Southwest Brooklyn
Industrial Development Corporation

Red Hook Small Business Hazard Mitigation Case Study Findings Report

September 2013

Southwest Brooklyn Industrial Development Corp 1978

Dewberry

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September 17, 2013

As Executive Director of the Southwest Brooklyn Industrial Development Corporation (SBIDC) I am proud to present you with this Small Business Storm Preparedness Plan Template and corresponding Red Hook Small Business Hazard Mitigation Case Study Findings Report. The report reveals the findings from an extensive analysis of the effects of Hurricane Sandy on three case study businesses in Red Hook, Brooklyn. Expert hazard mitigation engineers examined both the physical and operational aspects of the case study businesses and developed mitigation solutions that will help each prepare for the next weather-related event. This report provides a snapshot of the conditions in Red Hook, Brooklyn but shows examples that are applicable to any small business in Brooklyn or greater New York City.

The Small Business Storm Preparedness Plan Template holds a wealth of information, specific tips, and clear guidance for how to prepare your small business for a weather-related event. The template is designed so that you can fill it out based on your own needs and conditions and is useful for any small business, no matter what location you are in or what type of business you have.

Hurricane Sandy hit New York City on October 29, 2012 with impacts that hardly anyone expected. A majority of the businesses in Red Hook sustained major damages and suffered great loss. Electricity was out for a month among myriad other challenges. The storm destroyed many businesses' paperwork necessary for the various disaster financial assistance programs.

Businesses were not prepared. The City was not prepared. We hope that taken together, the Small Business Storm Preparedness Plan and Findings Report will help businesses be better equipped to handle future weather events. We also hope that businesses take this opportunity to continue to build valuable networks to share information and resources.

There will never be another Sandy; the next event will look different. That is why this Small Business Hazard Mitigation Case Study Findings Report and Small Business Storm Preparedness Plan Template have been designed to be useful in a variety of scenarios. Each and every business has multiple plans to handle different aspects of a business, so why not have a plan for an emergency? Now is the time to prepare for the next storm and continue the pattern of growth and development in Brooklyn. Let us work together to prove that Brooklyn is remarkably resilient, adaptable, and better prepared than before.

Sincerely,

David D. Meade

David D. Meade
Executive Director
Southwest Brooklyn Industrial Development Corporation

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Introduction

Red Hook, a neighborhood in southwest Brooklyn, New York, suffered severe flooding caused by Hurricane Sandy[1] on October 29 and 30, 2012, as did many New York neighborhoods. The local business community, suffered heavy losses to property, equipment, inventory and perishable food supplies. Many losses were sustained because property owners and small businesses did not prepare adequately for a storm of Sandy's magnitude, whose impacts were compounded by a weather front which approached from the west. Having largely dodged Hurricane Irene during the s 2011 hurricane season, New Yorkers may have assumed that Sandy's impacts would be minimal until it was too late to adequately prepare and mitigate against storm damages.

The Southwest Brooklyn Industrial Development Commission (SBIDC) sponsored a project to evaluate three typical Brooklyn small businesses for their building and operational vulnerabilities to severe storms, solutions to mitigate those vulnerabilities, and development of preparedness plans to be activated in advance of approaching storms. The *Small Business Storm Preparedness Plan* and accompanying template forms may be found, along with this report, on the SBIDC website at www.sbidc.org.

The Red Hook Small Business Hazard Mitigation and Storm Preparedness Project technical support was provided by Dewberry for the Southwest Brooklyn Development Authority. The objectives of the project were to:

- enhance the resiliency of the Red Hook business community by providing recommendations for mitigation strategies to reduce potential impacts of natural hazard events on both physical property and critical business records, and
- provide storm preparedness planning templates for businesses to better to respond to and recover from the impacts of natural disasters.

To ensure that the planning template forms would be of value to the wide range of businesses in Red Hook, SBIDC and Dewberry coordinated with three business owners who volunteered to participate in case study mitigation and storm preparedness evaluations as representative of separate business categories. While every business is unique both in the service or product it delivers along with its facilities, operation, and business support system, three general business categories were selected so that a variety of small business issues, challenges and lessons learned from Sandy could be examined. The three business categories and case study participants were:

1. Light or artisan manufacturing
2. Mid-size manufacturing
3. Restaurant

[1] Hurricane Sandy was often referred to in the media as Superstorm Sandy. For ease of reading, it will be referred to as Sandy throughout this report.

Chapter 1 - Red Hook, Brooklyn, New York

Background

Red Hook is a peninsula located in an area of southern Brooklyn, New York. The peninsula extends into Upper New York Bay between Buttermilk Channel, Gowanus Bay, and the Gowanus Canal (Figure 1).

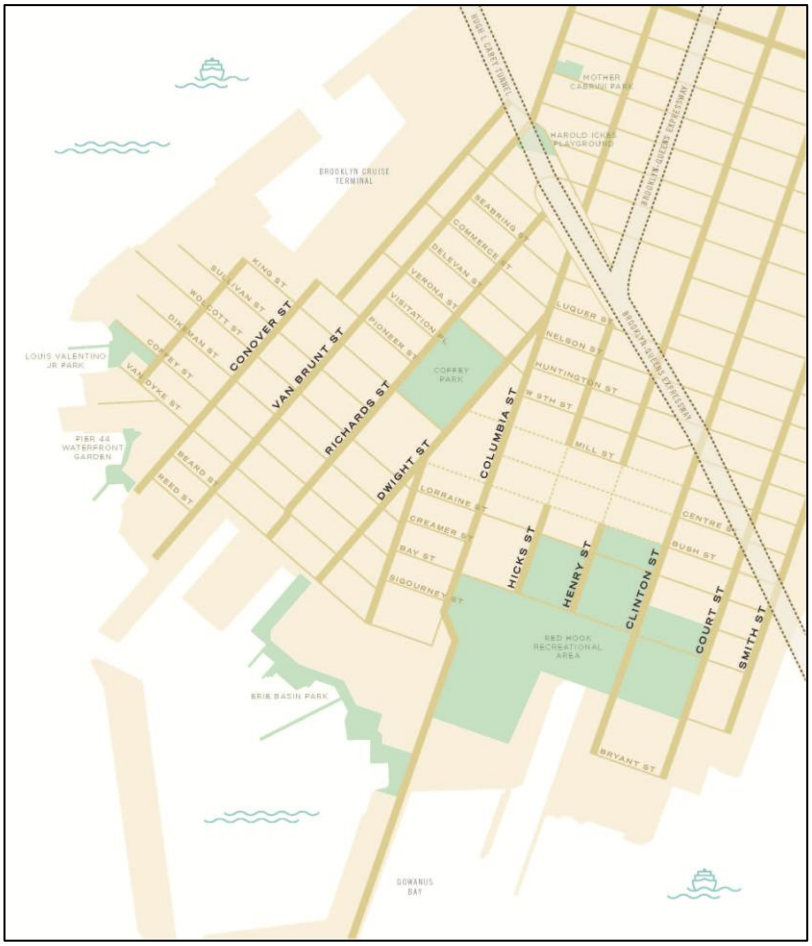


Figure 1 – Red Hook area map (courtesy of Brooklyn Slate Company)

Before European settlement, Red Hook was an area of low lying tidal flats. It was originally settled by the Dutch in the mid-1600s. Its early development as a port and trading center led Red Hook to become a critical transportation hub for New York City. The Dutch constructed dikes to form mill ponds, encouraging and supporting industrial growth. In the mid-1800s the City of Brooklyn created a plan to fill ponds and tidal flats in order to construct streets in the area. Soon after, developers began to build ports to handle goods transported to New York City via the Erie Canal and Hudson River. Development of Red Hook's port facilities and infrastructure into the mid-1900s made it one of the most active ports in the United States. In the 1960s, however, the introduction of freight containerization and intermodal transportation had a significant negative impact on Red Hook. A combination of port facilities not designed for the new large container ships and the lack of rail service into and out of the area led to a major decline in economic activity in Red Hook that continued into the early 1990s.

During the early 1990s New York City developed the plan entitled *Strategic Plan for Redevelopment of the Port of New York,* which included Red Hook. From 1993 to 1999, while the plan was being developed, container volume in the port increased more than 250 percent. Two new container cranes purchased through the New York Economic Development Corporation in 2000 gave impetus to continued growth in Red Hook. Recent container volume has declined, further challenged when the cranes went down following power loss during Sandy.

During the 1990s, Red Hook business and community leaders worked to implement a multi-faceted economic recovery that continues today. Red Hook is home to numerous small and mid-sized manufacturing, construction, transportation, and infrastructure businesses serving New York City and national and international markets. The economic growth of the past two decades has also brought residents back to Red Hook, creating opportunities that have led to new restaurants, retail businesses, and service firms, as well as a robust artists' community. In 2006, Carnival Cruise Lines began using the Brooklyn Cruise Terminal, providing additional stimulus to the Port of Red Hook. In addition, IKEA located a major retail outlet in Red Hook that is served by ferry and bus access, with ample on-site parking. Although still facing significant economic challenges, Red Hook is a growing, vibrant community that is continuing to work toward economic growth while preserving the fundamental fabric of the community.

Buildings

Red Hook's history as a port and trading center provides a legacy of large, strongly built warehouse and manufacturing buildings along or close to the waterfront. Many of the large warehouse buildings pre-date the Civil War, and were built using unreinforced masonry bearing walls and heavy timber interior framing. Similar buildings constructed from the late 1800s onward appear to also have been constructed using masonry bearing walls with structural steel interior framing. Many of the warehouse buildings have been redeveloped and leased to small manufacturers, professional service firms, and specialty contractors (Figure 2).

Figure 2 – Redeveloped warehouse building near Van Dyke & Ferris Streets

Smaller industrial buildings and commercial structures were developed to be close to and support the shipping terminals and other large businesses. Residential and small commercial development occurred in the central and western area of Red Hook, away from the main area of port activities.

Residential and light commercial structures are generally built with masonry exterior walls with wood frame interiors (Figure 3). These buildings held up during Sandy but were still vulnerable to flooding, as detailed later in this report. Some commercial buildings have basements with direct outside access through sidewalk hatch doors (Figure 4).

Figure 3 – Mixed-use commercial and residential development

Figure 4 – Sidewalk hatch entry to commercial basement storage area

Infrastructure

Transportation

Red Hook is fully connected to Brooklyn and Manhattan by the Hugh L. Carey Tunnel (formerly the Brooklyn-Battery Tunnel). Access to the Brooklyn – Queens Expressway (I-278) is available from Hamilton Avenue in the southeastern section of Red Hook. There are no direct public transportation services between Red Hook and Staten Island, though a drive across the Verrazano Narrows Bridge and onto the Staten Island Expressway takes approximately 30 minutes. Red Hook has no direct subway service. Public transportation consists of two bus routes, B-57 and B-61, which connect to the subway system at the Court Street and Borough Hall stations in Brooklyn. Red Hook is approximately 13 miles east of Kennedy International Airport and 11 miles southwest of LaGuardia Airport. Ferry service is available on weekends as of August 2013.

