

SECTION 05230

OFF-SITE LABORATORY TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Off-site laboratory testing shall be completed for the BPS/floodwall system if required by specification 05520 Floodwall System based on the proposed floodwall system. Full scale testing of the BPS/floodwall system shall be by an accredited off-site laboratory located in the United States that is acceptable to the Engineer and the Authority. The BPS/floodwall system consists of the following components: steel bollards, concrete foundation, concrete reinforcement; pavement systems, soil; posts; stop logs (beams), connections, shear pins, braces, tension rods, hold downs, rubber seals, neoprene pads, continuous gaskets, shims, hardware or any other appurtenance necessary to provide a complete BPS Floodwall system.
- B. The existing steel bollards and their foundations, independent of above and below grade positive attachments to development lot building structures, have been identified by the Authority as the means of support for the floodwall system components described in SECTION 05520 FLOODWALL SYSTEM. The combination of all these elements comprise a complete BPS Floodwall system that must be constructed at full scale for each of the test load cases.
- C. The Structural Engineer shall create an analytical model based on the members, connections, and components of the BPS Floodwall System design. This analytical model shall be calibrated using the test results to provide a calibrated repeatable model.
- D. The full scale testing results report and resulting repeatable model will be evaluated by the Engineer. The Engineer reserves the right to make changes to any of the BPS/floodwall system and may request re-testing in order to substantiate and improve performance of the BPS/floodwall system.

1.2 REFERENCES

The testing of the BPS/floodwall system shall meet the following standard codes:

- A. USACE EM 1110-2-2502, Retaining and Flood Walls;
- B. USACE EM 110-2-2705, Structural Design of Closure Structures For Local Flood Protection Projects;

- C. USACE EM 1110-2-2105, Design of Hydraulic Steel Structures Appendix E Bulkheads and Stoplogs;
- D. USACE EM 1110-2-2100, Stability Analysis of Concrete Structures;
- E. U. S. Bureau of Reclamation “Design of Small Dams” 3rd edition;
- F. American Society of Civil Engineers ASCE 7-10 Minimum Design Loads for Buildings and Other Structures;
- G. American Welding Society D1.1 Structural Welding Code - Steel (latest edition)
- H. American Welding Society D1.2 Structural Welding Code – Aluminum (latest edition)
- I. The specifications of FM Global;
- J. AISC Steel Construction Manual;
- K. Aluminum Design Manual, 2010 Edition;
- L. 29 CFR OSHA 1926 Construction Industry Regulations;
- M. New York City Building Code (2008);
- N. Building Code of New York State (2010).

Deviations from the testing regimen must be submitted for approval to the Engineer.

1.3 TESTING AND PERFORMANCE REQUIREMENTS

A. Whenever the term “Structural Engineer” is used in this specification, it shall mean the engineer employed by the manufacturer. The design of the floodwall system shall be the responsibility of the manufacturer under the supervision of a licensed Structural Engineer registered in the State of New York. The Structural Engineer shall sign and seal all drawings and calculations and shall be responsible for the implementation of the design by reviewing the fabrication process to assure conformance with his design and shall sign a statement certifying that the fabrication and erection of the floodwall system are in conformance with the floodwall design.

B. The “Engineer” when used in this specification shall mean the engineer employed by the Authority.

C. The “Testing Laboratory” when used in this specification shall mean the off-site testing laboratory employed by contractor. The information produced through testing in this section shall become the property of the Authority which shall be shared with the

Contractor, floodwall manufacturer, the Engineer of Record, the Structural Engineer and any other entity that the Authority chooses.

D. Perform a full-scale test to: a) provide information about response and load effects, b) study the failure mechanism, and c) calibrate the safety level and resiliency of the structure; and use the test results to d) compare measured and predicted strain and deflection, and e) support conclusions and recommendations to improve system performance in terms of strength and deflection. Testing shall be performed in accordance with the test load cases stated herein.

E. The Structural Engineer shall share a complete set of record computations that incorporate all revisions as a result of the review and approval by the Engineer to the testing laboratory.

1.4 SUBMITTALS

A. Submit a Work Plan of the full-scale testing program for acceptance by the Authority prior to commencement of physical testing, which:

- 1) defines the full-scale test and measures taken to replicate project conditions;
- 2) includes the analytic model based on members, connections, and components of the BPS Floodwall System design;
- 3) identifies the mechanisms that control behavior;
- 4) defines the purpose of the instrumentation including the specific purpose of each instrument,
- 5) identifies the parameters to be monitored;
- 6) predicts the magnitude of change, and;
- 7) identifies methods and procedures that will be used to collect, process, present, interpret and report data obtained.

B. Shop Drawings

- 1) Shop drawings for the test sections shall contain all dimensional and geometric information. Do not order, fabricate or deliver any materials to the off-site testing laboratory site before shop drawings have been approved by the Engineer.
- 2) Shop drawings for the BPS/floodwall system shall include layouts and details showing the type of steel for each member, sizes of members, connections, cuts, copes, concrete reinforcing, bolts, welds and other pertinent data. The shop drawings and the calculations performed by the Structural Engineer shall have been reviewed and approved for conformance with the contract documents and site conditions investigated by the off-site laboratory and the contractor and shall be stamped to indicate this concurrence by the contractor. Such indication by the contractor shall constitute the contractor's representation that he has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalogue numbers and similar data with respect thereto and has reviewed or coordinated each shop drawing with other shop drawings and samples and with the requirements of the work and the contract drawings.

- 3) The concrete and asphalt design mixes used for the construction of the BPS/floodwall system on site shall be the same mix designs used for the constructed condition on site and shall be submitted for review and approval to the Engineer.
- 4) All BPS/floodwall welds shall be indicated by standard welding symbols as defined by AWS. Shop drawings shall show size, length, and type of weld.
- 5) Job standards for all atypical connections for beams and girders, column splices, moment connections and wind bracing details shall be prepared by or under the supervision of the Structural Engineer, licensed in the State of New York and shall bear the signature and seal of the Structural Engineer.
- 6) Submit shop drawings and calculations in complete packages so that individual parts and the assembled unit may be reviewed together. Submit index sheets with all beam (stop log), post, bracing details at the same time the details are submitted for review.
- 7) The review of the shop drawings and calculations by Engineer of Record shall in no way relieve the Structural Engineer of the responsibility for the adequacy of the design of the connections and all required detailing for the proper fitting of the work in strict conformance with the contract documents or from the necessity of furnishing material and workmanship required by contract drawings and specifications in addition to that indicated on the shop drawings.
- 8) Shop drawings shall be submitted in English.

