCR)	**3.47**	**3.82**

Figure 1: Summary of Benefits by Benefit Type



The Manufactured Home Community Resiliency Pilot Program BCA evaluates two kinds of community interventions: (1) buyout and relocation, and (2) infrastructure strengthening and elevating homes. The BCA is based on program-indicative interventions at two exemplary manufactured home communities in the State. The BCR for the program in the base case is 2.86 and increases to 6.56 after accounting for sea level rise.

The Public Housing Resiliency Pilot Project is designed to enhance the physical resilience of several public housing properties, as well as the social and economic resilience of residents of the public housing properties. The BCR for the projects in the base case is 1.8 and increases to 2.9 after accounting for sea level rise.

The Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program is designed to facilitate the right-sizing of small-scale infrastructure (culverts with up to a 25 foot span) and the restoration of natural floodplains. The BCR for the program in the base case is 3.6.

The Right-Sizing Bridges Resiliency Program is designed to right-size flood prone bridges in targeted counties. The BCR for the program in the base case is 3.4.

The Right-sizing Critical Dams Resiliency Project is designed to ensure that dams in Harriman State Park and Minnewaska State Park Preserve meet current safety requirements and protect downstream communities from significant or widespread damage resulting from a dam failure. The BCR for the project in the base case is 2.0.

The Nassau County Outfall Pipe and Bay Resiliency Project replaces the existing Reynolds Channel Outfall with a new tunneled outfall pipe, 138 inches in diameter with a 10 inch lining, extending 5.3 miles from Bay Park STP to a diffuser in the Atlantic Ocean. The BCR for this project in the base case is 3.84. The BCR for the project under the sea level rise scenario is 3.83.

BCA Crosswalk Table (as per Appendix H)

See below for all pertinent data and quantifiable calculations for benefits and costs listed in the narrative description in a single table. All of the proposed programs and projects are listed in order.

Table 2: Appendix H Benefit Cost Analysis Table

(Starts on next page)

APPENDIX H BENEFIT COST ANALYSIS TABLE					
1	2	3	4	5	6
Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Manufactured Home Community Resiliency Pilot Program					
Life cycle costs					
Phase I: Community Based Planning & Outreach	BCA page #: 189	The costs will reflect the phase I component program elements of: 1) Community (and stakeholder/partners) identification and representation 2) Criteria Development for program inclusion 3) Selected Community outreach and engagement in comprehensive planning process 4) Mobilization of expertise and procurement. Obtain and engage partner/ planning firm to assist with outreach / participation efforts /research/asset inventories/ risk assessments etc. 5) Final Implementation Concepts and progression to next phases To fully inform and guide the process of resiliency strengthening interventions, targeted for the Manufactured Homes Community, the first action will be to establish a community-based planning process, modeled after the NY Rising Community Reconstruction Program, which incorporates residents of manufactured home communities, along with other relevant stakeholders (such as local governments, local planning and community organizations, emergency response organizations and technical experts), into the resiliency planning decision-making process. This step is centered on investing in community-based social resilience measures. Through participatory planning, including the involvement of manufactured home park owners, local municipalities, county leadership, and non-profit partners, the Program will facilitate the exploration of solutions to mitigate the current and future risks of manufactured home communities in the 100 or 500 year floodplain. The costs of this phase can include all expenditures necessary for meeting the goals of participation and engagement and	*The costs will be developed from budgets that address the various components of the program to arrive at final conceptual solutions.*		*2*

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		solicitation of implementation inputs. These costs potentially consist of sub-recipient grants for technical expertise, meetings/gatherings/outreach costs/surveys/foreign language translation/social media costs/data requirements etc.			

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Phase II: Scenario Option 1: Buyout & Relocation	BCA page #: 189	Capital Cost elements include: Planning, Park Buyout, Uniform Relocation Assistance (URA) Costs, Rental Assistance, Acquisition, Development of New Land, Demolition & New Units, Development Costs plus contingency factor. No long term annually recurring costs (O&M) incurred because of land use change to riparian natural habitat characteristic of floodplain. Costs of Option 1 reflect FEMA and NYS law and policies for compensating impacted households for relocation who reside in Flood Zone AE communities (within the 100 yr. and 500 yr. event floodplains). The buyout and relocation of select vulnerable MHC communities in flood prone areas to areas outside of these floodplains would avoid numerous losses to households, property and resources. The option reflects a land use change to a natural floodplain habitat that will support numerous ecological services that are highly valued by society. Financing sources for Cooperative MHC structure would come from ROC-USA, HCR and Leviticus. Studies show that cooperative ownership structures for MHCs have economic advantages for resident communities compared to investor owned MHCs. Some of the benefits of COOPs or resident owned communities (ROCs) include the realization of higher average sales prices, faster home sales, and better access to fixed rate home financing. Additional benefits include community cohesion and enhanced sense of place and civic integration.	The costs of the Option 1 Buyout & Relocation program element were based on parametric costing concepts, (and comparable home costs) and Manufactured Home Community (MHC) scaling for a sample of 40 constituent units or pads. Statistical analysis of an average square foot for a given unit was used to scale up Option 1 Program element costs to a budget that would allow for buyout and relocation of approximately 80 Units or Park pads or multiple MHCs containing combinations of approximately 80 units.	Phase II: Option 1 program element cost estimate of $28,000,000 (rounded).	2

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Phase II: Scenario Option 2: Infrastructure Strengthening & Safely Elevating	BCA page #: 189	Capital Cost elements include: Demolition & Elevation of 140 household units, Soft Costs, Berm/Levee construction supporting an MHC of that size, Bulkhead, Anchoring, URA Costs, Relocation Assistance and contingency. Option 2 involves safely securing homes located in the 100 yr. and 500 yr. floodplains by either raising the structures safely above flood elevations, anchoring/securing structures, &/or building flood proofing containment structures (berms, levees, bulkhead construction etc.) The infrastructure improvements would avoid numerous losses to households, property and resources.	The costs of the Scenario Option 2: Infrastructure Improvements: Safely Elevating were based on parametric costing concepts, (and comparable home costs) and Manufactured Home Community (MHC) scaling for a sample of 140 constituent units or pads. Statistical analysis of an average square foot for a given unit was used to scale up Option 2 Program element costs to a budget that would allow for safe infrastructure improvements for approximately 140 units within a flood prone area. References: 1) FEMA 551 / March 2007. Selecting Appropriate Mitigation Measures for Floodprone Structures. 2) FEMA P-85, Second Edition / November 2009. Protecting Manufactured Homes from Floods and Other Hazards: A Multi-Hazard Foundation and Installation Guide.	Phase II: Option 2 program element cost estimate of $42,000,000 (rounded).	2
Resiliency Value					
Phase I: Community Based Planning & Outreach	BCA page #: 196	For Phase I, resiliency value benefits consist of the process benefits of selecting the highest priority, most widely accepted, and most resilient project interventions in a timely manner. Without having this phase, the interventions would not necessarily result in the broadest and most inclusive investments that are implemented in a timely manner to benefit the most vulnerable populations. Because local stakeholders are engaged and providing an ongoing dialogue and interaction with experts and other community stakeholders, the intervention designs are better informed (through local community inputs and knowledge) and more comprehensively developed. These plans result in interventions that contain more carefully tailored and crafted	Phase I will result in fewer economic transactions costs in arriving at sustainable interventions. This means that the outreach and engagement process will minimize dissatisfaction and objections on the part of some stakeholders that can potentially derail, or delay the process. Greater community acceptance of proposed concepts for implementation and less opposition can result in improved schedules and streamlining that can save on mitigation costs. With less opposition to proposed concepts, fewer delays in implementation can speed up permitting and construction schedules. The quicker the adaptive resiliency investments are implemented, the less risk there is to the vulnerable populations in these	Reducing implementation time and risk levels from Phase I has value that is evident, but has not been quantified. These benefits have been assigned a Qualitative Weight of ++ because they are expected to have a strong positive impact.	**1**

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		elements that are specific to the local area's adaptive resiliency needs.	communities from future catastrophic flood and storm events.		
Phase II: Scenario Option 1: Buyout & Relocation	BCA page #: 196	The buyout and relocation of 80 homes would avoid damages to buildings, their contents and displacement costs incurred. Option will remove approximately 80 households from harm's way. These actions will result in avoided disruption, repair and displacement costs that were quantified and monetized in the CBA. Buyout and relocation will also avoid evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs.	The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to buildings/structures, their contents and avoided displacement costs. The estimates were based on data contained within Flood Insurance Studies and FIRMS and probable flood events impacting MHCs residing in 100 year event flood plains (Zone AE). The FEMA default depth damage function was applied to flood levels likely experienced in select riverine areas for given return periods (annual likelihood of flood events).	Storm impact damages for (10, 50, 100 & 500 yr.) events were converted to annual effective probable damages likely to be incurred over a 30 year period. See CBA Table for cumulative damages for Resilience Values by year. Cumulative Present Value Resilience Values: Option 1 Total: $62,856,974 Damage to buildings: $39,772,332 Damage to contents: $23,005,235, Displacement: $79,406	1
Phase II: Scenario Option 2: Infrastructure Strengthening & Safely Elevating	BCA page #: 196	The elevation, anchoring, securing and flood proofing infrastructure constructed (i.e., berms, levees, bulkheads) will avoid damages to approximately 140 structures, their contents and displacement costs experienced by vulnerable households. Option will elevate and secure approximately 140 vulnerable households and protect them from harm's way. These actions will result in avoided disruption, repair and displacement costs that were quantified and monetized in the CBA. Buyout and relocation will also avoid and greatly reduce evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs.	The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to buildings/structures, their contents and avoided displacement costs. The estimates were based on data contained within Flood Insurance Studies and FIRMS and probable flood events impacting MHCs residing in 100 year event flood plains (Zone AE). The FEMA default depth damage function was applied to flood levels likely experienced in select riverine areas for given return periods (annual likelihood of flood events).	Storm impact damages for (10, 50, 100 & 500 yr.) events were converted to annual effective probable damages likely to be incurred over a 30 year period. See CBA Table for cumulative damages for Resilience Values by year. Cumulative Present Value Resilience Values: Option 2 Total: $89,261,92 Damage to buildings: $56,626,63 Damage to contents: $32,448,162 Displacement: $187,134	1

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Environmental Value					
Phase I: Community Based Planning & Outreach	BCA page #: 200	The community based planning process will identify specific local environmental benefits or avoided costs that can be mitigated by the project interventions. For example, local environmental benefits can consist of potential energy savings in the use of raw materials and resources used in the buyout and relocation of select MHCs, as well as in the infrastructure strengthening phase intervention.		These benefits have not been quantified but are assigned a qualitative weight of (++).	**2**
Phase II: Scenario Option 1: Buyout & Relocation	BCA page #: 200	Ecosystem Service Benefits: Option will create approximately 27 acres of riparian habitat once the structures are demolished and removed from floodplain. The option reflects a land use change to a natural floodplain habitat that will support numerous ecological services that are highly valued by society.	The FEMA BCA Software program v. 5.1 Environmental Benefits estimation calculator was applied to estimate the annual monetized ecosystem service benefits generated from 27 acres of newly formed riparian habitat and associated functions. The ecosystem service values (per acre) reflect the combined riparian services of aesthetic value, air quality, biological control, climate regulation, erosion control, flood hazard reduction, food provisioning, habitat refugium, pollination, recreation/tourism, stormwater retention and water filtration. The acre values are from peer reviewed ecosystem valuation literature. The annual combined estimate per acre was then combined within the Option 1 project resource statement and projected over a 30 year period, and then discounted to present value using a 7% discount rate.	Cumulative Present Value of Ecosystem Service Benefits: Option 1 Environmental Value: $13,038,937	1

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Phase II: Scenario Option 2: Infrastructure Strengthening & Safely Elevating	BCA page #: 200	Environmental Benefits were not quantified and monetized for this option. Option 2 will result in environmental benefits associated with less resource use and expenditures associated with preparing for, and reacting to flood events and storms. During the 100 yr. events taking place within floodplain AE zones, many resources are marshalled to react to storms. Energy, fuel and materials are consumed to clean up and repair sites. For example emergency generators consume diesel fuel and are emission intensive and loud. Debris is removed and landfilled. All of these activities have associated environmental costs. Option 2 will result in avoiding many of these former vulnerability related costs.	To quantify and monetize the mental stress and anxiety costs and lost productivity associated with flood events, the FEMA BCA software tool v. 5.1 was applied. An estimate of the population that would be impacted, and would incur these costs was based on past event ratios. The software contains standard treatment costs per person, and productivity losses per person that were then applied to the impacted population corresponding to the 140 households.	The environmental benefits associated with Option 2 are described qualitatively and assigned a weight. **(++)**	**2**
Social Value					
Phase I: Community Based Planning & Outreach	BCA page #: 202	Phase I, Community Based Planning and Outreach would result in the creation and strengthening of social capital benefits. Social capital can include the relationships that are developed and strengthened within the Manufactured Home communities (as well as the larger host community and municipality) that are directly attributable to, and catalyzed by, the community planning and engagement efforts.	The benefits of social capital relationships can include new and expanded networks, engagement of isolated and marginalized or socially disenfranchised groups and individuals, and the formation of new social trust and bonds created among groups of diverse backgrounds. In addition, where feasible, the formation of Resident Owned Community cooperatives (ROCs) as an ownership structure, are conducive to forming new economic and social benefits and also strengthening existing social capital within a community.	Social capital benefits have not been monetized but are described qualitatively and assigned a strong positive weight of (++).	**1**

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Phase II: Scenario Option 1: Buyout & Relocation	BCA page #: 202	Option 1 will result in the following social values: 1) Mental Stress and Anxiety Costs Avoided: 2) Lost Productivity Costs Avoided: 3) Avoided Physical Injuries (Abbreviated Injury Scale). The buyout and relocation of 80 households from the vulnerable floodplain will remove these residents from harm's way. The CDC estimated that approximately 10.4% of the respondents in flooded areas reported injuries in the first week after Sandy; nearly 75% of those had multiple injuries. A certain percent of these residents (including many senior citizens and children) will also not experience the mental stress and anxiety associated with storm/flood event catastrophic events. In addition, a percentage of these communities will not experience the lost productivity associated with these impacts and the disruption in their work routines.	To quantify and monetize the mental stress and anxiety costs and lost productivity associated with flood events, the FEMA BCA software tool v. 5.1 was applied. An estimate of the population that would be impacted, and would incur these costs was based on past event ratios. The software contains standard treatment costs and per person, and productivity losses per person that were then applied to the impacted population corresponding to the 80 households. To quantify and monetize the costs of avoided physical injuries, the 10.4% of the population impacted ratio (adapted from Sandy study) was applied to the population associated with the 80 households who would be relocated. The Abbreviated Injury Scale (AIS) containing economic injury values by severity was then applied to an estimated distribution of the impacted population by severity. Most of the injuries quantified in this exercise were minor and moderate.	Scenario Option 1: Cumulative Present Value of Social Values Monetized: Social Value Total: $11,639,908 Mental Stress and Anxiety Costs Avoided:$633,216 Lost Productivity Costs Avoided: $2,264,336 Avoided Physical Injuries (Abbreviated Injury Scale)$8,742,356	1
Phase II: Scenario Option 2: Infrastructure Strengthening & Safely Elevating	BCA page #: 202	This Option will result in the following social values: 1) Mental Stress and Anxiety Costs Avoided: 2) Lost Productivity Costs Avoided: 3) Avoided Physical Injuries (Abbreviated Injury Scale). The infrastructure strengthening and safe elevation of 140 households within the vulnerable floodplain will protect and strengthen these residents from likely harmful, damaging and disruptive events. The CDC estimated that approximately 10.4% of the respondents in flooded areas reported injuries in the first week after Sandy; nearly 75% of those had multiple injuries. A certain percent of these residents (including many senior citizens and children) will also not experience the mental stress and anxiety associated with storm/flood event catastrophic events if hardening infrastructure and elevation is	To quantify and monetize the costs of avoided physical injuries, the 10.4% of the population impacted ratio (adapted from Sandy study) was applied to the population associated with the 140 households who would be elevated and protected from flood levels and events. The Abbreviated Injury Scale (AIS) containing economic injury values by severity was then applied to an estimated distribution of the impacted population by severity. Most of the injuries quantified in this exercise were minor and moderate. The expected storm impact injuries were converted to an annual probable impact based on the return period frequencies calculated and applied within the FEMA	Scenario Option 2: Cumulative Present Value of Social Values Monetized: Social Value Total: $23,431,991 Mental Stress and Anxiety Costs Avoided:$1,276,482 Lost Productivity Costs Avoided: $4,564,614 Avoided Physical Injuries (Abbreviated Injury Scale)$17,590,894	1

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		achieved. In addition, a percentage of these communities will not experience the lost productivity associated with these impacts and the disruption in their work routines.	BCA model for avoided buildings and content damages.		
Economic Revitalization & Community Development Value					
Phase I: Community Based Planning & Outreach	BCA page #: 206	The State's proposed Program directly engages and impacts residents of manufactured home communities in developing more socially physically resilient communities. Manufactured home communities often have many low- to moderate-income households, and higher proportions of elderly and disabled residents. The design of this Program ensures that community resilience will be improved, particularly through the comprehensive community assessment in the planning phase of this Program, which will identify current and future risks. By educating and informing residents about Resident Owned Community COOP ownership structures, the planning process can result in economic and community development revitalization benefits that can be part of the final implementation options.		Economic revitalization & community development values from community planning process will be assigned a strong positive qualitative weight of (++).	2

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Phase II: Scenario Option 1: Buyout & Relocation	BCA page #: 206	Studies show that cooperative ownership structures for MHCs have economic advantages for resident communities compared to investor owned MHCs. Among the benefits of COOPs or resident owned communities (ROCs) include the realization of higher average sales prices, faster home sales, and better access to fixed rate home financing. Additional benefits include community cohesion and enhanced sense of place and civic integration. ROCs provide more stable and affordable lot fees, more control (and less anxiety) to residents (less vulnerability to displacements), opportunity to build equity (wealth), and asset appreciation.	The ROC benefits have not been quantified but are described qualitatively. ROCs can provide:	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	2
The Resident Owned Community (ROC/Coop) model can result in community development and economic revitalization benefits to MHCs adopting this structure.	BCA page #: 206		1. Asset Appreciation	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			2. More secure and expanded lending market for creditors	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			3. Premium re-sale prices. Suppose the average price per unit for a 1000 sq. ft. investor-owned unit is $40,000 and the MHC has 80 units. The appraised value of this community MHC is $3.2 million. The relocated community converts to an ROC form and potentially, the appraised value rises by 7.3% to $3.444 million. Close to $250K in equity is now part of the ROC COOP according to studies.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			4. Faster re-sales and less time on market	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			5. Community price in asset and land ownership	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			6. Sense of community cohesion and team work. ("We are in this together for betterment of COOP").	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	

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			7. Civic integration. Desire of non-members (renters) to join to gain economic and other benefits of ROC.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			8. Access to mortgage loans and easier access to fixed rate home financing	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			9. More stable and affordable monthly lot fees. (Avoided escalation in fees over time). Significant benefit for senior citizens and more affordable to lower income families and younger buyers.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			10. Ability of members to build equity (wealth) over time.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			11. Sense of pride in owning land and home.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			12. Site Control. More control over fates and lives. Less anxiety and fear of displacement.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	
			Report by Charsey Institute at the University of New Hampshire – Building Value and Security for Homeowners in "Mobile Home Parks": A Report on Economic Outcomes, A report commissioned by the New Hampshire Community Loan Fund. Ward et. al.		
Phase II: Scenario Option 2: Infrastructure Strengthening & Safely Elevating	BCA page #: 206	Foregone economic activity from events and impacts without infrastructure strengthening and elevation. Some economic revitalization benefits consist of the foregone economic activity associated with storm impacts/displacement and dislocation. These impacts can consist of items such as lost consumer spending, business investment and other activity that would have contributed to a higher level of economic growth absent the storm/flood event.	These impacts have not been quantified but relate to such activities as business interruption, losses, and less spending than would otherwise have occurred, "but for" the incident. A severe storm/flood can result in sub-par economic growth that can persist for years. The permanent reduction of a community's population (aka Katrina communities) can persist for years after an event resulting in a loss that could have been avoided with infrastructure in place.	Effects were not monetized but are described qualitatively and assigned a weight of **(++)**.	2

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Public Housing Resiliency Pilot Project					
Life cycle costs					
Capital Costs	BCA page #: 213	The capital cost of the flood mitigation measures of the public housing program includes the cost of resiliency measures to retrofit the buildings as well as the cost of the resiliency measures. Resiliency measures will prevent structural damage, damage to contents and displacement of residents and will provide benefits as discussed below under Benefits. The resilient retrofit strategies include dry flood proofing, wet flood proofing, elevating equipment, drainage improvement as well as the construction of replacement housing (for the Freeport Housing Authority only). The cost estimate also includes a contingency.	The capital cost are based on the following engineering cost estimates: 2015 cost estimates from Dormitory Authority of the State of New York (DASNY) for Hempstead Housing Authority and Long Beach Housing Authority projects; 2012 Flood Mitigation Study commissioned by the Binghamton Housing Authority for their project;	The combined cost of the 5 projects is $40.68M	4
Operating Costs	BCA page #: 213	The operation and maintenance cost are assumed to remain the same before and after the flood mitigation interventions with the exception of the energy savings, which is addressed in the benefits section.	See Energy Savings Benefits	See Energy Savings benefits	NA
Workforce Development Program Cost	BCA page #: 213	The workforce development program will educate, train, and connect public housing residents with both traditional and "green collar" opportunities. Employment opportunities will include construction and installation of flood mitigation interventions, cultivation and maintenance of green infrastructure, and/or installation, operation, and maintenance of renewable and redundant energy generation. The program will be organized in Nassau County. The program will take 10 weeks and there will be a total of 20 slots. After the training, each participant will obtain an apprenticeship. [MORE INFO NEEDED] It is assumed that the program	The cost of the training program is $8,000 per participant. Source:	$160,000	2

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		will take place in 2015 with the effect on earnings starting in 2016.			
Resiliency Value					
Avoided Damage to structures	BCA page #: 214	Implementation of the measures will avoid damage to the structures in case of future flooding.	The FEMA BCA software v. 5.1 was used to estimate annual avoided damages to buildings/structures. Information on flood depth at 10, 50, 100 and 500 year recurrence intervals was obtained from the Nassau County Flood Insurance Study and Binghamton County Flood Insurance Study. The FEMA default depth damage function (DDF) for apartment buildings was used to quantify the damage to structures based on flood depth. The DDF quantifies damage to structure as a percent of the structure's replacement value. The replacement value was limited to the replacement value of the first floor and, if applicable, the basement. Taking into account the probability of different flood depth levels, the annual effective probable damage to structures with and without the mitigation projects was estimated. A 7 percent rate was used to discount future benefits to 2015.	Low Sea Level Rise Scenario: $7.86M; High Sea Level Rise Scenario: $18.80M	4

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Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Avoided Damages to Contents	BCA page #: 214	Implementation of the measures will avoid damage to building contents in case of future flooding.	The FEMA BCA software v. 5.1 was used to estimate annual avoided damages to building contents. Information on flood depth at 10, 50, 100 and 500 year recurrence intervals was obtained from the Nassau County Flood Insurance Study and Binghamton County Flood Insurance Study. The FEMA default depth damage function (DDF) for apartment buildings was used to quantify the damage to structures based on flood depth. The DDF quantifies damage to structure as a percent of the structure's replacement value. Building contents were assumed to have a value of 28 percent of the structure replacement value, which was limited to the replacement value of the first floor and, if applicable, the basement. Taking into account the probability of different flood depth levels, the annual effective probable damage to structures with and without the mitigation projects was estimated. A 7 percent rate was used to discount future benefits to 2015.	Low Sea Level Rise Scenario: $4.29M; High Sea Level Rise Scenario: $9.79M	4
Avoided Displacement	BCA page #: 214	Implementation of the measures will avoid displacement of residents in case of future flooding.	The FEMA BCA software v. 5.1 was used to estimate annual avoided displacement cost. Daily displacement was calculated as the sum of the federal per diem for lodging and for food. The total daily cost was calculated by multiplying the per diem values with the number of building residents (for food) and households (for lodging). Information on flood depth at 10, 50, 100 and 500 year recurrence intervals was obtained from the Nassau County Flood Insurance Study and Binghamton County Flood Insurance Study. The FEMA default depth damage function (DDF) for apartment buildings was used to quantify the duration of the displacement (number of days) based on	Low Sea Level Rise Scenario: $7.75M; High Sea Level Rise Scenario: $14.36M	4

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			flood depth. Taking into account the probability of different flood depth levels, the annual effective probable damage to structures with and without the mitigation projects was estimated. A 7 percent rate was used to discount future benefits to 2015		
Avoided Evacuation Cost Elderly	BCA page #: 214	In addition to the cost of food and lodging during displacement, displaced residents will incur cost for the evacuation itself. Elderly and disabled persons may need a transportation service and/or the help of volunteers. The analysis includes a cost estimate for all residents of senior housing and housing for persons with disabilities.	The cost is estimated as follows: (1) $80 per person for a transportation service, which is a USACE estimate for the transportation of elderly evacuated from an elderly care facility [1]; (2) two times the average county wage for volunteer time per resident as reported by the US Bureau of Labor Statistics. The volunteer cost estimate assumes an average of two hour to help each resident prepare for evacuation. To obtain an annual estimate of the avoided evacuation cost, the cost associated with one flood event was adjusted to take into account the probability of a flood in any given year based on the FEMA BCA tool.	Low Sea Level Rise Scenario: $0.49M; High Sea Level Rise Scenario: $0.49M	4
Avoided Evacuation Cost General Population	BCA page #: 214	By protecting the public housing against flood damage, the Public Housing Resiliency Program will reduce the likelihood of a flood-related evacuation. While the analysis monetizes the evacuation cost of persons needing special assistance, it does not monetize the evacuation cost of the general population. In addition to the displacement costs, which include lodging and food expenditures after evacuation, the evacuation itself is associated with transportation cost and lost earnings and well as cost incurred by federal, state or local government for	NA	NA	4

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		evacuation. These avoided costs have not been quantified as part of this analysis and are assigned a strong positive weight of (++).			
Avoided Loss of Electricity	BCA page #: 214	The proposed mitigation measures include energy retrofits that will increase efficiency and improve reliability.	The FEMA's BCAR identifies the per capita per day impact of power loss on residential customers to be $24.58 (in 2010 dollars). The probability for power loss was assumed to be equal to the probability of displacement, which was calculated by the FEMA BCA Tool.	Low Sea Level Rise Scenario: $0.12M; High Sea Level Rise Scenario: $0.12M	5
Environmental Value					
Energy Savings	BCA page #: 217	The proposed resilient retrofits will make the buildings more efficient and will produce energy savings. The amount of the energy savings will depend on the specific measures implemented. Retro-commissioning, a systematic process of analyzing an existing building to improve comfort and energy efficiency by correcting for deficiencies in design, construction, equipment, and maintenance which ensures that existing systems are performing as designed is a low cost approach that generates significant savings. Meta-analyses done in 2001 and 2005 by the Lawrence Berkeley National Laboratory showed that a $0.30 per square foot investment reduced energy consumption by a median of 16 percent, and had an average payback of 1.1 years. Source: RMI Outlet, Affordable Housing with unaffordable Energy, August 2013, http://blog.rmi.org/blog_2013_08_19_affordable_housing_with_unaffordable_energy_bills	The cost savings were estimated based on the building square feet and an average energy cost per square foot for multifamily residential buildings in the Northeast ($2.15/square foot), as obtained from the EIA. Source: US Energy Information Administration, Residential Energy Consumption Survey, Accessed from http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#summary	Low Sea Level Rise Scenario: $2.25M; High Sea Level Rise Scenario: $2.25M	4

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Other Environmental benefits	BCA page #: 217	The Public Housing Resilience Program will result in environmental benefits associated with less resource use and expenditures associated with preparing for, and reacting to flood events and storms. During the 100 yr. events impacting coastal zones, many community resources are marshalled to react to, and cope with storms and their aftermath. Energy, fuel and raw and processed materials are consumed to clean up and repair sites (witness the Post Sandy aftermath cleanup and restoration in Long Beach for instance). Emergency generators are deployed following power outages and consume diesel fuel, are emission intensive and loud. Emissions and particulates can be harmful to residents even with proper ventilation of the generators. In addition, the accumulation of debris from building materials and contents that must be removed and landfilled/recycled following extreme events. All of these activities have municipal solid waste, and hazardous waste removal and associated environmental costs. Routing wastes to a landfill involves collection, processing and truck transportation that can also be emission intensive. The PH Community Resilience Program will result in avoiding many of these former vulnerability related costs. These benefits receive a qualitative weight of (++).	NA	NA	4
Social Value					
Mental stress and anxiety costs avoided	BCA page #: 219	There is a clear and definite connection between mental stress impacts and disasters. The American Red Cross (ARC) estimates that 30-40 percent of the impacted population will need some sort of mental health-related assistance while another study found a rate of 32 percent. Source: FEMA, Final Sustainability Benefits Methodology, August 2012, p.10. Cost created by stress include treatment cost and loss of productivity.	To quantify and monetize the mental stress and anxiety costs associated with flood events, a standard FEMA value on treatment cost per person ($2,443) was multiplied with the number of residents in each housing property that would require treatment, which we assumed was 32 percent. To obtain an annual estimate of the avoided treatment cost, the cost associated with one flood event was adjusted to take into account the	Low Sea Level Rise Scenario: $13.52M; High Sea Level Rise Scenario: $25.41M	4

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			probability of a flood in any given year based on the FEMA BCA tool. The cost of the lost productivity associated with the stress and anxiety by a flood event was monetized by multiplying the standard FEMA value of $8,743 was multiplied by an estimate of the number of working residents in each property.		
Avoided Injuries	BCA page #: 219	The CDC has estimated that approximately 10.4% of the residents in flooded areas reported injuries in the first week after Sandy; and nearly 75% of those had multiple injuries. Source: Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report (MMWR) Nonfatal Injuries 1 Week After Hurricane Sandy — New York City Metropolitan Area, October 2012 Weekly, October 24, 2014 / 63(42): 950-954, Robert M. Brackbill, PhD et. al.	The Abbreviated Injury Scale (AIS) containing economic injury values by severity was used to obtain the cost of the injury. For housing developments reserved for elderly and disabled persons, it was assumed that average injury was moderate, which is valued as $105,876. For the other developments, it was conservatively assumed that all injuries were minor, valued at $13,494.	Low Sea Level Rise Scenario: $16.10M; High Sea Level Rise Scenario: $22.35M	4
Benefits to children of workforce development program participants	BCA page #: 219	The children of participants in the workforce development program are expected to benefit from their parents' employment beyond the value of increased wages and benefits. Examples include improved academic achievement and health improvements. These benefits receive a qualitative weight of (+). Source: Ridley, N. and Kenefick, E., Research shows effectiveness of workforce programs. http://www.clasp.org/resources-and-publications/files/workforce-effectiveness.pdf	NA	*NA*	4
Social Capital	BCA page #: 219	Through its workforce component, the Public Housing Resilience Program may also contribute to the development or strengthening relationships among residents within the public housing developments. The benefits of these social capital relationships can include new and expanded networks, engagement of isolated and marginalized or socially disenfranchised groups and individuals, and the formation of new social	NA	*NA*	4

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		trust and bonds created among groups of diverse backgrounds. Social capital benefits have not been monetized but are described qualitatively and assigned a positive weight of (+).			
Economic Revitalization & Community Development Value					
Increased Earnings and Benefits	BCA page #: 221	The workforce development program will educate, train, and connect public housing residents with both traditional and "green collar" opportunities. After the training, each participant will obtain an apprenticeship. [More info about the program] These participants will benefit from a lifetime increase in earnings.	Prevailing wage data from the New York State website were used to estimate wages and benefits for apprentices and journeyman in several construction trades in Nassau County. The lifetime earnings were estimated using median hourly wages and benefits for all trades range from x for a first year apprentice to x for a journeyman. It was further assumed the average employee would work 1960 hours and year and a 15-year career after completing the program. Finally, it was assumed that all participants are currently unemployed and that thus all earnings were a net benefit.	Low Sea Level Rise Scenario: $22.93M; High Sea Level Rise Scenario: $22.93M	3
Local Construction Jobs	BCA page #: 221	The mitigation projects will support local constructions jobs in addition to the construction jobs that would be provided to the apprentices in the workforce development program. These benefits received a qualitative weight of (+).	NA	NA	3

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Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program					
Life cycle costs					
Program Costs	BCA page #: 225		Capital Cost elements include: Updating 500 culverts, restore 300 acres of wetlands, removing 5,280 feet of berms, and removing 20,000 cubic feet of fill from floodplains.	Capital Costs: $106,000,000 (rounded) O&M Costs: $421,260	5
Resiliency Value					
Functional Loss to Critical Infrastructure	BCA page #: 226	For Wetland restoration, this element was not expressed quantitatively, as it would be difficult to monetize the beneficial impacts of natural areas to flood prevention, due to a lack of any current case studies on the subject.	Updating infrastructure would help avoid costs associated with evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs. The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to roads/bridges, and avoided displacement costs. The estimates were based on traffic data (AADT, additional miles, additional detour time) provided by the state.	Cumulative PV: $21,617,727	4

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Environmental Value					
Enhanced Water Quality	BCA page #: 229		This element of analysis is predicated on the assumption that individuals are willing to pay for higher relative water quality in their communities. Several studies have attempted to monetize what is referred to as "willingness to pay" (WTP) in consideration to water quality. Typically this metric is measured through direct surveys of individuals and households. An estimate of willingness to pay, based on research conducted in a study on behalf of the State of Wisconsin (2012), was applied to the bridges, culverts and wetland restoration approaches. A monetized value of $10 per household was used for each approach, this figure was annualized for each aspect of the project (bridges, culverts, wetland restoration), based on the estimated population affect figure.	Cumulative PV: $52,536,414	
Avoided Cost of Wetland Retention	BCA page #: 229		For the wetlands restoration aspect, avoided environmental damages were broken out into each element of wetlands restoration, actual restoration, berm removal and fill removal. Enhanced water quality was also quantified. FEMA 5.1 software was used to arrive at a per acre riparian land use benefit, based on acreage as provided by GOSR.	Cumulative PV: $1,865,972	
Enhanced Ecosystem Services	BCA page #: 229	Updated bridges and culverts would provide for more natural streamflow, and a more natural riparian environment immediately surrounding the project. This would in turn allow public environmental monitoring to spend less time investigating environmental anomalies associated with bridge or culvert damage or maintenance. This equates to a monetary benefit, however, no research appears to exist on the quantification of ecosystem services associated with bridges or			

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		culverts. As such this benefit is expressed qualitatively, with a Qualitative Weight of +.			
Improved fisheries & habitat for recreation opportunities & tourism	BCA page #: 229	Again referencing the study conducted by the Wisconsin Department of Natural Resources, the authors found a $3,200 per culvert benefit for increased fish passage, applying a 3.5% discount rate. The authors do not cite how many years the figure is discounted back, although they used prices from fish hatcheries, along with fish densities for specific streams to arrive at their figure. Another study (nature Conservancy, 2013) relates updated stream-simulation crossings with enhanced river-related recreation. Healthier streams correlate with healthier fish populations, which improve opportunities for recreation. The study cites another study completed by the U.S. fish and Wildlife Service, which places a high value on removing barriers along streams, however this study was based on a stream with sea-run fish, and these figures are unlikely to be realized at other locations. Ultimately, such benefits would likely vary widely by region and geography, and it would be difficult to extrapolate an accurate figure and apply it elsewhere. Nevertheless, it is reasonable to assume that updating infrastructure such as culverts and wetlands would have a positive and beneficial effect on area wildlife and fisheries, and that this effect would benefit area recreation and fishing opportunities. This element was expressed qualitatively, with a weight of ++ assigned.			

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Social Value					
Avoided Injury/Fatality	BCA page #: 231	The number of fatalities incurred would depend on factors such as proximity and warning time provided prior to failure, as well as extent of failure. Loss of life calculations were provided by GOSR for the dam benefit-cost analysis. These figures were based on relative warning time prior to failure, as well as whether or not the failure occurred during a storm event, was a "sunny day" failure, or whether there was a breach. However these figures range from 4 persons to as many as 218, as such, the NDRC Appendix H Data Resources figure for moderate injuries was applied to the dam BCA, and fatalities were expressed qualitatively. For the dam element of the rightsizing infrastructure aspect, a Qualitative Weight of ++ was assigned to this element.	Costs associated with injuries/fatalities were factored using the Center for Disease Control estimate of percentage of persons reporting injuries after a natural disaster (2012). Cost per person was taken from the Appendix H NDRC Data Resources, economic value of injury. The moderate figure was applied to the bridge concept, while the minor figure was utilized for culverts and floodplain restoration.	Cumulative PV: $628,115,322	4

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Mental Stress/Anxiety	BCA page #: 231		Mental stress and anxiety metric was modeled by applying the FEMA BCA 5.1 standard value for cost per person ($2,443) to total persons affected, which was estimated at 30% of total persons in the region of influence.	Cumulative PV: $147,423,822	
Economic Revitalization & Community Development Value					
Avoided impacts to real property	BCA page #: 233	Flood events can cause significant damage to real property, affecting individuals, businesses and local governments. These effects can typically be quantified on a case by case base, for example, monetized damage estimates associated with a hurricane for a specific city. When analyzing specific geographies, and the effects floods have on property values at these locations over time, an accurate quantitative model becomes difficult, and can ultimately prove spurious. However, case studies have attempted to quantify these benefits, and literature on the subject suggests that property values benefit from proximity to flood protected lands versus non-flood protected lands (Kousky and Walls, 2013). For this analysis, this element was expressed qualitatively, with a weight of ++ assigned.			
Avoided Disruption of Local Economic Activity	BCA page #: 233		Using the FEMA 5.1 per person per hour cost of disruption ($30.07 per hour). The FEMA figure was applied to an estimate of population affected (15%), as well as number of outage hours (hours that economic activity would have been disrupted by a flood event, estimated at 48 hours), to arrive at a total cost avoided figure. This was then annualized.	Cumulative PV: $1,985,852	5

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Right-Sizing Bridges Resiliency Program					
Life cycle costs					
Program Costs	BCA page #: 225		Costs were provided by NYGOSR. Costs include replacing bridges and across the state. The updated infrastructure would help mitigate environmental, social and economic damages associated with moderate and major flood events.	Capital costs: $111,100,000 (rounded) O&M Costs: $141,550	4
Resiliency Value					

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Functional Loss to Critical Infrastructure	BCA page #: 226	For Wetland restoration, this element was not expressed quantitatively, as it would be difficult to monetize the beneficial impacts of natural areas to flood prevention, due to a lack of any current case studies on the subject.	Updating infrastructure would help avoid costs associated with evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs. The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to roads/bridges, and avoided displacement costs. The estimates were based on traffic data (AADT, additional miles, additional detour time) provided by the state.	Cumulative PV: $21,617,727	4
Environmental Value					
Avoided Environmental Damages	BCA page #: 229	Data for existing and new dams was not available, nor was literature found which could be relied on for an accurate estimate. As such, these benefits were expressed qualitatively for dams. A Qualitative Weight of + is assigned to this resiliency benefit.	Updating infrastructure under consideration would reduce negative impacts to the immediate environment associated with flooding. This benefit that would occur as a result of reduced impact from flooding on the immediate environment is quantifiable. FEMA 5.1 software was used to estimate riparian land use benefits and value per acre. For the model, an estimate of acreage that would be affected in proximity to the type of infrastructure was applied to arrive at total benefits. This figure was annualized.	Cumulative PV: $6,072,672	5

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Enhanced Water Quality	BCA page #: 229		This element of analysis is predicated on the assumption that individuals are willing to pay for higher relative water quality in their communities. Several studies have attempted to monetize what is referred to as "willingness to pay" (WTP) in consideration to water quality. Typically this metric is measured through direct surveys of individuals and households. An estimate of willingness to pay, based on research conducted in a study on behalf of the State of Wisconsin (2012), was applied to the bridges, culverts and wetland restoration approaches. A monetized value of $10 per household was used for each approach, this figure was annualized for each aspect of the project (bridges, culverts, wetland restoration), based on the estimated population affect figure.	Cumulative PV: $52,536,414	
Enhanced Ecosystem Services	BCA page #: 229	Updated bridges and culverts would provide for more natural streamflow, and a more natural riparian environment immediately surrounding the project. This would in turn allow public environmental monitoring to spend less time investigating environmental anomalies associated with bridge or culvert damage or maintenance. This equates to a monetary benefit, however, no research appears to exist on the quantification of ecosystem services associated with bridges or culverts. As such this benefit is expressed qualitatively, with a Qualitative Weight of +.			

