



CLIMATE RESILIENT DESIGN STANDARDS & GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY





SECTION 7.0

DEPLOYABLE FLOOD BARRIER GUIDANCE



B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

SECTION 7.0 DEPLOYABLE FLOOD BARRIER GUIDANCE

7.1 DESCRIPTION AND ASSUMPTIONS

Deployable flood barriers are being employed across the City of Boston during flood events to protect private properties. This section provides guidance for selecting appropriate deployable flood barrier solutions, which are also referred to as temporary flood barrier solutions. Deployable flood barriers are defined as a barrier system that is deployed before and/or during a flood event and retracted after a flood event. The guidance provided is modeled after the *Temporary and Demountable Flood Protection Guide*, developed by the Environment Agency of the United Kingdom (Ogunyoye, 2011). Deployable barrier systems types vary and include, but are not limited to, barriers that are:

- ▶ pre-installed or partially pre-installed at the location of deployment;
- ▶ mobile, i.e. units brought to the location of deployment, constructed, and then removed, such as sand bags;
- ▶ passive systems that deploy and retract automatically based on flood levels without human intervention or electricity;
- ▶ rigid hard structures (i.e. walls);
- ▶ soft flexible structure (i.e. membranes);
- ▶ stackable or with features to adjust height of flood protection during an event;
- ▶ tubes filled with air or water;
- ▶ containers filled with water or aggregate (soil or rock);
- ▶ standalone flood defense systems; and/or
- ▶ connected to permanent flood protection barriers (such as reinforced walls and doors).

There are numerous deployable flood barrier types and products available, with demand growing for more interim solutions as extreme weather events are experienced more frequently. In lieu of a sample site location for context, this section presents a Comparison Matrix with several existing temporary flood defense barrier types including mobile modular rigid barriers, partially pre-installed flexible barriers, and pre-installed passive barriers. The specific products considered in these documents do not indicate endorsement or reflect a preference for one barrier type over another and do not represent the full spectrum of deployable flood barriers that are available. The intent of including specific products in the guidelines is to illustrate the framework for engineers and designers to evaluate the physical, structural, and operational capacity of products for a site. The process and sample considerations do not supersede local, state, or federal regulations.

If the site is within a flood pathway for the City of Boston, then engineers, designers, and developers should first consider if a permanent protection system is feasible. All sites considering deployable flood barriers should develop a plan for long-term flood protection in coordination with this process. A deployable flood barrier may be identified for temporary use while permanent solutions are design, permitted, and constructed. **The intent of the barrier should be to be deployed only during storm events (not during fair weather high or King tides) and not remain deployed once flood waters have receded.** Coordination with the City of Boston and surrounding stakeholders is necessary to implement deployable flood barriers within the public right-of-way. Temporary barriers may not impact ADA accessibility of the right-of-way when stored and/or deployed, and minimum travel lanes for pedestrians, bikes, and vehicles should be maintained. Emergency access, including access to fire hydrants, must be maintained.

Operational capacity is essential for effective deployment. The barrier may not provide flood protection if it is not deployed as designed and intended due to insufficient operations and maintenance (O&M) of the barrier. Detailed protocols for management, deployment, retraction, and emergency response are an integral part to this process. Owners should consider scenarios where the lead time (time between notice of a storm and successful deployment of barrier) is shorter than expected and/or trained manpower and equipment are not available; these scenarios are common due to the nature and variability of storms, as well as competing demands for limited resources in preparation

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

of a storm. Deployable barriers may not be selected without considerations and documented plans for long-term permanent flood protection.

7.2 DEPLOYABLE BARRIER DESIGN CONSIDERATIONS

The design considerations for deployable flood barriers reflect a range of engineering, physical, structural, and operational characteristics for both the site and product. This framework mirrors the process established in Section 3.0 of the guidelines with some additional considerations included to evaluate product characteristics. To understand the differences between evaluating the site capacity and product capacity, this section is broken up into two sets of design considerations:

- ▶ Design Considerations for the Site
- ▶ Design Considerations for the Product

A comprehensive evaluation of design considerations for the site and products available is essential to finding the appropriate solution that fits the physical, structural, and operational needs.

Design Considerations for the Site

This is not a comprehensive list of all potential considerations and additional studies may be recommended to advance design. Refer to Section 3.0 Design Considerations for a list of additional considerations that apply to permanent structures and may apply to temporary structures. The designer, engineer, and/or planner should consider the following design considerations *prior* to barrier considerations.

DESIGN CONSIDERATIONS FOR THE SITE

Climate Design Adjustments

- ▶ Refer to Section 2.0 and 3.0 for additional information.
- ▶ Identify the base flood elevation (BFE) for the 1% annual flood event.
- ▶ Map flood pathways on the site and surrounding areas.
- ▶ Evaluate the duration of flood (i.e. how long will the flood be on-site).
- ▶ Wind and Wave Impacts (wind is critical prior to flood events).
- ▶ Extreme Precipitation projections (water will be trapped inland of the barrier.).

Site Specific Constraints and Design Considerations

- ▶ Survey the existing location.
 - ▲ Identify properties, boundaries, utilities, potential for debris.
- ▶ Identify the extent of barrier (width and height, including freeboard).
 - ▲ Barrier should be designed to prevent flanking and reduce risk of overtopping.
 - ▲ Evaluate the total length of the barrier.
- ▶ Zoning.
 - ▲ Contact the Boston Planning and Development Authority (BPDA) to evaluate zoning regulations and requirements.
 - ▲ Identify any current regulations that may prevent use of deployable barriers.
- ▶ Assess available open space for deployment and/or storage of barrier.
- ▶ Public Right-of-way (ROW).
 - ▲ Barriers shall not encroach onto the ROW without coordination with the City of Boston. Deployed barriers must maintain a 4 ft. minimum accessible path of travel on the sidewalk, as well as minimum travel width and bike access lanes where applicable.
- ▶ Private Properties.
 - ▲ Barriers may extend across several properties. Coordinate with neighbors and the City of Boston for layout and easement considerations.

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Site Specific Constraints and Design Considerations (continued)

- ▶ Offsite Impacts (Adjacent and Downstream).
 - ▲ Deployable barriers may be designed in coordination with neighboring properties to provide a larger protection area.
 - ▲ The barrier should not preclude flood protection for adjacent parcels.
 - ▲ Evaluate the impact of the barrier on diverting flood water to unprotected areas.
 - ▲ Stormwater runoff must be considered when selecting deployable barriers. The implementation of barriers may change existing stormwater flow regime, which could lead to overloading of stormwater systems. Additionally, stormwater runoff may flood off-site areas and could create flooding situations in areas that otherwise might not be within the flood pathway.
- ▶ Ground and Terrain conditions.
 - ▲ Evaluate the ground condition where the proposed barrier is intended. Are there ground conditions that would impact the deployment of a barrier, such as curbs, undulations, hard surfaces, soft surfaces, snow and/or ice accumulation, slopes, etc.
- ▶ Subsurface conditions.
 - ▲ The subsurface conditions may not be able to support the deployable barrier. Refer to Section 3.0 for geotechnical considerations.
- ▶ Accessibility.
 - ▲ If barriers impact egress from a building, the building must be evacuated prior to deployment or additional evacuation measures must be considered.
 - ▲ Barriers must not preclude emergency access, including fire hydrant access.
- ▶ Volume Capture and Control.
 - ▲ Assess high intensity rainfall events (cloudbursts) in the design and modify designs to safely convey the discharge without causing downstream/upstream flooding.
 - ▲ The deployable barrier will need adequately sized conveyance and potential temporary mechanical pumping systems to manage the stormwater on the upgradient side of the barrier.
 - ▲ Pumping systems should be considered to handle stormwater volumes trapped on the dry side as well as potential overtopping during extreme storm surge to prevent flooding behind the barrier.
 - ▲ Stormwater management must include considerations of discharging pumped water so that it is in accordance with BWSC Standards.
- ▶ Structural Considerations.
 - ▲ Evaluate if the intended alignment of the barrier may connect to existing flood walls. Evaluate existing conditions. Refer to Section 3.0 for structural considerations.
- ▶ Incremental Considerations.
 - ▲ Consider products with the ability to increase in height or length during deployment.
 - ▲ Site specific incremental considerations, both vertical and horizontal, are as follows:
 - ▶ Boundaries – will the barrier tie into existing higher grades or walls?
 - ▶ Bridging gaps between permanent barrier solutions during storm events until a proper permanent solution can be achieved.
 - ▶ Master Plans – shall be changed according to the locations and sizes of barriers.
 - ▶ Planning – this project should be coordinated in conjunction with flood protection at relevant nearby sites.

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Existing site/owner Operational Capacity (Refer to Section 7.3 for O&M considerations)	<ul style="list-style-type: none"> ▶ Assess Operational Capacity. <ul style="list-style-type: none"> ▲ Manpower available before, during, and after storm events. ▲ Equipment available before, during, and after storm events. ▲ Technical capabilities of staff (laborer, operator, mechanic, etc.). ▲ Competing additional needs for manpower and equipment before, during and after storm events. ▲ Storage space available at site of off-site. ▲ Training & Inspection needs. ▶ Identify Available Lead Time. <ul style="list-style-type: none"> ▲ How long will it take from notice of storm event to get barrier to site? ▲ Reliability of flood notice and forecasting. ▲ What are the alerts/warning systems available? How much notice is typically given? ▲ Assess opportunities to increase lead time. ▶ False Alarm Cost. <ul style="list-style-type: none"> ▲ What are the costs/consequences of deploying when the storm event doesn't happen?
--	---

Design Considerations for the Product

Every deployable flood barrier has a set of physical, structural, and operational characteristics. Once the site specific and operational capacity is understood, several products may be identified for evaluation. The Comparison Matrix (Matrix) included in Section 7.3 is an example of the design considerations for several products. The products included in these guidelines are not intended to suggest an endorsement of any product or a preference of one barrier type over another. The information presented in the Matrix was provided by the product manufacturers. Refer to the Matrix for sample information and examples of considerations.

DESIGN CONSIDERATIONS FOR THE PRODUCT	
Physical Considerations	<ul style="list-style-type: none"> ▶ Barrier type. <ul style="list-style-type: none"> ▲ Modular, rigid, flexible, pre-installed, partially pre-installed, etc. ▶ Product Dimensions. <ul style="list-style-type: none"> ▲ Height range. ▲ Width Range. ▲ Adjustable. ▶ Material Type. <ul style="list-style-type: none"> ▲ Resistant to environmental/chemical exposure. ▲ Mobile (wheels/cart compatible). ▶ Pre-Installation Site Modifications. <ul style="list-style-type: none"> ▲ Required modifications to site for barrier to be used. ▶ Average Design Life. ▶ Cost.
Structural Considerations	<ul style="list-style-type: none"> ▶ Failure mechanisms. <ul style="list-style-type: none"> ▲ Sliding, excessive seepage, bearing capacity failure, overturning and collapse, settlement, uplift, shear, overtopping, pull out, structural failure boundary condition (overloading).

