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Memorandum

To: Josh Schnitzlein, Melissa Deas, and Nicholas Bonard

From: The Cadmus Group

Subject: Preliminary Desk Review Findings

Date: September 30th, 2019

Introduction

This memo summarizes initial desk review findings examining the anticipated need for flood retrofits for single-family residential housing in the District. This research included two preliminary components: 1) an initial GIS analysis meant to examine residential properties in the District in the current and project floodplain and 2) a review of existing programs and guidance documents regarding retrofitting single family homes against flooding.

The research is being developed in support of the District's proposed FloodSmart Homes program, which would serve as a "one-stop shop" for District properties impacted by flooding to receive a resiliency audit and incentives for implementing identified home upgrades for flood prevention. The goal of this desk research is to:

- To define a rough order of magnitude of the estimated level of needs for single-family homes
- To identify common retrofit measures or potential points of intervention;
- To identify priority programs in other jurisdictions for interviews under the subsequent tasks; and
- To identify potential measures for developing cost estimates.

Documents and Data Included in Review

To prepare this analysis, the project team reviewed a series of datasets available from the Climate Ready D.C. vulnerability assessment, the ongoing Watt's Branch study, the Anacostia Waterfront Framework Plan and Resilient DC as well as GIS layers from Open Data DC. The team discussed the appropriate data sets to use on several phone calls with DOEE staff. A summary of the layers used for the GIS analysis is also available as an Excel spreadsheet.

Table 1 - Summary of Data Layers

Category	Name	File Name	Description
Exposure	SLOSH flood risk	Storm_Surge_Risk_Areas	Areas with a risk of storm tide flooding from hurricanes, based on potential storm tide heights and classified by hurricane category

Exposure	FEMA floodplains	Floodplains_from_2016	Includes 100-year and 500-year floodplains
Exposure	Climate Ready DC (SLR)	SLR_TB_data_dist	Sea-level rise figures used in the District's climate vulnerability assessment
Assets	Building footprint and construction	Historic_Data_on_DC_Buildings	Includes year built and materials (construction) Buildings with property type "dwelling" were used.
Assets	Building and parcel tax data	DC Real Property Lots/ Common Ownership Lots	Assessor data filtered to single-family residential parcels. Includes building square footage.
Infrastructure and Adaptation	Stormwater BMPs	Best_Management_Practices	DOEE Stormwater BMPs. Examples include green roofs, rain gardens, and cisterns
Infrastructure and Adaptation	Impervious surfaces	Impervious_surface_2017	Impervious surfaces
Infrastructure and Adaptation	MS4 coverage	Subwatersheds in DC	Includes MS4, CSS, and Direct Drainage areas
Base layers	Hydrology	Waterbodies_2015	Planimetric waterbodies
Base layers	Census block group geography	Census_Block_Groups_2010	2010 Census block groups
Base layers	Neighborhood clusters	Neighborhood_Clusters	39 Neighborhood Clusters used for community planning and related purposes; not individual neighborhood boundaries

Summary of Results from Quantitative Analysis

Overview

The GIS analysis performed in support of this study will be provided as a separate attachment to DOEE after the analysis is finalized. The findings below summarize the results of the initial quantitative analysis, which was designed to:

- Define rough order of magnitude of the estimated level of need for single-family homes based on current and projected flooding conditions
- Understand the current Housing Stock and its condition by conducting buildings counts within the floodplain and examining the type of construction

The team will revisit the analysis after reviewing findings with DOEE and once cost estimates are available for priority measures. The team will then apply the estimated costs to the vulnerable buildings identified via the GIS analysis.