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Social Value					
Avoided Injury/Fatality	BCA page #: 231	The number of fatalities incurred would depend on factors such as proximity and warning time provided prior to failure, as well as extent of failure. Loss of life calculations were provided by GOSR for the dam benefit-cost analysis. These figures were based on relative warning time prior to failure, as well as whether or not the failure occurred during a storm event, was a "sunny day" failure, or whether there was a breach. However these figures range from 4 persons to as many as 218, as such, the NDRC Appendix H Data Resources figure for moderate injuries was applied to the dam BCA, and fatalities were expressed qualitatively. For the dam element of the rightsizing infrastructure aspect, a Qualitative Weight of ++ was assigned to this element.	Costs associated with injuries/fatalities were factored using the Center for Disease Control estimate of percentage of persons reporting injuries after a natural disaster (2012). Cost per person was taken from the Appendix H NDRC Data Resources, economic value of injury. The moderate figure was applied to the bridge concept, while the minor figure was utilized for culverts and floodplain restoration.	Cumulative PV: $628,115,322	4
Mental Stress/Anxiety	BCA page #: 231		Mental stress and anxiety metric was modeled by applying the FEMA BCA 5.1 standard value for cost per person ($2,443) to total persons affected, which was estimated at 30% of total persons in the region of influence.	Cumulative PV: $147,423,822	

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Economic Revitalization & Community Development Value					
Avoided impacts to real property	BCA page #: 233	Flood events can cause significant damage to real property, affecting individuals, businesses and local governments. These effects can typically be quantified on a case by case base, for example, monetized damage estimates associated with a hurricane for a specific city. When analyzing specific geographies, and the effects floods have on property values at these locations over time, an accurate quantitative model becomes difficult, and can ultimately prove spurious. However, case studies have attempted to quantify these benefits, and literature on the subject suggests that property values benefit from proximity to flood protected lands versus non-flood protected lands (Kousky and Walls, 2013). For this analysis, this element was expressed qualitatively, with a weight of ++ assigned.			
Avoided Disruption of Local Economic Activity	BCA page #: 233		Using the FEMA 5.1 per person per hour cost of disruption ($30.07 per hour). The FEMA figure was applied to an estimate of population affected (15%), as well as number of outage hours (hours that economic activity would have been disrupted by a flood event, estimated at 48 hours), to arrive at a total cost avoided figure. This was then annualized.	Cumulative PV: $1,985,852	5

APPENDIX H BENEFIT COST ANALYSIS TABLE

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Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Right-Sizing Critical Dams Resiliency Project					
Life cycle costs					
Program Costs	BCA page #: 225		Costs were provided by NYGOSR and include updating or replacing dams across the state.	Capital Costs: $49,550,500 O&M Costs: $ 25,000 per damn pa.	5
Resiliency Value					
Avoided O&M Costs with New Infrastructure	BCA page #: 226	Data for existing and new dams was not available, nor was literature found which could be relied on for an accurate estimate. As such, these benefits were expressed qualitatively for dams. A Qualitative Weight of + is assigned to this resiliency benefit. Operations and maintenance costs were not factored for wetland restoration, as such this element is not expressed for this aspect of the project.	We assume same loss rate over coming period. Protection of 4.55 acres of loss each year. Full value of the marshland is 404 acres x FEMA Riparian value or about $15M per year. Benefits stop at end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.	Cumulative PV: $6,034,907	4
Environmental Value					
Avoided Environmental Damages	BCA page #: 229	Data for existing and new dams was not available, nor was literature found which could be relied on for an accurate estimate. As such, these benefits were expressed qualitatively for dams. A Qualitative Weight of + is assigned to this resiliency benefit.	Updating the infrastructure under consideration would reduce negative impacts to the immediate environment associated with flooding. This benefit that would occur as a result of reduced impact from flooding on the immediate environment is quantifiable. FEMA 5.1 software was used to arrive at a riparian land use benefits figure. The returned FEMA software value per acre was used. For the model, an estimate of acreage that would be affected in proximity to the type of infrastructure was applied to arrive at total benefits. This figure was then annualized.	Cumulative PV: $6,072,672	5

APPENDIX H BENEFIT COST ANALYSIS TABLE

1	2	3	4	5	6
Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Social Value					
Avoided Injury/Fatality	BCA page #: 231	The number of fatalities incurred would depend on factors such as proximity and warning time provided prior to failure, as well as extent of failure. Loss of life calculations were provided by GOSR for the dam benefit-cost analysis. These figures were based on relative warning time prior to failure, as well as whether or not the failure occurred during a storm event, was a "sunny day" failure, or whether there was a breach. However these figures range from 4 persons to as many as 218, as such, the NDRC Appendix H Data Resources figure for moderate injuries was applied to the dam BCA, and fatalities were expressed qualitatively. For the dam element of the rightsizing infrastructure aspect, a Qualitative Weight of ++ was assigned to this element.	Costs associated with injuries/fatalities were factored using the Center for Disease Control estimate of percentage of persons reporting injuries after a natural disaster (2012). Cost per person was taken from the Appendix H NDRC Data Resources, economic value of injury. The moderate figure was applied to the bridge concept, while the minor figure was utilized for culverts and floodplain restoration.	Cumulative PV: $628,115,322	4
Mental Stress/Anxiety	BCA page #: 231		Mental stress and anxiety metric was modeled by applying the FEMA BCA 5.1 standard value for cost per person ($2,443) to total persons affected, which was estimated at 30% of total persons in the region of influence.	Cumulative PV: $147,423,822	

APPENDIX H BENEFIT COST ANALYSIS TABLE

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Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Economic Revitalization & Community Development Value					
Avoided impacts to real property	BCA page #: 233	Flood events can cause significant damage to real property, affecting individuals, businesses and local governments. These effects can typically be quantified on a case by case base, for example, monetized damage estimates associated with a hurricane for a specific city. When analyzing specific geographies, and the effects floods have on property values at these locations over time, an accurate quantitative model becomes difficult, and can ultimately prove spurious. However, case studies have attempted to quantify these benefits, and literature on the subject suggests that property values benefit from proximity to flood protected lands versus non-flood protected lands (Kousky and Walls, 2013). For this analysis, this element was expressed qualitatively, with a weight of ++ assigned.			
Avoided Disruption of Local Economic Activity	BCA page #: 233		Using the FEMA 5.1 per person per hour cost of disruption ($30.07 per hour). The FEMA figure was applied to an estimate of population affected (15%), as well as number of outage hours (hours that economic activity would have been disrupted by a flood event, estimated at 48 hours), to arrive at a total cost avoided figure. This was then annualized.	Cumulative PV: $1,985,852	5

APPENDIX H BENEFIT COST ANALYSIS TABLE

1	2	3	4	5	6
Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
Nassau County Outfall Pipe and Bay Resiliency Project					
Life cycle costs					
Capital Costs	BCA page #: 237	This is the total cost of the project as determined by an engineering assessment and the County's design/build legislation.		$ 450,000,000.00	5
Resiliency Value					
Return of Lost Marshland - Middle Bay	BCA page #: 237	Middle Bay salt marsh complex shows a 123 acre loss over a 27 year period as a result of excessive nitrogen levels present in the bay. This loss should be restored by passive restoration of marshland, resolving the problem causing loss. 123 acres of salt marsh will be restored over time. Aerial Photography will show acreage increase. http://www.dec.ny.gov/docs/water_pdf/impairmarshland.pdf	Assume same loss rate over coming period. Protection of 4.55 acres of loss per year. Full value of marshland is 404 acres x FEMA Riparian value or about $15M per year. Benefits stop at end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.	$ 6,977,546.09	4
Protection Against Further Projected Marshland Loss - - Middle Bay	BCA page #: 237	Excessive eutrophication caused by nitrogen leads to destabilized bay-edge marshes making these areas susceptible to accelerated erosion. http://www.dec.ny.gov/docs/water_pdf/impairmarshland.pdf. Middle Bay salt marsh complex shows a 123 acre loss over a 27 year period as a result of excessive nitrogen levels present in the bay and further loss must be prevented. Marshland loss prevention at the same rate of erosion (4.5555 acres per year), the entire Middle Bay salt marsh complex would be gone in 89 years. The current salt bay marsh complex to be protected against loss (404 acres). Aerial Photography will show prevented loss in acreage	We assume same loss rate over coming period. Protection of 4.55 acres of loss each year. Full value of the marshland is 404 acres x FEMA Riparian value or about $15M per year. Benefits stop at end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.	$ 28,481,422.31	4
Protection Against Further Projected Marshland Loss - - Middle Bay Flood Hazard	BCA page #: 237	This is a break out of the flood hazard value from the Protection Against Further Projected Marshland Loss - - Middle Bay	All calculations on this sheet using the Riparian value have had the Flood Hazard broken out and multiplied on its own line against the acreage value. Full Riparian Value ($37,492.94) - Flood Hazard Risk ($4,007.01) = Riparian Value used in this	$ 3,408,158.11	4

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			document as $33,485.93. The flood hazard value is not a duplication.		
Return of Lost Marshland - Middle Bay Flood Hazard	BCA page #: 237	This is a break out of the flood hazard value from the Return of Lost Marshland - Middle Bay value.	All calculations on this sheet using the Riparian value have had the Flood Hazard broken out and multiplied on its own line against the acreage value. Full Riparian Value ($37,492.94) - Flood Hazard Risk ($4,007.01) = Riparian Value used in this document as $33,485.93. The flood hazard value is not a duplication.	$ 834,950.59	4
Return of Lost Marshland - East Bay	BCA page #: 237	Middle Bay salt marsh complex shows a 108 acre loss over a 24 year period as a result of excessive nitrogen levels present in the bay. This loss should be restored. This will be achieved by passive restoration of marshland by alleviating the problem causing the loss. 108 acres of salt marsh will be restored over time. Aerial Photography will show increase in acreage. http://www.dec.ny.gov/docs/water_pdf/impairmarshland.pdf	We assume same loss rate over coming period. Protection of 4.55 acres of loss each year. Full value of the marshland is 606 acres x FEMA Riparian value or about $15M per year. Benefits stop at end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.	$ 6,892,454.06	4
Protection Against Further Projected Marshland Loss -East Bay	BCA page #: 237	Excessive eutrophication caused by nitrogen leads to destabilized bay-edge marshes making these areas susceptible to accelerated erosion. http://www.dec.ny.gov/lands/31989.html. East Bay salt marsh complex shows a 108 acre loss over a 24 year period. This loss should be restored. This will be achieved by passive restoration of marshland by alleviating the problem causing the loss.108 acres of salt marsh will be restored over time. Aerial Photography will show increase in acreage	We assume same loss rate over coming period. Protection of 4.55 acres of loss each year. Full value of the marshland is 606 acres x FEMA Riparian value or about $15M per year. Benefits stop at end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.	$ 28,134,087.90	4
Protection Against Further Projected Marshland Loss	BCA page #: 237	This is a break out of the flood hazard value from the Protection Against Further Projected Marshland Loss - - East Bay	All calculations on this sheet using the Riparian value have had the Flood Hazard broken out and multiplied on its own line against the acreage value. Full Riparian Value ($37,492.94) - Flood Hazard Risk	$ 3,366,595.21	4

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Costs and Benefits by category	**Page # in Factor Narratives or BCA Attachment**	**Qualitative Description of Effect and Rationale for Including in BCA**	**Quantitative assessment** **(Explain basis and/or methodology for calculating Monetized Effect, including data sources, if applicable)**	**Monetized effect (if applicable)**	**Uncertainty**
-East Bay Flood Hazard			($4,007.01) = Riparian Value used in this document as $33,485.93. The flood hazard value is not a duplication.		
Return of Lost Marshland - East Bay Flood Hazard	BCA page #: 237	This is a break out of the flood hazard value from the Return of Lost Marshland - East Bay value.	All calculations on this sheet using the Riparian value have had the Flood Hazard broken out and multiplied on its own line against the acreage value. Full Riparian Value ($37,492.94) - Flood Hazard Risk ($4,007.01) = Riparian Value used in this document as $33,485.93. The flood hazard value is not a duplication.	$ 824,768.26	4
Coastal Restoration (Eel Grass Area)	BCA page #: 237	The loss of critical eel grass habitat leads to coastal erosion. Both the Chesapeake and Tampa Bay estuary programs have seen increases in various eel grass species, following their efforts to reduce nitrogen loadings, address human impacts and implement restoration efforts. http://www.habitat.noaa.gov/abouthabitat/eelgrass.html. Data show that when nitrogen load reduction and chlorophyll a targets are met, seagrass cover increases. After nitrogen load reductions and maintenance of chlorophyll a at target levels, seagrass acreage has increased 25% since 1982.o Both the Chesapeake and Tampa Bay estuary programs have seen increases in various eel grass species, following their efforts to reduce nitrogen loadings, address human impacts and implement restoration efforts. (Greening, Holly; Janicki, Anthony; "Towards Reversal of Eutrophic Conditions in a Subtropical Estuary: Water Quality and Seagrass Response to Nitrogen Loading Reductions in Tampa Bay, Florida, USA." Environmental Management Vol. 38, No. 2, pp. 163-178). o High levels of nitrogen have been linked to the loss of eel grass habitat. (Coastal Resiliency and Water Quality in Nassau and Suffolk Counties, DEC 2014).From 1930 to 2012 Eel Grass has been reduced by 178,197 acres. These marine	The loss of eel grass population was over the course of 82 years. It will take 82 years to rebuild. Benefits are additive as would be the case if all were protected / created at once. 178,197 acres times 10% divided by 82 years *Acre Riparian Value	$ 1,358,563,844.42	4

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		grasses are part of a critical vegetative buffer that provides resilience to storms and habitat for marine organisms. Aerial Photography will show increase in acreage. http://www.ncbi.nlm.nih.gov/pubmed/16788855 http://www.habitat.noaa.gov/abouthabitat/eelgrass.html http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0062413 http://www.dec.ny.gov/docs/water_pdf/lireportoct14.pdf			
Coastal Restoration (Eel Grass Area) Flood Hazard	BCA page #: 237	This is a break out of the flood hazard value from the Coastal Restoration (Eel Grass Area)	All calculations on this sheet using the Riparian value have had the Flood Hazard broken out and multiplied on its own line against the acreage value. Full Riparian Value ($37,492.94) - Flood Hazard Risk ($4,007.01) = Riparian Value used in this document as $33,485.93. The flood hazard value is not a duplication.	$ 162,569,142.03	

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Comparison - Regional storm damage to community in surrounding area	BCA page #: 237	As of February 28, 2006, there were 6,246 NFIP policies in force in the City of Long Beach, with 1,530 claims awarded from January 1, 1978 to February 28, 2006 totaling $8,316,199. In addition, the City has adopted all required building codes regarding construction in the SFHAs and recently participated in FEMA's Community Rating System (CRS) Program. These are real costs that affect one area in the special flood hazard area. Communities protected by the Western Bays Marshland can expect see a decrease in claims due to increased protection from marshlands. http://www.longbeachny.gov/vertical/sites/%7BC3C1054A-3D3A-41B3-8896-814D00B86D2A%7D/uploads/%7BF71538B3-3066-402E-B6A1-E8C2FA816227%7D.PDF	+	$ -	5
Comparison - Long Beach Debris Removal and Logistical Cost Post Sandy	BCA page #: 237	Debris Management and Logistical costs: estimated at $32 million. http://www.longbeachny.gov/vertical/sites/%7BC3C1054A-3D3A-41B3-8896-814D00B86D2A%7D/uploads/Budget_Proposed_Amendment_Package_Presentation_5.20.14.pdf	+	$ -	5
Comparison - Long Beach Infrastructure Cost Post Sandy	BCA page #: 237	Infrastructure: Roads, bulkheads, parks, and beach repairs estimated up to $150 million. http://www.longbeachny.gov/vertical/sites/%7BC3C1054A-3D3A-41B3-8896-814D00B86D2A%7D/uploads/Budget_Proposed_Amendment_Package_Presentation_5.20.14.pdf	+	$ -	5
Environmental Value					
Ulva Lactuva	BCA page #: 239	Overgrowth of Ulva, phytoplankton exceeding 250 µg L-1, rapid microbial respiration causes hypoxia. Nutrients (primarily nitrogen) control the growth of primary producers in the Western Bays. This growth has accumulated on beaches in amount where trucking was needed for removal. The decay of ulva releases noxious fumes as well	This value is the was determined by multiplying the acreage of point lookout (21) by the Rec/Tourism value ($5,365.26) and dividing by 3, the years between reported incidences of impaired beaches.	$ 518,312.14	5

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Social Value					
Recreational activities resulting from improved water quality	BCA page #: 242	There will also be an increase in tourism and recreational Bayfront activities as a result of improved water quality and natural habitat.	+	$ -	5
Economic Revitalization & Community Development Value					
Protection of affordable housing stock	BCA page #: 240	The marsh lands are a natural barrier that guard bay communities from the immediate impact of extreme weather events and inundate further encroachment to inland areas. Only 4% of all rental units are available to be rented and 58% of Long Islanders have difficulty paying their rent or mortgage. Any housing units affected by storm damage puts a further stress on Nassau's housing stock by increasing demand and reducing supply which further inflates housing costs.	The overall population of Nassau is 448,528 with an estimated 157,142 homes damaged and 18,426 LMI damaged homes or 4% of the total damaged. Using the count of 51,943 NFIP policies and 28,055 claims from those policies 4% of the LMI policies would be 2,133.87. Using Long Beach data, they had $ 8,316,199 payouts from 1978 to 2006, 28 years. That works out to $297,007.11 a year and $194.12 per policy per year. Apply those rates to 2,133.87 estimated LMI policies and we get $414,232.29 per year.	$ 5,716,887.65	4
New Recreational Space	BCA page #: 240	Marine and other recreation, restaurant, and limited small water related retail. Convert the treatment plant to a pump station to make acreage available. Consider a Bayfront restaurant/ conference center/ banquet hall to the east. Expand/ reconfigure recreation facilities; provide new public marina, transient docking Evaluate new locations for City bus and DPW facilities; add community/ recreational facilities or mixed use - workforce residential plus marine-related retail or support industry. http://nebula.wsimg.com/917f04e34c02e602dc0817cbc37639d7?AccessKeyId=60A1AC8D585755425967&disposition=0&alloworigin=1	5 acres is the current space of the water pollution control plant. Assume return to green space, if becomes economic, value will be greater. Don't know if in perpetuity, so use the 50 year project useful life. Acre*FEMA Cultural Services- rec and tourism value. Due to uncertainties in development, only return to green space is assumed. The improvements made provide recreational use. Only recreation and tourism benefits are calculated from cultural services.	$ 541,904.93	5

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Clamming Industry	BCA page #: 240	Loss of shellfish industry due to increased nitrogen levels. The Great South Bay has a similar industry within a short distance from the Western Bay shellfish beds. Environmental and clam industry benefits. New York seagrass beds function as vital habitat and nursery grounds for numerous commercially, recreationally and ecologically important fish and shellfish species (Final Report of the New York State Seagrass Task Force, DEC 2009). Nitrogen Impacts on Shellfish and Sea Grass (Coastal Resiliency and Water Quality in Nassau and Suffolk Counties, DEC 2014). Passive restoration of Shellfish Beds due to alleviating the problem of elevated levels of coliform bacteria, responsible for the closure of 15,575 acres of shellfish beds in the western bays as well as nitrogen reduction. Shell fish beds will open and industry will return over time. http://www.dec.ny.gov/docs/water_pdf/lireportoct14.pdf, http://www.ncaquaculture.org/pdfs/2013_marine_session/conrad_shellfish_lease.pdf http://www.citizenscampaign.org/PDFs/western%20bays%20position%20paper.pdf http://www.dos.ny.gov/opd/programs/pdfs/SSERCMP.pdf http://www.ncaquaculture.org/pdfs/2013_marine_session/conrad_shellfish_lease.pdf	That the Hard clam landings in the Great South Bay are comparable in yield and price to the Shellfish beds in the Western Bays. I assume the 1970's number for the Hard Clam industry amount is not adjusted for inflation. 10 bushels per acre per year, assume $100 per acre lease for water column, and $124 per bushel because we don't know whether it's normalized. Assume resumption of industry over thirty years	$121,836,426.29	3

Manufactured Home Community Resiliency Pilot Program

The Manufactured Home Community Resiliency Pilot Program will provide significant value to a large number of vulnerable households and also benefit the surrounding communities. The Phase I Community Based Planning outreach and engagement process will inform the program's implementation in Phase II and result in cost effective and efficient interventions. Phase I benefits and costs are also described qualitatively below. The quantified and monetized programmatic indicative summary below was based on the likely benefits resulting from a Phase II implementation scenario. The implementation phase benefit cost analysis was based on evaluating two sample communities located within floodplains (100 and 500 year flood zones) that are the most vulnerable to flood/storm event impacts. These communities were evaluated because they are representative of households that would stand to benefit the most from the targeted interventions. The estimated net benefits from the program would accrue to a combined estimate of approximately 220 community households that would be covered.

Phase I Community Based Planning and Outreach costs will cover (i) Community (and stakeholder/partners) identification and representation, (ii) Criteria Development for program inclusion, (iii) Outreach activities and engagement in a comprehensive planning process, and (iv) Mobilization and procurement of technical expertise to assist communities, together with processing the final implementation concepts to Phase II. The benefits of Phase I consist of the process selection benefits of identifying and choosing the most significant, highest priority, most widely accepted and stakeholder inclusive, and the most resilient project interventions in a timely manner. In addition, Phase I will create significant social resilience value in these communities by engaging a vulnerable population in the decision making process. The tangible manifestation

of these benefits will materialize in the preferred final alternatives that are the most cost effective interventions evaluated under Phase II.

The table below summarizes the combined benefits and costs from the Phase II indicative Implementation stage scenario.

Table 3: Benefit Cost Analysis Summary – Manufactured Home Community Resiliency Pilot Program - Indicative

Cumulative Present Values (2015 – 2050)		
	Base Case	With Sea Level Rise Adjustment per U.S. Army Corps of Engineers (USACE) High Scenario
Total Mitigation Costs	$70,000,000	$70,000,000
Total Monetized Benefits	$200,229,737	$459,365,186
Resilience Value	$152,118,902	$411,254,351
Environmental Value	$13,038,937	$13,038,937
Social Value	$35,071,898	$35,071,898
Economic Revitalization	++	++
Total Net Benefits	$130,229,737	$389,365,186
Benefit Cost Ratio	2.86	6.56

In this scenario a Sea Level Rise Adjustment was based on adding feet (NAVD88) to the return period elevations identified from the flood profile for the indicative MHC evaluation site that was subject to flooding from the Hudson River. Since this indicative site was close to a tidal source, the sea level rise adjustment was completed. The other MHC study site used to calibrate

the scenario to evaluate Option 1 was too far inland and not linked by hydrology or hydraulics to be impacted. The source of the sea level rise projection was the USACE high scenario (to the year 2050) sourced from the USACE Sea Level Change Curve Calculator.[1] For the FEMA BFE for the Hudson proximity site, and using the Battery NY NOAA gauge, this projection resulted in a 1.56 ft. rise by the year 2050 (USACE High).

The table below shows the costs and benefits for the base case options within Phase II.

Table 4: Manufactured Home Community Resiliency Pilot Program – Indicative Benefit Cost Analysis

Base Case Scenario			
	Base Case Phase II Monetized Benefits and Costs Cumulative Present Values (2015 – 2050)		
	OPTION 1: BUYOUT and RELOCATION	OPTION 2: INFRASTRUCTURE STRENGTHENING: SAFELY ELEVATING	TOTAL PROGRAM INTERVENTION
Representative Number of Households:	80	140	220
MITIGATION COSTS			
Total Lifecycle Costs	$28,000,000	$42,000,000	$70,000,000
BENEFITS			
Resilience Value	$62,856,974	$89,261,928	$152,118,902
Damage to buildings	$39,772,332	$56,626,633	$96,398,965

[1] http://www.corpsclimate.us/ccaceslcurves.cfm

Damage to contents	$23,005,235	$32,448,162	$55,453,397
Displacement	$79,406	$187,134	$266,540
Environmental Value	$13,038,937	++	$13,038,937
Social Value	$11,639,908	$23,431,991	$35,071,898
Mental Stress and Anxiety Costs Avoided:	$633,216	$1,276,482	$1,909,698
Lost Productivity Costs Avoided:	$2,264,336	$4,564,614	$6,828,949
Avoided Physical Injuries	$8,742,356	$17,590,894	$26,333,251
Economic Revitalization	++	++	
Total Benefits	$87,535,818	$112,693,919	$200,229,737
Net Benefits (NPV)	$59,535,818	$70,693,919	$130,229,737
Benefit Cost Ratio (BCR)	3.13	2.68	2.86

The table below shows the corresponding sea level rise scenario.

Table 5: Manufactured Home Community Resiliency Pilot Program – Indicative Benefit Cost Analysis – Sea Level Rise Scenario

Sea Level Rise Scenario			
	Phase II Monetized Benefits and Costs Cumulative Present Values (2015 – 2050)		
	OPTION 1: BUYOUT and RELOCATION	OPTION 2: INFRASTRUCTURE STRENGTHENING: SAFELY	TOTAL PROGRAM INTERVENTION (Sea Level Rise)

		ELEVATING (Sea Level Rise)	
Representative Number of Households:	80	140	220
MITIGATION COSTS			
Total Lifecycle Costs	$28,000,000	$42,000,000	$70,000,000
BENEFITS			
Resilience Value	$62,856,974	$348,397,378	$411,254,351
Damage to buildings	$39,772,332	$222,551,855	$262,324,187
Damage to contents	$23,005,235	$125,281,833	$148,287,068
Displacement	$79,406	$563,690	$643,096
Environmental Value	$13,038,937	$0	$13,038,937
Social Value	$11,639,908	$23,431,991	$35,071,898
Mental Stress and Anxiety Costs Avoided:	$633,216	$1,276,482	$1,909,698
Lost Productivity Costs Avoided:	$2,264,336	$4,564,614	$6,828,949
Avoided Physical Injuries	$8,742,356	$17,590,894	$26,333,251
Economic Revitalization			
Total Benefits	$87,535,818	$371,829,368	$459,365,186
Net Benefits (NPV)	$59,535,818	$329,829,368	$389,365,186
Benefit Cost Ratio (BCR)	3.13	8.85	6.56

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

The Public Housing Resiliency Pilot Project is designed to enhance the physical resilience of several public housing properties, as well as the social and economic resilience of residents of the public housing properties. The Program has two components: piloting innovative flood mitigation interventions at selected public housing properties and creating workforce development opportunities for public housing residents. Five developments from four public housing authorities were analyzed as part of this BCA: North Shore Village in Binghamton (Binghamton Housing Authority), Inwood Gardens in Inwood and Mill River Gardens in Oceanside (Hempstead Housing Authority), Long Beach Channel Homes in Long Beach (Long Beach Housing Authority) and Moxey Rigby in Freeport (Freeport Housing Authority). The Program will increase the physical resiliency of the buildings as well as enhance the social and economic resiliency of its residents.

A benefit cost analysis was conducted to assess the cost effectiveness of the Public Housing Resiliency Pilot Project. To quantify and monetize core resiliency benefits associated with avoided damages and displacement, the FEMA Benefit Cost Analysis (BCA) Tool was used. Additional costs and benefits were monetized or quantified outside the FEMA BCA Tool using assumptions supported by the literature developed by consultants in conjunction with GOSR employees. The analysis was conducted for the high and low sea level rise scenarios developed by the National Oceanic Atmospheric Administration (NOAA) in December 2012.[2] The Public Housing Resiliency Pilot Project total cost, include flood mitigation interventions and workforce development program, is $40.8 million. Benefits, including resiliency, environmental,

[2] Detailed Integrated Tool to Estimate Potential Future Sea Levels for Consideration in Sandy Recovery. Accessed from http://www.corpsclimate.us/Sandy/curvesNJNY2_detailed_NOAA.asp, Sept 20, 2015

social, and economic revitalization benefits, were estimated to be between 1.8 to 2.9 times as large as the cost. The table below summarizes the combined benefits and costs.

Table 6: Overview of Benefits and Costs – Public Housing Resiliency Pilot Project

SUMMARY OF BENEFIT COST ANALYSIS BY PROPOSED PROJECT/PROGRAM Cumulative Present Values **2) PUBLIC HOUSING RESILIENCY PILOT PROJECT** Combined Projects Across Regions	**Sea Level Rise (low)**	**Sea Level Rise (High)**
MITIGATION COSTS	$40,840,000	$40,840,000
BENEFITS		
Resilience Value	$20,520,406	$43,568,994
Environmental Value	$2,248,904	$2,248,904
Social Value	$29,616,855	$47,757,230
Economic Revitalization	$22,925,693	$22,925,693
Total Benefits	$75,311,858	$116,500,820
Net Benefits (NPV)	$34,471,858	$75,660,820
Benefit Cost Ratio (BCR)	1.8	2.9

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program

In examining possible forward-looking initiatives that address the causes of flooding in riverine communities, the State consulted experts from the New York State Department of Environmental Conservation (DEC). The agency identified the importance of enhancing culverts (a tunnel that enables a stream or open drain to run under a road or railroad) that are no long capable of handling the increased volume of rivers and streams—a process referred to as "right-sizing" – as well as restoring natural floodplains. County officials and communities in GOSR's

NY Rising Community Reconstruction (NYRCR) Program also noted the importance of these projects to improving community resilience against floods.

The State proposes the Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program to facilitate the right-sizing of small-scale infrastructure (culverts with up to a 25 foot span) and the restoration of natural floodplains within all HUD Declared Most Impacted and Distressed counties with remaining unmet recovery need (URN) in Upstate New York. The summary of indicative benefits and costs from this program are outlined below:

Table 7: Overview of Benefits and Costs – Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program

SUMMARY OF INDICATIVE BENEFIT COST ANALYSIS BY PROPOSED PROGRAM Cumulative Present Values **3) RIGHT-SIZING CULVERTS AND RESTORING NATURAL FLOODPLAINS RESILIENCY PROGRAM**	**Cumulative Present Values**
MITIGATION COSTS	$106,421,260
BENEFITS	
Resilience Value	$16,420,931
Environmental Value	$44,304,779
Social Value	$325,179,124
Economic Revitalization	$1,151,699
Total Benefits	$387,056,534
Net Benefits (NPV)	$280,635,274
Benefit Cost Ratio (BCR)	3.6

Right-Sizing Bridges Resiliency Program

Since 2011, approximately 500 bridges in New York State (the State) have been damaged, destroyed, or temporarily closed due to flooding in extreme weather events, including Superstorm Sandy, Hurricane Irene, and Tropical Storm Lee. Research shows that extreme precipitation will increase in magnitude and frequency throughout this century. The State, with its partner, the New York State Department of Transportation (DOT), proposes to right-size flood prone bridges in targeted counties. The Right-Sizing Bridges Resiliency Program will build on the successful work being undertaken in DOT's Flood Prone/Scour Critical Bridges program, which is improving 105 bridges to make them more resilient to scour through funds provided by the Federal Emergency Management Agency's (FEMA's) Hazard Mitigation Program. This program preforms bridge scour, the removal of earth and sediment from around bridge abutments or piers that formed due to swiftly moving water.

Under the proposed Program, the candidate bridges for improvements will be determined through outreach to local DOT resident engineers knowledgeable about the flooding history of each bridge. Once a bridge candidate is vetted and selected, an engineering analysis will be performed and a design developed to ensure long-term resiliency. Environmental and project processes will drive extensive outreach to affected local communities, elected officials, community officials, businesses, and residents including LMI and LEP populations. The summary of indicative benefits and costs from this program are outlined below:

Table 8: Overview of Benefits and Costs – Right-Sizing Bridges Resiliency Program

SUMMARY OF INDICATIVE BENEFIT COST ANALYSIS BY PROPOSED PROGRAM Cumulative Present Values **4) RIGHT-SIZING BRIDGES RESILIENCY PROGRAM**	**Cumulative Present Values**
MITIGATION COSTS	$111,257,262
BENEFITS	
Resilience Value	$4,579,106
Environmental Value	$18,172,701
Social Value	$357,626,020
Economic Revitalization	$235,519
Total Benefits	$380,613,347
Net Benefits (NPV)	$269,356,085
Benefit Cost Ratio (BCR)	3.4

Right-Sizing Critical Dams Resiliency Project (Seven Sites)

Higher precipitation due to climate change has had, and will continue to have, significant impacts on New York State's (the State's) existing dam infrastructure, putting thousands of New Yorkers, their homes, businesses, and transportation networks at great risk. To ameliorate significant storm-related vulnerabilities, the State, with its partner, the New York State Office of Parks, Recreation and Historic Preservation (Parks), proposes the Right-Sizing Critical Dams Resiliency Project (the Project) in Harriman State Park and Minnewaska State Park Preserve to ensure these dams meet current safety requirements. The seven dams in this Project are defined as "high hazard" meaning that a dam failure may result in significant or widespread damage to homes, road networks, critical infrastructure or environmental features, with the loss of life and loss of significant economic loss also likely.

The Project was developed based on guidance and input from engineering firms specializing in dam safety. These firms performed extensive flood and inundation modeling to determine the consequences of a catastrophic failure of these structures in potential damages and risk to life and property. In addition to consultation with outside engineers, Parks has internal staff with technical backgrounds in dam management and safety and coordinates with DEC on required Federal Dam Safety Standards. The communities directly impacted by potential dam failure have been actively supportive of this Project and are vested in the proposed safety enhancements. Parks has regularly communicated with these communities regarding these dams and their safety.

The Project addresses seven high-hazard dams—First Reservoir Dam, Lake Cohasset Lower Dam, Lake Cohasset Upper Dam, Lake Sebago Dam, Lake Stahahe Dam, Lake Welch Dam, and Tillson Lake Dam—that must be upgraded to ensure the minimization of downstream

impacts due to overtopping. For each dam, the primary deficiency relates to inadequate existing spillway capacity, which could compromise the structural integrity and underpinnings of the dam structure and lead to its failure. Current standards require that the design exceed a 500-year storm event. Additional deficiencies to be corrected include the armoring of upstream and downstream slopes, outlet gate functionality, spillway channel, and spillway elevation. The summary of benefit and costs are outlined below:

Table 9: Overview of Benefits and Costs –Right-Sizing Critical Dams Resiliency Program

SUMMARY OF COST BENEFIT ANALYSIS BY PROPOSED PROJECT/PROGRAM Cumulative Present Values **5) RIGHT-SIZING CRITICAL DAMS RESILIENCY PROGRAM**	**Cumulative Present Values**
MITIGATION COSTS	$49,627,923
BENEFITS	
Resilience Value	$6,652,597
Environmental Value	$381,895
Social Value	$92,734,000
Economic Revitalization & Community Development	$598,633
Total Benefits	$100,367,126
Net Benefits (NPV)	$50,739,203
Benefit Cost Ratio (BCR)	2.0

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

The Bay Park Sewage Treatment Plant (STP) provides wastewater treatment services to 40% of Nassau County (approximately 550,000 people) and discharges an average of 50 million gallons per day into Reynolds Channel West (a tributary of Hewlett Bay) via an 84-inch, 2.3-mile long outfall. Over time, the release of nitrogen and other pollutants from the STP has unbalanced the ecosystem of the Western Bays, undermining the area's natural coastal barrier system through loss of salt marshes and subsequent erosion. During Superstorm Sandy, a storm surge flooded the Western Bays and inundated the Bay Park STP, shutting down critical treatment processes and equipment for 56 hours. The floodwaters resulted in the release of 2.2 million gallons of partially treated effluent into Hewlett Bay. The length of the existing outfall pipe, in combination with the failure of the effluent pumps, placed citizens at risk of illness and degraded water quality in the estuary. To prevent recurrence of these outcomes, New York State (the State), with partner Nassau County, proposes to replace the existing Reynolds Channel Outfall with a new tunneled outfall pipe, 138 inches in diameter with a 10 inch lining, extending 5.3 miles from Bay Park STP to a diffuser in the Atlantic Ocean.

Table 10: Overview of Benefits and Costs - Nassau County Outfall Pipe and Bay Resiliency Project

SUMMARY OF COST BENEFIT ANALYSIS BY PROPOSED PROJECT/PROGRAM Cumulative Present Values **6) NASSAU COUNTY OUTFALL PIPE AND BAY RESILIENCY PROJECT**		
	Base Case Results	**High Sea Level Rise**
MITIGATION COSTS	$450,000,000	$450,000,000
BENEFITS		
Resilience Value	$1,600,052,969	$1,594,109,904
Environmental Value	$518,312	$518,312
Social Value	$5,716,888	$5,716,888
Economic Revitalization	$122,378,331	$122,378,331
Total Benefits	$1,728,666,500	$1,722,723,435
Net Benefits (NPV)	$1,278,666,500	$1,272,723,435
Benefit Cost Ratio (BCR)	3.84	3.828

The OMB standard rate of 7% was applied to the final BCR on this project. However, there is some cause to justify use of lower discount rates. A BCA was also run to demonstrate the impact that sea level rise has on the analysis. Without Sea Level Rise the BCR for the outfall is 3.828274301.

Process for Preparing the BCA

The State of New York engaged in a multistep, iterative process for developing the Benefit Cost Analysis (BCA) for this proposal. Staff from the Governor's Office of Storm Recovery (GOSR) engaged in extensive consultation activities with the eligible counties and with the National Disaster Resilience Competition (NDRC) State Interagency Working Group. GOSR engaged Declared and Most Impacted and Distressed (MID) counties, as well as eligible Tribal Areas, to discuss program development strategies, to gather new data, and to solicit project and programs concepts. GOSR convened a high-level meeting in Albany with the NDRC State Interagency Working Group to frame this application approach and gather substantial feedback via an online survey. Many of these agencies were instrumental in shaping the projects and programs proposed here. GOSR also engaged one consulting firm, Louis Berger, to develop and coordinate the BCA in conjunction with program inputs (data and information) from GOSR staff and inputs from various New York State agencies and counties. GOSR and agencies provided descriptions of the program elements, policy goals, size and vulnerability configurations, estimated budgets, parameters and variables that were then applied as inputs in the Benefit Cost analyses by Louis Berger. In the case of the Nassau County Outfall Pipe and Bay Resiliency Project, the BCA was developed by 3PL consultants under the supervision of GOSR staff and in coordination with Louis Berger. The BCA was prepared using Appendix H as a guideline and multiple iterations were developed to ensure the broadest sense of cost efficiency of each program and project and the overall proposal.

Although HUD stated that they will accept a BCA for Covered Projects, the State completed project-specific BCAs for all proposed projects and demonstrative indicative BCAs for all proposed programs. In each case, the methodology employed follows OMB Circular A-94, "Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs." In all cases,

the base-case discount rate in OMB Circular A-94 (7%) when calculating net present value, however, the State also developed scenarios with lower discount rates when justified (no lower than 3%). In those cases the State justified each of those decisions with methodology and evidence.

The State and its consultants used BCA tools developed by the Federal Emergency Management Agency (FEMA). However, in each case the State ensured that the BCAs were:

1. Based on the proposal as presented in the CDBG-NDR application;
2. Account for economic revitalization and other social/community benefits (in each case, a supplemental narrative of no longer than three (3) pages is also provided to describe these factors;
3. In cases where scenarios are developed with modified discount rates when using another federal agency methodology, the State provides adequate justification as described above.

The BCA is provided such that that HUD will understand how the results of the analysis would change if HUD partially funds the application as permitted under the NOFA. In this case, individual BCAs prepared for different projects and programs are combined together for an aggregate net present value and benefit cost ratio.

In the case of programs[3], rather than projects, the State completed indicative BCAs to indicate commitment to using these methodologies in the selection of actual projects. For instance, in the case of the Manufactured Home Community Resiliency Pilot Program, the State developed two indicative proposal outcomes and developed scenarios to assess a BCA; however, this does not predetermine the outcome of the community consultation process. If the program is

[3] A "program" refers to a set of related measures or activities with a particular long-term goal or objective. A Program is implemented by a specified agency that uses defined policies and procedures to select projects or activities to assist.

enacted, a set of BCAs will be developed as per the methodology outlined in this document to assess the relative cost-efficiency of the proposals.

In each case, the State believes that the program level BCA methodologies are consistent with the guidance in Appendix H to the greatest extent feasible. The State is including a description of the BCA methodology the Applicant will use to inform its project or activity funding decisions. It also includes schedules submitted in response to Factor 3, indicating necessary time for reviews while still complying with the statutory timeframes for availability of CDBG-NDR funds. Finally, the State has ensured that for each proposed program, the BCA methodology or approach used for the Program is consistent with the general principles outlined in OMB Circular A-94 (A-94). The State is proposing the following projects and programs for CDBG-NDR funding:

(1) Manufactured Home Community Resiliency Pilot Program;

(2) Public Housing Resiliency Pilot Project (four sites);

(3) Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program;

(4) Right-Sizing Bridges Resiliency Program;

(5) Right-Sizing Critical Dams Resiliency Project (seven sites);

(6) Nassau County Outfall Pipe and Bay Resiliency Project (one site).

Proposal Cost and Funding

The State seeks funding to implement two sets of resilience-enhancing disaster recovery programs. The first set of interventions creates protections for highly vulnerable low-income communities: the Manufactured Home Community Resiliency Pilot Program and the Public Housing Resiliency Pilot Project. The second set of measures will modernize infrastructure to meet current and future demands in riverine and coastal areas, while protecting and improving ecosystem health. It includes the Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program, the Right-Sizing Bridges Program, the Right-Sizing Critical Dams Resiliency Project, and the Nassau County Outfall Pipe and Bay Resiliency Project. Both sets of activities reflect insights from the State's ongoing recovery efforts, targeting system weaknesses and pockets of vulnerability that require additional investment to address unmet needs.

The proposal budget in the table below, including Federal, State, local, and private funding, as well as the CDBG-NDR request of $470 million, amounts to a total of $865 million.

Table 11: Proposed Project and Program Budgets

	1: Manufactured Home Community Resiliency Pilot	**2: Public Housing Resiliency Pilot**	**3: Right-Sizing Culverts and Restoring Natural Floodplains Resiliency**	**4: Right-Sizing Bridges Resiliency**	**5: Right-Sizing Critical Dams Resiliency**	**6: Nassau County Outfall Pipe and Bay Resiliency**	**TOTAL**
	$	$	$	$	$	$	$
Private Funds	18,000,000	19,700,000	5,000,000				**42,700,000**
Local Funds			7,885,750			104,000,000	**111,885,750**
New York State Funds	3,000,000	2,700,000	2,850,000	11,110,000	4,960,000	45,376,250	**69,996,250**
Federal Funds		9,586,000				150,000,000	**159,586,000**
CDBG-DR Funds		10,258,681	643,250				**10,901,931**
CDBG-NDR Request	**48,974,461**	**35,800,000**	**89,950,968**	**100,000,000**	**44,590,500**	**150,623,750**	**469,939,679**
Total Cost	69,974,461	78,044,681	106,329,968	111,110,000	49,550,500	450,000,000	**865,009,610**

Manufactured Home Community Resiliency Pilot Program

The total proposed cost and funds for the Manufactured Home Community Resiliency Pilot Program are shown in the following table:

Table 12: Proposed Manufactured Home Community Resiliency Pilot Program Budget

National Objective	Eligible Activity	Responsible Entity	Amount of Funds	Proposed Source of Funds
Step 1: Community Driven Planning Process Costs				
LMI	Planning	NYS	$1,000,000	CDBG-NDR
Step 2: Anticipated Project Implementation Costs				
Indicative Intervention 1 (in two MHCs)				
LMI	Buyout of Property in Floodplain	NYS	$5,334,823	CDBG-NDR
LMI	Acquisition of Property outside of Floodplain	NYS	$5,334,823	Leviticus - $3,000,000 MHCFP - $2,334,823
LMI	Clearance & Demolition	NYS	$205,185	CDBG-NDR
LMI	Construction of New Housing	NYS	$15,101,652	CDBG-NDR - $11,818,684 MHCFP - $665,177 CPC - $2,617,791
LMI	Relocation Payments and Assistance	NYS	$820,742	CDBG-NDR
Indicative Intervention 2 (in two MHCs)				

LMI	Rehabilitation/ Reconstruction of Residential Structures	NYS	$40,740,550	CDBG-NDR - $28,358,341 CPC - $12,382,209
LMI	Relocation Payments and Assistance	NYS	$1,436,685	CDBG-NDR
	Total Program Cost		**$69,974,461**	
	CDBG-NDR Request		**$48,974,461**	

The total proposed cost for the Manufactured Home Community Resiliency Pilot Program consists of the cost of Phase I: Community Based Planning and Outreach and Phase II: Implementation Options. The cost of Phase II: Option 1, Buyout and Relocation is $28 million, and the cost of Phase II: Scenario Option 2: Infrastructure Strengthening: Safely Elevating is $42 million. The total costs of Phase II, options 1 and 2 is a combined $69.97 million. Proposed CDBG-NDR funds amount to $48.97 million, State funds amount to $3 million, and Private funds amount to $18 million. Operations and maintenance costs: These costs will be determined in full once the program determines its activities.