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Structural Considerations (continued)	<ul style="list-style-type: none"> ▶ Connection type. <ul style="list-style-type: none"> ▲ Bolt/Velcro/cable. ▲ Corrosion resistant. ▲ Surface requirements for connection. ▲ Connection strength. ▶ Damage resistance. <ul style="list-style-type: none"> ▲ Tear/puncture. ▲ Debris/impact. ▲ Tampering. ▲ Wave. ▲ Wind. ▶ Progressive failure mechanism likelihood.
Operational Considerations	<ul style="list-style-type: none"> ▶ Installation needs. <ul style="list-style-type: none"> ▲ Site preparation required prior to deployment. ▲ Time range for deployment. ▲ Manpower required. ▲ Resources required. ▲ Ease of installation. ▲ Installation cost. ▶ Repair during storm event. ▶ Retraction needs. <ul style="list-style-type: none"> ▲ Preparation or cleaning/decontamination required prior to retraction. ▲ Time range for retraction. ▲ Manpower required. ▲ Resources required. ▲ Ease of retraction. ▲ Retraction cost. ▶ Storage. <ul style="list-style-type: none"> ▲ Storage container. ▲ Size of storage needed. ▲ Foldable/flexible parts. ▲ Stackable? How high? ▶ Re-use of product.
Industry Certification	<ul style="list-style-type: none"> ▶ Industry standard certification/testing. ▶ Warranty.

7.3 OPERATION AND MAINTENANCE AND COST CONSIDERATIONS

Operations and maintenance (O&M) are critical to the performance of deployable flood barriers throughout its intended useful life. Additional descriptions of protocol recommendations and programs are included in the **Appendix F. Deployable Barrier O&M Considerations**. Using the understanding the operational capacity of the site and product, the following O&M considerations should be addressed:

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

O&M CONSIDERATIONS

Refer to Appendix F. Deployable Barrier O&M Considerations for more detailed considerations.

Develop Management Protocol	<ul style="list-style-type: none"> ▶ Inspection and Maintenance Program. ▶ Communications Plan. ▶ Training. ▶ Annual Testing and Drills. ▶ Improvement.
Develop Deployment Protocol	<ul style="list-style-type: none"> ▶ Notification of Storm Event. ▶ Lead Time Notification and Mobilization of Resources. ▶ Road Closures and Access. ▶ Site Preparation. ▶ Deployment. ▶ Stormwater Management. ▶ Real-Time Monitoring and Supervision. ▶ Damage Repair.
Develop Retraction Protocol	<ul style="list-style-type: none"> ▶ Notification of Retraction. ▶ Mobilization of Resources. ▶ Site Cleanup (Cleaning and/or decontamination). ▶ Safety Check. ▶ Barrier Removal. ▶ Re-Storage of Non-Damaged Equipment. ▶ Maintenance, Repair, or Replacement. ▶ Review and Debrief. ▶ Removal of Contained Flood Waters.
Develop Failure Response Plan	<ul style="list-style-type: none"> ▶ Emergency Notification Flowchart. ▶ Emergency Detection. ▶ Emergency Evaluation and Classification. ▶ Examples of Emergency Situations. ▶ Loss Prevention.

Cost considerations should reflect the features identified in the design considerations for capital costs and life-cycle costs of the infrastructure based on design considerations and existing information. Customization of deployable barriers allows for a range of probable costs. Costs can vary due to height and width requirements, storage capabilities and requirements, deployment and retraction times, and space availability. The Comparison Matrix in Section 7.3 includes a range of costs for a variety of products.

COST CONSIDERATIONS

Review Product Information	<ul style="list-style-type: none"> ▶ Review the Comparison Matrix provided in Section 7.3 to review information provided by product manufacturers regarding product cost. The costs provided are to be assumed as general estimates and may not reflect the cost of a fully customized/designed barrier system.
-----------------------------------	--

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Manufacturer Outreach	<ul style="list-style-type: none"> ▶ Reach out to suppliers of products listed in the Comparison Matrix in Section 7.3 to request more detailed, site specific product cost information. ▶ The Comparison Matrix does not include all products that may be considered for a site. Populate the Comparison Matrix with additional products for comparison.
Budgeting	<ul style="list-style-type: none"> ▶ The costs provided in the Comparison Matrix in Section 7.3 are estimates and may change based on the level of flood protection and site requirements. ▶ Budgets should be reviewed so that there are funds in place for the purchase, deployment, maintenance, and retraction of barrier products that meet criteria and considerations for the site
False Alarm Costs	<ul style="list-style-type: none"> ▶ The cost associated with deploying and retracting a barrier should be considered in selecting a barrier, especially if the storm event does not happen. This is often referred to as a “false alarm” cost. ▶ If the required lead time is long, the chance of a false alarm cost increases because forecasts may change as the storm approaches. ▶ In addition to the financial cost of operations, the cost may be qualitative and include considerations for public perception, business continuity in the area, public transportation, and loss of social programs.
Annual and O&M costs	<ul style="list-style-type: none"> ▶ Operation and maintenance costs will be assessed by current and project future wage rates and the manpower estimated for regular O&M associated with the selected barrier, including stormwater management. Refer to Appendix F. Deployable Barrier O&M Considerations for activities related to O&M. ▶ Annual costs should consider how deployment needs may change as storm events become more frequent and barrier deployment must occur more often. ▶ Costs should consider how deployable flood barriers may change once a permanent barrier solution is designed and implemented.
Capital Costs	<ul style="list-style-type: none"> ▶ In addition to the costs associated with the barrier product, there may be additional site modification costs required for installation. ▶ There may be additional costs associated with permitting.

7.4 BARRIER SELECTION

The Comparison Matrix provided in the Section 7.3 includes a variety of available products with information from manufacturers for each option. The products identified in the guidelines are not an inclusive list. The Matrix should be updated with information from manufactures to include additional flood barrier types. Using the information in the previous sections, the designer should evaluate what additional studies are needed to advance design and selection of the barrier. It may be necessary to re-evaluate the barriers considered for the site based on the findings of the previous sections, and the designer should always consider long-term potential for flood protection as an alternative.

System reliability is critical to deployable flood barrier effectiveness. The designer should consider what opportunities exist to increase the reliability of the system, which may include designing redundancies, simplifying design connections, designing secondary flood water containment systems, implementing alert systems, on-going monitoring and inspection, and more. One of the main characteristics in the reliability of deploying flood barriers is the operational capacity for deployment. The designer should consider scenarios where trained manpower and equipment are not available even with protocols in place; often storm events increase demand of limited resources so plans should be in place for this scenario. Annual deployment drills are also often done in fair weather conditions and may not reflect actual storm events, such as snowy and icy Nor’easters. There should be a plan developed for scenarios where the

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

flood barrier fails to deploy and an emphasis on safe-to-fail design, redundancy, and flood containment and emergency response.

The approach for the deployable flood barriers provides an opportunity to develop a plan for incremental adaptation over time. The final selection should consider how the deployable barrier will lead to a permanent barrier solution. The approach should include a unified vision for waterfront protection and public improvement. Designs must include coordination to identify temporary and permanent solutions that integrate with the physical environment, communities, and stakeholders. It is important to also consider existing and proposed resilience projects in the City of Boston. Climate Ready Boston has a map of these projects available on the [Coastal Resilience Projects Tracker](#).

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

7.5 COMPARISON MATRIX AND SAMPLE DEPLOYABLE FLOOD BARRIER INFORMATION

Type	Product	PHYSICAL CHARACTERISTICS									
		Barrier Type	Product Dimensions		Adjustable/Height Can Increase During Service?	Mobility	Material Information		Pre-Installation Site Modification	Average Design Life	Cost
		Description	Height Range	Width Range	Yes/No	Wheels/Cart	Material Type	Resistant to Environmental and Chemical Exposure	(Slight/Moderate/Extensive) *Not including retrofitting existing structures	Number of Years/Uses	Up Front Cost
ENTER TYPE	ENTER PRODUCT FOR COMPARISON	Barrier type and description	As provided by product manufacturer	As provided by product manufacture	Applicable if additional barrier modifications are available for increased protection height	Applicable if product is designed with wheels, or cart-compatible	As provided by product manufacturer	As provided by product manufacturer	As provided by product manufacturer	As provided by product manufacturer	Custom pricing may be available, as well as unit-based costs
Modular Barriers											
Rigid/Panel	Aquafence	Modular Barrier: Rigid panels that are placed together to form one cohesive barrier.	4 ft. to 9 ft.	Limitless (current longest stretch is 5100 lf.)	Potentially (Product available)	Yes	Marine grade laminate, stainless steel, aluminum, reinforced PVC canvas	Yes	Slight - Anchor installation for best performance (Varies by site)	50+ years	\$315/lf. - 4 ft. Height \$415/lf. - 5 ft. Height \$575/lf. - 6 ft. Height \$650/lf. - 7 ft. Height \$750/lf. - 8 ft. Height (Additional \$10/lf. for anchors)
Rigid/Panel	FB33 Adjustable Lift-Out Barrier	Modular Barrier: Rigid adjustable panels that can be used as single units or in multiples	6 in. increments from 1.5 ft. to 4 ft.	Dependent on barrier height	No	Yes	Carbon steel (stainless steel option available), neoprene, carbon steel mechanical tubing, closed-cell foam, mastic epoxy painted finishes	Yes	Slight - Optional removable mullions for multi-panel installation (Varies by site)	25+ years	Custom pricing based on required width and height
Rigid/Stop Log	CGSL Stop Logs	Modular Barrier: Stop log style barrier with customizable width and height	2:1 factor of safety based on material yield strength. Can increase height in 6 in. and 8 in. increments		Yes	Yes	6063-T5 aluminum panels, aluminum, low carbon steel, neoprene seals (Viton and other materials available)	Yes	Moderate - sill/conversion frame installation will require site work (Varies by site)	25+ years	Custom pricing based on required height, width, and jamb type
Rigid/Stop Log	FastLogs Stop Logs	Modular Barrier: Stop log style barrier with customizable width and height	2:1 factor of safety based on material yield strength. Can increase height in 6 in. increments		Yes	Yes	Mill-finish aluminum, steel (primed with one coat rust inhibitive, lead free, red primer), high-density closed cell neoprene sponge	Yes	Moderate - frame/jamb installation will require site work (Varies by site)	25+ years	Custom pricing based on required height, width, and jamb type
Rigid/Hinged	PS Flood Barriers Hinged Flood Barrier (Single)	Modular Barrier: Hinged door barrier with customizable width and height	2:1 factor of safety based on material yield strength		No	Yes	Steel, stainless steel, 6063 aluminum, 6061 aluminum, EPDM rubber	Yes	Moderate - frame/jamb/sill installation will require site work (Varies by site)	25+ years	Custom pricing based on required width and height
Rigid/Sliding	PS Flood Barriers Sliding Flood Barrier	Modular Barrier: Sliding door barrier with customizable width and height	2:1 factor of safety based on material yield strength		No	Yes	Steel, stainless steel, 6063 aluminum, EPDM rubber	Yes	Moderate - frame/jamb/sill installation will require site work (Varies by site)	25+ years	Custom pricing based on required width and height
Membrane Barriers											
Flexible	ILC Dover Vertically Deployed Flex-Wall	Membrane Barrier: Flexible wall with rapid vertical deployment for building and equipment protection	Ideal height for constructability and deployment time is a DFE of 4 ft. above grade or less. Higher heights are possible with the addition of braces to the posts	With intermittent deployable posts, no real limit to span (10 ft. to 12 ft. between posts or connection points)	No	N/A	Kevlar webbings, PVC coated polyester, metal (stainless steel, etc.), H2O covers	Yes	Extensive - excavation efforts (1.5 ft. trench) are necessary for barrier installation (Varies by site)	20 years	Custom pricing based on required width and height; estimated cost range of \$350-550/sf.
Flexible	ILC Dover Side Deployed Flex Wall	Membrane Barrier: Flexible wall with rapid horizontal deployment for building and equipment protection	DFE heights of 1 ft. to 10 ft. above grade (typically, but can go higher)	6 ft. to 60 ft. with deployable or permanent posts	No	N/A	Kevlar webbings, PVC coated polyester, metal (stainless steel, etc.), H2O covers	Yes	Moderate - structural supports may be needed for barrier installation (Varies by site)	19 years	Custom pricing based on required width and height; estimated cost range of \$350-550/sf.
Passive Barriers											
Automatic	Self Closing Flood Barrier (SCFB)	Membrane Barrier: Self-rising floodgate. Rises automatically as floodwaters approach	Up to 12 ft. Design should be verified by structural calculations.	Limitless but requires vertical supports	No	N/A	PUR foam core, fiberglass, gaskets, galvanized steel	Yes	Extensive - excavation efforts are necessary for barrier installation (Varies by site)	25+ years	Custom pricing based on required width, height, loadings needed, and FEMA zones
Automatic	FloodBreak Gate	Membrane Barrier: Self-rising floodgate. Rises automatically as floodwaters approach	No practical limit. Design validated by structural engineer to 39 ft. height (multiple 12 ft. tall gates installed)	Limitless with no stanchions or vertical stops. (100 ft. length gates are installed without stanchions across highways)	No	N/A	Marine grade aluminum, stainless steel fittings, and EPDM rubber gaskets	Yes	Extensive - excavation efforts are necessary for barrier installation (Varies by site)	Decades of service life with minimal maintenance. Recommend to change gaskets every 10 years	Custom pricing based on required width and height

