

Memorandum – Coastal Engineering Review GATE Jacob Riis Bathhouse Flood Mitigation TAR 15579

15 October 2020

Review Request Summary:

NPS Jacob Riis Bathhouse Flood Mitigation Design - Coastal Engineering Review of Project Site Design
157 Rockaway Beach Blvd, Rockaway Park, NY 11694

- Review FEMA map
- Provide specific guidance for the resiliency requirements to meet NPS policies
- Review applicability of the technology (AquaFence) anticipated for deployment.

Review:

A. Introduction:

Review of the site situation: This memo presents the considerations regarding the applicability of the technology and Design Water Level for the planned deployment of an AquaFence FloodWall around the perimeter of the central portion of the Beach Pavilion at the Jacob Riis Bathhouse.

B. Background:

The Jacob Riis Park Bathhouse (built in 1932) saw significant damage from Hurricane Sandy in 2012. Hurricane Sandy's storm surge burst through the Bathhouse, taking-out door and window coverings and knocking down the courtyard wall. The rehabilitation of the Bathhouse complex is designed to demonstrate elements of flow-through design, including roll-up doors on the Beach Pavilion and open fencing for the courtyard, in an effort to make this historic property more resilient to future storm surges and expected sea-level rise (SLR).

C. Proposed Flood Mitigation Strategy:

The Bathhouse is located within the AE Flood Zone and the Base Flood Elevation (BFE) identified in the planning document by architecture firm Beyer Blinder Belle (BBB) is 12'-0" (NAVD88) based upon the 2013 FEMA map. BBB has identified a design flood elevation (DFE) of 13'-0" for the area of the AquaFence FloodWall deployment. The existing North American Vertical Datum (NAVD88) ground elevations based upon a 6/1/2018 site survey range from 10.02' to 10.10' at the front of the Beach Pavilion facing the ocean. The NAVD88 ground elevations at the backside of the Beach Pavilion range from 9.64' to 9.68'.

BBB's proposed flood mitigation strategy for the Beach Pavilion and the surrounding site consists of three main components: (1) The central portion of the Beach Pavilion, which contains the major kitchen equipment and MEP spaces, will be surrounded with the AquaFence FloodWall Perimeter Protection system. (2) The east and west wings of the Beach Pavilion as well as the Entry Pavilion will allow water to flow through, as is the current strategy for the entire building. (3) The temporary structures in the courtyard will be removed prior to a flooding event.

BBB's planning document indicates that the AquaFence FloodWall Perimeter Protection system will be deployed as a 4' high wall. AquaFence's calculation review of the AquaFence Flood Protection System (V1200 model) document indicates the Flood Barrier's height as 3.94' above ground surface. Based upon this information, the lowest front facing elevation of the deployed AquaFence FloodWall would be 13.96' (NAVD88) and the rear facing would be 13.58' (NAVD88).

- Listing of existing flood level regulatory and/or advisory constructs:

The Beach Pavilion is along the Atlantic Coast of Long Island and within the 2013 FEMA regulated 100-yr floodplain, which is at 12' elevation (NAVD88). The Beach Pavilion is in Zone AE and is behind (approximately 50 feet) the LiMWA (Limit of Moderate Wave Action- Zone VE) line meaning that any breaking waves will be less than 1.5' high. The Zone VE flood elevation outside of and adjacent to the site is 13' (NAVD88).

While possibly not applicable due to federal ownership of the site, local regulatory constructs include [City of New York Local Law No. 109](#), which dictates certain requirements for temporary flood control. This and other regulations should be reviewed for applicability and obtained by the engineer/architect prior to installation.

- Direction on Design Water Level from NPS and other agencies:

The NPS document [Addressing Climate Change and Natural Hazards- Level 3 Handbook 2015, modified 2018](#) establishes the approach for both Baseline Hazard and Future Hazard in the case of sea level changes (see page 12 of 24). The document defers to current FEMA Flood Insurance Rate Maps for baseline hazards for locations within the floodplain and identifies a 2-foot minimum freeboard (3' for critical assets) for planning for sea level rise (unless project location projections are higher). The New York City Department of City Planning [Climate Resiliency Initiatives](#) also includes the use of a 2-foot additional freeboard for projects.