Public Housing Resiliency Pilot Project

The total proposed cost and funds for the Public Housing Resiliency Pilot Project are shown in the following table:

Table 13: Proposed Public Housing Resiliency Pilot Project Budget

National Objective	Eligible Activity	Responsible Entity	Amount of Funds	Proposed Source of Funds

LMI	Construction of New Housing	Freeport Housing Authority	$ 42.7 million	CDBG-DR ($9.0m), CDBG-NDR ($5.5m), FEMA-PA ($5.8m), Debt ($2.7m), Equity ($16m), Deferred Fee ($3.7m)
LMI	Rehabilitation of Residential Structures	Town of Hempstead Housing Authority	$16.4 million	CDBG-DR ($0.5m), CDBG-NDR ($14.4m), FEMA-PA ($1.5m)
LMI	Rehabilitation of Residential Structures	Long Beach Housing Authority	$12.2 million	CDBG-DR ($0.1m), CDBG-NDR ($11.8m), FEMA-PA ($0.3m)
LMI	Rehabilitation of Residential Structures	Binghamton Housing Authority	$ 6.6 million	CDBG-DR ($0.7m), CDBG-NDR ($3.9m), FEMA-PA ($2.0m)
LMI Public Services	Econ. Development or Recovery Activity that Creates/Retains jobs	Opportunity Long Island	$ 0.16 million	CDBG-NDR

The full proposal cost is $78,044,681, including $35,800,000 in CDBG-NDR, $9,586,000 in FEMA-PA, $10,258,681 in CDBG-DR, $2,700,000 in State funds, and $19,700,000 in private equity. This includes the costs of the workforce development program.

Operations and maintenance costs for improvements to public housing are absorbed with standard operating cost budgets without a net increase in cost.

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program

The total proposed cost and funds for the Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program are shown in the following table:

Table 14: Proposed Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program Budget

National Objective	**Eligible Activity**	**Responsible Entity**	**Amount of Funds**	**Proposed Source of Funds**
Urgent Need/LMI	Public Facilities and Improvements	NYS	$106.3 million	CDBG-NDR $89.95 million; DEC Basin Program and CWC $7.85 million; Local funds $7.89 million; $0.64 million CDBG-DR

Operations and maintenance costs: These costs will be determined in full once the program determines its activities.

Right-Sizing Bridges Resiliency Program

The total proposed cost and funds for the Right-Sizing Bridges Resiliency Program are shown in the following table:

Table 15: Proposed Right-Sizing Bridges Resiliency Program Budget

National Objective	**Eligible Activity**	**Responsible Entity**	**Amount of Funds**	**Proposed Source of Funds**
Urgent Need	Public Facilities and Improvements	NYS	$111.11 million	CDBG-NDR $100 million; DOT $11.11 million

Operations and maintenance costs: These costs will be determined in full once the program determines its activities.

Right-Sizing Critical Dams Resiliency Project

The total proposed cost and funds for the Right-Sizing Critical Dams Resiliency Project are shown in the following table:

Table 16: Proposed Right-Sizing Critical Dams Resiliency Project Budget

National Objective	**Eligible Activity**	**Responsible Activity**	**Amount of Funds**	**Proposed Source of Funds**
Urgent Need	Public Facilities and Improvements	NYS	$ 49.55 million	CDBG-NDR $44.59 million; Parks $4.86 million; Palisades Interstate Park Commission $0.1 million

Operations and maintenance costs: Operations and maintenance costs are estimated by Parks at $25,000 per year.

Nassau County Outfall Pipe and Bay Resiliency Project

The total proposed cost and funds for the Nassau County Outfall Pipe and Bay Resiliency Project are shown in the following table:

Table 17: Proposed Nassau County Outfall Pipe and Bay Resiliency Project Budget

National Objective	Eligible Activity	Responsible Entity	Amount of Funds	Proposed Source of Funds
Urgent Need	Acquisition, construction, reconstruction of public facilities	Nassau County	$ 450 million	FEMA HMGP (pending formal commitment $150 million); Nassau County (pending formal commitment), Nassau County ($104 million); NYS Environmental Facilities Corporation loans ($45.38 million); CDBG-NDR ($150.62 million)

Operations and maintenance costs: There are no additional operating and maintenance costs associated with the ocean outfall. Operation and maintenance costs will only apply to the converted Long Beach element of this project.

Current Situation and Problem to Be Solved

Overview

When Hurricane Irene struck in late August 2011, it caused extensive damage to the eastern half of the State, with damage stretching from Long Island to the Canadian border. Irene caused extensive flooding to numerous communities and widespread power outages. The flood damage ultimately proved to be most damaging, especially in Greene and Schoharie counties. Based on NOAA's Table of Events, Irene caused an estimated, CPI-adjusted $14 billion in damage and 45 deaths in impacted states, 10 of which were in New York (Source, Source).

One week after Irene struck, Tropical Storm Lee severely impacted the Southern Tier of the State. In some areas, nearly 12 inches of precipitation fell. While serious impacts were felt by many of the same counties hit by Irene, Broome and Tioga counties were especially hard hit. Lee forced the evacuation of 20,000 residents from downtown Binghamton in Broome County and caused the inundation of many of the city's public housing buildings (Source). Lee's record flooding ultimately caused an estimated, CPI-adjusted $3 billion in damage and 21 deaths in impacted states (NOAA Table of Events). Hurricane Irene caused $731 million in damage and Tropical Storm Lee caused $433 million in damage to homeowners and renters eligible for assistance in the MID-URN counties outside of New York City.

When Superstorm Sandy struck the State in October of 2012, its main impacts were felt downstate. Sandy caused unprecedented damage to homes, businesses, infrastructure, and an economy still recovering from the Great Recession. As many as 300,000 housing units were damaged and 2 million utility customers lost power (Source). In addition, 2,000 miles of roadways were flooded and rail lines were destroyed in several locations. Based on NOAA's Table of Events, Superstorm Sandy was the second costliest tropical cyclone in U.S. history,

causing an estimated, CPI-adjusted $67 billion in damage and 159 deaths in impacted states, 60 of which were in New York (NOAA Table of Events). Superstorm Sandy, alone, caused $3.188 billion in damages to individual homeowners and renters found eligible for assistance in the MID-URN counties outside of New York City.

Together, these storms caused extensive damage to individual homeowners and renters. In the State's APA8 (approved by HUD, April 2015) all damage to individual homeowners and renters for all three storms combined was estimated at $6 billion, with $4.7 billion of that amount eligible for assistance (excluding New York City). Within the MID-URN counties (excluding New York City), all damages to individual homeowners and renters from the three storms amounted to $5.563 billion, of which $4.352 billion was eligible for assistance.

The three qualified disasters also required enormous local, state, and Federal government intervention. Using FEMA PA data, the State estimated damage costs for the three qualified disasters combined caused more than $12.8 billion in FEMA PA claims for all damage to the State. Of this, $7.5 billion was permanent damage identified in MID-URN counties, with another $2.3 billion of permanent damage claimed by State agencies. Hurricane Irene caused $698 million in claims statewide; $221 million in permanent damage in MID-URN counties, with $191 million for MID-URN counties not including New York City. Tropical Storm Lee caused $397 million in claims statewide; $216 million in permanent damage in MID-URN counties, with an additional $102 million in permanent damage claimed by State agencies. Superstorm Sandy caused $11.7 billion in claims statewide. State agencies claimed $2.0 billion in permanent damage. MID-URN counties claimed $7.1 billion in permanent damage, with $5.8 billion in permanent damage claimed by New York City alone.

The State, using New York State Department of Financial Services (DFS) data, estimated insurance claims (excluding NFIP) and total case incurred loss for Superstorm Sandy within 5 of the most impacted MID counties: Nassau, Orange, Rockland, Suffolk, and Westchester counties, as well as the five MID counties/boroughs of New York City. Approximately 450,000 claims (276,000 outside New York City) were made to insurance companies for residential property damage, commercial property damage, personal automobile damage, commercial automobile damage, business interruption, *Write Your Own* Program, and private coverage categories. Total incurred loss amounted to $5.3 billion in these 10 counties; $2.3 billion in the 5 MID counties outside of New York City.

In addition to the widespread and deep destruction, the storms of 2011 through 2013 left a realization of New York State's vulnerability to the interrelated effects of climate change and extreme weather. The State has responded to the destruction caused by these events with an extensive recovery and rebuilding response. However, there are remaining unmet recovery needs across the State. In Action Plan Amendment Eight (APA8), the State has calculated $17.80 billion in unmet recovery needs statewide, and that State's NDRC-specific analysis identified economic revitalization, infrastructure, and/or housing unmet recovery needs in the 10 counties designated by HUD as Most Impacted and Distressed and the five counties of New York City. As the State continues its recovery and rebuilding, it is pursuing a systems-based approach to address the effects of climate change induced floods on riverine and coastal communities.

<u>Threats, Hazards, Vulnerabilities</u>

New York State is focusing on the effects of flooding in riverine and coastal communities caused or exacerbated by climate change. These threats, hazards, and vulnerabilities arise from both shocks (one-time events) and stressors (continued events). In both instances, they often

have broad, impacts that cross jurisdictional boundaries and so must be addressed with systems-based, regional solutions. These threats, hazards and vulnerabilities were found through a series of analyses initiated in the wake of Superstorm Sandy and in preparation for this NDCR application:

- The Governor's Office of Storm Recovery (GOSR) conducted significant outreach to New York's counties, state agencies, and other stakeholders to better shape its understanding of vulnerabilities for this application.
- GOSR's NY Rising Community Reconstruction (NYRCR) Program formed and supported citizen Planning Committees through an intensive, months-long recovery and resiliency planning process culminating in 66 NYRCR Plans. This grassroots program helped shape the State's understanding of hazards, risks, and vulnerabilities.
- The New York State Department of State (DOS) developed a risk analysis tool for use in the NYRCR Program. The DOS model incorporates predictions of sea level rise and the probability of different storm hazard levels, and analyzes the likelihood that an infrastructure asset will be exposed to various levels of storm hazards in the one-hundred year planning time frame. NYRCR Plans posted for public review on the GOSR website illustrate the model's utility in a wide range of project and program settings.
- In Action Plan Amendment Eight (APA8), GOSR revisited the State's unmet recovery needs analysis. The concentration of the State's needs in coastal and riverine communities has helped shape this application's approach. Following HUD's CDBG-DR Allocation Methodology as published in the Federal Register Notice FR-5696-N-11, the State estimated approximately $5.68 billion in unmet needs to repair and mitigate the State's housing,

business, and infrastructure as a result of the covered disasters. If HUD's high construction cost multiplier is factored in, unmet needs are estimated at $6.85 billion, reflecting the likelihood that reconstruction costs will be higher in New York State than elsewhere in the United States.[4] The State's additional analysis methodology, which incorporates infrastructure needs that may not be eligible for CDBG-DR funding, estimates approximately $17.8 billion in outstanding recovery and mitigation needs not currently funded by federal programs (if the HUD construction cost multiplier is applied to housing and small business).

Residents and businesses that have been subjected to repetitive flooding are most directly impacted by the threats discussed above, although the impacts of catastrophic flooding—including social and economic impacts—have adversely affected entire communities and, in fact, the entirety of New York State. A significant number of low- and moderate-income (LMI) individuals have been affected by past disasters in New York State. LMI communities and otherwise vulnerable populations face increasingly severe physical, social, economic, and environmental impacts of coastal and riverine flooding.

Remaining Unmet Recovery and Resiliency Needs in Housing:

As outlined in APA8, the State identified *$3.969 billion* in housing unmet recovery needs arising from the storms of 2011-2013. Of this, over <u>$3.598 billion of unmet recovery need was</u>

[4] Federal Register Notice (FR-5696-N-11) indicates that HUD employs a high construction cost multiplier in its updated CDBG-DR allocation methodology. In the case of New York State, housing and small business unmet needs are multiplied by a factor of 1.44.

identified in the 10 MID counties (excluding the five counties of New York City). If it is assumed that the complete housing allocation for all programs operated by the State using CDBG-DR allocations for New York State (totaling $1.959 billion, as per APA8) is applied to this unmet recovery need, it would leave an estimated unmet recovery and resilience need in excess of $2.327 billion in the state and at least $1.639 billion in the 10 MID counties (excluding the five counties of New York City). For each target area (outlined in Exhibit D: Need), the State outlines the estimated unmet recovery and resiliency needs. These estimates were calculated as follows: The State used both FEMA Individual Assessment (FEMA IA) and Small Business Administration (SBA) data from all three storms. Repair and resilience unmet needs are calculated separately per HUD's allocation methodology (outlined in the State's APA8 Unmet Needs analysis). The unmet needs for each FEMA damage category are estimated separately. Using data from APA8 (April 2015), the analysis breaks down total unmet needs by target area, which is the sum of repair and resilience measures for owners and renters. As noted above, before CDBG-DR programmatic interventions on behalf of the State, estimated unmet needs are $3.598 billion. Then, for each target area, the State subtracts "Committed" funding (awards and allocations that have been calculated by housing program staff but not necessarily disbursed to program applicants for all CDBG-DR housing programs operated by the State) from the total. Of the total budget for CDBG-DR housing programs ($1.959 billion), approximately $1.344 billion has been committed to the MID target areas at the time of this application. This produces an estimate of the remaining unmet needs *per target area*. The analysis shows a total of $2.7 billion in unmet needs for 29 counties (excluding New York City) impacted by the storms of 2011-2013, of which $2.254 billion is unmet need in the 10 MID target areas. The breakdown by target

area is outlined in Table 2, below. Nassau and Broome counties exhibit the largest unmet recovery needs after currently committed funds.

Table 18: Unmet Recovery Needs (Housing) after Currently Committed Funds

MID Target Area	**Unmet Recovery Needs After Currently Committed CDBG-DR Funds**
Broome	$379,651,450.22
Greene	$49,070,562.31
Nassau	$1,084,139,238.78
Orange	$229,672,071.06
Rockland	$82,214,842.89
Schoharie	$55,899,140.68
Suffolk	$34,928,045.04
Tioga	$123,366,912.05
Ulster	$116,508,317.27
Westchester	$99,083,241.51
Total	**$2,254,533,821.81**

If *all* of the remaining CDBG-DR budget for *all* housing programs (approximately $600 million) were allocated to meet these unmet needs, URN would still exceed $1.639 billion. This gap equates to approximately 80% of the complete CDBG-DR allocation for the State of New York for all other non-housing activities (excluding RBD and planning and administration). Clearly, this indicates a broad unmet recovery need in housing that exceeds the State's CDBG-DR allocation.

NY Rising Housing Recovery Program (Budget $1,056 million)

The State is highlighting specific URN using programmatic data from the *NY Rising Housing Recovery* Program as an example of additional URN.

As of the September, 2015, the State had awarded $915,942,950 to approximately 11,500 program applicants. These awards covered reimbursements and repair, reimbursement only, repair only, *budgeted* elevation awards and other resilience awards. The entire program budget, as per APA8, is $1,056 million.

The State expects to make new awards to approximately an additional 430 applicants. The State expects that these additional awards will amount to an additional $17.3 million. The cost of program delivery, in addition to these awards (already made and expected), exceeds the allocated budget for this program, as per APA8. Given that all other CDBG-DR funds are programmed, the State is identifying URN with respect to this program.

Using Programmatic Data to Determine the Costs of Resilience Measures

In the process of determining recovery solutions for impacted homeowners, the State offers a number of mitigation and resilience measures. The *Mandatory Home Elevation* requirement is for homes located in the 100-year floodplain AND that were substantially damaged in a Qualifying Disaster. The State has committed to use CDBG-DR funds to elevate all such housing units. The State offers other funding for certain optional items.

- *Optional Home Elevation:* for applicants whose property is in the 100-year flood plain, but whose homes are NOT substantially damaged or who are not in the 100-year floodplain, but suffered repeated verified flood loss.
- *Bulkhead repair or replacement*: funding for in-place and in-kind repair is available for applicants whose homes were damaged in one or more of the Qualifying Disasters.
- *Optional Mitigation Measures*: the program also assists in paying up to a maximum of $30,000 for homeowners who are repairing their homes, not reconstructing them. They include: elevation of mechanicals, electrical and plumbing components; securing of fuel

tanks; use of flood resistant building materials below base flood elevation (retrofits to be limited in scope to be cost effective); installation of flood vents; installation of backflow valves; and installation of roof strapping.

In total, using current budget assessments, the State has identified over $600 million dollars in such resilience measures for which it is aiding homeowners. These include:

- Over $500 million for elevation (all of which is included in the total award estimates highlighted above)
- $24 million in other optional measures ($1.2 million of which are included in the award estimates, above)
- At least $73 million for optional bulkheads ($8.3 million is included in the award estimates).

Table 19: Total Estimated Budget Costs of Mitigation in the NY Rising Housing Program

County	Required Elevation Total Budget Estimate		Optional Elevation Total Budget Estimate	Optional Mitigation Total Budget Estimate	Optional Bulkhead Total Budget Estimate		Total Mitigation Measures Total Budget Estimate
Broome	$ 910,000		$ 650,000	$ 60,000	$ -		$ 1,620,000
Greene	$ -		$ 650,000	$ 70,000	$ -		$ 720,000
Nassau	$ 107,510,000		$ 200,850,000	$ 15,810,000	$ 45,396,000		$ 369,566,000
Orange	$ 130,000		$ 130,000	$ 50,000	$ 52,000		$ 362,000
Rockland	$ 3,120,000		$ 1,040,000	$ 140,000	$ 312,000		$ 4,612,000
Schoharie	$ 650,000		$ 1,560,000	$ 230,000	$ -		$ 2,440,000
Suffolk	$ 86,970,000		$ 101,530,000	$ 7,410,000	$ 27,248,000		$ 223,158,000
Tioga	$ 910,000		$ 1,040,000	$ 60,000	$ -		$ 2,010,000
Ulster	$ 130,000		$ 130,000	$ 40,000	$ 52,000		$ 352,000
Westchester	$ -		$ 390,000	$ 60,000	$ 52,000		$ 502,000
	$ 200,330,000		**$ 307,970,000**	**$ 23,930,000**	**$ 73,112,000**		**$ 605,342,000**

The State has analyzed all active program applicants to explore and identify resilience measures for each applicant.

Elevations:

In total, the State has identified approximately $200 million of required elevation resilience measures in eight of the 10 MID Target Areas. The budgeted program estimate for elevating a unit is *$130,000* per elevation. The State has committed to funding all of these elevations and they are included in the award figures above.

However, updated programmatic data indicates that this budgeted number of $130,000 will be too low. Updated program estimates for elevations indicate that, because of the high cost nature of the region, the average elevation is now estimated at $190,000 each. This number,

combined with the approximately 2,370 program applicants in the MID Target Areas who have applied for optional home elevations indicate that the total recovery and resiliency needs for required and optional elevations will amount to $743 million – more than $230 million above the budgeted estimate.

Other Mitigation Measures:

The State has estimated that each of the over 2,400 applicants will request an average of $10,000 in other optional measures. This translates to almost $24 million across the MID target areas. Approximately $1.8 million is already accounted for in the awards total. However, the remainder is not.

Bulkhead Repairs and Replacement:

Finally, the program allows for optional bulkhead replacement and repair. The State has received over 1,400 applicants in the MID Target Areas for this resilience measure. However, apart from just over $8 million, bulkheads are not currently included in the State's total awards estimate – indicating an unmet resiliency need of approximately $65 million in the MID Target Areas. However, programmatic data indicates that bulkheads in these areas will likely cost more than $65,000 per intervention.

Table 20: Comparison of Budgeted and Programmatic Estimates for Elevations and Bulkheads

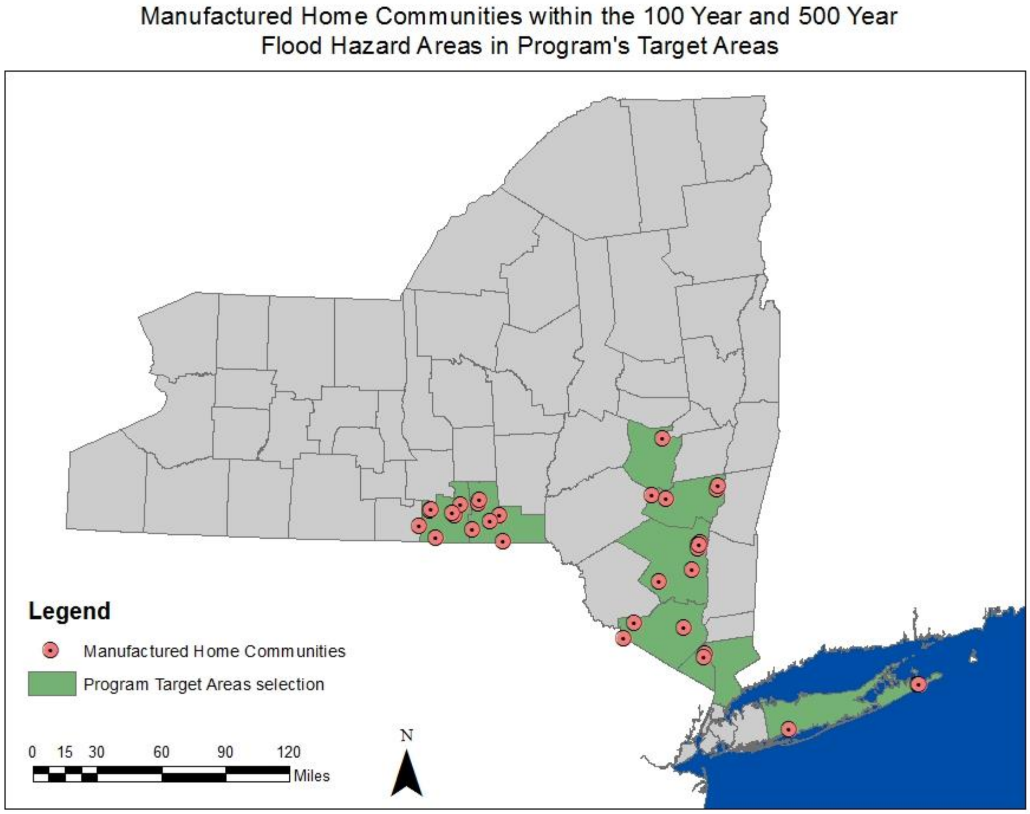
	Required Elevation			**Optional Elevation**			**Optional Bulkheads**		
MID Target Areas	**Program Applicant**	**Program Estimate ($)**	**Difference W/ Budget Estimate**	**Program Applicant**	**Program Estimate ($)**	**Difference W/ Budget Estimate ($)**	**Program Applicant**	**Program Estimate ($)**	**Difference W/ Budget Estimate**
Summary (10 MID Areas)	1,541	292,790,000	92,460,000	2,369	450,110,000	142,140,000	1,406	73,112,000	91,390,000

Manufactured Home Community Resiliency Pilot Program

Manufactured home communities (MHCs) provide a unique affordable housing option for an estimated 71,355 households in nearly 2,000 communities across New York State (the State). The majority of these communities were built on low-lying land often before land use regulations. Consequently, many are located in areas vulnerable to natural hazards, such as flooding, where mitigation would have been required if permitted today. The combination of low-incomes, relatively high population densities, and the unique type of tenancies as both homeowners and tenants contribute to the vulnerability of MHCs to stormwater and riverine flooding. The State recognizes the importance of preserving and increasing this housing stock, especially for low- and moderate- income residents.

In order to quantify the extent of the problem, the State sought to identify the number of manufactured home communities within Most Impacted and Distressed (MID) target areas located in the 100 year or 500 year floodplain. A key element in this assessment was geographic information system (GIS) dataset collected annually by New York State Homes and Community Renewal's (HCR) Division of Housing and Community Renewal (DHCR) in accordance with Section 233 of New York State Real Property Law. This analysis identified 40 MHCs in the 100 year or 500 year flood hazard areas, containing 1,686 units and housing 4,384 residents. The 40 MHCs are located in the in the Program's target areas of Broome, Greene, Orange, Rockland, Schoharie, Suffolk, Tioga, Ulster, and Westchester counties.

Figure 2: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in the Program's Target Areas



Source: NYS DHCR Data Geocoded and Verified by Dewberry; FEMA FIRM; OpenStreetMap Data

Figure 3: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Broome County

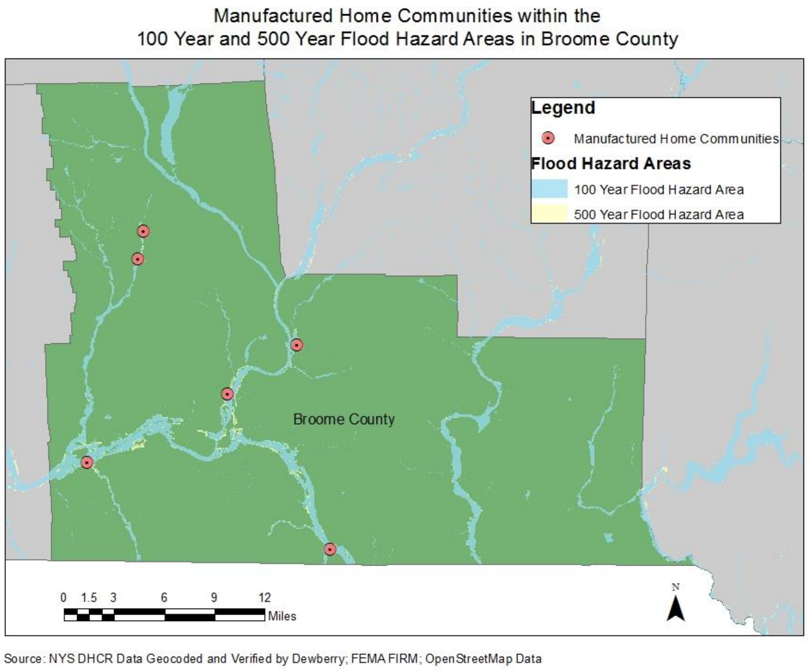


Figure 4: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Greene County

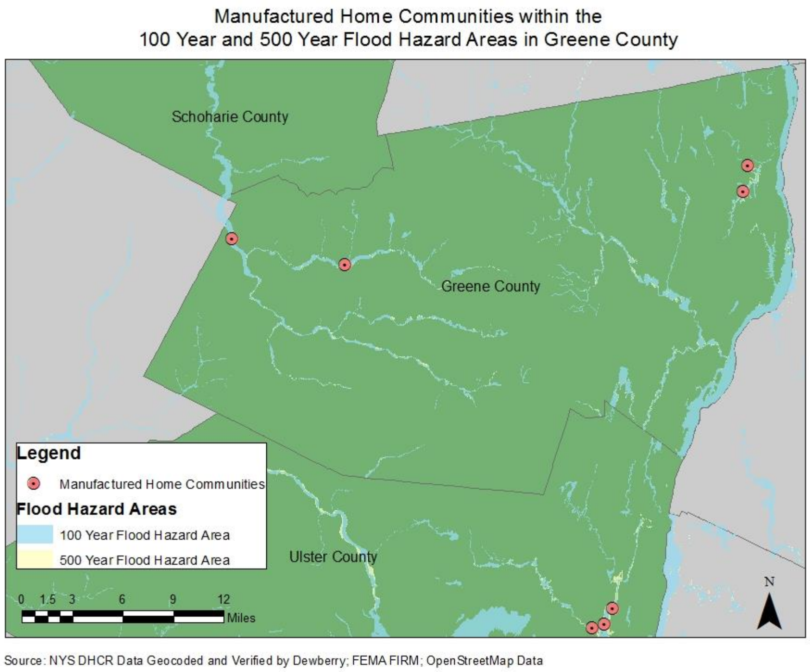


Figure 5: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Orange County

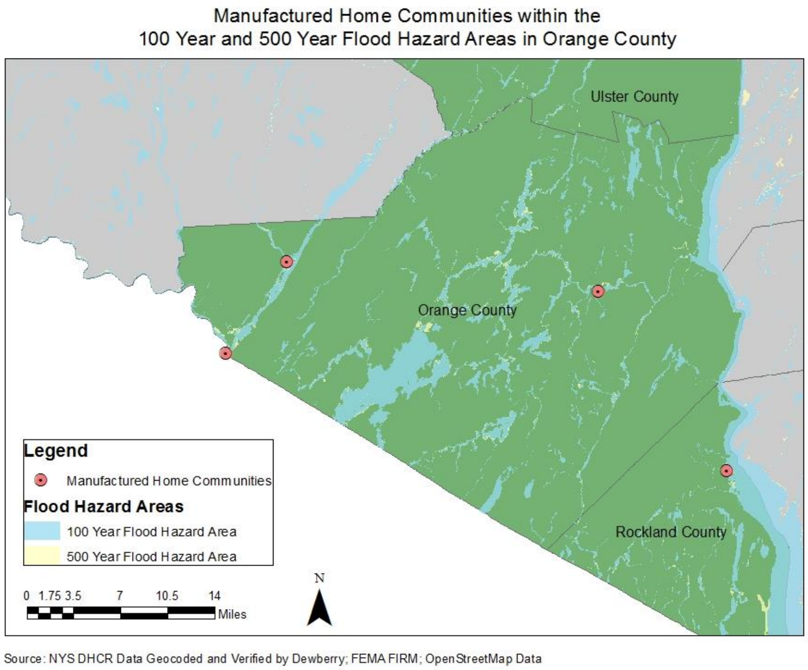


Figure 6: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Rockland County

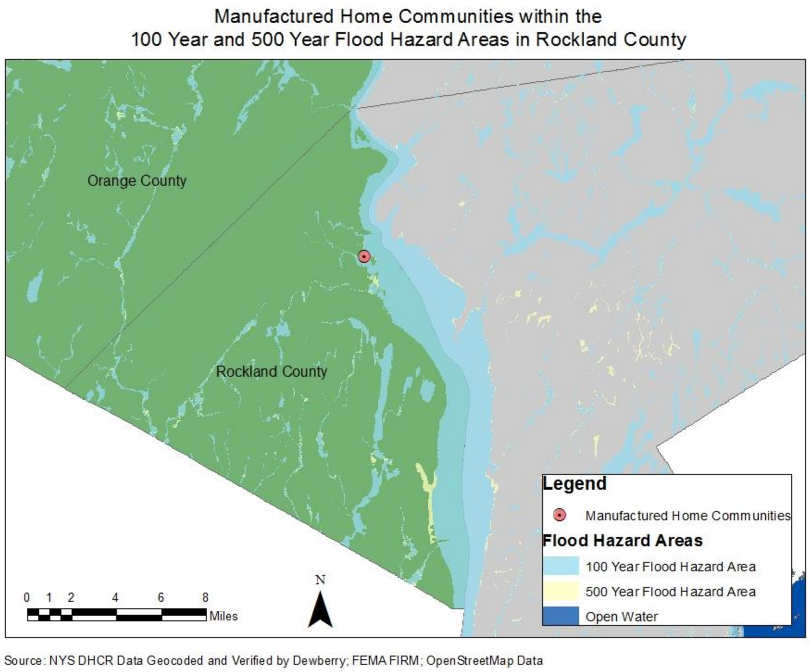
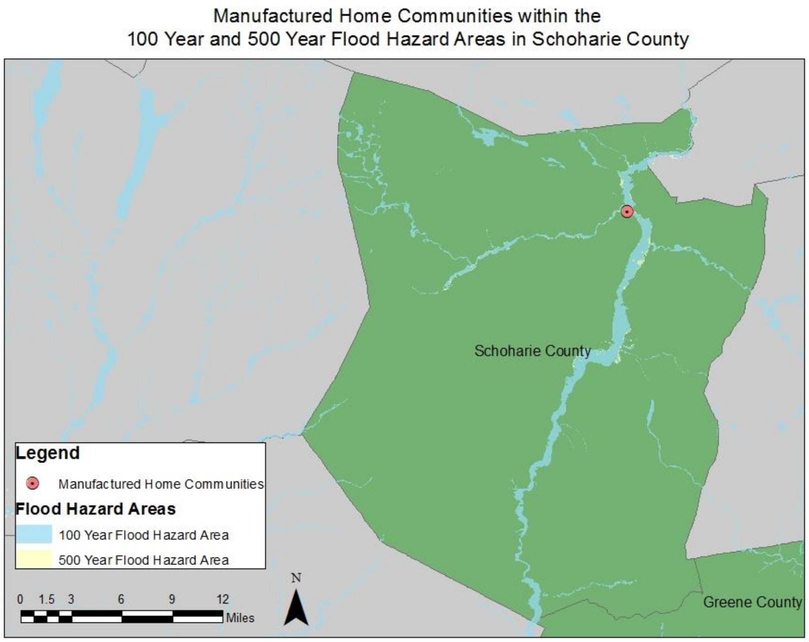
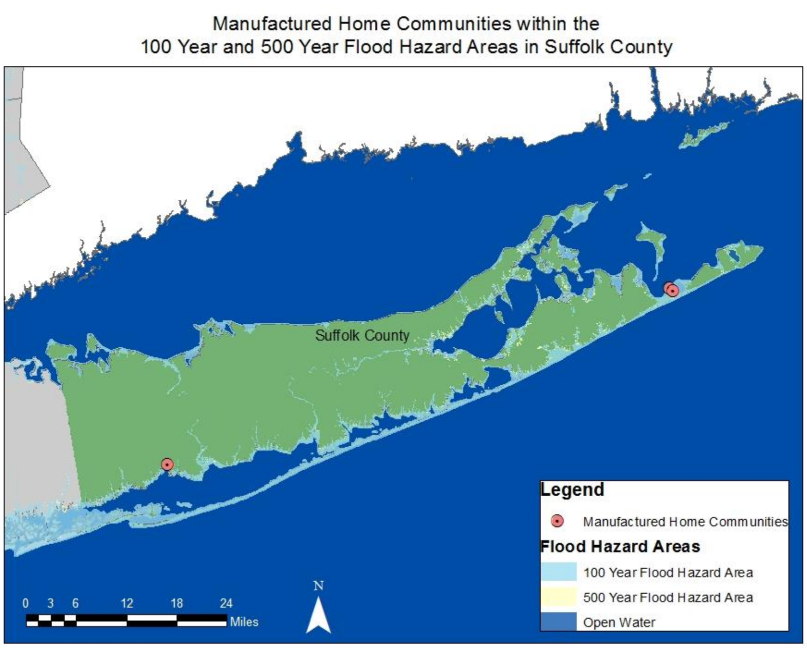


Figure 7: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Schoharie County



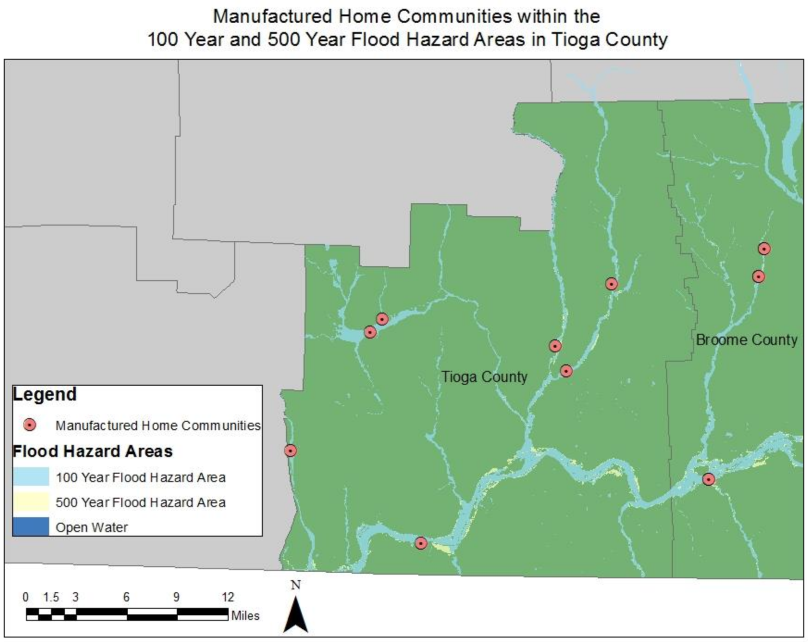
Source: NYS DHCR Data Geocoded and Verified by Dewberry; FEMA FIRM; OpenStreetMap Data

Figure 8: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Suffolk County



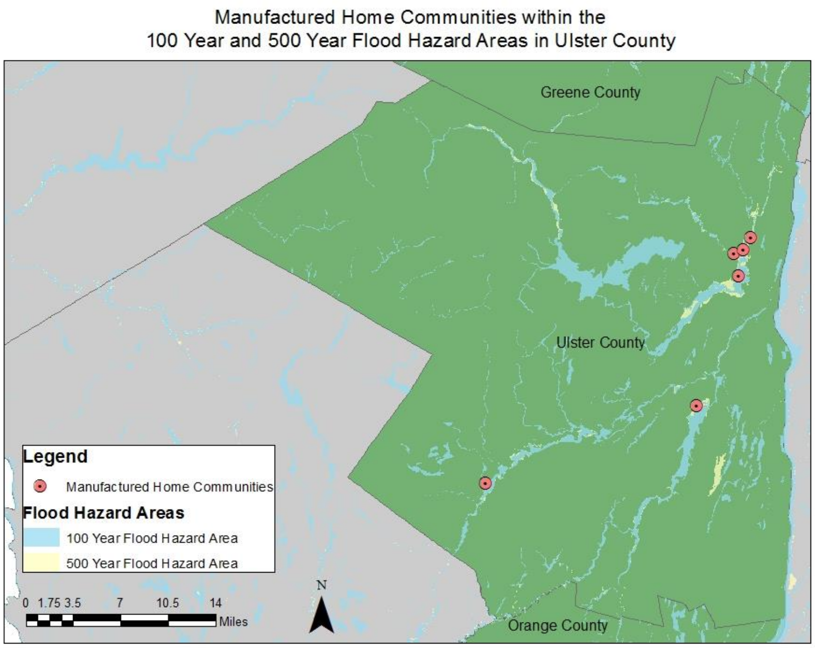
Source: NYS DHCR Data Geocoded and Verified by Dewberry; FEMA FIRM; OpenStreetMap Data

Figure 9: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Tioga County



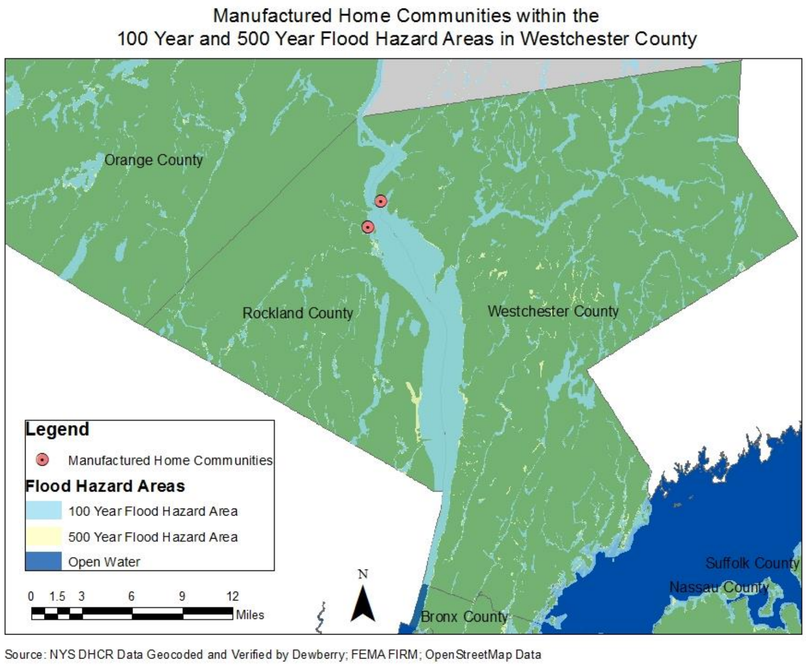
Source: NYS DHCR Data Geocoded and Verified by Dewberry; FEMA FIRM

Figure 10: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Ulster County



Source: NYS DHCR Data Geocoded and Verified by Dewberry; FEMA FIRM; OpenStreetMap Data

Figure 11: Manufactured Home Communities within the 100 Year and 500 Year Flood Hazard Areas in Westchester County



The State then engaged with MID county stakeholders, cross-disciplinary experts, State agencies, and community members to further define the problem and brainstorm solutions. (See **Attachment D – Consultation Summary** for a detailed list of stakeholders and experts consulted). As a result of this iterative process, the State further defined the particular vulnerabilities MHCs have historically faced and will continue to face during extreme weather events if the status quo remains. Vulnerabilities include socio-economic characteristics of residents, physical liabilities of this housing type, the topographic locations of communities in the floodplain, and inadequate storm and wastewater infrastructure leading to increased risk and increased cost of recovery. Institutionally, manufactured home owners also face unique financial vulnerabilities. Unlike traditional mortgages, financing for most manufactured homes is similar to automobile financing, with interest rates up to five percentage points higher than the average

mortgage. Manufactured-housing lenders also specialize in subprime lending, which can increase interest rates by an additional three percentage points.

There is consensus among stakeholders that without federal and State intervention, many MHCs will face increasing resiliency needs, jeopardizing valuable affordable housing and putting vulnerable populations at risk. Each community has unique conditions that must be addressed locally, through significant dialogue with key stakeholders and tailored approaches to resilience. Thoughtful interventions and risk-reduction measures will help these MHCs adapt to future shocks and stresses associated with climate change, as well as socioeconomic challenges.

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

The physical locations of the public housing buildings make them susceptible to flooding. In Nassau County, all four sites have buildings within the 100 year flood hazard area. In Broome County, the one site is within the 500 year flood hazard area. First floor flooding attributable to the covered storms ranged from 2.8” to 18” in the subject properties, with basements and sub-basements submerged. The public housing site in Broome County is within the 500 year flood hazard area. While immediate storm-related damage was addressed, the sites are still vulnerable to future storms and severe weather events. The BCA includes two possible scenarios for projected sea level rise. One low sea level rise and the other high sea level rise as detailed in section VIII b of this narrative. Public housing sites in the floodplain received flooding damage to structures (including mechanical and electrical equipment), loss of function, and threats to resident safety. The proposed investment would restore ordinary function, replace damaged systems with more energy-efficient systems, and mitigate the risk to structures and contents by removing elements from the floodplain, installing protective measures, improving storm-water management, and sealing the building envelope.

