Resilience and Solar Assessment
Stamford 2030 & City of Stamford

Stamford Government Center

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Stamford, CT 06901

Submitted To:
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Introduction

Climate change is increasing the frequency and severity of extreme storms, exacerbating droughts, shifting precipitation patterns, and causing more extreme heat waves. Facilities with a critical role in the community, such as police and fire stations, emergency operations centers, city halls, and emergency shelters can realize long-term operating and avoided impact cost savings, increased durability, and improved emergency operations through resilience planning. The objective of this assessment is to identify resilience and solar opportunities to improve the resilience and sustainability of the assessed property.

New Ecology, Inc. ("NEI") conducted a resilience and solar opportunity assessment of the Stamford Government Center building located at 888 Washington Boulevard, Stamford, CT. For this assessment, NEI conducted an onsite walkthrough of the property to visually identify critical risks; review the building's historical impact from extreme wind and hurricanes, flooding, ice and snow, and extreme heat and cold events and identify solar and storage potential. The hazards assessed align with those identified by the April, 2015 City of Stamford Hazards and Community Resilience Workshop. The walkthrough took place on April 20, 2018. The assessment team consisted of Tom Chase, Senior Project Manager and Tom Ziobron, Project Manager. Dan DiBlasio and John Varamo from the City of Stamford and Emily Gordon from Stamford 2030 were onsite for the walkthrough. This assessment was supported by a CIRCA Municipal Resilience grant to Stamford 2030 and the City of Stamford.