Notes:

- The types and products provided are not endorsed by the City of Boston and do not indicate a preference for one barrier type over another. The list is not comprehensive and does not reflect all possible products on the market. As products are identified for possible use, they should be entered into this table to compare and contrast with other products. The products should comply with City of Boston policies, zoning, and regulations.
- Product manufacturers should be contacted to provide content in this table and be able to provide back-up documentation for submittals.
- The following framework is based on the methodology developed for "Temporary and Demountable Flood Protection Guide," (Ogunyoye, Fola, Richard Stevens, and Scott Underwood, 2011).

Type	Product	STRUCTURAL CHARACTERISTICS																			
		Potential Failure Mechanisms										Connection Type		Surface Requirements	Barrier Resistance to Damage/Load					Likelihood of Progressive System Failure	
		Sliding	Excessive Seepage	Bearing Capacity Failure	Overturning & Collapse	Settlement	Uplift	Shear	Overtopping	Pull Out	Structural Failure Boundary Condition	Bolt/Velcro/Cable etc.	Corrosion Resistant?	Flat/Dry/Hard etc.	Low (likely damage)/Medium/High (unlikely damage)					Low/Medium/High	
ENTER TYPE	ENTER PRODUCT FOR COMPARISON	As per product manufacturer provided specifications and engineered studies of structural limitations										As provided by product manufacturer	Based on product material	Ideal and adaptable conditions as per manufacturer recommendations for proper barrier performance	As per product structural and material characteristics	As per product structural and material characteristics	As per product structural and material characteristics	As per product structural and material characteristics	As per product structural and material characteristics	As per product structural and material characteristics	As provided by product manufacturer engineered testing results

Modular Barriers

Rigid/Panel	Aquafence	No	No	No	No	No	Yes	Yes	Yes	No	Yes	Bolt	Yes	Ideal conditions: concrete or asphalt, smooth surface Can adapt to: pitch changes, curbs and obstacles, grass, wet surfaces	High (no impact on system stability)	Medium - High	High (most parts that could be removed are under water)	Medium - High	High	Medium (only after damage)
Rigid/Panel	FB33 Adjustable Lift-Out Barrier	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Steel frame mounted to wall, chloroprene rubber seal gasket	Yes	Ideal conditions: smooth surface Can adapt to: sloped surfaces, curbs and obstacles	High	Medium - High	Medium	Medium - High	High	Medium (only after damage)
Rigid/Stop Log	CGSL Stop Logs	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Jamb brackets	Yes	Ideal conditions: smooth surface Can adapt to: sloped surfaces, curbs and obstacles	High	High	Medium	Medium - High	High	Medium (only after damage)
Rigid/Stop Log	FastLogs Stop Logs	No	Yes	Yes	No	No	Yes	Yes	Yes	No	Yes	Jamb brackets mounted to face of opening	Yes	Ideal conditions: smooth surface Can adapt to: sloped surfaces, curbs and obstacles	High	High	Medium	Medium - High	High	Medium (only after damage)
Rigid/Hinged	PS Flood Barriers Hinged Flood Barrier (Single)	Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	Frame mounted to existing structure, rubber seal	Yes	Ideal conditions: smooth surface, poured concrete or filled CMU. Cannot adapt to curves, slopes, or obstacles.	High	Medium - High	Medium	Medium - High	High	Low
Rigid/Sliding	PS Flood Barriers Sliding Flood Barrier	No	Yes	No	No	No	No	No	Yes	No	Yes	Frame mounted to existing structure, rubber seal	Yes	Ideal conditions: smooth surface, poured concrete or filled CMU. Cannot adapt to curves, slopes, or obstacles.	High	Medium - High	Medium	Medium - High	High	Low

Membrane Barriers

Flexible	ILC Dover Vertically Deployed Flex-Wall	No	No	No	No	No	No	No	No	No	Yes	Metal post receivers and seal bars	Yes	Various	High	High	High	High	High	Low
Flexible	ILC Dover Side Deployed Flex Wall	No	No	No	No	No	No	No	No	No	Yes	Receiver posts	Yes	Various	High	High	High	High	High	Low

Passive Barriers

Automatic	Self Closing Flood Barrier (SCFB)	No	No	No	No	No	Yes	Yes	Yes	No	Yes	N/A	N/A	Designed for all applications and site conditions. Work will need to be done to ensure barrier will work when installed	High	High	High	High	High	Low
Automatic	FloodBreak Gate	No	No	No	No	No	Yes	Yes	Yes	No	Yes	N/A	Yes	Can be installed on sloped surfaces (up or down slope), have been installed in a variety of environments (marine, desert, and cold northern climates)	High	High	High	High	High	Low

Notes:
 1. The types and products provided are not endorsed by the City of Boston and do not indicate a preference for one barrier type over another. The list is not comprehensive and does not reflect all possible products on the market. As products are identified for possible use, they should be entered into this table to compare and contrast with other products. The products should comply with City of Boston policies, zoning, and regulations.
 2. Product manufacturers should be contacted to provide content in this table and be able to provide back-up documentation for submittals.
 3. The following framework is based on the methodology developed for "Temporary and Demountable Flood Protection Guide," (Ogunyoye, Fola, Richard Stevens, and Scott Underwood, 2011).

Type	Product	OPERATIONAL CHARACTERISTICS										
		Installation Needs						Repair During Service	Retraction Needs			
		Lead Time (Short/Long)	Time Range	Manpower Required	Resources Required	Pre-Storm Site Preparation	Installation Cost	Yes/No	Time Range	Manpower	Resources Required	Retraction Cost
ENTER TYPE	ENTER PRODUCT FOR COMPARISON	Short: Under 30 minutes Long: 30+ minutes	As provided by product manufacturer based on previous site installations	As provided by product manufacturer for optimal installation times	As provided by product manufacturer; what may aide in easing the installation process	Any necessary site work to prepare for ideal barrier installation conditions	Installation cost based on area wage rates and required crew sizes	Whether or not the barrier is accessible for repairs while in service	As provided by product manufacturer based on previous site retraction times	As provided by product manufacturer for optimal retraction times	As provided by product manufacturer; what may aide in easing the retraction process and what may be necessary to remove debris and water	Retraction cost based on area wage rates and required crew sizes
Modular Barriers												
Rigid/Panel	Aquafence	Long	1 hour: 150 lf. of 4 ft. and 5 ft. panels 1 hour: 120 lf. of higher height panels	6-8 people	Stored off site: flatbed truck, box truck, forklift Stored on site: cart/dolly/A frame, pallet jack Tools: battery powered drill	Pre-install drop in sleeve anchors for panel connection (best stability)	Dependent on crew size, wage rate, and transportation needs	Yes	1 hour (same process as installation, plus washing with fresh water hose)	6-8 people	Stored off site: flatbed truck, box truck, forklift Stored on site: cart/dolly/A frame, pallet jack Tools: Electric drill to speed up retraction time, broom/rake to remove debris, towels to wipe panels dry, water hose	Dependent on crew size, wage rates, transportation costs, amount of debris to be cleared
Rigid/Panel	FB33 Adjustable Lift-Out Barrier	Short	Under 10 minutes	1-3 people	None; compression clips are hand tightened	Debris clearing may be necessary to ensure ground is free of debris	Dependent on crew size and wage rates	No	Under 1 hour	1-3 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size, wage rates, amount of debris to be removed
Rigid/Stop Log	CGSL Stop Logs	Long	Under 1 hour	8-10 people	Ratchet wrench	Debris clearing may be necessary to ensure ground is free of debris	Dependent on crew size and wage rates	No	Under 1 hour (dependent on width and height of barrier)	1-3 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size, wage rates, amount of debris to be removed
Rigid/Stop Log	FastLogs Stop Logs	Long	Under 1 hour	8-10 people	None; hand tightened installation	Debris clearing may be necessary to ensure ground is free of debris	Dependent on crew size and wage rates	No	Under 1 hour (dependent on width and height of barrier)	1-3 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size, wage rates, amount of debris to be removed
Rigid/Hinged	PS Flood Barriers Hinged Flood Barrier (Single)	Short	Under 5 minutes	1-3 people	None; hand tightened installation	Clean all sealing surfaces and clear area around barrier of any debris	Dependent on crew size and wage rates	No	Under 1 hour	1-3 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size, wage rates, amount of debris to be removed
Rigid/Sliding	PS Flood Barriers Sliding Flood Barrier	Short	Under 5 minutes	1-3 people	None; hand tightened installation	Clean all sealing surfaces and clear area around barrier of any debris	Dependent on crew size and wage rates	No	Under 1 hour	1-3 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size, wage rates, amount of debris to be removed
Membrane Barriers												
Flexible	ILC Dover Vertically Deployed Flex-Wall	Short	Assuming no brace on interim posts, approximately 5 minutes per 20 ft.	1-3 people	Ratchet wrench and screw driver. Torque wrench can ensure the best seal	Clearing of area where barrier will be set up, placing of support posts	Dependent on crew size and wage rates	No	Same as installation. Possible additional time to remove debris and residual water.	1-3 people	Ratchet wrench and screw driver. Torque wrench can ensure the best seal. Broom/rake to remove debris.	Dependent on crew size, wage rates, amount of debris to be removed
Flexible	ILC Dover Side Deployed Flex Wall	Short	Varies. Fully clamped system for a 20 ft. wide system at 6 ft. DFE: 30 minutes Weighted skirt system for a 20 ft. wide system at 6 ft. DFE: 5 minutes	1-3 people	Ratchet wrench and screw driver. Torque wrench can ensure the best seal	Clearing of area where barrier will be set up, placing of support posts	Dependent on crew size and wage rates	No	Same as installation. Possible additional time to remove debris and residual water.	1-3 people	Ratchet wrench and screw driver. Torque wrench can ensure the best seal. Broom/rake to remove debris.	Dependent on crew size, wage rates, amount of debris to be removed
Passive Barriers												
Automatic	Self Closing Flood Barrier (SCFB)	N/A - barrier automatically deploys	30 seconds to a few minutes, depending on flood characteristics	N/A	N/A	Ground and concrete work needed for initial installation (provided by other), debris clearing may be necessary prior to event	Dependent on possibility of manual deployment (crew size and wage rate)	No	Under 10 minutes	1-2 people	Possibly a broom or pump to clear debris and remove excess water	Dependent on crew size and wage rate
Automatic	FloodBreak Gate	N/A - barrier automatically deploys	Depends on water velocity	N/A	None	None. Self clearing. Annual inspection and cleaning is recommended.	None in passive mode. Manual lift by forklift (2 employees, wage rate varies) or optional push button hydraulic lift	No	Floats down as water recedes	None in passive mode. 1-2 people for manual retraction	Self retracting in passive mode. Broom or power wash after flood event.	Dependent on crew size and wage rate

