Passive Flood Barrier Overview and Product Comparisons

A Briefing Document

SEPTEMBER 2015

Purpose

This briefing supplies supplemental information on passive floodproofing and expands on the "Retractable Barriers" section of A Better City's Building Resilience Toolkit. It provides a high-level overview of passive barriers followed by a detailed comparative analysis of the three self-activating passive flood barrier products available for protecting buildings and infrastructure: Floodbreak, the Self Activating Flood Barrier (SAFB), and AquaFragma.

Definition

Passive barriers will operate automatically in a flood or storm event, requiring no human intervention or electricity. In its guidance for floodproofing non-residential buildings, FEMA recommends passive intervention whenever possible[1]. A passive barrier can be permanently fixed, such as a floodwall or levee, or a barrier that activates during a flood. Barriers that self-activate are generally used in tandem with permanent floodwalls or other barriers, and deploy to protect entryways or other openings behind the barrier. Typically, self-activating barriers use water pressure or action to deploy. This brief will focus on self-activated systems.

[1] FEMA, "Floodproofing Non-Residential Buildings" (2013): http://www.fema.gov/media-library-data/300a860542ae1e7cdfcf3a11abcb7fde/P-936_sec1_508.pdf

Photo credit (top): Michael Nevins/Creative Commons via Wikimedia Commons

Benefits of Passive Floodproofing

- Passive barriers minimize human intervention in many areas, including deployment, demounting, and storage.
- Passive barriers do not use electricity to activate, allowing for constant flood protection.
- Passive barriers do not need to be deployed ahead of a flood event. This provides protection against flash floods while allowing site access and egress until flood waters reach the building site.
- Passive barriers can be permanently installed onsite and are typically customized for the site's needs.
- Recessed permanent barriers can be modified to minimize disruption to building aesthetics.
- Passive barriers have low long-term maintenance costs.

Limitations of Passive Floodproofing

- Upfront costs, especially for barriers requiring on-site construction, will be significantly higher than temporary barriers and flood shields.
- Local jurisdictions will likely require a building permit for the construction and placement of the barrier, which will include project review, approval, and inspection by applicable departments.
- Passive barriers usually need to be combined with other site protection (e.g. flood walls) to maximize effectiveness for larger sites.
- Onsite construction and excavation are usually needed to install permanent barriers.
- Passive flood barriers will still fail if floodwaters rise higher than the barrier.
- Products currently available are designed to protect against flooding, and not for regular fluctuations in coastal water levels caused by tidal and wave action.

Locations for Passive Flood Barriers

- Around low-lying buildings from all sectors.
- In front of building entrances, stairwells, and ramps vulnerable to flooding.
- Around infrastructure, including remote service buildings such as pumping or transfer stations.
- At vent and access shafts for underground infrastructure, such as subways or utilities
- On low-lying roadways.
- On top of levees or waterfront promenades.

Potential Funding Sources

Installing passive flood barriers may allow building owners to negotiate for lower flood insurance rates. Additionally, federal funding is available from several sources outlined below.

- FEMA provides funding for flood and disaster mitigation through three grant programs under the umbrella of Hazard Mitigation Assistance:
    - Pre-Disaster Mitigation: Individual homeowners, businesses, and private nonprofits can apply through their local government to fund projects that will reduce risks to people and structures from future hazards.

- Flood Mitigation Assistance: Individual homeowners, businesses, and private nonprofits can apply through their local government to fund projects that reduce or eliminate the long-term risk of flood damage to structures insured under the National Flood Insurance Program.
- Hazard Mitigation Grant Program: After a federally declared disaster, grant money is available to help communities implement hazard mitigation measures. Individual applicants apply through their local government for funding.

- Additional information and application instructions for Hazard Mitigation Assistance programs are available through the Massachusetts Emergency Management Agency.
- Hazard Mitigation Funding under Section 406 of the Stafford Act: Local, state, tribal, and some non-profit facilities damaged by disasters may use Section 406 funding to restore damaged facilities, as well as undertake preventative measures for future flood mitigation.

Product Descriptions

FloodBreak, a company based in Houston, TX, makes automatic floodgates that act as passive barriers (see Figure 1). The gates deploy when rising flood water creates hydrostatic pressure which activates the gate's closing mechanism. The barrier can rise up to 90 degrees and the floodwater holds it into place. When the flood water recedes, the barrier returns to its horizontal position.

A typical gate is 10'9," but taller gates can be custom designed. The widest gate deployed to date was 300 feet in width. FloodBreak gates are rated for water velocities up to 37 feet per second, which is a higher surge velocity than a typical Category 5 Hurricane. Costs are dependent on project conditions. In the past, a 6' x 3' pedestrian gate has cost $14,000 and a 25' x 3' vehicle gate has cost $70,000 (see Photo 1).