- How changing sea level considerations would interact with the regulatory and advisory constructs over time:

Projections for the site provide the following summary of expected sea level rise (SLR) derived from New York State Energy Research and Development Authority. In addition to the still water SLR projections included in Table 1, 100-year and 500-year recurrence flood elevations are included under varying SLR scenarios. These elevations are based upon the current FEMA 100-year and 500-year flood elevations of 12.0' and 16.0', respectively. When these values are added to SLR under 2100 high emission scenarios as an approximation of future storm impacts, the water elevation would be approximately 17.8' and 21.8', respectively.

The [Sea Level Rise and Storm Surge Projections for the National Park Service](#) 2018 report also provides sea level rise projections for the area. Specifically for the *Gateway National Recreation Area*, SLR increases range from 0.8' to 2.5' under various climate change scenarios based on potential greenhouse gas concentration trajectories introduced in the [fifth climate change assessment report of the Intergovernmental Panel on Climate Change](#).

Table 1. Water Levels under Varying Scenarios

Year	Emissions Scenario	Stillwater Increase (ft)	Mean Sea Level (NAVD88)	100-Year Recurrence (NAVD88)	500-year Recurrence (NAVD88)
1983-2001 Epoch (current)	1983-2001 Epoch (current)	N/A	-0.2	q	16.0
2050	Moderate Emissions	1.3	1.1	13.1	17.1
2050	High Emissions	2.5	2.3	14.3	18.3
2100	Moderate Emissions	2.8	2.6	14.6	18.6
2100	High Emissions	6.0	5.8	17.8	21.8

Sources: [NOAA Tide Station/Gauge = 8531680/Sandy Hook NJ, NAVD88 Datum](#); [FEMA Flood Map 3604970378G Preliminary 12/05/2013](#); [Horton et al. 2014, Climate Change in New York State](#); [FEMA Flood Insurance Study, City of New York 2013](#)

- Applicability of technology to be deployed:

Information summary from the manufacturer:

The AquaFence is an engineered system designed to withstand hydrostatic and hydrodynamic loading in accordance with ASCE 7-16 and ASCE 24-14. In addition to an analytical design approach, AquaFence flood barriers have been extensively tested both in-house as well as by third parties such as the US Army Corps of Engineers (USACE), FM Global, and multiple independent universities.

AquaFence technology uses the downward pressure of the flood water to create a self-stabilized design. As flood waters increase, the system becomes stronger. It is constructed of marine grade Baltic laminate, stainless steel, aluminum, and reinforced PVC canvas. A team of 3 to 4 persons can install approximately 100 linear feet of FloodWall per hour. The proposed plan for the Beach Pavilion consists of approximately ±580 linear feet. The FloodWall functions without anchoring to the ground, but in high wind situations, anchors will provide stability and enhanced performance. For the Beach Pavilion, it is proposed to utilize the ground anchors due to the site's proximity to the open marine coast and the possibility of generation of high winds and storm surge. Anchors will need to be placed approximately every 16" and when not in use, anchors will be capped. AquaFence FloodWalls can be fabricated and deployed for heights which range from 2.5' to 9' above the ground and the manufacturer offers site specific customization solutions for challenges which properties may face, including elevation changes, curbs, structural obstacles, spacing, and debris impact.

AquaFence panels can be stored flat in reusable crates which can be strategically positioned so the panels easily slide out in areas of deployment. After a flood event, panels should be rinsed off before returning to storage. When not in use, the crates could be situated on several parking spaces in the adjacent lot. For example, a typical parking spot can hold 2 crates deep and 4 high to provide 500 linear feet of 4' fence (±580 linear feet proposed). The AquaFence system is certified to be reused more than 60 times before replacement is recommended.