Figure 12: Project Site in Broome County

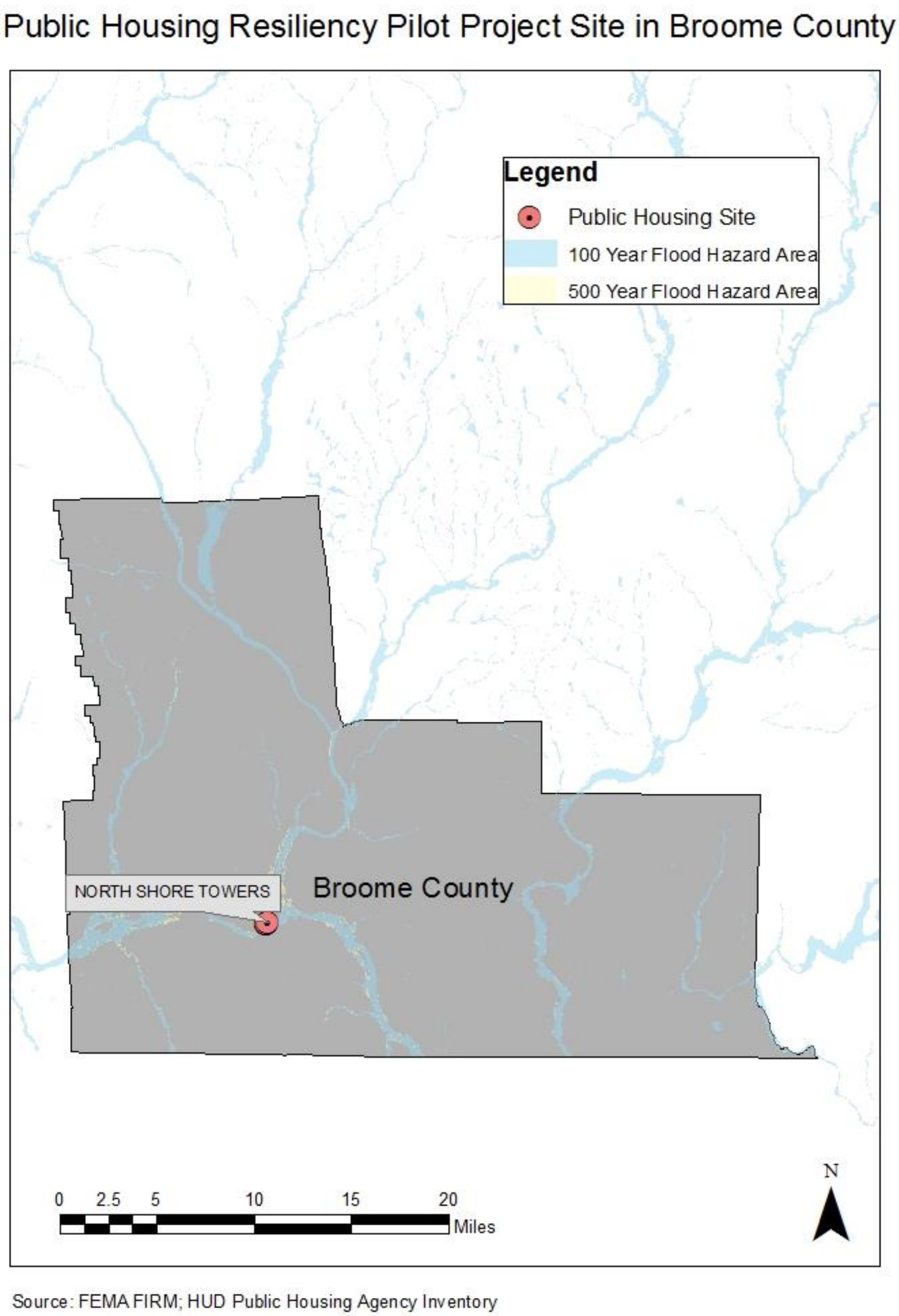
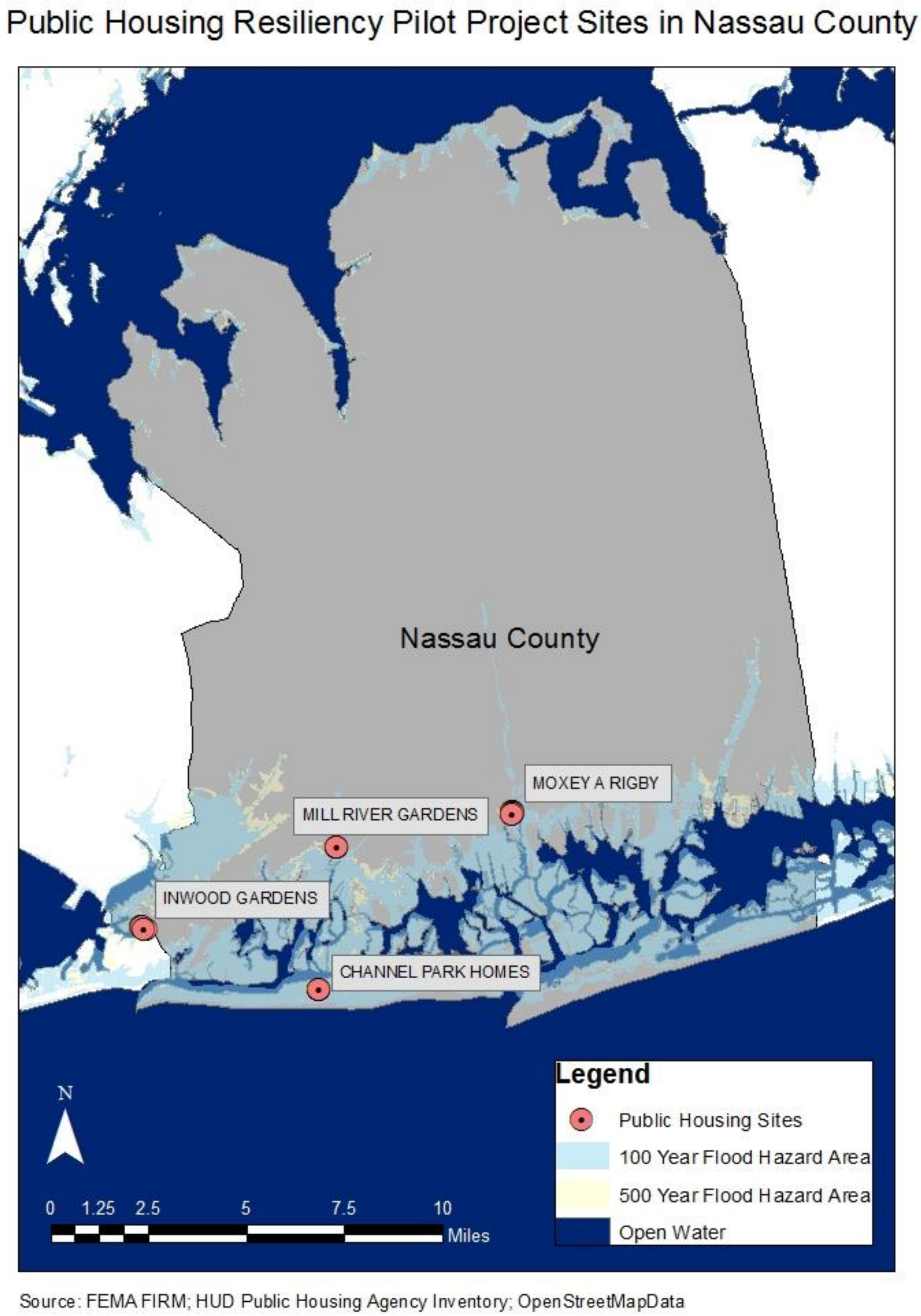


Figure 13: Project Sites in Nassau County



Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program

Riverine flooding is exacerbated by culverts that are insufficiently sized to handle large storms. Additionally, the loss of natural floodplain storage capacity due primarily to housing and commercial development has intensified the impact and the extent of this flooding. In examining possible forward-looking initiatives that address the causes of flooding in riverine communities, the State consulted experts from the New York State Department of Environmental Conservation (DEC). The agency identified the importance of right-sizing culverts and restoring natural floodplains. Discussions with county officials and communities in GOSR's NYRCR Program also noted the importance of these projects to improving community resilience against floods.

Culverts

Right sizing culverts will improve the resiliency of this infrastructure and avoid potential floods and disruptions to key road networks and vulnerable communities that rely on access to these networks. Culvert failure and associated road washouts can isolate vulnerable communities and also inflict significant property damage.

In addition, there are significant benefits to fish and wildlife associated with improving the culvert design to accommodate aquatic organism passage. Key fish species are dependent on access and more natural stream passage to spawn and propagate by safely navigating streams and are dependent on achieving uninterrupted passage (contiguous flow) through the right sized culverts. The right-sizing program will facilitate this passage.

Figure 14: Program-Indicative Culvert Before (top) and After (bottom) over Roaring Brook

Credit: The Nature Conservancy

Figure 15: Program-Indicative Culvert Before (top) and After (bottom) over Bronson Brook

Credit: American Rivers

Natural Floodplain Restoration

Stream bank stabilization and the achievement of more natural, stable stream velocities will result in less erosion and improved water quality. These improvements have value to fish and wildlife and riverine habitat conditions and are also highly valued for recreational purposes by New York State residents.

Figure 16: Program-Indicative Natural Floodplain Restoration in Schoharie County

Credit: NYSDEC

Figure 17: Program-Indicative Removal of Backus Berm Before (top) and After (bottom)

Credit: Upper Susquehanna Coalition

Right-Sizing Bridges Resiliency Program

Since 2011, approximately 500 bridges in New York State (the State) have been damaged, destroyed, or temporarily closed due to flooding by extreme events including Superstorm Sandy, Hurricane Irene, and Tropical Storm Lee. Research shows that extreme precipitation will increase in magnitude and frequency throughout this century. The State, with its partner, the New York State Department of Transportation (NYSDOT), proposes to right-size hydraulically-vulnerable and flood prone bridges in targeted counties that meet broader considerations including impacts on LMI and LEP populations, housing, businesses, and environmental conditions. Once a bridge candidate is vetted and selected, its design will consider future stream flows assuring benefits from greater flooding resiliency late into the century. Under this program, the candidate bridges for improvements will be determined through outreach to local resident engineers knowledgeable about the flooding history of each bridge. A detailed engineering analysis of each structure will be required. Environmental and project processes will drive extensive outreach to affected local communities, elected officials, community officials, businesses, and residents including LMI and LEP populations.

Figure 18: Program-Indicative Bridge over Schoharie Creek

Credit: NYSDOT

Figure 19: Program-Indicative Bridge over Cayuta Creek

Credit: NYSDOT

Figure 20: Program-Indicative Bridge over Ellis Creek

Credit: NYSDOT

Right-Sizing Critical Dams Resiliency Project (Seven Sites)

Dam failures result in sudden violent destruction to not only the area near the dam but to areas much farther downstream. The State has identified seven dams located in Harriman State Park and Minnewaska State Park Preserve that are defined as “high hazard” meaning that a dam failure may result in significant or widespread damage to homes, road networks, critical infrastructure or environmental features, with the loss of life and loss of significant economic loss also likely. Upgrading the identified critical dams will benefit all populations downstream in the risk reduction of potentially catastrophic flooding, loss of life, property and livelihood. In addition, loss of these dams would seriously impair transportation infrastructure causing an exacerbated emergency management situation putting life and property in jeopardy and negatively impacting commerce along the Interstate 87 corridor and freight rail service. Such a failure would also remove from service frequently and heavily used environmental and recreational resources utilized by people of all income ranges including low to moderate income who visit these state parks to swim and recreate in the facilities that these dams support. Right sizing through the select dam interventions will dramatically improve risk conditions for New York State vulnerable residents located in key watersheds throughout the State.

