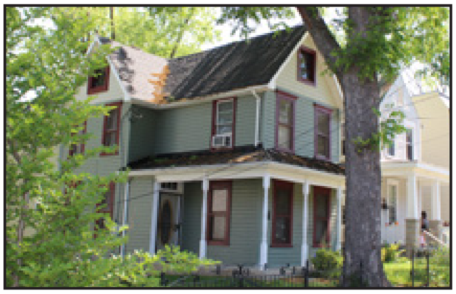

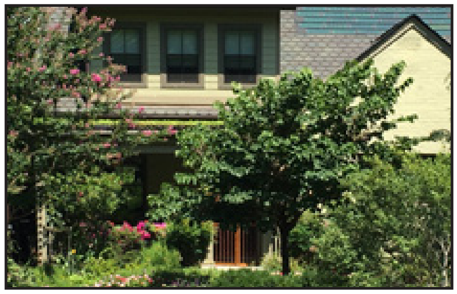

SUSTAINABILITY GUIDE OF EXISTING AND HISTORIC PROPERTIES

D.C. HISTORIC PRESERVATION REVIEW BOARD

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District of Columbia
Office of Planning

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I. INTRODUCTION

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I. INTRODUCTION

The District of Columbia contains a rich collection of older buildings that help define the character of its neighborhoods and establish a sense of place. The District's historic resources include over 800 individual landmarks and over 50 historic districts listed in the DC Inventory of Historic Sites and/or National Register of Historic Places. Beyond these recognized landmarks, a large quantity—approximately 72%—of the city's existing built fabric was constructed before 1945, now over 72 years old. Of this 72%, 29.6% were constructed before 1920 and 42.4% were constructed between 1920 and 1945.

The District, already a leader in green building and sustainability practices, aims to become the healthiest, greenest, and most livable city by enhancing its sustainability environmentally, economically, and socially. In order to achieve this goal, the Sustainable DC Plan (2013), outlines high-performance targets and actions including: a major reduction in energy use and greenhouse gas emissions by 2013 (50% from 2006 levels), an increase in renewable energy sources so that it constitutes 50% of the city's energy use, net-zero energy standards for new construction and existing multifamily and commercial buildings, and a decrease in total water (by 40%). Improving the performance of the District's existing older building stock through green retrofits is an important component of the Sustainable DC Plan.

These strategies and guidelines are intended to promote and facilitate green retrofits to improve performance and energy-efficiency of existing older buildings in a manner that preserves their historic character. Many of these strategies are targeted towards smaller residential and commercial buildings; however, resources and information throughout will also be applicable to other building typologies.

Sustainability is defined as meeting the economic, social, and environmental needs of today while ensuring future generations will also be able to meet their own needs.

Green Retrofits are any type of upgrade to an existing building intended to improve energy and environmental performance, reduce water usage, and improve the comfort and quality of the space in terms of natural light, air quality, and noise.

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How to use this guide:

This guide provides owners of older and historic buildings with **steps** for planning a green retrofit; **strategies** for improving performance and energy efficiency as part of a green retrofit; and **guidelines** for preserving the historic character of these buildings.

This document was prepared to help building owners who are not design, historic preservation or construction professionals. As such, it is an introduction to the systematic sequence of evaluation, planning and decision-making required to carry out an effective green retrofit. Nevertheless, the information presented also applies to other building typologies. For example, specific strategies and information relevant to larger multi-family, mixed-use, and commercial buildings are included within call-out boxes throughout the document.

It is worth emphasizing that the DC Historic Preservation Law protects *designated* historic landmarks and buildings *located within historic districts*. As a result, a higher level of design and permit review results for this sub-set of District buildings. For more information on historic preservation design review and relevant regulations, see Section IV.

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Existing Buildings and Energy Consumption

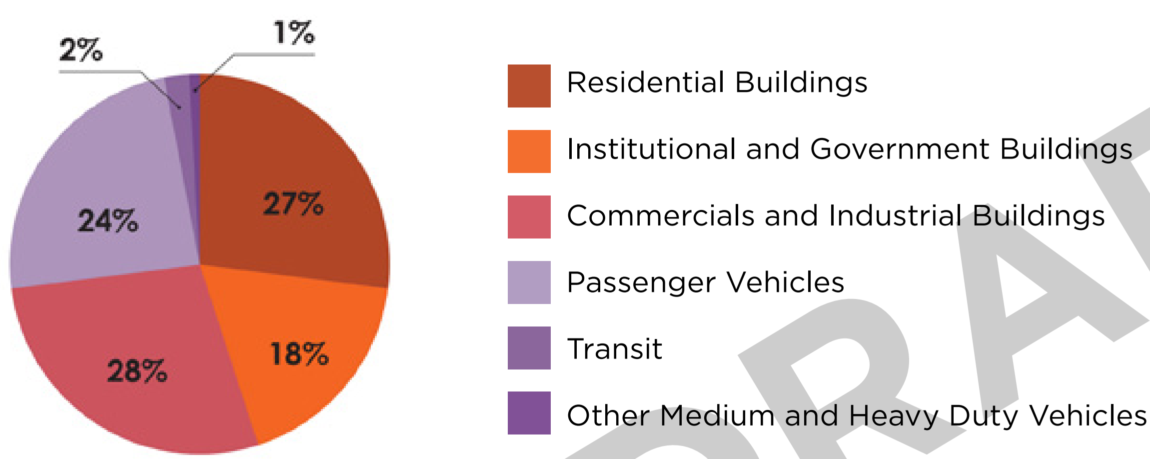
Buildings are the primary source of energy use, resource consumption, and greenhouse gas (GHG) emissions. In fact, as of 2016, residential and commercial buildings accounted for about 40% of total energy consumption in the United States. In the District, residential and commercial buildings accounted for 73% of the total energy consumption.[1] Energy use, through extraction and consumption of fossil fuels, is the most dominant source of GHG emissions; therefore, the city's success at reducing emissions depends on reducing its energy use and reliance on fossil fuels by improving performance of existing buildings and expanding renewable energy sources.

Recent changes to local law and building codes mandate green building requirements in new construction, larger renovations, as well as projects on district-owned buildings. The federal government has also implemented a major push to improve performance of federally owned buildings, including installation of solar energy systems on buildings within the District. Future modifications to the building code are expected to include new performance standards for existing buildings, regardless of building type or size. Adoption of a net-zero energy building code—that shifts away from fossil fuels—is expected in the District between 2020 and 2026.

Even without code requirements, retrofitting existing older buildings in the District yields the following positive outcomes:

- meaningful environmental benefits due to lowered energy use and therefore less GHG emissions;
- reduced energy costs for the Owner;
- better health of occupants through improved thermal comfort and quieter, more efficient systems; and
- protection of the city's older buildings—via this conscientious maintenance—which preserves the unique character of its neighborhoods.

2015 ESTIMATED PROPORTION OF SITE ENERGY USE BY SECTOR



Source: Clean Energy DC

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1 The elevated proportion of energy use in the District is in large part due to the dense urban makeup

Sustainability and Historic Preservation

There is a common misconception that the principles of sustainability and green building design are at odds with those of historic preservation. Quite the opposite is true: historic buildings offer effective solutions to save energy. Furthermore, *maintaining* existing buildings and improving their energy performance will help the District meet its sustainability goals.

THE GREENEST BUILDING

By preserving and retrofitting historic and older buildings, we reduce waste, maximize the use and life of materials and preserve the historic character of our city and neighborhoods. A 2011 study conducted by the National Trust for Historic Preservation[2] found that continuing the life of existing buildings typically offers benefits over demolition and new construction. This is due to the negative environmental impacts caused by the construction process. The study finds that it takes between 10-80 years for a new building (it must be 30% more efficient than an average-performing existing building) to overcome, through efficient operations, the negative climate change impacts related to the construction process. Renovation and reuse of existing buildings of comparable functionality and size almost always yield fewer environmental impacts than demolition and new construction over a 75-year period, when comparing buildings with equivalent energy efficiency levels. Categories studied were: Materials End-of-Life, Original Materials Production, Net Total Replacement Materials Production, Utility Consumption (energy use only), Demolition/Construction Activities, Material Transportation.

In addition, older buildings have been found to be more energy-efficient than more recently constructed buildings. The Energy Information Administration (EIA) has documented that older commercial buildings generally use less energy per square foot and perform better than those built between 1920 and 2000. These older buildings were constructed in an era without climate control technology. As a result, they used architectural means to keep the interior environment cool in the summer and warm in the winter. Because these structures are not as dependent on mechanical systems, they are more efficient and equipped to function without consuming as much energy as their modern counterparts. This does not hold true for buildings constructed after World War II when the interior environment became much more reliant on mechanical systems.

In summary, inherently sustainable and energy-efficient building features were designed out of necessity, in response to local climate conditions. These traditional strategies maximized natural sources of light, ventilation, and heating. Some of the most common features found in District buildings include:

- thick walls and with party wall construction;
- operable windows, transoms, attic vents, dormers, and high ceilings;
- shutters and awnings;
- landscaping and site features

These features are more completely explained in the following pages.

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2 The National Trust for Historic Preservation, Preservation Green Lab, The Greenest Building Report, 2011, http://forum.savingplaces.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=5119e24d-ae4c-3402-7c8e-38a11a4fca12&forceDialog=0

Inherently Sustainable Features

The following design features were traditionally applied to provide passive heating, cooling, and lighting, and to improve interior comfort of buildings. These features should be maintained where they exist, and can be designed and applied in green retrofits and new design, where appropriate, to improve efficiency and performance.

LANDSCAPING & WATER EFFICIENCY

Landscaping - Trees, other landscaping improve interior conditions and minimize energy use by providing sun shade, wind deflection, and privacy. For instance, deciduous trees can shade a house from intense sun in the summer but allow more desirable winter sun after leaves have fallen. Evergreen trees, particularly those planted on the north side of a building, can form a windbreak.

Permeable Surfaces - vegetative and other pervious surfaces help absorb water and reduce flash flooding.

Water Efficiency - Underground cisterns or reservoirs, were (and still are) commonly used to capture and store rainwater for future use.

These deciduous street trees on provide shade for pedestrians and adjacent buildings in the summer, but allow more sun in the winter.

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DAYLIGHTING & VENTILATION

Windows - Operable windows provide and control daylight and natural ventilation without energy consumption, reducing dependence on mechanical systems and artificial lighting.

The location and size of window openings is often determined in response to the building's orientation to the sun and local climate help to control heat gains and facilitate ventilation. For instance, larger windows and glass transoms carry light and air deep into a building with a narrow footprint. Likewise, smaller windows will help reduce sun exposure and heat gains on the interior.

Skylights, light wells at basement windows, roof monitors, dormers, and transoms all enhance daylighting within interior spaces.

Transoms like the ones on this storefront, improve natural lighting and ventilation on the interior.

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Shutters - Shutters, when functional, reduce heat losses or gains through windows and are beneficial for cooling and protecting the interior from the elements. Shutters can be placed on the exterior or interior of a building, and can be solid or have louvers that allow some light and air flow.

Attic Vents - Attic vents and dormer windows help circulate air, keeping a building cool and reducing moisture build-up. Dormers also increase the functionality of attic spaces by allowing light and ventilation and increasing space.

Operable shutters provide shading when needed, improving thermal performance of windows, as well as privacy and storm protection.

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Storm Windows - Storm windows provide additional insulation, reduce noise and drafts, and improve the general performance and durability of existing windows.

Screens - Screens can replace storm windows in the summer to permit fresh air flow while protecting the interior from elements, debris, animals and insects while windows are open.

Awnings - Awnings provide shade and help keep a building cool. On commercial buildings, awnings protect pedestrians from elements and provide shading for large show windows to keep interiors cool and protect merchandise.

Porches - Porches provide sheltered outdoor living space, take advantage of winds to maximize cross ventilation, and shade exterior walls and windows from the sun.

Awnings on these downtown buildings provide shade for pedestrians, large storefront windows and upper stories.

DESIGN & MATERIALS

Siting & Orientation - Building design and layout is generally influenced specific site conditions and orientation to the sun in order to control and enhance natural daylighting and passive ventilation and climate control.

Party Walls - Rowhouses have shared party walls (common walls between the adjoining buildings) and thus limited outside exposure, which helps to reduce heat gains and losses.

Durability & Repairability - Many old and durable building materials were locally produced, and have long lifespans. Repairability of different building components and assemblies also contributes to longer lifespans. For instance damaged shingles on a slate roof can be repaired individually, rather than requiring a complete roof replacement. Likewise, parts of a wood window assembly can be repaired if damage occurs or if a glass pane breaks, requiring less waste and expense.

Masonry - Thick masonry walls, common in the District, have high thermal mass and resulting thermal lag, which helps moderate interior temperatures, keeping buildings cooler in the summer and warmer in the winter.

High Ceilings - High ceilings increase daylighting in a space and improve air flow. They allow warmer air to rise to the ceiling, cooling the room.

Porches provide sheltered outdoor living space, maximize cross ventilation, and shade exterior walls and windows.

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These rowhouses have porches, shutters, and masonry walls, all of which improve performance and energy-efficiency.

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Preservation Goals & Considerations

The following preservation goals and considerations apply primarily to historic buildings and buildings within historic districts listed in the DC Inventory of Historic Sites and/or the National Register of Historic Places. Nonetheless, these important principles should be considered when working on any historic building.

The city's preservation law establishes the fundamental purposes for the review of work affecting historic properties. These include retaining and enhancing historic properties, ensuring that changes are compatible, and encouraging adaptation of historic property for current use.

Design guidelines establish the principles for achieving these purposes. In giving more specific advice, these guidelines also reflect considerations that are applied in the design and review of work affecting a historic property. These considerations include:

Visibility or prominence from the street: Changes that are visible to the public are more likely to affect a historic property's character. As a rule, alterations on primary elevations prominently visible from a street should be more carefully considered, while greater flexibility is warranted for changes on secondary elevations that are minimally visible or not visible at all.

Level of property significance: Historic properties may merit different levels of treatment depending on their relative significance. Buildings of greater architectural or historical character may warrant more careful treatment. Changes to properties in historic districts are reviewed in the context of their relative significance to the district.

Contextual and compatible design: The design of features for historic property should display an awareness of and response to the specific qualities of the property.

Quality of design and materials: Historic buildings typically display a high quality of design and materials which should be retained. Special features that are custom designed or crafted, or that represent an unusual degree of styling or detailing warrant care and all reasonable efforts should be made to preserve or replicate them accurately. A more flexible standard may be applied to elements that were mass-produced, do not have distinguishing characteristics or that are easily replicable.

Temporary and additive change vs. permanent and destructive change: Alterations that are temporary or easily reversible have less of a lasting impact on the character of a historic property than changes that permanently change, damage, or remove important features.

Achieving a reasonable balance: Adapting old buildings requires a thoughtful consideration of practical needs along with the civic benefits of protecting architectural and historical characteristics valued by the community.

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II. PLANNING A GREEN RETROFIT & EFFICIENCY UPGRADE

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I. PLANNING A GREEN RETROFIT & EFFICIENCY UPGRADES

Sustainability and green retrofits are about more than just new technology and gadgets. To deal with the bigger picture (reducing environmental impacts through a reduction in consumption, waste, and emissions), the retrofit planning effort for existing older buildings must take a holistic and comprehensive approach.

The planning approach should consider how different building systems, components and features function and are connected, and specifically tailor a retrofit plan and strategies to a building's individual characteristics. It should also balance the goals of sustainability and green design, constraints of an existing older building, and the preservation of historic character. A holistic approach is often the most cost-effective, as individual and uncoordinated efforts will only provide limited benefits and may ultimately require greater expense when additional repairs or upgrades are needed.

THE FOLLOWING STEPS SHOULD BE CONSULTED BEFORE AND THROUGHOUT THE RETROFIT PROCESS:

STEP 1 - KNOW YOUR BUILDING

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STEP 2 - EVALUATE CURRENT PERFORMANCE

↓

STEP 3 - OPTIMIZE CURRENT PERFORMANCE

↓

STEP 4 - DEFINE YOUR GOALS

↓

STEP 5 - DEVELOP A COORDINATED STRATEGY

↓

STEP 6 - MAINTAIN AND MONITOR PERFORMANCE

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Step 1: Know Your Building

Before initiating a green retrofit, it is crucial to gain a better understanding of your building, its history and evolution over time, relationship with its surroundings and neighboring buildings, physical aspects such as its materials and assemblies, character-defining features, and systems and operating functions. Answering these questions will help you determine needs, project goals, and the best strategies to incorporate as part of the retrofit.