Utilities

Figure 5 - Utility workers repair electrical and telecommunications lines after Sandy

Electrical service is provided by Consolidated Edison (Con Edison) of New York. Electrical service distribution in Red Hook is primarily through overhead conductors. Service ties are typically overhead taps to the building, dropping to the meter and service panel. Water and sewer service is provided to all buildings by the New York City Department of Environmental Protection. Sewer lines in Red Hook are mostly combined sanitary/stormwater lines. Telecommunications, including land line and wireless telephone service and internet connectivity, are available throughout Red Hook through a number of major service providers.

Chapter 2 - Red Hook Natural Hazards

New York City in general and the Red Hook area in particular have some exposure to natural hazards, including[2]:

- Wind
- Flooding
- Winter storms
- Earthquakes

Wind

Wind is caused by the movement of air masses from areas of high atmospheric pressure to areas of lower atmospheric pressure. The direction of wind is a function of variations in local and regional temperature, topographic conditions, and friction between the air mass and the earth's surface.

Although thunderstorms and nor'easters are more common, the Federal Emergency Management Agency (FEMA) recognizes New York City and neighboring counties as part of the national Hurricane-Prone Region (Figure 6).

Hazardous winds include:

- Straight-line wind storms
- Downslope winds
- Downbursts
- Thunderstorms
- Nor'easters
- Hurricanes
- Tornados

Hurricane-prone regions are those along the Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed for general use buildings is greater than 115 miles per hour. The basic wind speed for general-use buildings in New York City is 120 to 130 miles per hour depending on precise locations.

[2] NYC Hazards, New York City Office of Emergency Management, www.nyc.gov/hmtl/oem/hazards/hazards.shtml

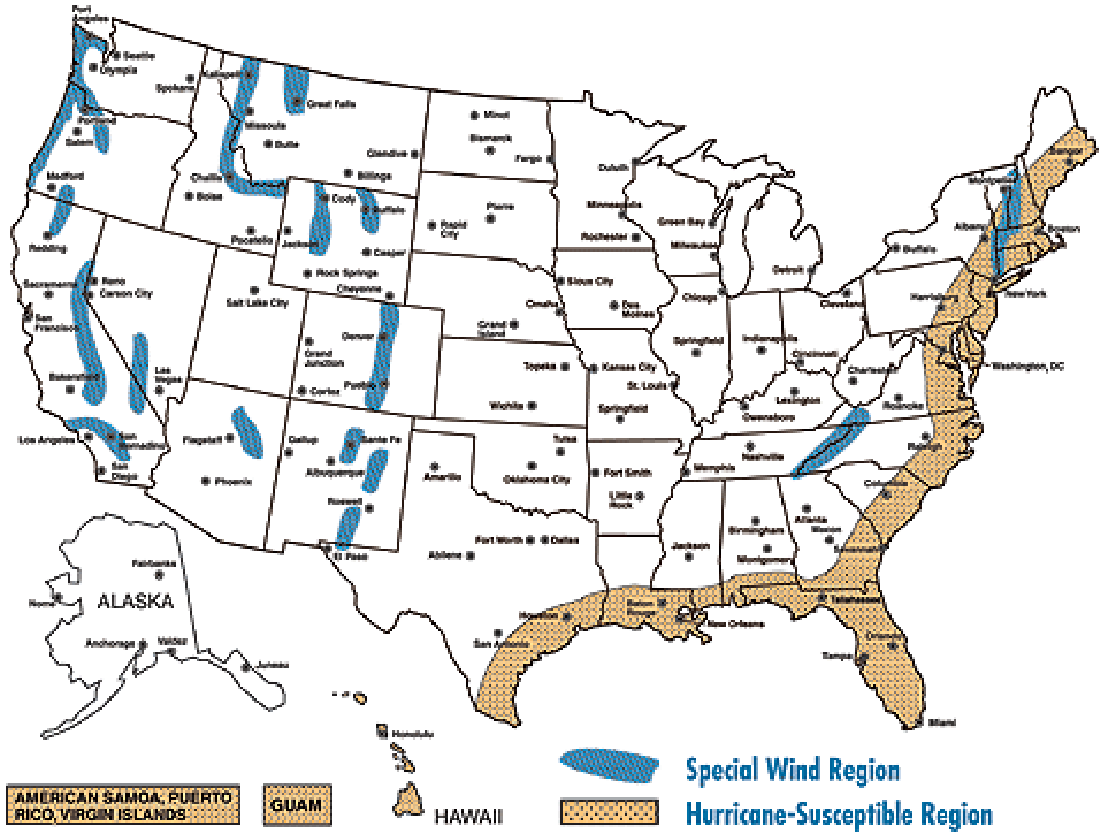


Figure 6 - FEMA Hurricane Prone Regions

Tornadoes are infrequent but do occur in New York City. Data published by the National Oceanic and Atmospheric Administration indicate one to five tornado watches occur annually in the New York City area (Figure 7). Ten tornadoes have been recorded in New York City since 1974, including five since 2010. The largest of the recorded tornadoes was the August 2007 "Brooklyn Tornado" that traveled an eight-mile long path across Staten Island and Brooklyn. A 2012 tornado began as a waterspout about one mile south of Breezy Point in Queens before making landfall and damaging the Brooklyn neighborhood of Canarsie.

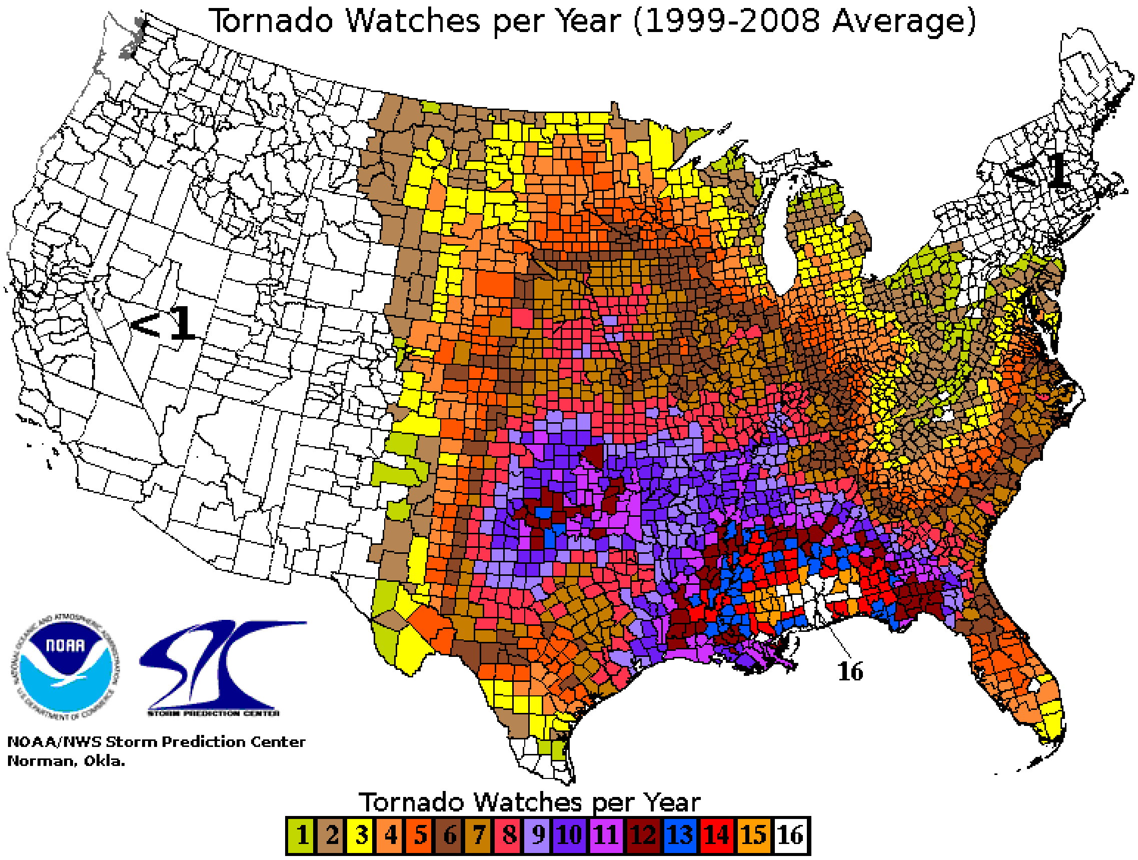


Figure 7 - Map of Tornado Frequency Occurrence

Wind storm damages include downed power lines, disruption of utilities and transportation systems, flying debris, and compromised roofs.

Flooding

New York City is susceptible to two types of flood hazards:

1. Intense rain storms
2. Coastal storms

Figure 8- Tree debris impacts electrical overhead lines in Brooklyn, July 2013

Floods caused by intense rain storms are generally brief "nuisance" floods that cause minor water damage to structures and personal property, sewer back-ups, and disruptions to traffic and public transportation systems.

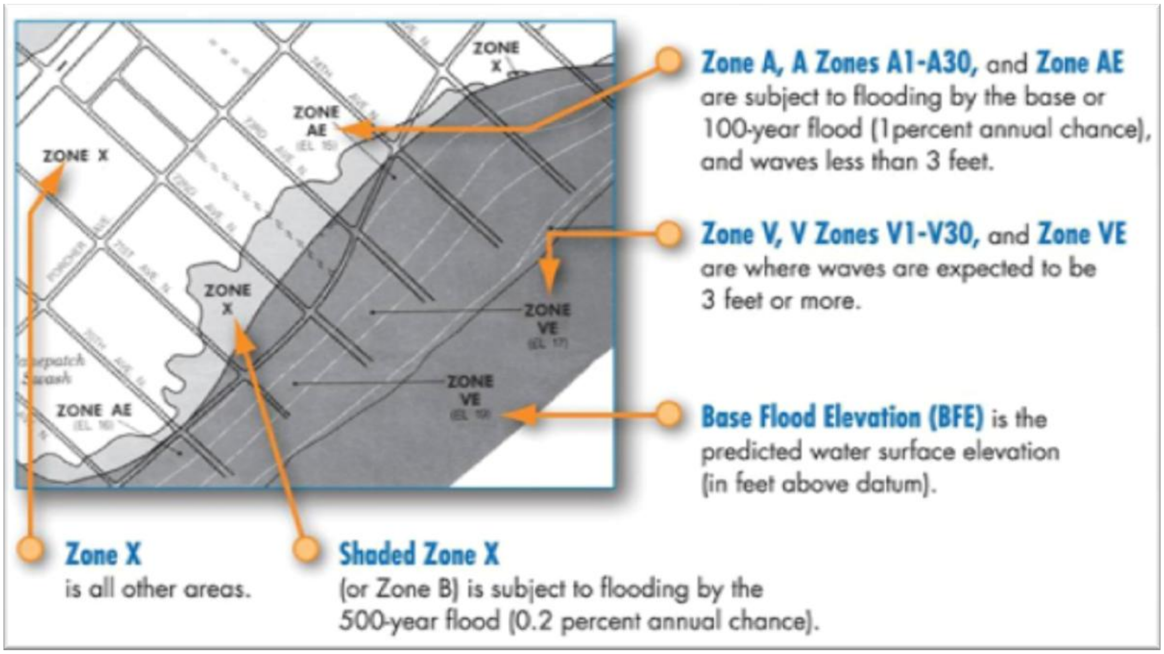


Figure 9 - Section of Typical Coastal Area Flood Insurance Rate Map

Coastal storms, including nor'easters, tropical storms, and hurricanes present a significant hazard to New York City not only because of heavy rainfall but also because they may include heavy, high storm surges caused by offshore winds. Several factors make New York City particularly vulnerable to coastal storms:

- The 90-degree angle formed by the New York–New Jersey border along the Hudson River forces storm surges through the Verrazano Narrows, which increases surge height and speed.
- Waterfront areas of New York City are densely developed.
- Extensive transportation and utility networks include underwater tunnels that are susceptible to flooding, especially if flooding reaches tunnel portals.