Figure 21: Overview Map of Dams in Harriman State Park

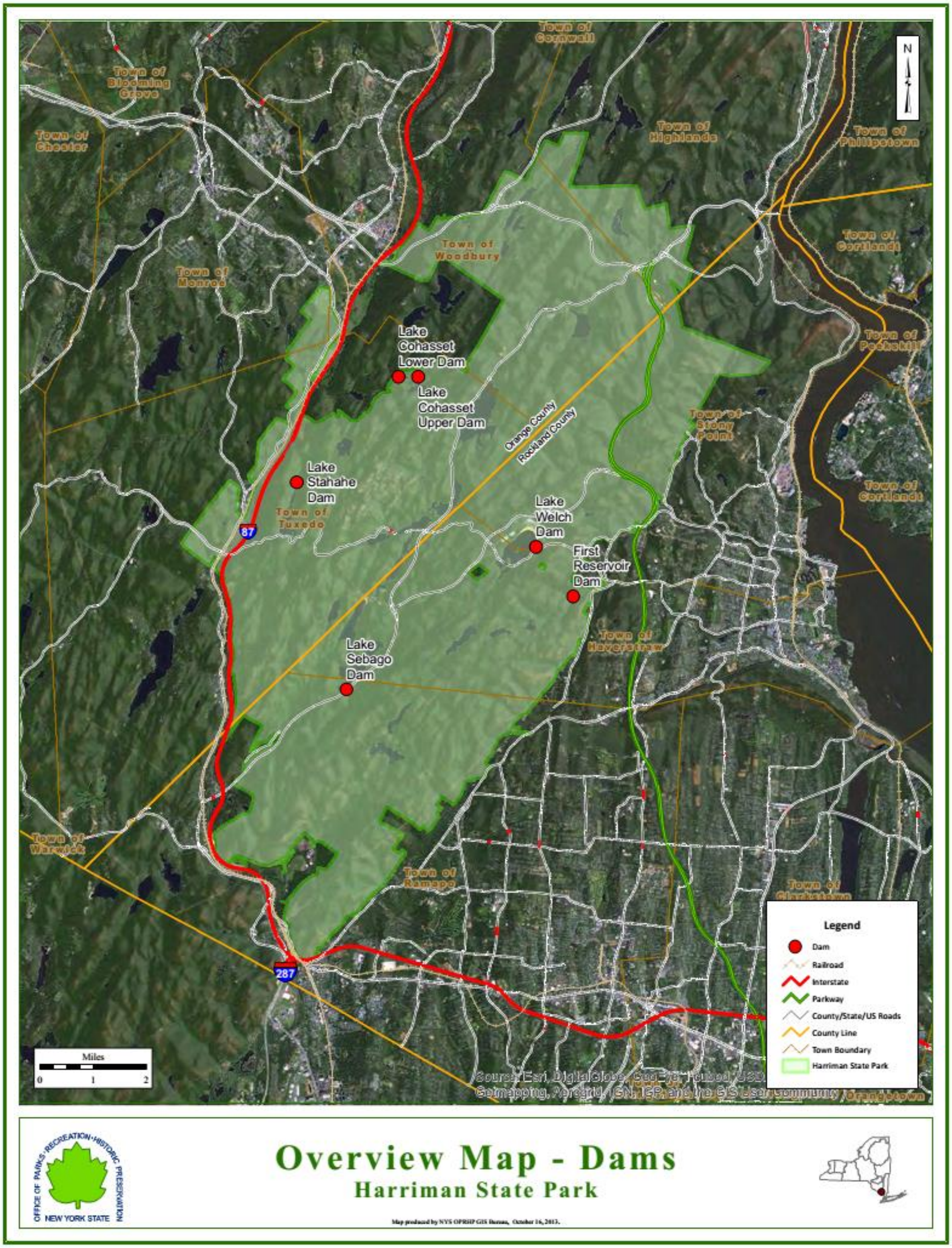


Figure 22: Dam Locations in Harriman State Park

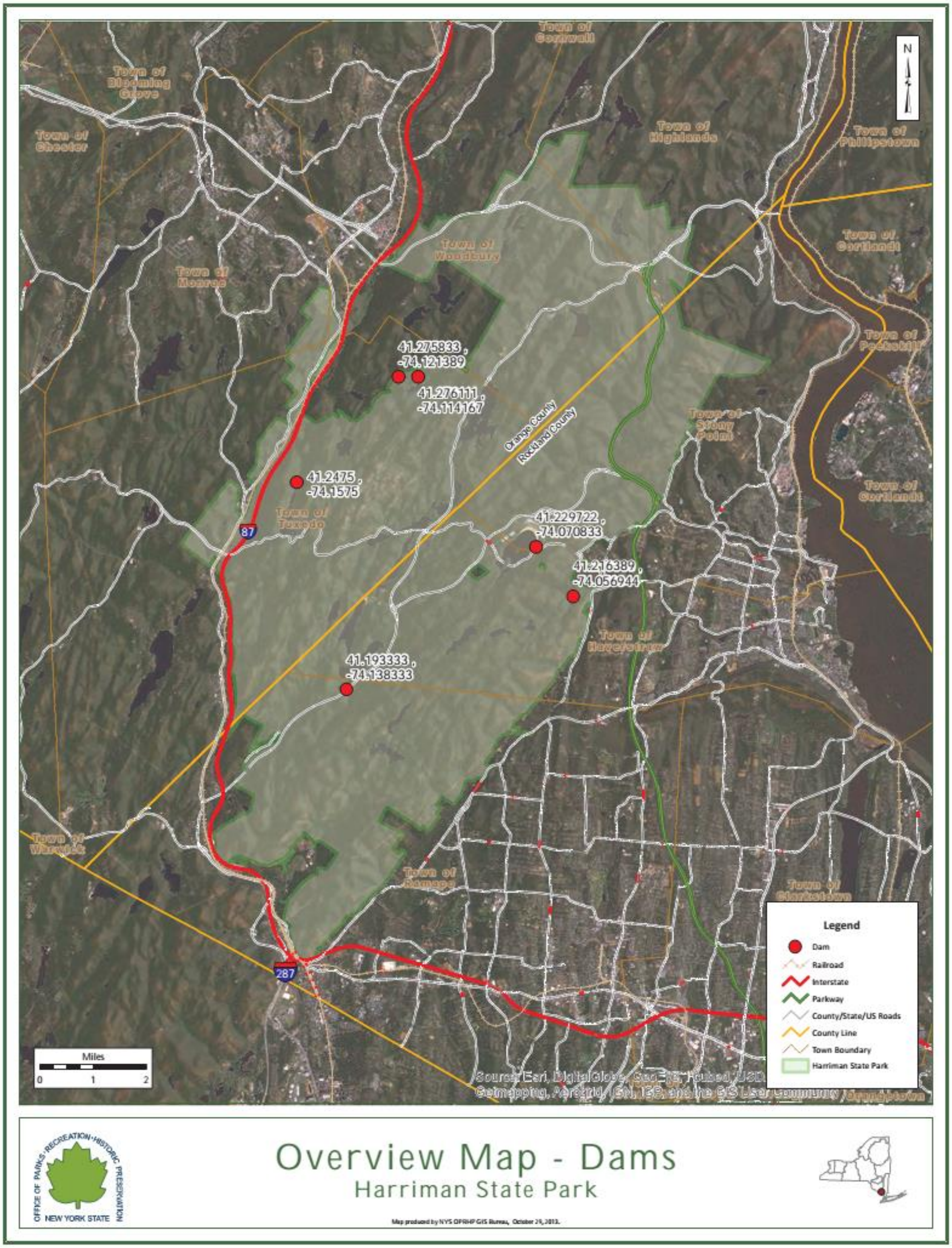


Figure 23: Tillson Lake Dam in Minnewaska State Park

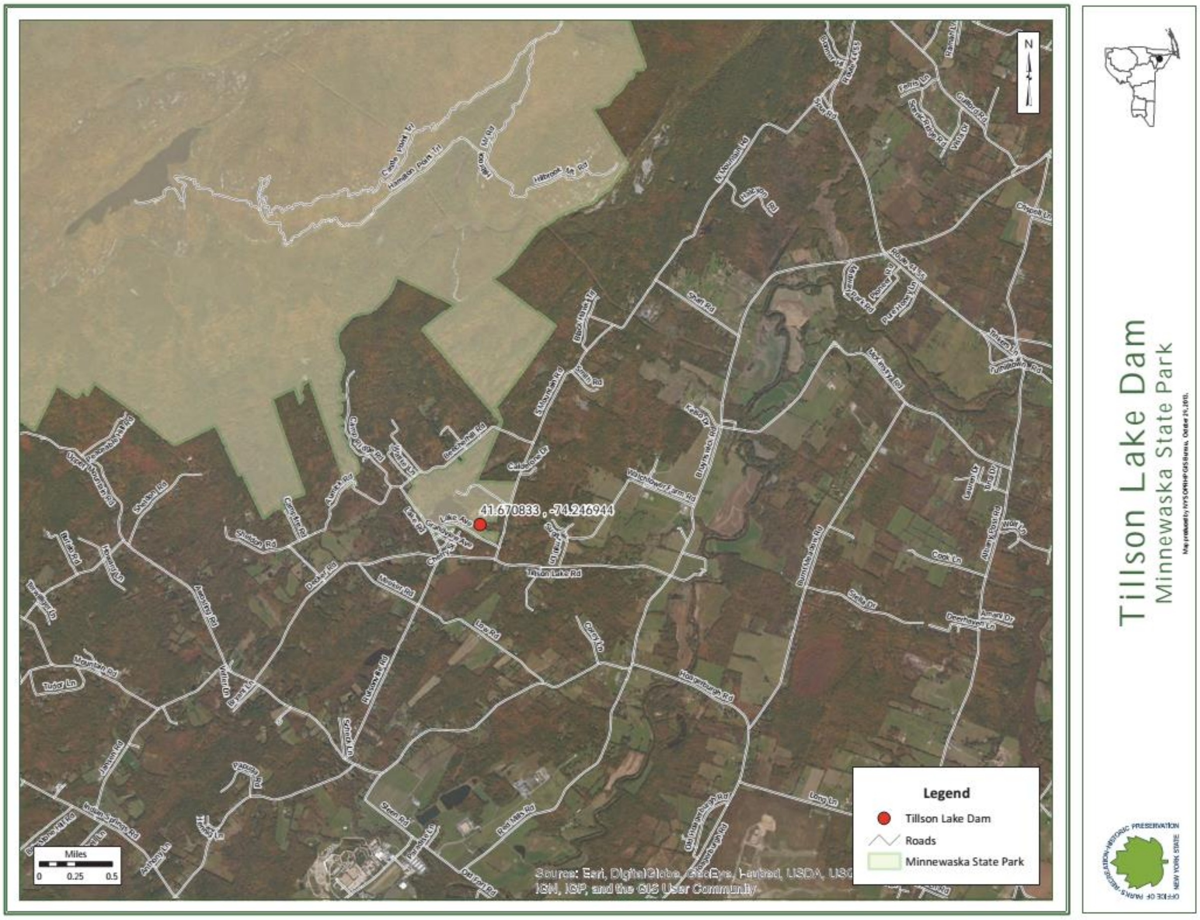


Figure 24: Lake Sebago Dam Site Map

Figure 25: Upper and Lower Lake Cohasset Dams Site Map

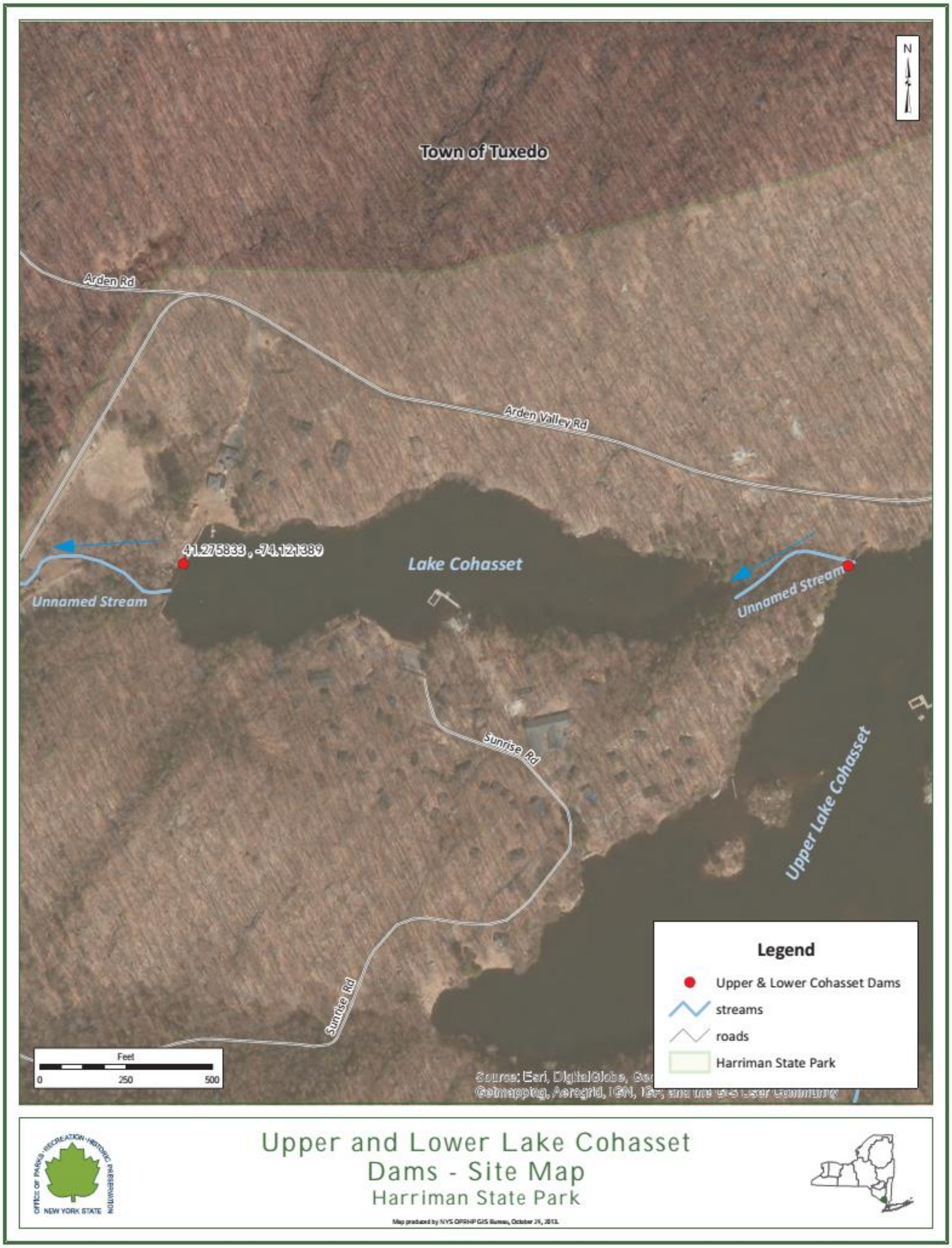


Figure 26: Lake Stahahe Dam Site Map

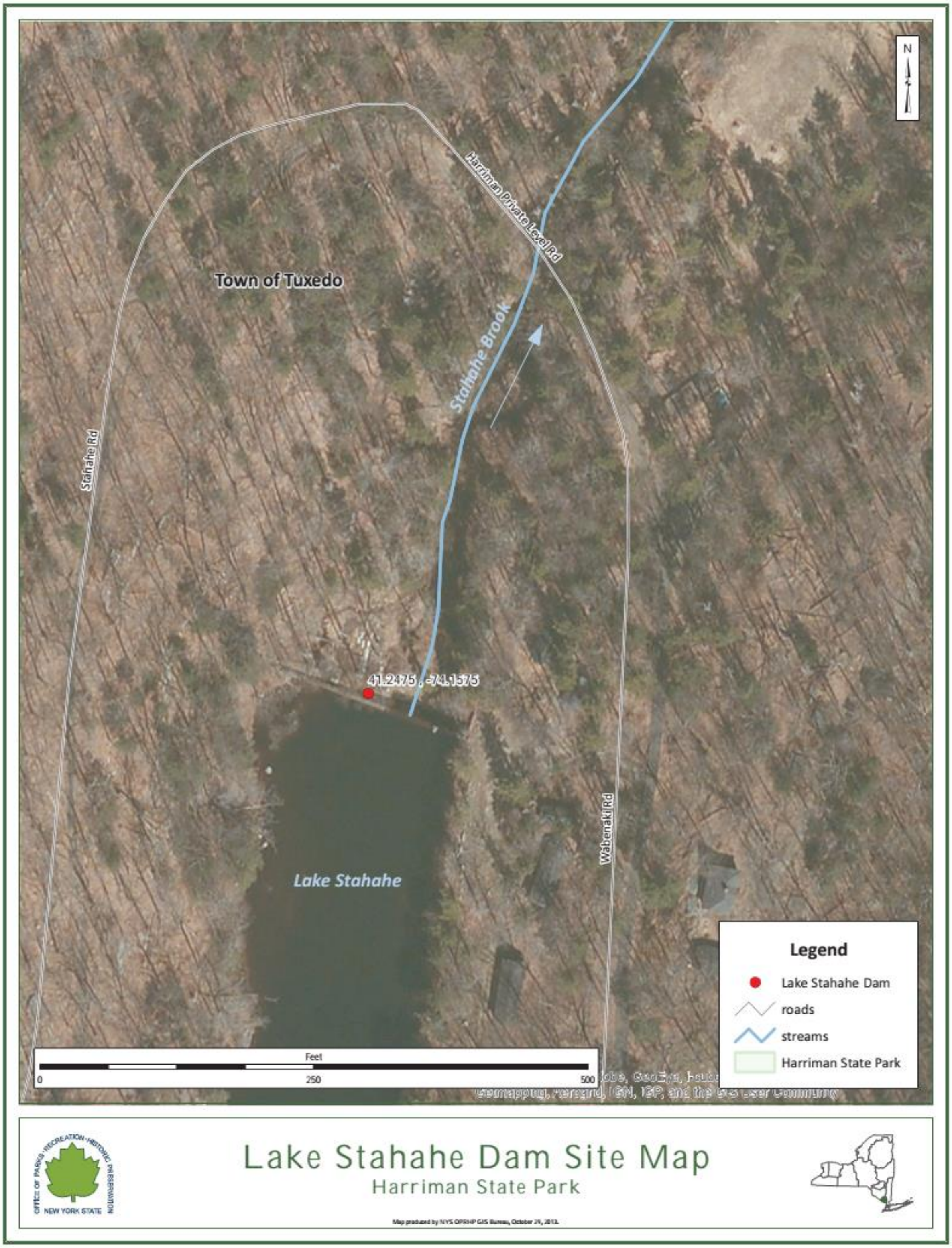


Figure 27: Lake Welch Dam Site Map

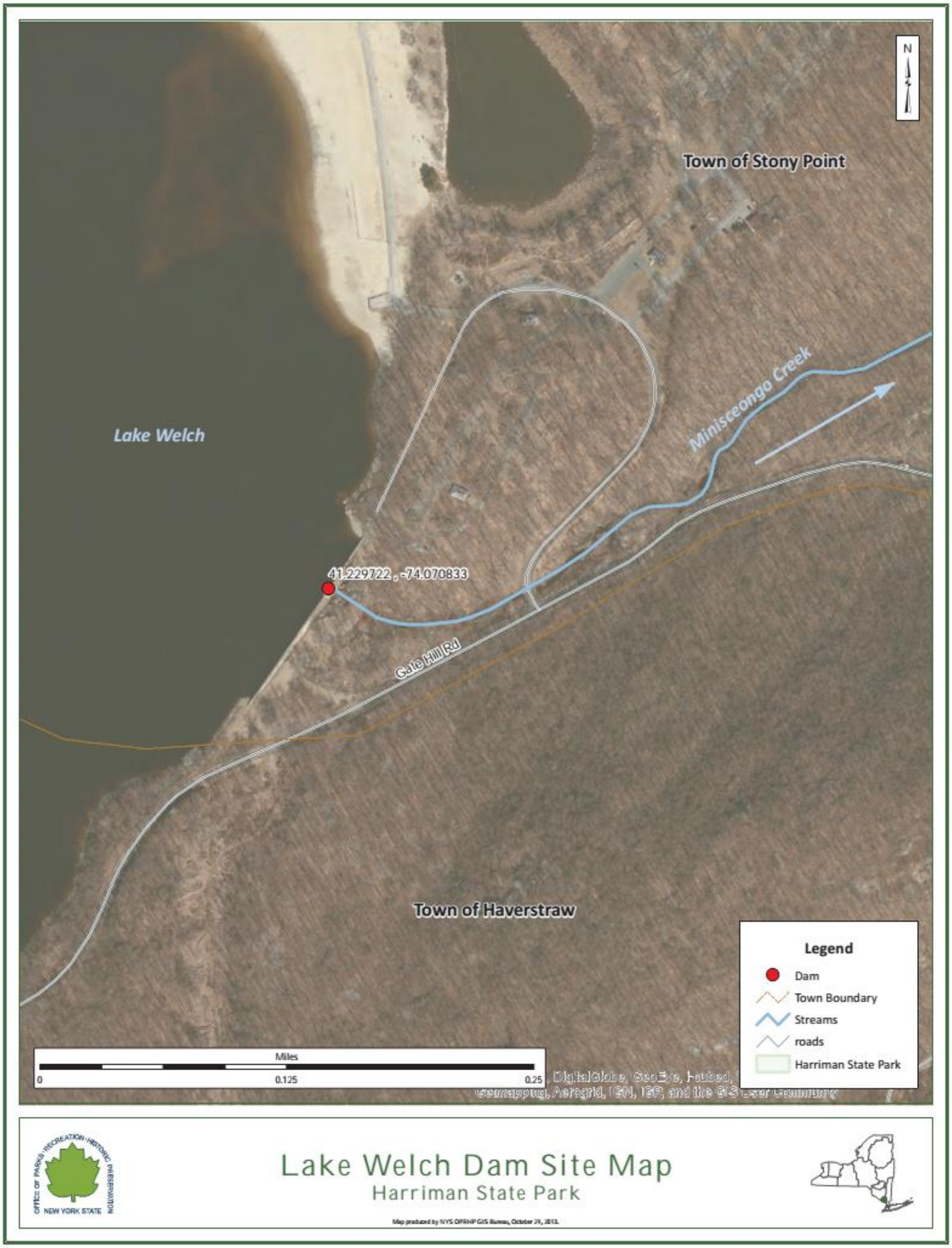


Figure 28: First Reservoir Dam Site Map

Figure 29: Tillson Lake Dam Site Map

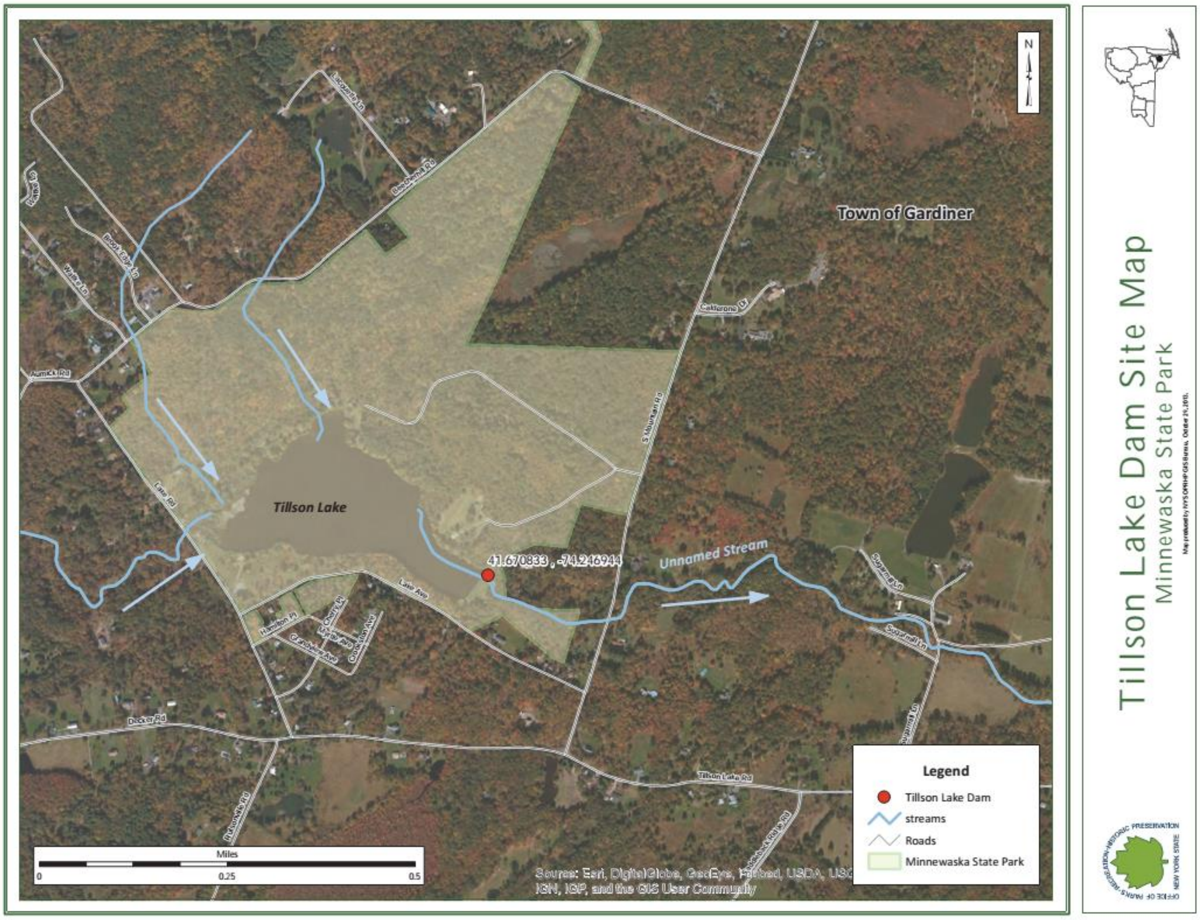


Figure 30: Lake Cohasset Dam

Figure 31: Lake Stahahe Dam

Figure 32: Lake Welch Dam

Figure 33: Lake Sebago Dam

Figure 34: Lake Sebago Dam Inundation Area

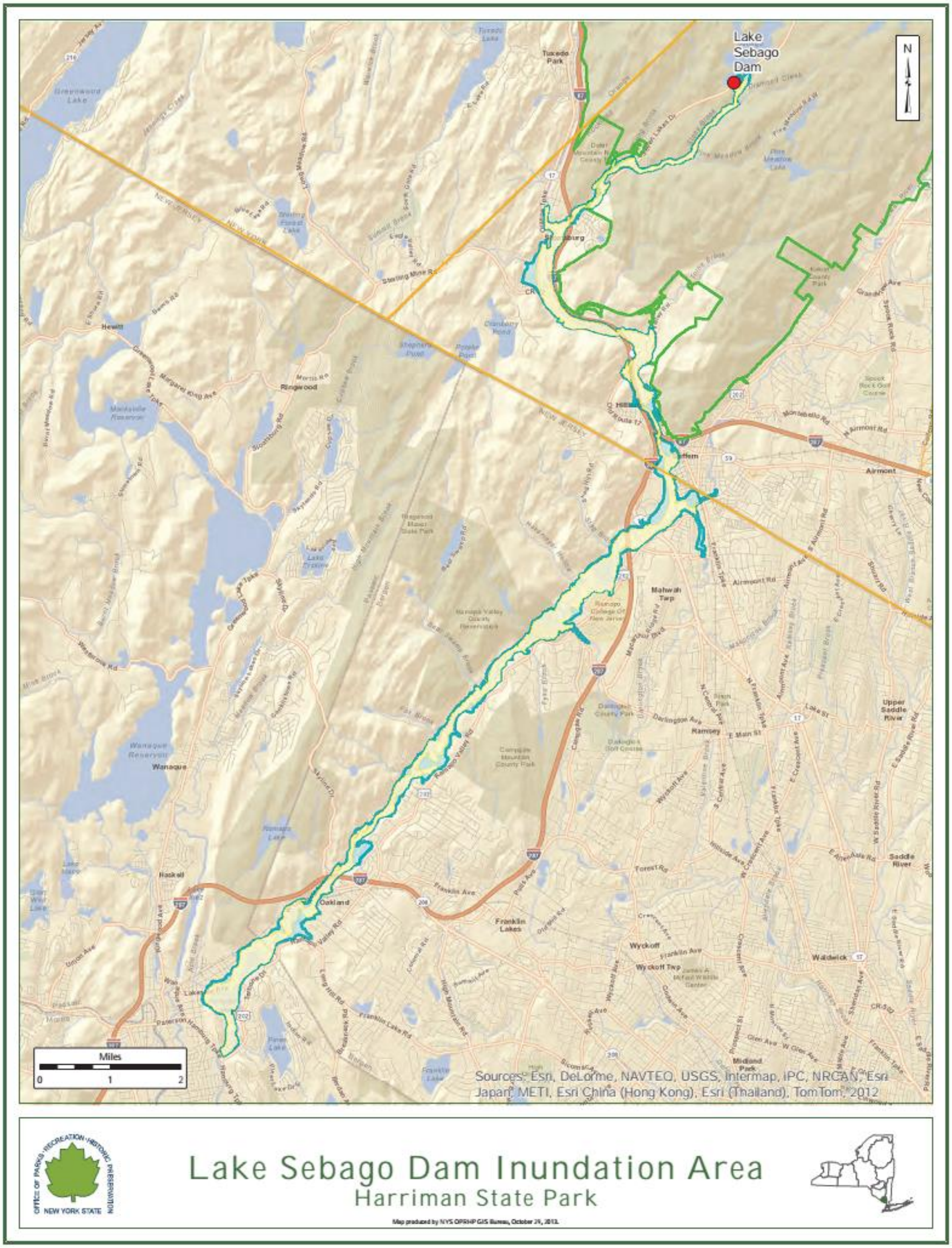


Figure 35: Lake Stahahe, Upper and Lower Cohasset Dams Inundation Areas

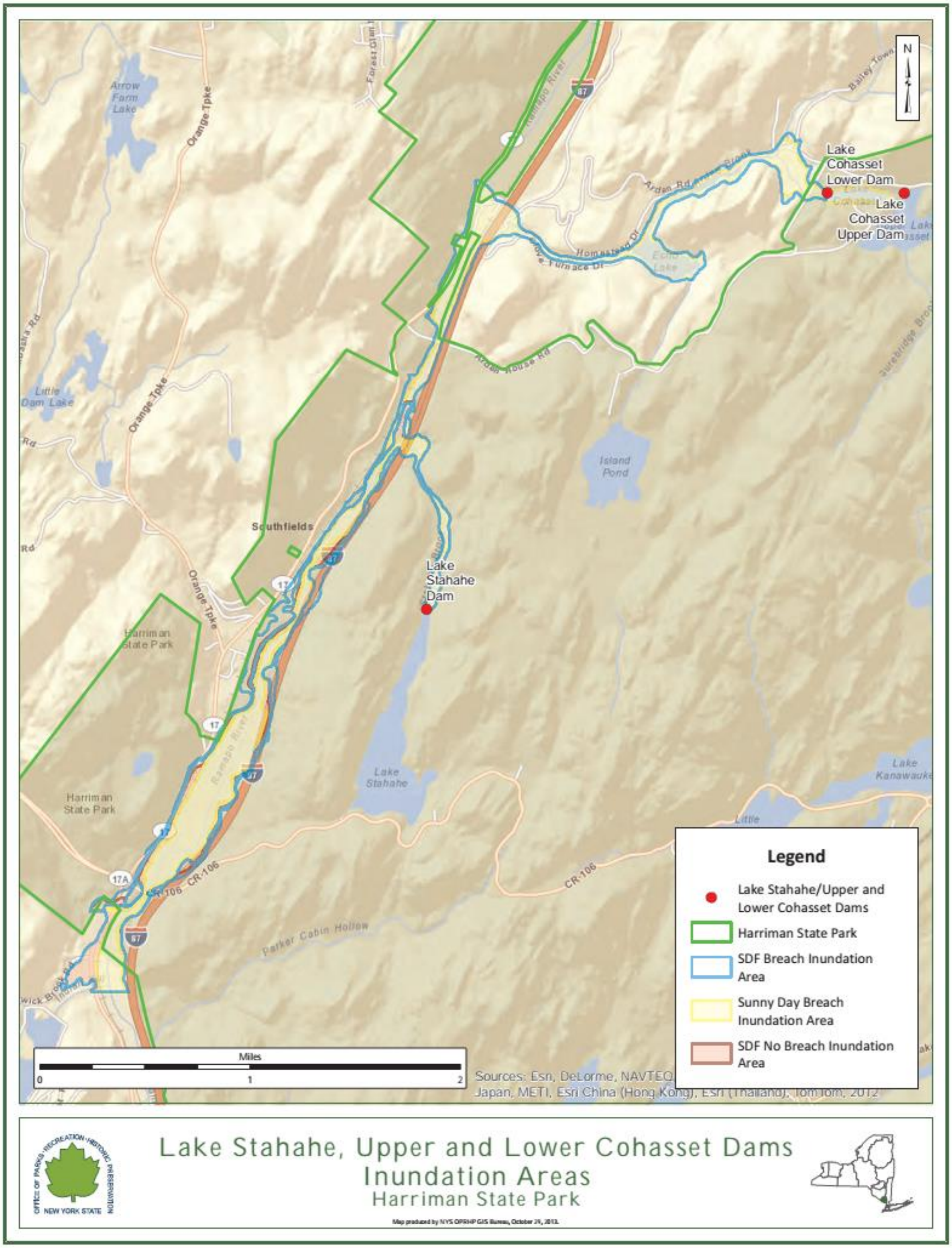
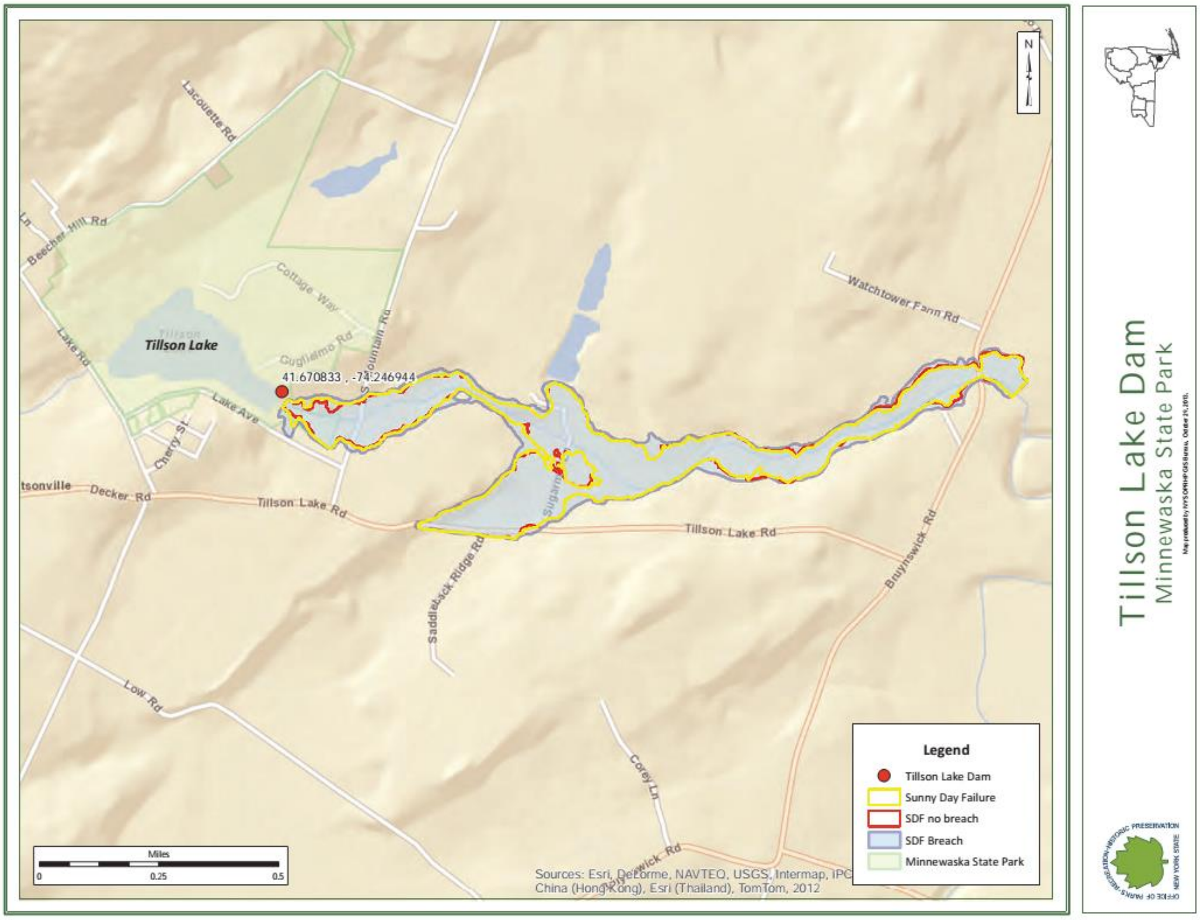


Figure 36: Lake Welch Dam Inundation Area

Figure 37: First Reservoir Dam Inundation Area

Figure 38: Tillson Lake Dam Inundation Area



Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

The Bay Park Sewage Treatment Plant (STP) is designed to treat up to 70 million gallons per day (mgd) and serves approximately 43 percent of the population of Nassau County (over 500,000 people). It presently provides a "secondary" level of treatment consistent with national technology standards, and it discharges treated effluent to a water body known as Reynolds Channel, part of the larger estuarine complex called the "Western Bays." High levels of nitrogen significantly "impair" the Western Bays, meaning that the level of nitrogen violates state and federal water quality standards. Studies by the U.S. Environmental Protection Agency (USEPA) consultants indicate that 80 to 90 percent of the nitrogen loading to the nitrogen-impaired portion of the Western Bays is from the Bay Park facility, as well as the smaller but still significant discharges from the City of Long Beach (7.5 mgd) and Greater Atlantic Beach (1.5 mgd) wastewater treatment plants.

The nitrogen levels, as well as other pollutants from the sewage treatment plants, have a destabilizing effect on the Western Bays. The ecosystem that supports the natural coastal barrier system is unbalanced causing erosion, loss of salt marshes and shell fishing industry. The South Shore of Nassau County is a Special Flood Hazard Area (SFHA), land identified by the United States Federal Emergency Management Agency (FEMA) as an area with a special flood or mudflow, and/or flood related erosion hazards. This low-lying part of Nassau County is also densely populated which leads to increase loss and damage to structures and property. Salt marshes protect against the impediment of flood waters and storm damage serving an essential benefit to these vulnerable populations.

The damage caused by flooding and storms exacerbates an existing affordable housing crisis in Nassau County: 56% of renters pay more than 30% of their income for housing; 64% of Long Island renters cannot afford a typical two-bedroom apartment; and 55% of 20-to-34 year-olds live with their parents or other older relatives. When an extreme weather event forces residents out of their home, the scant available apartments are consumed. Likewise, the damage or destruction of that home removes a housing unit from the market. These scenarios reduce supply in the market and increase demand. This, in effect, inflates housing costs.

The proposed project stands to dramatically improve water quality, promoting processes the support natural protections afforded by the salt marshes to reduce the impact on the housing market. The same processes create an environment that can lead to the return of Nassau's shell fish population and industry, as well as support growth in the tourism industry. A return of good paying jobs to the area will help alleviate the burden on residents struggling to afford rising rents. The American Planning Association put out a policy guide that states:

Many of the poor cannot enter into housing markets due to a lack of a stable income at a level that permits entry into the market without adopting a high financial burden. More and better jobs are needed along with improved access to jobs by the chronically unemployed and under-employed. Improved incomes can resolve many housing problems.

The Great South Bay in the 1970's, as a comparison, ran a $62 million-per-year industry that employed thousands. Enabling the Western Bays to be populated with shell fish through the reduction of nitrogen pollutants that fuel excessive Ulva growth. As the Ulva populations die off the clarity of water and increase in oxygen will create a nurturing habitat for eelgrass. The eelgrass act as nurseries for shellfish. The outfall should also reduce the elevated coliform

bacteria, a rod-shaped bacterium found in the intestinal tract of humans and other animals. Its presence in water indicates fecal contamination.

Through the outfall, pollutant levels in the Western Bays will be reduced. The coastal ecosystem will become suitable to support shellfish and saltmarshes that will attract industry and protect against storm surge, respectively. These benefits have a strong impact on the affordable housing issues faced by Nassau County.

Risk to the community includes loss of life and property damage from sea water storm surge and flooding. Associated risks that come with flooding include fires and health risk due to contaminated waters. The loss of power and potable water add to public health risk. Furthermore, the Magothy Aquifer has seen a 93 percent increase in nitrogen levels to 1.76 mg/l since 1987.

Another risk to the community is degradation of ecosystems in the Bays. Poor water quality has severely degraded the ecosystems of the Great South Bay. For example, New York Bay scallop landings routinely exceeded 200,000 pounds per year in this water body in the 1970s and 1980s; they are now nearly nonexistent. Hard clam landings in the Great South Bay once exceeded 500,000 bushels per year in the 1970s (a $62 million-per-year industry employing thousands). The hard clam take is now essentially zero. Pollution and nutrients have forced the closure of 15,575 acres of shellfish beds; however, a similar industry could arise in the Western Bays as a result of the proposed project which would reduce pollutants and revive the degrading ecosystems.

The loss of critical eel grass habitat has occurred on a similar scale. Historic photography and records indicate that there may have been 200,000 acres in 1930; today, only 21,803 acres remain. Both the Chesapeake and Tampa Bay estuary programs have seen increases in various

eel grass species, following their efforts to reduce nitrogen loadings, address human impacts, and implement restoration efforts. The Western Bays, a sub-region of the South Shore Estuary Reserve (SSER) that includes Hempstead Bay and South Oyster Bay, are located along Nassau County's south shore. This critical ecosystem is experiencing degrading water quality, excessive seaweed growth, and decreased shellfish harvesting. High levels of ammonia, nitrate, and ulva (seaweed), are concentrated around the outfall pipe of the Bay Park STP. The average contamination levels of nitrates in the summer have been increasing throughout the Western Bays since 2000. Winter Flounder populations are decimated, and 8,600 acres of the shellfish beds are closed to harvesting In the Western Bays.

Nowhere in New York State is densely populated low-elevation communities more protected from wave energy and coastal erosion by salt marsh islands than along the south shore bays of Nassau County. A 2012 study by Sheng et al. found that "a sufficiently wide and tall vegetation canopy reduces inundation on land by 5 to 40 percent", depending upon the type of storm. The marsh lands are a natural barrier that guards bay communities from the immediate impact of extreme weather events and from further encroachment to inland areas. Only 4% of all rental units are available to be rented, and 58% of Long Islanders have difficulty paying their rent or mortgage. Any housing units affected by storm damage puts a further stress on Nassau County's housing stock by increasing demand and reducing supply which further inflates housing costs. By implementing the proposed project, not only will the Western Bay's water quality and ecosystems be improved, storm surge, flood risk, and negative impacts to the County's housing market from storm related damage will be greatly reduced.

Another risk includes a negative economic impact due to beach closures. Beaches are vital assets in Long Island's over $4 billion tourism industry, and it is for that reason that when

they are closed due to rain or inclement weather, elevated levels of bacteria, unknown sources or contamination, storm water runoff, or from sewage leaks or spills, it is a concern to all Long Islanders. Beach closures and the reasons they close not only have short-term adverse economic impacts, but if the beaches are not opened quickly, and the causes of the closures not remedied, closures can have a long-term impact on the public image of Long Island as a tourism paradise.

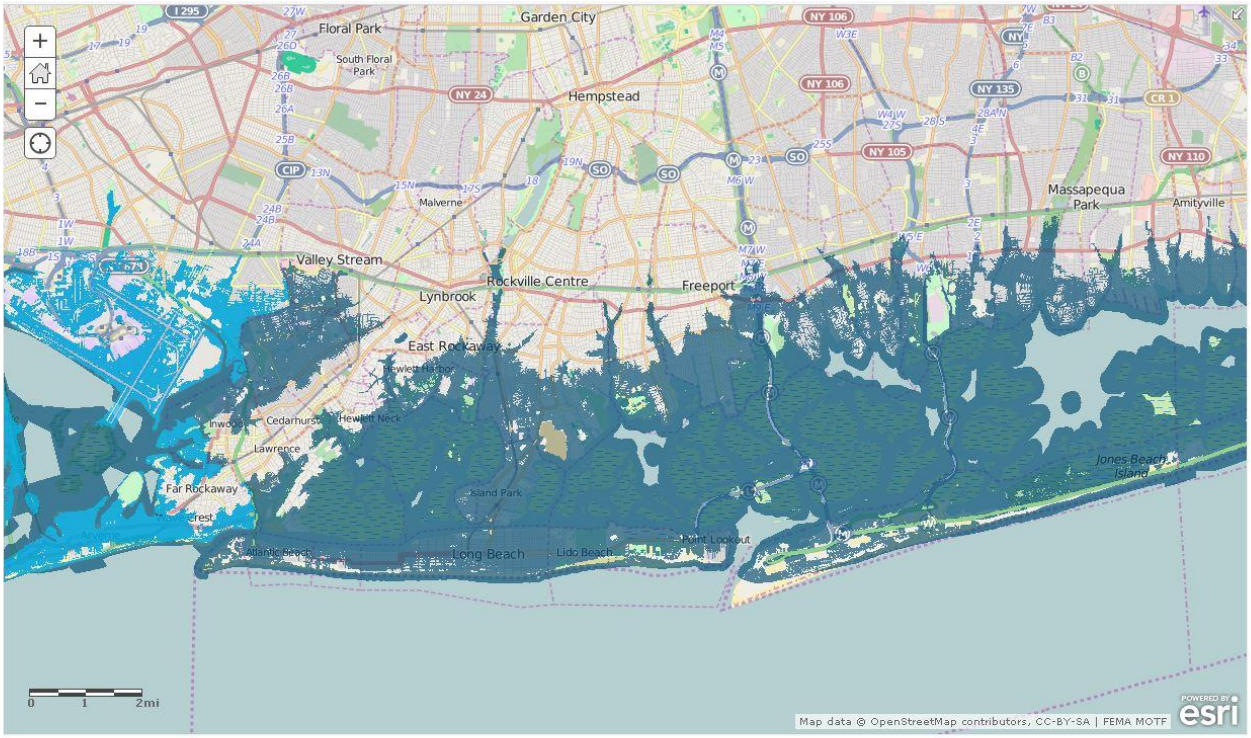
Excess nitrogen contributes to two notable problems in these waters: the proliferation of macro-algae (specifically Ulva, or “sea lettuce”) and extensive damage to the marsh grasses and their sub-structures that, in turn, are integral to maintaining natural shoreline protection against coastal storm surge and waves resulting in significant flood waters to the surrounding community.

Superstorm Sandy Impacts

Tidal surges caused by Hurricane Sandy, resulted in flooding of the Bay Park STP, and damage to this critical infrastructure impacted the 550,000 residents served by that facility. The Bay Park STP relies on tidal pumps to pump effluent from the facility during incoming and high tides to prevent backflow. During Hurricane Sandy, the tidal pumps failure and storm surge resulted in a maximum of 3 feet of flooding throughout 75% of the Bay Park STP, causing the Bay Park STP to fail. Operations were offline for about 56 hours, resulting in 100 million gallons of untreated sewage overflowing within the Bay Park STP and surrounding streets, neighborhoods, and 2.2 million gallons of partially treated effluent being released into Hewlett Bay. Replacement and extension of the outfall pipe and the addition of a diffuser would increase resiliency to current and future threats and hazards by eliminating the Bay Park STP’s dependence on tide pumps and allow future storm surge to pass over the outfall.

The outfall would aid in the restoration of marshland and eroded coast lines that were damaged by Hurricane Sandy. The restored wetlands would reduce the effects of future tidal surges. According to the FEMA Hurricane Sandy Impact Analysis, there are 7 electric facilities, 29 chemical facilities, and 32 schools exposed to surge from Hurricane Sandy.

Figure 39: Sandy Storm Surge Extent-FEMA MOTF



On Long Island, Hurricane Sandy killed more than a dozen people and destroyed or rendered uninhabitable over 2,000 homes. In total, 113,901 residents applied for disaster relief.

Nearly 65% of all structures and 70% of homes destroyed on Long Island were located in Nassau County. A total of 35,725 of the County's residents were displaced and requested FEMA housing assistance, with over 1,400 homes destroyed or deemed uninhabitable. A total of 74,736 structures were flooded or destroyed, 17,405 of which only experienced storm water inundation. An additional 34,602 personal automobiles were damaged or wiped out.

Nassau County's 18,426 storm-impacted low and moderate income (LMI) households was the highest count among counties struck by Hurricane Sandy. Freeport, East Rockaway, and Baldwin are listed among the communities with the largest number of LMI households with major to severe damage. These communities are protected by the Western Bays. As noted elsewhere, the Public Housing Authorities (PHA) of Long Island were significantly impacted by the storm.

The beneficiaries of the proposed project would be the 550,000 Nassau County residents, approximately 40 percent of the County's population, and the business owners (86,800,800 square feet of commercial development) that are located within the Bay Park STP's 70 square mile service area and the whole county (1.3 million residents as per the HUD LMI Summary Data). In the direct area, there are over 90 Census Tracts with LMI persons making up 35.9 percent of the population. Although, the total percentage of LMI persons is below the 50 percent threshold requirement to meet the National Objective of LMI, a total of 197,450 LMI persons are located within the direct area. In the whole county, 388,680 residents are LMI.

Given the high cost of living in much of New York, incomes of low income renters are higher than in most other areas of the country. The State believes the actual gap for landlords' ability to repair and mitigate damaged rental stock exceeds $314 million. For example, in Nassau County, where the cost of living is particularly high, an individual can earn $61,000 and be "low income" as defined by HUD. Long Island's housing affordability crisis stems, in part, from the lack of new development in the past decade. There is little immediately developable land due to region's history of low-density development and present-day zoning regulations that prevent the construction of houses on small lots, townhouses, or small apartment buildings, even in

downtowns.[5] Long Island's 4.3% rental vacancy rate means that there are fewer available rental homes than in any other suburban area in the New York region.

The Bay Park STP in East Rockaway, which normally treats 40% of Nassau County's wastewater, sustained major damages during Hurricane Sandy. Due to Sandy, the Bay Park STP failed to operate at full capacity until mid-December of 2012. The plant released millions of gallons of raw and partially treated sewage into nearby waterways and neighborhoods. Residents complained of wastewater spilling out of their toilets and flooding their homes.

As of early 2013, the total nitrogen (TN) deposition (wet and dry) in water and marshes of the Western Bay was 7.3 tons per year. The Long Beach Water Pollution Control Plant (WPCP), Greater Atlantic Beach Water Reclamation District (WRD), and Bay Park STP discharge a total nitrogen load into Reynolds Channel of 2,415 tons per year. The impaired waters in the Western Bays are closed to shell fishing and are eutrophic as a result of excess nitrogen and limited flushing into the ocean.

The eutrophication is evidenced by an excessive growth of Ulva that brings habitat impingement, transient hypoxia, recreation limitations, odors, disposal costs, and is toxic to fish larvae. The 10-year TN concentrations exceed 0.45 mg/L at 11 of 15 sampling stations in the bay. Sediments are enriched in organic carbon and harmful algal blooms of Heterosigma akashiwo and Peridinium spp. are present.

In addition, Quaternary Ammonium Compounds (QACs) and Diethylhexyl Phthalate (DEHP) have both been measured in declining volumes as distance from the Reynolds Channel Outfall increases. QACs are a unique sewage-source specific tracer that is stable, binds strongly

[5] http://library.rpa.org/pdf/RPA-Long-Islands-Rental-Housing-Crisis.pdf

to sediments, and is found at higher levels than other organic contaminants in sewage affected areas. The relationship between DEHP and QAC sewage tracers is a strong indication that sewage is the dominant source of DEHP to Hempstead Bay. These measurements illustrate the source of pollution in the Western Bays.

The "back-bay" water of southern Nassau County is characterized by extensive networks of marshlands that serve as a natural defense against coastal storm surge. Peer-reviewed scientific studies cited in a prior NYS Department of Environmental Conservation (DEC) technical report show that excess nitrogen discharges damage and degrade coastal marshlands. The loss of coastal marshlands has resulted and will continue to result in significant increases in erosion and shoreline damage during even moderate storm events, placing the densely populated, low-lying, communities of southern Nassau County at risk. Reducing nitrogen pollution will serve as an effective mitigation measure, with the unique benefit of increasing in effectiveness over time as nitrogen-damaged marshlands are naturally restored.

Table 21: Resiliency Actions post-Sandy

US Fish and Wildlife Service	The U.S. Fish and Wildlife Service (Service) has received almost $15 million in Hurricane Sandy recovery appropriations for coastal cleanup and marsh restoration	$ 15,000,000
US Fish and Wildlife Service	Restore natural functions in damaged and degraded coastal salt marshes on Long Island through an integrated approach that addresses tidal hydrology, surface water habitat, invasive species, living shoreline stabilization and sea level rise. Restoration of natural hydrology will increase resilience and decrease long-term vulnerability and risk from storm events	$ 11,093,000
FEMA	Bay Park 428	$ 378,874,678

Program Description

Over 700,000 New Yorkers in 1,480 communities live in designated flood-prone areas. Millions more work in, travel through, or enjoy recreation in areas at risk of riverine and coastal flooding or storm surge inundation. New York State's (the State) Phase 1 application to the National Disaster Resiliency Competition (NDRC) outlined a systems-based approach to increasing resilience in the State's Most Impacted and Distressed (MID) target areas with Unmet Recovery Need (URN). In this Phase 2 application, the State is proposing concrete steps to protect New Yorkers. These measures align with a systems-based framework of improving resiliency through actions that promote ecological and social well-being.

The State seeks funding to implement two sets of resilience-enhancing disaster recovery programs. The first group includes actions proposed creates protections for highly vulnerable low-income communities: the Manufactured Home Community Resiliency Pilot Program and the Public Housing Resiliency Pilot Project. The second set of measures modernize and right-size infrastructure to meet current and future demands in riverine and coastal areas, while protecting and improving ecosystem health. Both sets of activities reflect insights from the State's ongoing recovery efforts, targeting system weaknesses and pockets of vulnerability that require additional investment to address unmet needs.

Manufactured Home Community Resiliency Pilot Program

The State proposes the Manufactured Home Community Resiliency Pilot Program (the Program) to substantially increase the social, physical, and economic resilience of vulnerable MHCs in all MID counties with housing URN. This Program will meet the LMI National Objective and is a two-step response to effectively address this URN as well as the distinctive needs of MHCs. The State will select up to four pilot communities to engage in this two-step process, employing a selection criteria that considers the following factors: (1) location within a MID county; (2) location within a 100-year or 500-year floodplain; (3) amount of damage as a result of a Qualifying Storm(s); (4) number of LMI residents; and, (5) proximity to additional storm recovery investments. All threshold criteria will be met through this process (see Exhibit B). Once a list of eligible communities is refined, GOSR will launch the planning process.

Step 1: Community-Based Planning Process

The first step of the Program is a community-based planning process, modeled after GOSR's NY Rising Community Reconstruction (NYRCR) Program. This process will engage residents of MHCs, along with other relevant stakeholders like county and municipal officials, non-profit partners, and MHC park owners in a community-driven resiliency planning and decision-making process. This step is centered on empowering MHC residents, most of whom are LMI individuals. Through participatory planning, the Program will facilitate the exploration of solutions to mitigate the current and future risks of MHCs in the floodplain.

GOSR and its partners will guide communities through the development of community-specific plans. This includes facilitating the convening of community meetings with multiple stakeholders, conducting appropriate research, assisting with public outreach events, and undertaking rigorous analytical work, including the development of a community asset

inventory, risk assessment, needs and opportunities assessment, and benefit-cost analysis. At the conclusion, communities will have explored possible solutions in addressing current and future risk, and arrived at resilient CDBG-DR eligible project plans with multiple options, tailored to the specific needs of the community.

<u>Step 2: Project Implementation</u>

The planning process will drive the development of the best resiliency solution(s) for each participating community. Two likely categories of intervention are the buyout and relocation of an MHC outside of the floodplain, and the upgrading of an MHC through on-site resiliency improvements (green infrastructure, protective measures) and elevation of homes, to the extent safe and feasible. In this document, the State has conducted a benefit-cost analysis of these likely interventions to demonstrate that both are cost-effective. If other solutions emerge in the planning process, the State will perform a benefit-cost analysis on those interventions.

To guide final project selection, additional criteria will be developed to ensure that projects are designed to meet the requirements set forth in the NOFA, including: (1) credible evidence that the project will decrease risk to vulnerable populations; (2) clearly incorporating resiliency; (3) feasible with regard to permitting requirements and pre-development work including design and engineering; and (4) has a reasonable implementation period. All selected projects will align with federal and State guidelines and comply with HUD's CDBG-NDR funding program, including Covered Project requirements, if applicable.

The State will implement proposed solutions directly and/or through subrecipients. As detailed in the Capacity section of this application, GOSR has extensive experience in the implementation of infrastructure and housing resiliency activities both directly and through subrecipients. The State has also identified three partners that will provide leverage financing

and technical assistance: the Leviticus Alternative Fund, the Manufactured Home Cooperative Fund Program (MHCFP), and the Community Preservation Corporation (CPC).

Benefit to Vulnerable Populations and Section 3 Opportunities

The State's Program will directly engage and involve residents of MHCs in developing more socially and physically resilient communities. Typically MHCs are comprised of low- and moderate- income households (Source). In 2011, the median annual household income for Americans living in manufactured housing was $26,000, compared to a national median of $50,054 (Source). Further, about 77 percent of manufactured home households earn less than $50,000 (Source). Additional socio-economic vulnerabilities identified in the literature and through stakeholder conversations also include higher proportions of elderly and disabled residents (Source) and persons with limited English proficiency. Once specific sites are selected, the State will also explore opportunities to involve Section 3 residents and businesses in project implementation through GOSR's existing Section 3 programs.

Measuring Success

In order for the Program to be effective, metrics must be defined and measured throughout the duration of the program. The State's Phase 1 application describes a systematic approach to reducing the impacts of coastal, riverine, and storm water flooding exacerbated by climate change. The metrics below identify how the State can holistically measure success throughout the lifespan of the Program.

Resiliency Value:

- Number of MHC households protect on-site or relocated out of the floodplain.

Social Value:

- Increased percentage of resident-owned MHCs or resident-owned lots in MID project target area;
- Increased number of tenant associations developed in MID project target areas;
- Number of preserved or enhanced community cohesion in protected or relocated MHCs

Environmental Value:

- Increased number of EnergyStar manufactured homes in MID project target area

Economic Value:

- Decreased $ of spending by local municipalities in evacuating MHCs in MID project target area;
- Amount of tax-base preserved through protection of MHCs or relocation within community.

Alternatives Considered

The State evaluated multiple options of how to reimagine resilience in MHCs.

Alternative 1: The "no action" alternative would result in repeated damage to MHCs during storm surge events. LMI families and individuals will lose important assets. A significant amount of affordable housing stock would disappear, resulting in the displacement of residents, many of whom are LMI. Additional local, State, and federal resources will be spent on emergency response.

Alternative 2: This alternative involves the State undertaking a single project within one manufactured home community. This requires honing in on the particular damage of one community without engaging the larger universe of vulnerable MHCs in forward thinking resilience measures. It would force municipalities to tackle the problem alone rather than

utilizing statewide expertise and leveraging best practices. While this option would allow for the recovery of one community, the State has identified the need for an equitable, multi-community solution with State-wide advocacy efforts to preserve this affordable housing stock. This approach also fails to reap the co-benefit of lessons learned across multiple sites.

Addressing Risks and Increasing Resilience

By focusing on MHCs in the floodplain that were impacted by a Qualified Storm(s), this Program directly responds to the State's URN in housing, as well as its identified coastal and riverine risks. In addition, the Program will have a significant impact on social resilience by empowering vulnerable manufactured home residents to transform their own communities. With the expertise of State's Partners, the Program will increase the physical resilience of MHCs through project design and implementation, providing innovative approaches to physical resiliency against flooding and related climate change impacts. Additionally, this Program will decrease the cost spent on municipal resources in the immediate response to flooding.

Model for Other Communities

Due to the increased susceptibility of these communities to natural disasters, specifically riverine, coastal, and stormwater flooding, this Program can serve as a model across the nation as multiple states face a decreasing stock of MHCs. Based on research the State has conducted, there is a need for best practices and innovative solutions for building resilience in MHCs nation-wide. The model of engagement, measurable outcomes, and innovative project designs will offer states and municipalities with a template to address their vulnerable MHCs.

Feasibility

The proposed Program is highly feasible as it builds off of the successful NYRCR model of keeping communities at the core of resilience and recovery efforts. Paired with this is the

State's expertise in successfully managing CDBG-DR projects focused on providing protection from current and future threats and hazards, including future risks associated with climate change. Underpinning this model is a broad network of community leaders, non-profits, and State agencies already committed to supporting and preserving MHCs.

The Program is budgeted to assist up to four MHCs with low-to moderate- income residents with URN. Contingent upon funding, the Program can be scaled accordingly. Further, given the funding allocated to the implementation phase, and the proposed projects identified through the planning process, the project interventions could be scoped appropriately. Since the Program's projects are not predetermined, the useful life of a project is not yet measurable. However, the State recognizes the importance of determining the useful life of a project and will ensure that this criterion is taken into consideration in future project level BCAs.

BCA Summary:

The State undertook an indicative benefit cost analysis for the implementation phase in order to assess the methodology and potential outcomes. The scenarios developed were found to be cost effective. (See Narrative Below). Both Scenario Option 1: Relocation and Buyout, and Scenario Option 2: Infrastructure Strengthening: Safely Elevating, had benefit cost ratios greater than 1, meaning that projected benefits exceeded total program mitigation costs by a significant margin, taking into consideration the long-term effects of sea level rise that would impact select MH communities located in vulnerable floodplains.

Table 22: Program Schedule - MHC

Task	Start	End
Step 1 – Community Planning Process		
a. Solidify Universe of MHCs Eligible for the Program	January 2016	February 2016
b. Develop Program Policies and Procedures	January 2016	February 2016
c. Engagement and Planning with up to Four Communities*	April 2016	September 2016
Step 2 – Project Implementation		
a. Develop Project Concept	October 2016	December 2016
b. Establish Resident-Owned Conversion, if applicable	October 2016	December 2016
c. Procurement of A/E	January 2017	February 2017
d. Design and engineering	February 2017	August 2017
e. Environmental Review and Permitting	March 2017	September 2017
f. Public bidding	October 2017	December 2017
g. Construction	January 2018	November 2018

Budget: The budget was determined based on the recent experiences of the State in designing programs with similar goals and scope, including the State's current planning, housing, and infrastructure CDBG-DR funded programs. The project concept costs were calculated using current NY Rising program costs, estimates from other State agencies, and estimates from non-profit partners. The total budget was a combination of these costs for implementation in four communities in NDRC proposed target areas. Opportunely, by the time projects are designed for this Program, a number of NYRCR projects will have been designed and bid, providing reliable, timely construction costs for similar projects. Data will be available for a range of project types, sizes and bidding markets allowing for meaningful comparisons.

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

The Public Housing Resiliency Pilot Project is designed to enhance the physical resilience of public housing properties, as well as the social and economic resilience of residents of the public housing properties. The Program has two components: piloting innovative flood mitigation interventions at selected public housing properties and creating workforce development opportunities for public housing residents.

The Program will provide grant funding to four public housing authorities to implement resiliency improvements appropriate for each public housing property. GOSR is working with Enterprise Community Partners to determine the best interventions at each public housing property based on Enterprise's newly-released Multifamily Resilience standards. The Enterprise Multifamily Resilience standards provide guidance on retrofitting existing structures and new construction opportunities in small, storm-impacted Public Housing Authorities (PHAs).

As part of the Program, GOSR will document construction costs attributable to these activities, best practices, and long term cost savings, so as to inform a replicable model for future affordable housing developments throughout the state, and nationwide. Particular attention will be given to resiliency retrofits to the building envelope, nature-based stormwater management features, nature-based coastal protection features, and/or resilient back-up power and power generation.

In addition to physical resilience, GOSR seeks to enhance the social and economic resilience of residents of the public housing properties by incorporating workforce development into the larger effort. The workforce development program component will provide public housing residents with employment opportunities through apprenticeship programs on construction projects at the public housing properties. The workforce development program will

educate, train, and connect public housing residents with both traditional and "green collar" opportunities.

The project sites were selected for piloting mitigation interventions as a result of an iterative process. First, GOSR reviewed public housing building location data and identified the structures that fell within the 100-year and 500-year floodplains. From this initial list, GOSR identified public housing authorities that were known to have been damaged during Hurricane Irene, Tropical Storm Lee, or Superstorm Sandy. GOSR then conducted an outreach effort to that group of housing authorities to determine their levels of interest in participating in the NDRC and gathered site-specific information about damages and possibilities for implementing resiliency improvements. Out of this effort, GOSR found several public housing authorities that were well-suited for flood mitigation interventions.

Authorities participating in the Program include: 1) Town of Hempstead Housing Authority; 2) Freeport Public Housing Authority; 3) City of Long Beach Housing Authority; and 4) Binghamton Housing Authority.

Descriptions of Proposed Projects

Binghamton Housing Authority (BHA): North Shore Tower Complex

The North Shore tower complex consists of four buildings ranging from 2 to 10 stories with 224 units total, and a two-story tech center. All occupants are elderly and/or disabled. The Tech Center site serves the community and other nearby PHA sites, providing a model workforce-readiness and educational program. The properties sustained over $3.1 million in storm damage from flooding, including damage to mechanicals located in basements and crawl spaces.

Figure 40: North Shore Tower Complex (Binghamton Housing Authority)

Credit: Keystone Associates, Flood Mitigation Study Report for Binghamton Housing Authority (2012)

The resilient retrofit strategy for this complex includes a combination of dry floodproofing, wet floodproofing, and elevating equipment. Dry floodproofing protects a building by sealing its exterior walls to prevent the entry of flood waters. Engineers examined the possibility of dry floodproofing basement floors and walls in their entirety, but rejected such aggressive methods since holding water back could strain the building envelope to the point of failure, and dry floodproofing from the inside would result in hydrostatic pressure which would eventually force the dry floodproofing elements away from the wall, or floor, surface. The recommended course of action is to install door dams at the first floor areas susceptible to

flooding. With enough warning and a proper flood emergency plan, door dams will be implemented quickly for effective mitigation.

Wet floodproofing protects a building by allowing flood waters to enter so that internal and external hydrostatic pressures are equalized. Unique among the other proposed public housing authority projects, the North Shore Tower Complex provides the opportunity to mitigate and floodproof elevators. This will be achieved by affixing water level sensors in elevator pits with alarm function to raise elevators to second floor and lock position, installing check/gate valve on plumbing, spraying closed cell foam insulation as applicable, and by upgrading electrical cabling in wet locations to systems approved for wet locations. Compared to dry flood proofing, wet floodproofing measures are less costly, easier to implement, permanently installed, and effective in reducing the amount of facility cleanup; however, they are not be effective in saving primary heating, plumbing, and electrical systems from extensive damage in a future flood. Therefore, neither wet nor dry floodproofing would be pursued as a stand-alone mitigation approach.

Elevating equipment protects the most critical utilities (boilers, electrical/fire alarm panels, etc.) by raising or relocating to an elevation at or above the BFE. The elevation measures for North Shore include relocating critical systems to a resiliently-upgraded garage/maintenance building which dates from 1984, and will be cost-effective to harden. These measures offer the most effective means of reducing the amount of damage, unplanned equipment downtime, required repairs and replacement, and associated cost after the next flood by moving the major heating, plumbing, and electrical equipment away from locations that are difficult to floodproof. Elevating equipment also facilitates directed wet floodproofing by allowing water infiltration into the basement levels of selected buildings, maintaining structural integrity. By elevating the

equipment above the BFE, BHA will be able to properly schedule the equipment downtime and relocation to best serve the building occupants, rather than waiting for a future catastrophic event to force the action.

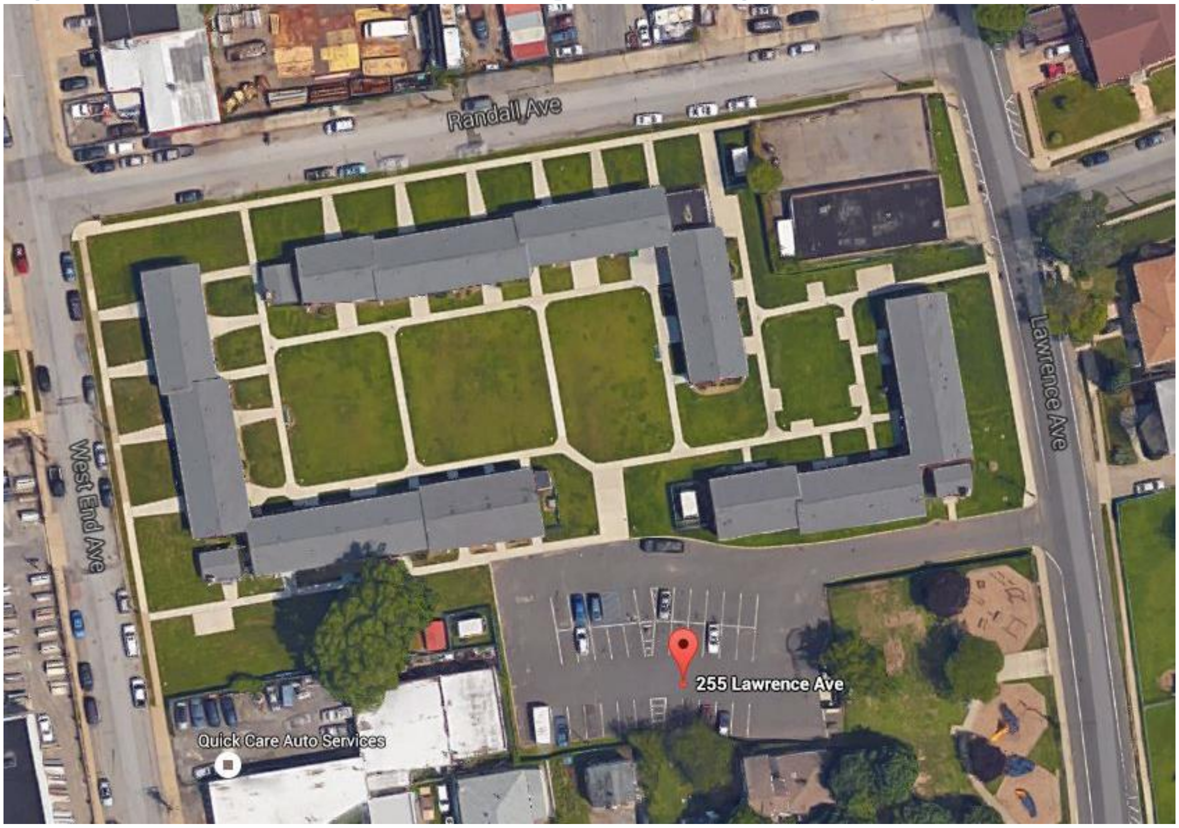
Town of Hempstead Housing Authority (TOHHA) - Mill River Gardens (Oceanside, NY) and Inwood Gardens (Inwood, NY)

Two of the six sites operated by TOHHA were impacted by Sandy. Inwood Gardens consists of 50 units in 3 buildings, housing low income families and seniors. Mill River Gardens, which borders the Hudson Channel of the Mill River, consists of 6 buildings comprising 62 efficiency and one bedroom apartments for seniors and one stand-alone recreation building/community center with a kitchen and separate mechanical system. GOSR will fund the repair and mitigation needs of these two sites.

Figure 41: Mill River Gardens (Town of Hempstead Housing Authority)

Source: Dormitory Authority State of New York, Multi Family Resilience Assessment Report

Figure 42: Inwood Gardens (Town of Hempstead Housing Authority)



Source: Dormitory Authority State of New York, Multi Family Resilience Assessment Report

During Hurricane Sandy, the storm surge created severe flooding at both sites, damaging building systems. Saltwater destroyed the boilers requiring replacement units at both properties. Given the flood damage sustained during Sandy and continuing risk of damage, the proposed resiliency retrofit will elevate all mechanical systems (generators and HVAC) at both sites. Aging diesel generators will be replaced with natural gas fired units elevated to a minimum of 2 feet above BFE. Raising these mechanical systems and associated utilities will minimize the risk of damage or disruption of services during severe future weather events, and allow TOHHA to maintain these essential services or expedite restoration if service is lost at the grid level. Standby generators will also be replaced and elevated. At Inwood Gardens, electrical

service is provided through a network of crawl spaces, and the electrical wiring therein will be made flood resistant.