C. Final Report as described in 1.5 C including record computations.

D. QA/QC Plan as described in 1.5 G.

1.5 TEST LOAD CASES

The off-site testing laboratory shall conduct the following separate full scale tests to simulate actual potential conditions at the World Trade Center site, including all materials, known subsurface conditions to a maximum depth of eight feet below the top of sidewalk.

The following straight wall cases shall be tested:

A. 5 ft high post, with four foot high hydrostatic and hydrodynamic loads (3 ft/s), and a 1,000 lbs collision load applied one foot down from the top of the post, 90 degrees to the wall at 3ft per second. System must be tested to failure or as otherwise directed by the Engineer;

B. 8 ft high post, with seven foot high hydrostatic and hydrodynamic loads (3 ft/s), and a 1,000 lbs collision load applied one foot down from the top of the post, 90 degrees to the wall at 3ft per second. System must be tested to failure or as otherwise directed by the Engineer;

Both cases require testing of the full cross section for at least a 25 foot width with the BPS centered at the middle and the 18 foot length shall be as directed by Contractor.

Assume that soils are not saturated for the test sections.

Granite pavers shall be installed in the following areas where the BPS floodwall system comes in contact with the ground:

A. Underneath where the vertical bracing touches the ground on the dry side of the BPS floodwall system.

B. Underneath the entire length of the floodwall and under the bollard sleeves.

1.6^{R1} QUALITY CONTROL, TESTING AND QUALITY ASSURANCE

A. Pre-test analytical testing identification: a) quantify major variables for primary structural members and connections, and b) determine the required number, placement location, operating range, precision, accuracy and sensitivity of instrumentation. Submit this information to the Engineer for review.

B. Provide redundant instruments to measure and quantify test results for major variables for both static and dynamic loading, including but not limited to the velocity and direction of travel for the collision mass that is used for impact loading. Provide both digital still-frame photography and time-lapse videography to supplement instrumentation data to document the failure mode, quantify the engineering behavior and system performance, and calibrate the safety level of the structure. As a minimum, provide:

- vibrating wire (VW) strain gages;
- VW piezometers
- VW pressure cells
- thermistors, and
- linear VW displacement transducers with data logger to provide real-time monitoring of instrumentation data.

Place particular attention on documenting member properties as well as obtaining detailed information about collision impact loading, including:

- velocity;
- collision mass;
- incidence angle;
- impact duration;
- dynamic force;
- time-displacement data.

Provide detailed documentation about the structural condition for all critical structure members, both prior to and immediately after testing. Process the instrumentation data and present the results in a form for direct analysis and comparison with the predicted behavior from the pre-test analytical model.

C. Prepare and submit a final report to document the test findings, with an executive summary of key results.

D. The manufacturer shall provide written certifications that inspections were performed by a qualified inspection firm in compliance with the New York City Building Code. Additionally, the Authority reserves the right to inspect any component of the floodwall system at the off-site testing laboratory using Authority personnel or their representatives.

E. All floodwall system components shall be of the same manufacturer as the system deployed on site.

F. Certification of materials guaranteeing that all materials and components for the floodwall system meet all applicable standards for use in flood protection projects shall be submitted for approval before fabrication and delivery to the site.

G. The Contractor shall provide a Quality Assurance plan in conformance with Authority requirements to include manufacturer's qualifications with material and workmanship certifications.

H. All floodwall system components used shall meet the "BUY AMERICA ACT" as per FAR Sub-part 25.2 for construction materials.

I. Fabrication shop(s) shall participate in the AISC Certification program.

J. Submit a quality control plan prepared by the laboratory to the Engineer for review and approval. The Engineer may elect to inspect the fabrication shop to verify that the fabrication is performed in accordance with the contract documents and that the shop is operated in accordance with Quality Control Plan.

K. Qualify welding processes and welding operators in accordance with the AWS Code and provide certifications that welders to be employed in the work have satisfactorily the AWS pre-qualification Inspector.

PART 2 - PRODUCTS

2.1 STEEL BOLLARDS – See Specification 05120 Structural Steel from Contract: 324.828.F-01.

2.2 CONCRETE – See Specification 03301 Portland Cement Concrete from Contract: 324.828.F-01.

2.3 STEEL REINFORCEMENT - See Specification 03200 Concrete Reinforcement from Contract: 324.828.F-01.

2.4 SOIL – See Specification 02920C Planting Soil Mixes (Sand Based Structural Planting Soil) from Contract: Final Streets & Sidewalk Surfaces, Streetscape Elements, & Open Spaces – Package #4 (Tower 1). Soil furnished and delivered to testing facility by the Contractor.

2.5 GRANITE PAVERS – See Specification 04465C Granite – Exterior Installation Only Contract: Final Streets & Sidewalk Surfaces, Streetscape Elements, & Open Spaces – Package #4 (Tower 1). Granite Pavers will be furnished and delivered to testing facility by the Contractor.

2.6 CURBING – See Specification 04465C Granite – Exterior Installation Only Contract: Final Streets & Sidewalk Surfaces, Streetscape Elements, & Open Spaces – Package #4 (Tower 1). Curbing will be furnished and delivered to testing facility by the Contractor.

2.7 ASPHALT CONCRETE – See Specification 02553 Asphalt Concrete Paving from Contract: 324.828.F-01

2.8 FLOODWALL SYSTEM- See Specification 05520 Floodwall System from Contract: WTC-964.952. Floodwall system will be furnished and delivered to testing facility by the Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION AND MEASUREMENTS

A. Examine and measure the site to assure dimensions for construction of the BPS and floodwall system components for full scale laboratory testing off-site. Confirm site constructed conditions with the Engineer of Record and the Authority and maintain the same tolerances for the designed/constructed condition for the BPS and floodwall system;

B. For BPS/floodwall requirements see Floodwall specifications.

3.3 ERECTION

A. All requirements for off-site laboratory testing shall be the same as the BPS/floodwall system requirements.

3.4 DELIVERY, STORAGE AND DISPOSAL

A. All BPS/floodwall system components for testing shall be delivered to the laboratory by the manufacturer or the contractor at no additional cost to the Authority. Ensure that all components are of the same manufacture and quality of actual BPS and floodwall system components; replace any damaged components prior to installation and testing at no additional cost to the Authority.