Impacts of the October 2012 coastal storm Sandy provided graphic evidence of the vulnerability of New York City to such storms. The genesis and impact of Sandy are described in the following chapter of this report.

The primary source of guidance for determining site specific flood hazard is the FEMA National Flood Insurance Program (NFIP). One of the responsibilities of the NFIP is to develop and promulgate Flood Insurance Rate Maps (FIRMs). These maps show the estimated level of the 1-percent-annual-chance, or 100-year, flood. Figure 9 shows a section of a typical FIRM along with an explanation of terms used. The 1-percent-annual-chance flood elevation is designated on the FIRM as the Base Flood Elevation (BFE). That term is also used in local planning, zoning, and floodplain management ordinances, as well as building codes and technical standards relating to flood mitigation design.

FIRM data is the starting point in developing flood mitigation measures. The use of the FIRM in mitigation design is discussed in Chapter 5. FIRMs are periodically updated based on significant flood events or major changes in hydrologic or other conditions. The FIRMs for New York City, certain adjacent New York counties, and coastal New Jersey are being revised as a result of Sandy.

Winter Storms

Severe winter weather is the result of frigid arctic air moving southward that affects non-arctic climate zones, including New York City, and results in temperatures that are hazardous to health and safety. When moist air mixes with frigid air, winter precipitation in the form of snow, sleet, or ice is often the result. Winter storms affecting New York City produce extreme cold, heavy snow, ice, sleet, and freezing rain. Typical damages caused by winter storms include downed power lines, collapsed roofs, and disrupted public transportation systems.

Earthquakes

Earthquakes are generally the result of sudden movement between geologic plates beneath the earth's surface. The movement travels to and along the earth's surface in a variety of wave forms. Structures supported on or in the earth through which the waves travel will themselves experience movement as a result. That movement imposes forces on the structures that may or may not have been anticipated in the original design. Earthquakes in New York City are relatively uncommon. Tremors for earthquakes origination in areas ranging from neighboring States to Canada and the southeastern United States are somewhat more frequent. Recent tremors felt in New York includes the August 2011 earthquake originating in central Virginia, and a June 2013, earthquake that originated in Morris County, New Jersey.

Earthquake-related damages in New York City have been generally minor, with major damage mostly involving tall, unreinforced chimneys. Therefore, this report will not detail earthquake mitigation measures.

Chapter 3 - Effects of Sandy

Figure 10 – Con Edison workers replacing damaged poles, transformers, and reconnection lines

Tropical Storm Sandy formed in the Caribbean Sea on October 22, 2012, and strengthened to a Category 1 hurricane before making landfall at Kingston, Jamaica, on October 24. The storm made landfall again in Cuba, then travelled along the East Coast. On October 29 Sandy approached the mid-Atlantic region as a Category 2 hurricane and weakened to a post-tropical storm before making landfall along the southern coast of New Jersey.

Sandy made landfall in the greater New York/New Jersey area at approximately 8:00 p.m. during high tide, resulting in larger than normal storm surges impacting the coast. Sandy caused major storm surges from the Chesapeake Bay to New England, including a record setting surge in New York City. A storm surge 13.88 of feet at New York's Battery Park easily surpassed the previous record of 10.02 feet caused by Hurricane Donna in 1960. Measurements in New York Harbor recorded a 32.5-foot-high wave, which was 6.5 feet higher than the previous record of 25 feet caused by Hurricane Irene in 2011. In general the storm surge was about 9 feet above normal.

Sandy is reported to have caused more than $32 billion in damages throughout New York State, including $19 billion in damages in New York City. Sandy related damages in the New York City metropolitan area Sandy related damages include:

- Loss of electrical power to more than over 811,000 customers in New York City and Westchester County, along with more than 940,000 customers on Long Island (Figure 11)
- A major fire caused by an exploding electrical transformer that destroyed 111 buildings and damaged 20 others
- More than 100,000 homes destroyed or severely damaged
- Extensive damage to transportation infrastructure, including two subway tunnels that were out of service during repairs (Figure 12):
  - R line serving southern Brooklyn, expected to be closed until October 2014
  - Greenpoint Tube on the G line, which has been restored to service but is scheduled to be closed for five weeks during summer 2014 to complete repairs

Figure 11 - Downed or severely damaged power lines threatened roads throughout the Sandy-impacted region.

Figure 12 - Receding flood water in Brooklyn R Train

Figure 13- Flooding Caused by Sandy in Red Hook

Red Hook experienced significant flooding over much of the area. Flood depths of 3 to 4 feet were reported by business owners near the waterfront (Figure 13). Businesses and residences close to the waterfront or in relatively low-lying areas were particularly hard hit. Buildings, especially those with basements, suffered extensive damage to equipment, supplies, inventory, and personal belongings.

Business recovery in Red Hook has been a particular challenge to many small businesses that lack reserve capital to make needed repairs, replace equipment, and restock inventory. Small businesses in Red Hook have had challenges working through the challenges of identifying and obtaining financial assistance available through various Federal programs. Recovery has been slow because of myriad factors such as:

- Lengthy time required to restore power
- Lack of timely response to Red Hook residents and business owners by Department of Homeland Security Federal Emergency Management Agency (DHS FEMA) and U.S. Small Business Administration (SBA)
- Isolation of small business work forces who live in other parts of the city and could not reach Red Hook because of Metropolitan Transit Authority issues and subway closures
- Lack of in-place recovery programs and mechanisms

This list is not complete, but it highlights the post-disaster challenges faced by Red Hook and communities nationwide following a catastrophic disaster. The response to Sandy was particularly slow in Red Hook because the area had not experienced a significant flood or hurricane disaster in decades, and the area and number of citizens and businesses impacted was so large that recovery of basic services such as utilities was especially slow. As a result, Red Hook businesses and organizations created several Sandy response support groups which provided basic services like meals, debris removal, cleaning and sanitizing, fund raising, communication, networking, and issuance of small recovery grants to businesses. September 2013 finds Red Hook - 11 months after the storm - partially recovered. Some businesses are operating at full capacity but still addressing backlog, while others are open on a limited schedule or operating at reduced capacity. Many have not recovered or have actually left the area.

Damages sustained by many New York small businesses, particularly those in Brooklyn, could have been prevented or lessoned if mitigation measures to reduce the impacts of flooding on buildings, their infrastructure, equipment, assets, and operations had been in place when Sandy struck. The next chapter will detail permanent as well as temporary mitigation measures appropriate for many small businesses. It must be emphasized that each business has unique needs, and many of the measures presented require permits from the New York Building Department and should be installed by a licensed contractor.

Investment in mitigation supports people, businesses, and continuing operation of infrastructure, critical facilities, and services like hospitals, public safety agencies, and utilities. Ultimately communities become more disaster-resilient through mitigation action.

Chapter 4 - Mitigation Concepts

Natural hazards are an integral component of Brooklyn's environment, as shown recently by Sandy. The New York region has experienced devastating storms once or twice each century since settlement. Only by learning to better understand the behavior of those hazards can the design, construction, and retrofit of residences, businesses, and critical infrastructure.

Any sustainable action that protects people and property, and ensures continued operation of critical infrastructure so that societal function is maintained during disasters and emergencies.

For example, a *sustainable* mitigation measure is often a permanent, in-place retrofit of a building or supporting element of a building. These mitigation measures represent changes or improvements to the building or its supporting infrastructure such that the property owner can be assured that the building or mitigated component will hold up to a disaster event. Permanent measures include elevating heating units and hot-water heaters and sealing electrical breaker boxes. More temporary measures, such as placement of sandbags or door barrier logs in a doorway in advance of a flood, are less sustainable mitigation measures. This is because they require property owners or staff to be in place and actively ensuring that the mitigation effort is effective.

Mitigation measures ideally should be integrated into new-site planning prior to construction, but many retrofitting mitigation methods can be installed in existing homes and businesses. Communities can benefit from mitigation planning and action that will increase safety and resilience from future significant storms.

Wind

Wind mitigation concepts address two concerns:

1. Wind forces on the building and attachments
2. Wind-borne debris

Wind Forces on Buildings and Attachments: Mitigation of wind force hazards requires an evaluation of the load path carrying the wind load from point of impact to the building foundation (Figure 14). Each component and connection must have sufficient strength to support all loads, including wind loads, to avoid damage or catastrophic failure.