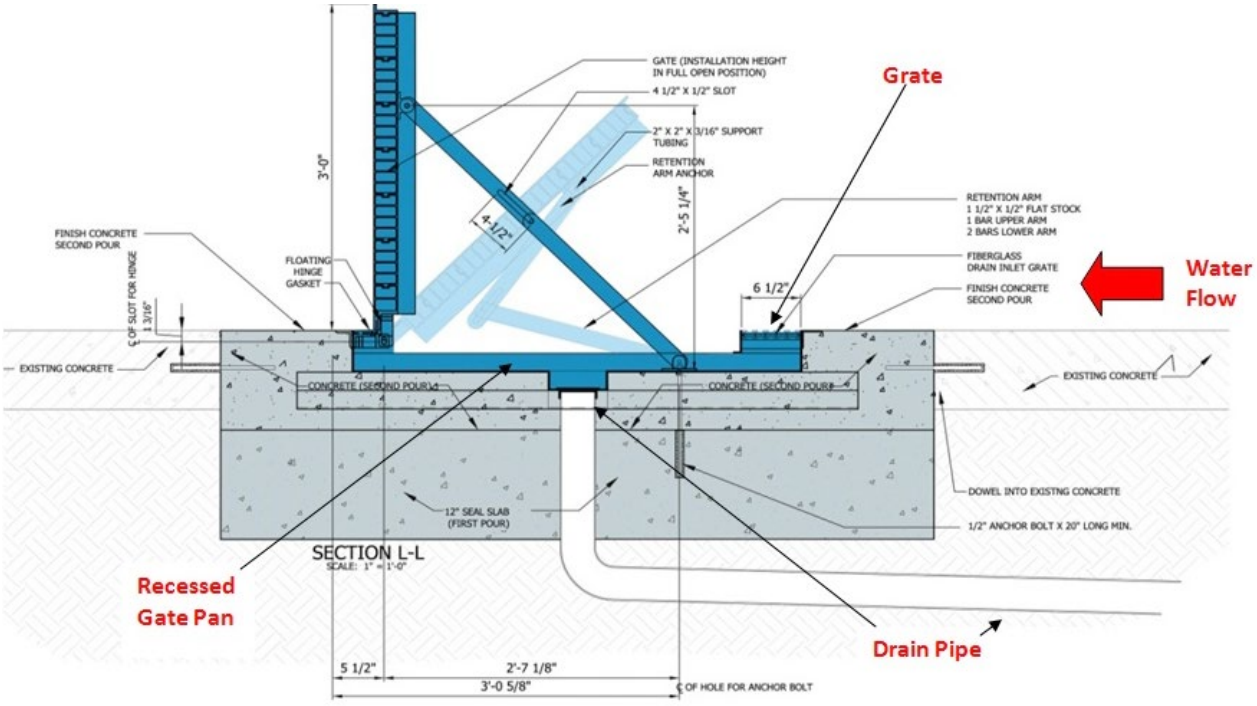

FIGURE 1 | A FloodBreak barrier gate diagram

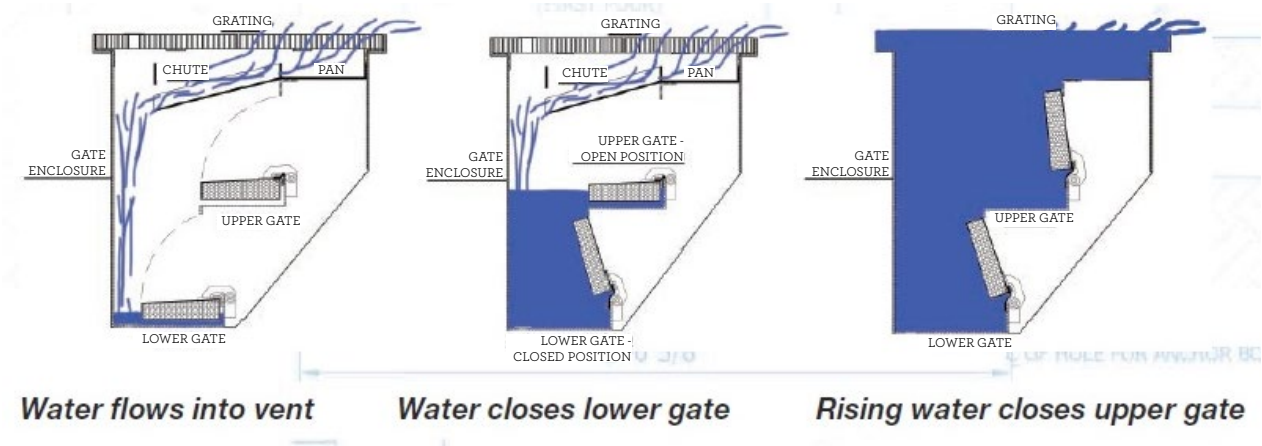

FIGURE 2 | Diagram of FloodBreak's Vent Shaft System

FloodBreak makes passive vehicle gates, pedestrian gates, roadway gates, and levee toppers. It has also designed a **Vent Shaft System** for New York City's transit system (see Figure 2). It deploys in floods and protects subway vent shafts, facility rooms, and transformer bays from street flooding. Custom designs for different types of urban infrastructure, such as water systems, are possible and the company provides support throughout the design and installation process.

Project Examples:

PHOTO 1 (left) | FloodBreak protecting a vehicle entrance to an apartment building in Great Neck, NY.
PHOTO 2 (right) | Flood protection at Dallas Love Field Airport, TX.

PHOTO 3 (left) | Protecting Lourdes hospital in Binghamton, NY. Arrows show areas with FloodBreak gates installed.
PHOTO 4 (right) | Gate installed at a NY Department of Environmental Protection facility.

FloodBreak has been used widely in the United States, especially for site specific protection. The company is currently working with water and sewer facilities in New York City, California, and Mississippi.

More details available at: http://FloodBreak.com
Contact: Rich Driscoll, rdriscoll@floodbreak.com, 713-980-6610