3.5 INSPECTION

A. Inspection during construction observation during testing of the constructed test conditions at the off-site laboratory shall be permitted by the contractor for the benefit of the Authority and its representatives, whose representatives may include the Authority, outside testing and inspection professionals, the Engineer of Record and the Structural Engineer. Inspection and test observation shall be scheduled by appointment with the laboratory.

3.6 PARTS REQUIRED FOR TESTING

- A. Provide the requisite quantity of BPS/floodwall component parts for testing. Do not reuse any test components that were used in previous tests without the written consent of the Engineer.
- B. The contractor shall remove and dispose of all tested and related materials at no cost to the Authority.

END OF SECTION

SECTION 05510

PERIMETER FLOOD BARRIER

PART 1 - GENERAL

1.1 SUMMARY

- A. A prefabricated Perimeter Flood Barrier shall be procured to connect to the BPS Floodwall System in the areas identified on the contract plans.
- B. The final layout configuration and alignment of the Perimeter Flood Barrier components shall be determined by the contractor in coordination with the manufacturer, based on existing conditions verified by survey, and approved by the Authority. The maximum distance that the Perimeter Flood Barrier may extend into the roadway is 8 feet.
- C. The Perimeter Flood Barrier shall be designed and manufactured by:
 - 1) Aquafence USA
700 US Hwy 46
Clifton, NJ 07013
Contact: Adam Goldberg, Director
Phone: (203) 939-5176
 - 2) Or, an Authority approved equal manufacturer that meets the following requirements:
 - Similar assembly process
 - Similar anchor mechanism
 - Similar components
 - Awarded FM Approval (Class 2511) with a Certificate of Compliance

1.2 DESIGN AND PERFORMANCE REQUIREMENTS

- A. The Perimeter Flood Barrier must meet all of the requirements of FM Approval (Class 2511) and have an FM Global Certificate of Compliance for three feet of floodwater.
- B. Deviations from the contract drawings must be submitted for approval in advance of the shop drawing submissions.

1.3 SUBMITTALS

A. Shop Drawings and Calculations

- 1) Shop drawings and calculations shall contain all dimensional and geometric information. Do not order, fabricate or deliver any materials to

the construction site before shop drawings have been approved by the Authority and EOR.

Prior to (review) submittal of the shop drawings and calculations to the Authority, such shop drawings and calculations shall have been reviewed and approved for conformance with the contract documents, by the contractor and shall be stamped to indicate this by the contractor. Such indication by the contractor shall constitute the contractor's representation that he has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalogue numbers and similar data with respect thereto and has reviewed or coordinated each shop drawing with other shop drawings and samples and with the requirements of the work and the contract drawings.

- 2) Shop drawings shall include layouts and details showing the types of material of each component, sizes of members, connections, anchor bolt size and spacing, and other pertinent data. Provisions for the connection of any other work shall be indicated on the shop drawings.
- 3) Job standards and details for all atypical connections shall be prepared by or under the supervision of the Structural Engineer, licensed in the State of New York and shall bear the signature and seal of the Structural Engineer.
- 4) Submit shop drawings and calculations in complete packages so that individual parts and the assembled unit may be reviewed together.
- 5) The review of the shop drawings and calculations by the Authority and EOR shall in no way relieve the contractor of the responsibility for the adequacy of the design of the connections and all required detailing for the proper fitting of the work in strict conformance with the contract documents or from the necessity of furnishing material and workmanship required by contract drawings and specifications in addition to that indicated on the shop drawings.
- 6) Show drawings shall be submitted in English.

B. Quality Assurance Plan as described in section 1.4.

C. Operations and Maintenance Manual as described in section 3.4.

1.4 QUALITY CONTROL, TESTING AND QUALITY ASSURANCE

A. The manufacturer shall provide written certifications that inspections were performed by a qualified inspection firm in compliance with the New York City Building Code. Additionally, the Authority reserves the right to inspect any component of the floodwall at the mill or at the fabricator's shop with Authority personnel or their representatives.

B. Certification of materials guaranteeing that all materials and components for the floodwall system meet all applicable standards for use in flood protection projects shall be submitted for approval before fabrication and delivery to the site.

C. The Contractor shall provide a Quality Assurance plan in conformance with Authority requirements to include manufacturer's qualifications with material and workmanship certifications.

D. All floodwall system components used shall meet the "BUY AMERICA ACT" as per FAR Sub-part 25.2 for construction materials.

E. Fabrication shop(s) shall participate in the AISC Certification program.

F. Submit the quality control plan to the Engineer of Record and approval. The Engineer may elect to inspect the fabrication shop to verify that the fabrication is performed in accordance with the contract documents and that the shop is operating in accordance with the Quality Control Plan.

G. If applicable, qualify welding processes and welding operators in accordance with the AWS Code and provide certifications that welders to be employed in the work have satisfactorily the AWS pre-qualification Inspector.

1.5 WARRANTY

The floodwall manufacturer shall warrantee all removable all perimeter flood barrier components for a period of 10 years from the date of the finished installation. The warrantee shall transfer to the Authority.

PART 2 - PRODUCTS

2.1 STRAIGHT PANELS AND CORNER PANELS

A. Each unit shall consist of two panels: one panel shall be anchored to the floor while the other panel is help upright by braces between the two panels.

B. Adjacent units shall be fastened together with adjustable clasps allowing up to a five degree angle between units.

C. Each standard unit shall be approximately 6 ft long and make a barrier that is 47 inches high. Each unit shall be about 160 lbs.

D. A foam rubber gasket shall extend along the outer edge of the lower panel for the length of the unit.

E. Corner panels of 30 degrees, 45 degress, 60 degress, and 90 degrees shall be utilized as necessary for changes in directions.

2.2 STANDARD SIDE CLOSURE PANELS

A. Side closure panels shall provide a tie-in to a fixed surface, and a starting point for a string of panels in the perimeter flood barrier system.