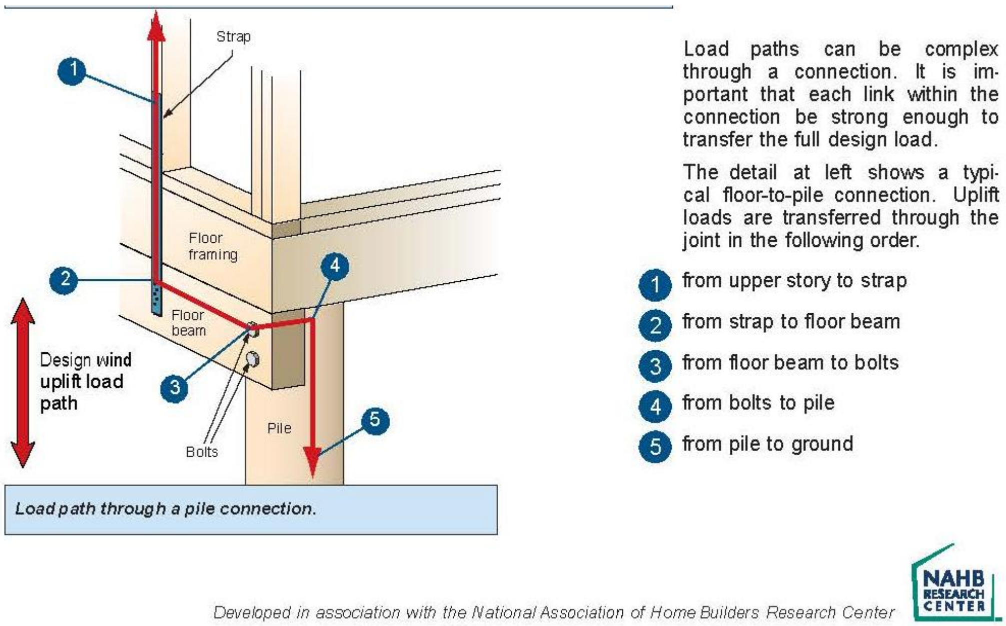


Figure 14 - General structure load path

Current building codes require construction that ensures that structural members employ measures to resist wind loads. Older buildings, built prior to use of current building codes or under previous codes, usually lack load reinforcement for high winds. They can usually be mitigated by reinforcement or replacement of key structural members or components. Load path connections are typically the critical area of concern. Mitigation methods to reinforce load path connections typically include reinforcing the existing framing structure. The technique used is a function of the material and the additional strength required.

Famously, the record winds of 1992's Category 5 Hurricane Andrew devastated buildings in southeast Florida but in Homestead, the majority of buildings that withstood the storm were very modest homes built by Habitat for Humanity that were constructed using hurricane clips like those shown. Today such connections are required by many communities for new construction and can be retrofitted in most buildings for less than $500 in materials. Typical connection mitigation designs include:

- Structural steel construction
  - Additional bolted connector plates
  - Replace existing welded connections with new, higher strength weld
- Concrete and masonry construction
  - Add steel connector straps attached to the concrete with new anchor bolts
- Timber construction
  - Replace existing connection hardware (nails or screws) with hurricane clips or a similar pre-formed connection device (Figure 15)

Figure 15 - Post construction hurricane clip to reinforce timber framing

- Mixed material construction
    - The construction industry has developed a large inventory of connectors for reinforcing connections between dissimilar materials. Figure 16 shows a post-construction connection between timber framing and a concrete block wall.

Figure 16 - Hurricane clip reinforcement for timber frame to concrete block wall connection

Wind-borne Debris Mitigation: Mitigation of wind-borne debris consists of protecting building openings and building exteriors using shutters or temporary impact-resistant shields. For windows not protected by metal security shutters, covering the outside of the window with ¾-inch plywood panels is an effective mitigation measure. Where practical, the plywood panel should be fastened by being screwed into a wooden window frame, or into expansion anchors installed around the window opening.

Figure 17 - Boarding windows to prevent wind and water damage (Photo: NY Daily News)

How to Install Temporary Door and Window Shields

1. Measure the window and add 7” to each edge measurement or whatever the frame will accommodate to provide overhang. Most lumber yards will cut ¾” plywood sheets to specified measurements for free or a nominal charge.
2. After locating the framing studs and measuring carefully, drive #8 or #10 Phillips-head wood screws (at least 2-1/2" long) through the plywood and into the center of the studs above, below, and at the sides of each window or door (approximately 7/8" outside the window frame).
3. The screws must hit the studs solidly to provide an adequate anchor for the plywood shutter.
4. When protecting a door entrance or low window where water entry is a concern, spray foam can be applied around the opening for extra protection against water penetration.

Figure 18 - Window storm shutters (Photo: Hurricane Shutters 2 Go)

More sophisticated pre-installed electric or manual crank storm shutters can cost $50 to $60 per square foot of window size. A set of shutters for a 3-foot by 4-foot window could cost about $600 to $720. The cost of a plywood cover will also depend on the size of the window. If the business's staff does the work, expect plywood to cost $0.80 per square foot. Screws or lag bolts, including washers, will cost about $0.10 to $0.15 each. Protecting a window that is 3 feet wide and 4 feet high will cost about $12. This figure covers only materials.

Applying duct tape or other types of tape over windows has been shown to be ineffective at preventing wind and water from entering a building through windows or doors. Taping can minimize the amount of flying glass. It will not prevent glass breakage from flying debris, high winds, or rapidly changing barometric pressure. More robust door and window shields that protect against flooding and wind borne debris are discussed below in Flood Mitigation.

Continued advocacy with the New York City Arborist's office or other departments that manage street trees should focus on regular tree maintenance such as pruning and removal of obvious high-hazard dead trees, especially those that overhang buildings and electric lines.

Flood Mitigation

Flood mitigation holistically is most effectively achieved by several approaches:

1. Relocating out of the flood zone
    - Moving to another site outside areas of flooding indicated on the Flood Insurance Rate Map (FIRM) showing the site location
    - Elevating the facility to an elevation at or above the Base Flood Elevation (BFE) on the FIRM showing the site location
2. Preventing floodwater from entering the building
    - Most commonly accomplished using floodwalls
    - Ensure flood barriers provide protections to a level equal to or above the BFE
3. Elevating key building components and contents
    - Elevate key mechanical equipment on platforms
    - Move perishable goods and valuable equipment to higher areas either permanently or in advance of a storm event

4. Floodproofing the building or key components
    - Seal key utilities and meters
    - Re-point leaky mortar joints
    - Shield doors, windows, and other openings to prevent water entry

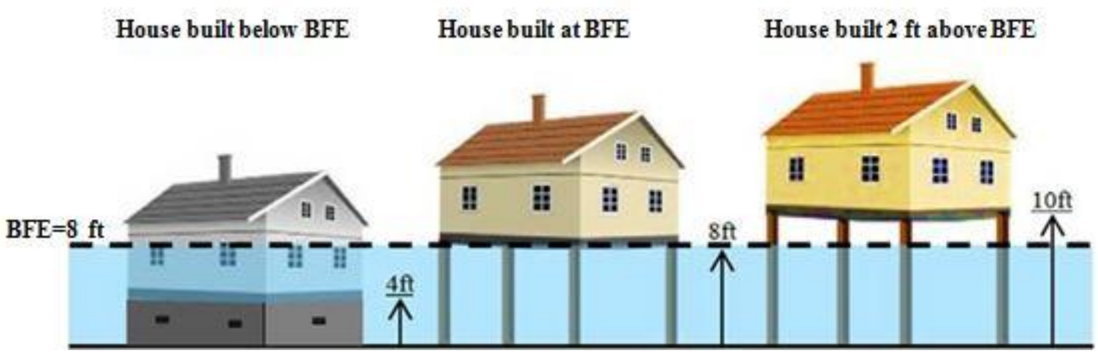


Figure 19 – Example of Buildings Elevated to and above the BFE

Relocation is not a feasible mitigation strategy for most of Red Hook's businesses and residents. Technical issues affecting the elevation of most of Red Hook's buildings include:

- Size and sensitivity to movement of many of the older masonry warehouse buildings
- Lack of room to build new foundation systems to support elevated structures
- Density of development and abutting walls that restrict installation of temporary framing required to lift buildings
- Lack of space for customer and/or supplier access, particularly for ramps needed for hand trucks and wheel chairs
- Access challenges for compliance with the Americans for Disabilities Act
- Façade design restrictions to maintain compliance with historic preservation ordinances

The most practical approach to flood mitigation in Red Hook is to prevent water entry through floodproofing. The following sections outline mitigation strategies for:

- Buildings
- Building services
- Essential business equipment

Floodproofing Concepts for Buildings

Flood barriers are the basic building block of floodproofing. Although permanent flood barriers are preferred, temporary flood barriers for doors and lower floor windows are a more feasible mitigation approach for the buildings observed in Red Hook. Door and window flood barriers are widely available in a wide range of sizes and configurations. Most temporary flood barriers require installation of barrier "logs" in the event of a flood threat. These temporary barriers are more effective than sandbags, easier to install when a flood is imminent, and require less storage space than sandbags. Figure 20 shows a typical temporary flood barrier installed in advance of a flood.

An alternative application for non-glass, pedestrian doors is the use of waterproof metal doors. Floodproofed doors provide the convenience of a passive mitigation approach, since many designs require no human action for the barrier to be effective.

Door and Window Shield Systems

As with wind mitigation designed to protect against debris, window and door shields can be an effective flood mitigation method. As discussed in the Wind Mitigation section, shielding openings can be done using plywood and hardware available at local lumberyards, or more expensive, custom installed devices can be used. The figures and photographs that follow show window and door shields that are readily available on the market. Costs can range from $60 to $100 per square foot or higher, not counting installation. Since many Brooklyn entrances and windows already feature security protection, some of these devices may not work or be practical for a particular building. Floodproof hatch openings to seal sidewalk entrances to basements are also available (Figure 24). Another simple approach to sealing sidewalk hatch-style doors in advance of a flood event is to have a pre-cut piece of ¾-inch Plexiglas available on site to place in the door frame once all basement valuables have been evacuated. Upon placement of the Plexiglas, the edges can be sealed using a can of spray foam sealant. This approach may not be watertight, but it should prevent major basement flooding and is easy to install.

Figure 20- Temporary flood barrier installed across building door

Figure 21 - Window shutters installed at a school/emergency shelter.

Figure 23 - Door shields protect entrances from low level flooding

Figure 22 - Typical Brooklyn sidewalk hatch doors into basement

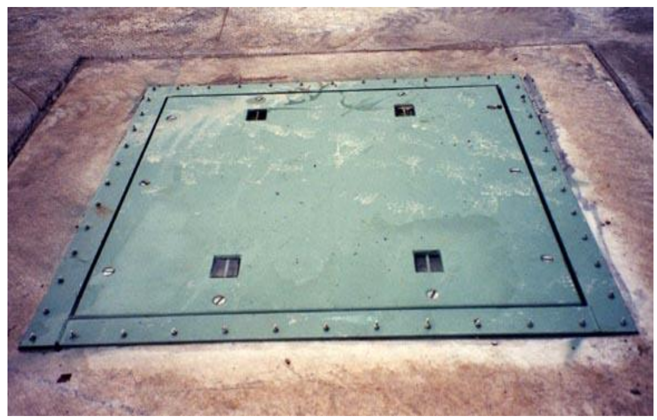


Figure 24 – Flush-mount floodproof sidewalk hatch

Floodproofing Leaky Mortar Joints: Floodwater seepage into basements through leaky masonry foundation walls is an opportunity for mitigation. There are few non-structural mitigation options for waterproofing leaking basement walls. A potential mitigation course of action for non-painted basement walls is for a mason to:

- Inspect mortar joints and carefully remove loose or damaged mortar
- Thoroughly clean the mortar joint to remove all loose material
- Re-point the joint with a high-strength, non-shrink grout
- Once the grout has dried, apply a waterproofing cementitious coating to the wall

This action should provide short-term benefits for unpainted walls with minor seepage. The area should be monitored and the floodproofing process must be repeated when or if the repaired mortar joints begin to “weep” or seep moisture.