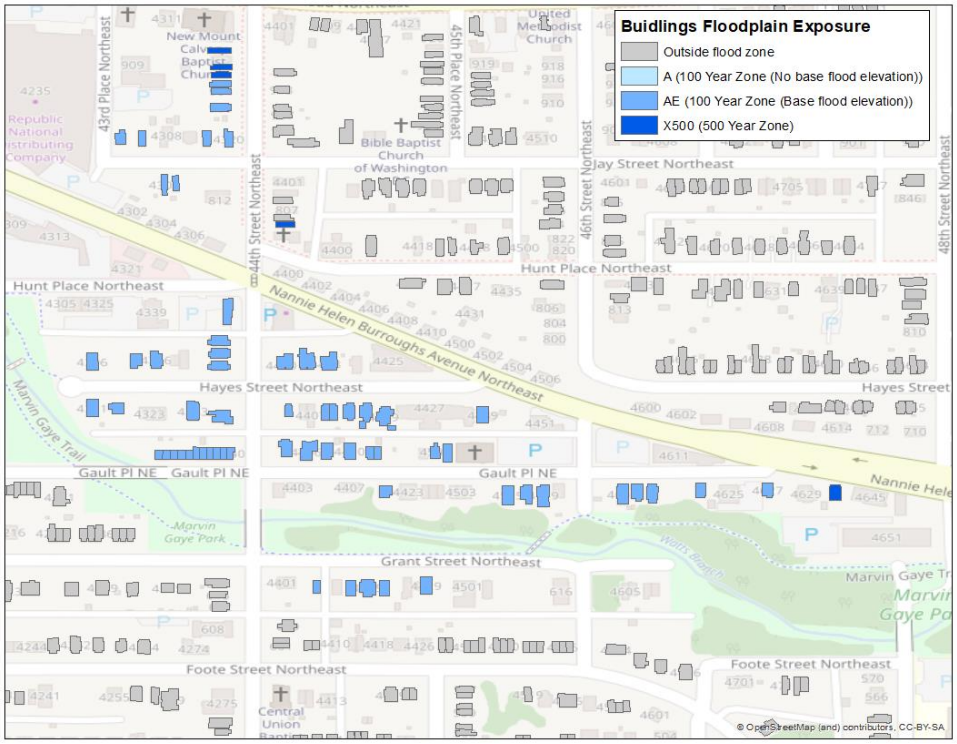
Dataset Comparison and Notes

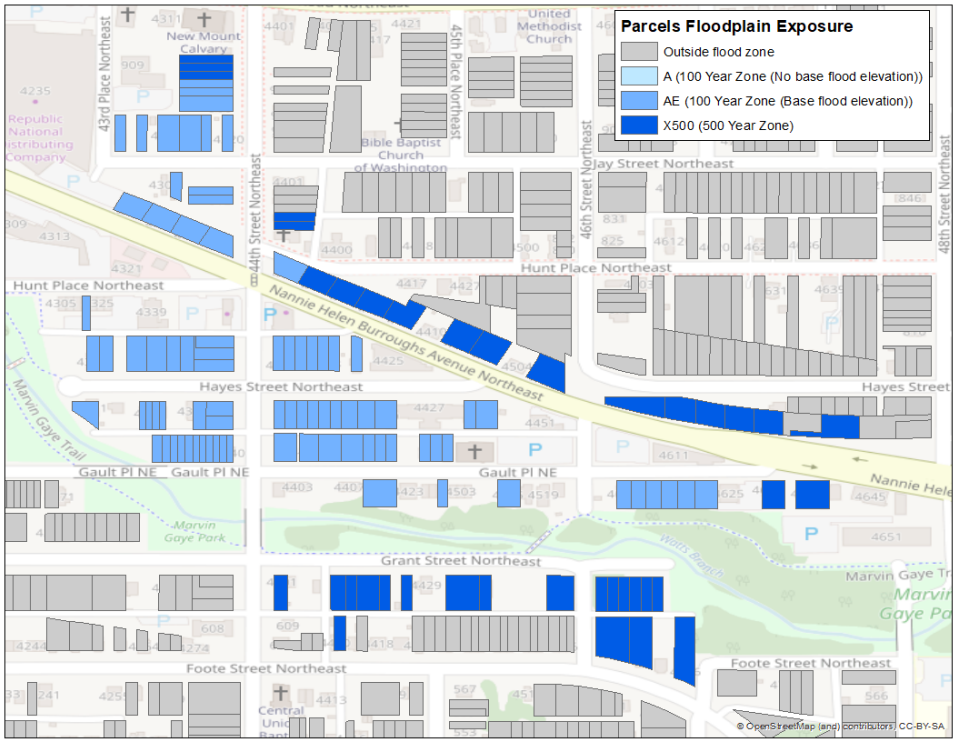
The analysis took advantage of multiple data sources available to characterize each the single-family residential building assets as well as flood exposure. The varying data sets are structurally different to the point where they cannot be combined directly. Instead, quantification of magnitude of the level of exposure in the district is estimated using multiple methods and presented side-by-side to depict both the level of need and the sensitivity of the estimates to the available data sources.