B. Side closures shall be anchored to a wall and to the ground.

C. Side closures shall be fully removable after a flood event.

2.3 ANCHOR BOLTS

1. Anchor bolts shall be installed to prevent overturning, secure the unit to the ground, and compress the gasket. Placement, sizing, and material of the Anchor Bolts shall be submitted for approval.
2. A minimum of 4 Anchor Bolts shall be installed per typical panel.
3. Contractor is responsible to ensure that anchor bolts do not conflict with or any underground utilities.

PART 3 - EXECUTION

3.1 LAYOUT

A. The final layout configuration and connection details of the perimeter flood barrier components shall be developed by the contractor and perimeter flood barrier manufacturer based on the existing conditions verified by survey (see survey requirements in Specification 05520 FLOODWALL SYSTEM).

B. The perimeter flood barrier components may extend into the road a maximum 8 feet.

C. Offset dimension "space" from perimeter flood barrier components to any utility obstruction shall be a minimum of two (2) inches.

D. Shop drawings shall include stand-alone details that explicitly show tolerances on major dimensions, i.e., layout configurations of all perimeter flood barrier components, existing roadway/surface grades and superelevation, clearances from existing bollards or other obstructions, corner conditions, sidewalk ramps, and/or any other atypical areas.

3.2 ERECTION

A. All components shall be erected so that no localized or cumulative dimensional errors or fit up problems result;

B. The contractor shall be responsible for any damage to the existing conditions on site during deployment, removal and storage of the floodwall system;

C. The perimeter flood barrier layout configuration shall be designed for atypical conditions that include but are not limited to utility manhole covers, utility poles, ramps, bollards, hydrants, roadway grades and superelevation, signs, driveways, vents, subsurface chambers, and building corner connections. Test fit sections

shall be deployed that address these conditions to the satisfaction of the Authority.

A staged full deployment shall be performed for the entire floodwall system (BPS Floodwall System and Perimeter Flood Barrier) to ensure that all conditions have been addressed. See Specification Section 05540 FLOODWALL INITIAL INSTALLATION, DISASSEMBLY AND STORAGE for information regarding the required initial installation.

3.3 DELIVERY AND STORAGE

A. All perimeter flood barrier components shall be delivered to the site according to an approved Operations & Maintenance Manual.

Within one week's notice from the Authority, the contractor shall deliver the perimeter flood barrier in storage crates to a pre-determined storage location as directed by the Authority.

B. See Specification Section 05540 FLOODWALL INITIAL INSTALLATION, DISASSEMBLY AND STORAGE for information regarding the required initial installation.

C. The contractor shall be responsible for making any adjustments necessary to the perimeter flood barrier to ensure that it will perform according to the project requirements.

3.4 OPERATION & MAINTENANCE MANUAL

A. The manufacturer shall prepare an Operations & Maintenance Manual for the installation, removal and storage of the perimeter flood barrier that includes:

1) Installation:

- a. Storage Crate Organization
- b. Pre-Installation Preparation
- c. Inventory Verification
- d. Perimeter Flood Barrier Installation
- e. Anchor Installation
- f. Connection to the BPS Floodwall System
- g. Connection to the VSC Building
- h. Special Considerations for Site Features
- i. Monitoring

2) Removal:

- a. Anchor Removal
- b. Perimeter Flood Barrier Removal
- c. Disconnection from BPS Floodwall System
- d. Disconnection from the VSC Building

- 3) Storage:
 - a. Washdown
 - b. Inspection of System Components
 - c. Parts Inventory
 - d. Spare Parts Assessment and Re-ordering
 - e. Storage of Components in Storage Crates
 - f. Long Term Storage, Clean up and Stock Piling
 - 4) Photos and video of the Perimeter Flood Barrier Installation.
- B. O&M Manual for the Perimeter Flood Barrier described in 3.5 A above shall be incorporated in the O&M Manual for the VSC BPS Floodwall System (See Specification 05520 FLOODWALL SYSTEM Section 3.5).
- C. The O&M Manual shall be developed in coordination with overall World Trade Center emergency management plans and direction from officials with jurisdiction and in responsible charge.
- D. The O&M Manual is a required submittal that requires approval by the Engineer of Record and the Authority prior to the Floodwall Initial Installation, Disassembly, and Storage (See Specification 05540 FLOODWALL INITIAL INSTALLATION, DISASSEMBLY, AND STORAGE).

3.5 SPARE PARTS

The contractor shall provide spare parts for no less than 10 linear feet of perimeter flood barrier and at least one of each component.

END OF SECTION

SECTION 05520

FLOODWALL SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Floodwall system shall be designed and fabricated for ease of assembly, removal and storage as acceptable by the Authority. The floodwall system shall include the following components: stop logs (beams), posts, connections, shear pins, braces, tension rods, hold downs, rubber seals, neoprene pads, continuous gaskets, shims, hardware or any other appurtenance necessary to provide a complete floodwall system which shall also include but are not limited to access staircases, storage racks and storage containers.
- B. The existing steel bollards have been identified by the Authority as an independent primary means of support for the floodwall system but will require site specific details. Perform all engineering analysis and engineering design based upon existing conditions on site and as shown in supplemental record documents as provided by the Authority utilizing the existing bollards and their foundations to provide a complete floodwall system.
- C. The floodwall system shall be designed and manufactured by:
- 1) Flood Control America, LLC
560 Herndon PKWY, Suite 310
Herndon, VA 20170-5240

Contact: Mr. George Fryklund, P.E.
Phone: (978) 440-8902
 - 2) Or, an Authority approved equal manufacturer that meets the following requirements:
 - Similar assembly process
 - Similar hold down mechanism
 - Similar Post and bracing
 - Similar flood logs that are interchangeable with FLOOD CONTROL AMERICA, LLC logs manufactured for the Tower One BPS Floodwall System (See Part 4 - Reference Documents)
 - Completion of a Full Scale Test conforming to the attached reference Specification 05230 OFF-SITE LABORATORY TESTING
- D. The floodwall system shall be designed for performance including fast, safe and easy deployment where weather events create very short lead times for installation. Floodwall system components shall be modular for assembly such that the floodwall system is easily erected and connected to the existing bollards on

site by manpower using only light duty equipment for erection. Except for identified atypical areas, the Floodwall system shall be comprised of interchangeable standard components that meet the design criteria and take into account site variance and installation tolerances. Posts shall be connected to the existing steel bollards on site with stop logs being placed between the posts and bracing where required.