Preventing Seepage Through Basement Walls: Water seepage can be prevented by

- Application of a water sealant coating to the wall
- Attaching a waterproofing membrane and semi-rigid drainage board/blanket to the wall
- Installation of a perforated pipe drain to collect and carry water from the drainage blanket to a sump or other outlet

This mitigation approach is most effective where installed on the exterior wall face. However, exterior construction is frequently not practical in densely developed urban areas such as Red Hook. The alternative is to construct a system on the interior walls of the basement, as depicted below. The system shown below has been mitigated against basement flooding from two severe storms where the area received 11" of rainfall in 6 hours since installation in 2004.

Interior construction generally requires a shallow excavation adjacent to the walls for installation of the drain line, and a collection sump with sump pump to discharge water to the stormwater sewer system.

Figure 25 – Installation of Interior Drainage System

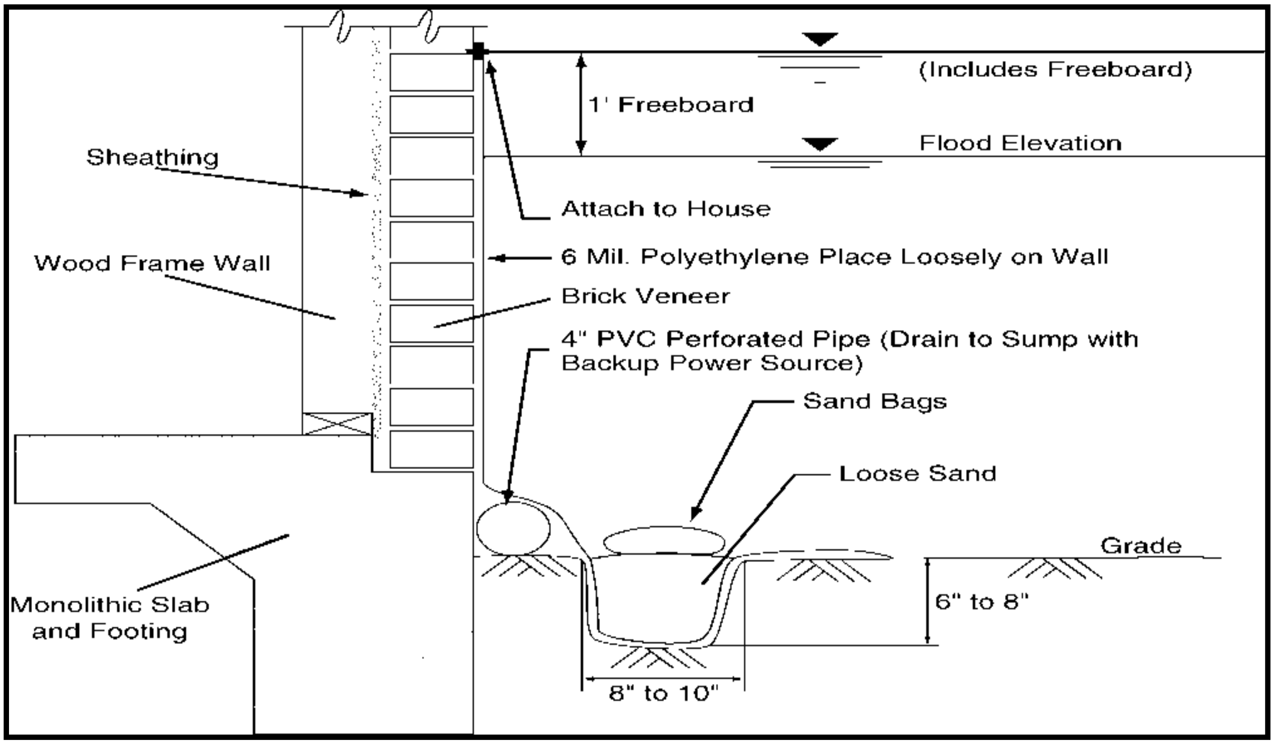


Figure 26 - **Schematic of Interior Drainage System**

Sump Pumps: A sump pump is a small pump installed in the lowest part of a basement or crawlspace. Sump pumps help keep the area under the building dry and help prevent it from flooding. Usually, sump pumps are installed in specially constructed sump pits. Water flows into the sump pit through drains or by natural water migration through the soil. The device pumps water out of the pit and away from the building so the basement or crawlspace stays dry. It has been estimated that more than half of American homes and businesses with basements will have to deal with a flooded basement at some point. It does not take much water to cause thousands of dollars of damage. A moist basement can also lead to mold and mildew growth, bringing with it related health and breathing hazards.

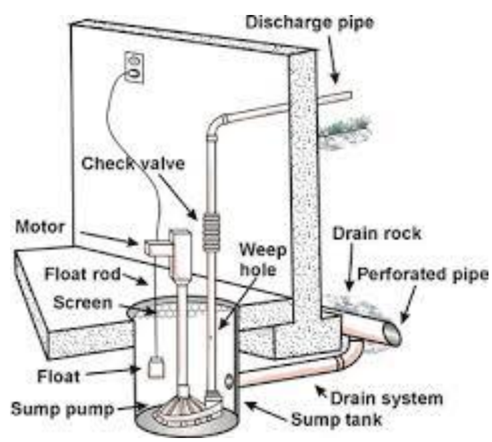


Figure 27 – Typical Sump Pump Schematic

Sump pumps may not be appropriate for every basement because of drainage issues and basement configuration. A consultation with a licensed plumbing contractor and the New York City Department of Buildings is the first step in consideration use of a sump pump for basement flood mitigation. Sump pumps also require a secondary power source (usually heavy marine batteries) so they perform as designed during power outages.

Water Sealants: Non-structural sealants are available for basement wall applications. The three major types of water sealants are:

- Portland cement based coatings designed to permanently adhere to concrete and masonry walls. Cementitious coatings can have insufficient bonding strength to resist lateral hydrostatic pressures present during flooding, especially if the basement wall exterior lacks a functioning wall drainage system.
- Silicate based sealers seep into concrete or masonry substrate. To be effective, silicate sealers must be applied to clean, unpainted surfaces. As with Portland cement coatings, the bond strength of silicate based sealers may not resist horizontal hydrostatic seepage forces without an exterior wall drainage system.
- Acrylic paints, occasionally marked as "waterproof," have been shown to have limited short- to mid-term effectiveness.

Floodproofing Concepts for Building Services

In the aftermath of a major natural disaster, business owners and managers are concerned not only about damage to the building housing the business, but also the infrastructure supporting each business operation. Five key infrastructure assets are:

- Electrical equipment
- Plumbing
- Mechanical equipment
- Essential business equipment
- Data systems

The *New York City Building Code, Appendix G – Flood Resistance Construction* requires compliance with both the National Flood Insurance Program (NFIP) regulations and the American Society of Civil Engineers (ASCE) Standard 24, *Flood Resistant Design and Construction.* Two primary requirements of ASCE 24 are:

1. Utilities and equipment shall be located above the Base Flood Elevation (BFE), or 1 to 3 feet higher for additional protection, depending on the NFIP mapped flood zone and structure category.[3]
2. Utilities and attendant equipment are permitted in areas of structures that are dry floodproofed.

Base Flood Elevation or BFE:

The computed elevation to which floodwater is anticipated to rise during the base flood (flood with a 1% chance of occurrence, also known as the 100-year flood). Base Flood Elevations (BFEs) are shown on Flood Insurance Rate Maps (FIRMs) developed by the Federal Emergency Management Agency (FEMA). The BFE is the regulatory requirement for elevation or flood-proofing of structures.

[3] ASCE 24-05 Flood Resistant Design and Construction §7.1 and Table 7-1.

The current code requirements and ASCE 24 guidance provides useful recommendations when considering mitigation retrofitting strategies for existing buildings as well as designing new buildings.

Electrical Systems

The most effective mitigation approach for protecting electrical systems is to elevate meters, and disconnect and then move switches and circuit breakers to a location above the BFE. The code stipulates that switches and circuit breakers may not be more than 5 feet above the floor unless an access platform is provided. Based on the current NFIP post-Sandy preliminary flood maps, the BFE in the Red Hook area is expected to be at or very near 5 feet above the first-floor elevation in most cases, meaning the buildings comply with current and proposed code requirements. The major exceptions are buildings with basements and electrical service meters in the basement. Where relocation is not feasible, electrical switches, meters, circuits, receptacles, fixtures, and other components should be rewired with wiring suitable for submergence, and should not contain fibrous components. Some systems can be isolated in watertight interior compartments.

Figure 28 - Some mechanical systems can be protected with sealed compartments

Dry floodproofing of electrical switches, meters, and equipment is an alternative. Electrical components can be installed in sealed, watertight shelves or platforms. However, temperature and moisture control requirements must be evaluated. Mitigation measures affecting the service entrance or meters must be approved by the utility service provider. Emergency generators used to power critical equipment can be an effective approach to reducing damages caused by natural hazard events. Emergency generators with automatic transfer switches are preferred to ensure that generators are effective in events where power is lost when the building is unoccupied.

Generators

Standby electric generators can provide an extra sense of security in view of New York's power supply challenges, especially during emergencies and disasters. Generators can be a convenient source of power for businesses if they are properly installed and used safely. Even a small, portable electric generator, if used improperly, can threaten the safety of building occupants, business employees, and power company linemen working on the electrical system.

Portable generators

Portable, gasoline-driven generators are designed to be used with appliances with cords connected to them. Lights, small appliances, etc., can be plugged directly into outlets on portable generators. In general, they are not designed to be connected to building wiring. Property owners or occupants should not attempt to personally install these devices or connect them to building electrical panels.

Figure 29 – Portable Generator

Fixed Generators

Large, fixed generators generally are directly connected to building wiring to provide standby power during emergencies and power outages. However, the wiring needs to be properly installed by a qualified electrical contractor. Properly installing a "permanent" generator is extremely dangerous, and not a "do it yourself" job. An electrical permit is required from the New York City Department of Buildings for fixed generator installation.

Mitigation design for electrical systems also applies to emergency power systems. Emergency generators, transfer switches, fuel pumps, controls, and wiring should be installed above the BFE. If elevation is not feasible, the emergency power system should be protected in a flood proof structure with a grated roof for heat escape and ventilation.

Most generators require gasoline unless an investment is made in a permanently installed natural gas generator. Flood risks must be considered in the selection of fuel tanks and fuel pumping equipment. If fuel system components cannot be installed above the BFE, those components should be designed for submersible use and anchored to prevent flotation. Generators are largely designed for outdoor installation to prevent asphyxiation; permanent generators installed in the interior of a building must be properly ventilated.