Inwood Gardens is also developed sinkholes, due to the elevated and quickly receding groundwater table levels following Sandy. To protect this from happening in the future, the landscaping will be rehabilitated to address drainage and better integrate the land and the buildings. An allée of standing water and wet soil trees will be planted along the south and west exposure. This will not only provide shade during the warmest periods of the day but will be a natural defense against excess water, correcting drainage issues. Additionally, a new administrative /community center is part of the reconfigured landscaping. It will be conveniently located between the existing residential buildings, forming the heart of the community development where year-round gathering can occur in the community support spaces and function as a fully resilient emergency center during severe weather events.

Table 23: Resiliency Interventions Considered for Inwood Gardens

PROTECTION	
1	WET PROOFING
1.1	Relocate equipment above DFE
1.2	Floodwater vents
1.3	Water-resistant materials below DFE
1.4	Electrical distribution
1.5	Insulation jacketing
2	DRY PROOFING
2.3	Seal Exterior wall
2.7	Waterproof enclosure at critical building systems
3	SITE PROOFING
3.1	Sewer Protection
3.2	Site improvements
3.3	Site improvements
4	RESILIENT ELEVATORS
4.1	Elevator Upgrades
5	BACKWATER VALVES

5.1	**Sanitary Sewer Upgrades**
ADAPTATION	
7	**ENVELOPE PERFORMANCE**
8	**ELEVATE M & E EQUIPMENT**
8.1	**Electrical panels**
8.2	**mechanical equipment**
8.3	**Gas meters**
8.4	**Emergency Generator**
9	**PROVIDE AREA OF REFUGE**
10	**ONSITE STORM WATER MANAGEMENT**
10.1	**Storm Sewer Protection**
REDUNDANCY	
14	**BACKUP POWER**
14.1	**Backup Generator**
15	**BACKUP LIGHTING**
15.1	**Provide 100% at Community Ctr**
COMMUNITY	
17	**BUILDING COMMUNITY TIES**
18	**CREATING COMMUNITY RESILIENCE SPACES**
19	**DEVELOPING AN EMERGENCY PLAN**
20	**SHARING BEST PRACTICES**

At Mill River Gardens, the wooden bulkhead located directly adjacent to the waterfront failed to provide adequate protection against the storm surge. This resulted in significant damage to the apartments and community center at Mill River. The existing bulkhead must be replaced, with a vertical bulkhead constructed of storm resistant steel sheeting pilings to defend the site. A sloped revetment with landscape features will soften storm impact, improve the site's relationship to its coastline, reduce the long-term potential for flooding and slow the landside erosion caused by wave action. Mill River Gardens will also incorporate resilient upgrades to its Administrative building/community center, to include sealing penetrations and adding redundant power systems that will serve the property in a severe weather event.

Table 24: Resiliency Interventions Considered for Mill River Gardens

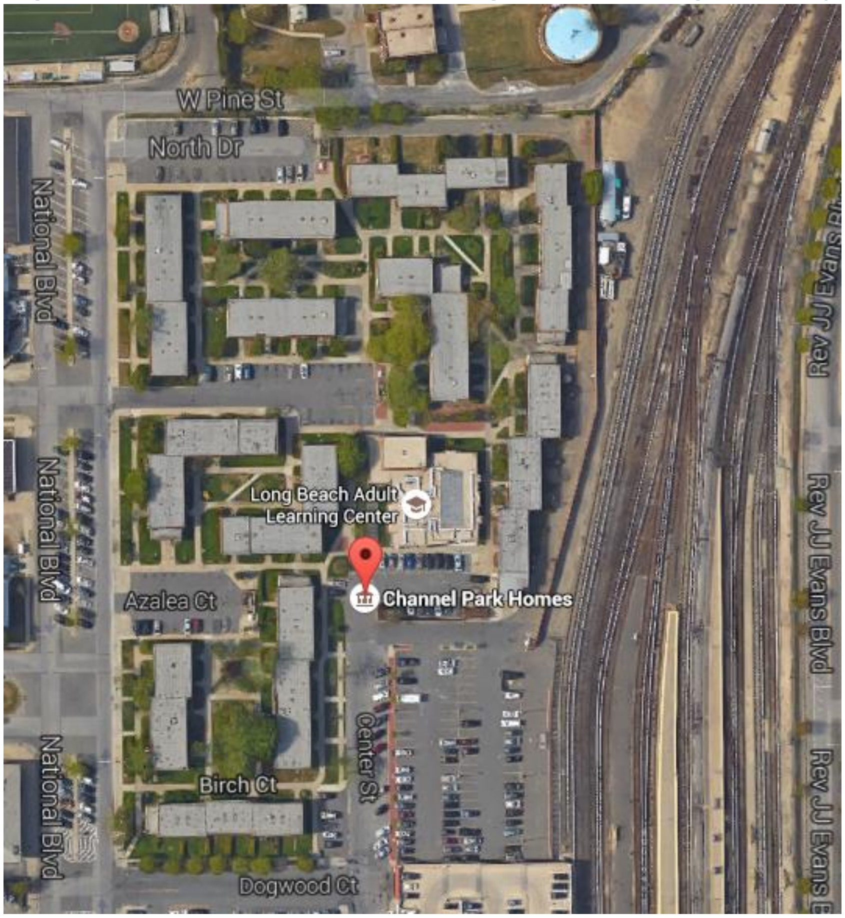
PROTECTION	
1	WET PROOFING
1.1	Relocate equipment above DFE
1.2	Floodwater vents
1.3	Water-resistant materials below DFE
1.4	Electrical distribution
1.5	Insulation jacketing
2	DRY PROOFING
2.1	Seal Exterior wall
2.2	Seal Exterior wall
2.3	Seal Exterior wall
2.4	Door Flood Barrier
2.5	Garage Door Flood Barrier
3	SITE PROOFING
3.1	Perimeter Flood Protection
3.2	Sewer Protection
4	RESILIENT ELEVATORS
4.1	Protection of Elevator Equipment
5	BACKWATER VALVES
5.1	Sanitary Sewer Upgrades
ADAPTATION	
7	ENVELOPE PERFORMANCE
8	ELEVATE M & E EQUIPMENT
8.1	Electrical panels
8.2	mechanical equipment
8.3	Gas meters
8.4	Electrical Meters
8.5	Emergency Generator
8.6	Elevate & Replace existing air handling unit
9	PROVIDE AREA OF REFUGE
10	ONSITE STORM WATER MANAGEMENT
10.1	Storm Sewer Protection
11	OPERABLE WINDOWS
12	WINDOW SHADING
13	DISTRIBUTED HEATING AND COOLING

REDUNDANCY	
14	BACKUP POWER
14.1	Backup Generator
15	BACKUP LIGHTING
15.1	Provide 100% at Community Ctr
COMMUNITY	
17	BUILDING COMMUNITY TIES
18	CREATING COMMUNITY RESILIENCE SPACES
19	DEVELOPING AN EMERGENCY PLAN
20	SHARING BEST PRACTICES

Long Beach Housing Authority (LBHA): Channel Park Homes

Channel Park Homes consists of 108 two-level homes in 12 buildings on a site two blocks from the bay. During Sandy, flooding raised the water level 12" to 18" above the first floor of each unit, impacting all the apartments as well as the central administration building and community facility spaces. The flood impinged on all utility mechanical and electrical service rooms, which are located on nine separate rooms attached to the residential areas.

Figure 43: Channel Park Homes (Long Beach Housing Authority)



Source: Dormitory Authority State of New York, Multi Family Resilience Assessment Report

The resilient retrofit strategy for Channel Park Homes will maintain and enhance the pedestrian-oriented environment of the site, and capitalize on its open space while providing significant resilient and energy-efficient improvements. This will be achieved through a combination of wet floodproofing methods, which will direct and minimize damage related to water incursions along with dry floodproofing methods that will keep the water out. Existing boilers and hot water heaters will be replaced and elevated (along with electrical panels) within the constraints of the existing mechanical rooms, thus avoiding the expense of raising the existing roofline, and resulting in energy savings. Per FEMA recommendation, doors will be replaced with fiberglass wood core throughout. Temporary flood barriers for sliding glass doors

will be installed. Roofing upgrade will provide additional insulation as well as wind resistance, and high solar reflectance. All low piping penetrations will be caulked and sealed. Sanitary and storm sewer back flow valves will be added to the water supply backflow valves that are currently in place. Windows will be replaced throughout with low shading coefficient, Low-E replacements set in a thermal-break aluminum metal frame casement for increased energy savings as well as resilience. Asphalt parking will be replaced with permeable interlocking concrete pavement as feasible to aid in site drainage. Standby generators and emergency lighting will provide redundancy, and the dry floodproofing of the existing Administration/Community Building will provide the physical locus of a “shelter-in-place” plan in the event of an extreme weather event.

Table 25: Resiliency Interventions Considered for Channel Park Homes

PROTECTION	
1	Wet Floodproofing
	1.1 Relocate equipment above DFE
	1.1.1 New elevated mechanical equipment
	1.1.2 Elevate existing electrical equipment
	1.2 Floodwater vents
	1.3 Water-resistant materials below DFE
	1.4 Hardened materials (plastic, glass)
	1.5 Foundations
	1.6 Cavity Wall Construction
	1.7 Solid Wall Construction
	1.8 Wall Finishes
	1.9 Floors
	1.10 Ceilings and Roofs
	1.11 Building Envelop Openings
2	Dry Floodproofing
	2.1 Seal base of exterior wall at Administration Building
	2.2 Seal leakage areas
	2.3 Seal inactive floor drains
	2.4 Waterproof covers for louvers and AC sleeves
	2.5 Sump pump
	2.6 House trap cap

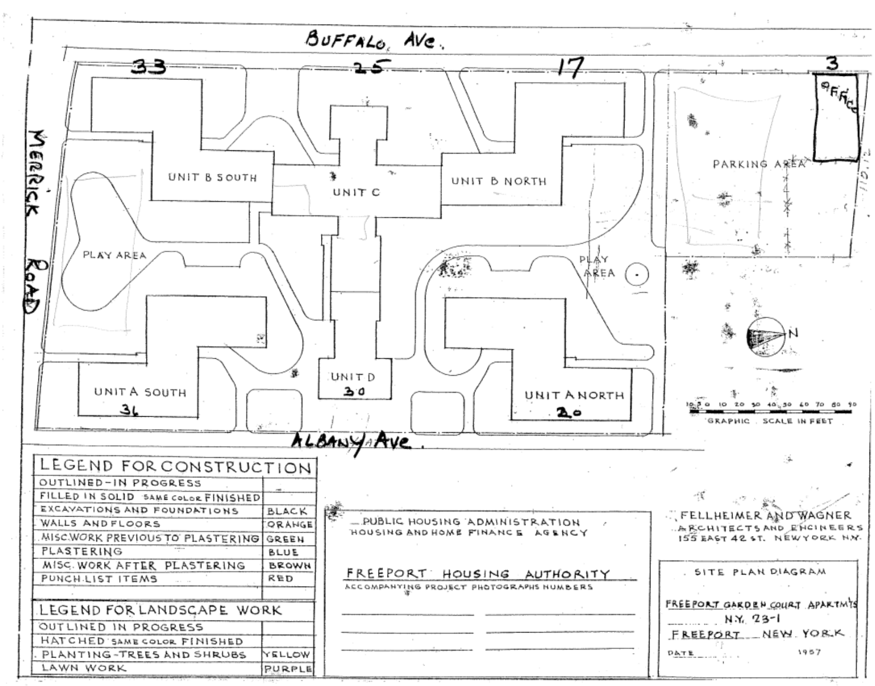
	2.7 Entrance flood barriers
	2.8 Sealed gasket flood doors
	2.9 Waterproof enclosure at critical building systems
3	Site Floodproofing
	3.1 Permanent Flood walls
	3.2 Berms
	3.3 Removable floodwall barrier system
4	Resilient Elevators
	4.1 Elevator Upgrades
5	Backwater Valves
	5.1 Sanitary Sewer Upgrades
	5.2 Sanitary Sewer Upgrades
6	Sump Pumps
	6.1 Sump Pump Upgrades
ADAPTATION	
7	Enhance Envelope Performance
	7.1 Seal leakage at floor to wall intersections
	7.2 Wall insulation
	7.3 Use of light surfaces to reduce heat island effect
8	Elevate M & E Equipment
9	Raising occupiable living spaces
10	Onsite Storm water Management
	10.1 Storm water storage (cisterns, bio swales)
	10.2 Permeable surfaces
11	Operable Windows for natural ventilation
	11.1 Window upgrades
12	Window Shading
	12.1 Overhangs
	12.2 Awnings
	12.3 Roller screens, shades, shutters
	12.4 Vegetation
13	Replace heating plant
	13.1 Split air-source heat pumps
REDUNDANCY	
14	Backup Power- Generator
	14.1 Generator #1
	14.2 Generator #2
	14.3 Generator #3
	14.4 Wiring Distribution
15	Backup Lighting- Emergency lighting during outages

	15.1 Natural daylighting at corridors and stairs
	15.2 Battery powered lighting
16	**Backup Water- Potable water access during outages**
	16.1 Rooftop storage tanks
	16.2 Rainwater storage
COMMUNITY	
17	**Developing an Emergency Plan**
	17.1 Dry Floodproofing Upgrades
	17.2 Community

Freeport Housing Authority: Moxey Rigby Homes

Moxey Rigby is a 100 unit family development owned and operated by the Freeport PHA. It was severely damaged during Superstorm Sandy, such that the substantial underground mechanicals were flooded. The development itself is considered physically obsolete—units do not meet current code, no units are accessible or adaptable, and it is not ADA compliant. As an alternative to providing assistance to the existing development, Freeport PHA will demolish the existing property, and build new, resilient, code compliant replacement housing across the street.

Figure 44: Moxey Rigby Site Plan (Freeport Housing Authority)



In order to secure private financing necessary for this ambitious project, the Freeport PHA will submit an application to convert its current federal subsidy stream to project-based assistance under the HUD Rental Assistance Demonstration (RAD) program**.** GOSR facilitated a relationship with Freeport PHA and HUD-funded technical assistance resources from Enterprise Community Partners and RECAP Advisors in order to accomplish this goal. At this time, RECAP completed a feasibility study indicating the project worked as a RAD conversion. Under this scenario, Freeport PHA would convert 100 family housing units to RAD, and then transfer that contract to the new construction site. The new housing would be financed with tax-exempt bonds, 4% Low Income Housing Tax Credit (LIHTC), and CDBG-DR. FEMA has also made approximately $5.8 million in 428 funds available to the project. The project would achieve 1:1 replacement and would not involve temporary relocation.

Many of the resilient construction measures proposed also provide energy-saving and environmental benefits. The new property will elevate all systems and residential areas above-grade, by way of cast concrete construction on concrete pilings. Open-air parking will be located at-grade, under the residential building. Construction materials will be water resistant and most of the water intrusion prevention would be at the garage lobby. Concrete is also very durable and would generally overcome wave action forces and floating debris damage. Locating parking under the property also facilitates increased potential for a community garden, increased play areas, or other incorporation of natural and recreational features. Exterior walls will be constructed with a rainscreen, which will provide energy-saving and environmental benefits while also serving as a superior means of resilient construction.

Three significant site measures are proposed: 5,000 square feet of engineered bioswale featuring drought resistant plants, an onsite water detention and recharge system, and 25,000

square feet of pervious pavement. These measures will provide for recharging of the groundwater, even in the absence of a severe weather event. A cogeneration (cogen) system and solar photovoltaic/battery backup system will provide power during outages, and also lower operating costs. Additionally, the generator, cogen, and photovoltaic systems combined will provide a significant percentage of the buildings energy need when combined with other initiatives such as Passive House construction.

Table 26: Resiliency Interventions Considered for Moxey Rigby

Item #	Description
BUILDING MEASURES	
1	Eliminate providing a basement in design
2	Raise first floor to 2nd floor level due to 5 ft design condition. Provide "open air" parking under the building and... Wetproof construction
2a	Dry Floodproof the 1st level lobby areas and stair areas only - Flood barriers at 2 entrances - Misc penetration measures - Additional measures for means of egress - SOG and wall hydrostatic resistance measures - Waterproofing
or	
2b	Dry Floodproof the entire building footprint.
3	Provide Impact Windows in lieu and standard vinyl windows
4	Emergency Generator 150 kw gas fired generator (diesel optional) - associated ATS, feeders, misc
5	Cogen: Providing domestic hot water as a byproduct of electric generation. In emergency will provide DHW and supplement Emergency Generator 2:10 Kw Yanmar gas fired cogen plants - Tie into emergency generator system
6	100 kw Solar PV System Battery storage system for onsite use during power outage - 100 kw with 125 kwh storage
7	Mechanical systems on roof
8	Additional structural design in lieu of code minimum. Add 10 mph wind speed
9	Rainscreen construction methods in lieu of current stds - Hardie plank with furring channel ilo vinyl siding
SITE MEASURES	
10	BioSwale with Drought resistant plants
11	OnSite water detention & recharge -36" HDPE system
12	Pervious pavement
Note 1	Total Development Costs included the following: 1. AE Costs 2. Closing Costs 3. Contingencies (both hard and soft costs) 4. Project Interest 5. Other Misc * based on a low income housing tax credit project with various additional sources of funding and associated requirements

Benefit to Vulnerable Populations

The proposed Public Housing Resiliency Pilot Project directly benefits residents of public housing developments by making the structures more resilient and by providing workforce

development opportunities to enhance social and economic resilience. The program will benefit 544 households, approximately 90% of which are LMI, including Very Low Income households below 50% of the median. Public housing serves high proportions of elderly and disabled residents, as well as a primarily LMI population that have fewer resources to call upon in an emergency, and which is therefore uniquely vulnerable to weather-related disruption. Such disruptions that affect housing have a domino effect that can extend to disrupted schooling and employment.

Measuring Success

Following are the metrics by which we will measure success:

Resiliency Value

- Power continuity during storm events

Environmental Value:

- Energy use and cost reduction
- Reduced water usage

Project goal is a 20% energy cost savings. As stated in section VIII c below, estimated energy savings is $2.48 million, based on a 16% energy cost savings. As the project develops, we will seek to identify additional measures which will reach 20% savings.

Social Value:

- Storm events survived without evacuation (sheltering in place).

Economic Revitalization:

- Number of Workforce Development Program participants enrolled
- Completion, placement and post-placement retention percentage for enrolled participants
- Annual Earnings ($) by Workforce Development Program participants.

Alternatives Considered

Alternatives considered include intensive measures such as constructing permanent flood barriers at each of the five sites, relocating residents to units outside of the flood plain, as well as temporary emergency response measures such as sandbagging and proactive temporary relocation. We also considered the possibility of letting the properties remain at their current level of resilience, anticipating that insurance or disaster relief funds would be required to address any impact of future severe weather events.

BCA Summary:

The BCA found a BCR of 1.8 low SLR forecast; 2.9 high SLR forecast for the project. For the workforce component, the BCA identified benefits from employment in the trades, including a normal progression through the skilled trades.

Table 27: Public Housing Resiliency Pilot Project Schedule

Task	Start	End
NDRC Awards Announced GOSR announces projects to PHAs PHAs commence outreach for workforce development	January 2016	January 2016
NEPA Environmental review commences, follow up letters issued to housing authorities	February 2016	April 2016
Grant awards finalized with HUD Scopes finalized on all NDRC PHA projects	March 2016	April 2016
GOSR - PHA agreements finalized Request for Qualifications design and construction activities	April 2016	May 2016
Procurement underway Public review period for environmental review Workforce training program commences	May 2016	June 2016
Procurement finalized Construction documents complete for rehab projects	June 2016	July 2016
Construction permits pulled	July 2016	July 2016
Construction commences on first projects (Binghamton) Workforce training program completes	August 2016	April 2017
Closing on financing for Freeport PHA Construction for all projects has begun	September 2016	September 2016
Construction substantially complete for all rehab projects	September 2017	September 2017

Construction 50 percent complete- Freeport PHA New Construction		
All NDRC funds drawn down (if Freeport PHA not complete, all NDRC funds will have been spent, but subject to default provisions if compliance benchmarks are not met by completion of construction)	January 2018	January 2018
Disseminate “best practices” document, including lessons learned	February 2018	April 2018
Freeport PHA residents move in	September 2018	October 2018*

*Milestone Program benefits realized

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program

The State will draw upon DEC's expertise through the proposed Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program. The Program will be available to municipalities and counties interested in undertaking assessment and right-sizing of small-scale infrastructure (culverts with up to a 25 foot span) and restoration of natural flood plains within the Most Impacted and Distressed (MID) counties with Unmet Recovery Need (URN) in Upstate New York. The Program will replace defective or insufficiently sized culverts with new structures that utilize best practice design and construction features with capacity to handle up to 1 in 500 year flood events. Consistent with DEC's current Water Quality Improvement Program (WQIP) and in order to maximize the resilience impact of the NDRC investment, the Program will require a 15% local match. The 15% match requirement will avoid over-burdening local governments, while encouraging them to make forward thinking interventions to improve community resilience. As noted in the Program budget, DEC has secured funding commitments for this Program from existing DEC Basin Programs and the Catskill Watershed Corporation (CWC). Therefore, in certain counties, some of the 15% match requirements will come from these funding sources.

Municipalities and counties planning to undertake this work will submit an application to DEC's WQIP grant program through the State's Consolidated Funding Application (CFA). The application will be similar to DEC's current WQIP grant program but will include additional criteria responsive to CDBG-NDR requirements, such as: (1) The project's connection to a Qualified Storm(s); (2) How the project will be responsive to the URN in housing and/or infrastructure; (3) LMI community and vulnerable populations served by the project; (4) Flow capacity; (5) Downstream impacts; (6) BCA analysis; and (7) Aquatic organism passage.

The State completed a BCA of some selected right-sizing scenarios to highlight its commitment in ensuring that any activity selected through this Program will undergo a BCA with a similar methodology. The BCAs for the specific projects funded under this Program are expected to have similar results to the BCA completed for this application, including for capital costs and operations and maintenance. Benefits include avoidance of functional losses to critical infrastructure, avoided environmental damages, enhanced water quality, avoided injury/fatalities, avoided mental stress/anxiety, and avoided disruption of the local economic activity. All projects considered by the grant would need to have a BCA greater than 1. The proposed Program will be implemented jointly by GOSR and DEC. The technical reviews and evaluations of eligible applications will be conducted by DEC while the contractual/administrative elements will be overseen by GOSR. Additional partners will provide technical support to DEC including a non-profit and an academic institution. Partner agreements for DEC and these partners are in Attachment F.

As a result of the LMI selection criteria, facilities receiving NDRC funding will be focused on LMI areas. As a result, this Program meets the LMI National Objective and projects funded through this Program will have been directly impacted by Superstorm Sandy, Hurricane Irene, or Tropical Storm Lee. Threshold Criteria will be met through the grant application process. See Exhibit B for Threshold Criteria. It is not anticipated that a project funded through the Program will be a Covered Project. However, if a project triggers Covered Project requirements, the State will ensure that all requirements are met. It is anticipated that this Program will run until September, 2019. The milestones for right-sizing projects and restoration projects are below; additional rounds are expected to follow the same schedule.

Table 28: Right-Sizing Culverts Anticipated Program Schedule

Task	**Start**	**End**
Conduct additional culvert assessments in MID counties (125 sub-watersheds/13,000+ structures)	Feb 2016	Feb 2017
Evaluate existing assessed culverts in MID counties and identify highest priority culvert replacement	Feb 2016	May 2016
Issue WQIP grant program for initial round of assessed culverts through CFA	May 2016	Jul 2016
Award Grants	Aug 2016	Oct 2016
Submission of permit applications (can be performed at different times; SEQR and NEPA review occur)	Oct 2016	Jul 2017
Complete Contracts (contracts can be executed prior to final permits issued; municipality/county grantees do their own procurement in this phase)	Oct 2016	Jan 2017
Construction	Jul 2017	Sept 2017
Completion of First Round of Projects, Reimbursement and Contract Closeout*	Sept 2017	Nov 2017
Issue second round of WQIP grant program based on newly assessed and prioritized locations conducted during year one through CFA	May 2017	Jul 2017
Award grants - grant reviews/scoring/notification	Aug 2017	Oct 2017
Submission of permit applications (can be performed at different times) – six to nine months.	Oct 2017	July 2018

Complete contracts – three months.	Oct 2017	Jan 2018
Construction	Jul 2018	Sept 2018
Completion of Second Round of Projects, Reimbursement and Contract Closeout*	Sept 2018	Nov 2018
Issue third round of WQIP grant program	May 2018	Jul 2018
Award grants - grant reviews/scoring/notification	Aug 2018	Oct 2018
Submission of permit applications (can be performed at different times) – six to nine months.	Oct 2018	July 2019
Complete contracts – three months.	Oct 2018	Jan 2019
Construction	Jul 2019	Sept 2019
Completion of Third Round of Projects, Reimbursement and Contract Closeout	Sept 2019	Nov 2019
Issue fourth round of WQIP grant program	May 2019	Jul 2019
Award grants - grant reviews/scoring/notification	Aug 2019	Oct 2019
Submission of permit applications (can be performed at different times) – six to nine months.	Oct 2019	July 2020
Complete contracts – three months.	Oct 2019	Jan 2020
Construction	Jul 2020	Sept 2020
Completion of Fourth Round of Projects, Reimbursement and Contract Closeout	Sept 2020	Nov 2020
Issue fifth round of WQIP grant program	May 2020	Jul 2020

Award grants - grant reviews/scoring/notification	Aug 2020	Oct 2020
Submission of permit applications (can be performed at different times) – six to nine months.	Oct 2020	July 2021
Complete contracts – three months.	Oct 2020	Jan 2021
Construction	Jul 2021	Sept 2021
Completion of Fifth Round of Projects, Reimbursement and Contract Closeout	Sept 2021	Nov 2021

The right-sizing milestones are based on conducting additional assessments. However, this process could be shortened by prioritizing projects that are already assessed by DEC. Based on DEC's current assessments, approximately 150 undersized culverts have been identified as a priority for upgrading.

Table 29: Floodplain Restoration Anticipated Program Schedule

Task	**Start**	**End**
Issue WQIP grant program for Natural Floodplain Restoration program through CFA	May 2016	Jul 2016
Award Grants (grant reviews/scoring/notification)	Aug 2016	Oct 2016
Submission of permit applications (can be submitted at different times; SEQR and NEPA review occur)	Oct 2016	Jul 2017
Complete Contracts (municipality/county grantees do their own procurement in this phase)	Aug 2016	Nov 2016

Construction	Nov 2016	Feb 2017
Completion of First Round of Projects, Reimbursement and Contract Closeout	Feb 2017	Apr 2017
Issue WQIP grant program for Second Round Natural Floodplain Restoration program through CFA	May 2017	Jul 2017
Award Grants (grant reviews/scoring/notification)	Aug 2017	Oct 2017
Submission of permit applications (can be submitted at different times; SEQR and NEPA review occur)	Oct 2017	Jul 2018
Complete Contracts (municipality/county grantees do their own procurement in this phase)	Aug 2017	Nov 2017
Construction	Nov 2017	Feb 2018
Completion of Second Round of Projects, Reimbursement and Contract Closeout	Feb 2018	Apr 2018
Issue WQIP grant program for Third Round of Natural Floodplain Restoration program through CFA	May 2018	Jul 2018
Award Grants (grant reviews/scoring/notification)	Aug 2018	Oct 2018
Submission of permit applications (can be submitted at different times; SEQR and NEPA review occur)	Oct 2018	Jul 2019
Complete Contracts (municipality/county grantees do their own procurement in this phase)	Aug 2019	Nov 2019
Construction	Nov 2019	Feb 2019
Completion of Third Round of Projects, Reimbursement and Contract Closeout	Feb 2019	Apr 2019

Issue WQIP grant program for Fourth Round of Natural Floodplain Restoration program through CFA	May 2019	Jul 2019
Award Grants (grant reviews/scoring/notification)	Aug 2019	Oct 2019
Submission of permit applications (can be submitted at different times; SEQR and NEPA review occur)	Oct 2019	Jul 2020
Complete Contracts (municipality/county grantees do their own procurement in this phase)	Aug 2019	Jan 2020
Construction	July 2020	Sept 2020
Completion of Fourth Round of Projects, Reimbursement and Contract Closeout	Sept 2020	Nov 2020
Issue WQIP grant program for Fifth Round of Natural Floodplain Restoration program through CFA	May 2020	Jul 2020
Award Grants (grant reviews/scoring/notification)	Aug 2020	Oct 2020
Submission of permit applications (can be submitted at different times; SEQR and NEPA review occur)	Oct 2020	Jul 2021
Complete Contracts (municipality/county grantees do their own procurement in this phase)	Oct 2020	Jan 2021
Construction	July 2021	Sept 2021
Completion of Fifth Round of Projects, Reimbursement and Contract Closeout	Sept 2021	Nov 2021

Right-Sizing Bridges Resiliency Program

The State proposes a program to right-size up to 30 flood-prone and scour critical bridges in upstate MID counties. Bridges will be sized to ensure that future stream flows are adequately addressed by comparing designs based on current streamflows with those developed for future time slices through the StreamStats tool. Right-sizing bridges will provide added flooding protection, improved water quality due to greater stream bank stability reducing erosion, more reliable access for emergency responders, improved local economies due to less uncertainty from flooding, and improved fish and wildlife habitat. To be selected for this program, after assessing whether the service area is in an LMI area or otherwise, the structure must have sustained damage during Superstorm Sandy, Hurricane Irene or Tropical Storm Lee and be evaluated under the following initial selection criteria:

- Project cost (right-of-way (ROW), engineering, construction, and construction inspection (CI));
- Annual maintenance costs for the proposed bridge;
- Annual average daily traffic counts on the bridge;
- Detour distance and time should the bridge be unavailable;
- Emergency replacement costs (ROW, preliminary engineering, CI, construction);
- Duration of emergency bridge closure due to extreme event (design and construction time); and
- Normal construction duration.

The Program—including technical reviews, evaluations of eligible bridges, and work on bridges—will be administered by DOT, which will enter into an MOU with the Governor's Office of Storm Recovery (GOSR) for funding. GOSR will provide technical assistance and ensure compliance with all HUD and other federal regulations.

This Program is expected to meet either LMI or Urgent Need. Threshold Criteria will be met through the grant application process. It is not anticipated that any project funded through this program would be a Covered Project. If a project expands above the threshold criteria, NYS will ensure that all Covered Project requirements are met.

DOT's existing hydraulic protocols allow the agency to quickly identify appropriate candidates depending on the final budget provided. The schedule below provides the maximum anticipated timeframes for ending dates. Start dates indicate initiation of project processes and some bridge projects will advance quicker than others. DOT expects to advance and award projects as they are completed, with all projects awarded by September 2017, and all funds fully expended within two years of obligation of the funding for each specific project. Funds for all selected projects would be obligated before September 30, 2017. Construction would be completed on all projects and funds would be fully expended within two years of obligation.

Environmental reviews will be completed for historic and cultural resources, endangered species, and water resources including wetlands and floodplains. The objectives of these reviews will to demonstrate that there will be no significant environmental impacts under New York's State Environmental Quality Review Act (SEQRA) or the Federal National Environmental Policy Act (NEPA). The documentation will demonstrate compliance with the applicable State and Federal regulations. It is anticipated the projects will be SEQR Type II as per 17 NYCRR, Part 15. Under the Flood Prone, Scour Critical Bridge Program, 45 bridges with a total cost of

$146.3 million went to construction within one year of receiving the FEMA grant, with all environmental permits in place.

Table 30: Right-Sizing Bridges Anticipated Program Schedule

Task	**Start**	**End**
Selection of projects	January 2016	January 2016
Preliminary Engineering/ Environmental Determinations (including permitting)	January 2016	January 2017
Final Design	July 2016	July 2017
Award Projects (municipality/county grantees do their own procurement in this phase)	Spring 2017	September 2017
Construction (Complete/Fully Expended)	Spring 2017	September 2019*

*Project milestone and benefits realized

Right-Sizing Critical Dams Resiliency Project (Seven Sites)

To ameliorate significant storm-related vulnerabilities, the State, with its partner, the New York State Office of Parks, Recreation and Historic Preservation (Parks), proposes a Critical Dam Resiliency and Right-Sizing Project. The comprehensive dam resiliency initiative was developed based on guidance and input from engineering firms specializing in dam-safety performed extensive flood and inundation modeling to determine the consequences of a catastrophic failure of these structures, so as to better understand the potential damages and risk to life and property. In addition to consultation with specialty engineering firms, the agency has internal staff with specific backgrounds in dam management and safety, who coordinated with DEC on required Federal Dam Safety Standards. In addition, the communities directly impacted by the effective management of the dams and potential dam failure, have been actively supportive of this project and are vested in the proposed safety enhancements. Parks has been in regular communication with the local communities over a multi-year period regarding these dams and their safety related to impacts on these communities.

The Project has an estimated total time for completion of 44 months, with the bulk of this time allocated to engineering analysis and design and construction. Both the State's Environmental Quality and Review Act (SEQRA) and the National Environmental Protection Act (NEPA) reviews will be conducted on each dam project prior to project construction.

Table 31: Critical Dam Resiliency and Right-Sizing Program Schedule

Task	**Start**	**End**
Process of Authorization to Commence	March, 2016	
Engineering Analysis and Design (includes engineering procurement)	April, 2016	October 2017
Permitting	November 2017	February 2018
Bidding Process and Bid Award	February 2018	June 2018
Construction Staging and Construction	July 2018	February 2020
Excavation of basin, riprap placement	August 2018	February 2020*

*Project milestone and benefits realized

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

The Bay Park Sewage Treatment Plant (STP) is discharging nutrients and pollution into the Western Bays preventing marshland habitats from thriving and reducing coastal vegetation. The diminished coastal barrier allows for greater wave action and flood damage to strike further inland, the effects of which are multiplied in Nassau County due to the volume of people and structures compacted into the region. Any damage to housing creates a decrease in the housing stock which leads to an increase in demand on an already stressed market.

The proposed project is to replace the Reynolds Channel 84-inch, 2.3-mile long outfall pipe with a new ocean outfall. The Bay Park outfall is located between the southern border of the Bay Park STP and a location about 3.5 miles off of the southern shore of Long Beach. The pipeline is proposed to cross under Hewlett Bay and Long Beach from north to south. The pipeline will be situated under the terrain of the Long Beach Water Pollution Control Plant (WPCP) near W. Pine Street at the northern end of Long Beach.

The outfall will be 5.3 miles long in total from the Bay Park STP to the ocean outfall diffuser. The pipe will run 2.5 miles between Bay Park and Long Beach and an additional 2.8 miles between Long Beach and the diffuser. The outfall tunnel will be 138 inches with a 10 inch lining. The ocean outfall will discharge into the Atlantic Ocean rather than Hewlett Bay where the Reynolds Channel outfall discharges. This is expected to lead to improved water quality in the Western Bays. The exact alignment for the outfall has not been determined. However, a basic overview of the general route is shown in Figure 1 below.

When Hurricane Sandy struck Long Island on October 29, 2012, a 9-foot tidal surge hit and flooded nearly 75 percent of the 40-plus acre Bay Park STP and shut down critical treatment processes and equipment. The initial wave, and later the storm surge, overran the STP and

carried along with it raw sewage, sludge, and debris. The flood waters rendered the entire Bay Park STP inoperable for 57 hours and resulted in multiple releases of raw or partially treated sewage from the facility.

The effluent that leaves the treatment plant flows by gravity during low tide and must be pumped into the Reynolds Channel/East Rockaway Inlet as the tide rises in the Atlantic Ocean. These effluent pumps (effluent tide outfall) are below grade and were almost completely submerged and rendered inoperable for an extended time period.

The combination berm/floodwall that is being constructed around the STP will prevent tidal overflow and mitigate against future flood events. The majority of the earthen berm/floodwall will be approximately 8 feet tall and will reach a design elevation of 17 feet in the North American Vertical Datum of 1988 (NAVD88) to protect the STP up to the 500-year flood elevation. The structure includes a slurry wall to stop infiltration of groundwater into the STP. However, the Reynolds Channel outfall remains a critical point for effluent to backflow into the STP.

Tidal surge with high winds and waves also overwhelmed the Long Beach WPCP. The plant was turned off for protection from the storm, and after floodwaters receded, emergency repairs were made to bring the plant online. The plant began treating wastewater after a 12 hour shutdown. A multitude of damaged equipment was repaired post-storm; however, the sand filter was not brought back online due to costly electrical repairs.

Over time, the loss of the sand filter has affected effluent quality at the plant leading to increased suspended solids load. In April 2014, the plant had a monthly permit violation for suspended solids due to the loss of the sand filter.

Figure 45: Proposed Bay Park STP Ocean Outfall

As part of the ocean outfall project, the Long Beach WPCP will be decommissioned and converted into a pump station which will transfer wastewater to the Bay Park STP for treatment and discharge through the proposed ocean outfall. As part of this project, approximately 5 acres of land will be decommissioned and can be reclaimed for development. The pump station will be approximately 100 feet by 120 feet. In addition, a 24 inch diameter force main will be constructed to transfer effluent from the Long Beach WPCP to the Bay Park STP. The force main will consist of dual force mains from Long Beach to cross Reynolds Channel. Then, the force main will merge and travel along Austin Boulevard in Island Park. There will be another marine crossing at the Barnum Island Channel with dual force mains before the force main connects to the existing Bay Park STP conveyance system at the Long Beach Road interceptor.

The outfall and Long Beach tie-in would mitigate this unmet infrastructure need and increase resiliency principally by reducing future loss to coastal and stormwater flood events.

The protection from the outfall will prevent damage to and loss of affordable housing, another unmet need in Nassau County.

The proposed ocean outfall has 4 main objectives.

1. Reduction of pollutant levels in the Western Bays, in particular nitrogen
2. Bolstering of resilient coastal marshland as a barrier against wave energy and erosion
3. Protection of densely populated low-elevation communities from storm and flood damage
4. Promotion of additional affordable housing stock and water related economic actives

Due to the impaired water quality standards, Nassau County intends to reduce pollutant levels in the Western Bays, especially nitrogen. Most of the nitrogen load in the Western Bays is from wastewater effluent discharges; therefore, by eliminating this pollutant source, water quality should improve. For comparison the Chesapeake Bay implemented a nitrogen reduction system. They set metric goals as follows:

- Nitrogen Reduction Chesapeake Bay 8 Year Reduction: 84%
- Phosphorus Reduction Chesapeake Bay 8 Year Reduction: 82%
- Nitrogen Reduction Chesapeake Bay 16 Year Reduction: 77%
- Phosphorus Reduction Chesapeake Bay 16 Year Reduction: 78%

The outfall will also secure the plant against backflow, prevent future service outages, and sewage spills caused by tidal wave action.

In addition, as a result of the reduced nitrogen load, coastal marshland will grow more resilient in the Western Bays. By bolstering the coastal marshland, it will provide a natural

barrier against wave energy and erosion. Healthy coastal wetlands can increase community resilience by providing flood storage, storm surge buffers, erosion control, water quality improvements, and wildlife habitat. They also reduce pollution in waterways by storing and filtering urban runoff and removing or retaining nutrients and sediment carried by runoff. Wetlands play a unique and critical function through their ability to recycle the nutrients in runoff into usable substances. Wetland functions also reduce the costs of constructing, operating, and maintaining drinking water treatment plants. This will protect the densely populated communities in low-lying areas from storm and flood damage.

The South Shore of Nassau County is a Special Flood Hazard Area (SFHA), land identified by the United States Federal Emergency Management Agency (FEMA) as an area with a special flood or mudflow, and/or flood related erosion hazards. This low-lying part of Nassau County is also densely populated which leads to increase loss and damage to structures and property. Salt marshes protect against the impediment of flood waters and storm damage serving an essential benefit to these vulnerable populations.

The damage caused by flooding and storms exacerbates an existing affordable housing crisis in Nassau County. 56% of renters pay more than 30% of their income for housing. 64% of Long Island renters cannot afford a typical two-bedroom apartment. 55% of 20-to-34 year-olds live with their parents or other older relatives. When a storm or flooding forces residents out of their home, the scant available apartments are consumed. Likewise, the damage or destruction of that home removes a housing unit from the market. These scenarios reduce supply in the market and increase demand. This, in effect, inflates housing costs

The proposal promotes processes that support natural protections afforded by the salt marshes to reduce the impact on the housing market. The same processes create an environment

that can lead to the return of Nassau's shell fish population and industry. A return of good paying jobs to the area will help alleviate the burden on residents struggling to afford rising rents.

The Great South Bay in the 1970's, as a comparison, ran a $62 million-per-year industry that employed thousands. Enabling the Western Bays to be populated with shell fish through the reduction of nitrogen pollutants that fuel excessive Ulva growth. As the Ulva populations die off the clarity of water and increase in oxygen will create a nurturing habitat for eelgrass. The eelgrass act as nurseries for shellfish. The outfall should also reduce the elevated coliform bacteria, a rod-shaped bacterium found in the intestinal tract of humans and other animals. Its presence in water indicates fecal contamination.

Through the outfall, pollutant levels in the Western Bays will be reduced. The coastal ecosystem will become suitable to support shellfish and saltmarshes that will attract industry and protect against storm surge, respectively. These benefits have a strong impact on the affordable housing issues faced by Nassau County.

The estimated useful life is 50 years. The main components of the proposal plan are as follows:

1. Construction of an Atlantic Ocean outfall from the Bay Park STP
2. Reduction of pollutant levels in the Western Bays, in particular nitrogen
3. Bolstering of resilient coastal marshland as a barrier against wave energy and erosion
4. Protection of densely populated low-elevation communities from storm and flood damage
5. Promotion of additional affordable housing stock and water related economic actives

The following metrics will be tracked through regular assessment:

- Resiliency Value: Damage to residences from coastal flooding.
- Environmental Value: Acres of marshland and eelgrass.
- Social Value: Level of effluent discharges impacting recreational opportunities and quality of life.
- Economic Revitalization: Damage to local businesses related from coastal flooding.

The outfall project, in combination with the repairs and improvements at the Bay Park STP, will target a nitrogen level below current Clean Water Act guidelines. This reduction in nitrogen and pollutants in the Western Bays will promote a healthy ecosystem that will allow the marsh lands and eel grass to thrive. This robust marshland serves as a barrier against future storm events by dissipating wave energy and amplitude, reducing the erosive effect of waves by slowing water velocity, and by stabilizing shorelines through sediment deposition. This will decrease the number of damaged homes and structures in Nassau County preventing impact on the already stressed affordable housing market. The eelgrass serves as nurseries for shellfish and effluent reduction can reduce coliform bacteria that has led to shellfish bed closures. This can attract industry and jobs with improved incomes to resolve housing issues.