1.2 REFERENCES

The overall design of the floodwall system (including integral concrete foundations) shall meet the following standard US government codes including US Army Corps of Engineers Design Manuals:

- A. USAME EM 1110-2-2502, Retaining and Floodwalls;
- B. USAME EM 110-2-2705, Structural Design of Closure Structures For Local Flood Protection Projects;
- C. USAME EM 1110-2-2105, Design of Hydraulic Steel Structures Appendix E Bulkheads and Stop logs;
- D. USAME EM 1110-2-2100, Stability Analysis of Concrete Structures;
- E. Bureau of Reclamation "Design of Small Dams" 2010 edition;
- F. American Society of Civil Engineers ASCE 7-10 Minimum Design Loads for Buildings and Other Structures (including Wind Loads);
- G. American Welding Society D1.1 "Structural Welding Code B Steel; (latest edition)
- H. The specifications of FM Global;
- I. AISC Steel Construction Manual;
- J. Aluminum Design Manual, 2010 Edition;
- K. 29 CFR OSHA 1926 Construction Industry Regulations;
- L. New York City Building Code (2008);
- M. Building Code of New York State (2010).

Deviations from the contract drawings must be submitted for approval in advance of the shop drawing submissions. Permanently embedded foundations, parts or modifications to the existing bollards shall be identified during the shop drawing process for approval by the Authority and prior to fabrication of any floodwall system components.

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

A. Whenever the term "Structural Engineer" is used in this specification, it shall mean the engineer employed by the manufacturer. The design of the floodwall system shall be the responsibility of the manufacturer under the supervision of a licensed Structural Engineer registered in the State of New York. The Structural Engineer shall sign and seal all drawings and calculations and shall be responsible for the implementation of the design by reviewing the fabrication process to assure conformance with his design and shall sign a statement certifying that the fabrication and erection of the floodwall system are in conformance with the floodwall design. The "Engineer of Record" when used in this specification shall mean the engineer employed by the Authority.

B. The design shall properly account for the load distribution of concentrated loads. Calculations and load conditions shall include slide factors, overturning, impact loading and uplift factors. Posts shall be designed for a minimum safety factor of 1.5 for sliding (flood condition without collision impact load) and/or 1.25 (flood condition with collision impact load). Minimum factor against overturning shall be 1.5. Steel bracing must be designed depending on existing conditions, wall height, post spacing, and loading conditions. The Structural Engineer shall verify that the imparted load shall be capable of being supported by the existing structure below grade.

C. Posts with attached HSS tube steel sections shall be designed with a shear pin capable of providing a full moment connection when bearing fully on the existing steel bollard utilizing removable shims. Shims inside of the HSS tube steel sections are required. Additional bracing in terms of the installation of a stiffening plate for each bollard shall be investigated. Friction connections are not acceptable for the post to bollard connection.

D. The Structural Engineer shall submit a complete set of record computations that incorporate all revisions as a result of the review and approval by the Authority and the Engineer of Record.

1.4 SUBMITTALS

A. Land and topographic surveys shall be performed under the supervision of a professional land surveyor registered in the State of New York prior to any fabrication or shop drawing submittals. The survey submission deliverable shall include:

- 1) Horizontal and vertical control and tie points;
- 2) Elevations at the top of each bollard and the corresponding ground surface (top of granite pavers) where flood components will be located (e.g. BPS Post, Flood logs, continuous gasket, bracing where applicable);
- 3) The distance from the top of the bollard to the as-constructed existing pavement where flood components will be located (e.g. BPS Post, Flood logs, continuous gasket, bracing where applicable);
- 4) The distance between bollards;
- 5) The date survey work was completed in the field; and
- 6) Location, size, and elevation of potential conflicts with the BPS Floodwall System

A copy of the survey shall be provided to the Engineer of Record for information.

B. Tolerance Analysis and Atypical Areas Identification Report

- 1) Defines the Standard BPS Post design, tolerances, and installation locations
- 2) Defines the Standard BPS Flood System stop log length, tolerances, and installation locations
- 3) Analyzes of the pad thickness required at each location using the elevations determined by land and topographical survey in the field (1.4 A above)
- 4) Identifies the continuous gasket sizing and minimum/maximum compression range upon with the gasket must perform taking into account installation tolerance and field condition variance on the project site.
- 5) Includes a list the atypical areas which require specialized BPS post designs, if applicable, and identifies bollard groupings of these atypical areas where possible

A copy of the Tolerance Analysis and Atypical Areas Identification Report shall be provided to the Engineer of Record for review and approval.

C. Shop Drawings and Calculations

- 1) Shop drawings and calculations shall contain all dimensional and geometric information. Do not order, fabricate or deliver any materials to the construction site before shop drawings have been approved by the Authority and EOR. Prior to (review) submittal of the shop drawings and calculations by the Structural Engineer to the Authority, such shop drawings and calculations shall have been reviewed and approved for conformance with the contract documents, by the contractor and shall be stamped to indicate this by the contractor. Such indication by the contractor shall constitute the contractor's representation that he has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalogue numbers and similar data with respect thereto and has reviewed or coordinated each shop drawing with other shop drawings and samples and with the requirements of the work and the contract drawings.
- 2) Shop drawings shall include layouts and details showing the type of steel for each member, sizes of members, connections, cuts, copes, cope reinforcing, bolts, welds and other pertinent data. Provisions for the connection of any other work shall be indicated on the shop drawings.
- 3) All welds shall be indicated by standard welding symbols as defined by AWS. Shop drawings shall show size, length, and each type of weld.
- 4) Job standards and details for all atypical connections for beams and girders, column splices, moment connections and wind bracing details shall be prepared by or under the supervision of the Structural Engineer, licensed in the State of New York and shall bear the signature and seal of the Structural Engineer.
- 5) Submit shop drawings and calculations in complete packages so that individual parts and the assembled unit may be reviewed together. Submit index sheets with all beam (stop log), post, and bracing details at the same time the details are submitted for review.
- 6) The review of the shop drawings and calculations by the Authority and EOR shall in no way relieve the Structural Engineer of the responsibility for the adequacy of the design of the connections and all required detailing for the proper fitting of the

work in strict conformance with the contract documents or from the necessity of furnishing material and workmanship required by contract drawings and specifications in addition to that indicated on the shop drawings.