BUILDING CHARACTERISTICS	*1. Building Type & Use*	Is your building use residential (owner occupied or rental), mixed-use, or commercial? If residential, is it single family or multi-family? If commercial or mixed-use, is it occupied by a retail store, restaurant, or office? The type of building, its use, and activities will play a large role in the type and amount of energy used and as a result, the best strategies to utilize.
	2. Location & Orientation	How is your building oriented towards the sun? Where is it located on the block or in relationship to your neighbors? Is it detached, semi-detached, part of a row? Location and orientation can influence a property's visibility, sun exposure, shading, potential moisture issues, and more.
	3. Construction	When was your building constructed and what are the primary materials on your building? The most common building materials on older existing buildings in the District include brick, stone, concrete and wood. Different materials and construction methods will require different retrofit and upgrade strategies to reach the same energy efficiency levels. How many stories is your building? Do you have a basement or an attic? What is the roof shape and structure? Are there any noticeable alterations? Alterations may help you identify areas of flexibility or any areas that may need attention during the retrofit. What type of windows do you have? is the material wood, steel, or aluminum? How do they function? Are they double-hung, casement, fixed, or other? Different window materials and types may lend themselves to different retrofit strategies.

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BUILDING CHARACTERISTICS	4. *Character-Defining Features*	What are the unique character-defining features on your building? Regardless of whether or not a building is designated a historic landmark, older existing buildings contribute to the character and diversity of the District's neighborhoods. Character is defined by the elements (known as the *character-defining features*) that make a building unique or special including the distinctive materials, features and spaces, architectural styling or design, and unique construction methods or craftsmanship. Character-defining features should be identified during the planning phase and preserved when implementing strategies.
	5. *Inherently Sustainable Features*	What passive systems and inherently sustainable features (listed in the previous section) exist on your building and what condition are they in? Are there passive systems that could be integrated into the retrofit? Inherently sustainable features should be identified and incorporated into your overall plan so that they work in cooperation with other strategies utilized. Maintaining and using these efficient features will improve sustainability and reduce unnecessary waste.
	6. *Existing Systems*	How do you heat and cool your house? Forced hot air, water pipes, steam pipes? Are your existing systems operating effectively? Did you identify inherently sustainable features that you can take advantage of for passive heating and cooling?
REGULATORY REQUIREMENTS & LANDMARK STATUS	7. *Historic Designation Status*	Is your building an individual landmark or located within a historic district listed in the DC Inventory of Historic Sites or National Register of Historic Places? If you are located within a historic district, is your building a contributor or non-contributor? You can find out by searching for your property on the Office of Planning PropertyQuest database, accessible here: http://propertyquest.dc.gov/. For more information on landmarks, historic districts, and the review process, see Section IV. Historic landmarks and buildings within historic districts require additional review by the Office of Historic Preservation to ensure that alterations and green retrofit strategies do not negatively impact the historic character. Historic landmarks may also qualify for financial incentives that could help with retrofit and renovation costs.

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Step 2: Evaluate Current Performance

Evaluating the current performance of your building envelope and systems will identify deficiencies and help determine retrofit priorities and goals. The evaluation will provide an understanding of how the building is operating and will also help to identify improper equipment performance, what equipment or systems need to be rehabilitated, retrofitted, or replaced, opportunities for saving energy and money, and strategies for improving performance of the various building systems.

Below are some tests commonly used to asses building performance. Most of these tests should be performed and analyzed by a professional energy auditor or building professional who follow a standard for audits (e.g. Building Performance Institute).

A. Energy Audit

   » A comparative process in which owners understand the current, baseline performance of their home or building. Owners should begin by comparing past utility bills over, typically, a one-to-two year period. Identify the highest costs (e.g., gas in the winter, electricity in the summer) to see where the greatest energy efficiencies are located (and thus, the greatest energy gains can be found).

B. Blower Door Test

   » Unwanted air infiltration/ex-filtration can be a large source of energy loss. Measuring the air tightness of a building can be performed by a blower door test, typically done by placing a large fan in a door opening and shutting all other exterior windows/doors. The fan can be used to positively or negatively pressurize the building (either by blowing air into or sucking air out of the building) in order to identify and measure air leakage locations. This test is typically performed by a professional, and can be done in conjunction with thermal imaging.

C. Thermal Imaging

   » Thermal imaging, or infrared (IR) surveys can be performed on the exterior or interior of a home or building, and are used in order to determine locations of air leakage or inadequate thermal insulation. Performing an interior and exterior survey with an IR camera, potentially in combination with positively or negatively pressurizing the building, it is possible to determine areas lacking sufficient thermal insulation, and air leakage locations. Addressing these locations of inadequate insulation and/or air infiltration/leakage is a productive first step in a home energy retrofit.

D. Energy Modeling and Hygrothermal Analysis

   » There are multiple computer software programs which can provide an in-depth or whole-building energy analysis of a building component or home. Many new construction projects include a whole-building energy analysis, which provides a view of how each system can impact the efficiency of a building (e.g., whether more insulation or better windows will satisfy code and/or Green/LEED requirements, and potentially be more effective in keeping future energy costs low). In addition

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to whole-building modeling, hygrothermal or thermal analysis programs such as WUFI or Therm can provide a closer look at an individual building component, such as a cross-section of a window or wall in order to determine the potential for condensation, how much insulation is required, or if/where a vapor barrier should be installed.

E. Utility Bill Analysis

» Utility bill analysis is a low cost method used to identify unusual operation or functioning, such as high fuel use in one season compared to the previous year. This analysis can also be used to establish consumption baselines in order to identify goals and strategies for reducing consumption.

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Step 3: Optimize Current Performance

Following evaluation, optimizing performance of existing systems including HVAC, electrical and lighting systems, and the building envelope to ensure they are running properly may provide energy savings without making significant alterations or investment.

Typical measures to optimize performance of existing systems includes weatherizing, changing filters and cleaning and repairing existing equipment. They do not include capital improvements such as installation of new, more-efficient equipment. Studies have found that optimization of current performance is one of the most cost-effective procedures to increase the energy efficiency of existing buildings and have improved operations. Additionally, optimizing existing systems is a fundamentally sustainable approach that minimizes changes to the building envelope.

WEATHERIZING

Weatherization generally refers to methods for reducing air, water, and vapor infiltration, while also making a building more efficient and potentially improving the thermal envelope. These items are incorporated into new construction projects and additions, but can also be implemented as part of smaller scale repairs or routine maintenance procedures. Maybe more importantly, these methods are not always expensive and can include low-cost options depending on what the ultimate goal(s) are for improving your building.

Existing buildings with historic character warrant special consideration while weatherizing. The following are common considerations in this context:

- Maintain and preserve durable, characteristic features and maximize operational efficiency of the building envelope.
- Do not undertake treatments that result in the loss of characteristic features before carrying out simple and less damaging weatherization measures.
- Preserve intact, character-defining features and materials. Where necessary, repair deteriorated and. damaged features, matching the original in design and finish.
- Identify and preserve inherent thermal properties of your historic building and determine appropriate insulating measures for the characteristic features and climate.
- Insulate unfinished spaces such as attics, basement and crawl spaces before insulating finished areas that may result in damage and removal of historic plaster, trim and other characteristic features.
- Try to avoid change to the proportional relationships of wall to trim and wall to window caused by interior insulation and furring out walls as this relationship is generally an important character-defining feature of historic interior spaces.

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Step 4: Define Your Goals

After evaluating current performance and optimizing existing equipment and systems, you should define goals and priorities for the green retrofit to determine the strategies to implement. A cardinal rule on any existing or historic building should be “do no harm”—for example, don’t create new problems by trapping moisture, creating condensation, or causing deterioration. Other goals could include reaching a specific energy usage target, a specific percentage in reduction, or reducing energy use as much as possible. They could also include meeting code requirements or specific standards such as LEED or PassiveHaus. Another goal may be to reduce costs and improve comfort.

- Monthly energy/cost savings
- Setting specific return on investment goals or payback periods for potential renovations
- Meeting project-specific air infiltration requirements (such as from IECC 2015) which mandates a maximum air leakage as the following: 0.4 cfm/sq maximum for the whole building, 0.04 cfm/sq for the assembly, 0.004 cfm/sq for the material.
- Produce renewable energy

Step 5: Develop a Coordinated Plan

A green retrofit will require comprehensive planning approach that evaluates the building and its systems holistically to provide the greatest energy savings. The plan should be designed and tailored specifically to your building, site, character-defining features, climate, and occupancy.

Because retrofit strategies range in cost and complexity, it is important to develop a coordinated plan based on needs and goals determined in Steps 2, 3, and 4. If your goal is to reduce energy bills, start small by evaluating user behavior, taking advantage of passive and inherently sustainable features, optimizing existing systems, and implementing other cost-effective strategies. If your goal is to meet net-zero energy, or to reduce your energy use by a certain amount, you will need to plan a long-term, multi-system approach utilizing multiple green retrofit strategies.

Depending on the size and complexity of the retrofit, you may want to consult construction and design professionals that are experienced in green retrofits during the planning process. A list of some professionals commonly engaged in a green retrofit are included on the following page.

PLANNING FOR MAJOR UPGRADES

While you are planning a retrofit and implementing these strategies, keep in mind the following list of ideal circumstances and points in time for major upgrades to occur. When these circumstances come up or significant end-of-life replacements are needed (such as your roof), you may be able to include additional energy-efficiency improvements at minimal added cost.

- Building Purchase or Refinancing. When financing, a retrofit can be included in the transaction cost.
- Major Renovation or Improvements. If you are planning a major renovation or project, ore replacing mechanical equipment that is near the end of its service life, energy-efficient upgrades could be incorporated at minimal additional cost.
- Building Envelope Improvements. When combined with major end-of-life equipment upgrades, such as HVAC, improvements to the building envelope offer opportunities for reduced costs because of reduced heating and cooling loads that will require smaller and less expensive mechanical equipment.
- Life Safety and Code Requirements. If you are implementing life safety or code requirement upgrades that require substantial cost and effort, energy-efficiency upgrades may be incorporated at minimal al additional investment.
- Tenant Turnover. In rental properties, tenant turnover may provide an opportunity to improve efficiency and increase the value of the space.
- Portfolio Management. If managing a portfolio of properties, it may be beneficial to implement a set of replicable energy-efficiency upgrades as part of an ongoing management plan.

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CONSIDER MATERIAL LIFESPANS AND IMPACTS

While considering appropriate strategies you should also recognize the lifespan of your building's materials and components. To that end, consider the following:

- Older materials and assemblies, including masonry walls, slate roofs, or wood windows are generally intended to repairable and have a long lifespan. Minimize intrusions, alterations, and long-term impacts to these features.
- Complex systems will require more maintenance to perform properly. On the other hand, passive and inherently sustainable features require little energy and maintenance to perform.
- Design systems that will allow repairs and replacements without disrupting the entire building or damaging character-defining features.

IDENTIFY FINANCING OPPORTUNITIES

All strategies should be evaluated for their cost-effectiveness. Initial cost of a product or design is only part of the true cost; long-term operation costs generally exceed initial costs. Consider the long-term savings and ease of maintenance when budgeting for a retrofit and energy-efficient upgrades.

- Analyze prospective investments based on their expected financial and environmental benefits (maintenance savings, utility bills, comfort).

There are a wide range of incentives, resources and financing opportunities available to District residents for implementing green retrofits and energy-efficient upgrades. Identify these opportunities during the planning phase, before implementing. Section V includes a list of some of the available resources and opportunities.

Step 6: Maintain and Monitor Performance

Existing buildings should be maintained regularly to preserve character-defining features and maximize reliability, performance, and operational efficiency. You should also regularly monitor performance as you implement upgrades to determine how strategies are working and where adjustments need to be made in your long-term plan.

PROFESSIONAL SERVICES

Depending on the size and scope of your project, you may want to consider consulting professionals to address specific retrofit or design challenges. Larger projects will likely require integrated teams that should be formed early in the planning process. Typical professionals involved in green retrofits include:

- **Licensed Architect** – Designs basic to comprehensive renovations, advises on the construction, and provides guidance on selection of material finishes. Identify professional architects with experience working on high-performance, green building or historic renovations.
- **Historic Preservation Professional** – Advises on treatments and planning to ensure character and integrity of the historic building is maintained during the upgrade.
- **General Contractor** – Oversees day-to-day activities and manages subcontractors.
- **Energy Auditor** – Inspects, surveys, and analyzes energy flows of building to maximize comfort, efficiency, health safety and durability.
- **Structural Engineer** – Evaluates structural integrity, which may be needed if installing a green roof or other upgrades that require support. Should be a licensed professional.
- **Sustainability Consultant** – Assesses goals and identifies appropriate strategies and experts required, facilitates integrative design.
- **Mechanical and Building Envelope Engineer -** Evaluate mechanical systems, and design improvements or replacements, conduct whole building energy analysis, blower door testing, hygrothermal analysis, and other evaluations and analysis.
- This guide from DCRA has quick tips to consider when selecting an Architect, Engineer or Interior Designer for your next project: https://dcra.dc.gov/publication/how-select-architect-engineer-or-interior-designer-your-next-project

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III. GREEN RETROFIT STRATEGIES & GUIDELINES

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III. GREEN RETROFIT STRATEGIES & GUIDELINES

The following section includes strategies and guidelines to facilitate green retrofits of older existing buildings in the District. The combination of strategies selected for a specific building should align with project goals and consider character-defining and inherently sustainable features.

Strategies and guidelines are organized by the following building components and are divided by low-, moderate-, and higher-cost strategies.

- Walls & Roofs
- Windows & Doors
- Landscape, Site Features & Water Efficiency
- Renewable Energy

Groupings of brick rowhouses in the Capitol Hill Historic District.

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WALLS & ROOFS

Exterior walls and roofs are the most visible aspects of a historic building and define the style and character. Materials, proportions and scale of openings and doors, massing and rhythm of features such as bays and porches, and other ornamentation all help define the character of a building's exterior. Typical wall materials of existing older buildings in the District include brick (the most prevalent), wood, and stone. Other materials frequently used include cast stone, stucco, glass block, and terra-cotta.

Masonry houses generally consist of multi-wythe walls (i.e., a wall consisting of multiple thicknesses of masonry) comprised of brick masonry or a mixture of brick and stone masonry. The exterior is typically exposed masonry or painted. The typical interior wall finish is lath and plaster. Wood-framed houses have wood frames generally covered with clapboard siding or shingles.

Buildings generally have primary and secondary facades. Primary facades face public streets and display the most ornamentation while secondary elevations (side and rear elevations) are less formally composed, and sometimes employ lesser quality and/or lower cost materials. In the case of the District's many rowhouses, there is generally a primary facade with the main entrance and ornamentation facing on to the public street and sidewalk, shared party walls that do not contain openings, and a secondary elevation facing a rear yard or alley. Alterations to primary facades should generally be avoided while secondary elevations provide greater flexibility for change.

Wood-framed rowhouses in the Anacostia Historic District.

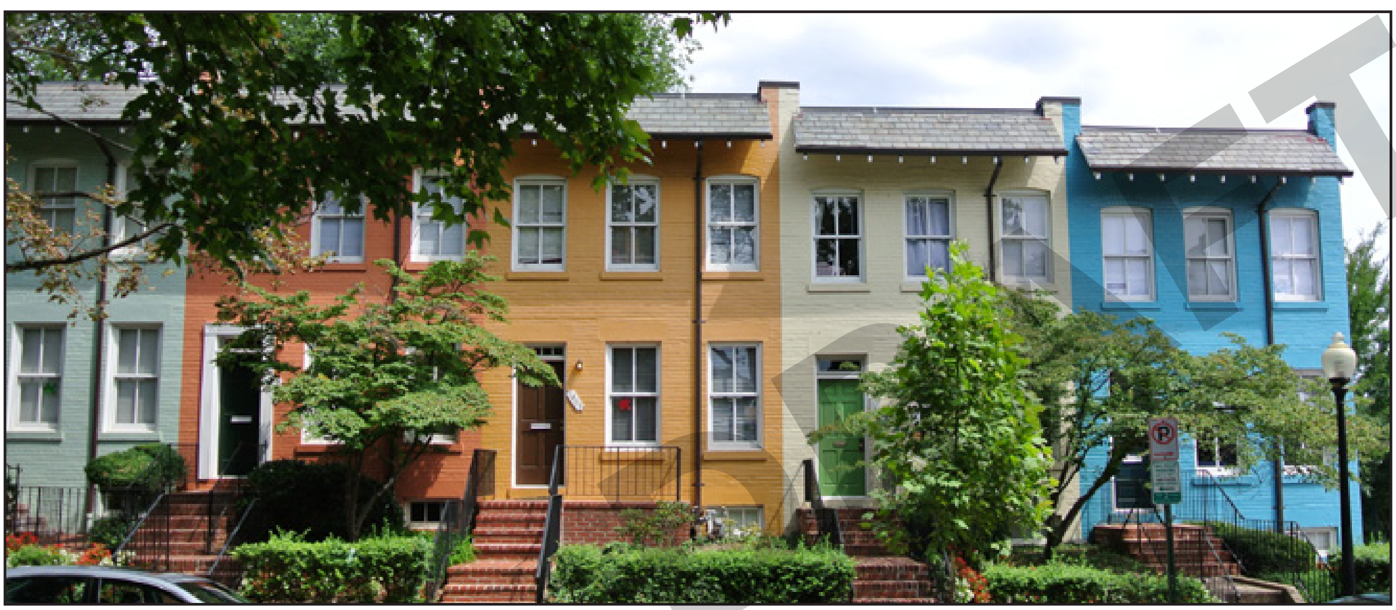
Roofs are often distinctive features of historic buildings. Their shape, materials and detailing contribute to the appearance and character of the historic building. Roofs are either flat (low-sloped) or steep-sloped, and covered with: metal, slate, clay tile, asphalt shingles, built-up and rubber roofing, wood shingles and shakes. Most rowhouses, semi-attached residential buildings and commercial buildings have inconspicuous flat roofs, usually paired with a cornice, parapet or pent roof that provides a finished appearance from the street.