UK Flood Barriers makes a product called the Self Activating Flood Barrier (SAFB) which they describe as a floating entrenched wall that remains recessed during normal conditions. When flood waters begin to rise, the basin in front of the flood barrier fills, causing the wall to rise. Once the basin is filled, the barrier locks into a watertight position.

SAFB's include telemetry systems that will provide warning when activated and the company describes the product's lifespan as 50 to 100 years. The maximum length of one barrier is 50 meters (164 feet). Costs vary based on the site, but average $10,200 per square meter inclusive of installation costs. The company conducts complete surveys of sites prior to installation. Further technical specifications about SAFB are available from the company upon request.

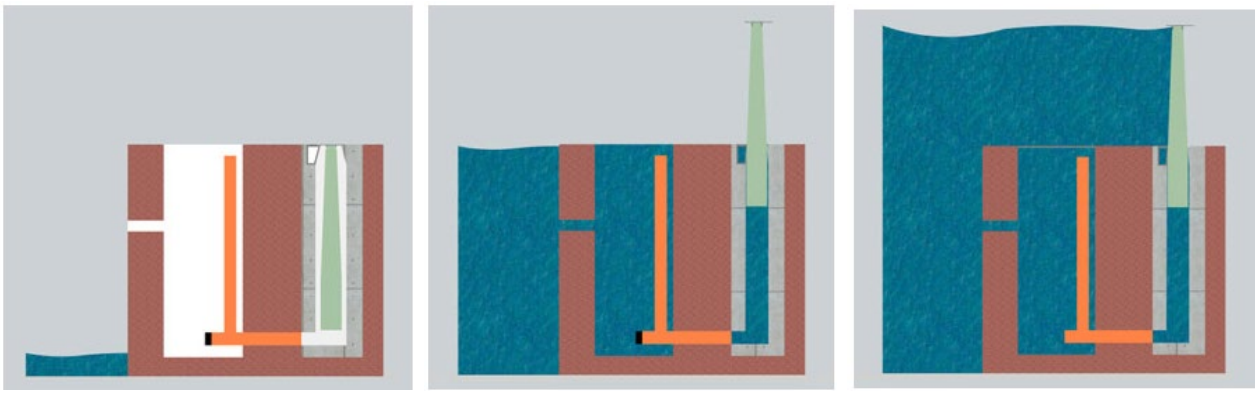

FIGURE 3 | Diagram of the Self Activating Flood Barrier (SAFB)

Project Examples:

PHOTO 5 (left) | SAFB as a flood wall in Cockermouth, England. The recessed wall provides additional height to the town's flood wall in case of high water and access to the waterfront during normal conditions.
PHOTO 6 (right) | Testing a newly installed passive barrier for a parking ramp entrance in Monterrey, Mexico.

PHOTO 7 (left) | Gate installation at a water treatment facility in West Wickham, England.
PHOTO 8 (right) | Water treatment facility protection in West Wickham, England. The pumping station is vulnerable to flash flooding.