- 7) Shop drawings must show permanent marking of members for erection purposes. These permanent markings must match the markings on the BPS Floodwall System around Tower One. See included reference Installation and Maintenance Manual.
- 8) Show drawings shall be submitted in English.

D. Samples shall be provided by the Contractor of the materials specified herein before ordering materials. Submit a minimum size (1'-0" x 1'-0") for the stop logs and rubber seals, showing the interface between the log and the continuous gasket at the ground surface.

E. Quality Assurance Plan as described in section 1.5.

F. Physical Template of a BPS Floodwall Post as described in section 3.1 F.

G. Operations and Maintenance Manual as described in section 3.5.

1.5 QUALITY CONTROL, TESTING AND QUALITY ASSURANCE

A. The manufacturer shall provide written certifications that inspections were performed by a qualified inspection firm in compliance with the New York City Building Code. Additionally, the Authority reserves the right to inspect any component of the floodwall at the mill or at the fabricator's shop with Authority personnel or their representatives.

B. Certification of materials guaranteeing that all materials and components for the floodwall system meet all applicable standards for use in flood protection projects shall be submitted for approval before fabrication and delivery to the site.

C. The Contractor shall provide a Quality Assurance plan in conformance with Authority requirements to include manufacturer's qualifications with material and workmanship certifications.

D. All floodwall system components used shall meet the "BUY AMERICA ACT" as per FAR Sub-part 25.2 for construction materials.

E. Fabrication shop(s) shall participate in the AISC Certification program.

F. Submit the quality control plan to the Engineer of Record and approval. The Engineer may elect to inspect the fabrication shop to verify that the fabrication is performed in accordance with the contract documents and that the shop is operating in accordance with the Quality Control Plan.

G. Qualify welding processes and welding operators in accordance with the AWS Code and provide certifications that welders to be employed in the work have satisfactorily the AWS pre-qualification Inspector.

1.6 OFF-SITE FLOODWALL SYSTEM TESTING

OFF-SITE FLOODWALL SYSTEM TESTING is only required if the floodwall designer and manufacturer is NOT FLOOD CONTROL AMERICA, LLC (560 Herndon PKWY, Suite 310; Herndon, VA 20170-5240). Reference 05230 OFF-SITE LABORATORY TESTING.

1.7 WARRANTY

The floodwall manufacturer shall warrantee all removable steel and aluminum components of the floodwall for a period of 10 years and all rubber strip seals and neoprene pads for a period of 5 years from the date of the finished installation. The warrantee shall transfer to the Authority.

PART 2 - PRODUCTS

2.1 POSTS AND BRACING

A. All posts and bracing shall be structural steel designed by the Structural Engineer to meet loading requirements referenced herein. Structural steel shall mean structural steel as defined in Section 2 – Classification of Materials of the AISC “Code of Standard Practice for Steel Buildings and Bridges”.

B. All posts and bracing shall be Hot Dipped Galvanized as per ASTM A-123 and according to the recommendations of the American Galvanizers Association.

C. All pins and security retainer clips shall be Type 304 stainless ASTM F593-02 (2008) e1 Standard Specifications for Stainless Steel Bolts, Hex Cap Screws and Studs.

2.2 STOP LOGS

A. All stop logs shall be manufactured of high strength extruded aluminum with a uniform specified profile to accommodate stacking. All stop logs shall include two formed channels, shaped to accept rubber seals that can be installed by pressure, without the need of adhesives to attach the rubber seal to the stop log. All stop logs shall have two (2) rubber seals. The rubber seal side of the stop log shall be positioned facing down.

B. Stop logs shall be an aluminum extrusion ASTM B221M Alloy 6005.

C. All stop logs shall be designed to be reversible so that either side (the wet side or the dry side) can be used.

D. Contractor shall verify the capacity of the stop logs/BPS System due to any modification of the stop log for connection of the perimeter flood barrier to the bps flood wall panel and shall strengthen the BPS System if required. R2

2.3 MISCELLANEOUS STEEL COMPONENTS

- A. All miscellaneous steel components shall be designed to provide either a shop welded, or bolted or pinned connection.
- B. Posts and plates shall be either ASTM A36 or ASTM A992, Grade 50 steel, galvanized as per ASTM A-123. Tubes shall be ASTM A500, Grade 50.

2.4 SHEAR PINS AND HIGH STRENGTH BOLTS

- A. All shear pins and bolts shall be certified and x-rayed by the manufacturer certified to meet the Quality Assurance standards; High Strength bolts shall conform to the provisions of the AISC "Specifications for Structural Joints Using High Strength Bolts".
- B. Finished bolts shall conform to ASTM F468M, Standard Specification for Nonferrous Bolts, Hex Cap Screws and Studs for General Use.
- C. Stainless steel Type 304 ASTM F593-02 (2008) e1 – Standard Specifications for Stainless Steel Bolts, Hex Cap Screws and Studs Carbon Steel ASTM-36 Hot Dipped Galvanized

2.5 HOLD DOWNS

- A. Hold-downs shall be designed to secure the aluminum stop logs once they are stacked within the steel post section. The stop logs shall be designed to withstand floodwater forces and shall have watertight seals horizontally (where the lowest stop log meets the ground surface) and vertically (where the stop logs meet the posts). Vertical and horizontal hold-downs shall be hot dipped galvanized, designed from carbon steel such that varying wall heights on a post can be held securely.

2.6 RUBBER SEALS

- A. The rubber seals in the posts and shall be a common design to simplify replacement and inventorying of spare parts. The posts and stop logs shall lock securely in place without adhesives when rubber seals are pressed into grooves fabricated in either the stop logs or the posts.
- B. All rubber seals shall meet the following criteria:

Material Type	EPDM	EPDM micro porous
Hardness	60-70 ShA	30 ShA
Specific mass	1,4 g/cm ³	0,7 g/cm ³
Temperature range	-30/100 °C	-30/+100 °C
Strength	7 N/mm ²	1 N/mm ²
Ductility	350%	150%

2.7 CONTINUOUS GASKET

- A. The continuous gasket shall be designed to account for changes in grade on the project site and to limit damage to the ground surface due to deployment and removal of the floodwall system. Armacell Ensolite IUO or Authority approved equal shall be used.
- B. All continuous gaskets shall be provided for a single use. When storing the floodwall system, the continuous gasket components shall be replaced.
- C. Two sets on continuous gaskets shall be provided for the entire site under this contract:
 - 1) One for the first deployment
 - 2) One to be included in storage with the BPS Floodwall System Components after the first deployment

2.8 EMERGENCY ACCESS STAIRWAYS

- A. Emergency Access Stairways shall be a minimum 22 inches wide and shall be designed according to 29 CFR 1926 OSHA for the locations shown on the contract drawings. The contractor shall submit shop drawings for each stair location.
- B. All stairways shall be constructed from galvanized steel according to ASTM A123.
- C. Stairways shall be positively connected to the flood wall posts.