Plumbing Systems

The key issues for plumbing, piping, and fixtures installed below the elevations specified in ASCE 24 are:

- Plumbing systems should be anchored and protected to withstand flood-related loads, including the effects of buoyancy and hydrodynamic forces.
- Exposed lines must resist dynamic loads caused by debris impact.
- Plumbing lines with openings, including connections to other lines, including the public sewer system, must be protected with automatic backwater valves, or other automatic backflow devices to prevent discharge of sewage into the floodwater, and prevent infiltration of the floodwater into the building's plumbing.
- A review of the New York City Building Code and telephone discussions with a Brooklyn-based plumbing contractor revealed that installing backflow prevention devices in existing systems is allowed. The contractor also indicated that, in accordance with ASCE 24, the backflow prevention device had to prevent building flow into floodwater carried by the sewer system as well as prevent floodwater from entering the building plumbing system.

It should be noted that sanitary systems that must remain operational during or immediately after a flood must be equipped with a sealed storage tank with a capacity to store a minimum of 150 percent of the anticipated sewage flow associated with occupancy during flood condition.

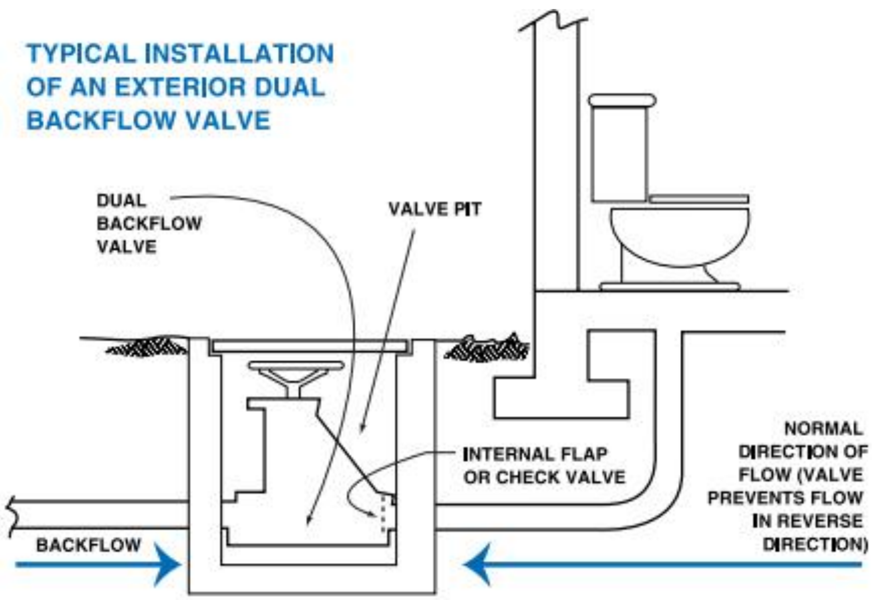


Figure 30 – Typical Exterior Dual Backflow Valve

Plumbing system components, including domestic water booster pumps and hot water circulating pumps, should be elevated above the BFE. If elevating the equipment is not feasible, use of submersible pumps should be considered. Equipment and components such as sump pumps lift pumps, or domestic sanitary waste pumps typically installed in areas vulnerable to flooding should be design for submersible use.

Mechanical Equipment

Heating, ventilation, and air-conditioning (HVAC) system components should be located above the BFE. Where elevating equipment is not feasible, floodproofing by constructing a watertight enclosure with adequate ventilation through a grated roof may be a feasible alternative.

Figure 31 - Elevation of air conditioning condenser in a floodprone area; additional anchorage is recommended (FEMA P-55)

Air handling units that serve areas vulnerable to flooding should be located apart from other components of the HVAC system. The separation is recommended to mitigate the risk of contaminated air from flood-damaged units migrating to other portions of the building.

Essential Business Equipment

Essential business equipment includes machines, tools, patterns, and raw materials required by the business to provide its product or service to customers. Core business equipment may be very heavy and bolted to a supporting structure, or relatively light and bolted to the floor. Some equipment may be mobile, or easily disconnected for relocation in advance of a storm event. Core business equipment also includes tools, molds, material handling systems, and product delivery or shipping equipment. Computers controlling equipment or other production processes are considered critical business equipment. Data systems used to manage general business operations are discussed in the Data Systems section.

Where feasible, critical heavy business equipment or components susceptible to flood damage should be elevated above the BFE. If elevation is not feasible, dry floodproofing equipment with a permanent enclosure or temporary flood barriers can be an effective mitigation approach.

Lightweight critical business equipment may be moved to a storage area above the BFE as part of the business preparedness plan. After the flood recedes, the equipment can be restored to its pre-flood location and function.

Supporting equipment such as molds, hand tools, countertop equipment, etc., can be prioritized based on variables including cost, frequency of use, value added to basic business output, and customer satisfaction. Using the prioritization list, the business may be able to rearrange normal storage and staging operations to place the highest priority equipment in higher storage spaces, and work down so that the potential for flood damage is inversely proportional to the value of the equipment.

The same prioritization can be used to allocate storage space for raw materials and finished products, with perishable items expected to be high on the priority list.

In some cases, it may make business sense to arrange for off-site storage in another facility that is less susceptible to flooding during the predicted event.

Data Systems

Data systems are used to manage critical business information, including, but not limited to:

- Customer orders, including design drawings and material specifications for manufacturing businesses
- Inventory control
- Invoicing and receivables tracking
- Accounts payable tracking
- Profit/loss accounting statements
- Employee records, including payroll and tax withholdings
- Bank statements
- Insurance policies
- Lease agreements
- Tax returns

The primary mitigation approach for critical business information and documents is to store them, in whatever format, above the BFE. For paper records, file cabinets should be on a floor or pedestal above the BFE. For electronic information systems, all components including servers, switches, and network hubs should be installed above the BFE.

Similarly, voice and data communication systems used to inform employees, customers, and suppliers should be elevated above the BFE. Each of the case study businesses used cellular phones and texts to communicate with employees, which allowed off-site flexibility.

Businesses frequently use off-site storage for redundancy of both paper and electronic records. It is critical that the off-site storage facilities are located outside areas identified on a FIRM as Special Flood Hazard Areas, or that storage facilities are floodproof.

The cost of implementing both permanent and temporary flood mitigation measures like the ones discussed here are dependent upon the specific building configurations for the small business, along with its support systems such as mechanical, heating, cooling and plumbing systems, utilities like power and natural gas, and interior building drainage into New York City sewer systems. In addition, the assets such as equipment, stock, and "products" requiring protection must be considered.

As with any proposed building or building component permanent modification, the New York City Department of Buildings and a licensed contractor should be consulted to assure the appropriateness of the proposed mitigation measures as well as any design and permit requirements.

The cost ranges presented in the table that follows are estimates to provide a range of mitigation measure costs. Once a mitigation approach has been determined and the appropriate officials have been consulted, it is recommended that at least three bids or estimates are obtained and that an attorney review a contract with the selected contractor or tradesman installing the mitigation measure. All contractors should carry full licenses and bonds per New York City requirements, and should present certificates of insurance so the business is not liable for on-site injury.

Storm Hazard Mitigation Measures for Brooklyn New York Small Businesses						
	$0 - $500	$500 - $1500	Greater than $1500	Temporary Measure	Permanent Measures	Notes
Building Mitigation						
Flood barriers for doors and windows						
Plywood	✓			✓		
Sandbag openings	✓			✓		
Door and window shutter systems		✓	✓	✓	✓	
Flood logs	✓	✓		✓		
Retrofit gaskets and seals	✓	✓			✓	
Door shields	✓	✓	✓	✓	✓	
Basements						
Clean and repair basement wall joints	✓	✓			✓	Requires re-pointing
Exterior or interior basement wall membrane or semi-rigid drainage board			✓		✓	
Interior basement wall coating		✓			✓	
Sump pumps			✓	✓	✓	
Building Infrastructure Mitigation						
Elevate electric service entrance & meters to BFE		✓				Consult with utility
Floodproof or seal electric meters		✓				Consult with utility
Emergency generators		✓	✓			May require permit
Backflow prevention devices		✓	✓			May require permit
Elevate HVAC equipment above BFE	✓	✓				May require permit
Floodproof HVAC located below BFE	✓	✓	✓			May require permit
Isolate air handlers serving areas below BFE from other HVAC Components	✓	✓	✓			May require permit
Mitigation for Essential Business Equipment/Assets						
Permanent equipment elevation above BFE	✓	✓			✓	
Temporary equipment elevation located below BFE using lifts, blocks or other methods	✓			✓		
Temporarily relocate light equipment out of flood susceptible areas	✓			✓		
Relocate priority equipment and supplies to upper storage space above BFE	✓				✓	
Mitigation for Data Systems						
Store critical paper documents and desktop computers above BFE or off-site	✓				✓	
Scan current critical working documents for electronic back-up	✓				✓	
Place network servers above BFE	✓	✓			✓	Consult with provider
Place voice and data communication routers & switches above BFE	✓				✓	Consult with provider
Back-up of critical electronic documents & data off-site	✓	✓	✓		✓	Consult with provider
Relocate critical documents, equipment in advance of storm	✓	✓		✓		Line up transportation and crew in advance

Winter Weather

Winter weather mitigation concepts include:

- Strengthening overhead utility lines by installing stronger wire and poles, and reducing span lengths between poles
- Placing underground lines, especially those in pipes or conduits, below the frost line to prevent breakage caused by frost heave
- Removing or trimming trees near overhead utility lines or roofs
- Strengthening roof structures
- Removal of excess snow from roofs and overhang
- Retrofitting older, pre-Building Code roof structures to carry wet snow loads
- Use of generators during power outages

While Red Hook business owners and citizens cannot implement the first three measures, which are the responsibility of the electrical utility and New York City Department of Parks and Recreation, understanding that these measures reduce snow and ice impacts on overhead power lines can help community organizations advocate for this mitigation and maintenance investment. The last four measures can be employed at the business location as needed and appropriate to the site, building, and business function.

Earthquake

Engineers and scientists learn more about the mechanics of earthquakes and their impacts on buildings with each earthquake event. This enhances understanding of both the mechanics of earthquake forces affecting structures and the structural response to those forces. Given the reality of earthquake uncertainty in predicting specific earthquake events and forces, the current design approach is to design for earthquakes of a specified size affecting a specific location over a certain period of time. While earthquakes are rare in the New York City region, they do occur. Investment in earthquake mitigation methods is probably less of a priority for New York small business owners, so specific concepts are not further addressed in this document.