The Historic_Data_on_DC_Buildings dataset, referred to below as “Buildings”, includes detailed information on year built, construction material, and semi-detached type. The major caveat with this dataset is that the property type categorization is not standardized and does not clearly identify single-family versus multi-family residential buildings. The data has been filtered down to records with Purpose = 'dwelling' for this draft submission of quantitative analysis. In addition, semi-detached buildings are in some instances represented by a single polygon, potentially leading to underestimated total building counts. For the final analysis, the Cadmus team will investigate whether that categorization can be improved or revised; thus, the final counts may change slightly.

The DC Real Property Lots/ Common Ownership Lots dataset, referred to below as “Parcels”, contains information about floor area/square footage and clearly identifies property type, allowing single-family residential parcels to be identified more reliably. However, it does not contain the building characteristics available in the Buildings dataset. There is also a difference in coverage between the two datasets, as can be seen in the following figures.

Example Detail Maps





Overview Counts

Summary counts of buildings and parcels by FEMA floodplain zone and by SLOSH flood risk are presented in the tables below. Buildings and parcels with exposure based on Sea Level Rise level layers will be included in the final analysis.

Parcel counts by floodplain category – district-wide summary:

FEMA Floodplain Zone	Count of Parcels	Total Square Footage (computed)
100	455	3,513,949
500	229	907,737

Parcel counts by flood risk category – district-wide summary:

Greatest risk for storm surge for by category	Count of Parcels	Total Square Footage (computed)
Category 2 and higher storms	3	6,459
Category 3 and higher storms	6	33,352
Category 4 and higher storms	238	683,777
Category 5 and higher storms	226	460,163

Building counts by floodplain category – district-wide summary:

FEMA Floodplain Zone	Count of Dwellings
100-year zone	213
500-Year zone	153

Building counts by flood risk category – district-wide summary:

Greatest risk for storm surge for by category	Count of Dwellings
Category 3 and higher storms	60
Category 4 and higher storms	201
Category 5 and higher storms	258

Counts by Ward and Building Characteristics

In addition to these overall counts, the following tables show counts of buildings grouped and summarized by ward, year built, and building detached type. The building dataset also includes information about building material and foundation material, although not basement type. Due to inconsistencies on how the values in these columns were entered, these groupings were not included with this draft analysis. Based on input from interviewers on the most useful groupings of building material, this may be added to the final analysis.

FEMA Floodplain Zone	Ward	Count of Dwellings
100-year zone	District total	213
500-Year zone	District total	153

FEMA Floodplain Zone	Ward	Count of Dwellings
100-year zone	3	2
100-year zone	4	1
100-year zone	7	183
100-year zone	8	27
500-Year zone	2	16
500-Year zone	6	31
500-Year zone	7	65
500-Year zone	8	41

FEMA Floodplain Zone	Construction Year	Count of Dwellings
100-year zone	Before 1890	1
100-year zone	1890-1919	44
100-year zone	1920-1979	165
100-year zone	Year unknown	3
500-Year zone	Before 1890	17
500-Year zone	1890-1919	20
500-Year zone	1920-1979	111
500-Year zone	Year unknown	5

FEMA Floodplain Zone	Building Detached Type	Count of Dwellings
100-year zone	Unknown	5
100-year zone	Detached	110
100-year zone	Rowhouse	41
100-year zone	Semi-Detached	57
500-Year zone	Unknown	32
500-Year zone	Detached	34
500-Year zone	Rowhouse	31
500-Year zone	Semi-Detached	56

Greatest risk for storm surge for by category	Ward	Count of Dwellings

Category 3 and higher storms	District total	60
Category 4 and higher storms	District total	201
Category 5 and higher storms	District total	258

Greatest risk for storm surge for by category	Ward	Count of Dwellings
Category 3 and higher storms	6	60
Category 4 and higher storms	2	2
Category 4 and higher storms	6	104
Category 4 and higher storms	7	27
Category 4 and higher storms	8	68
Category 5 and higher storms	6	258