Notes:

- The types and products provided are not endorsed by the City of Boston and do not indicate a preference for one barrier type over another. The list is not comprehensive and does not reflect all possible products on the market. As products are identified for possible use, they should be entered into this table to compare and contrast with other products. The products should comply with City of Boston policies, zoning, and regulations.
- Product manufacturers should be contacted to provide content in this table and be able to provide back-up documentation for submittals.
- The following framework is based on the methodology developed for "Temporary and Demountable Flood Protection Guide," (Ogunyoye, Fola, Richard Stevens, and Scott Underwood, 2011).

Type	Product	OPERATIONAL CHARACTERISTICS						CERTIFICATION		
		Reuse of Product (Can be used multiple times)	Storage					Industry standard certification/testing	Warranty	Selection preferred
		Yes/No	Mobile Unit	Stored In	Foldable/Flexible Parts	Stackable	Stackable Height	FM Global, National Flood Barrier Testing & Certification Program	Number of Years	Y/N
ENTER TYPE	ENTER PRODUCT FOR COMPARISON	Based on material resistance to environmental and chemical elements	Can the product be moved to other storage locations	As per product manufacturer provided storage units	Determined by material of barrier; rigid (foldable) or fabric based (flexible)	Determined by product design	As per product manufacturer provided storage unit or structural limits of barrier components	Industry standard certification/testing is available for many barrier types	As provided by product manufacturer	Compare Products for Site
Modular Barriers										
Rigid/Panel	Aquaforce	Yes	Yes	Storage crate	Foldable	Yes	3 ft. and 5 ft. panels: 63 lf./crate, crates stack 4-high. 250 ft. per 4x7 ft. space 6, 7, 8 ft. panels: 36 lf./crate, crates stack 4-high. 144 ft. per 4x7 ft. space	FM Approved, National Program Tested and Certified	Standard 2 year manufactureres warranty; extension available with service contract	
Rigid/Panel	FB33 Adjustable Lift-Out Barrier	Yes	Yes	Hanging bracket	No	Yes	Bracket dimensions are 38 in. x 17 in.	FM Approved	1 year limited warranty against defects and workmanship from date of shipment	
Rigid/Stop Log	CGSL Stop Logs	Yes	Yes	Rack	No	Yes	10 ft. maximum stackable height	NOT FM approved, exceeds FEMA and NFIP Floodproofing Certification Standards	5 year warranty	
Rigid/Stop Log	FastLogs Stop Logs	Yes	Yes	Rack	No	Yes	10 ft. maximum stackable height	FM Approved	1 year limited warranty against defects and workmanship from date of shipment	
Rigid/Hinged	PS Flood Barriers Hinged Flood Barrier (Single)	Yes	No, stored in place at deployment location	Stored on site/preinstalled	No	N/A	N/A	NOT FM approved but barriers are designed to meet the same criteria. Can be third party tested for an additional cost	0 year limited warranty against defects and workmanship from date of shipment. Additional manufacturers warranty available for purchase totaling up to 5 years	
Rigid/Sliding	PS Flood Barriers Sliding Flood Barrier	Yes	No, stored in place at deployment location	Stored on site/preinstalled	No	N/A	N/A	NOT FM approved but barriers are designed to meet the same criteria. Can be third party tested for an additional cost	1 year limited warranty against defects and workmanship from date of shipment. Additional manufacturers warranty available for purchase totaling up to 5 years	
Membrane Barriers										
Flexible	ILC Dover Vertically Deployed Flex-Wall	Yes	No, stored in place at deployment location	Trench box determined by custom barrier size	Flexible	N/A	N/A	NOT FM Approved, Various ASTM Standards, FM2510, Federal Standard 191 (Textile Test Methods), Federal Motor Vehicle Safety Standard 302, and NASA Standards	Flexibility available. Standard 1 year from date of shipment. Additional warranty for purchase	
Flexible	ILC Dover Side Deployed Flex Wall	Yes	No, stored in place at deployment location	Storage container determined by custom barrier size	Flexible	N/A	N/A	NOT FM Approved, Various ASTM Standards, FM2510, Federal Standard 191 (Textile Test Methods), Federal Motor Vehicle Safety Standard 302, and NASA Standards	Flexibility available. Standard 1 year from date of shipment. Additional warranty for purchase	
Passive Barriers										
Automatic	Self Closing Flood Barrier (SCFB)	Yes	No, stored in place at deployment location	Stored underground/preinstalled	N/A	N/A	N/A	Not FM rated, meets FEMA flood protection requirements	5 year warranty on material and installation	
Automatic	FloodBreak Gate	Yes	No, stored in place at deployment location	Stored underground/preinstalled	N/A	N/A	N/A	No testing methodology for permanently installed passive automatic barriers. Passed every customer test and proven in dozens of flood events. Company is hopeful to be able to participate in FM Approval in the next few years	Standard 1 year limited warranty. Extension available with service contract	

Notes:

1. The types and products provided are not endorsed by the City of Boston and do not indicate a preference for one barrier type over another. The list is not comprehensive and does not reflect all possible products on the market. As products are identified for possible use, they should be entered into this table to compare and contrast with other products. The products should comply with City of Boston policies, zoning, and regulations.
2. Product manufacturers should be contacted to provide content in this table and be able to provide back-up documentation for submittals.
3. The following framework is based on the methodology developed for "Temporary and Demountable Flood Protection Guide," (Ogunyoye, Fola, Richard Stevens, and Scott Underwood, 2011).



AquaFence®

AquaFence products are used across North America for new construction, existing buildings, water diversion, construction site protection, perimeter protection, interior asset protection, and entrance protection.

AquaFence has the highest-level certifications for Flood Barriers from FM Approvals, US Army Corp of Engineers, and ASFP. AquaFence is code compliant throughout major metropolitan areas and recognized as a minimally invasive solution with little prep work and no fill material needed.

Municipalities, transportation hubs, commercial properties and industrial complexes worldwide choose AquaFence for its simplicity, rapid deployment, reliable construction, reusability, and ease of break down and storage. This makes AquaFence the leading and most cost effective choice in Flood Barrier protection.

Highlights

- Deploy 100 linear ft./hour with 4-person team
- Unlimited Barrier Length
- No Fill Material Needed
- Minimal Advance Site Work
- No Heavy Equipment Needed
- Reusable dozens of times
- Easy Breakdown
- Site Specific Customizations
- Stackable Storage Crates



US Army Corps
of Engineers®



CODE COMPLIANT

- International Building Code IBC 2015
- ASCE 7-10 – Minimum Design Loads for Buildings and Other Structures
- ASCE 24-14 – Flood Resistant Design for Construction



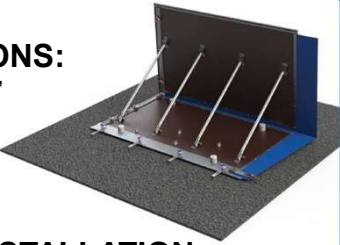
AquaFence®

STANDARD BARRIER SPECIFICATIONS

V1200 (4')

DIMENSIONS:

Height: 47.2"
Width: 82.7"
Depth: 47.2"

**PANEL INSTALLATION:**

Deployment Time 100 linear feet per hour (3-4 person crew)

V1800 (6')

DIMENSIONS:

Height: 70.9"
Width: 47.2"
Depth: 70.9"

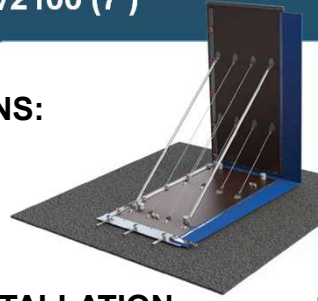
**PANEL INSTALLATION:**

Deployment Time 90 linear feet per hour (3-4 person crew)

V2100 (7')

DIMENSIONS:

Height: 82.7"
Width: 47.2"
Depth: 82.7"

**PANEL INSTALLATION:**

Deployment Time 80 linear feet per hour (3-4 person crew)

MATERIALS

- Marine Laminated Plywood
- Stainless Steel
- Aluminum
- PVC Canvas
- Closed Cell Gasket

CORNER CONFIGURATIONS



SIDE CLOSERS



RECOMMENDED TOOLS

- Rechargeable Hand Drill
- Pallet Jack or U-Frame Cart

STORAGE

Stored in reusable, click lock, stackable wooden crates (L 7.38' x W 4.15' x H 4.23') which can be stacked 4 high. After a deployment, the panels should be cleaned and dried for storage and future use.

SINGLE CRATE STORAGE CAPACITY

63 linear feet/crate	V1200
36 linear feet/crate	V1800 & Higher



CONTACT

Adam Goldberg
203-939-5176

Adam.Goldberg@AquaFence.com

AquaFence U.S.A.
700 US Hwy 46
Clifton, NJ 07013

www.aquafence.com



FB33



Adjustable Flood Barrier with Mechanical Seals

This unique, adjustable flood barrier provides effective flood protection up to 48" in height for almost any door or other opening. The FB33 has been tested and certified by FM Approvals® and exceeds FEMA and NFIP Floodproofing Certification Standards.

Simply set the FB33 panel between pre-installed brackets, turn the handle to expand the sides of the panel, hand tighten the compression clips to create a seal against the floor surface, and walk away. It's that easy.

The FB33 features a patented design that keeps the water out, yet is lightweight and is easily deployed by one person.

A single three-foot-wide FB33 can take the place of 60 sandbags and weighs about the same as one. And, unlike sandbags, it's fast and easy to deploy.

APPLICATIONS — THE FB33 AT WORK...

The FB33 Modular Flood Barrier is perfect for doorways, loading docks, garage doors or any other openings in municipal, industrial or commercial facilities. The FB33 has also been popular for retail stores and strip malls, as, well as apartments and condominiums. If your building is seaside, or in a location prone to flooding, the FB33 may be the perfect solution.

The FB33 has gone through rigorous impact and leak testing by FM Approvals® and has proven effective and reliable in the field.