VENTILATION AND INSULATION

Buildings can use passive ventilation (e.g., operable windows and passive vents), active ventilation (e.g., mechanical circulation), or a combination of both to help condition interior spaces. Today, contemporary commercial buildings typically rely solely on mechanical (active) ventilation, whereas natural (passive) ventilation is typically provided for residential conditioning.

Inadequate ventilation can lead to stagnant air, increasing the amount of moisture and heat build-up in interior spaces. For residential construction, this moisture and heat can flow into the attic when no dedicated air sealing is provided between the attic and living spaces below. Venting the attic with louvers in gable ends, ridge vents, and soffit or eave vents is often therefore provided to increase air flow and help control moisture and heat build-up. However, this venting often negates whole-building air sealing, and results in energy loss from unwanted air exfiltration or infiltration.

To avoid these energy losses, air sealing and insulation can be provided to separate the attic from interior living spaces to prevent interior conditioned air from flowing into the attic. Then attic venting can be provided (as described above) to prevent moisture build up, and keep the space cooler. Improving ventilation both to attics and interior living spaces, with a combination of appropriate natural (passive) and mechanical (active) ventilation and whole-building air seals can improve air circulation, keep the building cooler and reduce moisture build-up. It’s important to keep in mind that attic ventilation strategies must be considered simultaneously with whole-building air sealing to avoid energy loss from unwanted air exfiltration or infiltration.



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Strategies

LOW COST

Attic Insulation	• Add either batt insulation in the attic floor to prevent heat/loss gain through the attic space, or insulation hung against a sloped roof deck (while allowing for ventilation) to provide a conditioned attic space.
Attic Vents and Air Circulation	• Attic vents, such as louvers in gable ends, ridge vents, or soffit vents are open to allow for increased air flow within the attic area. • Consider adding ceiling fans to help circulate air and improve occupant comfort
Whole Building Air Sealing	• Wall-to-roofing transitions are often areas which can include improperly-detailed connections, allowing air leakage or heat transfer.
Weatherize	• Refers to multiple cost-effective measures to reduce air, heat, water, and vapor infiltration and make your building more efficient. • Replace interior and exterior perimeter sealant and weatherstripping, which generally have significantly shorter lifespans than windows. • Replace locks or utilize existing locks in the summer and winter to prevent excess air and heat loss through the window perimeter.

R-value: Measure of thermal resistance of a material or an assembly (such as a wall or a roof). An R-value is a quantitative measure of resistance to heat flow (e.g. insulation). A high R-value indicates a high resistance to heat flow, and a low R-value indicates a more conductive material (e.g. masonry or metal).

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Strategies

MODERATE COST	
Wall Insulation	• Adding wall insulation: Providing additional wall insulation, either in the form of exterior cavity insulation or interior insulation between stud framing can increase the building thermal performance. Where possible, provide continuous insulation without thermal breaks such as metal studs or similar wall elements interrupting the insulation. Take care to insulate only the outside face, but not the inside face of existing water pipes so as not to make them more vulnerable to freezing during cold weather days.
Building Envelope Repair	• Repointing exterior masonry will provide increased wall durability, and limit air infiltration into the building. Repointing can also help limit water infiltration into the building.

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Strategies

HIGHER COST

Roof Membrane Repair & Upgrade	• When selecting replacement roofing membranes/ roofing systems, consider the durability of the selected material. A slate roofing shingle, which has a high upfront cost, can have a 75+ year lifetime, compared to an asphalt roofing shingle, which has a 10+ year lifetime. Durability is a key component of sustainable design. • Owners may consider replacing roofing membranes to provide additional durability, to replace in conjunction with a roofing insulation project, or in order to provide a "cool-roof" membrane, typically a white membrane which reflects the sun and thereby absorbs less solar radiation.
Roof Insulation	• Adding sufficient roofing insulation can be performed in conjunction with a roofing membrane/system replacement project.
Wall Insulation	• Requires additional hygrothermal analysis by a building professional to avoid negatively affecting the durability of the masonry walls or wall finishes.

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Guidelines

1. Begin by focusing on the building envelope. A building's height to area ratio (i.e., is the building taller than it is wide, or wider than it is tall), can provide a good starting point in order to know where to focus repairs. A large, low building may benefit from a retrofit to provide sufficient roofing insulation more than a retrofit to add additional wall insulation.
2. Coordinate strategies with information learned from the energy audit/IR survey/blower door tests.
3. Building codes are moving towards requiring minimum continuous insulation. Consider continuous or comprehensive insulation layouts and appropriateness for repairs, additions, or new buildings.
4. Identify and preserve inherent thermal properties of your existing building and determine appropriate insulating measures for the characteristic features and climate.
5. Evaluate material durability and expected service life of existing and replacement materials when considering repairs,rehabilitation, or replacement of roofing, windows and walls. Strive to maintain the inherent durability and repairability of historic buildings with any alterations.
6. Insulate unfinished spaces such as attics, basement and crawl spaces before insulating finished areas that may result in damage and removal of historic plaster, trim and other characteristic features.
7. Try to avoid change to the proportional relationships of wall to trim and wall to window caused by interior insulation and furring out walls as this relationship is generally an important character-defining feature of historic interior spaces
8. Retain and preserve identified character-defining features of walls and roofs. This may include such as materials and functional and decorative features. This may include cornices, foundations, bays, quoins, arches, water tables, brackets, entablatures, storefronts, and roof shape, pitch, or overhangs.
9. If implementing strategies on roofs such as green roof or solar, you must consider if the existing structure can support the additional load. Additionally, maintain roof drainage to avoid ponding water and material degradation.
10. Do not make new penetrations through primary facades, instead introduce alterations thoughtfully on secondary facades. Seal all penetrations to prevent air/water entry.
11. Try to introduce energy conservation strategies and features in an unobtrusive way that will not impact the historic character of the building.
12. New roofing materials should convey a similar scale and texture to those used traditionally. If installing a new roof, also consider installing insulation or undertaking other energy-efficient strategies that may only require minimal added cost.

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13. Maintain existing or install new gutters and downspouts, if needed, with care so that no architectural features are damaged or lost due to water damage.
14. Do not install skylights, solar collectors, ventilators, satellite dishes, and mechanical or communication equipment on roof slopes and planes that are visible from the street.
15. Do not replace existing durable or character-defining roofing materials that are in good condition.
16. Do not install insulation or undertake other treatments that would result in the loss of character-defining features.
17. Install cool or green roofs on a flat roof or secondary roof slope to limit visibility from the street.
18. Refer to DC Historic Preservation Design Guidelines:
    - *Walls and Foundations of Historic Buildings:* https://planning.dc.gov/node/594282
    - *Roofs on Historic Buildings:* https://planning.dc.gov/node/594272

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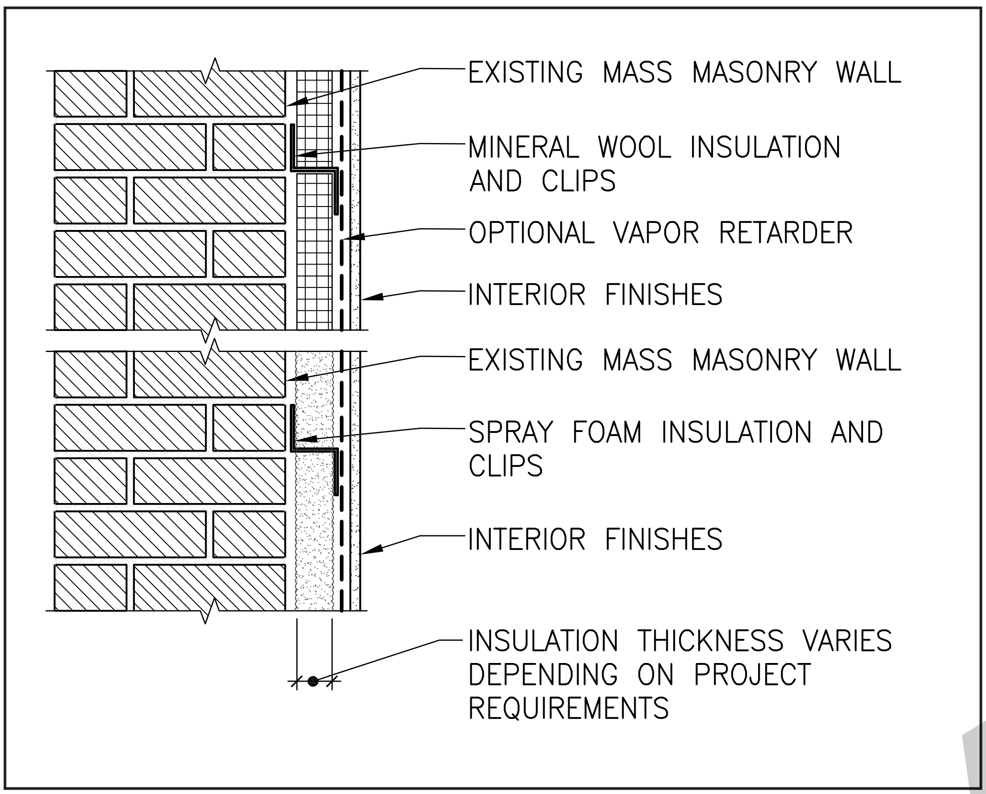
Walls

Adding continuous exterior insulation to walls provides the most effective increase in thermal efficiency. However, this has the largest adverse impact to the exterior aesthetic and character of an historic building, and is typically not permissible. This typically leaves the building owner implementing energy efficient upgrades from the interior. The typical exterior wall assemblies below show possible interior insulation repairs/upgrades. The details shown must be evaluated to confirm the addition and amount of interior insulation will not cause significant damage to the existing historic materials.

Insulating the interior side of mass masonry walls should be reviewed by a building envelope professional. Mass masonry walls are intended to absorb and store moisture, and dry to both the interior and exterior. Insulation on the interior hinders drying, and can cause the wall to stay wet for a longer period of time. Furthermore, by reducing the wintertime wall temperatures, it can exacerbate freeze/thaw cycling of the walls, thus a building envelope professional can evaluate whether the existing wall is durable enough to allow for interior insulation.



Mass masonry wall with interior insulation

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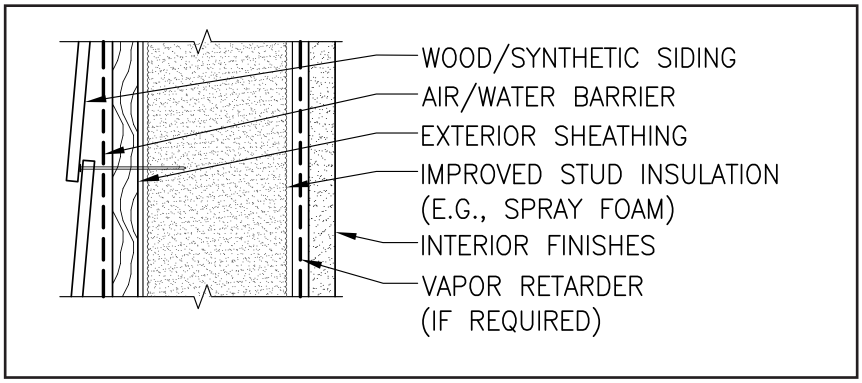
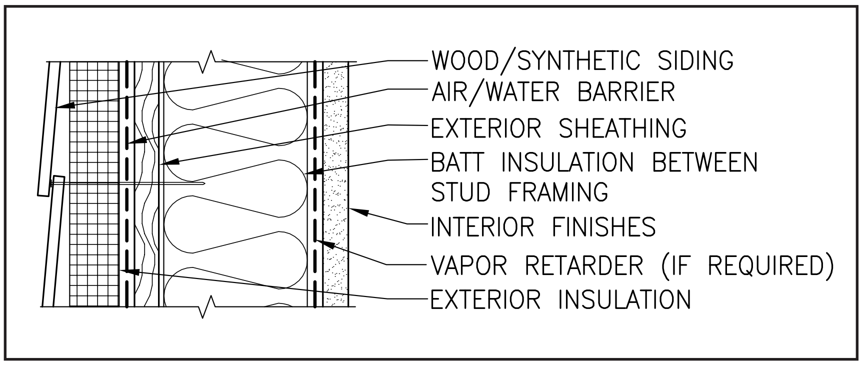
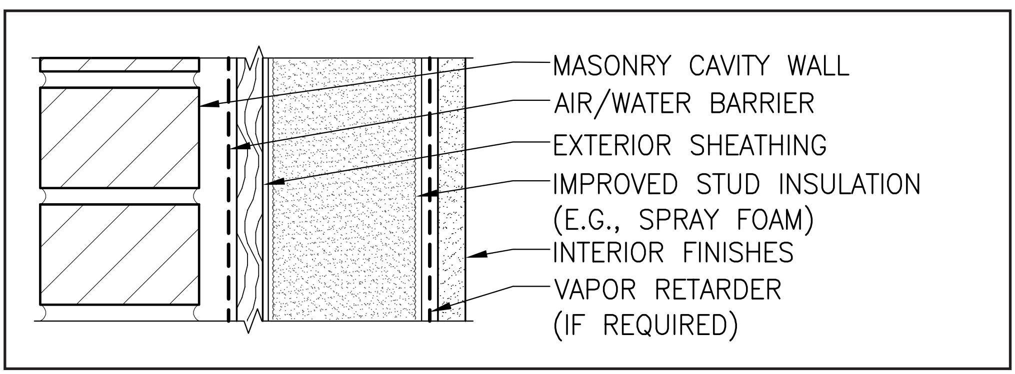
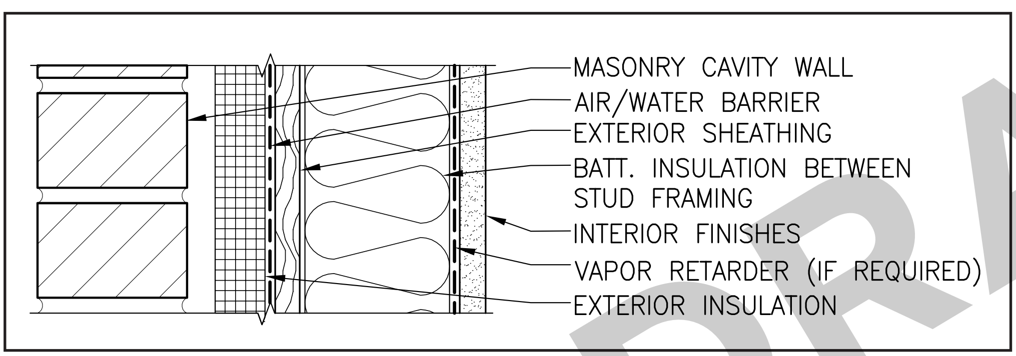




