View looking east from Pier "C" Park

6.0 ALTERNATIVES ANALYSIS

Whereas the concept screening process discussed in Section 3.3 led to the identification of the three Build Alternatives to be evaluated in the DEIS and FEIS, the alternatives analysis described in this section is used to guide the decision-making process that leads to the selection of the Preferred Alternative. The Preferred Alternative is the Build Alternative that will be advanced for Final Design. This analysis process involved the development and application of criteria that were essential to the decision-making process for selection of the Preferred Alternative. The following sections discuss this evaluation and the overall alternatives analysis process (evaluation of the three Build Alternatives and the No Action Alternative), which ultimately led to the identification of Alternative 3 as the Preferred Alternative.

6.1 Development of Impact Criteria

The criteria used in this evaluation reflect a refinement of the 21 criteria established in the concept screening process described in Section 3.3. A number of the same criteria have been used in both evaluations; for example, impacts to historic properties were considered during both the concept screening and alternatives analysis phases. During the concept screening phase, the metric for historic properties was whether or not historic properties could potentially be effected by a particular alternative. Following data collection and analysis, in the alternatives analysis phase, the metric for historic properties has evolved from a qualitative to a quantitative metric. The metric in the alternatives analysis process is the number of historic properties that would be adversely affected under each Build Alternative. Similarly, other criteria used in the concept screening phase have been further refined based on data collection and additional study to allow for a more quantitative analysis.

The evaluation criteria for this alternatives analysis are divided into the purpose and need and five additional categories, as follows:

- Flood Risk Reduction
- Socioeconomics and Built Environment
- Benefit-Cost Analysis
- Construction, Maintenance, and Operations
- Environmental Impacts

Since the evaluation criteria provide the basis for reviewing the alternatives and ultimately for decision making, it was important to explain the criteria and metrics to the public, prior to evaluating the alternatives. A community meeting was held on July 28, 2016, during which the evaluation criteria and draft alternatives analysis matrix were presented to the public. The public was provided an opportunity to comment on this information in advance of recommendation of the Preferred Alternative. No significant comments were received during the comment period for that meeting. A discussion of that meeting can be found in Section 7.0. The evaluation criteria are explained in Sections 6.1.1 through 6.1.6.

The alternatives analysis process focused on those criteria that exhibited distinguishing characteristics among the Build Alternatives, such as the varying amounts of coastal surge risk reduction provided or varying impacts to viewsheds and waterfront access. Careful consideration of these distinguishing characteristics defined the choices and tradeoffs among the alternatives. **Table 6.1** summarizes the results of this analysis for each Build Alternative, as well as the No Action Alternative, and the explanation of the criteria is provided below.

6.1.1 Meets Purpose and Need

This criterion measures whether or not each alternative meets the Project purpose and need. The purpose of the Project is to reduce the flood risk within the Study Area (see Section 2.0). The Project intends to minimize the impacts from coastal storm surge and rainfall flood events on the community, including adverse effects on public health, while providing benefits that would enhance the urban condition and recognizing the unique challenges that exist within a highly-developed urban area. This is based on the project need, which is the Study Area's historic flooding and the high likelihood of future flood events

Table 6.1 Alternatives Analysis Matrix

ALTERNATIVES ANALYSIS MATRIX

Category	Criteria		ALT-1 Option 1	ALT-1 Option 2	ALT-2 Option 1	ALT-2 Option 2	ALT-3 Option 1	ALT-3 Option 2	No Action Alternative (Baseline)
Purpose and Need (P&N)	Meets P&N (Y/N)		Y	Y	Y	Y	Y	Y	N
Flood Risk Reduction	Coastal Storm Surge Risk Reduction for Residents	Percentage of Population **in Floodplain** Receiving Risk Reduction (2010 Census)	98		86		85		0
		Percentage of Study Area in Floodplain Receiving Flood Risk Reduction	83	82	74	73	73	72	0
	Critical Facilities **NOT** Receiving Coastal Flood Risk Reduction		None		One (Fire Station, 1313 Washington Street)		One (Fire Station, 1313 Washington Street)		One Hospital (308 Willow Avenue) Four Fire Stations (201 Jefferson St, 43 Madison St, 801 Clinton St, 1313 Washington St) NHSA Water Treatment Plant (1600 Adams St.)
	Potential to Adapt to Higher Coastal Flood Events		Yes						No
	Potential Runoff to be Managed by DSD Components (gallons and persons receiving benefits)		Up to 7 million gallons/14,160 persons						0
Socioeconomics and Built Environment	Environmental Justice Populations Receiving Flood Reduction Benefits	Rainfall	Minority: 3,400; Hispanic: 2,720; Over 75: 370; Households in Poverty: 1,330						Environmental Justice communities would remain exposed to flood risks
		Coastal	Minority: 7,950; Hispanic: 6,520; Over 75: 1,340; Households in Poverty: 2,400		Minority: 7,280; Hispanic: 6,200; Over 75: 1,280; Households in Poverty: 1,990				
	Public Health Benefits (acreage no longer flooding during 5 Year rainfall events and population within this area)		48.1 acres with reduction in flooding severity, including 35.5 acres without flooding (7,870 persons living within this area)						No benefit to Public Health. Flood events will continue to represent an adverse impact to Public Health
	Viewshed Impacts	Residential	First floor of Tea Building and Maxwell Place		No impacts to critical viewpoints		No impacts to critical viewpoints		None
		Recreational Users	Shipyard Park, and Hudson River Walkway from Lincoln Harbor to Maxwell Place and minor impacts to veiw from 1600 Park ballfields		Minor impact to view from 1600 Park Ballfields		Minor impact to view from 1600 Park Ballfields		None
		Retail/Dining	1st floor businesses: Shops at Lincoln Harbor. 1st floor businesses along Sinatra Dr. N.		No impacts to critical viewpoints		No impacts to critical viewpoints		None
	Length of Waterfront Access Impacted (ft)		7,950		150		150		0
	Acres of New or Improved Park Space included in DSD		6						0
	Acres of New or Improved Park Space included in Resist		6.91		3.53		2.55		0
	Connectivity and Circulation	Number of Parking Spaces Removed	2	0	15 to 31	13 to 29	9 to 18	7 to 16	0
		Number of Gate Closures during Storm Conditions	29	31	21	25	19	23	0
Benefit-Cost Analysis	Benefits for Resist (in millions)		$1,448M		$1,417M		$1,416M		-
	Estimated Resist Cost (in millions)		$433.1-$475	$444-$485.5	$193.8-$217.3	$205.2-$224.7	$185.4-$205.7	$196.3-$220.6	-
	Estimated Resist Cost Contingency (in millions)		$98.4-$109	$101.2-$111.6	$44.4-$50.3	$47.3-$52.2	$39.1-$44.2	$41.8-$47.9	-
	Total Resist Cost (in millions)		$531.5-$584	$545.2-$597.1	$238.2-$267.6	$252.5-$276.9	$224.5-$249.9	$238.1-$268.5	-
	Resist Benefit/Cost Ratio		2.26		4.83		5.05		-
	Total Project Benefit/Cost Ratio (includes Resist and DSD)		2.22		3.88		3.99		-