Greatest risk for storm surge for by category	Construction Year	Count of Dwellings
Category 3 and higher storms	1920-1979	60
Category 4 and higher storms	Year Unknown	28
Category 4 and higher storms	1890-1919	12
Category 4 and higher storms	1920-1979	157
Category 4 and higher storms	Before 1890	4
Category 5 and higher storms	Year Unknown	65
Category 5 and higher storms	1920-1979	191
Category 5 and higher storms	Before 1890	2

Greatest risk for storm surge for by category	Building Detached Type	Count of Dwellings
Category 3 and higher storms	Unknown	58
Category 3 and higher storms	Rowhouse	2
Category 4 and higher storms	Unknown	98
Category 4 and higher storms	Detached	10
Category 4 and higher storms	Rowhouse	66
Category 4 and higher storms	Semi-Detached	27
Category 5 and higher storms	Unknown	258

Comparison with Additional Datasets

In next steps, the Cadmus team will reach out to the USACE team to compare these results based on district-wide datasets with that resulting from datasets developed specifically for the Watts Branch study. While the flood modeling they developed is not available for the entire District, comparing the results for that neighborhood based on these two datasets will allow us to characterize the sensitivity of the final counts to the data availability.

Common Adaptive Measures

Cadmus conducted a literature review of resilience performance standards, other City and County retrofit programs for flooding, and guidance documents to develop a list of commonly utilized adaptation measures for flooding. This list will be refined via interviews with District agencies, program managers and other parties to identify measures for the cost analysis. A summary of each of the documents reviewed for this exercise follows below. After which, a table provides a preliminary identification of which measures would be most appropriate for the building typologies identified through the GIS analysis results.

Resilience Standards

The resilience standards reviewed included the District's own multifamily housing resilience tool, RELi, and FORTIFIED for HOMES, which are described in more detail below.

- **DC DOEE Multi-Family Housing Resilience Tool**[1]

This tool is a custom vulnerability assessment of a multi-family home with site-specific suggestions of retrofit strategies. More details on this tool are presented on page 12.

- **RELi**[2]

RELi, or Resilience Action List and Credit Catalog, is a comprehensive set of resiliency standards and criteria in design and planning. RELi incorporates hazard-specific design criteria, like flood preparedness, with broad resilience strategies, like energy efficiency. RELi goes beyond the benchmarking system to outline a system of requirements and credits in 8 different categories, such as hazard mitigation, materials used, community vitality, etc. Flood-specific credits are covered in the hazard preparedness section, hazard adaptation and mitigation, and productivity health and diversity.

- **FORTIFIED HOME**[3]

Created by the Institute for Business and Home Safety (IBHS), FORTIFIED HOME is the national standard for resilient construction, offering specific design and construction standards for both Hurricanes and High-Wind. By following FORTIFIED's superior building standards, homeowners prevent further destruction and protect their homes against future severe storms. A FORTIFIED HOME evaluator guides the homeowner throughout the retrofit or construction process. In order to receive the designation

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[1] DOEE (nd). *Vulnerability Assessment, Resilience Audit and Solar Tool for Affordable Housing.* https://doee.dc.gov/sites/default/files/dc/sites/ddoe/service_content/attachments/DOEE_%20Assessment%20Tool%20Public%20Outreach.pdf

[2] Pierce, Douglas. LEED Fellow (2017). RELi: Resilience Action List & Credit Catalog. http://online.anyflip.com/zyqc/ojoi/mobile/index.html

[3] Fortified Home (nd). *Fortified Home.* https://fortifiedhome.org/nciua/

certificate (i.e. FORTIFIED Roof, FORTIFIED Silver, or FORTIFIED Gold), a certified third party evaluates and verifies the upgrades. The standard was reviewed as it related to flooding and water damage. FORTIFIED certification has been used to provide insurance discounts for certified homes in four states in the Southeast.

Flood Retrofit Programs

The subsequent section delivers an overview of the key case study cities and programs identified and reviewed from the desk research.