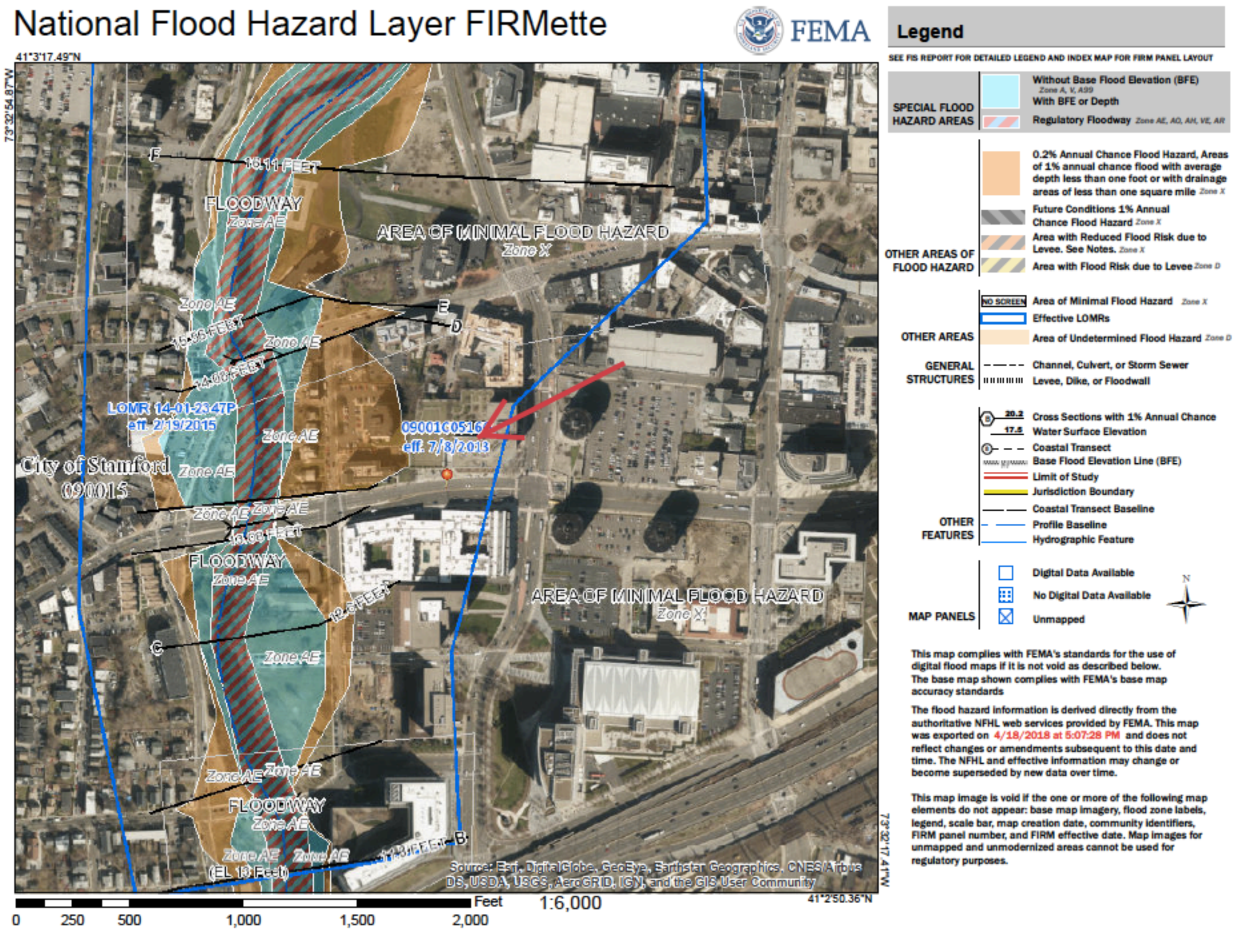
Building Overview

The Stamford Government Center building is a 250,000 square foot, ten-story office building with a mechanical penthouse and a full basement, constructed in 1986. The building houses the major government operation functions for the City of Stamford including office space, meeting rooms, data servers, the 911 call center, and the City's emergency operations center. Attached to the building is a four-story parking garage with a rooftop greenspace.

The building is located at approximately 45 feet elevation above sea level and approximately 600 feet from the Rippowam River, which feeds into the Stamford Harbor and is connected to the Long Island Sound. While coastal and riverine flooding have not previously impacted the building, rising sea level and heavy precipitation and stormwater will increasingly threaten the site given the low-lying topography of the location. The sea wall and storm barrier in Stamford has served as effective protection in the past, but will face increasing risk of being overtopped in the future. Currently, the building is immediately on the border of the 0.2% annual flood risk area (the "500-year" flood) and in close proximity to the 1% annual flood risk area (the "100-year") flood. Please see the FEMA flood map in Figure 1, below.

Ongoing maintenance and capital repairs have been performed as needed, with recent updates including replacement of the cooling tower and heat exchanger, a new membrane roof, and elevator upgrades. The 911 call center is supported by a dedicated generator, currently undergoing replacement, and a separate generator supports life safety systems for the rest of the building.

Figure 1: FEMA Flood Map



Resilience Opportunities

The primary hazards to the Stamford Government Center building are coastal, riverine, and stormwater flooding and associated storm and sanitary sewer backups, extreme heat, and electric outage. Based on the results below, NEI concludes that several low- to moderate-cost measures will improve the building's resilience to flooding, heat, and electric outage. Additional measures will improve the resilience of the building in the event of more extreme flooding. Our recommendations, in order of priority, are shown in Table 1.

Table 1: Resilience Opportunities

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
1	Develop Emergency Management Manual	All	A disaster can come at any time or can progress more slowly, but one of the most crucial factors in providing continuity of service is the coordination of facility and management staff in responding to the event. Provide a plan and contact list for staff, leadership, and other building occupants to communicate effectively throughout a disaster. Follow the Enterprise Disaster Staffing Toolkit guide to creating an organization-level emergency plan.	1	each	-	-	Immediate
2	Building Energy and Water Utility Tracking	N/A	Ongoing utility tracking and benchmarking will improve routine operations by providing easy access to billing and usage information and indicators of potential problems shown through spikes or declines in expected usage. Utility data will also help in identifying critical loads in planning for disasters. ENERGY STAR Portfolio Manager is a free tool for utility tracking and benchmarking.	1	each	-	-	Immediate
3	Energy Audit	N/A	Routine, in-depth, energy audits are key in ensuring that buildings operate efficiently. An efficient building is one that is much easier to protect and back up during an extreme event. The audit will likely identify the existing domestic hot water boiler and air handler	1	each	$15,000	$15,000	Immediate