Note: Total Costs used in the Benefit - Cost Analysis also included Operations & Maintenance Costs

Table 6.1 Alternatives Analysis Matrix (continued)

ALTERNATIVES ANALYSIS MATRIX									
Category	**Criteria**		ALT-1 Option 1	ALT-1 Option 2	ALT-2 Option 1	ALT-2 Option 2	ALT-3 Option 1	ALT-3 Option 2	**No Action Alternative (Baseline)**
Purpose and Need (P&N)	Meets P&N (Y/N)		Y	Y	Y	Y	Y	Y	N
Construction / Maintenance and Operations	Constructability	Number of Private Parcels Requiring Easements	15	15	8	8	8	8	0
		Potential Utility Relocation (for Resist, linear feet)	4,860	4,600	2,300	2,060	1,280	1,030	0
		Potential Utility Crossings (Resist)	87	86	69	69	64	64	0
	Temporary Construction Impacts (acres)		29.4	29.3	30.1	30.2	29.8	29.9	None
	Estimated Annual Maintenance Cost (for Resist, millions)		$3.6-5.4	$3.7-5.5	$1.5-2.4	$1.6-2.6	$1.4-2.3	$1.5-2.4	-
Environmental Impacts	Recognized Environmental Conditions (RECs)	Number of REC Properties Affected	43	46	45	49	45	49	0
		Estimate of hazardous soils requiring off-site disposal (tons) for construction of resist	29,324	28,596	16,781	16,470	16,043	15,762	0
		Estimate of contaminated soils requiring off-site disposal (tons) for consruction of DSD	121,669						0
	Freshwater Wetlands	Freshwater Wetlands Within Construction Footprint (Square Feet)	230						0
	Threatened and Endangered Species/ Essential Fish Habitat	Impacts to T&E and Essential Fish Habitat	Potential for minor impacts due to in-water work along waterfront. Negligible impacts from new outfalls		Negligible in-water impacts from new outfalls		Negligible in-water impacts from new outfalls		None
	State and Federal Environmental Permitting	NJDEP Flood Hazard Act (NJAC 7:13) Permit	Individual Permit						None
		Acreage of Floodplain Disturbance	3.2 ac Permanent 5.8 ac Temporary	3.2 ac Permanent 6.1 ac Temporary	2.8 ac Permanent 5.5 ac Temporary	2.8 ac Permanent 6.4 ac Temporary	2.8 ac Permanent 7.5 ac Temporary	2.8 ac Permanent 5.9 ac Temporary	None
		Number of Properties Impacted pursuant to NJAC 7:13 (both Public and Private)	2 properties potentially impacted (pursuant to NJAC 7:13)		5 properties potentially impacted (pursuant to NJAC 7:13)		5 properties potentially impacted (pursuant to NJAC 7:13)		None
		NJDEP Wetlands Permitting (NJAC 7:7A)	Individual Permits (for in-water work associated with bulkhead replacement)		General Permit (for proposed outfalls and work in wetlands)		General Permit (for proposed outfalls and work in wetlands)		None
		USACE Sections 10 and 404 Permitting	Individual Permit (for in-water work associated with bulkhead replacement)		Nationwide Permit (for proposed construction of outfalls)		Nationwide Permit (for proposed construction of outfalls)		None
	Historic Properties	Number of historic buildings with adverse effect	5	4	4	3	3	2	0
	Archaeological Resources	Acres of potential archaeological resources affected by the alternative	10.32	10.29	8.96	9.07	8.24	8.36	0
	Noise	Number of Noise Receptors during Construction	Schools - 4 Parks - 13		Schools - 1 Parks - 4		Schools - 3 Parks - 4		0

Source: Dewberry, 2015-2017

from both rainfall and coastal surge flooding. All three of the Build Alternatives meet the purpose and need, whereas the No Action Alternative does not.

6.1.2 Flood Risk Reduction

This category of criteria considers the ability of each alternative to provide flood risk reduction (coastal surge and rainfall flooding) to the community. This analysis was based on coastal surge and rainfall flood modeling conducted as part of the Rebuild by Design Hudson River Project: Feasibility Study Report. For the purposes of this evaluation, the Project's impacts to flood patterns was considered for populations within the Study Area, but it was also recognized that the flood modeling identified benefits to populations within northern Jersey City, beyond the Study Area. The Flood Risk Reduction category is made up of the following criteria:

Percentage of Population in Floodplain Receiving Coastal Storm Surge Risk Reduction Benefits

This criterion measures the percentage of the population (based on 2010 Census data) in the Study Area within the Federal Emergency Management Agency (FEMA) 2015 preliminary one percent annual chance event (100-year) floodplain that receives coastal storm surge flood risk reduction benefits from the Resist feature. Those benefits include a reduction in the magnitude of coastal storm surge impacts to property and a possible reduction in flood insurance rates. This criterion considered only those areas located within the Study Area, but it was recognized that coastal modeling results showed that, under various coastal storm surge scenarios (10-year, 50-year, and 100-year), communities in northern Jersey City, immediately south of the Study Area, would receive a reduction in coastal storm surge flooding from the implementation of the Project.