- ▶ Patented design is tough, reliable and lightweight
- ▶ Modular design allows for easy storage and deployment
- ▶ Suitable for new or existing construction
- ▶ Custom built for any sized opening
- ▶ Multiple panels can be connected with optional mullions
- ▶ Exceeds FEMA & NFIP Floodproofing Certification Standards



Size	Custom built to the width of the opening
Panel Frame	Carbon Steel mechanical tubing
Panel Envelope	Durable Neoprene
Mounting Brackets	ASTM A569 Carbon Steel (Stainless Steel optional)
Debris Guard	ASTM A569 Carbon Steel (Stainless Steel optional)
Seals	Three-comb, closed-cell foam gaskets
Hardware	Mounting anchors: Stainless Steel when applicable Optional removable mullions for multi-panel installation
Finish	Panel: high solids mastic epoxy painted Wall frame: high solids mastic epoxy painted

AVAILABLE OPTIONS

- ▶ Removable mullions to connect multiple panels for openings too wide for single panel
- ▶ Stainless Steel wall bracket

BUILT TO MEET YOUR REQUIREMENTS

The FB33 Modular Flood Barrier is custom built to the width of your opening. Depending on the specific nature of your installation, different brackets are used to mount the panel either between the door jambs, or face mounted on the outside of the opening. These steel brackets provide a smooth and strong connection to the wall of the building structure.



FOR MORE INFORMATION

845.373.6700 ■ www.presray.com ■ contact@presray.com



CGSL



Stackable Flood Barrier with Mechanical Seals

This heavy-duty, stop-log-style flood barrier provides reliable flood protection for wide openings that are subject to relatively high floodwaters. The patented, modular design of CGSL stop logs enables convenient storage and transportation options to site; and easy deployment by one or two people when needed. Compression gaskets, made of high-density, closed-cell neoprene, provide an effective water seal with minimum maintenance. An aluminum sill plate protects recessed threshold to prevent tripping hazard when barrier is not in use.

HEAVY-DUTY FLOOD PROTECTION

CGSL flood barriers exceed FEMA and NFIP Floodproofing Certification Standards. When floodwaters threaten, simply stack logs on top of each other and tighten dogs and bolts to secure the logs. Barriers are available in 6" and 8" high logs and are engineered for higher flood waters as compared to our line of FastLogs.™ Various barrier heights can be achieved by simply adding additional logs. These barriers are easily stored and transported when needed.

APPLICATIONS — THE CGSL AT WORK...

CGSL Stop Logs provide effective flood protection in commercial & industrial applications and for critical infrastructure and civic facilities such as transit systems, utilities, stadiums and parking garages. These barriers are engineered to handle seated and unseated loads in large openings, where very low leakage is required in large openings. Suitable for new or existing construction.

- ▶ Patented design can handle seated and unseated loads
- ▶ Compression gaskets provides effective protection with minimum maintenance
- ▶ Jamb is on the outside leaving opening clear
- ▶ 6" or 8" aluminum stop logs are rust free and highly durable
- ▶ Exceeds FEMA & NFIP Floodproofing Certification Standards



Size	Custom built to match opening size
Panel	6063-T5 aluminum channels
Frame	Low carbon steel with aluminum jamb covers
Seals	Presray type 25 durometer, fully-molded neoprene (Viton® and other materials are available for special environments)
Sill Cover	Aluminum plate
Finish	Panel: Bright aluminum plate Conversion Frame: Primed with rust inhibitive, lead free, red primer

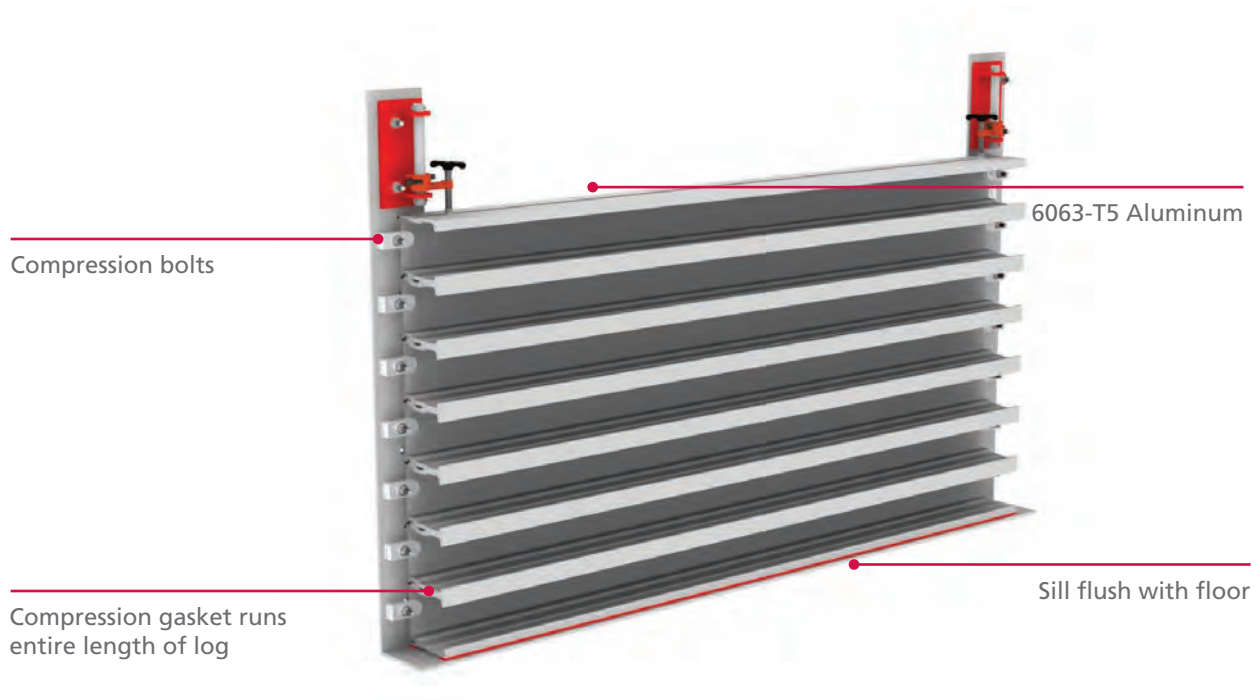
AVAILABLE OPTIONS

- ▶ Removable jamb when face mount jamb can't be used
- ▶ Compression Gaskets available in Viton® and other materials
- ▶ Hinged cover plates for jamb sides and floor sill available in a variety of materials

CUSTOM BUILT TO MEET YOUR REQUIREMENTS

Every CGSL Flood Barrier is custom built from shop drawings to ensure that it meets the special needs of your building or facility.

Barrier is designed with a minimum of a 2:1 factor of safety based on material yield strength, and will provide an effective seal against the flood level for which it is designed.



FOR MORE INFORMATION

845.373.6700 ■ www.presray.com ■ contact@presray.com



FASTLOGS®



Stackable Flood Barrier

Using an ingenious, patented design, FastLogs provide lightweight, cost-efficient and reliable flood protection for openings in most buildings. FastLogs are durable and easy to deploy by a single person without any tools.

FastLogs have been tested and certified by FM Approvals® and exceed FEMA and NFIP Floodproofing Certification Standards.

Compression seals are made of high-density, closed cell neoprene sponge between the barrier, wall jambs and floor surface. Finished Shrouds protect the Jamb Brackets when not in use, and can be painted to match the building's color scheme to minimize any aesthetic impact.

Various barrier heights can be achieved in 6" increments by simply adding additional logs. FastLogs are available in three models: Light Duty (LD), Standard Duty (SD) and Heavy Duty (HD).

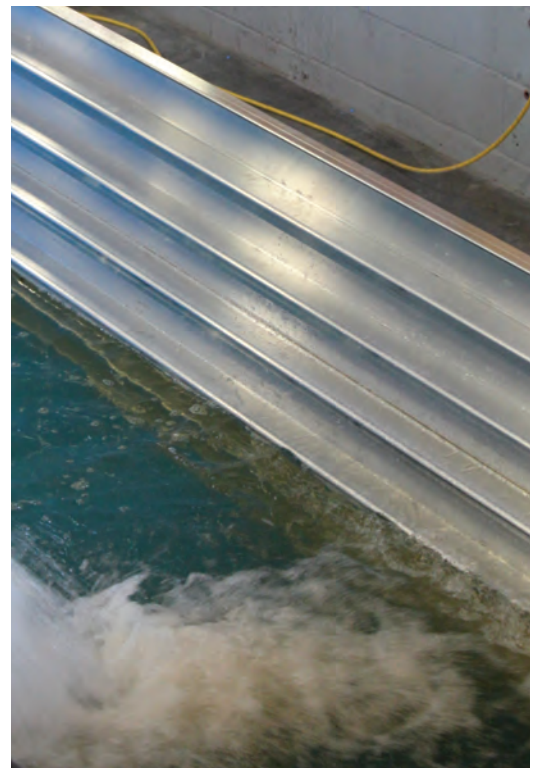
APPLICATIONS — FASTLOGS AT WORK...

FastLogs are perfect for large openings, garage doors, loading docks and other openings that require rapid, easy-to-install protection where very low leakage is acceptable.

The ingenious interlocking design of FastLogs causes water pressure against the barrier to tighten the logs by transferring horizontal water pressure into downward pressure on the compression seals located across the bottom of each log.

FastLogs® is a registered trademark of Presray Corporation.

- ▶ Easy and affordable flood protection
- ▶ Minimum impact on aesthetics of building
- ▶ Heavy-duty, rust-free components
- ▶ Logs are easy to store
- ▶ Patented design exceeds FEMA & NFIP floodproofing certification standards