- **NYC Home Resiliency Audit Program**[4]

As part of FloodHelp NY, the Center for New York City Neighborhoods administers this program to provide home resiliency audits at no cost to homeowners impacted by Superstorm Sandy in 2012. A credentialed engineer inspects the home and conducts a flood risk assessment; the homeowner receives a detailed technical report with a flood insurance quote. In addition to the audit, the program also offers counseling to homeowners to walk through the report and discuss appropriate retrofit measures, such as backflow preventers to reduce future flood insurance. The program also provides an Elevation Certificate, certifying the home's elevation. Depending on which flood zone the home is located in, the homeowner may qualify for additional no-cost programs, such as a backwater valve installation. The team reviewed program documents as well as sample audit reports

- **South Carolina: Safe Home Mitigation Grant Program**[5]**; Catastrophe Savings Account**[6]

The Safe Home Mitigation Grant Program provides financial assistance to property owners for retrofitting their homes in order to improve resiliency against hurricanes and high-wind damage. Only owner-occupied, single family homes along the coast qualify for this award, not to exceed $5,000. Eligible projects include: Bracing gable ends; roof-to-wall connectors; secondary water barrier; exterior doors (including garage doors); roof covering; repair or replacement of manufactured home piers; anchors and tie-down straps; opening protection (window replacement, hurricane shutters); roof deck attachment; issues associated with weak trusses, studs and structural components. South Carolina is also one of the participating three states, along with Alabama and Mississippi, to offer a Catastrophe

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[4] City of New York: Department of City Planning (2014). *Coastal Climate Resiliency: Retrofitting Buildings for Flood Risk*. https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/retrofitting-buildings/retrofitting_complete.pdf

[5] South Carolina Department of Insurance (2019). *SC Safe Home Mitigation Grant Program*. https://www.doi.sc.gov/605/SC-Safe-Home

[6] South Carolina Department of Insurance (nd). *Catastrophe Savings Accounts*. https://doi.sc.gov/636/Catastrophe-Savings-Accounts

Savings Account (CSA) for storm victims. The CSA holder builds a tax-free disaster fund to pay for eligible disaster expenses.

- **RainReady Initiative**[7]

The Center for Neighborhood Technology offers a grant program to Chicago-area homeowners in flood-prone areas. Homeowners receive a site assessment at no cost along with guidance on design recommendations and smart landscaping developments to improve drainage. Qualifying participants receive a grant for 50% of the total cost of landscaping improvements, with a cap at $1,300. In order to be qualify, residents must own a single-family home and be willing to disconnect downspouts from the village sewer. Eligible projects include: rain garden or bioswale, cistern or dry well, de-paving/permeable paving. As the RainReady program aligns more closely with the RiverSmart program than FloodSmart, it was included in the review as a potential program for follow-up interviews to better understand the program and staffing model, since it has been deployed in multiple cities. Its qualifying measures will be reviewed less closely.

- **RetroFIT Program (Floodproofing, Improvements, Together)**[8]

As a part of Mecklenburg County's flood mitigation efforts, RetroFIT is a program offering technical assistance and financial aid for property owners living in the floodplain to fortify their homes against flood damage, especially those structures incompliant with floodplain regulations. This program specifically targets homeowners underserved by other existing mitigation efforts and those at risk for future flood loss. Grants are available to cover 75-95% of costs for qualifying floodproofing projects. Eligible projects include: structure elevation, structure relocation, wet floodproofing, dry floodproofing, equipment elevation, infilling basement, and demolition.

- **Cook County Flood Damage Assistance**[9]

Following the severe storms of April and May of 2013, the Neighborhood Housing Services of Chicago established a Residential Resiliency Program to provide flood relief funds in the form of a one-time flood mitigation grant of up to $25,000 for homeowners directly impacted by the floods. In order to be eligible, applicants must have owned their homes prior to April 2013, be able to prove direct impact (e.g. insurance claims, photographs, etc.), and earn up to 80% of the Area Median Income for Cook County. Eligible projects include: installation of backwater valves, overhead sewer, ejector pumps, interior drain tile, and improved landscape grading to help prevent future flooding; installation or replacement of

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[7] CNT (nd). *RainReady*. https://www.cnt.org/rainready

[8] City of Charlotte (2019). *RetroFIT (Floodproofing) Program.* https://charlottenc.gov/StormWater/Flooding/Pages/retroFIT.aspx

[9] Neighborhood Housing Services of Chicago, Inc. (nd). *Flood Damage Assistance.* https://www.nhschicago.org/flood/cook-county-flood-damage-assistance/

sump pump and French drains; foundation wall repair; removal of mold, asbestos, or lead-based paint; replacement of gutters and downspouts.