Framed wall with veneer





Framed wall with masonry veneer

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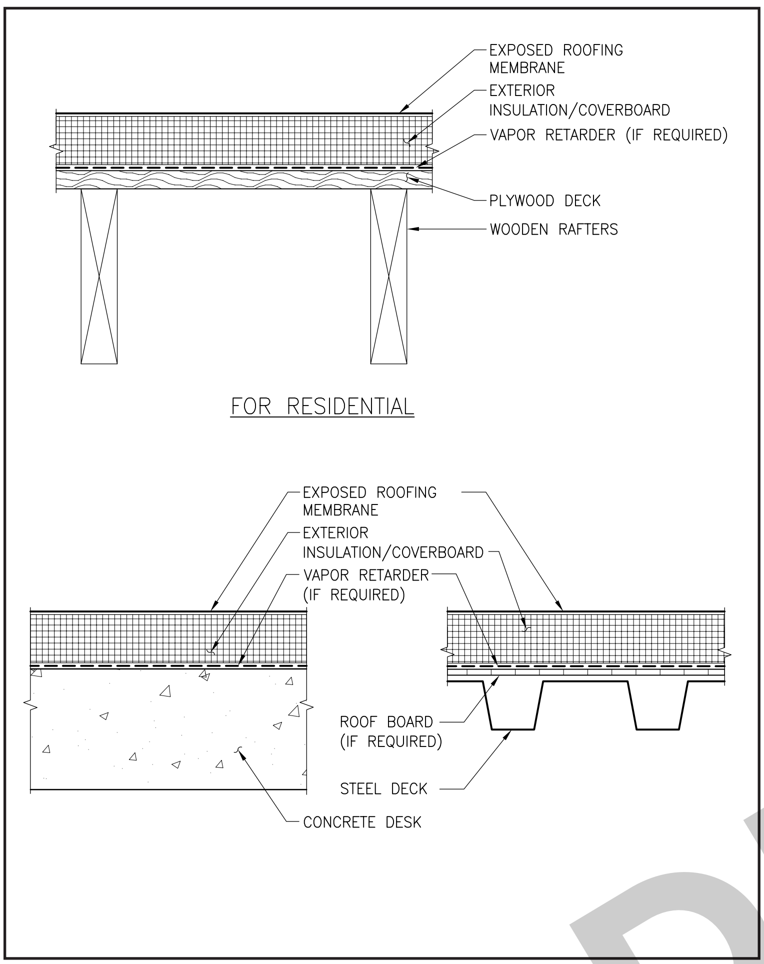
Roofs

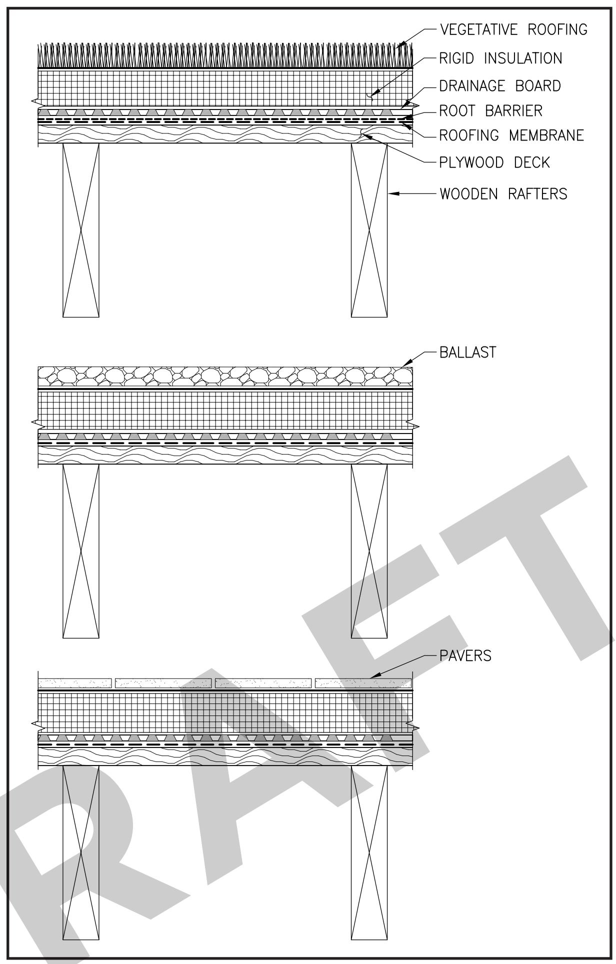
Insulating a roof or attic space can be an important step towards increasing energy efficiency of your building. Energy codes are progressively requiring more and more roofing insulation. There are several options for adding additional insulation to existing roof assemblies—insulation above the roof deck of a low-slope (flat) roof, insulation below the roof deck of a steep-sloped roof (e.g., cathedral ceiling), or insulation in the attic space below a steep-sloped roof.

For a low-sloped roof assembly above either a wood-framed structure (typical in residential construction) or a concrete or steel structure (typical in commercial construction), the preferred option for increased (or replacement) insulation is rigid insulation above a roof deck. The details below show a common low-slope "protected" roofing assembly with the insulation above the membrane, and several types of overburden to weigh down the insulation. The insulation may also go below the roofing membrane for exposed membrane applications.

In steep-sloped roofing assemblies (typical for residential construction), insulation improvements are typically determined by the use of the attic. Insulating along the underside of the roof deck, between rafters, increases the total conditioned space in the building, and is required for cathedral ceilings, or when mechanical equipment, ductwork, or other temperature/moisture-sensitive items are placed in the attic space. Alternatively, insulating the attic floor is typically done with batt or blown-in insulation between the joists. Regardless of the insulation arrangement, ventilating the space above the insulation by way of eave, gable and ridge vents is critical for passive ventilation.



Typical commercial low-slope roofing assemblies



Typical commercial low-slope roofing assembly

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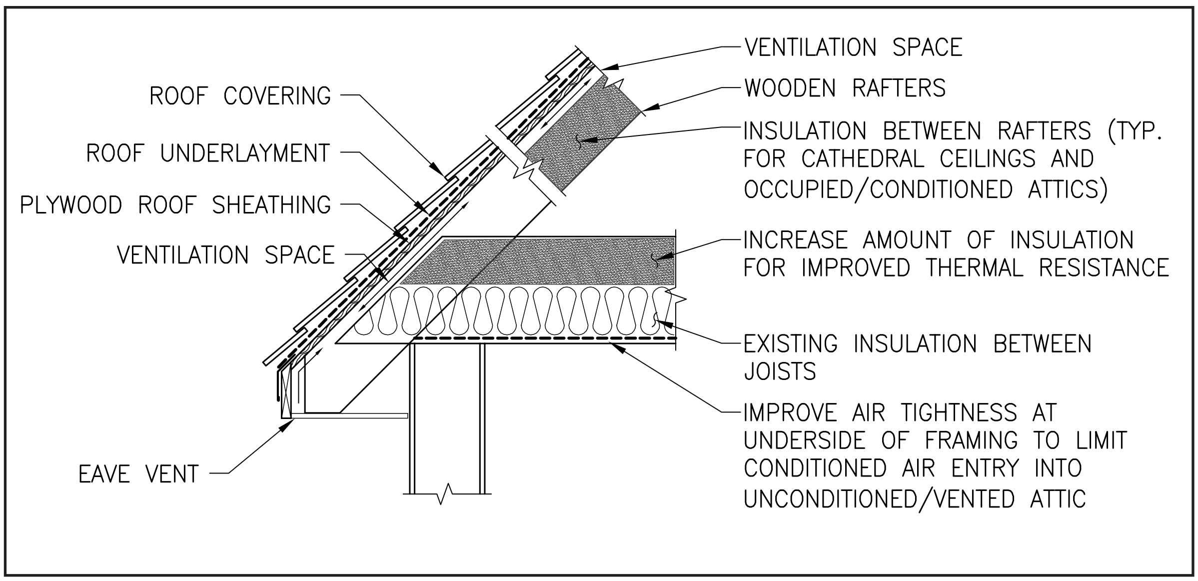
Roof Eaves

Passive ventilation is a critical part of residential roofing performance, reducing moist air build-up in the attic or along the underside of the roof deck, and also providing a way for rising warm air to escape the enclosure. However, roofs eaves and attics are common areas for thermal and air barrier inefficiencies, and can also allow conditioned interior air to escape if not properly detailed. Improving the air tightness of the ceiling assembly, or providing a dedicated air barrier above the conditioned space as shown in the figure below, can help improve energy efficiency while maintaining passive ventilation.

Adding more insulation to the attic or roof framing assembly, along with minimizing or relocating mechanical equipment and uninsulated ductwork to interior conditioned spaces, will also increase the thermal performance and overall energy efficiency. For proper passive ventilation, the insulation should be held back a minimum of 1 in. from the underside of the roof sheathing at the roof eave and continue up the roof slope to connect with gable end vents and/or ridge vents. Some resources also suggest radiant barriers or panels along the underside of the rafters to help reduce cooling loads in hot climates.



Roof eave vent

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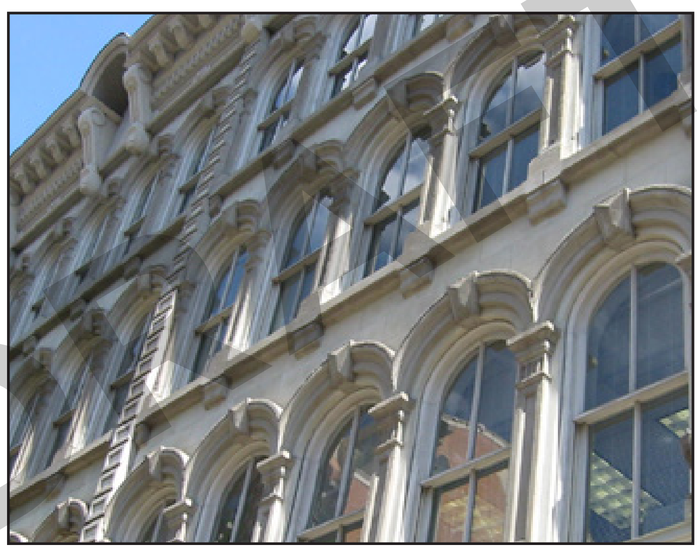
WINDOWS & DOORS

Windows and doors are often important architectural feature of older existing buildings. They provide a sense of scale, craftsmanship, proportion and architectural styling.

Most windows on older buildings are constructed of wood with a painted finish. Windows come in a variety of styles and configurations. They can be simple as simple as a single pane of glass in the upper and lower sashes, or have multiple panes in each.

Windows require regular maintenance and repair. In many historic buildings, the typical ratio of fenestration (i.e., windows, skylights, glass doors) to the total exterior wall surface area is around 20%. Consequently, the large expense for a full window or glazing replacement will only improve a limited area of the exterior enclosure, and may not be a cost-effective solution given the long pay-back period based on the projected energy savings from the upgrade in window performance. However, this option may be justifiable if there are other reasons for replacing the windows (e.g., interior leakage, window failures, etc.). Conversely, upgrading the remaining opaque area of the exterior enclosure (walls, roofs) and only performing moderate improvements to the existing windows (e.g., air sealing, interior storm windows, etc.) may prove a better return on investment while also retaining an important character-defining feature. Window replacement should be thoughtfully considered in the context of all potential energy retrofits.

Historic wood doors are significant features and should be retained, not replaced, where possible. While an insulated replacement door may have more thermal resistance, door replacements only represent a small area of the total exterior wall surface and may not have a significant effect on the overall building energy performance. Similar to windows, maintenance of the existing doors, including regular painting and renewed weatherstripping to maintain the current appearance, can be a low-cost strategy for improving energy performance.



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Strategies

LOW COST

Weatherstripping	• The majority of heat loss through historic windows occurs around the perimeter of the sash rather than through the glass. The tighter the seal around the window and between the upper and lower sash, the more energy efficient the window will be. • Replace interior and exterior perimeter sealant and weather stripping, which generally have significantly shorter lifetimes than windows. • Joint fillers, caulk, glazing putty and sealants can be used to seal cracks and openings on non-moving parts such as around frames and glazing. Metal, silicone, rubber and felt weather stripping can be applied to moving elements to provide a tighter fit without sealing them shut. • Adding inexpensive weather stripping to existing windows can increase their energy efficiency by as much as 50%.
Locking Mechanisms	• Repairing or replacing locking mechanisms or utilizing existing locks in the summer and winter can prevent excess air and heat loss through the window perimeter.
Window Treatments	• Adding interior shading or drapes to minimize heat gain or loss through the windows.

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Strategies

MODERATE COST	
Storm Windows/Doors	• Storm windows can be installed on the interior or exterior of a older window to greatly improve thermal efficiency. Exterior storm windows will require approval from the local historic review board, where applicable. • Storm windows provide additional insulation in the air space between the existing window and the storm window. They provide winter protection to historic windows where reglazing/replacing windows is cost-prohibitive or undesirable. To be effective, ensure a proper seal between both the glass and the frame and the frame of the wall. • Storm doors can improve the thermal performance of a historic door. Storm doors should be compatible with the appearance of a historic door, such as a fully-glazed storm door with a frame that matches the existing door.
Window Repair	• Maintenance and repair can extend the life of historic windows and greatly improve their energy efficiency. • The type of maintenance will depend on the window material and functionality.

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Strategies

HIGHER COST	
Reglazing Windows	• Reglazing can ensure that the window retains the same characteristic features, by keeping the existing wood/steel frame. • Retrofitting thermal glazing into existing single-glazed sash can improve the energy efficiency of historic windows while retaining the original sash and frame. Double-insulated glass within existing sash can provide a comparable level of energy efficiency as a standard new double-glazed unit if done in concert with the installation of weatherstripping. • Reglazing existing older windows is typically comparable in price to replacing with new windows. However, it provides less flexibility in the replacement glazing than full replacement, as the new glass thickness typically has to match the existing to fit within the frame.
Replacement	• Replace existing windows with new insulated windows. • Note that window replacement is not always the most efficient or most cost effective solution. » The service life of historic wood windows is significantly longer than that of modern insulated windows, and provide more capability for repair. » Window replacement has a relatively low return on investment, and should be performed only in instances where repair of existing is impractical due to poor design or materials.

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Guidelines

1. Perform regular maintenance on older windows and doors to ensure functionality and weathertightness.
2. Install weatherstripping and caulk where appropriate to make windows and doors weathertight.
3. Refer to DC Historic Preservation Design Guidelines:
    - » Window Repair and Replacement Preservation and Design Guidelines: https://planning.dc.gov/node/936492
4. Install removable storm windows for added insulation in the winter.
5. Repair or reopen transoms to improve air flow and cross ventilation.
6. Maintain, repair, or reinstall operational shutters and awnings.
7. Preserve decorative and functional features of a primary entrance such as the door, frame, screen, threshold, glazing, panels, hardware, transoms, sidelights.
8. Retain and preserve original materials of commercial storefronts. Install awnings where appropriate to provide shade for pedestrians and store windows.
9. If window replacement is necessary, replacement windows should match the size, design, muntin profile, color and appearance of the historic windows.
10. Replace missing windows with new, energy-efficient windows that are appropriate to the style of the historic building that are also durable, repairable and recyclable.
11. Use clear (low-e) glass or film without a noticeable color to reduce solar heat gain.
12. Prior to considering replacement windows, property owners should consider whether weather stripping, storm windows or basic repairs can achieve improved energy efficiency.

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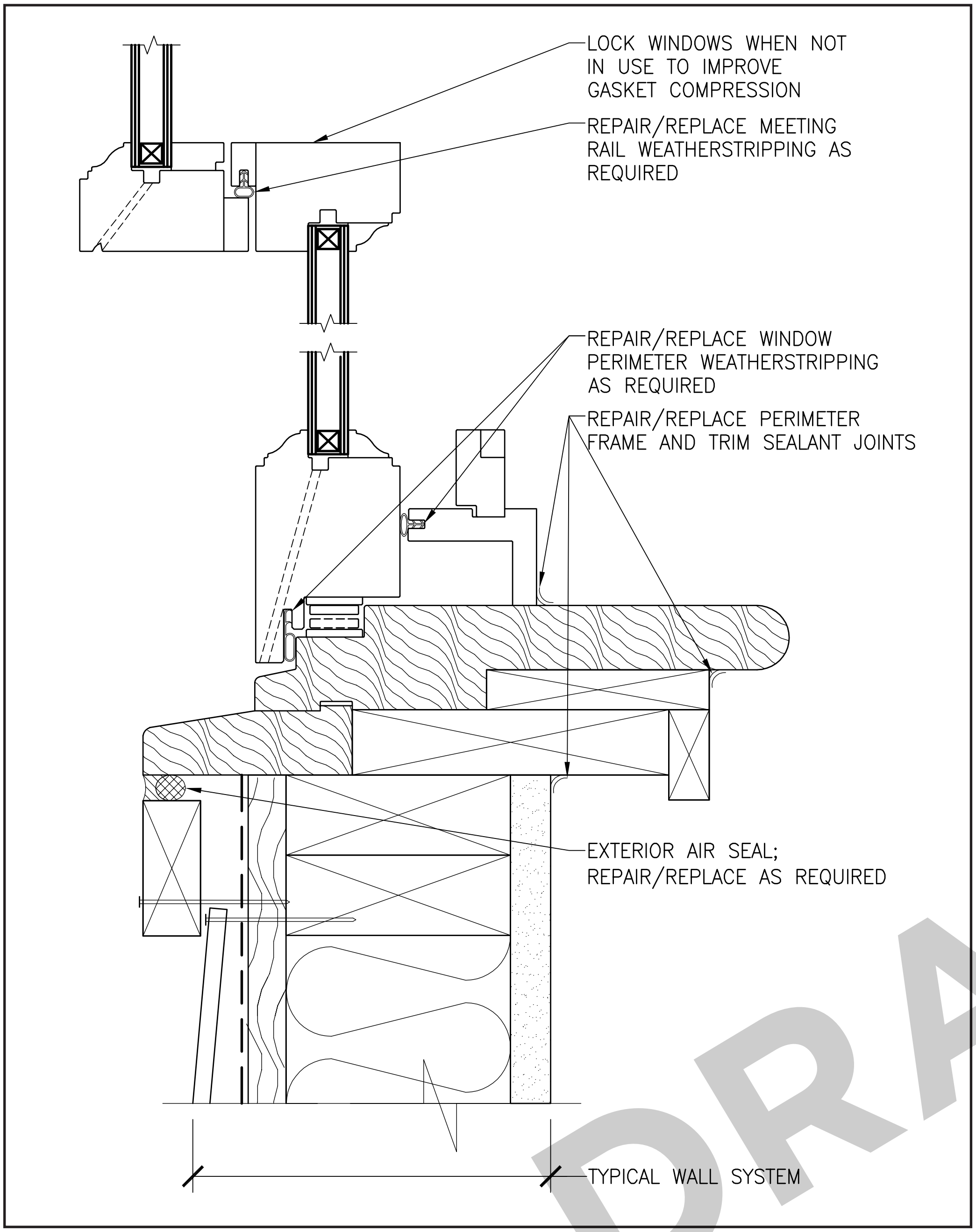
Windows

Regular maintenance and replacement of interior and exterior perimeter seals, gaskets, and weatherstripping around windows and doors, especially at operable units that rely on the continuity and compression of these components to resist air infiltration and water penetration, can significantly improve the energy performance of existing doors and windows. The figure below shows a typical wood-framed double hung window unit and identifies common locations for interior and exterior sealant joints, and gaskets or weatherstripping integral to the unit that should be regularly maintained and replaced when necessary.