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
			units, currently on the capital improvements list, as well as other potential energy conservation measures. The CT Greenbank offers third-party audit services through a cost-sharing program.					
4	Solar Feasibility and Backup Battery Analysis	N/A	In addition to the preliminary solar feasibility analysis below, a battery backup analysis will indicate the potential financial and resilience benefit of installing large-scale batteries in addition to a solar PV system. Contact NEI to find out more about a pilot CT Green Bank solar+storage analysis opportunity.	1	each	-	-	Immediate
5	Cool Roof	Extreme Heat, Power Outage	A cool roof is a reflective, light colored roof that reduces the amount of solar energy a building absorbs by reflecting the solar energy back into the atmosphere. Cool roofs can be a painted-on or membrane product, reduce the building's cooling load, and allow the interior to remain comfortable longer in the event of a power outage on a hot day. Cool roofs also reduce local heat island effects.	28,000 (estimated)	sf	$17.50	$490,000	Medium Term (or prior to solar PV installation)
6	Window Shading	Extreme Heat, Power Outage	Shading windows reduces the amount of solar heat gain in the interior of the building, thereby reducing cooling loads during the summer months and leading to lower indoor temperatures during power outages when the cooling system is not operational. Add	540 (estimated)	each	$100	$54,000	Medium Term (or at the same time as the tentatively planned window re-glazing)

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
			overhangs to south-facing windows or awnings to east- or west-facing windows. Or, add interior window shading treatments such as thermal curtains or honeycomb blinds. In addition to shading, consider installing some operable windows to allow for natural ventilation during a long-term power outage.					
7	Surface Stormwater Management	Flood	Surface stormwater management is a suite of infrastructure strategies that capture, store, direct, and infiltrate water into the ground or delay stormwater from entering the storm sewer rapidly and potentially backing up. Strategies may include experimental site protection such as temporary barriers, rainwater catchment basins that capture and store stormwater and then slowly release it into the stormwater stem or put it to use on site, or increasing the capacity of the existing stormwater pipes to move more water away from the building and site and adding backflow prevention. The Stamford Government Center building and landscaping is primarily impervious and is located in an area of moderate risk of riverine and coastal flooding during an extreme storm event. Engage a civil engineer to design a stormwater management plan and	1	each	$5,000	$5,000	Medium Term

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
			to help determine the best strategy options. Incorporate the current planned concrete and slate paver upgrades in the planning.					
8	Backwater Valves	Flood	Backwater valves are installed where the wastewater pipes exit the building, so sewage and stormwater only flows outward. Valves have a hinged flapper that remains open to allow outward flow, but seals tightly if there is backpressure. Install individual backwater valves on the lowest fixtures in the building, or whole-building backwater valves for storm sewer and sewer lines. Will require incorporation into an emergency plan to ensure proper operation during an extreme event.	2 (estimated)	each	$3,000	$6,000	Medium Term
9	Component Protection Floodproofing	Flood	Component protection floodproofing is protecting mechanical and electrical equipment by surrounding the equipment in a waterproof basin, with a low wall, or by using a waterproof enclosure, rather than waterproofing the entire basement or first floor of the building. If equipment cannot be elevated, critical building systems can be floodproofed in this manner, allowing the rest of the space to flood. Due to hydrostatic pressure, these enclosures are recommended only for shallow	3 (estimated)	each	$5,000	$15,000	Long Term

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
			floodwaters up to 3 ft.					
10	Sump Pumps	Flood	Sump pumps are designed for intermittent use, but should be able to operate independently during a power outage. Ensure that the existing sump pumps are in good working condition, that they are wired to the emergency electrical panel, and that they operate automatically.	4	each	-	-	Ongoing Maintenance
11	Resilient Elevators	Flood	Protect elevator shafts below the grade and reinforce shaft walls to resist the hydrostatic pressure of floodwater. Program elevator controls to return car to flood safe floor in the event of flooding and to shut down all but one elevator in the event of a power outage, install flood alarms in pits, and keep controls and equipment above the first floor.	4	each	$12,000	$48,000	Long Term
12	Quick Connects for Mobile Heating, Cooling, and Electricity	Power Outage	Quick connects are connection points on the exterior of the building for connecting temporary backup heating, cooling, or electrical equipment. Quick connects to hot water piping, chilled water piping, or electrical panels allow temporary mobile heating, cooling, and power equipment to connect to the building and provide services in the event of damage to permanently installed equipment.	3	each	$2,500	$7,500	Long Term

#	Opportunity	Hazards	Description	Quantity	Unit	Unit Cost	Estimated Cost	Implementation Timing
13	Safeguard Fuel Storage	Flood	Secure fuel storage fixed and portable tanks and containers to prevent spillage and movement in case of a flood. Perform this task as necessary during routing operations and maintenance. Existing fuel tank in parking garage is not secured and may move during a flood.	1	each	$1,000	$1,000	Ongoing Maintenance
14	Access to Potable Water	Power Outage, Water Outage	Provide potable water storage in a central system or portable potable water storage containers: 1 gal/person/day for 1 day in stored bottled water, plus 1 gal/person/day for 6 days in collapsible storage capacity.	250	each	$1	$250	Ongoing Maintenance

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Solar Opportunity

The Stamford Government Center building is a good candidate for a solar PV system and may be a good candidate for backup battery storage. To evaluate the solar PV potential at the site, NEI created a preliminary solar system layout, estimated annual electricity production, and performed a cost savings estimate.