Other research on resilience interventions for flooding & stormwater management in other markets

Cadmus evaluated the NYC Retrofitting Buildings for Flood Risk Report, Retrofitting Boston Buildings for Flooding Report, and DC DOEE Multi-Family Housing Resilience Tool for further insight into different strategies for retrofitting homes under different conditions. The team also reviewed outreach materials from the National Flood Insurance Program to understand the types of mitigation measures the program is encouraging.[10] A summary of each document and tool are outlined below followed by a table identifying a list of commonly occurring adaptive measures assessed by building typologies.

- **National Flood Insurance Program (NFIP): Homeowner's Guide to Retrofitting**[11]

The Homeowner's Guide to Retrofitting encourages homeowners to mitigate risk by protecting their homes from flooding and flood damage. This guide walks a homeowner through the medley of retrofit options available to fit each home by specific hazards and home conditions (e.g. construction type, foundation type, elevation); along with Federal, state, and local programs available to provide financial assistance. Each retrofit strategy includes key considerations, advantages and disadvantages, relative costs, and guidance for working with design professionals and contractor services.

- **NYC: Retrofitting Buildings for Flood Risk**[12]

New York City's has a significant volume of compact multi-story buildings. It is often infeasible for these buildings, typically found on small lots, attached (or in close proximity) to other buildings, of masonry construction, to be retrofitted in order to comply with NFIP requirements. This report provides a step-by-step methodological guide for property owners, developers, or architects to approach retrofitting many common types of New York buildings (i.e. bungalow, detached, semi-detached, attached with garage, attached, mid-rise walk-up, and mid-rise with elevator). The methodology guides its reader to identify the flood risk and flood elevation, review relevant regulations, and identify and design the most suitable retrofit strategy(ies).

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[10] FEMA, National Flood Insurance Program (NFIP). *Before and After Flooding.* https://www.floodsmart.gov/flood/first-prepare-for-flooding

[11] FEMA (2016). *Homeowner's Guide to Retrofitting*. https://www.fema.gov/media-library-data/1404148604102-f210b5e43aba0fb393443fe7ae9cd953/FEMA_P-312.pdf

[12] City of New York: Department of City Planning (2014). *Coastal Climate Resiliency: Retrofitting Buildings for Flood Risk*. https://www1.nyc.gov/assets/planning/download/pdf/plans-studies/retrofitting-buildings/retrofitting_complete.pdf

- **Retrofitting Boston Buildings for Flooding: Potential Strategies**[13]

This report outlines potential strategies for retrofitting buildings in preparation for flooding. The report demonstrates how such recommendations may apply to Boston building typologies (i.e. triple-deckers, wharf buildings, contemporary high rises, century industrial lofts, and two-family detached homes). For each building typology, the report analyzes numerous retrofitting strategies, delineating by FEMA strategies and Retrofi+ strategies (i.e. incorporates supplemental design recommendations). The building-specific case studies also identifies strategies eligible for NFIP flood insurance reduction. Several of the typologies explored will also have relevance to the properties in the dataset analyzed for the District.

- **Washington DC: Multi-Family Retrofit Tool**

This tool, developed by the DC Department of Energy & Environment, conducts a custom vulnerability assessment. Through a site visit and interview with the property manager, property owners are able to identify potential resilience preparedness strategies and best practices to protect vulnerable residents and maximize building durability. The tool outputs tailored resilience strategies to suit site-specific needs. The program is followed by an outcomes counseling session to connect affordable housing property owners with available funding and financing to maximize the probability that the recommended resiliency strategies are realized.

A list of frequently occurring adaptive measures were pulled from these sources and were applied to the housing types observed under the GIS analysis. The information from these sources is consolidated into Table 1, which outlines numerous retrofit strategies to reduce a property's vulnerability to flooding and improving its ability to adapt to severe storms and flooding. These results are preliminary and will be refined through interview conversations and further research on costs. In addition, after a more detailed review of the quantitative analysis and the available data from the building categorization, the Team may determine alternative methods for organizing the measures (e.g. low-rise versus midrise, etc.) in future drafts. For this analysis, the multifamily class is assumed to be midrise.