Nassau County is most impacted and distressed (MID) as a result of Hurricane Sandy due to Nassau County's loss of coastal protection, the population density of 4,655 people per square mile, and an affordable housing crisis. The Bay Park STP is discharging nutrients and pollution into the Western Bays preventing marshland habitats from thriving and reducing coastal vegetation. The diminished coastal barrier allows for greater wave action and flood damage to strike further inland, the effects of which are multiplied in Nassau County due to the volume of

people and structures compacted into the region. Any damage to housing creates a decrease in the housing stock which leads to an increase in demand on an already stressed market.

High levels of nitrogen significantly “impair” the Western Bays by the proliferation of macro-algae (specifically Ulva, or “sea lettuce”) and extensive damage to the marsh grasses and their sub-structures that, in turn, are integral to maintaining natural shoreline protection against coastal storm surge and waves. Studies by the U.S. Environmental Protection Agency (USEPA) consultants indicate that 80 to 90 percent of the nitrogen loading to the nitrogen-impaired portion of the Western Bays is from the Bay Park facility, as well as the smaller but still significant discharge from the City of Long Beach.

Of the 3,007 counties in the United States, Nassau County is ranked as the 27th most densely populated. This closely compacted community has the entirety of its south shore located in a SFHA. The effects of this were apparent after the land fall of Hurricane Sandy, leaving behind thousands of damaged homes. Close to 1,400 homes were destroyed or rendered unsafe. More than 1,000 residences in the Town of Hempstead alone were damaged and the Sheltering and Temporary Essential Power (STEP) Program had more than 2,500 applicants. In East Rockaway, 1,056 housing units were flooded, 73 of which had more than four feet of water, 259 had one to four feet, and 116 had less than one foot. In Bay Park, 660 housing units were flooded, with 80 units having greater than four feet of water and 439 with one to four feet of water.

Long Island’s 4.3% rental vacancy rate means that there are fewer available rental homes than in any other suburban area in the New York region. 56% of renters pay more than 30% of their income for housing. 64% of Long Island renters cannot afford a typical two-bedroom apartment. 55% of 20-to-34 year-olds live with their parents or other older relatives. Thousands

of Long Islanders live in illegal apartments because of the lack of legal rental units. Storm damage and displacement reduces housing stock and puts more people in the rental market at the same time. For example, 3 years after Sandy, around 5% of Long Beach residents are still displaced, and some are renting and paying a mortgage.

The cost for engineering/design and construction of the ocean outfall is $450,000,000. The proposal is requesting $150,623,750 after removing funding the County has already obtained.

Table 32: Capital Costs and Funding

Funding Source	**Funding Description**	**Funding Amount**	**Project Total + Funding Amount**
FEMA HMGP	New HMGP application to fund eligible elements of the outfall pipe.	$ (150,000,000.00)	$ 300,000,000.00
Nassau County	Local match for HMGP project	$ (50,000,000.00)	$ 250,000,000.00
NYS EFC Loan - Nassau County	Design/Environmental Review/Geotechnical EFC SMLP Loan for costs associated with the Design of the Bay Park Ocean Outfall.	$ (8,937,500.00)	$ 241,062,500.00
Nassau County Loan	0% interest on the 75% of the EFC Loan	$ (32,712,500.00)	$ 208,350,000.00
NYS EFC Loan – Long Beach diversion to Bay Park	Design/Environmental Review/Geotechnical EFC SMLP Loan for costs associated with the Design for conversion of the Long Beach WPCP to a Pump Station and Force Main	$ (931,562.00)	$ 207,418,438.00
Nassau County Loan	0% interest on the 75% of the EFC Loan	$ (2,794,688.00)	$ 204,623,750.00
Nassau County	This is funding provided by the Nassau County Capital Fund. Formal Commitment	$ (54,000,000.00)	$ 150,623,750.00
			$ 150,623,750.00

The cost for engineering/design and construction of the ocean outfall is $450,000,000. See the following table for an estimated timeline for each project phase.

Table 33: Estimated Project Schedule - Nassau County Outfall Pipe and Bay Resiliency Project

Task	**Start**	**End**	**Months**
Project Administration	Q2 2016	Q3 2020	54
Procurement Services	Q2 2016	Q3 2017	17
Design Process	Q4 2016	Q4 2017	11
Sampling and Survey Program	Q2 2016	Q2 2018	25
Environmental Review	Q2 2016	Q2 2017	12
Obtaining federal, state and local permits	Q2 2016	Q2 2017	12
Construction Process	Q4 2017	Q3 2020	35*

*Project Milestone and Benefits Realized

There are no additional operating and maintenance costs associated with the ocean outfall. Operation and maintenance costs will only apply to the converted Long Beach WPCP. Pump station operation and maintenance costs are estimated to be approximately $579,637.

Risks to Community

Manufactured Home Community Resiliency Pilot Program

The community-specific risks can only be calculated after specific sites are selected. However, the cost benefit analyses describes the resilience values (and other benefits) associated with either buyout and relocation or infrastructure strengthening and safely elevating and securing structures homes within MHCs. These resilience value benefits are based on avoided costs that show that if the status quo is maintained, the risks to these communities are considerable and would likely result in additional damages being incurred over time over the long-term that factors in sea level rise and greater frequency of flood/extreme weather events associated with climate change.

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

The primary risks associated with future disasters would be borne by the public housing properties which are the subject of this proposal. However, it is possible that the surrounding community near Mill River might experience excess riverine flooding if the bulkhead is not restored, and the tech center at Binghamton HA serves the wider community; a future disaster would put the center out of service for repairs, as was the case in the last storm.

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program; Right-Sizing Bridges Resiliency Program; Right-Sizing Critical Dams Resiliency Project (Seven Sites)

The community risks for all three right-sizing projects are outlined together. The risks to communities of not right-sizing bridges, culverts, dams and restoring floodplains to improve

retention capacities is substantial. Climate change will impose ever greater risks to communities that depend on this infrastructure being properly sized and durable to withstand greater likelihood of flooding and extreme weather events over the projected long-term (50 to 100 year) time horizons. Risks to communities include flooding of homes, businesses, community centers, municipal buildings, public recreation amenities, roads, and transit infrastructure. There is personal cost associated with flooding, as well as municipal costs, and costs of inability to access vital services during and after an event. Delaying the interventions serves to compound these risks. As infrastructure ages, together with the increased frequency of extreme weather events, there is an increased likelihood that these structures will be compromised.

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

The risks to the community associated with not implementing this project include negative health impacts to the ecosystem and economy, as well as the avoided costs, marsh island reconstruction and of nitrogen removal. On May 12, 2014 a Long Island Resiliency & Clean Water Infrastructure Meeting was held at the Nassau County Legislative Chambers in Mineola. There, alternatives presented along with the results of their evaluation, including a five stage biological nutrient removal (BNR) process tied in with a denitrification filtration system. This process would need to be implemented if the county did not construct the outfall and the cost to bring the total nitrogen load to less than 4 mg/L at accost of $400 million.

Description of Benefits and Costs

A list of the benefits and costs of the proposal and the rationale for including each effect using the table provided according to the following categories:

a. *Lifecycle costs;*

b. *Resiliency Value;*

c. *Environmental Value;*

d. *Social Value; and*

e. *Economic Revitalization.*

Manufactured Home Community Resiliency Pilot Program

Lifecycle Costs

Phase I

To fully inform and guide the process of resiliency strengthening interventions, targeted for the Manufactured Home Community, the first action will be to establish a community-based planning process, modeled after the NY Rising Community Reconstruction Program, which incorporates residents of manufactured home communities, along with other relevant stakeholders (such as local governments, local planning and community organizations, emergency response organizations and technical experts), into the resiliency planning decision-making process. This step is centered on investing in community-based social resilience measures. Through participatory planning, including the involvement of manufactured home park owners, local municipalities, county leadership, and non-profit partners, the Program will facilitate the exploration of solutions to mitigate the current and future risks of manufactured

home communities in the 100 or 500 year floodplain. The costs of this phase can include all expenditures necessary for meeting the goals of participation and engagement and solicitation of implementation inputs. These costs potentially consist of sub-recipient grants for technical expertise, meetings/gatherings/outreach costs/surveys/foreign language translation/social media costs/data requirements etc.

The costs will reflect the phase I component program elements of:

1) Community (and stakeholder/partners) identification and representation

2) Criteria Development for program inclusion

3) Selected Community outreach and engagement in comprehensive planning process

4) Mobilization of expertise and procurement. Obtain and engage partner/ planning firm to assist with outreach / participation efforts /research/asset inventories/ risk assessments etc.

5) Final Implementation Concepts and progression to next phases

The costs will be developed from budgets that address the various components of the program to arrive at final conceptual solutions. GOSR has budgeted $1,000,000 for planning costs within four MHCs These costs are included in the Phase II scenarios below.

<u>Phase II: Option 1, Buyout and Relocation</u>

Costs of Scenario Option 1 reflect FEMA and NYS law and policies for compensating impacted households for relocation who reside in Flood Zone AE communities (within the 100 yr. and 500 yr. event floodplains). The buyout and relocation of select vulnerable MHC communities in flood prone areas to areas outside of these floodplains would avoid numerous losses to households, property and resources. The option reflects a land use change to a natural

floodplain habitat that will support numerous ecological services that are highly valued by society.

Financing sources for Cooperative MHC structure would come from ROC-USA, HCR and Leviticus. Studies show that cooperative ownership structures for MHCs have economic advantages for resident communities compared to investor owned MHCs. Some of the benefits of COOPs or resident owned communities (ROCs) include the realization of higher average sales prices, faster home sales, and better access to fixed rate home financing. Additional benefits include community cohesion and enhanced sense of place and civic integration.

The costs of the scenario Option 1 Buyout and Relocation program element were based on parametric costing concepts, (and comparable home costs) and Manufactured Home Communities (MHC) scaling for a sample of 40 constituent units or pads. Statistical analysis of an average square foot for a given unit was used to scale up Option 1 Program element costs to a budget that would allow for buyout and relocation of approximately 80 Units or Park pads or multiple MHCs containing combinations of approximately 80 units.

Capital Cost elements include: Planning, Park Buyout, Uniform Relocation Assistance (URA) Costs, Rental Assistance, Acquisition, Development of New Land, Demolition and New Units, Development Costs plus contingency factor. No long term annually recurring costs (O&M) incurred because of land use change to riparian natural habitat characteristic of floodplain. The total program cost estimate for this option is **$28,000,000.** The table below shows the cost elements for option 1 and the assumptions used to scale up the MHC estimates to the program budget. It should be noted that since this is a programmatic evaluation, various combinations of MHC communities (units per MHC) can be combined to meet the program’s

budget goals. These combinations will be better informed after the Phase I Community-Based Planning and Outreach phase is completed.

Table 34: MHC Scenario Option 1 Mitigation Costs: Buyout and Relocation Costs

Cost Element \a	**Amount**
Planning	$500,000
Clearance and demolition of purchased site	$200,000
Park Buyout \b	$5,200,000
Uniform Relocation Assistance Costs \c	$320,000
Rental Assistance \d	$480,000
Acquisition \b	$5,200,000
Development of New Land	$3,200,000
Demolition and New Units \e	$9,600,000
Development Costs \f	$1,920,000
BASE TOTAL	$26,620,000
Contingency	$1,380,000
Grand Total	$28,000,000
Source: NYS GOSR Notes/Assumptions:	

Cost Element \a	**Amount**
\a Original cost estimate based on 40 units (households) that was then doubled to reflect 80 units/households. \b Acquisition cost based on $50k/unit average cost plus an additional 30% per unit (soft costs). \c URA costs based on $4000 per household \d Rental assistance based on $500 per month per household for 12 mos. \e Assumes $120K per unit package \f Based on 20% of Demolition and new units	

Phase II: Option 2, Infrastructure Improvements: Safely Elevating

Option 2 involves safely securing homes located in the 100 yr. and 500 yr. floodplains by either raising the structures safely above flood elevations, anchoring/securing structures, and/or building flood proofing containment structures (berms, levees, bulkhead construction etc.) The infrastructure improvements would avoid numerous losses to households, property and resources. Specific interventions will be informed by local knowledge that is gathered during the Phase I Community Based Planning and Outreach phase.

The costs of the Scenario Option 2: Infrastructure Improvements: Safely Elevating were based on parametric costing concepts, (and comparable home costs) and Manufactured Home Community (MHC) scaling for a group of 140 constituent units or pads. Statistical analysis of an average square foot for a given unit was used to scale up Option 2 Program element costs

(based on 70 households) to a budget that would allow for safe infrastructure improvements for approximately 140 units/households within a flood prone area.[6]

For Scenario Option 2: Infrastructure Improvements: Safely Elevating, capital cost elements include: Demolition and Elevation of approximately 140 household units, Soft Costs, Berm/Levee construction supporting an MHC of that size, Bulkhead, Anchoring, URA Costs, Relocation Assistance and contingency. The total program cost estimate for this option is **$42,000,000.** The table below shows the cost elements for option 2 and the assumptions used to scale up the MHC estimates to the program budget.

Table 35: MHC Option 2 Mitigation Costs-Infrastructure Strengthening: Safely Elevating

Cost Element \a	**Amount**
Planning	$500,000
Demolition and Elevation \b	$16,400,000
Soft Costs \c	$12,600,000
Berm/Levee \d	$2,376,401
Bulkhead \d	$8,124,547
Anchoring \e	$210,000
Uniform Relocation Costs (URA) \f	$560,000

[6] See References: FEMA 551 / March 2007. Selecting Appropriate Mitigation Measures for Floodprone Structures, and FEMA P-85, Second Edition / November 2009. Protecting Manufactured Homes from Floods and Other Hazards: A Multi-Hazard Foundation and Installation Guide.

Relocation Assistance \g	$840,000
Base Total	$41,610,948
Contingency:	$389,052
Grand Total Estimate:	$42,000,000

Source: NYS GOSR

Notes/Assumptions:

\a Original cost estimate based on 70 units (households) that was then scaled to reflect 140 units/households.

\b Adapted from unit cost estimates in ($/sf) for a modular home. Costs include demolition and removal of existing mobile home, foundation preparation, bonding and insurance, all strapping and blocks, basic modular design (rectangular), open foundation on piles. Includes standard interior and exterior finishes (no granite countertops, etc.)

Includes all permits. Does not include Special Needs / ADA Compliance Requirements or relocation and storage costs for homeowner during construction

\c Estimated at 30% of total cost

\d Based on $/LF estimate unit cost for 2 m scaled program area.

\e Based on $1500 per unit cost estimate

\f Based on estimate of 140 households x $4,000 per unit

\g Based on estimate of 140 households x $500 per mo. For 12 mos.

Resiliency Value

Phase I

For Phase I, resiliency value benefits consist of the process benefits of selecting the highest priority, most widely accepted, and most resilient project interventions in a timely manner. Without having this phase, the interventions would not necessarily result in the broadest and most inclusive investments that are implemented in a timely manner to benefit the most vulnerable populations.

Because local stakeholders are engaged and providing an ongoing dialogue and interaction with experts and other community stakeholders, the intervention designs are better informed (through local community inputs and knowledge) and more comprehensively developed. These plans result in interventions that contain more carefully tailored and crafted elements that are specific to the local area's adaptive resiliency needs.

Phase I will result in fewer economic transactions costs in arriving at sustainable interventions. This means that the outreach and engagement process will minimize dissatisfaction and objections on the part of some stakeholders that can potentially derail, or delay the process. Greater community acceptance of proposed concepts for implementation and

less opposition can result in improved schedules and streamlining that can save on mitigation costs. With less opposition to proposed concepts, fewer delays in implementation can speed up permitting and construction schedules. The quicker the adaptive resiliency investments are implemented, the less risk there is to the vulnerable populations in these communities from future catastrophic flood and storm events.

Reducing implementation time and risk levels from Phase I has value that is evident, but has not been quantified. These benefits have been assigned a Qualitative Weight of ++ because they are expected to have a strong positive impact.

Phase II: Scenario Option 1: Buyout and Relocation

The buyout and relocation of 80 homes will avoid damages to buildings, their contents and displacement costs that would have been incurred. Option 1 will remove approximately 80 households from harm’s way. These actions will result in avoided disruption, repair and displacement costs that were quantified and monetized in the CBA. The buyout and relocation option will also avoid evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs.

The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to buildings/structures, their contents and avoided displacement costs. The estimates were based on data contained within Flood Insurance Studies and Flood Insurance Rate Maps (FIRMS) and probable flood events impacting mobile home/manufactured home communities residing in 100 year event flood plains (Zone AE). The FEMA default depth damage function was applied to flood levels likely experienced in select riverine areas for given return periods (annual likelihood of flood events).

Storm impact damages for (10, 50, 100 and 500 yr.) events were converted to annual effective probable damages likely to be incurred over a 30 year period. The cumulative present value of annual avoided damages (for a period covering 2015 to 2045) was calculated by applying the 7% discount rate (per HUD Appendix H). Table 3 shows the cumulative present value of resiliency values for Option 1, and the annual undiscounted values by resiliency benefit type.

Table 36: Base Case Scenario Option 1: Buyout and Relocation: Resilience Values

Base Case	**Cumulative Present Values (2015 – 20145)**	**Undiscounted Annual Values**
Damage to buildings:	$39,772,332	$3,071,775
Damage to contents:	$23,005,235	$1,776,785
Avoided Displacement Costs:	$79,406	$6,133
Total Resilience Value:	$62,856,974	$4,854,693
Note: The BCA modelling completed for Option 1 did not require an adjustment for long term sea level rise, given that the subject location was not linked through hydrology or hydraulics to impacts that would require this adjustment.		

Phase II: Scenario Option 2: Infrastructure Strengthening and Safely Elevating

The elevation, anchoring, securing and flood proofing infrastructure constructed (i.e., berms, levees, bulkheads) will avoid damages to approximately 140 buildings, their contents and also avoid the displacement costs experienced by 140 vulnerable households.

Scenario Option 2 will elevate and secure approximately 140 vulnerable households structures and protect them from harm's way. These actions will result in avoided disruption, repair and displacement costs that were quantified and monetized in the CBA. Buyout and relocation will also avoid and greatly reduce evacuation and community assistance costs such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs.

The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to buildings/structures, their contents and avoided displacement costs. The estimates were based on data contained within Flood Insurance Studies and FIRMS and probable flood events impacting MHCs residing in 100 year event flood plains (Zone AE). The FEMA default depth damage function was applied to flood levels likely experienced in select riverine areas for given return periods (annual likelihood of flood events). The actual flood profile for the selected evaluation community was assessed to incorporate flood elevations associated with the 10, 50, 100, and 500 yr. return period elevations required by the flood module program. Storm impact damages for (10, 50, 100 and 500 yr.) events were converted to annual effective probable damages likely to be incurred over a 30 year period. The cumulative present value of annual avoided damages (for a period covering 2015 to 2045) was calculated by applying the 7% discount rate (per HUD Appendix H). The table below shows the cumulative present value of resiliency values for Option 2, and the annual undiscounted values by resiliency value type.

Table 37: Base and Sea Level Rise Case Scenario Option 2: Infrastructure Strengthening and Safely Elevating: Resilience Values

Base Case	**Cumulative Present Values (2015 – 2050)**	**Undiscounted Annual Values**
Damage to buildings:	$89,261,928	$4,373,499
Damage to contents:	$56,626,633	$2,506,100
Avoided Displacement Costs:	$32,448,162	$14,453
Total Resilience Value:	$187,134	$6,894,052
With Sea Level Rise		
Damage to buildings:	$222,551,855	$17,188,561
Damage to contents:	$125,281,833	$9,676,012
Avoided Displacement Costs:	$563,690	$43,536
Total Resilience Value:	$348,397,378	$26,908,109

Environmental Value

Phase 1

Local environmental benefits

Community based planning process will identify specific environmental benefits or costs that can be mitigated by the project interventions. These benefits have not been quantified but are assigned a qualitative weight of (++).

Phase 2

Scenario Option 1: Buyout and Relocation

Option 1 will create approximately 27 acres of riparian habitat once the structures are demolished and removed from the floodplain. These acres will be restored to their natural habitats and will provide ecosystem service benefits to the community. Option 1 reflects a land use change to a natural floodplain habitat that will support numerous ecological services that are highly valued by society. Environmental benefits of this type are considered for projects that result in a land use change related to acquisition/demolition and acquisition/relocation. The FEMA BCA Software program v. 5.1 Environmental Benefits estimation calculator was applied to estimate the annual monetized ecosystem service benefits generated from 27 acres of newly formed riparian habitat and associated functions.

The FEMA environmental benefits module has adopted the Millennium Ecosystem Services Assessment category classifications of Provisioning, Regulating, Supporting and Cultural services. The literature values that have been adopted fall within these categories. Ecosystem service values (per acre) reflect the combined riparian services of aesthetic value, air quality, biological control, climate regulation, erosion control, flood hazard reduction, food provisioning, habitat refugium, pollination, recreation/tourism, stormwater retention and water filtration. The per-acre values were obtained from peer reviewed ecosystem valuation literature.[7] The annual combined estimate per acre was then multiplied by the number of acres gained, and

[7] See Final Sustainability Benefits Methodology Report – Contract HSFEHQ-10-D-0806, Task Order: HSFEHQ-11-J-1408, August 23, 2012, FEMA, Federal Emergency Management Agency, Department of Homeland Security, 500 C Street, SW, Washington D.C., 20472.

combined within the Option 1 project resource statement and projected over a 35 period, and then discounted to present value using a 7% discount rate.

These benefits were monetized by applying the Appendix H approved annual ecosystem service benefits per acre per year for the full riparian services. The annual undiscounted value of these services was estimated to amount to $1,007,049 per year. The cumulative present value of these service benefits was calculated to be $13,038,937 over the 35 year period spanning 2015 to 2050.

Scenario Option 2: Infrastructure Improvements: Safely Elevating

Environmental Benefits were not quantified and monetized for this option. However these benefits are also significant and would receive a qualitative weight of (++).

Option 2 will result in environmental benefits associated with less resource use and expenditures associated with preparing for, and reacting to flood events and storms. During the 100 yr. events taking place within floodplain AE zones, many resources are marshalled to react to storms. Energy, fuel and materials are consumed to clean up and repair sites. For example emergency generators consume diesel fuel and are emission intensive and loud. Debris is removed and landfilled. All of these activities have associated environmental costs. Option 2 will result in avoiding many of these former vulnerability related costs.

Social Value

Phase I

Phase I, Community Based Planning and Outreach would result in the creation and strengthening of social capital benefits. Social capital can include the relationships that are developed and strengthened within the Manufactured Home Communities (as well as the larger

host community and municipality) that are directly attributable to, and catalyzed by, the community planning and engagement efforts. Social capital benefits have not been monetized but are described qualitatively and assigned a significant positive weight of (++). The benefits of social capital relationships can include new and expanded networks, engagement of isolated and marginalized or socially disenfranchised groups and individuals, and the formation of new social trust and bonds created among groups of diverse backgrounds. In addition, where feasible, the formation of Resident Owned Cooperatives (ROCs) as an ownership structure are conducive to forming new economic and social benefits and also strengthening existing social capital within a community.

Phase 2

Scenario Option 1: Buyout and Relocation

Option 1 will result in the following social value benefits:

1. Mental Stress and Anxiety Costs Avoided
2. Lost Productivity Costs Avoided, and
3. Avoided Physical Injuries

The buyout and relocation of 80 households from the vulnerable floodplain will remove these residents from harm's way. The CDC has estimated that approximately 10.4% of the respondents in flooded areas reported injuries in the first week after Sandy; and nearly 75% of those had multiple injuries.[8] This ratio of injury incidence was applied to the subject MHC

[8] Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report (MMWR) Nonfatal Injuries 1 Week After Hurricane Sandy — New York City Metropolitan Area, October 2012 Weekly, October 24, 2014 / 63(42): 950-954, Robert M. Brackbill, PhD et al.

communities evaluated within the Benefit Cost Analysis to quantify the likely injuries that would be avoided for this vulnerable population.

The buyout and relocation of 80 households also means that a certain percent of these residents (including many senior citizens and children) will also not experience the mental stress and anxiety associated with storm/flood event catastrophic events. In addition, a percentage of these communities will not experience the lost productivity associated with these impacts and the disruption in their work routines.

To quantify and monetize the mental stress and anxiety costs and lost productivity associated with flood events, the FEMA BCA software tool v. 5.1 was applied. An estimate of the population that would be impacted, and would incur these costs was based on past event ratios. The software contains standard treatment costs per person, and productivity losses per person that were then applied to the impacted population corresponding to the 80 households.

To quantify and monetize the costs of avoided physical injuries, the 10.4% of the population impacted ratio (adapted from Sandy study) was applied to the population associated with the 80 households who would be relocated. The Abbreviated Injury Scale (AIS) containing economic injury values by severity was then applied to an estimated distribution of the impacted population by severity. Most of the injuries quantified in this exercise were minor and moderate. The injury impact associated with a storm/flood event was then converted to an annual effective amount based on the thirty year projection horizon that takes into account the probability of the event occurring. The effective probability factor applied was based on the FEMA BCA program's resilient value annual damages compared to the total storm impact damages. The table below shows the Option 1 social values by type that were monetized.

Table 38: Base Case Scenario Option 1: Buyout and Relocation Social Values

	Cumulative Present Values (2015 – 20145)	**Undiscounted Annual Values**
Mental Stress and Anxiety Costs Avoided:	$633,216	$48,906
Lost Productivity Costs Avoided:	$2,264,336	$174,884
Avoided Physical Injuries (Abbreviated Injury Scale)	$8,742,356	$675,207
Total Social Value:	$11,639,908	$898,996

Scenario Option 2: Infrastructure Strengthening: Safely Elevating

Option 2 will result in the following social value benefits accruing to the household population corresponding to 140 MHC units. These benefits consist of:

1. Mental Stress and Anxiety Costs Avoided
2. Lost Productivity Costs Avoided, and
3. Avoided Physical Injuries

The infrastructure strengthening and safe elevation of 140 households within the vulnerable floodplain will protect and strengthen these residents from likely harmful, damaging and disruptive events. To quantify and monetize the mental stress and anxiety costs and lost productivity associated with flood events, the FEMA BCA software tool v. 5.1 was applied. An

estimate of the population corresponding to the 140 households that would be impacted, and would incur these costs was based on past event ratios. The table below shows the social value benefits monetized for Option 2.

Table 39: Base Case Scenario Option 2: Infrastructure Strengthening and Safely Elevating Social Values

	Cumulative Present Values (2015 – 2050)	**Undiscounted Annual Values**
Mental Stress and Anxiety Costs Avoided:	$1,276,482	$98,588
Lost Productivity Costs Avoided:	$4,564,614	$352,543
Avoided Physical Injuries (Abbreviated Injury Scale)	$17,590,894	$1,358,614
Total Social Value:	$23,431,991	$1,809,745

Economic Revitalization

Phase I

The State's proposed Program directly engages and impacts residents of manufactured home communities in developing more socially physically resilient communities. Manufactured home communities often have many low- to moderate-income households, and higher proportions of elderly and disabled residents.

The design of this Program ensures that community resilience will be improved, particularly through the comprehensive community assessment in the planning phase of this Program, which will identify current and future risks. By educating and informing residents about Resident Owned Community COOP ownership structures, the planning process can result in economic and community development revitalization benefits that can be part of the final implementation options.

Economic revitalization and community development values from community planning process will be assigned a significant positive qualitative weight of (++).

Phase 2

Scenario Option 1: Buyout and Relocation

The Resident Owned Community (ROC/Coop) model can result in community development and economic revitalization benefits to MHCs adopting this structure. Studies show that cooperative ownership structures for MHCs have economic advantages for resident communities compared to investor owned MHCs[9]. Among the benefits of COOPs or resident owned communities (ROCs) include the realization of higher average sales prices, faster home sales, and better access to fixed rate home financing. Additional benefits include community cohesion and enhanced sense of place and civic integration. ROCs provide more stable and affordable lot fees, more control (and less anxiety) to residents (less vulnerability to displacements), opportunity to build equity (wealth), and asset appreciation.

[9] Charsey Institute at the University of New Hampshire – Building Value and Security for Homeowners in "Mobile Home Parks": A Report on Economic Outcomes, A report commissioned by the New Hampshire Community Loan Fund. Ward et al.

The ROC benefits have not been quantified but are described qualitatively and assigned a significant positive weight (++). Resident owned communities can provide the following benefits:

1. Asset Appreciation
2. A more stable, secure and expanded lending market for creditors
3. Premium sales prices. Suppose the average price per unit for a 1000 sq. ft. Investor owned unit is $40,000 and the MHC has 80 units. The appraised value of this community MHC is $3.2 million. The relocated community converts to an ROC form and potentially, the appraised value rises by 7.3% to $3.444 million. Close to $250K in equity is now part of the ROC COOP according to studies.
4. Faster re-sales and less time on market
5. Community pride in asset and land ownership
6. Sense of community cohesion and team work. ("We are in this together for betterment of COOP")
7. Civic integration. Desire of non-members (renters) to join to gain economic and other benefits of ROC.
8. Access to mortgage loans and easier access to fixed rate home financing
9. More stable and affordable monthly lot fees (avoided escalation in fees over time). This is a significant benefit for senior citizens and more affordable to lower income families and younger buyers starting families/households.
10. Ability of members to build equity (wealth) over time

11. Site Control. Site control translates into greater control over fates and lives. ROC structure provides for less anxiety and fear of displacement because owners control disposition of property and community is democratized.

Scenario Option 2: Infrastructure Improvements: Safely Elevating

The infrastructure enhancement and safe elevation of structures within the floodplain results in less disruption and loss of the economic base. For example, after Hurricane Katrina, the New Orleans population has still not rebounded to pre-Hurricane levels. The economic activity contributed by this lost population migration segment could have been retained within this region if infrastructure failure did not happen. Foregone regional economic activity from events and impacts without infrastructure strengthening and elevation can therefore be avoided and must be recognized as a benefit that is hard to quantify, but is evident nevertheless. These impacts can consist of items such as lost consumer spending, business capital investment and expansion and other activities that would have contributed to a higher level of economic growth absent the storm/flood event. These impacts have not been quantified but relate to such activities as business interruption and losses and less spending than would otherwise have occurred, “but for” the incident. A severe storm/flood can result in sub-par economic growth that can persist for years. Also, the permanent reduction of a community’s population (aka Katrina communities) can persist for years after an event resulting in a loss that could have been avoided with enhanced infrastructure in place. The effects of this lost economic activity were not monetized but are assigned a qualitative significant positive weight (++).

Manufactured Homes Community Resilience Program: Qualitative Narrative for Unquantified Benefits

The following benefits are described qualitatively. These benefits relate to several phases of the program described below. To attach significance weights to these qualitative benefits, the weighting scheme from Appendix H was applied.

Resiliency Value

Phase I: Community Based Planning: For Phase I, resiliency value benefits consist of the process benefits of selecting the highest priority, most widely accepted, and most resilient project interventions in a timely manner. Concerted planning efforts can save time and money and result in quicker implementation of the resilient intervention. This intangible benefit was not monetized. Without having Phase I, the interventions would not necessarily result in the broadest and most inclusive investments that are implemented in a timely manner to benefit the most vulnerable populations. Because local stakeholders are engaged and providing an ongoing dialogue and interaction with experts and other community stakeholders, the intervention designs are better informed (through local community inputs and knowledge) and more comprehensively developed. These plans result in interventions that contain more carefully tailored and crafted elements that are specific to the local area's adaptive resiliency needs.

Phase I will result in fewer economic transactions costs in arriving at sustainable interventions. This means that the outreach and engagement process will minimize dissatisfaction and objections on the part of some stakeholders that can potentially derail, or delay the process. Greater community acceptance of proposed concepts for implementation and less opposition can result in improved schedules and streamlining that can save on mitigation costs. With less opposition to proposed concepts, fewer delays in implementation can speed up permitting and construction schedules. The quicker the adaptive resiliency investments are implemented, the less risk there is to the vulnerable populations in these communities from future catastrophic flood and storm events. Reducing implementation time and risk levels from Phase I has value that is evident, but has not been quantified. These benefits have been assigned a Qualitative Weight of (++) because they are expected to have a strong positive impact.

Environmental Value

Phase I: Community Based Planning: The community based planning process will identify specific local environmental benefits or avoided costs that can be mitigated by the project interventions. For example, local environmental benefits can consist of potential energy savings in the use of raw materials and resources used in the buyout and relocation of select MHCs. These benefits have not been quantified but are assigned a qualitative weight of (++).

Phase II - Scenario Option 2: Infrastructure Strengthening: Safely Elevating: Option 2 will result in environmental benefits associated with less resource use and expenditures associated with preparing for, and reacting to flood events and storms. During the 100 yr. events taking place within floodplain AE zones, many resources are marshalled to react to, and cope with storms and their aftermath. Energy, fuel and raw and processed materials are consumed to clean up and repair sites. For example, emergency generators deployed following power outages consume diesel fuel, are emission intensive and loud. Emissions and particulates can be harmful

to residents even with proper ventilation of the generators. In addition, the Phase II option will avoid the accumulation of debris from building materials and contents that must be removed and landfilled/recycled following extreme events. All of these activities have municipal solid waste, and hazardous waste removal and associated environmental costs. Routing wastes to a landfill involves collection, processing and truck transportation that can also be emission intensive. Option 2 will result in avoiding many of these former vulnerability related costs. Environmental Benefits were not quantified and monetized for this option. However these benefits are also significant and would receive a qualitative weight of (++).

Social Value

Phase I: Community Based Planning: Phase I, Community Based Planning and Outreach would result in the creation and strengthening of social capital benefits. Social capital can include the relationships that are developed and strengthened within the Manufactured Home Communities (as well as the larger host community and municipality) that are directly attributable to, and catalyzed by, the community planning and engagement efforts. The benefits of social capital relationships can include new and expanded networks, engagement of isolated and marginalized or socially disenfranchised groups and individuals, and the formation of new social trust and bonds created among groups of diverse backgrounds. In addition, where feasible, the formation of Resident Owned Community cooperatives (ROCs) as an ownership structure, are conducive to forming new economic and social benefits and also strengthening existing social capital within a community. Social capital benefits have not been monetized but are described qualitatively and assigned a strong positive weight of (++).

Economic Revitalization

Phase I: Community Based Planning: The State's proposed Program directly engages and impacts residents of manufactured home communities in developing more socially physically resilient communities. Manufactured home communities often have many low- to moderate-income households, and higher proportions of elderly and disabled residents. The design of this Program ensures that community resilience will be improved, particularly through the comprehensive community assessment in the planning phase of this Program, which will identify current and future risks. By educating and informing residents about Resident Owned Community COOP ownership structures, the planning process can result in economic and community development revitalization benefits that can be part of the final implementation options. Economic revitalization & community development values from community planning process will be assigned a strong positive qualitative weight of (++).

Phase II - Scenario Option 1: Buyout & Relocation: The Resident Owned Community (ROC/Coop) model can result in community development and economic revitalization benefits to MHCs adopting this structure. Studies show that cooperative ownership structures for MHCs have economic advantages for resident communities compared to investor owned MHCs[10]. Among the benefits of COOPs or resident owned communities (ROCs) include the realization of higher average sales prices, faster home sales, and better access to fixed rate home financing.

[10] Carsey Institute at the University of New Hampshire – Building Value and Security for Homeowners in "Mobile Home Parks": A Report on Economic Outcomes, A report commissioned by the New Hampshire Community Loan Fund. Ward et al.

Additional benefits include community cohesion and enhanced sense of place and civic integration. ROCs provide more stable and affordable lot fees, more control (and less anxiety) to residents (less vulnerability to displacements), opportunity to build equity (wealth), and asset appreciation. Resident owned communities can provide the following benefits: Asset Appreciation; a more stable, secure and expanded lending market for creditors; Premium sales prices. Suppose the average price per unit for a 1000 sq. ft. Investor owned unit is $40,000 and the MHC has 80 units. The appraised value of this community MHC is $3.2 million. The relocated community converts to an ROC form and potentially, the appraised value rises by 7.3% to $3.444 million. Close to $250K in equity is now part of the ROC COOP according to studies; Faster re-sales and less time on market; Community pride in asset and land ownership; Sense of community cohesion and team work; Civic integration; Desire of non-members (renters) to join to gain economic and other benefits of ROC; Access to mortgage loans and easier access to fixed rate home financing; More stable and affordable monthly lot fees (avoided escalation in fees over time). This is a significant benefit for senior citizens and more affordable to lower income families and younger buyers starting families/households; Ability of members to build equity (wealth) over time; Site Control. Site control translates into greater control over fates and lives. ROC structure provides for less anxiety and fear of displacement because owners control disposition of property and community is democratized. The ROC benefits have not been quantified but are described qualitatively and assigned a strong positive weight (++).

Phase II - Scenario Option 2: Infrastructure Strengthening: Safely Elevating: The infrastructure enhancement and safe elevation of structures within the floodplain results in less disruption and loss of the economic base. For example, after Hurricane Katrina, the New Orleans population has still not rebounded to pre-Hurricane levels. The economic activity contributed by this lost population migration segment could have been retained within this region if infrastructure failure did not happen. Foregone regional economic activity from events and impacts attributable to not having infrastructure strengthening and elevation in place, can therefore be avoided, and must be recognized as a benefit that is hard to quantify, but is evident nevertheless. These impacts can consist of lost consumer spending, business interruption losses, foregone business capital investment and expansion and other activities that would have contributed to a higher level of economic growth absent the storm/flood event. These impacts have not been quantified but would have occurred, “but for” the incident. A severe storm/flood can result in sub-par economic growth that can persist for years. The effects of this lost economic activity were not monetized but are assigned a qualitative strong positive weight (++).

Public Housing Resilient Construction Demonstration Project (Five Sites at Four Public Housing Authorities)

Lifecycle Costs

The **Capital Cost** of the flood mitigation measures of the public housing program includes the cost of resiliency retrofits to existing structures, the cost of resilient new construction at Moxey Rigby, and related resiliency site interventions. Resiliency measures will prevent damage to structures, critical systems, and grounds; loss of resident-owned property and contents; and above all displacement, injury, or death of residents.

The resilient retrofit strategies for each proposed project area discussed under the project descriptions and include dry flood proofing, wet flood proofing, elevating mechanicals, installing back-up generators, green stormwater management systems, as well as the construction of replacement housing (for the Freeport Housing Authority only).

The Capital Cost for each of the proposed projects (in total) is as follows:

- North Shore Village, Binghamton: $6.55 million
- Mill River Gardens, Hempstead: $7.99 million
- Inwood Gardens, Hempstead: $8.44 million
- Long Beach Channel Homes, Long Beach: $12.20 million
- Moxey Rigby Homes, Freeport: $42.7 million

The **Operation and Maintenance Cost** are assumed to remain the same before and after the flood mitigation interventions with the exception of the energy savings, which is counted as a benefit.

The cost of the **Workforce Development Program** is estimated at $8,000 per participant or $160,000 total. The Workforce Development Program will be held at Inwood Gardens, Long Beach Channel Homes, and Moxey Rigby.

Resiliency Value

The resiliency values analyzed for the Public Housing Resilience Pilot Program are avoided damages to structures and their contents, avoided displacement, avoided loss of power and avoided evacuation cost. Using the FEMA standard values for useful life ranges, the project useful life assumptions were as 50 years for retrofits and 100 years for new construction. The FEMA BCA software v. 5.1 was used to estimate annual avoided damages to buildings and their contents and avoided displacement of its residents. Information on flood depth at 10, 50, 100 and 500 year recurrence intervals was obtained from the Nassau County Flood Insurance Study and Binghamton County Flood Insurance Study. The FEMA tool's default depth damage function (DDF) for apartment buildings was used to quantify the damage to structures an contents as well as the displacement based on flood depth. Avoided power loss and evacuation cost were analyzed outside the tool.

The cumulative present value of annual avoided damages was calculated by applying the 7% discount rate (per HUD Appendix H). The table below shows the cumulative present value of

resiliency values under a National Oceanic and Atmospheric Administration (NOAA) high and low sea level rise prediction[11].

Avoided Damage to Structures

Implementation of the resiliency measures will avoid damage to the structures in case of future flooding. The FEMA default depth damage function (DDF) for apartment buildings quantifies damage to structure as a percent of the structure's replacement value. The replacement value was limited to the replacement value of the first floor and, if applicable, the basement. Taking into account the probability of different flood depth levels, the annual effective probable damage to structures with and without the mitigation projects was estimated.

Avoided Damages to Contents

Implementation of the measures will avoid damage to building contents in case of future flooding. The DDF quantifies damage to structure as a percent of the structure's replacement value. Building contents were assumed to have a value of 28 percent of the structure replacement value, which was limited to the replacement value of the first floor and, if applicable, the basement. Taking into account the probability of different flood depth levels, the annual effective probable damage to contents with and without the mitigation projects was estimated.

Avoided Displacement

Implementation of the measures will avoid displacement of residents in case of future flooding. The FEMA default depth damage function (DDF) for apartment buildings was used to

[11] Detailed Integrated Tool to Estimate Potential Future Sea Levels for Consideration in Sandy Recovery. Accessed from http://www.corpsclimate.us/Sandy/curvesNJNY2_detailed_NOAA.asp, Sept 20, 2015

quantify the duration of the displacement (number of days) based on flood depth. Daily displacement cost was calculated as the sum of the federal per diem for lodging ($77) and for food ($46, then reduced by the cost of eating at home of $7). The total daily cost was calculated by multiplying the per diem values with the number of building residents (for food) and with the number of households (for lodging):

*Daily per Diem Cost = (Number of residents * ($46-$7)) + (Number of units * ($77))*

The number of days of displacement with and without the mitigation projects was estimated taking into account the probability of different flood depth levels.

Avoided Evacuation Cost

In addition to the cost of food and lodging during displacement, displaced residents will incur cost for the evacuation itself. Elderly and disabled persons may need a transportation service and/or the help of volunteers. The analysis includes a cost estimate for all residents of senior housing and housing for persons with disabilities. The cost is estimated as follows: (1) $80 per person for a transportation service, which is a USACE estimate for the transportation of elderly evacuated from an elderly care facility[12]; (2) two times the average county wage for volunteer time per resident as reported by the U.S. Bureau of Labor Statistics. The volunteer cost estimate assumes an average of two hour to help each resident prepare for evacuation. To obtain an annual estimate of the avoided evacuation cost, the cost associated with one flood event was adjusted to take into account the probability of a flood in any given year based on the FEMA BCA tool.

[12] http://www.nad.usace.army.mil/Portals/40/docs/NACCS/10B_Emergency_Costs_26Jan2015.pdf

Avoided Loss of Electricity

The proposed mitigation measures include energy retrofits that will increase efficiency and improve reliability. The FEMA's BCAR identifies the per capita per day impact of power loss on residential customers to be $24.58 (in 2010 dollars). The probability for power loss was assumed to be equal to the probability of displacement, which was calculated by the FEMA BCA Tool.