NEI used HelioScope to model solar generation for the potential solar PV systems on the Stamford Government Center roofs. HelioScope is a web-based solar PV system modeling and electricity production estimation tool. It estimates potential solar generation per year, accounting for building location, local weather data, shading, solar system type, size, and capacity, as well as solar panel direction and tilt.

Table 2 provides an overview of the preliminary solar PV system details, and Figure 2 shows the preliminary system layout used for this analysis. NEI estimates that a solar system of approximately 109.5 kW DC can be accommodated on the existing Government Center roof. The system would produce approximately 137,400 kWh of electricity per year.

Solar system assumptions include the following:

ROOF

- Minimum setbacks, pathways, and clearance around equipment, penetrations, and roof curbs are assumed.
- The calculated system sizes include five-foot perimeter setbacks and 1.5-foot intra-row spacing on the flat roof sections, along with clearance around all penetrations that impact panel shading.
- Systems are otherwise maximized for available unshaded roof area.

STRUCTURAL

- The structural integrity of the roofs will need to be assessed to confirm the additional dead load and uplift from the arrays can be accommodated.
- Typical dead load requirements are between 3 and 5 lbs./sf.

ELECTRICAL

- An outdoor disconnect and solar meter will need to be added close to the existing electric meter.
- Arrays on all roof locations will tie back to the main electrical room.
- Additional wall space will be needed in the electrical room to allow space for inverters.
- Interconnection, solar meter, and disconnects shall be in accordance with utility requirements.

SHADING

- The roof areas described do not appear to have any significant shading from neighboring buildings or trees. Shading from adjacent roofs has been accounted for in sizing the system.

The financial assumptions used in this analysis appear below in Table 3. Table 4 provides a summary of the financial impact of a solar PV system for this location under a direct purchase model.

Table 2: Preliminary Solar PV System Details

Field Segment	Estimated System Size (kW)	System Type
1	44.4	Ballasted, 10° Tilt, 180° Azimuth
2	15.0	Ballasted, 10° Tilt, 180° Azimuth
3	25.2	Ballasted, 10° Tilt, 180° Azimuth
4	12.6	Ballasted, 10° Tilt, 180° Azimuth
5	3.9	Ballasted, 10° Tilt, 180° Azimuth
6	8.4	Ballasted, 10° Tilt, 180° Azimuth

Figure 2: Preliminary Solar PV System Layout

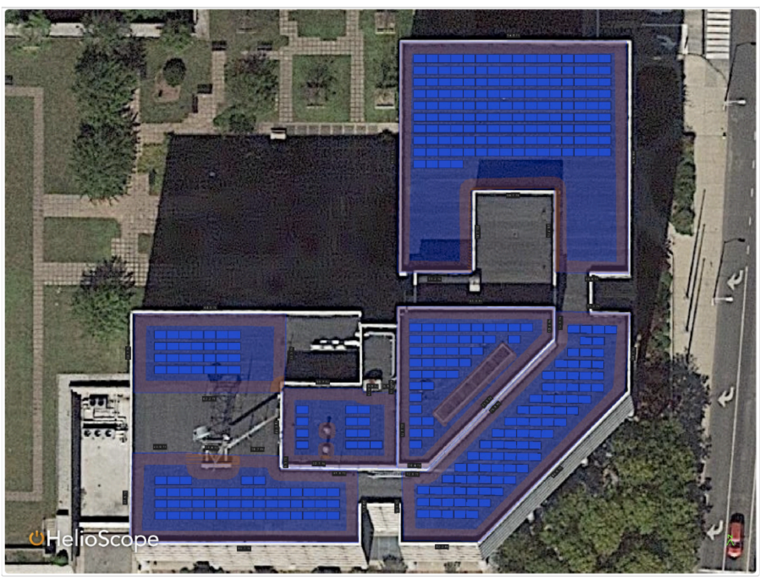


Table 3: Solar PV Analysis Assumptions

Metric	Assumption
Lifecycle Term (years)	25
Inflation Rate	2.0%
Discount Rate	4.0%
Escalation Rate for Utility Costs (per year)	3.0%
Degradation Rate for Solar PV Performance (per year)	-0.5%
ZREC Value (per kWh)	$0.10