Percentage of Study Area in Floodplain Receiving Coastal Storm Surge Flood Risk Reduction

This criterion measures the percentage of the land in the Study Area within the FEMA 2015 preliminary one percent annual chance event (100-year) floodplain that receives coastal storm surge flood risk reduction benefits.

Critical Facilities Not Receiving Coastal Flood Risk Reduction

Pursuant to Executive Order 11988, FEMA has identified a list of critical facilities for which even a slight chance of flooding is too great. These critical facilities are: hospitals, fire stations, police stations, and facilities that store critical records. The North Hudson Sewerage Authority (NHSA) Wastewater Treatment Plant has also been identified as a critical facility by the community. This criterion identifies critical facilities within the FEMA 2015 preliminary one percent annual chance event (100-year) floodplain that would not receive coastal storm flood reduction benefits for each alternative.

Potential to Adapt to Higher Coastal Flood Events

This criterion considers whether the termini of the Resist features in both the north and south portions of the Study Area are anchored at locations that would enable the Resist barrier to adapt to a 0.2-percent annual chance event (500-year storm), should a decision be made at a later date to elevate the height of the Resist barrier. It is noted that all Resist foundations are proposed to be built to specifications allowing for an upgrade in height to adapt to the 0.2-percent annual chance flood.

Runoff to be Managed by Delay, Store, Discharge (DSD) Components

The DSD components of the Project address rainfall flooding by capturing rainfall before it enters the combined sewer system. The capacity of the proposed DSD system was estimated, as well as the number of people (based on 2010 Census data) that would receive stormwater benefits from the construction of DSD components (based on the five-year rainfall model results).

6.1.3 Socioeconomics and Built Environment

This category of criteria focuses on the social and economic impacts for each of the alternatives. It focuses on impacts (and benefits) to vulnerable demographic groups (such as low-income populations) and impacts that the alternatives would have on the man-made environment. The Socioeconomics and Built Environment category is made up of the following criteria:

Environmental Justice Populations Receiving Flood Risk Reduction Benefits

This criterion has two metrics. The first metric characterizes the minority and low-income populations that would receive flood risk reduction benefits from reduced magnitude and frequency of rainfall induced flooding. The second metric characterizes the minority and low-income populations that would receive flood risk reduction benefits from reduced magnitude and frequency of coastal storm surge induced flooding. These estimates are based on 2010 Census and 2015 American Community Survey (ACS) data. For purposes of this analysis, minority and low-income populations include low-to-moderate income households, minority populations, individuals over 75 years of age, and Hispanics, as defined in the Together North Jersey Plan. The populations within each demographic group were compiled at the census block level. A complete description of the definition of these populations can be found in Section 4.8.

Public Health Benefits (Acreage No Longer Flooding During Five-Year Rainfall Events and Population Within this Acreage)

Although there are public health benefits associated with the reduced coastal storm surge flooding, this metric focuses on rainfall-induced combined sewage backups onto streets and inside buildings. This criterion provides a comparison of the area that currently experiences flooding during a five-year

rainfall event to the areas that no longer flood based on the future DSD improvements and stormwater model that was generated as part of the Rebuild by Design Hudson River Project: Feasibility Study Report. The comparison also includes the population residing within this area based on 2010 Census data. This population will receive public health benefits due to the elimination of combined sewer flooding events in these areas.

Location of Adverse Viewshed Impacts

This criterion identifies where the Project infrastructure would adversely affect the views of the Hudson River and the New York City skyline. The analysis compares existing residential, recreational, and retail/dining views to views following infrastructure construction at locations along the Lincoln Harbor waterfront, Shipyard Park, and the waterfront along Sinatra Drive.

Length of Waterfront Access Impacted (Linear Feet)

This criterion considers the linear length along the Hudson River shoreline where new Resist features would impact pedestrian access to the waterfront bulkhead. Within these locations, the bulkhead elevation would be raised and pedestrians would be required to access the walkway at the top of the new bulkhead by a series of steps or ramps at select intermittent locations, compared to the relatively unrestricted current at-grade access.

New or Improved Park Space (Acres)

This criterion considers the net acreage of park space that is either created or improved. This acreage takes into account the fact that some proposed park areas are located where a park already exists, such as portions of the Cove Park at Weehawken Cove. Improvements include recreational facilities such as playgrounds, picnic areas, and trails. Acreage includes park areas associated with both the Resist and DSD aspects of the Project. Acreage associated with DSD park space is the same for all of the alternatives.

Connectivity and Circulation

This criterion has two metrics: (1) the number of parking spaces removed and, (2) the number of gates that would be closed during storm conditions. The first metric is the number of on-street parking spaces that would be permanently eliminated by the Project. For some alternatives, the number of parking spaces removed is presented as a range, since this number will vary depending on the final design. Closure of gates would only impact vehicular and pedestrian access patterns in the hours prior to a storm event; however, no areas in the Study Area are rendered inaccessible by the closure of gates.

6.1.4 Benefit-Cost Analysis

A benefit-cost analysis is used to demonstrate that the benefits of a project outweigh its costs (the benefit-cost ratio is greater than 1.0). FEMA and U.S. Department of Housing and Urban Development (HUD) guidance require that a project's benefit-cost ratio be greater than 1.0. The benefit-cost analysis considers a project's benefits (the dollar value of the total benefit provided by the project) and its total cost (engineering, construction, and any mitigation requirements). Specifically, this category includes the following criteria:

Benefits for Resist (Millions)

This criterion considers the benefits (in dollars) of the Resist portion of the Project. The following factors were used:

- Estimated value of avoided flood damages to property
- Avoided loss of function (residential displacement and non-residential business and/or service losses, based on the number of days individuals will be out of residences/businesses because of flood damage)
- Socioeconomic benefits including a reduction in mental stress and anxiety (FEMA estimated a rate of $2,443 per resident) and avoided loss of production to wage earners (FEMA estimated rate of $8,736 per resident)
- Environmental benefits (including provisions for increased open space)

Estimated Resist Infrastructure Costs (Millions)

This is the estimated cost for the Resist feature. A range of costs were developed to accommodate the early design phase of the Build Alternative and the knowledge that the costs would be further refined during the final design phase. These costs include final design and project management, as well as engineering and construction costs.