Wood window weatherstripping

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LANDSCAPE, SITE FEATURES, & WATER EFFICIENCY

Landscaping and site features are generally eye-pleasing and improve the appearance of a property, but can also be a cost-effective way to reduce energy use, resource consumption, and heating and cooling costs. In addition, landscape, site feature, and water efficiency strategies (sometimes referred to as green infrastructure) help manage stormwater and reduce the phenomenon known as heat island effect.

Stormwater is the excessive rainfall that is unable to soak into the ground, and as a result floods streets or empties through storm drains into the nearest body of water. Unmanaged stormwater inundates infrastructure, contributes to flooding, and negatively impacts our environment as it pollutes groundwater and nearby water bodies.

Existing landscape and site features that enhance building performance, stormwater management, and improve interior comfort should be maintained and supplemented using new strategies such as permeable paving, green roofs, rain gardens and planter boxes, and rainwater harvesting, including underground cisterns.

Urban Heat Island Effect:

Extensive paved surfaces in urban areas are known to raise ambient temperatures above those of the surrounding region. As a result, downtown is sometimes 10-15 degrees hotter on summer afternoons than surrounding rural areas.

The increased temperatures lead to greater ozone production and poor air quality.

Green Infrastructure:

Many of the following strategies are considered green infrastructure, which is an approach to stormwater management that works to restore the natural processes required to manage water and improving human health.

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Strategies

LOW COST

Landscaping	• Preserve existing trees and plants, particularly where mature trees are present. • Use native plants, shrubs, and well-placed trees to reduce water consumption and provide shade and wind protection. • Perform routine maintenance of trees to promote tree health and avoid property damage.
Compost Landscaping	• Use compost food scraps to enrich soil instead of store-bought chemical fertilizers.
Rainwater Harvesting - Rain Barrels	• Rainwater harvesting systems collect and store rainfall from rooftops or other impervious surfaces to rain barrels or below ground cisterns where it is stored for non-potable uses or for on-site disposal or infiltration. • Stored water can be used for non-potable uses including irrigation; washing sidewalks, cars or pets; refilling water features or swimming pools; and can be connected to indoor non-potable fixtures such as toilets and clothes washers. If treated, it may also be used for potable uses. • These systems range in size and cost. They also come in a variety of materials including ceramic, wood, and plastic.
Water Efficient Irrigation Systems	• Install systems that reduce water consumption such as drip irrigation, soaker hoses, moisture sensors and timers.

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Strategies

MODERATE COST

Permeable Paving	• Permeable paving materials allow stormwater to filter through voids or pervious joints in the surface where it is captured in underlying layers of soil and gravel. • Examples include: porous asphalt, porous concrete, brick pavers, vegetated permeable pavement, interlocking pavers, and more.
Rain Gardens & Planter Boxes	• Shallow vegetated basins or planter boxes capture and store stormwater runoff and pass it through a filter bed of engineered soil media composed of sand, soil and organic matter. Filtered runoff may then be collected and returned to a storm sewer or allowed to infiltrated into the soil.

Examples of permeable pavement.

Maintain mature and healthy trees and landscaping.

Examples of different composting methods.

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Strategies

HIGHER COST

Green Roofs	• Also known as vegetative roofs, green roofs are made up of a series of waterproofing and protective layers covered by a growing medium suitable for growing plants that don't need significant amounts of water. • Green roofs are an effective way to address stormwater management and reduce runoff. They also provide shade, improve noise insulation from rooftop mechanical equipment, and reduce roof surface temperatures thereby lessening mechanical loads and countering heat island effect. Green roofs also act as a filter to help neutralize acid rain and trap dust and airborne particles.
Rainwater Harvesting - Underground Cisterns	• Underground cisterns, like rain barrels and above ground systems, collect and store rainfall from rooftops or other impervious surfaces for later use. Underground cisterns have a wide capacity range (250-30,000+ gallons), though residential cisterns typically have a capacity of about 1,500-5,000 gallons. • Underground cisterns are constructed of concrete, fiberglass or steel with an above ground manhole access cover for maintenance and inspection. Most cisterns have a standard pressurized plumbing system that conveys water to the house or wherever needed for use.

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Guidelines

LANDSCAPING & SITE FEATURES

1. Identify and preserve existing inherently sustainable features such permeable paving and surfaces and mature trees that block harsh sun or serve as a wind break.
2. Identify and preserve character-defining features within the landscape. These may include: masonry walls and walkways, stairways, plantings, fences, gates, etc.
3. Do not introduce new features that are visually incompatible in size, scale, design, materials, color and texture.
4. Do not undertake work that would impact topography, particularly if the topography is a character-defining feature of the site or surroundings. Document and evaluate topographic variation such as shape, slope, elevation, aspect and contour.
5. If character-defining or inherently sustainable features are deteriorated beyond repair and in need of replacement, replace with compatible, appropriate materials and indigenous plant species.
6. Place new trees and landscaping away from foundations or basement walls to avoid moisture infiltration from watering or damage from roots. Select new plant and tree species according to their mature size to account for the long-term impact of mature growth.
7. Do not allow vines, ivy, or other growing plants to grow directly on building or site walls, as they can cause damage to underlying materials.
8. Avoid paving up to the building foundation with impermeable surfaces as this can increase building temperature, cause damage to the foundation, and trap moisture. Instead use permeable paving materials.
9. Install permeable paving that is compatible with the character of the building and surroundings in place of impervious hardscaping materials for patios and walkways where appropriate.
10. Consider the character of the property and surrounding area when designing rain gardens or planter boxes. Select compatible and appropriate plant species.

RAINWATER HARVESTING

1. Above ground rainwater collectors should be placed in unobtrusive locations, tucked in a corner or in a rear yard not visible from the public right of way.
2. Avoid placing collectors in locations that would obscure character-defining features.
3. Provide appropriate screening for visible rain barrels or collectors if visibility is unavoidable and if the appearance is incompatible with the character of the building or its surroundings.

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Guidelines

4. Do not install underground cisterns where excavation or drilling would disturb significant archeological resources or character-defining features of a cultural landscape.
5. When undertaking major excavation or regrading for installation of an underground cistern, ensure protection of nearby buildings, trees, and site features. Implement a protection and monitoring program during construction.

A ceramic and plastic rain barrel (left) and a plastic rain barrel tucked between two porches (right). The example on the right is minimally visible because of its placement and surrounding landscape while the plastic barrel on the left would benefit from some screening.

GREEN ROOFS

1. Engage a structural engineer or architect to ensure the building has enough structural capacity to support a green roof. The roof must support the weight of additional roofing materials and the water it will absorb.
2. Make sure your roof is water tight and has a functional drainage system.
3. Implement a regular maintenance schedule and moisture-monitoring system protect the building from added moisture and damage. Adequate access to the roof is necessary.
4. Green roofs are ideal for buildings with flat or slightly-sloped roofs that have a substantial parapet or cornice that obscure the green roof from view.
5. Retain original character-defining roofing features and materials. Consider installation on a building addition or secondary structure on the site.
6. Set vegetative materials back from the edge of the roof to minimize visibility, especially if on a low-rise building or if there is not a substantial parapet for screening.
7. Select low, appropriately-scaled, herbaceous plants and perennial grasses that will not be visible from the public right of way.

Visibility of the green roof on this low-rise building is minimized by the setback from roof edges.

DC Historic Preservation Design Guidelines:

- *Landscaping, Landscape Features and Secondary Buildings in Historic Districts:* https://planning.dc.gov/node/594342

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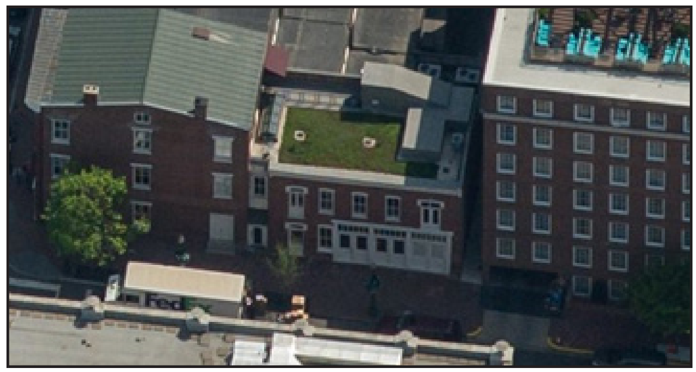
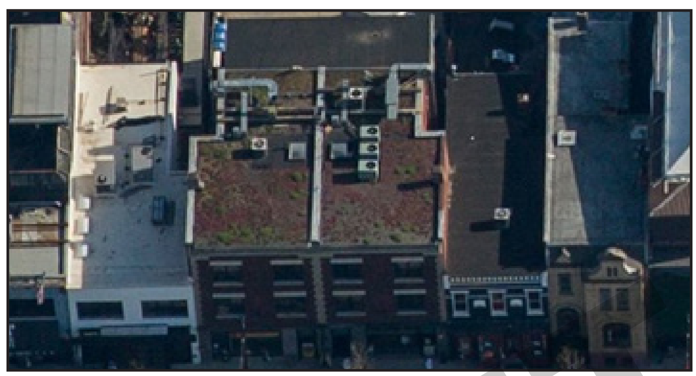
Guidelines

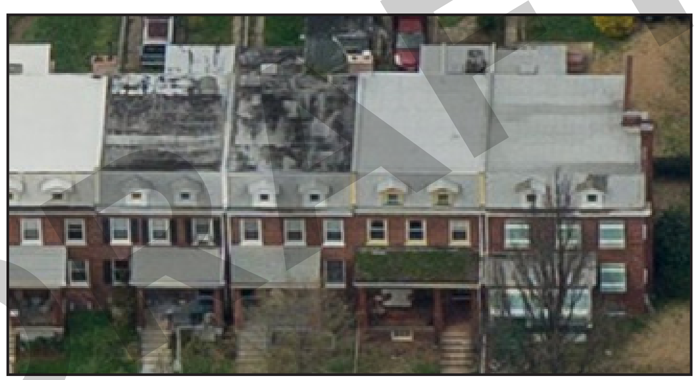

This example took advantage of a rear addition, reducing visibility and avoiding removal of original building materials.

Visibility of the green roof on this low-rise building is minimized by a setback from roof edges.

The extensive green roof on this commercial building is obscured from view by its parapet and cornice.

This green roof is installed on the porch roof, with high visibility from the street. The underlying waterproof membrane is visible below the plant materials.

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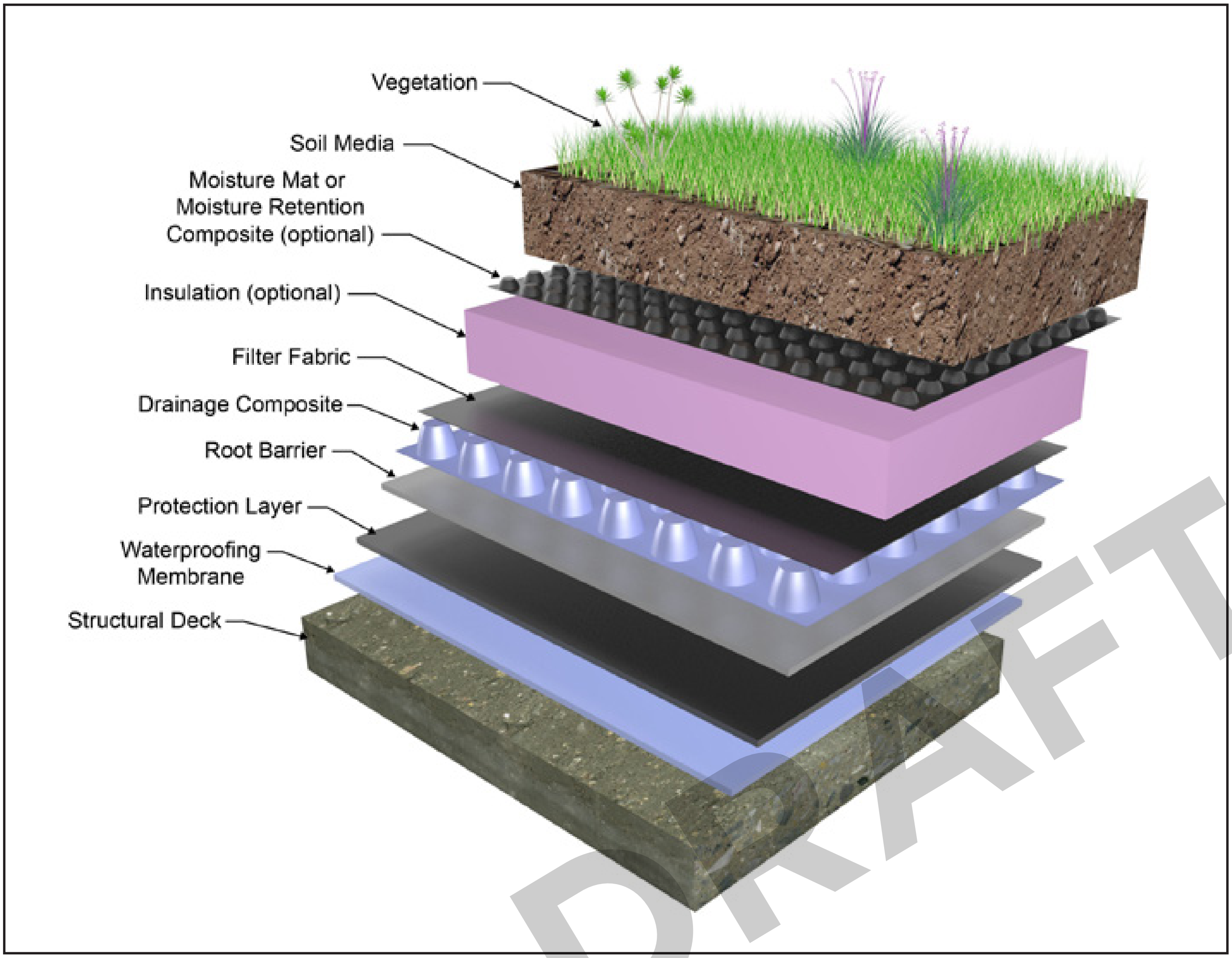
Green Roofs

Vegetative green roofs generally include the following components, as indicated below: a supporting structure, continuous waterproofing membrane, root barrier, a drainage layer/moisture retention mat system, insulation, and soil and plantings. The selection of an appropriate waterproofing membrane, combined with the proper construction of typical detailing and base flashing, is critical for providing a durable watertight long-term roofing assembly. The soil media, insulation, and drainage/moisture retention systems must all be designed to reduce the volume of runoff.

Involving a licensed architect or engineer is a prudent first step in selecting the appropriate system for the existing structure, as they can help provide guidance by analyzing and reviewing the relevant details, drainage, installation, and any suggested quality control measures or testing of the system. Additionally, engaging a licensed roofing contractor or the vegetative roofing supplier can help with providing guidance on maintenance of the plantings.