Table 4: Summary of Solar PV Financial Impact – Direct Purchase

Net Investment without Federal ITC	$383,250
Net Investment with Federal ITC	$268,275
Net Saving (NPV) with Incentives	$363,771
Annual Average Utility Saving (NPV)	$29,541

	Without Incentives	*With Incentives*
Savings-to-Investment Ratio	1.95	2.36
Simple Payback (years)	13	9

If the City of Stamford can take advantage of the federal investment tax credit for renewable energy generating systems through a third party, the estimated savings to investment ratio of the system analyzed would be 2.36 and the simple payback would be 9 years. Without the federal investment tax credit, the estimated savings to investment ratio would be 1.95 and the simple payback would be 13 years

NEI assumes that direct purchase and ownership would be supported by the sale of zero-energy renewable energy credits (ZRECs). The CT ZREC plan is currently in year 6, and the year 7 RFP is scheduled to be announced in August, 2018. ZREC values for medium sized systems, including those in the 100-250 kW capacity, are determined by the bids submitted during the RFP opening. NEI assumed the average ZREC value from the list of all accepted bids for the year 6 medium size category. If a bid is accepted, ZRECs are sold to Eversource over 15 years.

NEI recommends that the City engage a solar PV system designer and installer and investigate direct purchase and ownership options. NEI also suggests that the City investigate third-party power purchase agreement options, such as those available through the CT Green Bank. A third-party power purchase agreement would enable the installation of a solar PV system and monthly electricity cost savings without upfront investment cost. However, NEI recommends that should the City of Stamford procure a solar PV system for the building, that the cool roof upgrade recommended in the resilience measures above be implemented in advance of the solar PV installation.

Opportunities Summary

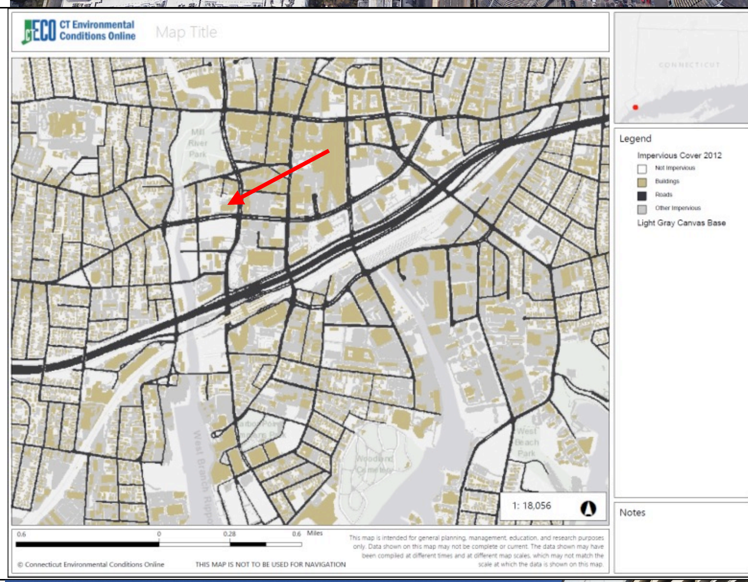
In summary, NEI identified the following opportunities to improve resilience at the Stamford Government Center Building:

- Engage a solar installer to provide a rooftop solar PV system either through direct purchase or through a power purchase agreement. Given the large electricity use of the building and the ample open flat roof space, a solar PV system could provide significant cost savings and enable future battery backup capacity.
- As part of routine building management and staff protocol, create an Emergency Preparedness Plan to specify roles and responsibilities during emergencies including extreme weather events, building operations or shutdown procedures, and to support recovery after an extreme event.
- Implement ongoing utility tracking and benchmarking. In addition to improving ongoing operations by helping to identify issues early, tracking and benchmarking utility data will provide a more complete picture of what would be required to provide critical functions beyond life safety