PART 3 - EXECUTION

3.1 EXAMINATION (TOLERANCES)

- A. Examine and measure the site to assure the general tolerances for the floodwall system. Notify the Authority and the Engineer of Record to conditions detrimental the proper and timely completion;

- B. Confirm overall existing steel bollard spacing variance in the land and topographical survey (1.4 A);
- C. Offset dimension "space" from the post to the existing embedded bollard collar shall be a minimum of two (2) inches;
- D. Over-sized hole in steel bollard, shear pin diameter plus minimum one-eighth (1/8) inch;
- E. Centerline of shear pin hole in the steel bollard shall be located in the stress free zone, GENERALLY no more than four (4) inches from the top of the bollard to the shear pin hole centerline and a minimum of 30 inches from the ground surface to the shear pin hole centerline, and shall align with the holes in the HSS section.;
- F. Prior to fabrication of the BPS Floodwall components, the contractor shall create a physical template of the BPS post that shall be used to verify system fit-up, bollard hole alignment, and shear pin installation on the project site.;
- G. Offset dimension "space" from the post and/or flood wall face to any utility obstruction shall be a minimum of two (2) inches.
- H. Shop drawings shall include stand-alone details that explicitly show tolerances on major dimensions, i.e., length and height of stop logs, post and bracing, corner conditions (that maintain adequate bearing justified by calculation), sidewalk ramps, and any other identified atypical areas.
- I. Tolerances for erection shall not exceed design tolerances.

3.2 FINISH

- A. Stop log, post and bracing surfaces shall be smooth and free of sharp or irregular edges; excessive pits on the surface; excess slag; mill scale; rust stains; corrosion; non-uniformity of color.

3.3 ERECTION

- A. All posts shall be erected (plus or minus 1/4") , plumb (plus or minus 1" for any post); stop logs (differential chamber with 1/4" in a 20 foot run) so that no localized or cumulative dimensional errors or fit up problems result;
- B. The contractor shall be responsible for any touch up of the galvanized floodwall system components;
- C. The contractor shall be responsible for any damage to the existing conditions on site during deployment, removal and storage of the floodwall system;
- D. The floodwall system shall be designed for atypical conditions that include but are not limited to ADA ramps, trees, light poles, other poles, hydrants, Siamese

connections, signs, driveways with removable bollards, vents, subsurface chambers, and building corner connections. For each wall height (both 5 feet and 8 feet heights) test fit sections shall be deployed that address these conditions to the satisfaction of the Authority.

A staged full deployment shall be performed for the floodway system to ensure that all conditions have been addressed.

3.4 DELIVERY AND STORAGE

A. All floodwall system components shall be delivered to the site in shipping containers supplied by the floodwall manufacturer slide on-slide off that fits in an indoor facility according to an approved Operations & Maintenance Manual.

Within one week's notice from the Authority, the contractor shall deliver the floodwall system in containers to a pre-determined storage location as directed by the Authority.

B. See Specification Section 05540 FLOODWALL INITIAL INSTALLATION, DISASSEMBLY AND STORAGE for information regarding the required initial installation.

C. The contractor shall be responsible for making any adjustments necessary to the BPS Floodwall system to ensure that the wall will perform according to the project requirements.

3.5 OPERATION & MAINTENANCE MANUAL

A. The manufacturer shall prepare an Operations & Maintenance Manual for the installation, removal and storage of the floodwall system that includes:

1) Installation:

- a. Storage Container Organization
- b. Pre-Installation Preparation
- c. Inventory Verification
- d. Post Installation
- e. Brace Installation
- f. Stop Log Installation
- g. Hold-Down Clamp Tightening
- h. Emergency Egress Stairs Installation
- i. Special Considerations for Site Features
- j. Monitoring

2) Removal:

- a. Releasing the Hold-Down Clamps
- b. Removing the Stop Logs

- c. Removing the Bracing
 - d. Removing the Posts
- 3) Storage:
- a. Washdown
 - b. Inspection of System Components
 - c. Parts Inventory
 - d. Spare Parts Assessment and Re-ordering
 - e. Storage of Components in Containers
 - f. Long Term Storage, Clean up and Stock Piling
- 4) Photos and video of the BPS Floodwall System Installation.
- B. Training: While deployment, removal and storage of each segment of the floodwall are being performed, provide a structured training to Authority personnel for the proper deployment, removal and storage of the floodwall system. The training shall include the following:
- 1) Table Top Exercises
 - 2) Segment Deployment Exercises (Standard Posts and Atypical Areas)
 - 3) Lessons Learned
- C. During deployment of the floodwall system, keep building entrances open (note stop logs identified on the contract drawings that will be deployed once the building is evacuated), and maintain access to fire hydrants and building Siamese connections until directed by the Authority.
- D. Floodwall system emergency staircases shall be deployed as per the Operations and Maintenance Manual or as directed by the Authority.
- E. The O&M Manual shall be developed in coordination with overall World Trade Center emergency management plans and direction from officials with jurisdiction and in responsible charge.
- F. The O&M Manual is a required submittal that requires approval by the Engineer of Record and the Authority prior to the Floodwall Initial Installation, Disassembly, and Storage (See Specification 05540 FLOODWALL INITIAL INSTALLATION, DISASSEMBLY, AND STORAGE).
- G. All of the BPS Floodwall System components must be color coded and labelled to match the color codes and labels used for the Tower One BPS Floodwall System (See Part 4 – Reference Documents).

3.6 SPARE PARTS

- A. The manufacturer shall provide spare parts for each floodwall system component and shall provide complete square footage of wall equal to horizontal sections of floodwall stop log sections for each wall height (approximately 50 square feet for the 5 foot high wall and 80 square feet for the 8 foot high wall).