The AquaFence FloodWall is designed to perform in floods up to the full height of the barrier. The system was tested for overtopping by the USACE as part of the FM Approvals certification. For this test, the water level was increased until just above the height of the barrier, subjecting the system to overtopping for the duration of an hour. Overtopping was also experienced during wave testing of the system and the conclusion in both cases was that it did not affect performance.

- **EA Comments:**

Based upon review of the documentation provided, a search of client reviews of the technology, and an analysis of the AquaFence FloodWall technology, it is deemed to be practical for the currently defined 100-year flood water level conditions based upon 2013 FEMA determinations. As noted previously, the deployment area is outside of the expected moderate wave force zone, which is important as the AquaFence is not meant to withstand high wave force impacts for any period of time. Due to the probability of smaller waves, the recommendation of providing ground anchors by AquaFence is deemed appropriate at the project location. As a technology that can be deployed in advance of a coming storm, it stands to provide adequate protection.

However, future expected changes in SLR would make the anticipated deployment height of the AquaFence potentially inadequate to deal with the present day defined 100-year storm elevation by approximately the year 2050 in a high-emissions scenario. As noted above, AquaFence can be manufactured up to a height above ground of 9'. Therefore, depending on the proposed design life of the current project, consideration could be given to procuring a taller AquaFence if that design life is projected beyond 30 years.

- **Adaptive Alternatives:**

Because of the inherent uncertainty within projections of sea level rise, another possibility for the project would be to consider technologies which could provide more adaptability as conditions change in the future. This means instead of the purchase of a specific height technology like Aquafence, NPS could look at options which would be installed at a certain height and could be raised in the future to meet changing flood elevations which would meet an adaptive design objective.

Adaptive technologies could be considered, but an exhaustive analysis was not performed for this review, but two types of examples with individual identified manufacturers are provided below for reference. Due to time constraints, a cost analysis has not been conducted to compare these technologies to Aquafence:

Water filled flood barriers: This technology utilizes tubes which can be filled quickly to act as barrier to flood waters. This concept was derived from sand-bag systems which have been in existence for centuries.

Example manufacturer:

- [*AquaDam Temporary Perimeter Flood Barrier*](#)

The AquaDam works by constraining (2) water-tight tubes within a woven outer sleeve. In conjunction with the stability baffle, this design creates a temporary non-rolling water-filled dam which is able to control up to $\frac{3}{4}$ of its height in external mud/water depths, when filled with water. The AquaDam is 5' tall and rated for up to 44" of water depth control.

Although a single layer of this technology would not extend beyond that of the Aquafence, it is possible a double layer deployment could be executed for the current location. This technology could be filled to the anticipated height of an oncoming storm in short order. AquaDam represents just one manufacturer of this technology.

Removable variable height barrier: This technology is based upon the stop-log systems used for water control structures and has been used for many years for protection of existing structures as well.

Example manufacturer:

- [Flood Control International Inc's Removable stop log flood barriers](#)

This system uses removable stop log flood barriers which are engineered to provide similar levels of protection to permanent flood defenses, but with the advantage of being fully removable when not required. They can be supplied for virtually any configuration including arcs, closed rectangles or circles and straight runs of any length. The portable flood barrier design can be used on slopes up to 20° and can be stepped for steeper gradients. This makes this stoplog flood barrier system a solution for building openings or as a continuous flood wall. Each individually designed system is load calculated based on application and the prevailing flood conditions and can be configured for flood protection heights up to 13'. Single spans up to 10' are possible.

- Freeze/Thaw Considerations:

The manufacturer and engineer should assess the potential impacts from freeze/thaw to the anchor and gasket system.

Warranty Period:

Request that the manufacturer provide the Warranty period to better understand the design life of product.

- Additional Floodplain Considerations:

The design team should ensure that the positioning of the Aquafence does not increase velocity of water passing between the fence and adjacent buildings. It is possible that the fence could deflect water/wave energy towards these other buildings.

D. Options for the project:

The following options could be available for providing resiliency to the Jacob Riis Bathhouse:

- [Deploy AquaFence FloodWall as described:](#)

As noted previously, this would provide resiliency to 100-year water elevation impacts likely to approximately 2050.