[13] Boynton, Adria. Boston Planning & Development Agency Planning Department (2016). *Retrofitting Boston Buildings for Flooding: Potential Strategies* https://www.boston.gov/sites/default/files/imce-uploads/2017-01/retrofitting_report_10.7.2016.pdf

	Retrofit Strategies	Single family attached	Single family detached	Mixed use	Notes (Guidance consolidated from sources referenced above).
Flood Proofing	Wet floodproofing	●	●	●	Wet floodproofing allows water to flow through a building in a controlled way. This strategy offers a lower likelihood of structural damage and quicker recovery time. A floodable first floor can be achieved through wet floodproofing vents that allows movement of water. Additionally, landscaping and pervious surfaces, such as rain gardens or bioswales, can reduce flooding impacts by retaining water through groundwater infiltration. For attached housing, wet or dry flooding proofing may be more expensive and difficult to coordinate across connected single-family households. Homes would also lose living space.
	Dry floodproofing			●	Dry floodproofing seals the structure such that it becomes essentially impermeable. This can be done by fortifying the foundation, floor slabs, and walls; applying waterproof coating; sealing wall penetrations; etc. However, in addition to being costly and challenging, this strategy is prohibited in residential homes, apart from mixed-use buildings, as pressure on exterior walls during a flood may result in structural failure. This strategy may be used at a smaller scale, for instance, to protect critical systems that cannot be elevated.
	Deployable flood barriers (flood walls, levees)	●	●	●	Flood barriers may be temporary (e.g. sandbags, water-inflated tubes, flood panels) or more permanent measures (e.g. floodwalls or berms/levees, though the latter may be infeasible in a dense urban setting). To prevent failure, barriers should be carefully designed to withstand hydrostatic pressure from flooding and ensure concrete footings do not degrade nor fissures open up. This strategy, however, requires advanced notice of flooding and offers only short-term protection. For the purposes of the cost analysis, the team would recommend breaking this category into deployable and permanent flood barriers, some of which can be deployed within sidewalks or other assets near residential properties.
Building Systems	Elevation of structure above the BFE/DFE		●	●	This strategy may take the form of elevating the structure as a whole (i.e. building a new, or extending the existing, foundation) or elevating only the ground floor (i.e. constructing an elevated floor within the house or adding an additional story), such that the lowest occupiable floor meets or exceeds the design flood elevation. Numerous urban design considerations and strategies that can preserve the connection between the home and street when a structure is elevated (e.g. front porch/stairs, raised yard, interior vestibule,

					etc.) The resources cited indicate that this strategy is often prohibitively expensive, sometimes cost exceeds the value of the building.
	Resilient elevators		●	●	An elevator's machine room or mechanical closet should be instated above the DFE, and shafts that extend below this level should be wet floodproofed and designed to resist hydrostatic pressure from floodwater. Rather than defaulting to the ground floor, elevators should be programmed to go a flood-safe level during flooding.
Site Level Specific Strategies	Relocation	●	●	●	Relocation to an area outside the floodplain achieves the greatest security from flooding but may be infeasible in high density urban areas. Relocating a site or building is rarely a viable and often prohibitively expensive.
	Elevation of critical systems above the BFE/DFE	●	●	●	Critical systems include mechanical equipment from electrical, heating, ventilation, plumbing and air conditioning systems. When possible, these systems should be raised to the roof, or at a minimum above the base flood elevation. It may be more cost effective to purchase new, more efficient equipment than to relocate heavy older equipment.
	Secure critical systems and infrastructure	●	●	●	If critical systems or infrastructure are too difficult, expensive, or infeasible to relocate to above the BFE (e.g. fuel storage tank), they should be securely sealed and anchored as to not float away and create additional hazards during flooding.
	Fill basement/ cellar	●	●	●	Sub-grade basements or cellars can be infilled with compact soil to reduce damages to building elements and contents located below the BFE. This strategy is typically coupled with the elevation of utilities and other critical systems. However, this strategy will result in loss of floor area (i.e. livable or rentable space).
Pumps	Backwater valves	●	●	●	Installing a septic line backflow prevention valve blocks flood water from re-entering the building through wastewater pipes. This strategy is a relatively inexpensive retrofit.
	Sump pumps	●	●	●	Sump pumps and discharge pumps can remove accumulated water in the lowest point of the floor, typically in the basement. Sump pumps can be paired with other techniques in case other floodproofing options are overwhelmed.
Low or No Cost	Back-Up strategies	●	●	●	Additional back-up measures can be taken to provide critical needs in the event of a power out or water out and to avoid accidents during flooding. These include: installing back-up generators above the DFE; fixing emergency lighting, pathway lighting, wayfinding signs and reflective strips; repairing uneven surfaces or broken steps; installing handrails at entry; ensuring access to potable water; refining non-slip waterproof surfaces, etc.