Estimated Resist Cost Contingency (Millions)

Due to the Project being in the early stages of planning and design, there are many unknown variables. Modifications to the design may arise from obtaining more accurate existing information or other unforeseen deviations from the feasibility study produced by outside sources (such as more accurate information regarding location of utilities). These contingency costs are 22 percent of the estimated construction cost for the Resist infrastructure.

Estimated Total Resist Infrastructure Cost (Millions)

This criterion represents the overall estimated cost of the Resist feature (including final design, project management, engineering, construction, and contingencies).

Resist Benefit-Cost Ratio

This metric is a number that is calculated by dividing the Resist benefits by total Resist infrastructure Project cost including construction, contingency, and maintenance costs. A benefit-cost ratio greater than 1.0 means the Project's benefits outweigh its costs.

Total Project Benefit-Cost Ratio (Includes Resist and DSD)

This metric is a number that is calculated by dividing total benefits by total Project costs, including DSD. A benefit-cost ratio above 1.0 means the Project's benefits outweigh its costs.

6.1.5 Construction, Maintenance, and Operations

This criteria considers the difficulty of constructing the alternative (in terms of impacts to utilities, properties requiring easements for construction and/or access, etc.), as well as costs associated with the operation of the structure once it is completed.

Constructability

The constructability criterion has three metrics: (1) the number of private parcels requiring easements; (2) utility relocation; and (3) the number of potential utility crossings. The number of private parcels requiring easements is the number of parcels where temporary easements are required for construction access or where permanent easements are required for installation of Resist features. No easements will be required for DSD. The linear feet of utilities requiring relocation is based on an analysis of utility relocation for Resist infrastructure only. The number of utility crossings has been developed for Resist infrastructure only.

Temporary Construction Impacts (Acres)

This criterion provides a measure of the areas that would be disturbed during Project construction. It considers the overall Limits of Disturbance (LOD) for the Resist and DSD features of the Project. Temporary construction areas will be restored to pre-construction conditions.

Estimated Annual Maintenance Cost (Millions)

This criterion provides an estimated range of costs for annual operations and maintenance. The largest drivers of operations and maintenance cost are the overall size of the proposed structures/facilities and the number of gates associated with the Resist feature. At this stage, annual maintenance costs are calculated as one percent of construction costs.

6.1.6 Environmental Impacts

This category primarily considers impacts to the natural environment (including considerations for environmental permitting requirements), as well as to cultural resources. Specifically, this category includes the following criteria:

Recognized Environmental Conditions (RECs)

There are three metrics for this criterion: (1) the number of REC properties affected; (2) the estimate of contaminated soils requiring off-site disposal for the construction of Resist infrastructure; and (3) the estimate of contaminated soils requiring off-site disposal for the construction of DSD infrastructure. The number of RECs provides a measurement of the number of potentially contaminated properties that would be encountered during construction of the Project. It considers those sites that were determined by the Hazardous Waste investigation to be an REC for the Project. These are sites that have unresolved soil and/or groundwater contamination issues. All soils removed for construction are assumed to be contaminated and require off-site disposal.

Freshwater Wetlands Within Construction Footprint (Square Feet)

Freshwater wetlands were delineated as part of the Project. This criterion identifies the area of freshwater wetlands that would fall within the footprint of the LOD for the Project.

Impacts to Threatened and Endangered Species and Essential Fish Habitat

The metric for this criterion is a qualitative metric that considers the potential for impact on the Essential Fish Habitat for smooth dogfish, summer flounder, bluefish, and Atlantic butterfish, as well as the potential for impact on the listed Atlantic and shortnose sturgeons.

State and Federal Environmental Permitting

This criterion considers five metrics: (1) whether permitting would be required under the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13); (2) the acreage of floodplain disturbance; (3) the number of properties impacted under the New Jersey Flood Hazard Control Act; (4) whether a New Jersey Department of Environmental Protection (NJDEP) permit is required under the New Jersey Freshwater Wetlands Protection Act (N.J.A.C. 7:7A); and (5) whether a U.S. Army Corps of Engineers permit is required under Section 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act.

An individual permit would be required for all of the alternatives under the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13). An individual permit requires a more significant level of effort to obtain compared to other types of permits. The acreage of floodplain disturbance characterizes the acreage of disturbance within the 100-year floodplain. Both permanent impacts (areas where new above-ground features are proposed), as well as temporary impacts (areas where below-grade features are proposed or areas where work is otherwise temporary in nature, such as staging areas during construction) have been identified.

The New Jersey Flood Hazard Control Act (N.J.A.C. 7:13) requires avoidance of impacts from proposed actions within the floodplain on adjacent properties. Based on coastal modeling, the number of adjacent properties projected to experience a slight increase in flooding compared to existing conditions was determined. NJ TRANSIT-owned property would be affected under all alternatives.

The New Jersey Freshwater Wetlands Protection Act (N.J.A.C. 7:7A) regulates activities along a shoreline. This metric considers whether permitting would be required under the Act. The type of permit and the reason for the anticipated permit is identified. An individual permit would require a more significant level of effort to obtain as compared to a general permit.

The U.S. Army Corps of Engineers permitting metric considers whether permitting would be required under Sections 10 of the Rivers and Harbors Act and/or Section 404 of the Clean Water Act. The type of permit and the reason for the anticipated permit is identified.

An individual permit would require a more significant level of effort to obtain compared to a nationwide permit.

Number of Historic Properties with Adverse Effects

The metric for this criterion is the number of historic properties listed or eligible for listing in the National Register of Historic Places that would be adversely affected by an alternative. Under Section 106 of the National Historic Preservation Act, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register of Historic Places in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association.