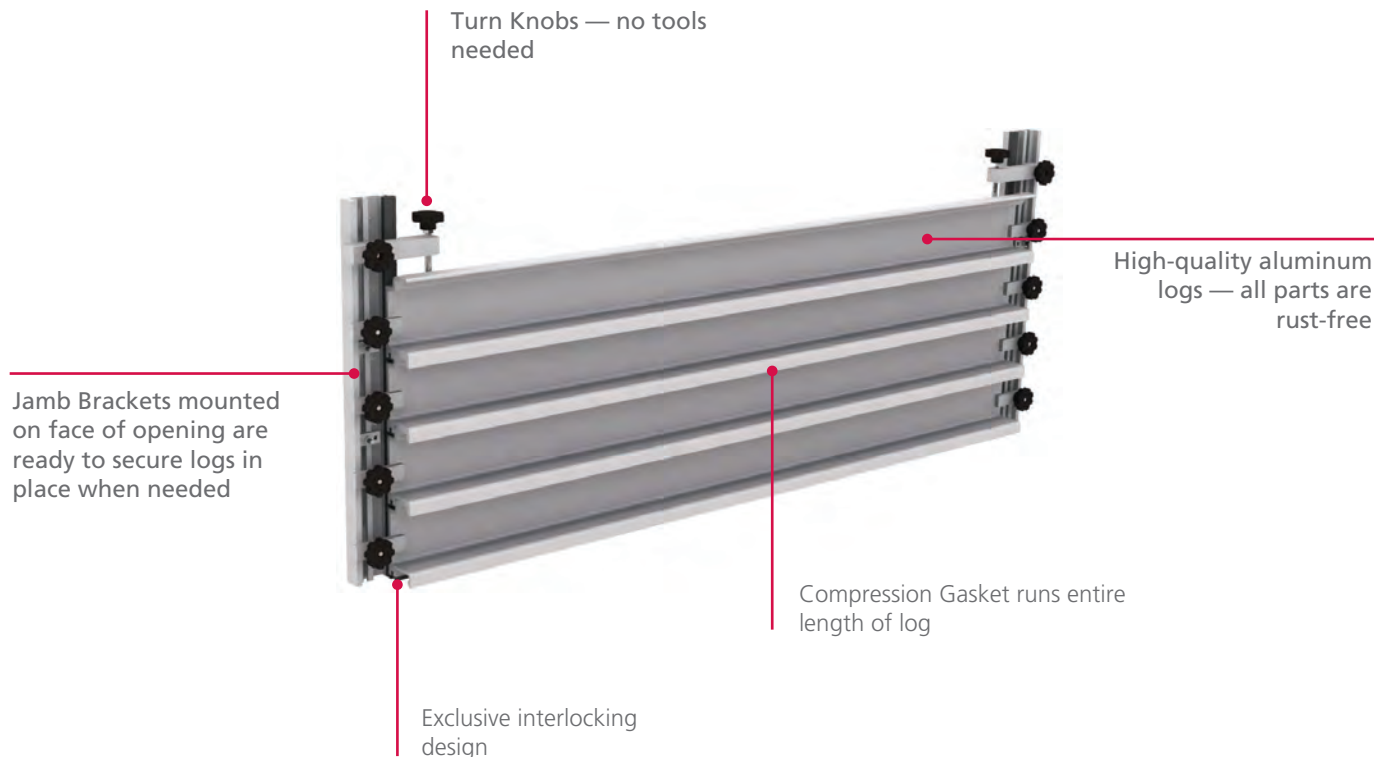
Logs	Presray AL6061-T6 aluminum channels
Frames	Presray AL6061-T6 aluminum jamb Extrusion Steel jambs optional for certain conditions
Seal	Presray compression gasket composed of high-density closed cell neoprene sponge with skin, retained in the stop logs and jambs
Hardware	Presray Compression Brackets; Presray Hold Down Brackets; KN8C Turn Knobs
Finish	Stop logs mill-finish aluminum; jambs mill-finish aluminum Steel jambs (if used) primed with one coat rust inhibitive, lead-free, red primer

CUSTOMIZED TO MEET YOUR REQUIREMENTS

Custom cut and assembled to the exact dimensions for your opening, FastLogs are designed with a minimum of 2:1 factor of safety based on material yield strength.

FastLogs are mounted in front of the opening using Jamb Brackets mounted on the face of the building. The Jamb brackets have mounting holes for concrete anchors and bolts (options include epoxy anchors for block walls, and studs for concrete embedment).

Short ordering times are possible because Presray keeps the aluminum logs, jamb brackets and hardware always in stock.



FOR MORE INFORMATION

845.373.6700 ■ www.presray.com ■ contact@presray.com

Model: HSS-550 (Single), HPS-555 (Paired)



PS Flood Barriers™
Solutions That Hold Water

Hinged Flood Barriers

PS Flood Barriers

Hinged Flood Barriers are designed specifically for the height of water protection you require. The barriers are permanently installed and stored in the open position. During flooding, the Hinged Flood Barrier is swung closed and is latched, providing flood protection. The Hinged Flood Barrier is available in a single swing or paired swing configuration.

The Hinged Flood Barrier comes in two variations. The HSS-550 is a single swing flood barrier and the HPS-555 is a “paired swing” flood barrier. Depending upon the layout of your facility, the offering of a single or paired hinged barrier allows for flexibility when designing the flood protection system.

Standard Features:

- Available in mild steel, stainless steel, or aluminum.
- Compression seal—requires no compressed air for activation.
- Latch system designed for simple, quick deployment.

Application Use:

- Walk doors.
- Sectional doors.
- Retaining walls.
- Driveways.
- Store fronts.
- Interior hallways/room.

Benefits:

- Quick placement when needed.
- Can be done with or without a raised sill.
- Minimum personnel needed to close flood barriers.

Custom sizing and design available.

877.446.1519

psfloodbarriers.com



**Safe.
Simple.
Durable.**

Made in USA.

 **PS DOORS**

PS DOORS

Attn: PS Flood Barriers

1150 South 48th Street
Grand Forks, ND 58201

Phone: 701.746.4519

Toll Free: 877.446.1519

Email: 4psinfo@psdoors.com

**ISO9001:2008
CERTIFIED**
QUALITY MANAGEMENT SYSTEM

Model: HS-560



PS Flood Barriers™
Solutions That Hold Water

Sliding Flood Barrier

PS DOORS Flood Protection Solutions

The Sliding Flood Barrier is designed specifically for the height of flood protection you require. The barrier simply slides horizontally into place covering your opening. The Sliding Flood Barrier is stored at the opening for quick and easy deployment.

Standard Features:

- Mild steel, stainless steel or aluminum.
- Compression seal—requires no compressed air for activation.
- Latch system designed for simple, quick deployment.
- Recessed sill with cover, or flush sill.

Application Use:

- Walk doors.
- Sectional doors.
- Retaining walls.
- Driveways.
- Store fronts.
- Interior hallways/rooms.
- Loading docks.
- Openings with limited swing area.

Benefits:

- No sill required = no tripping hazard.
- Flood barrier is in place for quick and easy closing on short notice of flooding conditions.
- Minimum personnel needed to place flood barriers when needed.
- Stored right at opening for quick deployment.

Custom sizing and design available.



**Safe.
Simple.
Durable.
Made in USA.**

Professionally Distributed by:

877.446.1519

psfloodbarriers.com

 **PS DOORS**

PS DOORS

Attn: PS Flood Barriers

1150 South 48th Street
Grand Forks, ND 58201

Phone: 701.746.4519

Toll Free: 877.446.1519

Email: 4psinfo@psdoors.com

**ISO9001:2008
CERTIFIED**
QUALITY MANAGEMENT SYSTEM

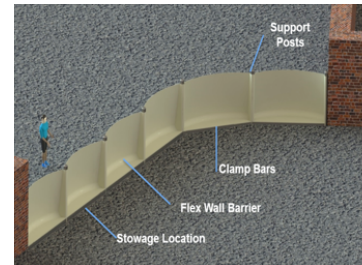


FLOOD MITIGATION
SOLUTIONS

Vertically Deployed Flex-Wall®



The Vertically Deployed Flex-Wall® is a high-strength fabric wall that can be deployed rapidly for flood protection around/between buildings, across doors of any size or in front of glass walls. It can be scaled to withstand any water height, and can be shaped to fit around any structure, including corners of any angle. It is stored in a covered trench at the point of use so that all materials and components are available when needed. The patented Flex-Wall is simple to operate and can be easily deployed or stowed by a single person within minutes, even in high winds. The Flex-Wall can surround entire spaces (buildings), or span openings and seal against existing walls (doors, driveways, etc.).



FEATURES AND BENEFITS

- **Point-of-use storage** — Deploys at last moment for minimal operational disruption, resumes operations faster, no lost components
- **Rapid deployment** — Site secured in minutes by one to two people with powered operation; chain fall backup if power outage occurs
- **Compact stowage** — Stores in small spaces
- **Scalable design** — Sized to fit any vertical opening
- **Robust materials and construction** — Withstands debris impacts with optional debris netting
- **Prevents flooding** — Seepage is <0.5 gal/min/ft of perimeter

Vertically Deployed Flex-Wall®



OPERATION

The Vertically Deployed Flex-Wall is deployed by removing the trench container cover, installing the support posts into their receivers, and then lifting and attaching the fabric wall onto the posts. Tall walls are easily deployed by a two-person team.

SYSTEM COMPONENTS

Fabric Wall — Two-layer flexible and damage-tolerant structure

- Structural layer made of Kevlar® and polyester webbings
- Water-retention layer made of PVC-coated polyester

Container — Trench and cover

Receivers — Metal post holders anchored to the trench

Support Posts — Metal beams that react load to the ground

Seal Bar — Structure that attaches and seals the wall deadman to the trench

CONFIGURATION OPTIONS

Short Walls

- Straight support posts
- Fabric wall
- Tamper-proof covers on trench box
- Manually deployed

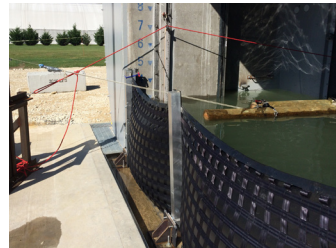
Standard configurations can be modified to meet any water height or perimeter outline.

Tall Walls

- Braced support posts
- Fabric wall
- Tamper-proof covers on trench box
- Manually deployed

Braced support posts react load to the ground for taller walls.

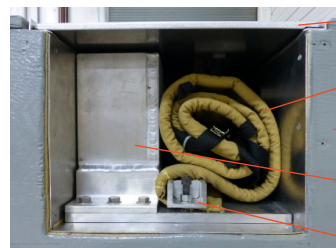
OUR SOLUTIONS ARE CUSTOM-DESIGNED TO MEET YOUR REQUIREMENTS



5 FPS, 1,000 LB LOG
IMPACT TEST



STRUCTURAL WALL CAN BE
PACKED INTO A SMALL AREA



COVER AT GRADE

FABRIC WALL

TRENCH

RECEIVER

CLAMP AND SEAL



One Moonwalker Road
Frederica, DE 19946 USA
+1.302.335.3911
+1.800.631.9567
customer_service@ilcdover.com

www.ilcdover.com

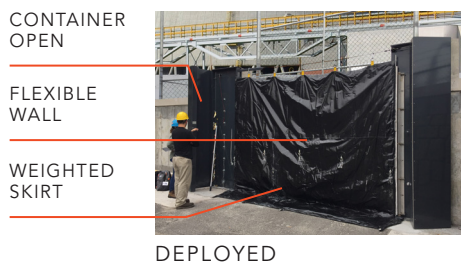
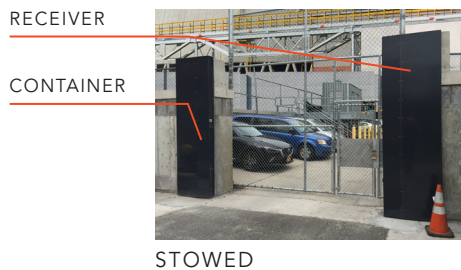


FLOOD MITIGATION SOLUTIONS

Side Deployed Flex-Wall®



The Side Deployed Flex-Wall® is a high-strength fabric wall that can be deployed rapidly for flood protection around/between buildings, across doors of any size or across window walls. The patented system can be scaled to withstand any water height and can be arranged to fit around any structure through the use of intermediate support posts. It is stored in a container at the point of use so that all materials and components are available when needed, and sealed to the ground by either integral weights or clamp bars. The Flex-Wall is simple to operate and can be easily deployed or stowed by a single person within minutes, even in high winds. The Flex-Wall can surround entire spaces (buildings) or free-standing equipment, or span openings and seal against existing walls (doors, driveways, etc.).