The SAFB has been widely used in Europe, and has projects in the U.S. as well. It was used by the National Archives in Washington, DC during Hurricane Sandy. The company has made installations in New York, New Jersey, Colorado, and Pennsylvania.

More details available at: http://www.ukfloodbarriers.co.uk/
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Aquafragma: Similar to FloodBreak, Aquafragma is a self-operating barrier that is activated by hydrostatic pressure that uses a buoyant hinge system to push a gate upright. Different from Floodbreak, however, Aquafragma is fully secured from its ground plate and does not require permanent sidewalls, which can lead to more versatile deployment. Aquafragma can be used in front of building entrances or along waterways, including rivers, canals, or coastal promenades. The barrier issues warnings upon activation. The barrier can be built to any width and can be used with or without sidewalls depending on the area it is meant to protect (for example, it could protect entrances to subways, basements, or roadways). A longer deployment would use one continuous barrier plate and multiple series of "operating bodies" behind the gate to push it upward.

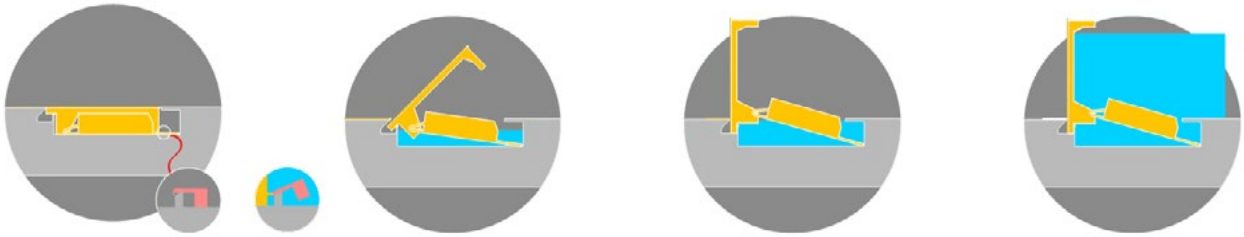

FIGURE 4 | Diagram of the Aquafragma Self-Operating Flood Barrier

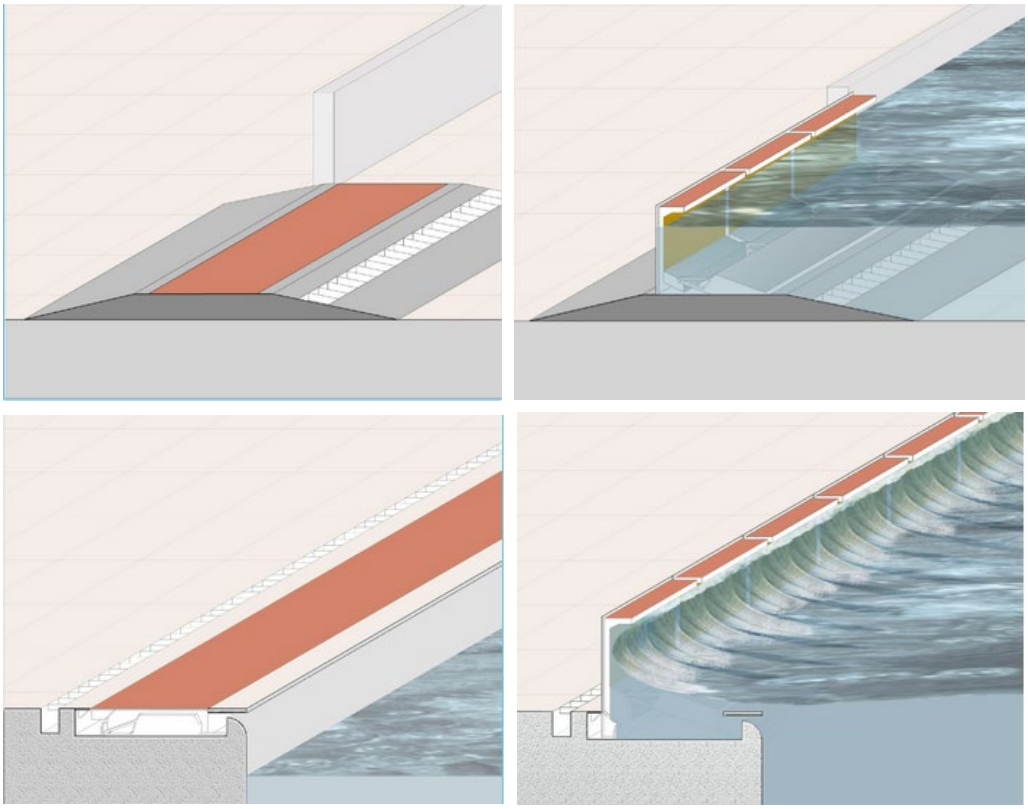

FIGURE 5 | Aquafragma applications for roadways (above) and coastal promenades (below)

Aquafragma is based in Cyprus and the UK and is a new company. They currently have three units being inspected at the Building Research Establishment in Watford, UK. Costs for systems are approximately $5,000 square meter plus additional installation costs.