Acres of Potential Archaeological Resources Affected

The metric for this criterion is the square footage of potential archaeological sites listed in or eligible for listing in the National Register of Historic Places that could be impacted by the Project. Because no subsurface archaeological investigations have been undertaken, no eligible archaeological properties are known to exist within the Project footprint. This metric reflects an upper boundary of the area of significant archeological resources potentially impacted based on literature reviews.

Number of Noise Receptors Impacted During Construction

This considers the number of sensitive noise receptors that could be impacted during construction operations. Sensitive noise receptors include schools, parks, and places of worship. No long-term noise impacts from the Project are anticipated.

6.2 Summary of Findings, Impacts, and Benefits

This section summarizes the findings, impacts, and benefits of the Project with respect to each alternative. For all three Build Alternatives, the purpose and need of the Project would be met. This discussion focuses on the criteria that provide a differentiation among the Build Alternatives. Therefore, the analysis in this section of the FEIS does not consider the following criteria, which have been determined to be identical or substantially similar among all Build Alternatives:

- Percentage of Study Area in floodplain receiving coastal storm surge flood risk reduction
- Potential to adapt to higher coastal flood events
- Total Project benefit-cost ratio
- Temporary construction impacts
- Freshwater wetlands within the construction footprint
- Benefits for Resist
- Acres of potential archaeological resources affected
- Number of noise receptors during construction

Additionally, since the DSD component is the same for all Build Alternatives, the following criteria are also the same for each Build Alternative.

- Potential runoff to be managed by DSD components
- Public health benefits
- New or improved park space included in DSD
- Contaminated soils requiring disposal from construction of DSD

While these criteria are included in the alternatives analysis matrix (see **Table 6.1**), they do not represent a differentiating factor between Build Alternatives and are not discussed in this analysis, although they are discussed in detail in applicable discipline studies in Section 4.

ALT-1 Alternative 1

For Alternative 1, also known as the "Waterfront Alternative," coastal storm risk reduction would be accomplished by construction of a Resist barrier along most of the low-elevation Hudson River waterfront in the Study Area (see **Figure 6.1**). Under Alternative 1, 98 percent of the persons residing within the FEMA preliminary 100-year floodplain would receive coastal storm flood risk reduction benefits (see **Figure 6.2**). The cost of the Resist infrastructure for Alternative 1, excluding contingency, is between $433.1 million and $485.5 million and the benefit-cost ratio for the Resist infrastructure in Alternative 1 is 2.26. Alternative 1 has 29 to 31 gates, the greatest number under all Build Alternatives. A greater number of gates can lead to a higher risk of failure due to human error. In addition, since the Resist barrier is longest in Alternative 1, the maintenance costs would be highest under Alternative 1.

Under Alternative 1, all critical facilities would receive flood risk reduction benefits. In addition, benefits to minority and low-income populations would be greatest. Alternative 1 would provide coastal storm surge flood risk reduction to an additional 670 minority people, 50 Hispanic people, 60 people over 75 years of age, and 410 low income households due to the location of the Resist barrier along the waterfront, as compared to Alternatives 2 and 3, which place it inland. Under Alternative 1, impacts to parking would be limited, with no more than two parking spaces removed. Alternative 1 has the greatest potential for impacts to historic properties; it is anticipated that five historic properties for Option 1 and four historic properties for Option 2 would be adversely affected. The greatest amount of new or improved public park space, approximately 6.91 acres, would be included as part of Alternative 1's Resist infrastructure (see **Figure 6.3**). Alternative 1's Resist infrastructure would require the greatest amount of off-site disposal of contaminated soils, approximately 29,000 tons. This would be from excavation of soils for the Resist structure footings. It is recognized that some soil could be reused on site if properly backfilled and capped in place.

Because the Resist infrastructure is primarily located along the waterfront, the Alternative 1 impacts on

Figure 6.1 Alternative 1

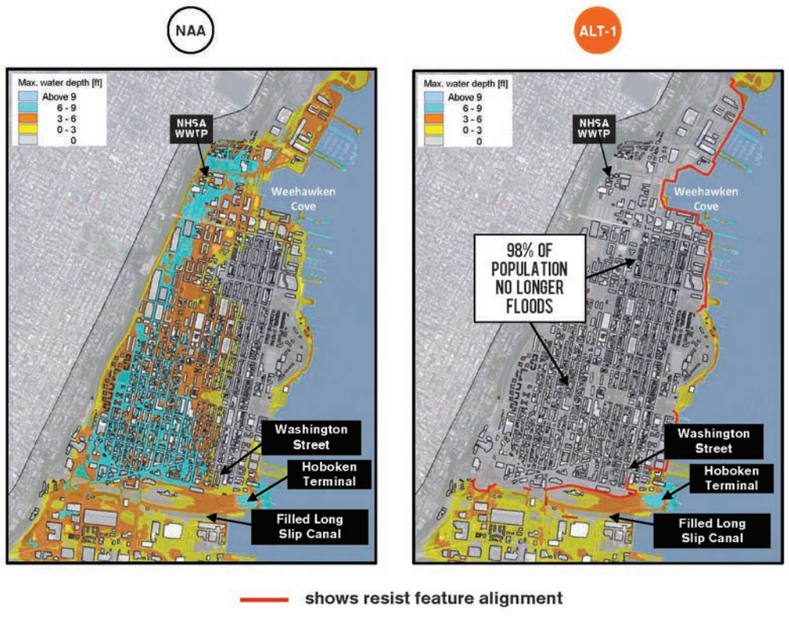

Figure 6.2 Alternative 1 - Coastal Flood Risk Reduction

Figure 6.3 Alternative 1 - South Waterfront Amenities

viewshed and on waterfront access are greatest of the three Build Alternatives. Views of New York City would be adversely impacted for the following groups: residents on the first floor of the Tea Building and Maxwell Place, recreational users of Shipyard Park, and for first floor businesses along Lincoln Harbor. Waterfront access would be modified along approximately 1.5 miles (7,950 linear feet) within the Study Area. In this area, the existing bulkhead would be replaced with a taller bulkhead capable of resisting the 100-year coastal storm surge. While the existing bulkhead structure in this area already precludes direct interaction with the Hudson River shoreline, the new bulkhead would require the public to use steps or ramps to access new walkways on the top of the bulkhead, which would be elevated as much as 14 feet higher than the current walkway along the bulkhead. Access ramps would be built to Americans with Disabilities Act (ADA) standards, but overall access would still be reduced compared to the current, unrestricted at-grade waterfront access. Proximity to the waterfront and potential for wave action also requires a higher design elevation for Alternative 1. Due to in-water work, which would be required to construct new bulkheads, the potential for impact to the listed Atlantic and shortnose sturgeon, as well as Essential Fish Habitat, would be greatest under Alternative 1. The construction of new bulkheads would require issuance of an individual permit under Section 404 of the Clean Water Act and possibly Section 10 of the Rivers and Harbors Act.