	Emergency Preparedness Kit	●	●	●	The National Flood Insurance Program and private insurers recommend emergency preparedness kits in addition to insurance as a protective measure for homes.[14] These kits should include minimally materials so that families can be prepared to shelter and/or information regarding where they should evacuate if necessary.
	Water Alarm	●	●	●	Water alarms can be used to detect the presence of leaks in basements. This can alert the home or property owner to take precautions before major water damage. Alarms can be installed alongside sump pumps for redundancy or within homes without pumps.

[14] Esurance. (2018) *What to put in your emergency flood kit.* https://www.esurance.com/info/flood/what-to-put-in-your-emergency-flood-kit

Next Steps

In our next steps, we will conduct follow-up interviews with District staff and begin outreach to some of the other existing flood retrofit programs to help better define FloodSmart Homes scope and priority measures. These interviews will include:

- DHCD, specifically regarding their Single Family Rehabilitation Loan Program and their report on conserving affordable housing.
- RiverSmart, based on their experience serving single-family homes and some of the challenges they referenced in serving low-income homeowners
- The U.S. Army Corp of Engineers, based on their site assessments and knowledge of agency sentiments from the charette exercise.
- HSEMA, based on their experiences with hazard mitigation in the District.
- Program managers from the New York City, Mecklenburg County, Cook County, South Carolina and the Association of State Floodplain managers based on their experiences managing active flood retrofit programs for residential housing.
- The team will also reach out to Tom Little of SmartVent to assist in discussing the prioritized flood retrofit measures and their costs.

The team has spoken to DISB for other components of the CRDC project, and may follow-up with them if specific questions arise. The interviews will occur over the next several weeks, and Cadmus will also review this memo's findings with DOEE staff on an upcoming check-in call. The planned protocol for District agencies is included as an Appendix to this attachment.

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Appendix - Interview Protocol for District Agencies

We are conducting 30-minute interviews on behalf of the District Department of Energy and Environment. These interviews are to help inform the design of the FloodSmart Homes program, a proposed retrofit program targeting single family homes in the current and projected floodplain. Your name was identified during our review of documents from the ongoing Watt's Branch study. We would like to ask some questions regarding your previous work to inform our study of flood risks in the District. To date, we have reviewed District documents and begun GIS mapping to understand the extent of homes, which would might require support from the program. This analysis and research on likely retrofit measures and their costs will inform how this program might be funded.

- Could you describe a bit about your role at your agency and your knowledge of climate risks facing the District?
    - Provide background and information from the GIS analysis based on response.
- Based on your experience with conducting assessment of homes with the District, what are some of the common challenges and impacts from flooding or water damage that you see within the housing stock?
    - Based on your knowledge of the flooding projections from Climate Ready D.C., how do you expect that these challenges may evolve?
- From your observations, are homeowners already beginning to pursue flood retrofit projects on their own without a District program? If so, why or why not?
    - In the case of retrofits, what type of work have you been observing?
- The FloodSmart Homes program will operate as an audit program. After audits potential flood mitigation measures will be identified and if pursued by a homeowner, supported by District funds. Can you describe some of the challenges you have experienced in moving homeowners from audits to retrofits?
    - Are these challenges different for different buildings or for homeowners of different income levels?
    - How could the FloodSmart Homes audit program and incentive delivery be designed to mitigate these risks?
- While the FloodSmart Homes program will support building-level retrofits, the District is also investigating neighborhood-level strategies for flood mitigation. Do you have any recommendations on how the FloodSmart Homes program might target outreach or work with neighborhoods in light of this context?
    - Do you have other thoughts on how outreach could be targeted based on your experience running your agency's programs?
- Are you aware of flood retrofit programs in other communities that may be strong models for us to review? We are currently evaluating programs in North Carolina, New York City and Chicago.