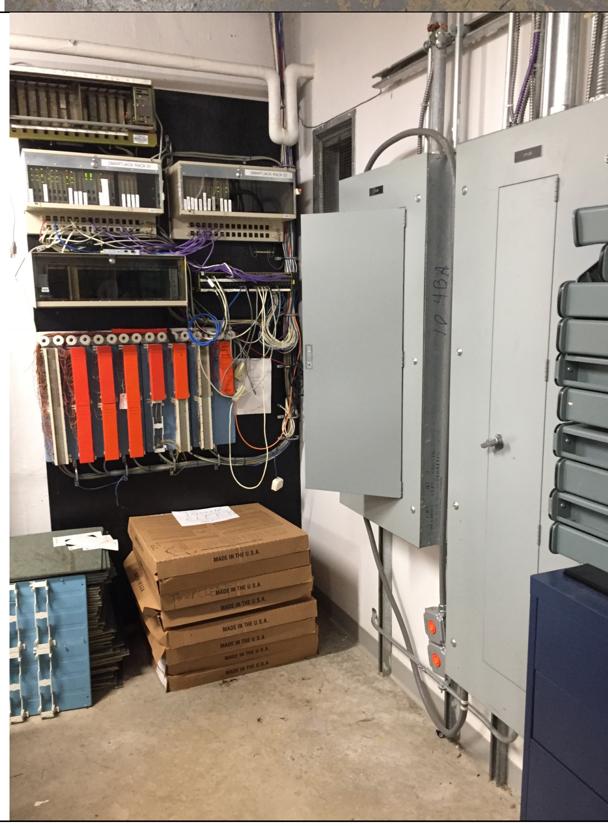
in the event of an extended utility outage. Engaging a firm to complete a full energy audit as well as investigating battery backup feasibility are also recommended.

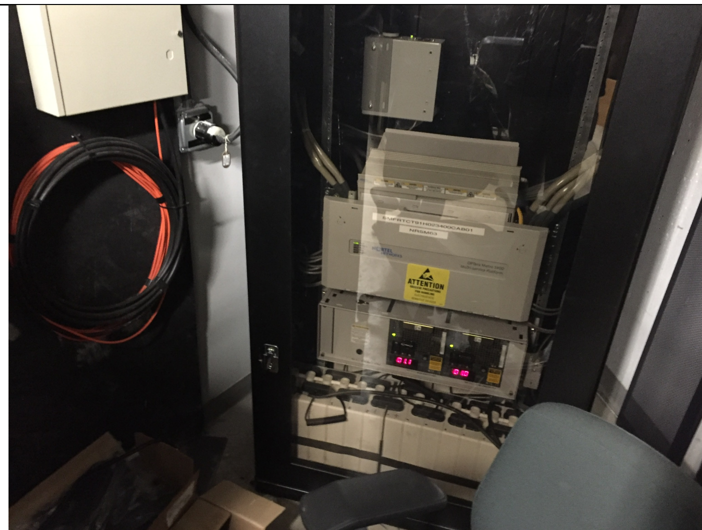
- A cool roof coating and thermal window shades will lower the cost of cooling the building and allow the building to remain habitable longer during an electric outage during the summer.
- Improved surface stormwater management as through bio swales and other green and low impact development best practices as well as backwater valves on sewer lines exiting the building will provide protection against nuisance flooding, which is the most pressing flooding risk at present.
- Connecting sump pumps to the emergency panel, component protection floodproofing, upgrading elevators for resilience, adding utility quick connects, securing the fuel storage tank in the parking garage, and storing potable water for emergency use are lower priority but would provide an additional level or resilience and should be incorporated into the ongoing maintenance and long-term capital plan for the building.

Appendix 1: Photos

Aerial view of the Government Center Building.	
Impervious surface coverage map, Government Center indicated by arrow.	
South-facing roof space available for solar PV installation.	

Roof space available for solar PV installation.	
Mechanical equipment at floor level in basement	
Floor drain in basement, ensure drains have backflow preventers.	

Existing sump pumps, ensure pumps are connected to emergency electric panel.	
Electrical panels near floor level in basement.	

Telecom equipment at floor level in basement.	
Impervious surface at garage entrance.	
Impervious surface at street.	

Impervious surface at main entrance.	
Unsecured fuel storage tank.	

Sand bags at generator air intake in garage.