Since the Resist infrastructure is most extensive under Alternative 1, it would result in the greatest permanent disturbance in the floodplain (3.2 acres). Similarly, a total of 15 easements on private property would be required for either temporary construction or permanent placement of infrastructure. This is the greatest number of easements under any of the Build Alternatives. Conversely, since the Resist structure is located primarily along the waterfront only two properties (one private parcel and one NJ TRANSIT-owned property) are anticipated to experience a slight increase in flooding compared to the No Action Alternative. Compared to the other Build Alternatives, Alternative 1 would have the fewest flood impacts on adjacent areas. Therefore, the mitigation efforts for this alternative are anticipated to be less than those for Alternative 2 and Alternative 3. The impacts associated with modeled increased flooding would be mitigated in accordance with the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13).

The estimated construction costs for Alternative 1 are the highest for any of the alternatives. Even though the greatest number of people would receive coastal storm flood risk reduction benefits under Alternative 1, the 2.26 Resist benefit-cost ratio under Alternative 1 is the lowest among all three Build Alternatives.

ALT-2 Alternative 2

For Alternative 2, also known as the “15th Street Alternative,” coastal storm surge risk reduction would be accomplished through construction of a Resist barrier further inland than Alternative 1, in the

Figure 6.4 Alternative 2

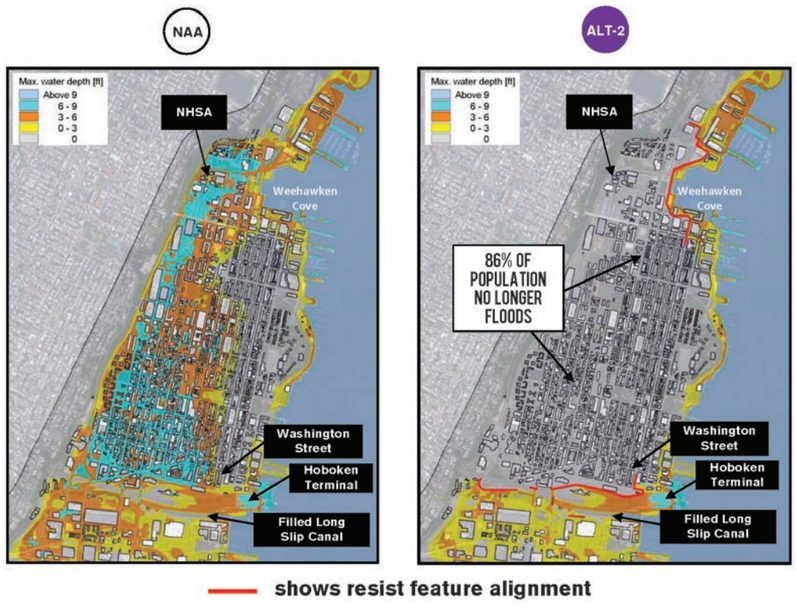

Figure 6.5 Alternative 2 - Coastal Flood Risk Reduction

Figure 6.6 Alternative 2 - Inland Resist Barrier at 15th Street and Garden Street

northern part of the Study Area. Specifically, south of Weehawken Cove, the Resist barrier would travel east along 15th Street from the northern end of Garden Street to Washington Street and then south along Washington Street (see **Figure 6.4**). Because the Resist barrier would be located inland, a high level storm sewer collection and discharge system is required to intercept stormwater on the riverside of the Resist barrier to prevent the water from flowing into the existing combined sewer system and then traveling beneath the Resist barrier and causing flooding on the other side of the barrier. Stormwater collected in this gravity-fed, high level storm sewer system would be discharged into the Hudson River. Under this alternative, 86 percent of the persons residing within the FEMA preliminary one-percent annual chance (100-year) floodplain would receive coastal storm flood risk reduction benefits (see **Figure 6.5**). Fewer minority and low-income populations would receive coastal storm surge flood risk reduction benefits compared to Alternative 1; however, this alternative still provides significant flood risk reduction to minority and low income populations within the Study Area compared to the No Action Alternative. The cost of the Resist infrastructure for Alternative 2, excluding contingency, is between $193.8 million and $224.7 million and the benefit-cost ratio for the Resist infrastructure in Alternative 2 is 4.83.

Since the Resist barrier is primarily located inland, impacts to the viewshed and waterfront access are limited to approximately 150 linear feet along the shoreline of the Hudson River, thereby avoiding two of the most significant impacts of Alternative 1. For Alternative 2, there would be no impacts to critical viewpoints. The 21 to 25 gates proposed for Alternative 2 are fewer than the number of gates proposed under Alternative 1. In addition, since the Resist barrier under Alternative 2 would be substantially shorter than under Alternative 1, the construction footprint would be smaller and the annual cost to maintain the shorter, upland Resist structure would be less than Alternative 1. Similarly, the permanent development in the 100-year floodplain would be less under Alternative 1 and would total 2.8 acres. Although the Resist barrier would be located inland, issuance of a nationwide permit under Section 404 of the Clean Water Act would still be required for bulkhead construction at the three stormwater discharge sites along the Hudson River (one for the Resist barrier's high level storm sewer and two for the DSD system).

Alternative 2 provides flood risk reduction benefits for all critical facilities, with the exception of the fire station located at 1313 Washington Street. Although this fire station is not located within the FEMA 2015 preliminary 100-year floodplain area, it is located outside the extended area of protection provided by the recommended Resist feature DFE adapted for sea-level rise. The number of parking spaces lost due to infrastructure construction would be greatest under Alternative 2. A total of 13 to 31 parking spaces would be removed, depending on the final design. The greatest loss of parking spaces would occur along Washington Street, between 13th and 15th Streets.