- B. The total number of spare parts for each wall component shall not be less than 2% of the total number pieces or linear footage for that particular component of the floodwall system.
- C. Petroleum-based products such as the components of the continuous gasket system shall be designed to be replaced in its entirety.

PART 4 – Reference Documents

3.1 TOWER ONE BPS FLOODWALL SYSTEM SHOP DRAWINGS

Shall be provided upon contract reward.

3.2 TOWER ONE BPS FLOODWALL SYSTEM INSTALLATION AND MAINTENANCE MANUAL

Shall be provided upon contract reward.

END OF SECTION

SECTION 05540

FLOODWALL INITIAL INSTALLATION, DISASSEMBLY, AND STORAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. The initial installation of the floodwall system shall follow the approved Operations and Maintenance Manual (See Specification 05520 FLOODWALL SYSTEM and Specification 05510 PERIMETER FLOOD BARRIER). The contractor is responsible for storage of the floodwall system and perimeter flood barrier components off-site prior to initial installation and delivery to the site. One week prior to installation, the Authority will notify the contractor.
- B. Remove bollard covers, remove foam insulation from covers, store covers, install the wall posts, install shear pins, install continuous gasket, install the flood logs, and install the entire removable floodwall system components as directed by the Authority.
- C. Upon direction from the Authority, dis-assemble the floodwall system according to approved Operations and Maintenance Manual (See Specification 05520 FLOODWALL SYSTEM and Specification 05510 PERIMETER FLOOD BARRIER). Remove all floodwall system and perimeter flood barrier components and replace any damaged or defective components which shall be covered by warrantee. Store all floodwall system and perimeter flood barrier components in an organized manner in the storage containers provided by the manufacturer and deliver to a location as directed by the Authority.
- D. Remove ornamental steel bollard covers from storage, install ornamental covers with foam insulation applied to the top of the steel bollard, set the ornamental cover so that it sits firmly in place and attach cover to the bollard collar with set screws. Any lost or damaged ornamental bollard covers or set screws shall be replaced by the contractor at no additional cost to the Authority.
- E. Any damage of the existing street or streetscape, inclusive of but not limited to bollards, ornamental bollard covers, pavers, curbing, utility poles, hydrants shall be restored to original condition to the satisfaction of the engineer at no additional cost to the Authority.

1.2 REFERENCES

All work shall meet the following standard codes:

- A. NYC Building Code;
- B. ICC/ANSI 117.1-2003;
- C. New York State MUTCD.

1.3 SUBMITTALS

The contractor shall update the approved Operations and Maintenance Manual (See Specification 05520 FLOODWALL SYSTEM and Specification 05510 PERIMETER FLOOD BARRIER) with any lessons learned and submit to the Engineer of Record for review and approval.

1.4 WARRANTY

Warrantees for any damaged or defective floodwall system components shall be as per 05520 FLOODWALL SYSTEM, 1.7 WARRANTY and 05510 PERIMETER FLOOD BARRIER, 1.5 WARRANTY.

PART 2 – PRODUCTS

2.1 INSULATION FOAM

- A. Foam Insulation shall be Great Stuff Pro Window & Door Insulating Foam Sealant as manufacturer by the Dow Chemical Corporation, Midland MI or engineer approved equal.

2.2 FLOODWALL SYSTEM

- A. Reference 05520 FLOODWALL SYSTEM for overall requirements.

2.3 PERIMETER FLOOD BARRIER

- A. Reference 05510 PERIMETER FLOOD BARRIER for overall requirements.

PART 3 – EXECUTION

3.1 STORAGE BEFORE DELIVERY

- A. All components shall be delivered to the site in shipping containers supplied by the flood wall manufacturer according to the approved Operations & Maintenance Manual.
- B. The manufacturer shall deliver the floodwall system and perimeter flood barrier in storage containers/crates to a pre-determined storage location on site within one week after given direction by the Authority.

3.2 INSTALLATION

A. The contractor shall construct the BPS floodwall system in segments on site within one week of direction of the Authority.

B. All posts shall be erected plumb, square and true for fit up and so that no cumulative dimensional errors occur.

C. The perimeter flood barrier on Liberty Street shall be placed in its entirety including connections to the adjacent BPS floodwall system. Anchors shall be installed on one unit of the perimeter flood barrier.

D. The perimeter flood barrier at Greenwich street shall be placed in its entirety including connections to the adjacent BPS floodwall system and to the VSC building. Anchors shall be installed on one unit of the perimeter flood barrier.

E. The contractor shall be responsible for any damage to existing conditions caused by the floodwall system or perimeter flood barrier installation and shall replace any damaged conditions at no additional cost to the Authority.

3.3 MAINTENANCE AND PROTECTION OF TRAFFIC - See Maintenance and Protection of Traffic section in the General Conditions; contractor is responsible for obtaining all permits required for installation of the floodwall system and perimeter flood barrier from agencies having jurisdiction.

3.4 DISASSEMBLY

A. The contractor shall disassemble each segment of the floodwall system and perimeter flood barrier in an orderly fashion as described in the approved Operations & Maintenance Manual (See Specification 05520 FLOODWALL SYSTEM and Specification 05510 PERIMETER FLOOD BARRIER).

B. The contractor shall inspect all components during disassembly and shall be responsible for touch up of the galvanized floodwall system components after disassembly.

C. The contractor shall be responsible for any damage to existing conditions caused by the disassembly of the floodwall system and shall replace any damaged conditions at no additional cost to the Authority.

3.4 STORAGE

A. The contractor shall store all components of the floodwall system and perimeter flood barrier in the prescribed storage in an orderly fashion as described in the approved Operations & Maintenance Manual (See Specification 05520 FLOODWALL SYSTEM and Specification 05510 PERIMETER FLOOD BARRIER).

B. An inventory of spare parts shall be made to determine whether additional component parts need to be purchased and stockpiled.

C. The Contractor shall store both the components and the containers containing the components of the BPS Floodwall System and the perimeter flood barrier off-site (within 25 miles of the project site) for one year at a set cost to the Authority. Within one-week after notice from the Authority, the Contractor shall redeliver the components and the containers containing the components of the BPS Floodwall System to the project site at no additional cost to the Authority.

END OF SECTION