More details available at: www.aquagragma.com
Contact: Dr. Antonis Toumazis, aquafragma@diontoumazis.com, 00357 2237 4027

Product Comparison

Based on interviews with vendors and desk research, the table below summarizes key characteristics of three passive barrier options:

	FloodBreak	SAFB	AquaFragma
Operating mechanism	Buoyancy from water raises the gate and hydrostatic pressure with the ground plate and surrounding walls holds gate in place.	Water causes the wall to rise and lock into a watertight position with the surrounding walls.	Buoyancy from water raises the gate and hydrostatic pressure with ground plate holds gate in place.
Common applications	Gates of differing sizes, levee toppers, and vent shaft protection for infrastructure.	Around low-lying buildings or infrastructure and along waterways and coastlines.	Building entrances, ramps, infrastructure protection, coastal promenades, and riverfronts or canals.
District-level applications	Typically as part of a larger floodwall or levee system.	Has been used to protect neighborhoods along waterways.	May be applied to protect a neighborhood or larger area from the passage of flood water.
Coastal area applications	FreeView barrier system, an adaptation of Floodbreak, can sit on top of a levee, cantilevered on a water edge, or be used as a seawall.	Can be used with levees or seawalls in coastal areas.	Can be used on coasts and in tandem with seawalls. For coastal areas with high water, gate stays in an upright position and will not return to a flat position.
Access when deployed	Emergency egress ramps can be used during a flood.	Can design a lock system to allow emergency vehicles to enter and exit protected perimeter without compromising flood defenses.	Entry and exit should be through a pre-established route. Barrier can be built with a hump, so its deployment is delayed until water has risen higher.
Plate material	Marine grade aluminum and stainless steel.	Polyester closed cell foam inside, reinforced with laminated steel and a GRP (glass reinforced plastic) Kevlar shell.	Aluminum or stainless steel for the load-bearing elements, extruded polystyrene for the light-weight material filling, and anti-slip GRP for the top surface.

	FloodBreak	SAFB	AquaFragma
Dimensions	Up to 300' wide and 10'8" tall. Can be custom designed to be larger.	Up to 40' wide and 8'2" tall, but can be custom designed to be larger.	Designed to satisfy product requirements. Higher flood design level requires deeper housing.
Storm resistance	Tested for velocities up to 37 feet per second (25 mph), with a surge velocity higher than an expected Category 5 hurricane.	Product will be custom designed to meet local building code requirements.	Product will be custom designed to withstand loads specific to designated applications.
Lifespan	Longer than the buildings it is protecting; gasket requires replacement every 10 years.	Minimum of 50 years with regular maintenance.	50 years with silicone seal replacement every 5 years.
Maintenance	Minimal, periodic visual inspection and lubrication of gaskets recommended.	Minimal, recommend an annual maintenance check.	Minimal, periodic inspection recommended.
Warranty	1 year, longer options available.	10 years.	5 years, longer options available.
Insurance reductions	Yes, several clients have negotiated lower insurance rates.	Yes, clients have negotiated lower insurance premiums. Company will work with insurance companies to advise them on protection gained by barrier installation.	Specialist insurance companies may offer lower premiums to AquaFragma users. AquaFragma's distributor, Aquobex, can offer further guidance.
Barrier cost	Dependent on project conditions. In the past, a 6' x 3' pedestrian gate has cost $14,000 and a 25' x 3' vehicle gate has cost $70,000.	Approximately $10,200 per square meter (10.8 feet), but depends on project specifics.	Approximately $5,000 per square meter (10.8 feet), plus installation costs.

	FloodBreak	SAFB	AquaFragma
Installation cost	Varies depending on local conditions. Typically installed by a site's general or sub-contractor.	Included in estimate cost figure above, but will vary by project.	Depends on location. Product is portable and comes in its own metal housing, so installation can require a shallow trench below pavement level.

Conclusions

Passive flood barriers are an option for increasing building resilience from flooding in coastal and riverine areas. This guide is meant to provide an introductory product comparison for three passive flood barriers on the market. Facility managers should assess their sites and communicate with potential vendors to fully understand their options and appropriate technologies to deploy. Additional guidance on other flood protection options can be found in the Building Resilience Toolkit located at: www.challengeforsustainability.org/resiliency-toolkit/.