Figure 6.7 Alternative 3

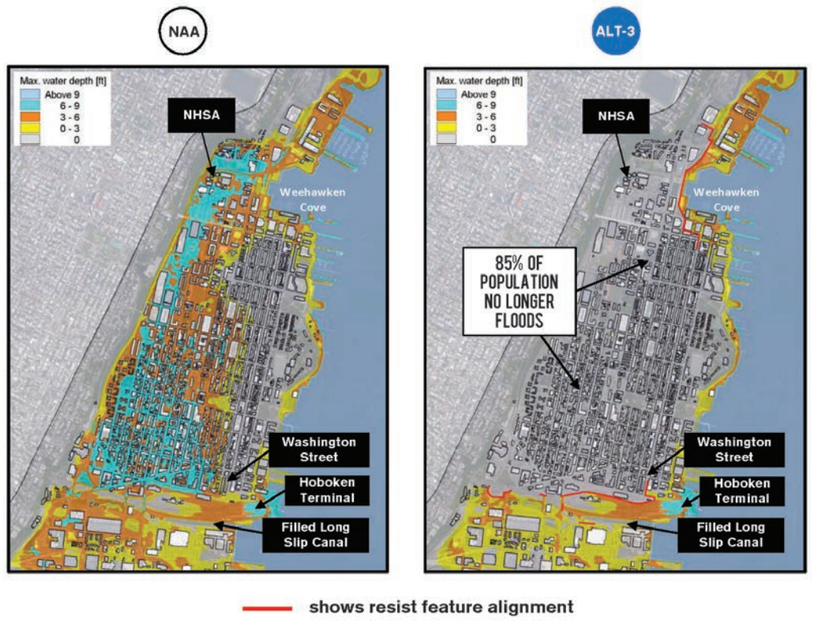

Figure 6.8 Alternative 3 - Coastal Flood Risk Reduction

Figure 6.9 Alternative 3 - Inland Resist Barrier along Garden Street, from 15th Street to the alleyway

Due to the inland location of the Resist barrier, the number of private properties impacted by increased flooding as a result of Resist barrier construction would be greater under Alternative 1. Four private properties, as well as NJ TRANSIT-owned property, are expected to experience slight increases in flooding during coastal storm surge flooding events. The impacts associated with increased flooding would be mitigated in accordance with the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13). In addition, temporary or permanent easements for construction or permanent infrastructure placement would only need to be acquired on eight private parcels. Under Alternative 2, approximately 3.53 acres of new or improved park land would be included in the Resist component (see **Figure 6.6**).

Alternative 2's Resist infrastructure would result in approximately 16,500 tons of contaminated soils requiring off-site disposal. Impacts to listed species and Essential Fish Habitat would be negligible. It is anticipated that four historic properties for Option 1 and three historic properties for Option 2 would be adversely affected.

ALT-3 Alternative 3

For Alternative 3, also known as the "Alleyway Alternative," coastal storm risk reduction would be accomplished by construction of a Resist barrier farther inland, in a manner similar to Alternative 2. Specifically, the Resist barrier would travel along the east side of Garden Street and continue along the alleyway midway between 15th and 14th Streets, from Garden Street to Washington Street. The feature would continue south along Washington Street, ending between 14th and 13th Streets (see **Figure 6.7**). Under this alternative, 85 percent of the persons residing within the FEMA preliminary one-percent annual chance (100-year) floodplain would receive coastal storm flood risk reduction benefits (see **Figure 6.8**). The Resist barrier is shorter for Alternative 3 than the other Build Alternatives; therefore, it has less potential for new or improved park spaces (approximately 2.55 acres) (see **Figure 6.9**).

The benefits and impacts of Alternative 3 are similar to those described for Alternative 2, except with respect to four criteria. First, the cost of Alternative 3 is slightly lower than Alternative 2. More specifically, under Alternative 3, the estimated cost of the Resist barrier, excluding cost contingencies, is between $185.4 million and $220.6 million (and the benefit-cost ratio for the Resist infrastructure in Alternative 3 is 5.05). Second, six to 13 fewer parking spaces, primarily along Washington Street, would be removed under Alternative 3 compared to Alternative 2. Since the Resist barrier travels along the alleyway, neighborhood impacts would be less than those under Alternative 2. Third, Alternative 3 proposes 19 to 23 gates, the fewest of any of the Build Alternatives. Having the fewest mechanical gates is important because these features represent a point of vulnerability and the higher number of gates reflects greater opportunities for the Resist structure to be compromised during a storm. Fewer gates would also result in lower maintenance costs. Fourth, impacts to

historic properties would be the least under Alternative 3, as it is anticipated that only three historic properties for Option 1 and two historic properties for Option 2 would be adversely affected. As with Alternative 2, four private properties, as well as NJ TRANSIT-owned property, are expected to experience slight increases in flooding during coastal storm surge flooding events. The impacts associated with increased flooding would be mitigated in accordance with the New Jersey Flood Hazard Control Act (N.J.A.C. 7:13).

No Action Alternative

The No Action Alternative proposes no measures to address either coastal storm surge or rainfall flood risk reduction. While the City of Hoboken may continue with plans to develop the BASF and Block 10 sites, no comprehensive DSD system or Resist structures would be built. Therefore, the No Action Alternative does not meet the purpose and need of the Project and is not a viable alternative. The No Action Alternative serves as the benchmark to measure the costs and benefits of each Build Alternative evaluated. Since there would be no Project under this alternative, there are very few impacts, other than those that are a result of the perpetuation of existing conditions.

Impacts to private and public property resulting from coastal storm surge and rainfall flooding would continue without change in frequency or magnitude in the short term under the No Action Alternative. However, because of climate change and sea-level rise (as discussed in Section 1), the frequency and magnitude of coastal surge and rainfall flooding events would be expected to increase into the future.