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Typical green roof assembly showing the individual layers and components

RENEWABLE ENERGY

On-site renewable energy systems are increasing in prevalence in the District and can be added on a building or property to capture renewable energy and reduce reliance on fossil fuels. Examples of renewable energy systems commonly used in the District include solar photovoltaic, solar thermal, as well as geothermal.

Renewable energy systems have been installed on many existing older buildings including historic landmarks and buildings located within historic districts; however, installation may not be appropriate in all instances.

The District has many programs promoting and assisting the installation of renewable energy systems. Many of these resources are found in Section V.

Solar Photovoltaic (PV) Systems

Solar photovoltaic (PV) systems capture sun rays and convert the sunlight into electricity. These systems can be a cost-effective and reliable producer of electricity. The basic building blocks of a PV system are solar cells. Solar cells consist of semiconductor materials, such as crystalline silicon or thin-films, that absorb sunlight and convert it into energy for immediate use or storage in batteries. There are a variety of solar cell materials available which vary in their appearance and efficiency.

PV systems are modular, meaning they can (and should) be designed to meet the specific energy needs of a building and its users. Solar cells are generally interconnected with other cells to form flat-plate panels or modules and installed on a building, or in a rack to form a PV array. Panels can either be fixed in place or allowed to track the movement of the sun. Thin-film PVs a make it possible for solar cells to double as rooftop shingles, roof tiles, building facades, even glazing for skylights. These systems are new to the residential market and are increasing in popularity and effectiveness. Products such as the new solar roof shingles have the potential to integrate renewable solar energy in a subtle and attractive way on older existing buildings.

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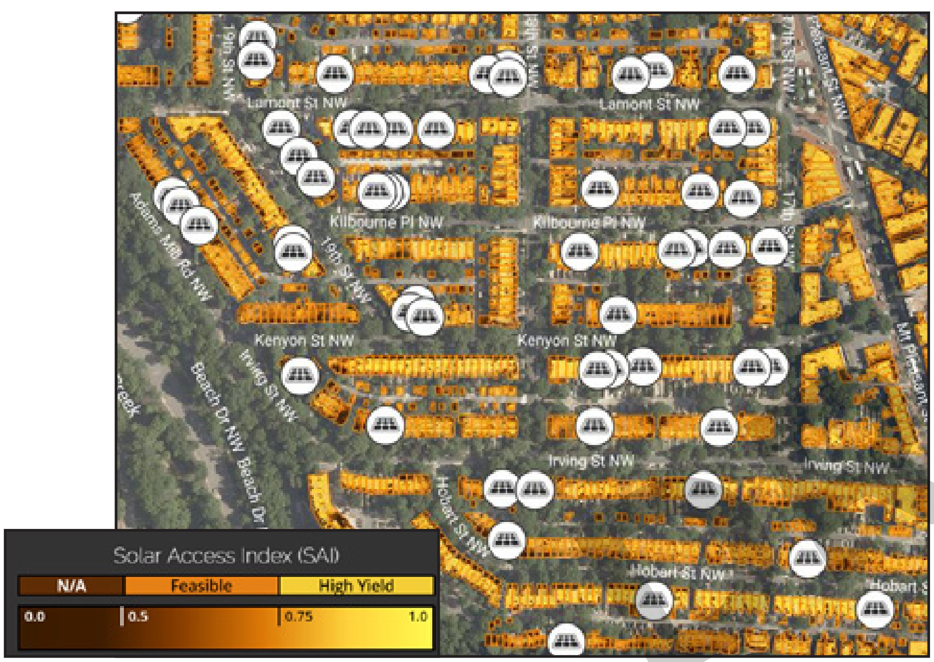
Solar Thermal Systems

Solar thermal systems differ from PV in that they use solar radiation to provide clean heat energy for water or space heating. Systems use solar collectors, box structures with dark surfaces that are typically installed on a roof. As the liquid passes through the collector, it is warmed and then circulated through the building for use. Active thermal systems use fans or pumps to circulate air or liquids through the collectors to heat for use or storage. In the District, a conventional electrical or natural gas system is typically used as a backup.

Because solar photovoltaic and thermal systems are dependent on regular access to sunlight, they will not be practical for all locations depending on orientation to the sun, tree cover, etc. Visibility of solar systems may also be a limiting factor, especially for historic landmarks and buildings located in historic districts. When considering renewable energy systems, is important to balance project goals, historic character, and sustainability.

Mapdwell Solar System (below) is an interactive online rooftop solar mapping tool that allows users to determine their rooftop solar potential as well as where solar has been installed elsewhere in their community.

If on-site solar is not an option due to access to sun or impacts to the character of a building, explore other options for renewable energy such as community solar, which allows multiple users to share the benefits of one local renewable energy source.
Because solar photovoltaic and thermal systems are dependent on regular access to sunlight, they will not be practical for all locations depending on orientation to the sun, tree cover, etc. You can use this tool to determine your rooftop's solar potential and to see where solar systems have been stalled elsewhere in the District: https://www.mapdwell.com/en/solar.dc



Mapdwell Solar System(left) is an interactive online rooftop solar mapping tool that allows users to determine their rooftop solar potential as well as where solar has been installed elsewhere in their community.

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Guidelines

SOLAR PV & SOLAR THERMAL SYSTEMS

1. Locate solar installations so that they are not visible from the public street view.
2. Install solar systems so that they do not result in a perceptible change in the building's massing, height or roofline, and do not cover or obscure distinctive roof features or finishes.
3. Avoid solar installations that would result in the permanent loss of significant character-defining features, such as the removal of distinctive roof features or finishes.
4. Consider placing solar systems on a secondary building or rear addition where they may have less impact than on the primary roof.
5. Install solar systems in a manner that does not damage the building's roof or roof structure.
6. Ensure that the roof structure and sheathing are in good condition before installing a solar system to avoid having to remove the installation for roof repairs.
7. If placed in the landscape, provide adequate screening to limit visibility of solar installations from public street view.

FOR BUILDINGS WITH FLAT ROOFS:

8. Place solar panels at a low angle to reduce their potential for visibility from public street view; the more horizontal the orientation, the less visible it will be.
9. Set the solar panels back from the edge of the roof to minimize visibility, especially if it is a low-rise building or if there is not a substantial parapet.
10. Hang structural supports below the top of parapet walls that are visible from street view rather than resting supports on top of parapets.

FOR BUILDINGS WITH SLOPED ROOFS:

11. Locate solar installations on a rear roof slope.
12. Set solar panels away from roof edges and ridges to minimize visibility.
13. Install low-profile panels flush with the roof in complementary color with the roof finish to avoid a discordant or visually obtrusive addition.
14. Consider solar roof shingles and films.

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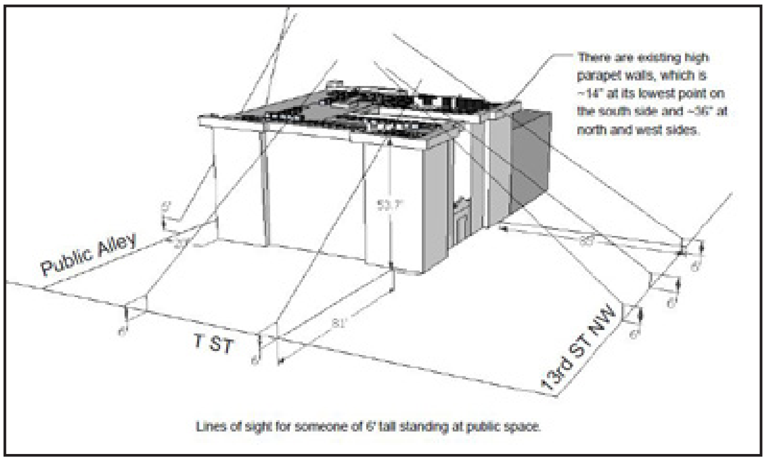
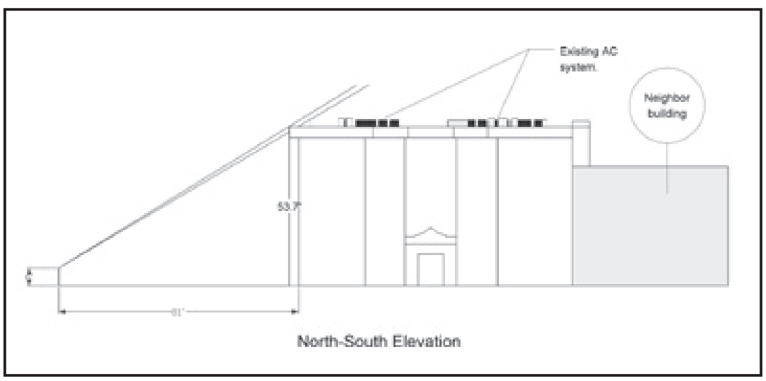
Installation of Solar PV or thermal systems require permits and inspections from DCRA. Historic landmarks and buildings in historic districts will also require historic preservation review. The below images and drawings show a way to diagram the impact and visibility of the PV array.

For more information, see the Solar Permitting Guidelines from DCRA:
https://dcra.dc.gov/publication/solar-permitting-guidelines

THE WHITELAW HOTEL CASE STUDY



Axonometric View: An example sight line study used to determine whether or not installation of solar panels would be visible from the street.



Section View

A successful outcome; a mock up was installed to ensure that panels would not be visible over the parapet from streets.

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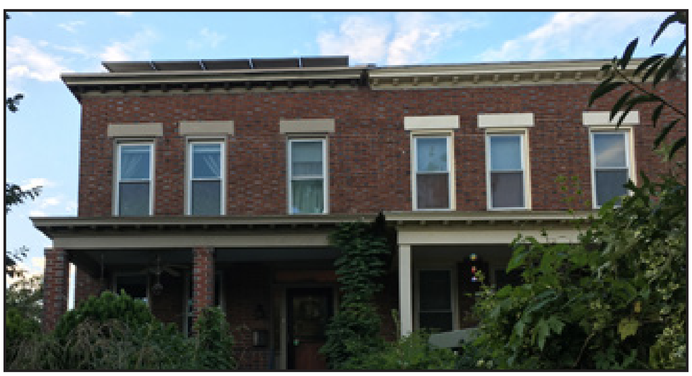
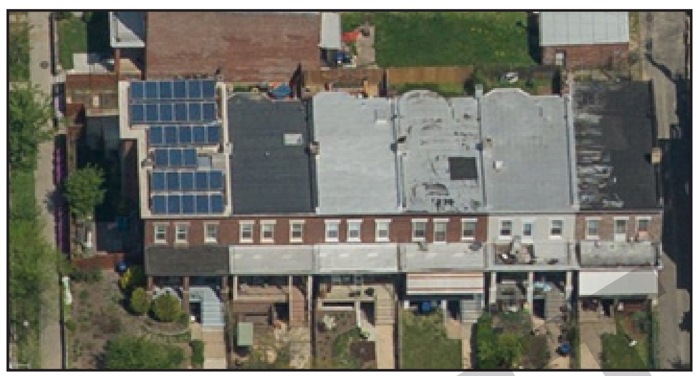
Guidelines

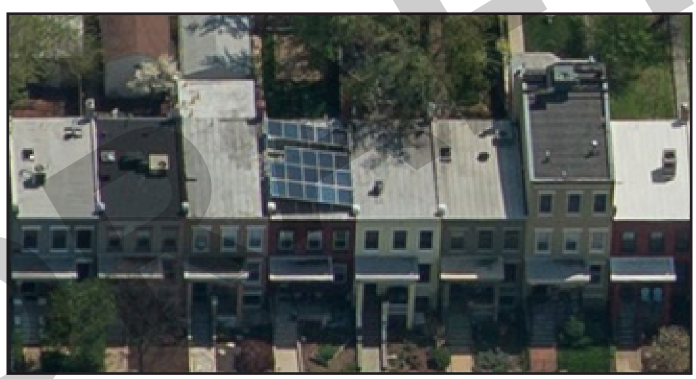
Solar panels on the rear roof slope of this semi-detached house are installed flush to the roof and setback from edges minimizing visibility from the street.

Panels installed on the flat roofs of this row are imperceptible from the street, hidden by parapets and pent roofs.





Visibility of solar panels on this corner rowhouse would be significantly improved if they were setback from roof edges.

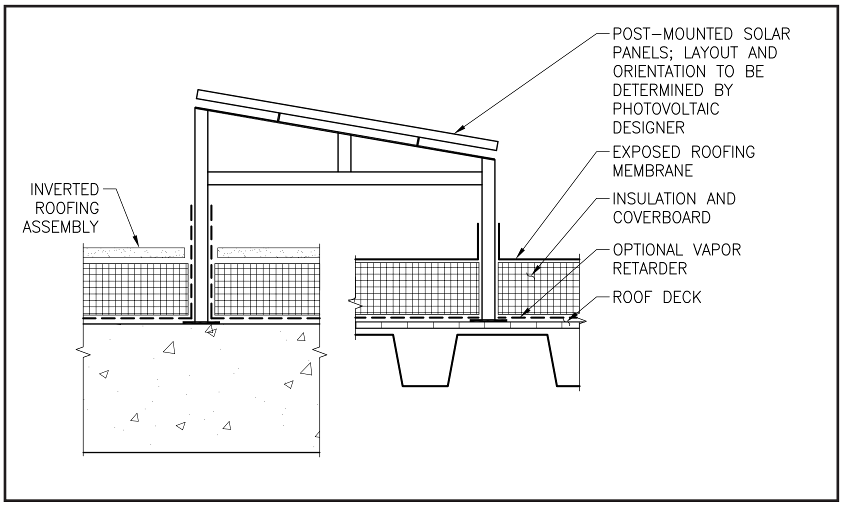


Panels on this rowhouse are tilted at a high angle, which increases visibility and disrupts the roofline of the row.

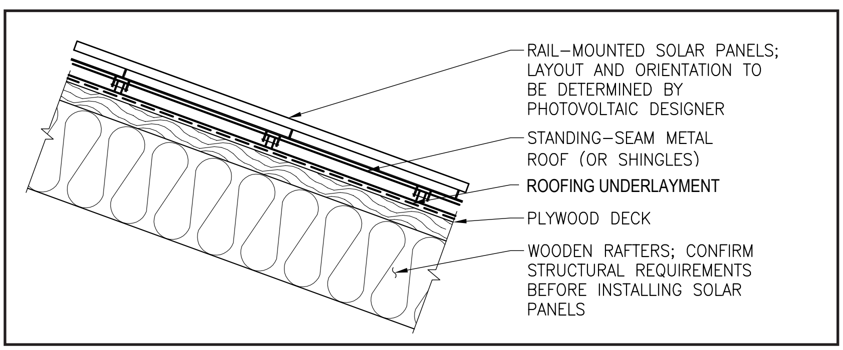
Photovoltaic Panels

It is most efficient to mount PV panels with a southern exposure at an angle equaling the latitude coordinate of a given location to optimize the solar exposure year round: for Washington DC, that is approximately 39°N or a 9.5:12 slope roof. However, mounting PV panels at this exposure and angle is not always practical.

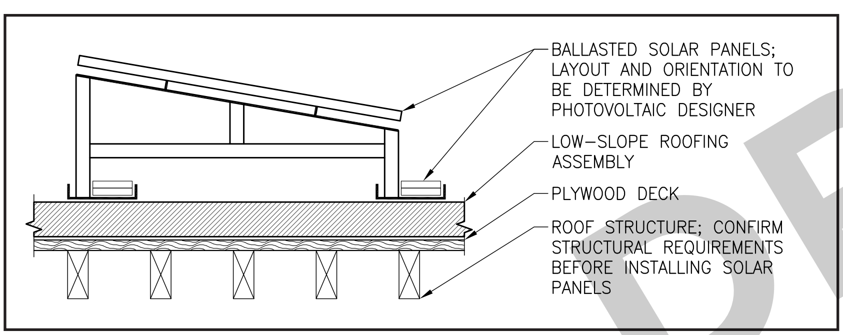
In general, for steep-slope roofs, it is recommended that PV panels be mounted along the most southern exposure, or SW exposure, matching the roof slope to avoid sightline impacts. For southern exposures on the primary elevation, the PV panels may need to be held back from the roof edge to avoid visual impacts from the street level. On flat roofs, it may be easier to orient and mount PV panels with the preferred exposure and angle, but the dunnage (supporting structure) should be located away from primary elevation to limit visual impacts from adjacent spaces.