Table 40: Resiliency Values (Cumulative Present Values)

	Low Sea Level Rise	**High Sea Level Rise**
Damage to buildings:	$7,865,332	$18,799,024
Damage to contents:	$4,290,683	$ 9,794,021
Avoided Displacement Costs:	$7,751,901	$ 14,363,458
Avoided Evacuation Cost:	$487,193	$487,193
Avoided Loss of Electricity:	$125,297	$125,297
Total Resilience Value:	**$ 20,520,406**	**$ 43,568,994**

Environmental Value

Energy Savings

The proposed resilient retrofits will make the buildings more efficient and will produce energy savings. The amount of the energy savings will depend on the specific measures

implemented. Retro-commissioning, a systematic process of analyzing an existing building to improve comfort and energy efficiency by correcting for deficiencies in design, construction, equipment, and maintenance which ensures that existing systems are performing as designed is a low cost approach that generates significant savings. Meta-analyses done in 2001 and 2005 by the Lawrence Berkeley National Laboratory showed that a $0.30 per square foot investment reduced energy consumption by a median of 16 percent, and had an average payback of 1.1 years.[13] The average energy cost per square foot for multifamily residential buildings in the Northeast ($2.15/square foot) was obtained from the EIA.[14] The cost savings were estimated as follows:

*Energy Savings = Total building square feet * ($2.15*0.16)*

The environmental value under the low and high sea level rise scenario is included in the table below.

Table 41: Environmental Value (Cumulative Present Values)

	Low Sea Level Rise	**High Sea Level Rise**
Energy Savings	$ 2,248,904	$ 2,248,904

[13] RMI Outlet, Affordable Housing with unaffordable Energy, August 2013, http://blog.rmi.org/blog_2013_08_19_affordable_housing_with_unaffordable_energy_bills
[14] US Energy Information Administration, Residential Energy Consumption Survey, Accessed from http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=consumption#summary

Social Value

The social values analyzed include mental stress and anxiety costs avoided, lost productivity costs avoided, and avoided physical injuries. FEMA Standard Values were used to monetize these avoided costs. Additional unquantified values may relate to social cohesion benefits from these interventions. Table 3 shows the cumulative present value of the social values under high and low sea level rise scenarios.

Mental stress and anxiety costs avoided

There is a clear and definite connection between mental stress impacts and disasters. The American Red Cross (ARC) estimates that 30-40 percent of the impacted population will need some sort of mental health-related assistance while another study found a rate of 32 percent.[15] To quantify and monetize the mental stress and anxiety costs associated with flood events, a standard FEMA value on treatment cost per person ($2,443) was multiplied with the number of residents in each housing property that would require treatment, which we assumed was 32 percent. To obtain an annual estimate of the avoided treatment cost, the cost associated with one flood event was adjusted to take into account the probability of a flood in any given year based on the FEMA BCA tool. The calculation used is as follows:

*Avoided Mental Health Treatment Cost = Number of Residents *0.32 *$2,443*

Lost productivity avoided

[15] FEMA, Final Sustainability Benefits Methodology, August 2012, p.10.

The cost of the lost productivity associated with the stress and anxiety by a flood event was monetized by multiplying the standard FEMA value of $8,743 was multiplied by an estimate of the number of working residents in each property:

*Lost Productivity Avoided = Number of Working Residents *0.32 *$8,743*

Avoided Injuries

The CDC has estimated that approximately 10.4% of the residents in flooded areas reported injuries in the first week after Sandy; and nearly 75% of those had multiple injuries.[16] The Abbreviated Injury Scale (AIS) containing economic injury values by severity was used to obtain the cost of the injury. For housing developments reserved for elderly and disabled persons, it was assumed that average injury was moderate, which is valued as $105,876. For the other developments, it was conservatively assumed that all injuries were minor, valued at $13,494. The following calculations were used:

Avoided Injuries in Buildings with Elderly/Disabled: Number of residents 0.0104*$105,876*

Avoided Injuries in Other Buildings: Number of residents 0.0104*$13,494*

Table 42: Social Value (Cumulative Present Values)

	Low Sea Level Rise	**High Sea Level Rise**
Mental Stress and Anxiety Costs Avoided (Treatment Cost and Lost Productivity)	$ 13,515,669	$ 25,406,629

[16] Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report (MMWR) Nonfatal Injuries 1 Week After Hurricane Sandy — New York City Metropolitan Area, October 2012 Weekly, October 24, 2014 / 63(42); 950-954, Robert M. Brackbill, PhD et al.

Avoided Physical Injuries	$ 16,101,185	$ 22,350,600
Total Social Value:	**$ 29,616,855**	**$ 47,757,230**

Economic Revitalization

Increased Earnings and Benefits

The workforce development program will educate, train, and connect public housing residents with both traditional and "green collar" opportunities. After the training, each participant will be placed into an apprenticeship program with the building trade unions. These participants will benefit from a lifetime increase in earnings. Prevailing wage data from the New York State website were used to estimate wages and benefits for apprentices and journeyman in several construction trades in Nassau County. The lifetime earnings were estimated using median hourly wages and benefits for all trades range from x for a first year apprentice to x for a journeyman. It was further assumed the average employee would work 1960 hours and year and a 15-year career after completing the program. Finally, it was assumed that all participants are currently unemployed and that thus all earnings were a net benefit.

*Annual Earnings = Number of participants * average wage and benefits per hour * 1960 hours.*

The table below shows the cumulative present value of resiliency values under a low and high sea level rise scenario.

Table 43: Economic Revitalization (Cumulative Present Values)

	Low Sea Level Rise	**High Sea Level Rise**
Increased Employee Compensation	$ 22,925,693	$ 22,925,693

Public Housing Community Resilience Program: Qualitative Narrative for Unquantified Benefits

To attach weights to qualitative benefits, the Appendix H weighting scheme is applied.

Resiliency Value

Avoided evacuation cost – By protecting the public housing against flood damage, the Public Housing Resiliency Program will reduce the likelihood of a flood-related evacuation. While the analysis monetizes the evacuation cost of persons needing special assistance, it does not monetize the evacuation cost of the general population. In addition to the displacement costs, which include lodging and food expenditures after evacuation, the evacuation itself is associated with transportation cost and lost earnings and well as cost incurred by federal, state or local government for evacuation. These avoided costs have not been quantified as part of this analysis and are assigned a strong positive weight of (++).

Environmental Value

The Program will result in environmental benefits associated with less resource use and expenditures associated with preparing for, and reacting to flood events and storms. During the 100 yr. events impacting coastal zones, many community resources are marshalled to react to, and cope with storms and their aftermath. Energy, fuel and raw and processed materials are consumed to clean up and repair sites (witness the Post Sandy aftermath cleanup and restoration in Long Beach for instance). Emergency generators are deployed following power outages and consume diesel fuel, are emission intensive and loud. Emissions and particulates can be harmful to residents even with proper ventilation of the generators. In addition, the accumulation of debris from building materials and contents that must be removed and landfilled/recycled following extreme events. All of these activities have municipal solid waste, and hazardous waste removal and associated environmental costs. Routing wastes to a landfill involves collection, processing and truck transportation that can also be emission intensive. The PH Community Resilience Program will result in avoiding many of these former vulnerability related costs. In addition, the water quality benefits and beautification benefits associated with the proposed bioswales and related interventions were not quantified in this study. These benefits receive a qualitative weight of (++).

Social Value

Children of participants in the workforce development program are expected to benefit from their parents' employment beyond the value of increased wages and benefits. [17] Examples include improved academic achievement and health improvements. These benefits receive a qualitative weight of (+). Through its workforce component, the Public Housing Resilience Program may also contribute to the development or strengthening relationships among residents within the public housing developments. The benefits of these social capital relationships can include new and expanded networks, engagement of isolated and marginalized or socially disenfranchised groups and individuals, and the formation of new social trust and bonds created

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[17] Ridley, N. and Kenefick, E., Research shows effectiveness of workforce programs. http://www.clasp.org/resources-and-publications/files/workforce-effectiveness.pdf

among groups of diverse backgrounds. Social capital benefits have not been monetized but are described qualitatively and assigned a positive weight of (+).

Economic Revitalization

The mitigation projects will support local constructions jobs in addition to the construction jobs that would be provided to the apprentices in the workforce development program. These benefits received a qualitative weight of (+).

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program; Right-Sizing Bridges Program; Critical Dam Resiliency and Right-Sizing Project (Seven Sites)

A description of the benefits and costs defined in the analysis follows, benefits are categorized as either resiliency, environmental, social or economic. All Costs and Benefits for all right-sizing projects and programs are presented together in this section.

Lifecycle Costs

For bridges, culverts and dams, costs included upfront capital costs and annually recurring operations and maintenance costs. For floodplain restoration, costs were delineated by each factor included in the process: wetlands restoration, berm removal and fill removal and the total number of acres designated for restoration. Operations and maintenance were not quantified for the floodplain concept.

Program infrastructure mitigation costs were provided by GOSR with inputs from DEC, DOT, and Parks. Costs include replacing bridges and culverts and dams across the State. The updated infrastructure would help mitigate environmental, social and economic damages associated with moderate and major flood events. Costs for bridges provided were $111.11 million; combined costs for culverts and floodplain restoration totaled approximately $106 million, and approximately $50 million for dams for a combined total cost of $256 million.

Capital Cost elements for floodplain restoration include the restoration of 300 acres of wetlands, removing 5,280 feet of berms, and removing 20,000 cubic feet of fill from floodplains. Costs provided were $2,200,000 for restoration of wetlands, $180,000 for berm removal and $16,250,000 for floodplain fill removal.

The table below provides overall costs for the rightsizing infrastructure aspect of the project.

Table 44: Program Mitigation Costs, Rightsizing Infrastructure

Cost Element	Cost
Capital Cost – Bridges	$111,100,000
Capital Cost – Culverts & Floodplain Restoration	$106,000,000
Capital Cost Dams	$49,550,500
Total Capital Costs:	$266,650,500
Operations & Maintenance – Bridges	$157,262
Operations & Maintenance – Culverts & Floodplain Restoration	$421,260
Operations & Maintenance – Dams	$77,423
Grand Total	$267,306,445

Resiliency Value

Updating infrastructure to better withstand and accommodate flood events would help avoid costs associated with evacuation and community assistance such as emergency response costs, volunteer costs, storm preparation costs, storm cleanup costs, and repair costs.

Resiliency values for bridges, culverts and dams included functional losses to critical infrastructure, or the costs associated with a bridge, culvert or dam being placed out of commission and non-operational for a certain amount of time. The FEMA BCA software v. 5.1 was applied to estimate annual avoided damages to roads, bridges and dams, and the avoided displacement costs associated with loss of infrastructure during and after a flood event. The

BCA software required inputs based on traffic data (AADT, additional miles, additional detour time), which were provided by the state agencies. Estimated avoided damages from flood/extreme weather events were annualized based on the event return period annual probability of occurrence.

Avoided operations and maintenance costs associated with updated bridge infrastructure was calculated, based on data provided by DOT. This data was not available for culverts, so O&M costs were extrapolated using data from a case study on stream simulation culverts (State of Wisconsin, 2012). Resiliency values were not quantified for wetlands restoration; this benefit would be difficult to accurately quantify given the lack of data on wetland restoration and berm and fill removal, and flood damages prevented.

Table 45: Resiliency Values, Rightsizing Infrastructure

Benefit Element	Undiscounted Annual Benefit	Cumulative Present Values
Functional Losses to Critical Infrastructure		
Right-Sizing Bridges Resiliency Program	$107,977	$1,490,167
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$1,085,899	$13,474,963
Right-Sizing Critical Dams Resiliency Project	$482,046	$6,652,597
Total	$1,675,922	$21,617,727
Avoided O&M Costs with New Infrastructure		
Right-Sizing Bridges Resiliency Program	$223,824	$3,088,939
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$237,405	$2,945,968
Right-Sizing Critical Dams Resiliency Project	$0	$0
Total	$461,229	$6,034,907
Total Resiliency Values	$2,137,151	$27,652,634

Environmental Value

Updating bridges, culverts, and dams, and restoring floodplains hosting riparian wetlands would reduce negative impacts to the immediate environment associated with flooding. Environmental benefits for the bridge, culverts and dam aspects include avoided environmental damages, enhanced water quality associated with updating infrastructure (resulting in less erosion, sediment deposition and improved stream turbidity), and avoided cost of wetland retention. The benefits that would occur as a result of reduced impact from flooding on the immediate environment is quantifiable. FEMA 5.1 software was used to arrive at a riparian land use benefits figure. The full riparian wetland value applied is based on vetted literature values for ecosystem services and reflect combined provisioning, regulating and supporting services provided by wetlands in these locations.[18] The value applied was $37,493 per acre. For the model, it was assumed two acres of land immediately surrounding the infrastructure would be affected, for a total of $74,986 in benefits. This figure was then annualized.

For the wetlands restoration aspect, avoided environmental damages were broken out into each element of wetlands restoration, actual restoration, berm removal and fill removal. Enhanced water quality was also quantified. FEMA 5.1 software was used to arrive at a per acre riparian land use benefit, based on acreage as provided by GOSR.

The value of enhanced water quality is predicated on the assumption that individuals are willing to pay for higher relative water quality in their communities. Several studies have attempted to monetize what is referred to as "willingness to pay" (WTP) in consideration to water quality. Typically this metric is measured through direct surveys of individuals and households. An estimate of willingness to pay, based on research conducted in a study on behalf

[18] See Final Sustainability Benefits Methodology Report, FEMA, August 23, 2012.

of the State of Wisconsin (2012), was applied to the bridges, culverts and wetland restoration approaches. A monetized value of $10 per household was used for each approach, this figure was annualized for each aspect of the project (bridges, culverts and wetland restoration), based on the estimated population affected figure. The next table provides annual benefits associated with environmental values.

Table 46: Environmental Values, Rightsizing Infrastructure

Benefit Element	Undiscounted Annual Benefit	Cumulative Present Values
Avoided Environmental Damages		
Right-Sizing Bridges Resiliency Program	$28,212	$389,344
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$446,167	$5,536,501
Right-Sizing Critical Dams Resiliency Project	$10,639	$146,828
Total	$485,018	$6,072,672
Enhanced Water Quality		
Right-Sizing Bridges Resiliency Program	$1,185,117	$16,355,497
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$2,915,690	$36,180,917
Right-Sizing Critical Dams Resiliency Project	$0	$0
Total	$4,100,807	$52,536,414

Avoided Cost - Wetland Retention		
Right-Sizing Bridges Resiliency Program	$103,463	$1,427,861
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$241,426	$2,587,361
Right-Sizing Critical Dams Resiliency Project	$17,033	$235,068
Total	$136,858	$4,250,290
Total Environmental Values	$4,947,745	$62,859,376

Social Value

Two categories of social values were analyzed in the right-sizing aspect of the project, avoided injuries and fatalities, and avoided mental stress and anxiety. Costs associated with injuries/fatalities were factored using the Center for Disease Control estimate of percentage of persons reporting injuries after a natural disaster (2012). Cost per person was taken from the Appendix H NDRC Data Resources, economic value of injury. The moderate figure was applied to the bridge concept, while the minor figure was utilized for culverts and floodplain restoration. Estimated percent reporting injuries (10% per CDC, 2012) and cost per person (NDRC) were factored with total population affected to arrive at total cost avoided. This figure was then annualized.

The mental stress and anxiety metric was modeled by applying the FEMA BCA 5.1 standard value for cost per person ($2,443) to total persons affected, which was estimated at 30% of total persons in the region of influence. This total costs avoided figure was then annualized to

arrive at an annual effective benefit. The table below presents undiscounted annual benefits associated with both injuries and fatalities and mental stress.

Table 47: Social Values, Rightsizing Infrastructure

Benefit Element	Undiscounted Annual Benefit	Cumulative Present Values
Avoided Injury / Fatality		
Right-Sizing Bridges Resiliency Program	$24,176,383	$333,652,133
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$16,757,598	$207,945,724
Right-Sizing Critical Dams Resiliency Project	$6,269,043	$86,517,466
Total	$47,203,024	$628,115,322
Avoided Mental Stress / Anxiety		
Right-Sizing Bridges Resiliency Program	$1,737,144	$23,973,887
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$9,447,418	$117,233,401
Right-Sizing Critical Dams Resiliency Project	$450,449	$6,216,534
Total	$11,635,012	$147,423,822
Total Social Values	$58,838,035	$775,539,144

Economic Revitalization

This aspect was categorized as avoided disruption to local economic activity, where updated infrastructure could prevent a flood event from creating these economic costs. FEMA's BCA software was utilized to quantify these values, using the FEMA 5.1 per person per hour cost of disruption ($30.07 per hour). The FEMA figure was applied to an estimate of population affected (15%), as well as number of outage hours (hours that economic activity would have been disrupted by a flood event, estimated at 48 hours), to arrive at a total cost avoided figure. This was then annualized.

Table 48: Economic Revitalization Values, Rightsizing Infrastructure

Benefit Element	Undiscounted Annual Benefit	Cumulative Present Values
Avoided Disruption to Local Economic Activity		
Right-Sizing Bridges Resiliency Program	$17,066	$211,988235,519
Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program	$92,811	$1,151,699
Right-Sizing Critical Dams Resiliency Project	$43,377	$598,633
Total Social Values	$153,254	$1,985,852

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program; Right-Sizing Bridges Program; Critical Dam Resiliency and Right-Sizing Project (Seven Sites): Qualitative Narrative for Unquantified Benefits

Resiliency Value

Avoided debris, sediment maintenance costs, and streamflow: One study on the subject of stream-simulation culverts suggests there is a statistically significant negative correlation between culvert obstruction and a culvert's constriction ratio, meaning culverts with a larger constriction ratio are less likely to require maintenance (Wisconsin Department of Natural Resources, 2012). However, because available literature and case studies utilize differing locations and culvert types, it is not possible to obtain an accurate quantification of maintenance benefits by utilizing more than one study. In addition, data on maintenance costs of various bridge types do not appear to be available. As such, this benefit should be expressed qualitatively. These benefits have been assigned a Qualitative Weight of + because they are expected to have a moderate positive impact.

Functional losses to critical infrastructure - floodplain restoration: Although this element was expressed quantitatively for bridges, culverts and dams, quantifying this element for floodplain restoration would prove difficult, and somewhat ambiguous. This is because floodplain restoration would create an indirect beneficial effect for infrastructure, helping to reduce risk to these projects by reducing flood risk, although the extent of this benefit would be difficult to measure. A Qualitative Weight of + is assigned to this resiliency benefit.

Avoided operations and maintenance costs associated with new infrastructure: Updating existing infrastructure with newer projects would, all else equal, include the benefit of lower operations and maintenance costs, either attributable to the structure being newer, or to benefits from newer technologies. These benefits were quantified for culverts and bridges, as both existing and new O&M costs were either provided or were extrapolated from recent literature. However, data for existing and new dams was not available, nor was literature found which could be relied on for an accurate estimate. As such, these benefits were expressed qualitatively for dams. A Qualitative Weight of + is assigned to this resiliency benefit.

Operations and maintenance costs were not factored for wetland restoration, as such this element is not expressed for this aspect of the project.

Environmental Value

Enhanced ecosystem services: Updated bridges and culverts would provide for more natural streamflow, and a more natural riparian environment immediately surrounding the project. This would in turn allow public environmental monitoring to spend less time investigating environmental anomalies associated with bridge or culvert damage or maintenance. This equates to a monetary benefit, however, no research appears to exist on the quantification of ecosystem services associated with bridges or culverts. As such this benefit is expressed qualitatively, with a Qualitative Weight of +.

Improved fisheries and habitat for recreation opportunities and tourism: Again referencing the study conducted by the Wisconsin Department of Natural Resources, the authors found a $3,200 per culvert benefit for increased fish passage, applying a 3.5% discount rate. The authors do not cite how many years the figure is discounted back, although they used prices from fish hatcheries, along with fish densities for specific streams to arrive at their figure.

Another study (The Nature Conservancy, 2013) relates updated stream-simulation crossings with enhanced river-related recreation. Healthier streams correlate with healthier fish populations, which improve opportunities for recreation. The study cites another study completed by the U.S. Fish and Wildlife Service, which places a high value on removing barriers along streams, however this study was based on a stream with sea-run fish, and these figures are unlikely to be realized at other locations.

Ultimately, such benefits would likely vary widely by region and geography, and it would be difficult to extrapolate an accurate figure and apply it elsewhere. Nevertheless, it is reasonable to assume that updating infrastructure such as culverts and wetlands would have a positive and beneficial effect on area wildlife and fisheries, and that this effect would benefit area recreation and fishing opportunities. This element was expressed qualitatively, with a weight of ++ assigned.

Social Value

Social benefit elements included in the BCA for the rightsizing infrastructure aspect of the project included avoided costs associated with injuries and fatalities, as well as avoided costs associated with mental stress and anxiety. Both these elements were expressed quantitatively for bridges, culverts and floodplain restoration, and dams, with the exception of fatalities.

Fatalities associated with an infrastructure failure were not included for bridges, culverts and floodplain restoration, rather these projects' cost avoidance benefits were monetized by applying injury multipliers for minor (in the case of culverts and floodplains) and moderate (in the case of bridges) injuries. However it is reasonable to assume that fatalities would occur in the event of a dam failure, particularly in downstream areas.

The number of fatalities incurred would depend on factors such as proximity and warning time provided prior to failure, as well as extent of failure. Loss of life calculations were provided by GOSR for the dam BCA. These figures were based on relative warning time prior to failure, as well as whether or not the failure occurred during a storm event, was a "sunny day" failure, or whether there was a breach. However these figures range from 4 persons to as many as 218, as such, the NDRC Appendix H Data Resources figure for moderate injuries was applied to the dam BCA, and fatalities were expressed qualitatively. For the dam element of the rightsizing infrastructure aspect, a Qualitative Weight of ++ was assigned to this element.

Economic Revitalization

Avoided impacts to real property: Flood events can cause significant damage to real property, affecting individuals, businesses and local governments. These effects can typically be quantified on a case by case base, for example, monetized damage estimates associated with a hurricane for a specific city. When analyzing specific geographies, and the effects floods have on property values at these locations over time, an accurate quantitative model becomes difficult, and can ultimately prove spurious. However, case studies have attempted to quantify these benefits, and literature on the subject suggests that property values benefit from proximity to flood protected lands versus non-flood protected lands (Kousky and Walls, 2013). For this analysis, this element was expressed qualitatively, with a weight of ++ assigned.

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

Bay Park will have a number of benefits relating to resiliency, the environmental, society, and the economy. Project costs will be a result of capital costs over the lifetime of the project.

Lifecycle Costs

The lifecycle costs of this project are a result of the project's capital costs. These are equal to the total cost of the project as determined by an engineering assessment and Nassau County's design/build legislation. Total project costs are estimated at $450 million.

Resiliency Value

Resiliency benefits arising from this project include return of marshland, protection against future projected marshland loss, and coastal restoration. Return of lost marshland is an expected benefit in Middle Bay and East Bay. The Middle Bay salt marsh complex shows a 123 acre loss over a 27 year period as a result of excessive nitrogen levels present in the bay. The East Bay salt marsh complex shows a 108 acre loss over a 24 year period as a result of excessive nitrogen levels present in the bay. These losses should be restored. This will be achieved by passive restoration of marshland by alleviating the problem causing the loss. It is estimated that 123 acres of salt marsh in Middle Bay and 108 acres of salt marsh in East Bay will be restored over time. Aerial photography will show an increase in acreage (Source). The State assumes the same loss rate over the coming period with protection of 4.55 acres of loss each year. The full value of the marshland is 404 acres x FEMA Riparian value or about $15M per year. Benefits stop at the end of project useful life to be conservative (unknown whether protection will continue). Benefits are additive as the marshland would have been lost and will be sustained.

Protection against future protected marshland loss in Middle Bay and East Bay is expected. Excessive eutrophication caused by nitrogen leads to destabilized bay-edge marshes

making these areas susceptible to accelerated erosion (Source). Without marshland loss prevention at the same rate of erosion (4.5555 acres per year), the entire Middle Bay salt marsh complex is estimated to be eliminated in 89 years. The current salt bay marsh complex to be protected against loss is 404 acres. East Bay salt marsh complex shows a 108 acre loss over a 24 year period. This loss should be restored. This will be achieved by passive restoration of marshland by alleviating the problem causing the loss. 108 acres of salt marsh will be restored over time. Aerial Photography will show prevented loss in acreage in both salt marshes.

Coastal restoration of eel grass areas is of great value to the area. The loss of critical eel grass habitat leads to coastal erosion. Both the Chesapeake and Tampa Bay estuary programs have seen increases in various eel grass species, following their efforts to reduce nitrogen loadings, address human impacts and implement restoration efforts (Source).[19] Data show that when nitrogen load reduction and chlorophyll a targets are met, seagrass cover increases. After nitrogen load reductions and maintenance of chlorophyll a at target levels, seagrass acreage has increased 25% since 1982. High levels of nitrogen have been linked to the loss of eel grass habitat (Coastal Resiliency and Water Quality in Nassau and Suffolk Counties, DEC 2014). From 1930 to 2012, eel grass area has declined by 178,197 acres. These marine grasses are part of a critical vegetative buffer that provides resilience to storms and habitat for marine organisms. Aerial Photography will show increase in acreage (Source) (Source) (Source) (Source).

These resiliency benefits are grounded in comparisons of regional storm damage to the community, an understanding of the costs of debris removal and logistics, and the costs of infrastructure after the storm. As of February 28, 2006, there were 6,246 NFIP policies in force

[19] Greening, Holly; Janicki, Anthony; "Towards Reversal of Eutrophic Conditions in a Subtropical Estuary: Water Quality and Seagrass Response to Nitrogen Loading Reductions in Tampa Bay, Florida, USA." Environmental Management Vol. 38, No. 2, pp. 163-178.

in the City of Long Beach, with 1,530 claims awarded from January 1, 1978 to February 28, 2006, totaling $8,316,199. In addition, the City has adopted all required building codes regarding construction in the SFHAs and recently participated in FEMA's Community Rating System (CRS) Program. These are real costs that affect one area in the special flood hazard area. Debris management and logistical costs were estimated at $32 million (Source). Infrastructure costs from roads, bulkheads, parks, and beach repairs were estimated to be as much as $150 million (Source). Communities protected by the Western Bays Marshland can expect see a decrease in claims due to increased protection from marshlands (Source).

Environmental Value

The environmental value of this project is comes from a reduction in overgrowth of *Ulva Lactuva*. Overgrowth of Ulva, phytoplankton exceeding 250 µg L-1, rapid microbial respiration causes hypoxia. Nutrients (primarily nitrogen) control the growth of primary producers in the Western Bays. This growth has accumulated on beaches in amount where trucking was needed for removal. In addition, the decay of the ulva releases noxious fumes. This value is determined by multiplying the acreage of point lookout (21) by the Recreational/Tourism value ($5,365.26) and dividing by 3, the years between reported incidences of impaired beaches.

Social Value

The community development value of this project results from the protection of affordable housing stock. The marsh lands are a natural barrier that guard bay communities from the immediate impact of extreme weather events and inundate further encroachment to inland areas. Only 4% of all rental units are available to be rented and 58% of Long Islanders have difficulty paying their rent or mortgage. Any housing units affected by storm damage puts a

further stress on Nassau's housing stock by increasing demand and reducing supply which further inflates housing costs.

Economic Revitalization Value

This project is estimated to result in two main economic revitalization benefits: new recreational space and revitalization of the clamming industry. The project is expected to contribute to new marine and other recreation, restaurant, and limited small water related retail uses. Converting the treatment plant to a pump station will make acreage available. This may present an opportunity for a Bayfront restaurant/conference center/banquet hall to the east. The project may also allow Nassau County to expand/reconfigure recreation facilities; provide new public marinas, transient docking and evaluate new locations for transit facilities and other Department of Public Works facilities that will add community and/or recreational facilities. The project may also enable workforce residential plus marine-related retail or support industries in the area. The improvements may provide recreational use (Source).

Loss of the shellfish industry occurred in this area due to increased nitrogen levels. The Great South Bay has a similar industry within a short distance from the Western Bay shellfish beds. Environmental and clam industries are likely to benefit. New York seagrass beds function as vital habitat and nursery grounds for numerous commercially, recreationally and ecologically important fish and shellfish species (Final Report of the New York State Seagrass Task Force, DEC 2009). Nitrogen has substantial detrimental impacts on shellfish and sea grass (Coastal Resiliency and Water Quality in Nassau and Suffolk Counties, DEC 2014). Passive restoration of shellfish beds is likely due to alleviating the problem of elevated levels of coliform bacteria, responsible for the closure of 15,575 acres of shellfish beds in the western bays as well as

nitrogen reduction. Shell fish beds are expected to open and industry may return over time (Source) (Source) (Source) (Source) (Source).

Nassau County Outfall Pipe and Bay Resiliency Project: Qualitative Narrative for Unquantified Benefits

To attach weights to qualitative benefits, the Appendix H weighting scheme is applied. The Outfall Pipe and Bay Resiliency is an essential project to the balance of development to nature in Nassau County. It serves to remediate a number of issues affecting the coastal communities and allow them to recover from Hurricane Sandy and be more resilient in the case of future storm events.

Resiliency Value

Hurricane Sandy inundated the Bay Park Sewage Treatment Plant (STP) shutting down a number of critical facilities including the tidal pumps used to force effluent out of the current Reynolds Channel Outfall. Operations were offline for about 56 hours resulting in 100 million gallons of untreated sewage overflowing within the Bay Park STP and surrounding streets, neighborhoods, and 2.2 million gallons of partially treated effluent to be released into Hewlett Bay. Two fifths of Nassau County (approximately 550,000 people) with an average flow of 50 million gallons per day were without service.

The ocean outfall will not need the tidal pumps to force effluent out and will not be susceptible to backflow from storm surge effectively sealing off a point of entry for floodwaters into the STP and preventing the risk of backflow. These benefits receive a qualitative positive weight of (++).

The Outfall Pipe and Bay Resiliency project will also convert the Long Beach Water Pollution Control Plant (WPCP) into a pumping station and tie in the service area to that of the STP's service area. The Long Beach WPCP had a 12 hour shutdown that will be prevented by this tie in. This is qualitatively weighted at (+).

Environmental Value

The sub region's significant concentrations of shorebirds, wintering waterfowl and colonial nesting water birds have been reduced. Most water bird colonies in the Reserve occur on the islands of the western bays from Hempstead east to Captree. Hempstead Bay is also an important part of the Atlantic Flyway for migrating and wintering waterfowl, particularly brant, with an average of nearly 25,000 waterfowl counted on mid-winter aerial surveys. The importance of the western bays for migrating, wintering and resident coastal birds also needs to be recognized and the benefits on the habitat from the outfall is weighted as (+).

The closure of the Long Beach WPCP will not only lower the total amount of effluent going into the western bays, it will also solve the problem of an increased suspended load output cited in its 2014 permit violation. This benefit is weighted as a (+).

Social Value

The western bays serve as an estuary to a number of recreational finfish that have seen their populations decline. The Outfall Pipe and Bay Resiliency will improve the water quality for these species nurseries domiciled in the bay. These benefits received a weight of (+). There will also be an increase in tourism and recreational Bayfront activities as a result of improved water quality and natural habitat. This is given a qualitative weight of (+).

Economic Revitalization Value

The project will also be a significant public works project that will create a number of long term construction jobs. Nassau County has been implementing its Section 3 Plan as well as conducting Minority and Women's Business Enterprises (MWBE) outreach and networking sessions in order to connect prime contractors on federally funded projects with local MWBE subcontractors. The efforts have been met with great success in meeting the New York State goals of 15% MBE and 15% WBE participation as well as getting local Unions to buy in on meeting Section 3 goals. This benefit is given a qualitative weight of (++).

Conversion of the existing Long Beach Water Pollution Control Plant will help the plan to develop the 19 acres surrounding it and the 22 acres adjacent. The inclusion of new green space was already quantified but the further plans to implement marine and other recreation, restaurants, and limited small water related retail will develop a more robust economy as well as potentially increase tax revenues through development, commercial, and retail uses. This benefit is weighted a (++).

Description of Risks to Ongoing Benefits from the Program

The risks to ongoing benefits from the proposed programs and projects include the coastal and riverine geography of the State— making it especially vulnerable to climate change and sea level rise. However, the State, in developing its application, has focused on incorporating scientific forecasts of climate change into its models that inform the selection of these proposed programs and projects. In addition, the State recognizes the following as potential impediments to resiliency: the lack of resilient housing options for vulnerable populations, the high costs of land and housing in most of the Target Areas, limited public rights of way for facility improvements, aging infrastructure requiring costly maintenance to achieve a state of good repair, limited funding availability for resiliency improvements, and the difficulty of coordinating actions across multiple jurisdictions. The State is committed to overcoming these impediments as it continues to plan for resilience.

Manufactured Home Community Resiliency Pilot Program

A sensitivity analysis was conducted that assesses the impacts to the benefit cost ratios (BCAs) for the program given changes in the discount rate from the base level of 7%, and increases in mitigation costs.

The project discount rate incorporates a risk component. In cost benefit analyses future benefits and costs that are less certain to arise can be discounted with a higher discount rate, and those that are more certain to be realized can be discounted with a lower rate. Because Phase I Community Based Planning and Outreach efforts will result in more targeted, broadly accepted project interventions, it is reasonable to assume that there is more certainty attached to the benefits of Phase II implementation interventions being realized, since they will benefit from the Community Based Planning and Outreach. The sensitivity analysis allows us to see what

impacts the lower discount rates (moving from 7% to 3%) will have on the BCRs. The table below shows the results of the sensitivity analyses for changes in the project discount rate,

Table 49: Sensitivity Analysis of MHC Implementation Options and Program BCRs

	Base Case			With Adjustment for Sea Level Rise		
Discount Rate	**Option 1**	**Option 2**	**Total Program**	**Option 1**	**Option 2**	**Total Program**
3.0%	5.19	4.45	4.75	5.19	14.69	10.89
4.0%	4.51	3.87	4.12	4.51	12.76	9.46
5.0%	3.95	3.39	3.62	3.95	11.20	8.30
6.0%	3.50	3.00	3.20	3.50	9.91	7.35
7.0%	3.13	2.68	2.86	3.13	8.85	6.56

To account for uncertainty in program mitigation costs estimated at the concept level, and eventual final implemented costs when Phase II construction starts, the sensitivity analysis tests rises in total mitigation costs up to 75% above base level estimated costs, on the BCRs.

Table 50: Sensitivity Analysis of Manufactured Homes Community Resilience Program BCRs

	Base Case			With Adjustment for Sea Level Rise \a		
% Change in Total Costs Above Base Levels	**Option 1**	**Option 2**	**Total Program**	**Option 1**	**Option 2**	**Total Program**
+ 15 %	2.72	2.33	2.49	2.72	7.70	5.71
+ 25 %	2.50	2.15	2.29	2.50	7.08	5.25
+ 50 %	2.08	1.79	1.91	2.08	5.90	4.37
+ 75 %	1.79	1.53	1.63	1.79	5.06	3.75
Base Case Costs:	3.13	2.68	2.86	3.13	8.85	6.56

Note:

\a Adjustment for Sea Level Rise only affected case study evaluated for Option 2, given locations of floodplains and given hydrology and hydraulic conditions at the evaluation sites.

The program benefit cost ratios can all tolerate significant rises in mitigation costs from base cost levels, and that the program interventions are all cost effective with these higher up front cost scenarios.

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

Many of the improvements contained in this proposal will have been untested by current Housing Authority staff, and are relatively new to the field. Maintenance staff and potentially residents will require training in maintaining the newly installed systems. The workforce development aspect will hinge on the ability of residents and tenants to be willing to engage in this program. A detailed sensitivity analysis to the impacts of sea level rise is outlined in the Description of Benefits and Costs section, above.

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program; Right-Sizing Bridges Program; Right-Sizing Critical Dams Resiliency Project (Seven Sites)

Climate change may increase the degree of uncertainty when planning for future situations and it may present a world that is very different from what is anticipated and what these interventions are intended to protect against.

Right-sizing culverts, bridges, and dams and restoring natural floodplains are well-proven strategies that help mitigate the impacts of flooding. However, these strategies only respond to one threat faced by climate change: more intense rain events. Climate change is also expected to bring hotter weather, which these strategies do not directly respond to.

Given the State's recent experience with extreme weather events and the predicted increase in those events, the State's apparatus has become responsive to such challenges. In the event of any of these unanticipated risks occurring, the State will look towards its experience and that of its partners in responding and adapting these programs and projects.

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

See below for a table that outlines the key risks and uncertainties that may affect the project and how those risks affect the positive and negative effects of the proposal.

Table 51: Risks Associated with Nassau County Outfall Pipe and Bay Resiliency Project

Life cycle costs	**Risks**
Present Value Comparison	*Key Risk: The third WPCP doesn't tie into BP* *Effect: Negative but the impact would be limited due to the majority of volume being run through the outfall*
Middle Bay Salt Marsh Riparian Improvements and Protected Shoreline	Key Uncertainty: Length of time for regrowth Effect: Faster growth provides more protection and slower growth may leave the marsh open to repeated damage
East Bay Salt Marsh Riparian Improvements and Protected Shoreline	Key Uncertainty: Length of time for regrowth Effect: Faster growth provides more protection and slower growth may leave the marsh open to repeated damage
Eelgrass Riparian Improvements and Protected Shoreline	Key Uncertainty: Wasting Disease Effect: This disease caused the majority of the destruction in the bay. It could damage regrowth Key Uncertainty: Sea Level Rise Effect: Eelgrass survive in shallower water. Deeper water would have a negative impact
Comparison - Regional storm damage to community in surrounding area	Key Uncertainty: Scaling Up of damages Effect: These numbers are for one city. The costs of the entire SFHA would be show a greater impact
Comparison - Long Beach Debris Removal and Logistical Cost Post Sandy	Key Uncertainty: Scaling Up of damages Effect: These numbers are for one city. The costs of the entire SFHA would be show a greater impact

Comparison - Long Beach Infrastructure Cost Post Sandy	Key Uncertainty: Scaling Up of damages Effect: These numbers are for one city. The costs of the entire SFHA would be show a greater impact
Ulva Lactuva Growth	Key Uncertainty: Monetary Impact Effect: This could have recreational impacts and it does have environmental impacts. Quantifying is unclear at this time
Protection of affordable housing stock	Key Uncertainty: Promotion of Development Effect: The project should encourage development to allow for affordable housing. The more housing created the greater overall positive
Conversion of existing WPCP to developable space	Key Uncertainty: Development Type Effect: More Green Space or more Commercial Space will affect the dollar impact Key Uncertainty: Sea Level Rise Effect: The bayside of Long Beach is at a low elevation and at risk for flooding which would have a negative impact.
Shellfish Beds Restoration	Key Uncertainty: Industry Growth Effect: If fishermen do not establish industry it will have a negative impact on the proposal

Implementation Challenges

The State has identified financial, stakeholder, and technical/capacity risks as challenges to implementing this proposal. In its response to the Qualified Disasters, the State has engaged in an unprecedented level of engagement. GOSR conducted significant outreach to New York's counties, state agencies, and other stakeholders to better shape its understanding of vulnerabilities and implementation challenges for this application. These implementation challenges range from financial (municipalities not being able to supply the local match for certain projects), to stakeholder (ensuring that vulnerable communities are sufficiently engaged in decision-making), to technical and capacity (local staffs not yet having the capacity to maintain and manage large and new resiliency construction projects or resiliency features). These are outlined in more detail below; however, the State believes that its recent experience, its breadth of knowledge, and the broad community support for this proposal will aid significantly in overcoming these challenges.

Manufactured Home Community Resiliency Pilot Program

Challenges during the Community-Driven Planning Phase may include ensuring all key stakeholders are invested in the process, including the landowner. Another challenge may be ensuring that all voices in the community are heard, specifically vulnerable populations. These challenges are mitigated, however, by the breadth of experience GOSR and partners have in implementing effective community-driven approaches to planning through the NY Rising Community Reconstruction Program. Further, since this Program arose organically from consultation with stakeholders in MID-URN Target Areas, key stakeholders inherently have invested interest in the success of the Program.

The Community Based Planning part of the Program is intended to reduce the challenges of the project implementation part of the Program. Based on the success of this part in identifying and targeting select communities that buy into the program mitigation concepts, the challenges from the implementation phase are expected to be minimized. However, technical risks during project implementation may include maximizing both cost efficiency and flood mitigation to ensure timely interventions. GOSR's strong relationships with local municipalities and counties, including those formed through the NYRCR planning process, through previous and current storm recovery interventions will assist while overcoming these challenges.

Public Housing Resiliency Pilot Project (Five Sites at Four Public Housing Authorities)

The management and project oversight capacity of small Public Housing Authorities is one challenge, as is the challenge of sourcing appropriate contractors and design professionals to implement the innovative building technologies proposed. It is similarly challenging to attain project cost efficiencies for newer, more innovative construction methods. There is often a learning curve associated with proper installation and maintenance. Knowledge sharing and open lines of communication between GOSR and its Partners, especially Enterprise Community Partners and New York State Homes and Community Renewal, will help to overcome these challenges.

Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program; Right-Sizing Bridges Program; Right-Sizing Critical Dams Resiliency Project (Seven Sites)

The proposed program is highly feasible as it builds on NYSDOT's effective Scour Critical Bridge program, the deep experience of Parks in maintaining and developing critical dams, and DEC's ongoing capacity and initiatives to right-size culverts as part of the Hudson River Estuary Program. Together, these programs and projects can be scaled and scoped based upon the availability of funds.

There are two main challenges to implementation. First, easements may be difficult to obtain from landowners for resiliency interventions. Second, local municipalities may have problems identifying sources of funding for the Right-Sizing Culverts and Restoring Natural Floodplains Resiliency Program and thus may not be able to apply to the Program. Broad community support is expected to help in overcoming these challenges.

Nassau County Outfall Pipe and Bay Resiliency Project (One Site)

There is little technical risk and the project benefits from widespread stakeholder support. "Soft" rock tunneling and outfall construction in an ocean environment have been performed for the past three decades around the world—and risks will be minimized as extensive surveys will be conducted prior to the design process to identify conditions along the potential route and identify potential areas of concern. Therefore, the primary challenges to implementation are the expediency of environmental review and the timeliness and availability of federal funding. GOSR and its Partners expect that review may be completed within 12 months and that funding is likely to be available for the project.

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