- [Provide adaptive modification to the AquaFence FloodWall to raise the height in the future \(if possible\) or initially procure a version with greater height:](#)

As noted above, this option is based upon expected design life. If the initial deployment is focused on use for 30-years, to 2050 it is deemed adequate. Should NPS wish the system to be in service longer, consideration can be given to the initial deployment of a system of greater height than 4'. Also, for consideration, would be possible modifications to the system in the future to raise the height. It is unlikely that this would be possible due to the construction of the panels without significant modification, however the review did not specifically investigate this possibility.

- [Provide an adaptive based technology to the building for flood control:](#)

The use of other technologies which provide for more adaptive deployment over time may potentially be more practical. As noted above, this decision would be driven by the anticipated design life of the AquaFence deployment. Discussion of some example systems is provided above within this memorandum.

E. Summary:

The Jacob Riis Bathhouse center section is planned to be protected from current storm surge by the AquaFence technology which can be deployed in advance of a coastal storm impact. This technology is deemed appropriate in this current low energy wave environment at the facility. The anticipated deployment design for an AquaFence 3.94' high, however, will likely provide protection to the 100-year coastal storm up to 2050, with expected SLR increases using a high emissions scenario. Options for the project should be based upon the expected design life of the deployment and could include the deployment of the AquaFence as described, a version of the AquaFence with a higher elevation, or possibly a more adaptive protection technology at the site.

F. References:

- AquaDam®. AquaDam Temporary Perimeter Flood Barrier.
<https://www.aquadam.net/applications/flood-control/>
- Federal Emergency Management Agency (FEMA). 2013. Flood Insurance Study. Preliminary: 360497V000B. Federal Emergency Management Agency. Volume 1 of 1. City of New York, New York. <http://www.nyc.gov/html/sirr/downloads/pdf/360497NY-New-York-City.pdf>
- Flood Control International®. Removable Stop Log Flood Barriers.
<http://www.floodcontrolinternational.us/PRODUCTS/FLOOD-BARRIERS/stop-logs.html>
- Horton et al. 2014. Climate Change in New York State. Updating the 2011 ClimAID Climate Risk Information. Supplement to NYSERDA Report 11-18 (Responding to Climate Change in New York State). <https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Environmental/ClimAID/2014-ClimAid-Report.pdf>
- Intergovernmental Panel on Climate Change (IPCC). 2014: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. <https://www.ipcc.ch/report/ar5/syr/>
- National Flood Insurance Program. Flood Insurance Rate Map. Map Number 3604970378G, Preliminary December 5, 2013. https://floodmaps.fema.gov/prelim/PrelimData/New York/Queens County/prelim_issue_date-2013-12-05/FIRM/3604970378G.pdf
- New York City. Department of City Planning. Climate Resiliency Initiatives - Frequently Asked Questions. <https://www1.nyc.gov/site/planning/plans/climate-resiliency-faq.page>
- NOAA Tides and Currents. Sandy Hook, NJ - Station ID: 8531680.
<https://tidesandcurrents.noaa.gov/stationhome.html?id=8443970>
- The City Of New York Law Department. Local Law No. 109 of 2013, Council Int No. 1093-A of 2013. <https://www1.nyc.gov/assets/buildings/pdf/local-law-109-13.pdf>
- US Department of the Interior and National Park Service. 2015, modified 2018. Addressing Climate Change and Natural Hazards. Facility Planning and Design Considerations Level 3 Handbook. https://www.nps.gov/dscw/upload/AddressingClimateChangeAndNaturalHazards-Level3Handbook_Jan2015_041218AF2.docx
- US Department of the Interior and National Park Service. 2018. Sea Level Rise and Storm Surge Projections for the National Park Service, Natural Resource Report Series NPS/NRSS/NRR—2018/1648. <https://www.coastalreview.org/wp-content/uploads/2018/08/2018-NPS-Sea-Level-Change-Storm-Surge-Report-508Compliant.pdf>
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