Post-mounted solar panels



Rail-mounted solar panels (for metal roofs)



Ballasted solar panels (for low-slope roofs)

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Geothermal Systems

Geothermal heat pump systems (GHPs), also known as ground-source heat pumps, take advantage of the relatively constant temperature stored below the earth's surface (50-60 degrees Fahrenheit) to provide heating and cooling in buildings. A ground loop is a heat exchanger, similar to a cooling coil or an evaporator in a chiller, that either extracts or adds heat to the ground. There are four types of ground loop systems including: horizontal, vertical, and pond/lake (all closed-loop systems, and open loop. The type of system depends on the climate, soil conditions, available land, and installation costs, though in the District systems are generally vertical, closed-loop.

GHPs are extremely efficient, last a long time, and are typically well suited for historic buildings because they require little equipment and are not visually intrusive. When compared to traditional HVAC systems, they require less equipment, have fewer moving parts, provide better zone space conditioning, and maintain better internal humidity levels. GHPs can cut energy bills by up to 65%. The cost for geothermal systems can be high as they require drilling and placement of wells deep below grade, though typically, energy cost savings allow the investment to be recouped within two to ten years.

Diagram of a typical vertical, closed-loop system.

Additional information on GHP systems can be found here:
https://planning.dc.gov/publication/geothermal-heat-pump-design-manual

Guidelines

GEOTHERMAL

1. Do not incorporate where excavation or drilling would disturb significant archeological resources or character-defining features of a cultural landscape.
2. Place above ground components in an inconspicuous location and provide adequate screening if necessary.
3. When undertaking major excavation or regrading for installation of a geothermal system, underground cistern, etc., ensure protection of nearby buildings, trees, and site features. Implement a protection and monitoring program during construction.
4. Also see guidelines under Landscape, Site Features, and Water Efficiency.

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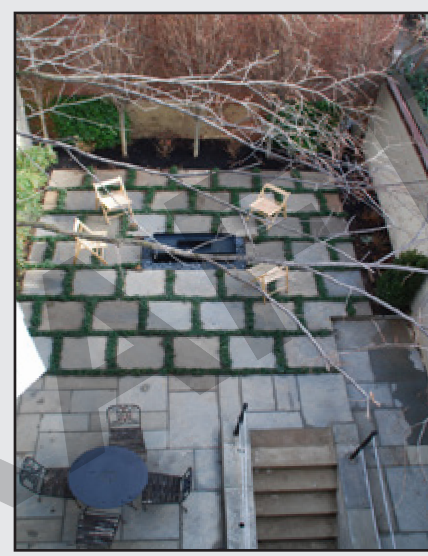
RENEWABLE ENERGY CASE STUDY "CARBON NEUTRAL ROWHOUSE"

Location	Capitol Hill Historic District, Ward 6
Description	This mid-19th century rowhouse located four blocks from the U.S. Capitol underwent a major retrofit and renovation to improve efficiency and remove unsympathetic additions such as metal siding, awnings, and a concrete porch. A geothermal system, solar thermal water heating system, insulation, and other retrofit strategies, such as permeable paving, landscaping, tankless hot water heater, LED lights, and Energy Star appliances were implemented. These strategies have helped this semi-attached single family house gain energy savings of 60-80%. The project was awarded the District of Columbia Award for Excellence in Historic Preservation in 2010.
Strategies Used	Geothermal, solar thermal system, insulation, system upgrades, permeable pavers and landscaping, efficient lights and appliances.



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Renewable Energy Resources

ADDITIONAL INFORMATION & RESOURCES

U.S. Department of Energy, "Planning for Home Renewable Energy Systems":
https://energy.gov/energysaver/planning-home-renewable-energy-systems

SOLAR

- DCRA Solar guidelines:
  https://www.buildgreendc.org/solar/
- NPS, "Solar Panels on Historic Properties":
  https://www.nps.gov/tps/sustainability/new-technology/solar-on-historic.htm
- DOEE, Solar initiatives and resources:
  https://doee.dc.gov/solar

SOLAR THERMAL

- DCRA solar system guidelines:
  https://static1.squarespace.com/static/53beb24ee4b0fec1ec33e9ac/t/5638b94ee4b0924367e96ff7/1446558030116/Solar+Thermal+Systems+Guidelines.pdf
- Energy.gov solar water heaters:
  https://energy.gov/energysaver/solar-water-heaters
- Active solar heating:
  https://energy.gov/energysaver/active-solar-heating

GEOTHERMAL

- Department of Energy, "Geothermal Heat Pump Basics":
  https://energy.gov/eere/energybasics/articles/geothermal-heat-pump-basics

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INCENTIVES AND FUNDING SOURCES

- https://www.buildgreendc.org/incentives/
- DC Pace Financing:
  http://urbaningenuity.com/dc-pace
  - » Property Assessed Clean Energy (PACE) is a financing tool in Washington, DC that allows property owners to repay the cost of energy efficiency, water and renewable energy improvements over time through a special assessment placed on the property.
- DCSEU discounts and rebates for residential:
  https://www.dcseu.com/for-my-home
  - » Homeowners: Energy Use, Appliances, Audits and Insulation, Heating and Cooling, Electronics and Lighting. Incentives, programs and tips on lowering your energy bill exist across theses categories.
- DCSEU discounts and rebates for businesses:
  https://www.dcseu.com/for-my-business
  - » Business owners: Efficient Equipment, Affordable Housing and Benchmarking. Incentives, programs and tips exist across theses categories.
- Federal Residential Renewable Energy Tax Credit:
  https://energy.gov/savings/residentialrenewable-energy-tax-credit; https://www.energystar.gov/about/federal_tax_credits

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IV. REGULATORY OVERVIEW

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HISTORIC PRESERVATION REVIEW

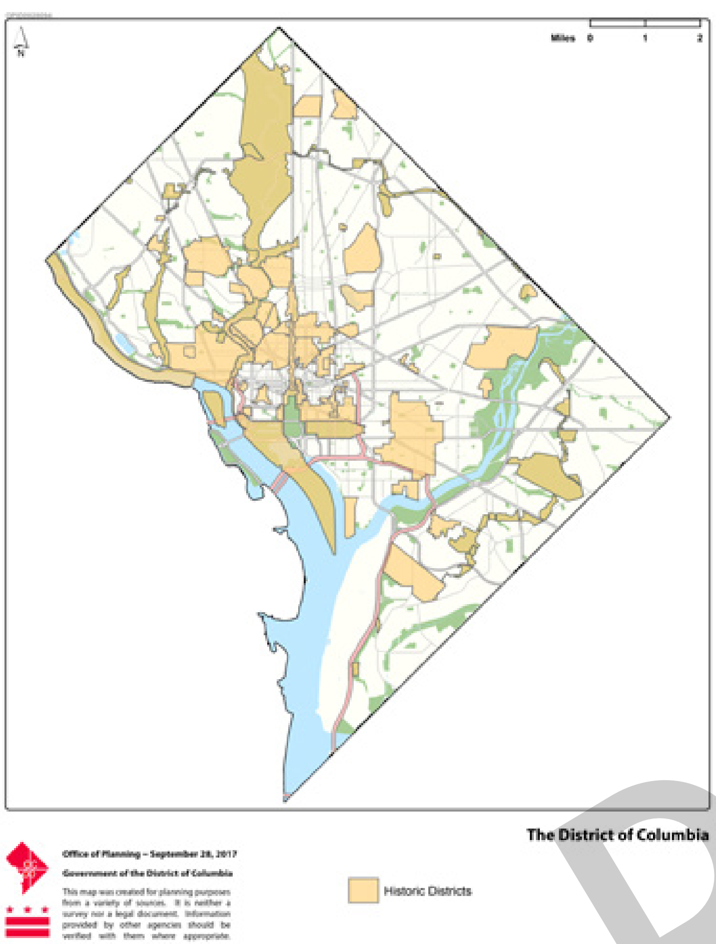
WHAT IS A HISTORIC LANDMARK OR DISTRICT?

A historic landmark is a building, structure, object or feature, or a site that is listed in the National Register of Historic Places or in the District of Columbia's Inventory of Historic Sites.

A historic district is a geographic area listed as a historic district in the DC Inventory of Historic Sites or nominated to the National Register of Historic Places by the State Historic Preservation Officer. (DC Municipal Regulations Title 10A; Chapter 99 Definitions)

In historic districts, buildings and other resources located within the historic district are identified as contributing or non-contributing.

Contributing buildings and resources are those that are integral to defining the historic character of the historic district and conveying its significance. Contributing buildings are generally constructed within the historic district's period of significance and represent its history. The significant features of these buildings and resources should be preserved.



Non-contributing buildings and resources are those that do not contribute to the historic character of the district. These properties generally include vacant lots, buildings built outside the district's period of significance, buildings that have been so altered that they no longer convey the historic and architectural character of the district, or buildings unrelated to the historic character of the district.

IT IS IMPORTANT TO NOTE THAT <u>BOTH</u> CONTRIBUTING AND NON-CONTRIBUTING BUILDINGS REQUIRE HPO REVIEW IN HISTORIC DISTRICTS.

For further information and full texts of the preservation law and regulations, see the HPO website at http://planning.dc.gov/page/historic-preservation-office.

To find out whether your property is located in an historic district, check www.propertyquest.dc.gov

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HISTORIC PRESERVATION REVIEW & PERMITS

HISTORIC PRESERVATION REVIEW

The preservation review process is administered by the D.C. Historic Preservation Office (HPO) which has a professional staff of architects and preservation specialists who can provide architectural and technical assistance on products and methods appropriate to the renovation of older properties.

Most types of work affecting a building in the District of Columbia require a building permit. Permits ensure compliance with construction, zoning, fire, electrical, and other applicable codes to protect the safety and well-being of District residents. The HPO reviews all permit applications for exterior work on landmarks and in historic districts to ensure compatibility with the site and surrounding neighborhood. Permits are required for window, door, porch, and roof replacements; work and replacement of front steps or walks; retaining wall construction or repair; re-pointing brick masonry; installing or replacing fences; additions, new construction, and demolitions. See the table on the following pages for a complete list of projects that require a permit and HPO review.

Property owners are encouraged to consult informally with the HPO before submitting an application for exterior work. The staff can approve most types of work, such as repair and replacement and minor alterations in an expedited permit review process. More substantial projects, such as new construction and additions, are subject to review by the HPRB at its monthly meetings. Complex projects may require more than one presentation to the HPRB. The HPO staff can provide property owners or their representatives the necessary guidance and direction to obtain a building permit.

MAJOR PROJECTS REQUIRING HISTORIC PRESERVATION REVIEW BOARD APPROVAL		PERMIT REQUIRED
DEMOLITION	Demolition of historic landmarks or contributing buildings in historic districts, including significant demolition as defined in HPRB Regulations	X
NEW CONSTRUCTION	New buildings	X
	New two-story garages and garages prominently visible from a street	X
MAJOR ADDITIONS	Front and side additions	X
	Large rear additions (more than 250 square feet in footprint or 500 square feet on two or more levels)	X
	Front porch enclosures and new front porches (other than reconstruction of missing original porches)	X
	Roof additions and roof decks visible from a street	X
MAJOR ALTERATIONS	Front alterations, such as new dormers, entrances, and entrance features	X
	New or significant alterations to window or door openings on front facades	X
	Significant alteration or removal of important architectural features, such as special windows, distinctive materials, or decorative elements	X
MAJOR SITE WORK	New curb cuts, driveways and parking pads in front and often side yards	X
MISCELLANEOUS	Subdivisions involving historic landmarks, significant changes in lot boundaries, or a major combination or division of lots	X
	Work that exceeds HPO delegated authority	X
	Work that HPO identifies as inconsistent with HPRB standards	X

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MINOR PROJECTS REQUIRING HISTORIC PRESERVATION OFFICE APPROVAL		PERMIT REQUIRED
IN-KIND OR COMPATIBLE REPAIRS OR REPLACEMENT OF BUILDING COMPONENTS	Masonry, woodwork, metalwork, siding, trim, and other architectural features	X
	Roofing, coping, gutters, and downspouts	X
	Masonry pointing, cleaning and waterproofing (except by sandblasting or other damaging methods)	X
MINOR ALTERATIONS TO BUILDING OPENINGS	Window and door replacement	X
	Creation or closure of window or door openings	X
	Basement areaways and window wells	X
UNOBTRUSIVE MINOR ALTERATIONS	Rear porches and decks	X
	Roof decks and roof access stairs	X
	Skylights, solar installations, antennas, and satellite dishes	X
	Plumbing, heating, ventilating, air conditioning, and mechanical equipment and installations	X
	Utility meters	X
	Exterior lighting fixtures	X
COMPATIBLE SITE ALTERATIONS, REPAIRS AND REPLACEMENT	Fences, retaining walls, steps, walkways, and garden features	X
	Patios, garden storage sheds, swimming pools, and similar private property features that do not affect historic character	X
STOREFRONTS AND PUBLIC SPACE	Awnings, canopies, signs, storefront renovations, and unenclosed sidewalk cafes	X
	Projection and public space permits, including occupation of public space for dumpsters, barricades, and other construction activities	X
ADDITIONS AND NEW BUILDINGS	Building additions not exceeding 250 square feet in footprint or 500 square feet on two or more levels	X
	Construction of one-story garages	X
	Removal or alteration of additions that do not contribute to historic character	X
	Alterations to non-contributing buildings that are compatible with the character of the affected historic landmark or district	X
	Work reviewed by HPRB under the conceptual design review process and delegated to HPO	X

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MINOR PROJECTS REQUIRING HISTORIC PRESERVATION OFFICE APPROVAL (CONTINUED)		PERMIT REQUIRED
CONSTRUCTION ACTIVITIES	Raze applications for non-contributing buildings	X
	Raze applications pursuant to an approval by HPRB or the Mayor's Agent	X
	Excavation, sheeting and shoring, underpinning, grading, blasting, and other ground disturbance	X
	Renewal, revision, supplemental, and temporary building or public space work permits, including temporary signs, scaffolding and other construction activities	X
	Other routine, minor, or compatible work consistent with the above	X
SUBDIVISIONS (EXCEPT FOR HISTORIC LANDMARKS OR THEORETICAL BUILDING SITES)	Minor or insignificant lot changes compatible with the character of the property or its setting	X
	Conversion of assessment and taxation lots to record lots	X
	Subdivisions required to implement a rehabilitation or construction project approved by HPRB	X

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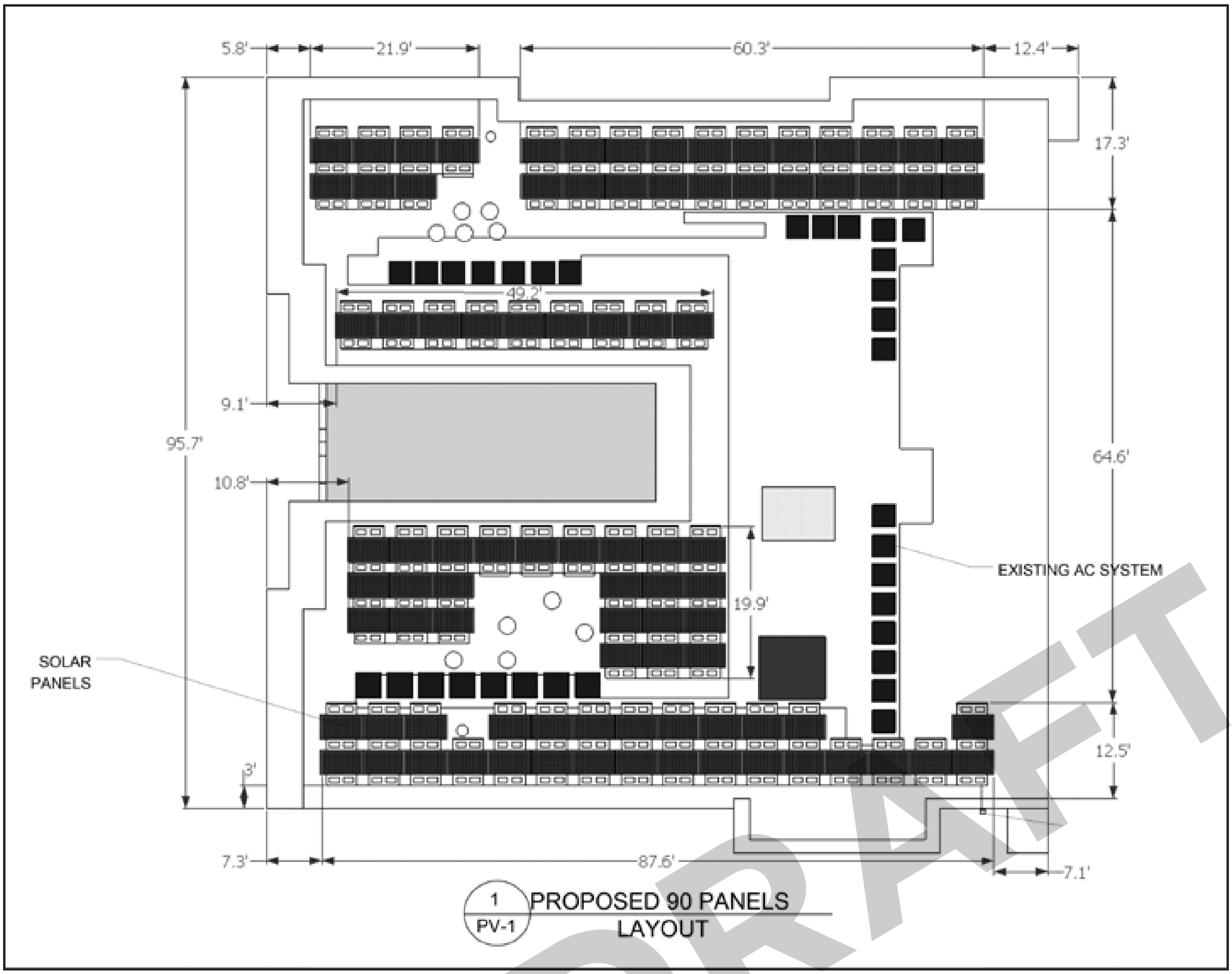
SOLAR PANEL INSTALLATION & PERMITS

HPO reviews solar panel installations for historic buildings and for buildings in historic districts. For residential installations, the required documents are typically submitted by the installer. Whether for a single-family home or a multi-family building, HPO requires

1. A Roof Plan that includes placement of solar installation and other existing roof features (chimneys, skylights); along with dimensions of setbacks from front, side and rear edges of building.
2. A Roof Section that shows the angle of the solar panels along with dimensions of the thickness of the panels; height of structural supports; and cumulative height of installed panels on structural supports above the roof.