Earthquake mitigation concepts include:

- Strengthening structural elements to resist earthquake forces
- Enhance building flexibility to accommodate deflections caused by earthquake induce ground motions
- Isolation of structure from earthquake induced ground motions
- Anchor non-structural elements to reduce falling debris hazard

Chapter 5 - Case Studies

Three Red Hook businesses were selected by the Southwest Brooklyn Industrial Development Corporation to participate in a mitigation assessment and disaster preparedness planning process as representatives of the larger business community. Three dominant types of businesses were chosen, with the understanding that each small business varies in its product or service offering, location, and specific natural hazard and operational storm risks. The businesses were selected to represent light or artisan manufacturing, mid-size manufacturing, and restaurants

Each Case Study" investigation was approached in a consistent manner:

First, initial contact and introduction was initiated by the Dewberry LLC Hazard Mitigation Team to set up appointments and learn about the particular business and its manager's concerns. Case Study site visits were conducted during July 2013 during which the business owners described:

- business production and operations
- Sandy impacts to their facility and operation
- post-Sandy and other recovery issues
- long-term mitigation priorities
- emergency preparedness concerns

On-site tours of each facility included damage inspection, utility and support system examination, and building exterior measurements. After the tour, mitigation options were developed for each Case Study business.

Mitigation and preparedness meetings were held with each Case Study business during August 2013. During the meetings, an array of appropriate permanent and temporary mitigation options was presented to each business owner.

Case Study 1: Light Artisan Manufacturing

Business Description: The light or artisan manufacturing case study features a small business that fabricates custom art glass pieces. Their primary market is repair and restoration projects, with some new custom design production and a small amount of retail art glassware pieces sold mostly through a front show room on weekends.

The business leases space in a renovated storage building on the Red Hook waterfront. The two- and three-story masonry building measures 480 feet long by 144 feet deep. The business leases a ground-floor module measuring 50 feet by 144 feet (Figure 32). Doors and windows are located in openings originally designed for horse-drawn carts. In many front entrances of the units leased in this building, an entire opening is used as a decorative entrance. In other cases, the original opening has been closed with brick masonry to match the existing facade, with new openings formed for windows and pedestrian doors.

Although the business masonry walls separate each tenant, each wall has one or more heavy steel rolling doors hanging on tracks attached to the walls. The doors are not watertight and allow floodwater and water from the interior sprinkler system to flow between units.

Figure 32 – Light manufacturing business facility

Business records, including design drawings and specifications for finished products, are primarily paper documents, scanned for electronic back-up. On-site information management resources include individual computers connected through a local area network. Off-site back-up of electronic data is provided by an IT service provider.

Damages from Sandy: Flooding during Sandy resulted in 2 ½ to 3 feet of water in the business space that damaged sanding/polishing machine motors. The custom-designed motors required parts that are no longer available. The brackish flood water caused some special problems in restarting operations:

- Corrosion on steel glass molding forms had to be cleaned and surface smoothness refinished
- Residual moisture in the oven fire bricks contained salts that vaporized when the ovens were restarted. The vaporized salts fogged the clear glass during kiln firing, rendering initial manufactured pieces unacceptable for use
- Corrosion damage to drive motors powering floor mounted glass polishers destroyed motors; replacement delays slowed operation resumption

Business Concerns: During the initial interview, the business manager identified three areas of concern relative to disaster preparedness planning:

- Scanning product templates to back-up design drawings created on paper
- Sources of parts and materials to bring aging, custom designed equipment back in service
- Better understanding of funding sources and documentation requirements

The business manager indicated that some critical documents and electronic data are backed up by an off-site provider located in Manhattan. Although the documents and data were found to be protected, availability was an issue for a time due to widespread power outage throughout the New York City metropolitan area. The bookkeeper's records and computer were destroyed by the storm, impacting the resumption of the accounts management side of the business.

Based in FEMA post-Sandy data, the BFE at the Case Study 1 site is 12 feet, and the ground surface elevation is 7 to 8 feet. This means that the FEMA-calculated 1-percent-annual-chance, or 100-year flood elevation for Flickinger Glassworks is about 5 feet above the business interior floor elevation. A specific level can be obtained from detailed building engineering design drawings, or a FEMA Elevation Certificate.

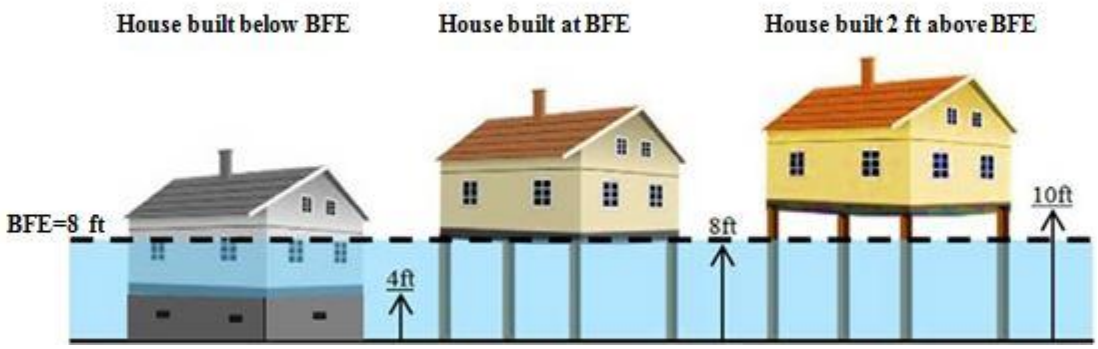


Figure 33 – Effects of Building to or Above the BFE

Based on the information collected, recommendations for flood hazard mitigation were developed and preparedness plan templates drafted to facilitate compilation of information both of a general business nature and identified by the Case Study business as important to its recovery.

The major vulnerability of Case Study 1 is flooding. As the business is a tenant, building-wide solutions were deemed beyond the business's authority and responsibility.

Mitigation Recommendations: At the second meeting, attended by the business owner, recommendations for mitigation concepts were presented. The recommendations included:

- Install temporary flood barriers at exterior doors and windows
  - Possibly substituting watertight pedestrian doors to decrease the time and labor required to install the temporary flood barriers
  - Install temporary plywood at double-glass entrance door and front windows once office equipment and records have been evacuated 24 hours in advance of an event as the business is closed
  - Install temporary plywood at the rear door opening
- Enclose the heavy steel doors between tenant spaces with a watertight frame. Seal frame joints and edges with water-resistant, environmentally safe insulating foam in

preparation of a disaster. Although temporary flood barriers are technically feasible for sliding doors between the neighboring businesses, the location makes access to install the barriers impractical.

- In preparation for an advancing storm, use small hydraulic lifts to elevate the polishing machines, placing temporary supports beneath each machine. Economical options for temporary support include automotive jack stands or concrete masonry blocks

Figure 34 - Platform at case study 1 Business elevates critical equipment

During the time between the first and second visit, the staff had built a platform for the motor that supports an essential glass kiln.

The owner's initial response was that the recommended mitigation measures appeared to be feasible for the business and would represent a minimal investment of several hundred dollars for lumber, plywood, and hardware plus staff time to build more robust equipment or motor stands plus temporary plywood shields for doors and windows. Since Flickinger Glassworks crates large pieces for safe shipping, they have a woodworking shop onsite so equipment is available to craft wooden mitigation devices such as the motor stand shown.

Case Study 2: Mid-Size Manufacturing

Business Description: The mid-size manufacturing Case Study represents a business that makes systems parts from high grade steel and specialty metals, primarily for the aerospace industry. The business owns a one story, high-bay, masonry building. The building, located a few blocks from the waterfront, measures 125 feet long by 100 feet deep (Figure 35).

Figure 35 – Mid-size manufacturing business facility

Although entrances to the building are at street level, the interior main operations floor is elevated about 3.5 feet above the street level. A vehicle access door provides street-level access into a “cut-out” area for unloading large steel bars used as raw materials as well as loading manufactured product for shipping.

The main plant floor contains computer controlled metal turning and milling machines, quality-control measuring stations, drawings and specifications for parts, and finished products (Figure 36). The main floor is partially mitigated against flooding because it is on a level about 3 feet above the street elevation, which is accessed by stairs at both exterior pedestrian entrances. Office space for management and technical staff is located on an upper mezzanine level.

Figure 36 – Mid-size manufacturing main production floor

Openings in the building include two steel pedestrian doors, one steel overhead door, and a line of windows along two walls near the top of the building.

Business records, including design drawings and specifications for finished products, are primarily paper documents, scanned for electronic back-up. On-site information management resources include individual computers connected through a terminal server and sequential server software. Electronic data is backed-up on a separate hard drive weekly. Paper files and electronic servers are stored on the mezzanine level.

Damages from Sandy: Flooding during Sandy entered the building primarily through gaps in the overhead door frame/building connection at the vehicle access door. Water in the building reached a depth of about 3 feet, just below the main floor level. Floodwater also entered the building via backflow in combined sanitary/storm sewers that impacted the street-level utility room and employee locker room/restroom area. Damage was sustained to the boiler motor, electrical panels, and locker room fixtures. Floodwater came close to, but did not reach, the production equipment floor level. The business owner indicated that the business did not experience a loss of power during Sandy.

Figure 37 - Floodwater entered the utility room through backflow drainage, damaging the furnace and other key mechanical support systems during Sandy.

Business Concerns: During the initial interview, the business owner identified four areas of concern relative to disaster preparedness planning:

- How to prevent water from entering the building
- How to minimize impact of water that did enter into the building
- Mechanical room floodproofing
- Drain backflow prevention

Based in FEMA post-Sandy data, the BFE at the Case Study 2 site is 12 feet, and ground surface elevation is 6 to 7 feet. The major vulnerability of Case Study 2 is flooding. As the business owns the building and is the sole occupant, a broader range of mitigation options is feasible.

Mitigation Recommendations: At the second meeting, attended by the business owner and two production leaders, recommendations for mitigation concepts were presented. The recommendations included:

- Installation of temporary flood barriers at exterior doors
  - Replace two pedestrian doors with watertight doors to decrease the time and labor required to install the temporary flood barriers
  - Use temporary flood barriers like flood barrier logs at two pedestrian door entrances
  - As an alternate to temporary flood barriers at the loading dock high bay door, use temporary barriers around the perimeter of the loading bay

- Install backflow preventer in the sewer line
  - The building has a “green roof” with a vegetative cover (Figure 38). Roof drainage is connected to the building’s sewer system. During floods, if a backflow preventer is activated, the roof drain may cause backflow into plumbing appliances on the lower floor, or fail to drain adequately, resulting in excess water weight on the roof
    - If the backflow preventer is installed, a roof rain shutoff valve should be installed to prevent overflows
    - Add weep holes to the roof parapet to provide emergency drainage from the roof
- Revise configurations for storing small tools and equipment, particularly gauges and calibrated measuring devices, to an elevation above the BFE

Figure 38 - Case Study 2 green roof

The owner’s initial response was that the recommended mitigation measures appeared to be feasible for the business.