In addition, while the No Action Alternative would not result in isolated areas of modeled increased flooding as identified for the Build Alternatives, it would leave the entire community (including those properties identified as receiving modeled increased flooding) vulnerable to flood risks.

Public health impacts associated with the combined sewer discharges within the Study Area would not be addressed and there would be no urban enhancements associated with infrastructure construction. Furthermore, there would be no reduction in flood insurance rates. Critical facilities, including police and fire stations, would continue to be at risk during significant flooding events. The community would continue to experience transit delays, as rail and roadways would continue to be impacted by flooding. The balance of the $230 million in federal funds provided to the state of New Jersey for the RBD-HR Project would not be expended and would be returned to the federal government.

6.3 Preferred Alternative

All three of the Build Alternatives would meet the purpose and need of the Project by reducing flood risk for a substantial majority of the population. In addition, the impacts to socioeconomics–notably to minority and low-income populations–would be positive under all Build Alternatives. As a result of implementing any of the three Build Alternatives, these populations would receive substantial flood risk reduction benefits from both coastal surge from Resist, as well as rainfall flooding from DSD components.

Photograph 6.1 Typical Rolling Gate

Figure 6.10 Conceptual Rolling Gate Closing at 15th Street and Garden Street

Alternative 1; however, would have the greatest impact on viewsheds and waterfront access (approximately 7,950 feet of waterfront access impacted), both of which are highly valued by residents within the Study Area, as is evident by the public comments received throughout the Project (see Section 7, Consultation and Coordination). By comparison, the impacts on viewsheds and waterfront access are minimal under both Alternatives 2 and 3 (approximately 150 feet of waterfront access impacted) because these alternatives are primarily located inland. In addition, Alternative 1's Resist barrier would require the greatest number of gates (29 to 31), which increases operation and maintenance costs and increases the risk of failure due to operational error. Alternative 1 would also require more easements on private property (approximately 15 properties requiring easements) compared to Alternatives 2 and 3 (approximately eight properties requiring easements). The construction of Alternative 1's Resist barrier would also require funding beyond what is currently available. For these reasons, Alternative 1 is not recommended as the Preferred Alternative.

The remaining Build Alternatives, Alternatives 2 and 3, were then considered comparatively. The two most important differences between Alternatives 2 and 3 are impacts in the area around 15th Street and Washington Street in Hoboken (both in terms of impacts to the community and in benefits from coastal surge reduction) and annual maintenance and operating costs. For Alternative 3, the routing of the Resist barrier down the alleyway will reduce the impact of the Resist barrier on the local community in the northern part of Hoboken by placing it behind structures and reducing impacts to the street grid. This is reflected in that only seven to 18 parking spaces would be removed under Alternative 3, compared to removal of 15 to 31 parking spaces in Alternative 2, which would involve routing the Resist barrier along a longer stretch of Washington Street and on 15th Street. The construction costs are also slightly lower under Alternative 3, which is reflected in a higher benefit-cost ratio for the Resist portion of Alternative 3 (5.05 for Alternative 3, 4.83 for Alternative 2). Alternative 3 requires the fewest gates (19 to 23 gates) (see **Photograph 6.1** and **Figure 6.10**) and has the shortest overall Resist barrier length; therefore, Alternative 3 has lower estimated annual maintenance and operating costs. For these reasons, Alternative 3 is recommended as the Preferred Alternative.

In regards to Alternative 3 Option 1 and Option 2, Option 1 features an alignment south of Observer Highway in the NJ TRANSIT Yard, while the Option 2 alignment runs along Observer Highway from Washington Street to Marin Boulevard. The land between these two options has been proposed for redevelopment under the Hoboken Yard Redevelopment Plan. The more southerly Option 1 would provide flood risk reduction benefits for this proposed redevelopment site. However, for this redevelopment plan to proceed, existing railroad tracks in this area must be relocated. If these tracks cannot be relocated to meet the construction deadlines established for this project, then Option 2 would be implemented. Option 2 could pose challenges to the future construction of the Hoboken Yard Redevelopment Plan, as it would potentially impact accessibility to this area (both during construction of the redevelopment area and after completion) and it would not provide flood risk reduction benefits to the redevelopment area. Further design considerations would need to be taken into account during the final design phase to provide community cohesion and connectivity for the redevelopment area if Option 2 is selected. Alternatively, Option 1, which would be located behind the redevelopment area, would not impact cohesion or accessibility to the redevelopment area. NJ TRANSIT, the property owner, is aware of both Option 1 and Option 2 on their property. The option constructed will be determined when a final agreement is made concerning the Hoboken Yard Redevelopment Area between NJ TRANSIT, the developer of record and the City of Hoboken.

In addition to the Resist component, the Preferred Alternative also includes the DSD components described in Section 3. DSD was common to all three Build Alternatives, so it did not represent a differentiating factor between the Build Alternatives. The implementation of DSD is anticipated to be undertaken over the next 15 to 20 years by the City of Hoboken and other partners, although the actual duration of construction activities for any given DSD site, including excavation, construction of tank infrastructure, and installation of park amenities, is not anticipated to exceed several weeks. During this period, adaptive management techniques will be used to provide for effective implementation and allow for improvements and/or modifications based on lessons learned while implementing the DSD components.

As with all of the other proposed alternatives, Alternative 3 would cause inconveniences to neighboring properties in the form of noise, dust, vibration, and restricted vehicular and pedestrian access during the 44-month construction period for the Resist barrier. Alternative 3 (and Alternative 2) would have a larger impact in terms of modeled areas of increased flooding compared to Alternative 1, although this would be mitigated in accordance with N.J.A.C. 7:13. An approach to address minor increases in flood depths to the five properties during the 100-year coastal storm surge as a result of Resist barrier construction will be developed in partnership with NJDEP; the municipal governments of Hoboken, Weehawken, and Jersey City; and local property owners as the Project moves into final design. Additionally, to address concerns regarding urban design, context sensitive solutions will be incorporated into the final design of the Resist features and final design will maintain bike and pedestrian path connectivity. This will be accomplished through coordination with the affected community including elected officials through the final design and construction phases of the Project.