FEATURES AND BENEFITS

- **Point-of-use storage** — Deploys at last moment for minimal operational disruption, resumes operations faster, no lost components
- **Rapid deployment** — Site secured in 5 to 10 minutes (weighted skirt) or 15 to 20 minutes (clamped skirt) by one to two people
- **Compact stowage** — Stores in small spaces
- **Scalable design** — Sized to fit any vertical opening
- **Robust materials and construction** — Withstands debris impacts with optional debris netting
- **Prevents flooding** — Seepage is <math><0.5\text{ gal/min/ft}</math> of perimeter

Side Deployed Flex-Wall®



OPERATION

The Side Deployed Flex-Wall is deployed by opening the storage container and pulling the flexible wall across an opening and bolting it to a receiver. Once attached, the integral sealing skirt is lowered and held in place by bolts to ground anchors, or by weights that are integrated into the skirt at the factory. For long spans, intermediate posts can be installed. For tall walls where higher flood levels are a concern or for extremely long spans, a cable would be included that is secured at the storage container and then attached at the receiver during deployment. The Flex-Wall is then pulled across the opening like a shower curtain. Shaped deployment to create a safe landing zone for emergency egress is also possible.

SYSTEM COMPONENTS

Fabric Wall — Two-layer flexible and damage-tolerant structure

- Structural layer made of Kevlar® and polyester webbings
- Water-retention layer made of PVC-coated polyester

Container — Above-ground metal box with tamper-proof door panel

Intermediate Posts — Metal beams that react load to the ground as required, based on span

Receiver — Structure that attaches to the wall opposite the container, which accepts the Flex-Wall

CONFIGURATION OPTIONS

- Standard wall heights (2 ft., 4 ft., 8 ft. and 12 ft.)
- Custom heights provided based on flood elevations
- Straight or braced support posts
- Fabric wall with or without debris impact
- Clamped or weighted skirt depending on seepage allowance
- Tamper-proof covers on storage container and anchors
- Components made of any metal or finish
- Deployment support via cables based on wall height and deployment wind conditions

STANDARD AND CUSTOM-CONFIGURED SOLUTIONS TO MEET YOUR REQUIREMENTS



CUSTOMIZATION EXAMPLE OF EMERGENCY EGRESS



LOG IMPACT TESTING PERFORMED AT ILC DOVER TEST FACILITY



12' TALL X 16' WIDE SIDE DEPLOYED FLEX-WALL TESTED AT 10 FT. OF WATER



One Moonwalker Road
Frederica, DE 19946 USA
+1.302.335.3911
+1.800.631.9567
customer_service@ilcdover.com

www.ilcdover.com

SELF CLOSING FLOOD BARRIERS

The Self Closing Flood Barrier has been in use globally since 1998. Its design uses the approaching floodwaters to automatically raise the barrier. The automatic operation, along with its minimal footprint with no need for steps or ramps makes this type of defence ideal for unmanned sites, for where aesthetic considerations mean that a permanent barrier is not acceptable, or where there would be insufficient warning and manpower to use manually installed barriers.

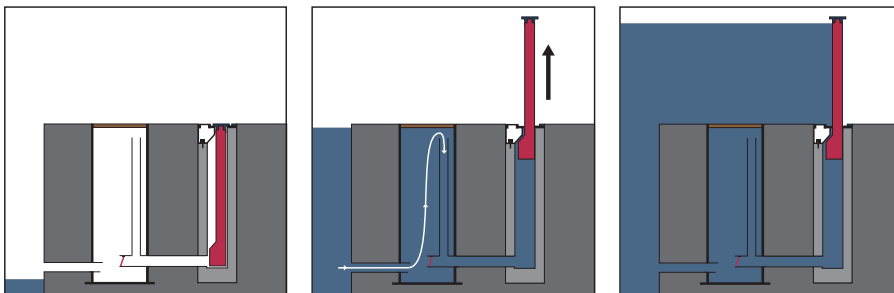
Single barriers are available up to 10m in length and 2.5m in height. Multiple units can be linked together to create long runs where required, with permanent or removable intermediate posts.

OPERATION OVERVIEW

The barrier usually resides below ground in a vertical position within a steel or concrete trough. The barrier consists of a rigid foam core and a GRP outerlayer. When floodwater rises to a pre-determined level, the water spills into service pit and then through a pipe into the trough and causes the barrier to float and raise fully. When the trough is filled, an angled support block locks the barrier into place, sealing it and making it watertight. The barrier is now fully effective and watertight to its full height.

As the floodwater recedes, the barrier lowers to its resting position again. The trough can be 'pumped out' also to lower the barrier before the adjacent groundwater levels recede fully.

Permanent Flood Protection - Barriers rise as the floodwaters rise.



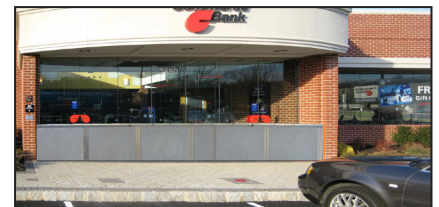
USES

The Self Closing Flood Barrier can be used to protect areas such as:

- Underground garages
- Riverside defences
- Coastal defences
- Railway defences
- Unmanned sites, such as utility stations
- Building openings such as roller shutter doors.

BENEFITS

- Uses the floodwater itself to operate the barrier - no manual intervention required.
- No storage required - the barriers recesses fully into the ground when not in use.
- Fast action - with a fast flood the barrier will close within a minute.
- Easy to test - the pit can be filled with water which automatically lifts the barrier ready for inspection.
- Unlimited lengths - from 1m to 1km or more.



SPECIFICATION



Initially we require site plans, cross sections and the flood heights required, as well as a brief to describe the proposed operation of the barrier. It may be prudent for one of our engineers to attend site to discuss the proposed barrier to ensure that the correct barrier is specified. The location of buried services is vital and should be identified before the project has begun. The barrier needs to be connected to a drainage system; gravity drainage is simplest, or the barriers can be specified with pumped removal of floodwater.



REQUIREMENTS

- A site survey is required to obtain dimensions and flood heights. Also, the location of buried services needs to be determined.
- The barriers need to be connected to a drainage system; either by gravity or by pumped removal of floodwater.



CONFIGURATIONS

The Self Closing Flood Barrier configuration is in straight lengths from 1m with the overall flood barrier wall designed into suitable section lengths of up to 10m each as standard. Sections can be linked together using angled guide-posts for changes in direction.

Trough

There are two types of trough available in which the floating wall operates:

- (1) Steel:
 - utilised for single barriers up to 7m in length.
 - Mild steel Grade S235 to BS EN 10025-2: 2004.
 - Cathodic Protection designed depending on water type
 - Four layer paint protection system applied
- (2) Concrete: can be precast or cast in-situ to any length.



Service Pit

The invert of the service pit must be lower than the trough. The connection to the storm water drainage is for removing the floodwater only and uses a stop-valve to prevent water entering the trough before the trigger level is reached. If the storm water drainage is shallower than the service pit, a pump is required to empty the trough and pit post-flooding. An electrical connection will be required if this is the case.

Vehicle Gate

The FloodBreak Vehicle Gate is a fully-engineered system that will automatically block entrances from street-level flooding. Using FloodBreak's passive flood mitigation technology, these vehicular gates provide worry-free flood protection 24/7 while allowing full access to your facility.

Driveways * Loading Docks * Garage Ramps * Equipment Bays



Revolutionary Flood Control

Like the rest of FloodBreak's passive flood mitigation product line, the Vehicle Gate is fully automatic and does not depend on people or power to deploy. It is the only practical, truly passive flood control solution - the preferred method according to FEMA.

The Smart Choice

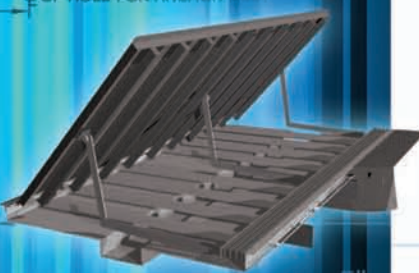
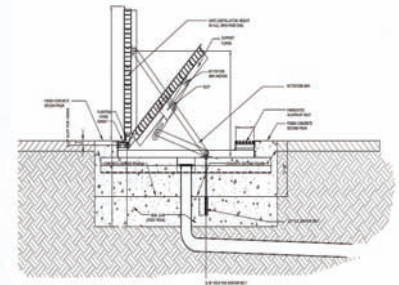
The FloodBreak Vehicle Gate has been protecting customers since 2002. Major hospitals, governments and commercial facilities all rely on FloodBreak's 24/7 flood protection. In the past two years alone, there have been 12 identified flood saving deployments.

How It Works

The FloodBreak system uses hydrostatic pressure created by the rising flood waters to automatically activate the gate. When the flood recedes, the gate automatically returns to its hidden position underneath the ground allowing full access to the facility.

Features:

- Passive flood mitigation preferred by FEMA
- Manufactured to exact size requirements
- Weather resistant materials & durable rubber gaskets
- Minimal maintenance
- No training required
- Easy to install



1.713.980.6610
floodbreak.com

NO PEOPLE, NO POWER

24/7 CONFIDENCE



FloodBreak
REVOLUTIONARY FLOOD CONTROL



CLIMATE RESILIENT DESIGN STANDARDS & GUIDELINES
FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

**APPENDIX F. DEPLOYABLE FLOOD BARRIER
OPERATIONS & MAINTENANCE CONSIDERATIONS**



B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

APPENDIX F. DEPLOYABLE FLOOD BARRIER O&M CONSIDERATIONS

This appendix provides detailed operations and maintenance (O&M) considerations related to Section 7.0 of the guidelines, as well as cost considerations. The following considerations should be developed in an O&M plan in conjunction with Section 3.0 overall guidelines. The Owner of the deployable flood barrier is responsible for the development of the O&M plan and should coordinate with stakeholders. O&M is critical to the performance of deployable flood barriers and reducing risk.

F1. DEVELOP MANAGEMENT PROTOCOL

Management protocol should be considered for deployable flood barriers so that involved parties have clear and accountable responsibilities. Management protocol includes inspections, training, public awareness, improvements, and maintenance before, during, and after flood events. The parts that make up this protocol are discussed in detail below:

Inspection and Maintenance Program	<ul style="list-style-type: none">• Barriers should be inspected annually and before, during, and after every storm event for any damage or deterioration.• Sites should be inspected annually and before, during, and after storm events. Site preparation, such as snow and ice removal, may be required.• Barrier connections to existing structures should be inspected during site inspections so that the connections are structurally sound and free of damage.• All inspection and management requirements should be documented in an O&M plan. Records should be kept of all maintenance and operations activities. There should be annually scheduled training events (drills) and regular updates (at least every 5 years) of the O&M plan.
Communications Plan	<ul style="list-style-type: none">• Identify stakeholders and responsible parties for O&M, including but not limited to:<ul style="list-style-type: none">▪ Property Owners;▪ Planners;▪ General Public;▪ Regulatory Authorities;▪ Massachusetts Emergency Management Agency (MEMA);▪ City of Boston Emergency Management;▪ City of Boston Transportation Department; and▪ City of Boston Public Works Department.• Stakeholders and responsible parties should be contacted to develop a communications plan as part of the O&M plan.• All stakeholders and responsible parties should be notified of any changes to the O&M plan.
Training	<ul style="list-style-type: none">• Staff should be identified to be trained on the management, maintenance and operations of barriers and sites, or owner should consider hiring pre-trained staff and/or contractors.• Scheduled training should take place annually.
Annual Testing and Drills	<ul style="list-style-type: none">• Trial deployment tests should be conducted annually to evaluate if the barrier is functioning properly, no barrier damage has occurred, and staff have hands-on

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

experience for operations (deployment and retraction). Drills will also update deployment and retraction times and equipment needs.