Case Study 3: Restaurant

Business Description: The restaurant Case Study is locally owned and operated single-location café and bar. The business leases the first floor and basement of a three-story masonry building (Figure 39).

Figure 39 – Corner café and bar

Customer seating, food preparation, and serving are confined to the first floor. The basement is used for storage of food, beverage inventory, and critical operating equipment including the main ice making machine, water filtration system, and cooler compressors. A small office area is also in the basement.

Openings in the building include a pedestrian door and windows for outdoor service. There is also a sidewalk hatch opening typical of Brooklyn for exterior basement access. Invoices are kept as paper documents but are fully scanned as backup, with off-site archiving.

Electronic management information consists of summary data using commercial off-the-shelf software on the business owner's computer. Electronic data is backed up weekly on a separate hard drive.

Damages from Sandy: Although flooding during Sandy entered the building through gaps in the door and windows, the primary pathway was via the sidewalk hatchway to the basement. The business owner also reported substantial seepage through the basement walls. The seepage rate reportedly appeared in some locations to flow at a rate that looked like a steady stream from a leaky faucet.

Flooding filled the basement, and rose to a depth of about 1 foot in the ground-floor restaurant. Extensive repair and restoration for the restaurant were required, starting with sanitation. Restaurant wood paneling and molding, doors, flooring, tables, and chairs all required replacement. Basement repairs included equipment replacement, floor restoration and painting, and new electrical panels. While the basement walk-in refrigerator motor was damaged, the door seal remained watertight while the basement was submerged.

Business Concerns: During the initial interview, the business owner identified main concerns as:

- Keeping water from entering the street-level food preparation and customer dining space
- Keeping water from entering the basement where critical equipment is located and food and beverages are stored

Based on FEMA post-Sandy data, the BFE at the Case Study 3 site is 11 feet, and ground-surface elevation is 7 to 8 feet. The major vulnerability of Case Study 3 is flooding. As the business leases the basement and first-floor space, building-wide solutions were deemed beyond the business' authority and responsibility.

Mitigation Recommendations: At the second meeting, attended by the business owner, recommendations for mitigation concepts were presented. The recommendations included:

- Installation of a temporary flood barrier at exterior doors and windows at street level
- Install flush mounted, watertight sidewalk hatch door leading to the basement. The existing hatch frame has room into which a temporary flood barrier could be inserted. The temporary barrier should be custom fabricated to fit tightly, but easily installed. These are available on the market but it could also be fabricated locally out of ¾-inch Plexiglas. Waterproof spray-foam sealant can be used to seal small gaps after installation.
- Clean and re-point masonry joints in the interior and rear basement walls to reduce seepage; replace broken bricks where feasible
- Conduct a plumbing survey to determine the status and terminus of drain lines leaving the basement. Cap the lines no longer in use to reduce potential backflow.
- Develop a more prescriptive plan to evacuate the basement equipment, stock, and supplies before a predicted severe storm event
- Disconnect and evacuate basement equipment where feasible; empty the walk-in cooler unit of perishable food; move heavy equipment into the walk-in cooler unit, and assure door gasket remains water tight. (Note: the basement food cooler remained sealed during Sandy.)

Figure 40 - **The watertight cooler can be re-purposed to store essential equipment before floods.**

The owner's initial response was that the recommended mitigation measures appeared to be feasible for the business.

Potential Mitigation Actions: Document Management

Each of the initial interviewed three Case Study businesses uses paper documents with some digital redundancy. Issues identified as main concerns are:

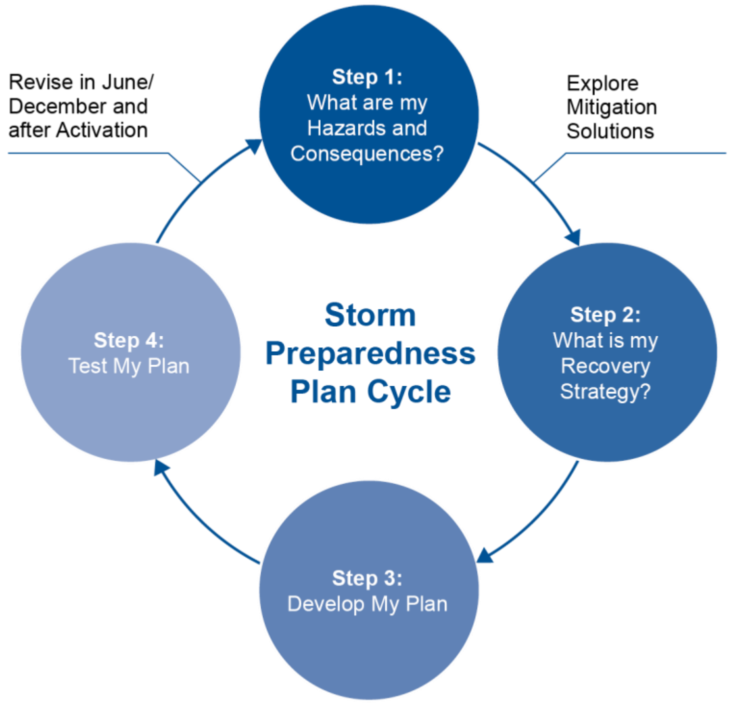
- Keeping water from entering the basement office space
- Having scanned records of unique paper designs and customer orders
- Redundant electronic business records off site
- Assuring that support businesses like bookkeepers and IT also have back-up, digital records

At the second series of meetings attended by business owners, recommendations of document management in both paper and electronic form was further explored and are expected to be the norm in the future as businesses start their mitigation efforts and develop preparedness plans.

Preparedness Planning

During the second meetings, each business owner was provided a draft template for organizing critical disaster preparedness information. Each owner indicated the template concept was a very useful tool that would capture important information. Each owner also provided suggestions for making the format more "user friendly" for their business.

The Small Business Storm Preparedness Planning cycle is shown below:



The Small Business Storm Preparedness Plan, along with accompanying template forms that businesses can use as they work through each step of their customized plan, may be found at www.SBIDC.org. The preparedness planning templates were developed to reflect concerns and needs expressed by Case Study business owners and others interviewed during the project.

The *Red Hook Small Business Hazard Mitigation Case Study Preparedness Findings Report* is also archived at www.SBIDC.org, along with presentations from the Small Business Preparedness Workshop conducted on September 17, 2013, at the Brooklyn Cruise Terminal.

Chapter 6 - Next Steps for Small Business Owners

This report has introduced the most prevalent New York natural hazards and the potential consequences to small businesses resulting from the impact of those hazards, as experienced by so many in the aftermath of Sandy during late 2012. The Findings Report introduced hazards and New York-appropriate permanent and temporary mitigation measures to reduce or eliminate impacts and damages from hazard events. The Case Study businesses are very different in the services or products they provide to their customers, but they shared common mitigation themes of needing to keep floodwater out of critical areas of their operation, and ensuring that proper measures are in place in advance of storm events to fast-track disaster recovery.

Investment in mitigation of a business location and operations will help reduce damage, shorten recovery time, and provide peace of mind that positive measures to protect assets and staff are in place.

Hazard Mitigation Resources for Small Business Owners

FEMA's Building Sciences experts have developed a series of publications featuring discussion and specifications for many building and building support system mitigation options appropriate for small businesses. Many of the publications that are titled as homeowner or residential guides will have helpful information appropriate to some New York small business buildings or mechanical systems. **Prior to making any investment in mitigation of a building or its support systems, business owners should consult with the New York City Buildings Department and a licensed contractor.**

These publications are downloadable from www.fema.gov if the specific document title is entered into the Search line on the site's homepage:

- FEMA 15 - Design Guidelines for Flood Damage Reduction
- FEMA 54 - Elevated Residential Structures
- FEMA P-55 - Coastal Construction Manual
- FEMA 102 - Floodproofing for Non-Residential Structures
- FEMA 116 - Reducing Losses in High Risk Flood Hazard Areas - A Guidebook for Local Officials
- FEMA L-233 - Taking Shelter From the Storm - Building a Safe Room for Your Home or Small Business (brochure)
- FEMA 247 - Against the Wind:Protecting Your Home from Hurricane and Wind Damage
- FEMA 257 - Mitigation of Flood and Erosion Damage to Residential Buildings in Coastal Areas
- FEMA 259 - Engineering Principles and Practices of Retrofitting Floodprone Structures
- FEMA P-312 - Homeowner's Guide to Retrofitting
- FEMA 347 - Above the Flood Elevating Your Floodprone House
- FEMA P-348 - Protecting Building Utilities from Flood Damage
- FEMA P-499 - Home Builder's Guide to Coastal Construction

- FEMA 543 - Design Guide for Improving Critical Facility Safety from Flooding and High Winds
- FEMA P-550 - Recommended Residential Construction for Coastal Areas: Building on Strong and Safe Foundations
- FEMA P-798 - Natural Hazards and Sustainability for Residential Buildings
- FEMA L-780 - Building Science for Disaster-Resistant Communities: Wind Hazard Publications
- FEMA L-781 - Building Science for Disaster-Resistant Communities: Hurricane Hazard Publications
- FEMA L-782 - Building Science for Disaster-Resistant Communities: Flood Hazard Publication
- FEMA P-804 - Wind Retrofit Guide for Residential Buildings
- FEMA P-936 - Floodproofing Non-Residential Buildings

The process to prepare small businesses to better weather storms such as floods, hurricanes, nor'easters, and severe winter storms is detailed in the accompanying *Small Business Storm Preparedness Plan* and Template Forms. . Once a storm recovery strategy has been created, the suite of template forms can be customized and completed as appropriate to each business and its needs. The Workbook of forms has been designed for easy modification, using sections and forms that apply to specific business operations. It was designed to help:

1. Assess hazard risk and potential impacts to the business
2. Determine a business recovery strategy
3. Create a plan for the business that speeds disaster recovery
4. Test and revise the plan twice annually.

Finally, if the plan must be activated, suggested steps and tasks are outlined in the *Small Business Storm Preparedness Plan,* which allow securing and shut down of business operations in a measured, practical manner during an "advance notice" event. Steps to bring the business back up to operations safely after the storm has passed are also provided.

Resources for Small Business Owners

More information for small business preparedness planning and emergency preparedness measures including temporary hazard mitigation can be found at:

www.sbidc.org
http://www.dhses.ny.gov/oem/
www.nyc.gov/oem
www.disastersafety.com
www.sba.gov/prepare
www.fedex.com/us/smallbusiness/FERC_smallbus_pdf_120809.pdf
https://www.osha.gov
www.preparemybusiness.org
http://www.fedex.com/us/smallbusiness/FERC_smallbus_pdf_120809.pdf
www.ready.gov/business
www.redcross.org/prepare/
www.nfib.com/business-resources/disaster