- Communications tests should be considered during drills so that there is proper communication in place for storm events.

Improvement

- Lessons learned from deployment should be incorporated into the O&M plan.
 - Often testing and drills are done in fair weather conditions with simulated competing demands on resources. Additional and sometimes unforeseen events may occur during a real storm event, and the lessons learned should be used to modify O&M accordingly.
 - Opportunities for ways to continue learning about the system and how to care for it should be considered periodically.
 - Management of the overall deployable barrier system should improve over time as more staff become familiar with the system, trainings continue to take place, and new barrier products become available.
 - Improvement through a new barrier system may be a potential way to improve the overall system. Future barrier products may be simpler and easier to adapt to various difficult site conditions.
-

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

F2. DEVELOP DEPLOYMENT PROTOCOL

Deployment protocol should be considered for deployable flood barriers so that the level of effort (manpower, equipment) and time needed for deployment is documented and understood by stakeholders. Deployment protocol includes storm notification, lead time and mobilization, road closures and access, site preparation, deployment, stormwater management, monitoring, and damage repairs.

Notification of Storm Event

- The responsible parties for deployment should identify a reliable notification system for storm events. This may be through the City of Boston Emergency Management, MEMA, NOAA, and/or other systems.
- Mobilization should occur once forecasts and alert systems identify that a storm event is evident.
- The communications plan developed for the O&M should include parties needed for deployment.

Lead Time Notification and Mobilization of Resources

- The lead time is the amount of time between the notification of the storm event and deployment completion. Due to the nature and variability of storm events, designers should seek to a product that reduces lead time as much as possible.
- Lead time may be impacted by:
 - accuracy of forecasts;
 - effective, reliable communications plan;
 - location of barrier storage (for example, if materials for deployment and the barrier are stored on site, the lead time will be less than if materials and barriers need to be transported to the site);
 - location and/or accessibility of site;
 - availability of equipment and manpower (for example, competing demands during a storm event may impact equipment or manpower available for deployment);
 - site preparation needed prior to deployment; and
 - ease or complexity of deployment (for example, the more parts required for deployment, the higher likelihood of longer deployment times and risk of missing materials).
- All necessary materials for retraction should be mobilized to the site with deployment mobilization, if feasible.
- Refer to the Comparison Matrix in Section 7.3 for potential required resources for barrier deployment and retraction.

Road Closures and Access

- Prior to the storm event, some access routes may be temporarily inaccessible due to preventative measures.
 - Consider implementing a plan with multiple routes for any resources that must be transported to the site for deployment. Coordinate plan with Emergency Management's Traffic Control Plan.
 - Closed roads may allow for larger amounts of space for deployment efforts.
 - Identify any roads or access routes that may become inaccessible during a storm. Access routes may become inaccessible before a storm event reaches the intended site for deployment. Coordinate with Emergency Management's Traffic Plan.
-

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Road Closures and Access (continued)

- Other sites may deploy privately-owned barriers that may impact your access and deployment of the barrier. Coordination with nearby stakeholders is essential during the management protocol so that communication and access is maintained.

Site Preparation

- Sites may need to be prepared so that deployable barrier products can function and protect as designed.
- Site preparation may involve sweeping, ice melting and clearing, snow clearing, debris removal, landscaping/grass cutting, etc.
- The protocol for site preparation should be based by season and include estimated time, manpower, and equipment for completion.

Deployment

- Barrier products should be installed in accordance with manufacturer procedures to avoid any unnecessary damage to the barrier and effective installation.
- Access to the public right of way (ROW) should remain available during deployment efforts.
- Barriers should be installed in accordance with related training that staff receives prior to storm events for efficient processes.

Stormwater Management

- Standard stormwater infrastructure (inlets, catch basins, deep sumps) should be maintained with typical frequency.
- Stormwater may collect behind the barrier due to precipitation and/or overtopping of barriers.
- Additional pumps and generators may be required to discharge stormwater away from the barrier.
- Deployment and management protocols should include provisions for stormwater management.

Real-Time Monitoring and Supervision

- Once deployed, the barrier should be monitored and supervised frequently to evaluate the barrier for continuous protection.
- Monitoring and supervision may be available offsite for protection of personnel. Security cameras, water level alarms, and other monitoring/alert systems may be used.
- If adverse or unusual conditions are observed and an emergency situation is identified, follow Emergency Response Plan in Failure Response Plan.
- In the event that the barrier fails, the failure response plan should be followed.

Damage Repair

- As needed, damaged barrier parts should be repaired or replaced in accordance with manufacturer recommendations and outlined in O&M plan.
- If information is not provided for repair, reach out to product manufacturer prior to any attempts to repair damaged parts.

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

F3. DEVELOP RETRACTION PROTOCOL

Retraction protocol should be considered for deployable flood barriers so that the level of effort (manpower, equipment) and time needed for retraction is documented and understood by stakeholders. Retraction protocol includes notification, mobilization, site cleanup, barrier removal, potential maintenance and repair, and removal of flood waters.

Notification of Retraction	<ul style="list-style-type: none">• Retraction activities should not occur until after the storm event has passed and forecasts and/or alert systems provide information to support retraction.• The communications plan developed for the O&M should include parties needed for retraction.
Mobilization of Resources	<ul style="list-style-type: none">• All necessary resources (manpower, equipment, materials) for retraction should be mobilized to the site in accordance with the O&M plan.• Lead time should be considered for retraction.• Some resources may take longer to mobilize to the site after storm events as access routes may be temporarily inaccessible.<ul style="list-style-type: none">▪ Consider implementing a plan with multiple routes for any resources that must be transported to the site for retraction. Coordinate plan with Emergency Management’s Traffic Control Plan.▪ Closed roads may allow for larger amounts of space for retraction and cleanup efforts.• Refer to the Comparison Matrix in Section 7.3 for potential required resources for barrier retraction.
Site Cleanup	<ul style="list-style-type: none">• Debris that gathered during the storm event should be cleared from the site and properly disposed of in accordance with City policies.• Waste created from flood protection efforts should be disposed of in accordance with City policies. Waste may include barrier product packaging, garbage from storm flows, etc.• Additional site cleanup may be required if floodwaters contained hazardous materials. If so, coordinate with a Licensed Site Professional (LSP) for characterization and disposal requirements.
Safety Check	<ul style="list-style-type: none">• The barrier should be checked to evaluate if parts are safely intact and available for removal.• Site conditions should be assessed for safe working conditions for staff and public for barrier retraction.• If the site is deemed to be unsafe, staff should wait to remove the barrier until it is evaluated to be safe to do so.
Barrier Removal	<ul style="list-style-type: none">• Barriers should be assessed for damaged parts prior to retraction efforts.• Barrier products should be removed in accordance with manufacturer procedures to avoid any unnecessary damage to the barrier.• Access to the public ROW shall remain available during retraction efforts.• Barriers should be removed in accordance with related training that staff receives prior to storm events to provide seamless and familiar processes.

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

Re-storage of Non-Damaged Equipment

- Non-damaged barrier parts should be re-stored in the same fashion and areas as pre-storm conditions as outlined in O&M plan.

Maintenance, Repair, or Replacement

- As needed, damaged barrier parts should be repaired or replaced in accordance with manufacturer recommendations and outlined in O&M plan.
- If information is not provided for repair, reach out to product manufacturer prior to any attempts to repair damaged parts. Warranties may be voided if barrier is tampered with.

Review and Debrief

- Upon completion of barrier retraction, the overall process (deployment, management, and retraction) should be reviewed, including a debrief, to identify lessons learned and opportunities for improvement to protocols.

Removal of Contained Flood Waters

- All flood water contained on the flood side of the barrier should be removed in accordance with stormwater management protocols, as identified in the deployment protocol.
 - Additional site cleanup may be required if floodwaters contained hazardous materials. If so, coordinate with a Licensed Site Professional (LSP) for characterization and disposal requirements.
-

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

F4. DEVELOP FAILURE RESPONSE PLAN

While the guidelines provide a process to reduce risk associated with deployable flood barriers, a failure response plan is essential for public health and safety. The designer should prioritize safe-to-fail over fail-safe during barrier selection and site design processed. In all cases, err on the side of protecting public safety and begin the notification process as soon as judgement and common sense suggests that an emergency condition could be developing. The Failure Response Plan should be included in the development of the O&M plan with the plans and procedures to reduce risk (management protocol, deployment protocol, and retraction protocol).

Emergency Notification Flowchart	<ul style="list-style-type: none">• An emergency response plan (or emergency action plan) should be coordinated with stakeholders and responsible parties identified in O&M plan, as well as local police and firefighters.• Responsible parties with procedures, including necessary equipment and personnel, should be identified with contact information.
Emergency Detection	<ul style="list-style-type: none">• Real-time monitoring during a storm event may identify emergency situations. Monitoring is essential so that the emergency notification process can begin before the system fails.• Refer to Deployment Protocol for additional information.• The on-site monitor should evaluate the emergency and provide a classification.
Emergency Evaluation and Classification	<ul style="list-style-type: none">• Failure is imminent or occurred<ul style="list-style-type: none">▪ This condition conveys that failure is about to or has occurred and can no longer be prevented. Once it is assessed that failure can not be prevented, emergency services should be contacted (if not already done so), to take steps necessary for consequence prevention.• Potential failure situation is developing<ul style="list-style-type: none">▪ This condition conveys that there is time available to analyze the situation and identify preventative measures and/or next steps. The time available may range from hours to days, or possibly longer. Emergency services should still be notified of the developing condition. Monitoring is essential to identify if the condition upgrades to failure is imminent or occurred.• Non-failure emergency condition<ul style="list-style-type: none">▪ This condition conveys that the barrier is not likely to fail, but flooding may still occur behind the barrier. Emergency services should be notified and may evaluate if evacuations and/or road closures are necessary for public health and safety. Monitoring is essential to identify if the condition upgrades to a potential or imminent failure situation.
Examples of Emergency Situations	<ul style="list-style-type: none">• The development of the Failure Response Plan should include emergency situations with outlined procedures for the different emergency conditions.• These should be based on the barrier type selected for the site and will vary. They will likely include the following conditions at a minimum:<ul style="list-style-type: none">▪ Changes in forecast: forecasted levels may be higher than protection capabilities/what the barrier is designed to handle. This may result in structural failures.▪ Debris impacts: there may be debris in the flood water that damages the barrier, which may progress to failure.

B CLIMATE RESILIENT DESIGN STANDARDS AND GUIDELINES FOR PROTECTION OF PUBLIC RIGHTS-OF-WAY

- Leakage and/or seepage: flood through the barrier or supporting soils may result in failure and/or flooding behind the barrier.
- Refer to Section 7.3 Comparison Matrix for identified product failure mechanisms.

Loss Prevention

- The owner and responsible parties should prioritize public health and safety in the failure response plan. Procedures should be in place to prevent loss of life and other consequences resulting from an emergency condition. This may include, but is not limited to:
 - Evacuation of properties protected by the barrier;
 - Road closures of the right of way protected by the barrier;
 - Flood containment—there may be an opportunity to compartmentalize the flood waters so that a failure does not result in full inundation of the protected right of way; and
 - Additional deployable flood barriers as a secondary line of defense in protection of the right of way.
-