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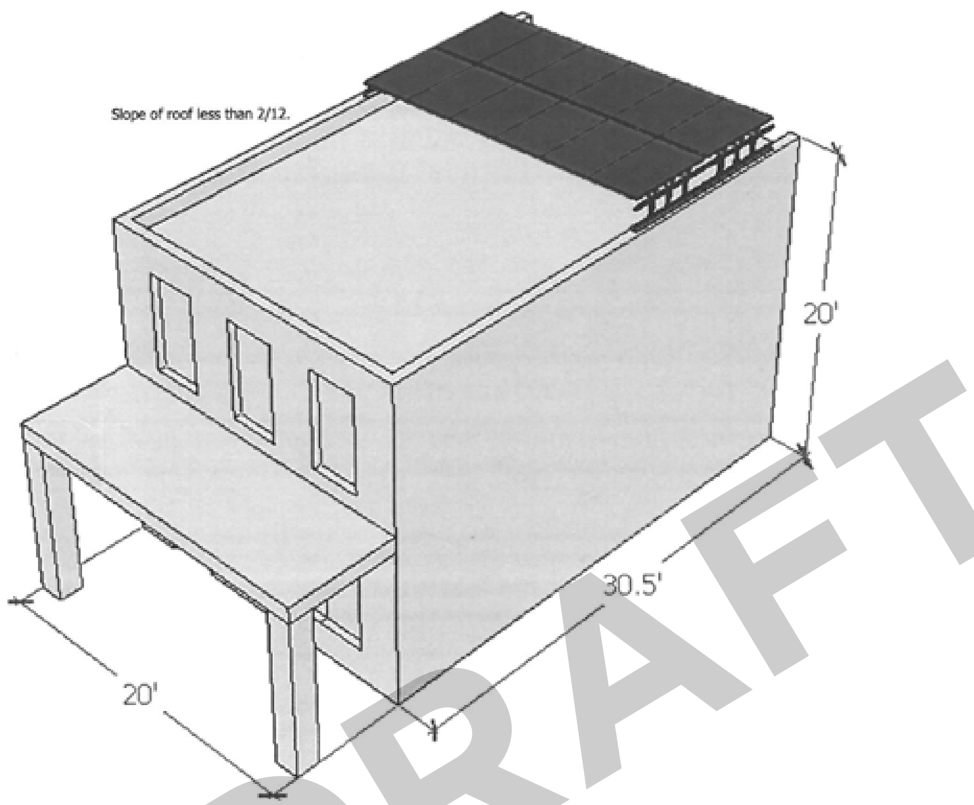
Above: the Roof plan showing entire roof of The Whitelaw Hotel, including placement of the solar installation, existing features, and setbacks from the edges of the building.

SOLAR PANEL INSTALLATION DRAWING EXAMPLE

1 Street View Of Buildings
Scale: NTS



2 Proposed Design Of PV Modules On Roof Of Building
Scale: NTS

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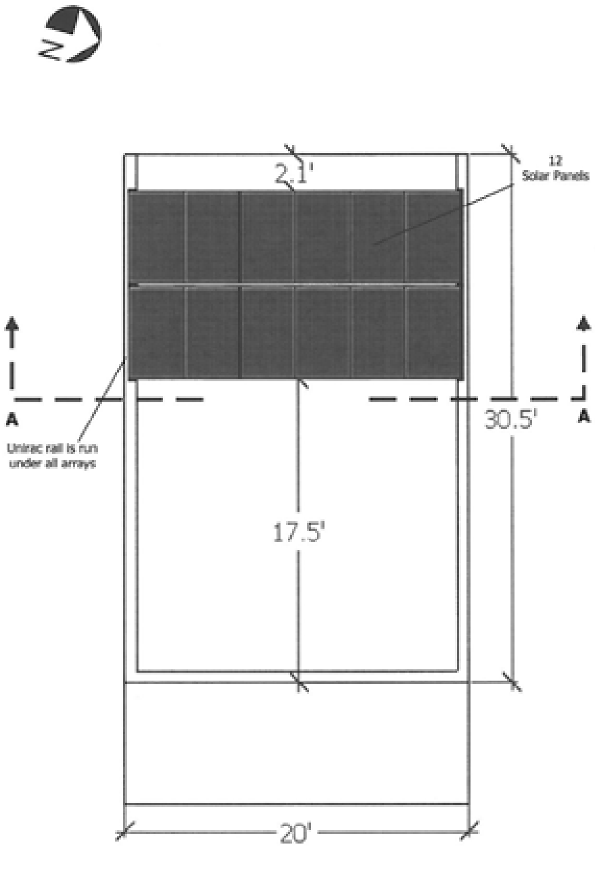
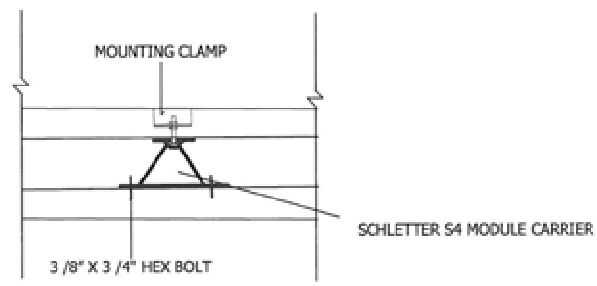
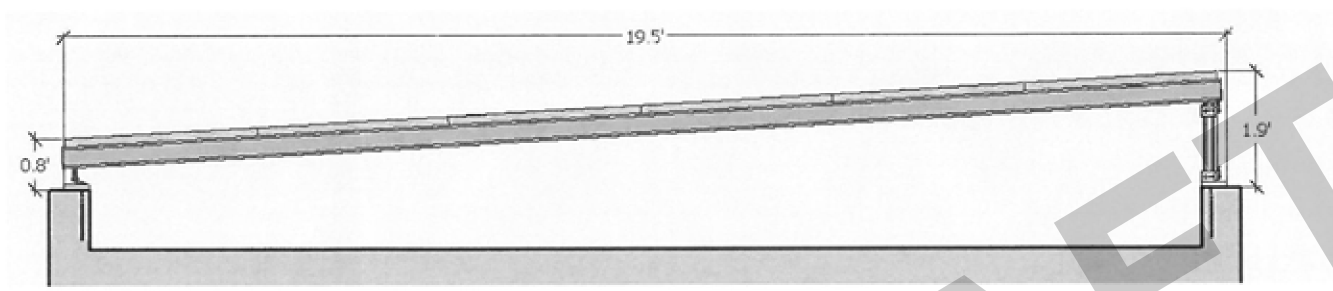


1 Proposed Layout Of PV Modules
Scale: 1": 6.4'



2 Mount Detail For Section A-A
Scale: NTS



3 Cross Section Of A-A
Scale: 1":2.4'

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For more information on the design review process, visit the HPO website here:
https://planning.dc.gov/node/1180411

CODE COMPLIANCE & THE SUSTAINABLE DC PLAN

CHALLENGES TO CONSIDER FOR EXISTING AND HISTORIC BUILDINGS

The District is currently formulating ambitious goals for regulating energy use within buildings. The aim is to make all buildings—both old and new—as energy efficient as possible. One area of focus is net zero energy. These targets—net zero energy and inclusion efficiency retrofits—elicit the following pragmatic questions:

- What are some of the code related risks that can result from achieving these energy targets?
- What resources are available to help navigate these technical challenges?
- How can existing buildings be put on the path toward being "net-zero energy ready" in anticipation of these requirements?

There are some common conflicts that arise between code requirements and energy efficiency retrofits. They are:

- Insulating walls and attics to improve R values with respect to room size
- Reducing Air Leakage to meet code requirements
- Structural integrity of a roof (for solar panel or green roof installation)

INSULATING WALLS AND ATTICS TO IMPROVE R VALUES

In Section III page 33 of this report, details are provided for improving the R value of exterior walls. These details do not account for one crucial code requirement: there are minimums for room sizes. All rooms must be a minimum of 7 feet in all plan dimensions per Section 1208.1 (2013 District of Columbia Building Code.) In Section 1208.3, the total square footage for a dwelling unit is prescribed to be a minimum of 120 square feet. In many older and historic buildings, there are small existing bedrooms. Prior to deciding to add exterior insulation to a small room, the Owner should create a plan diagram—with the proposed thicker walls—to verify that the code minimum requirements are maintained. If this study is not done and the room does not meet code, it will be flagged during the permit process.

Also included in this report are details for insulating attics. Inserting enough insulation can be difficult where a sloped roof meets the back wall. If the Owner decides to lower the ceiling height to accommodate the insulation, the Owner must once again verify code minimums. Section 1208.2 prescribes the heights for various conditions; in every case, a seven-foot ceiling height must be maintained.

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AIR LEAKAGE

For the alteration of an existing building, the code uses the extent of the work as a means to establish if the current code standards must be met. For example, a Level Three Alteration is triggered by having the work area be greater than 50% of the building floor area. For single family residential buildings, this prompts the requirement for air leakage testing at to confirm the addition has a minimum of 5 air changes per hour to satisfy the building code's requirement that all buildings have adequate ventilation or less. If it is determined that the addition has less than 5 air changes per hour from natural (passive) ventilation, then additional mechanical ventilation is required to meet a minimum of 5 air changes per hour prescribed by code.

STRUCTURAL INTEGRITY OF A ROOF (FOR SOLAR PANEL OR GREEN ROOF INSTALLATION)

Integrating sustainable technologies on the roof can be one of the most viable options for building owners. For the most part, roof structures were not designed to handle more weight than the roof and calculated snow loads. For this reason, any roof installation requires that the structure of the roof be evaluated for its capacity to support such technologies as photo voltaic panels or a green roof.

RESOURCES FOR NAVIGATING CODE QUESTIONS

The Department of Consumer and Regulatory Affairs (DCRA) is the best place to turn for any questions concerning the modifications to an existing or historic building. See Section II, page 22 for professional services information.

NET ZERO ENERGY "READY"

The push toward "Net Zero Energy Ready" is a concept that stems from a Department of Energy program intended to encourage single family home builders to take a forward-looking approach toward construction. This approach goes beyond modifying and upgrading the building envelope and the heating, cooling and ventilation systems to conserve energy. It includes considering what appliances are brought into the building; it addresses the air quality in a home; it offers a PV-ready checklist to facilitate future installation of solar panels; and finally, this program encourages building in such a way to mitigate the effect of regionally specific natural hazards.

Policy recommendations: facilitate neighborhood solar installations to lessen the cost.
https://www.buildgreendc.org/laws-regs/

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RELEVANT DC CODES, PLANS, & POLICIES

New Construction Codes:

- International Building Code (IBC)
- International Residential Code (IEBC)

Existing Building Code:

- International Existing Building Code (IEBC) provides information of the different levels of alterations, and the related impacts to other building components.

Green Building Codes:

- *DC Energy Code*
  - » 2013 DC Energy Code consists of the 2012 International Energy Conservation Code with a District of Columbia supplement, and regulated the design and construction of buildings for the effective use and conservation of energy over the useful life of each building.
- *International Green Construction Code (IgCC)*
  - » Intended to drive green building practices into every level of construction. IgCC is not a rating system, such as LEED® by USGBC, but is intended to be accepted as mandatory at a local jurisdiction level.
  - » Note that the IgCC provides multiple exceptions for historic properties, and most residential properties. Depending on the level of alteration, renovations may trigger additional mandatory upgrades targeted at high-energy using systems.
  - » IgCC removed the existing IECC exemption for air barriers, meaning that all construction covered under the IgCC will require both an air barrier and associated testing to determine compliance with the building thermal envelope air tightness.
- *Sustainable DC*
  - » A DC-based initiative which intends for the District to be the healthiest, greenest, and most livable city in the United States in one generation.
  - » Sustainable DC sets high-performance goals for the city, including the following goals to be implemented by 2032:
    - – Achieve a city-wide reduction in energy use and greenhouse gas emissions by 50%,
    - – Increase the use of renewable energy so that it constitutes 50% of the city's energy usage,

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- Meet net-zero energy standards for new construction and major renovation projects,
- Decrease total water usage by 40%.

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V. ADDITIONAL RESOURCES

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RATING SYSTEMS & PERFORMANCE STANDARDS

Resources

DC OFFICE OF PLANNING - HISTORIC PRESERVATION OFFICE

- https://planning.dc.gov/page/historic-preservation-office
- DC Historic Preservation Design Guidelines: https://planning.dc.gov/page/design-guidelines
- DC Inventory of Historic Sites: https://planning.dc.gov/node/886122

DC DEPARTMENT OF ENERGY & ENVIRONMENT (DOEE)

- Energy Assistance and Weatherization Resources: https://doee.dc.gov/energyassistance
- Renewable Energy Resources for Businesses: https://doee.dc.gov/service/additional-renewable-energy-resources-businesses

DC DEPARTMENT OF CONSUMER AND REGULATORY AFFAIRS (DCRA)

- https://dcra.dc.gov/
- How to Select an Architect, Engineer or Interior Designer for Your Next Project: https://dcra.dc.gov/publication/how-select-architect-engineer-or-interior-designer-your-next-project
- DCRA Green Building Division: https://www.buildgreendc.org/

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NATIONAL PARK SERVICE

- Technical Preservation Services, Sustainability:
  https://www.nps.gov/tps/sustainability.htm
- Energy Conserving Features Inherent in Older Homes:
  https://www.nps.gov/tps/sustainability/greendocs/conservation-features-older-homes.pdf
- The Secretary of the Interior's Standards for Rehabilitation & Illustrated Guidelines on Sustainability for Rehabilitating Historic Buildings
  https://www.nps.gov/tps/standards/rehabilitation/sustainability-guidelines.pdf
- Preservation Briefs:
  https://www.nps.gov/tps/how-to-preserve/briefs.htm
    - » Brief 47 - Maintaining the Exterior of Small and Medium Size Historic Buildings
    - » Brief 3 – Improving Energy Efficiency in Historic Buildings
    - » Brief 4 – Roofing for Historic Buildings
    - » Brief 9 – Repair of Historic Wooden Windows
    - » Brief 13 – Repair and Thermal Upgrading of Historic Steel Windows
    - » Brief 24 – Heating, Ventilating, and Cooling Buildings: Problems and Recommended Approaches

PLANNING

- DCRA How to Select an Architect, Engineer, or Interior Designer Your Next Project
  https://dcra.dc.gov/sites/default/files/dc/sites/dcra/publication/attachments/How%20to%20Select%20an%20Architect%20Engineer%20or%20Interior%20Designer%20Guide%20%28FINAL%29.pdf
- New Buildings Institute, Retrofit Savings Estimator developed to help building owners and other users to quickly evaluate the potential energy savings associated with existing building retrofit strategies, and to identify the most promising retrofit strategies that should be part of a building performance upgrade.
  https://newbuildings.org/retrofit-savings-estimator/
- US Department of Energy, Home Energy Saver Energy Calculator – provides a customized list of energy savings recommendations:
  http://homeenergysaver.lbl.gov/consumer/
- Environmental Protection Agency (EPA), Target Finder Calculator, online calculator that helps architects, engineers, and property owners and managers assess the energy performance of commercial building designs and existing buildings:
  https://www.energystar.gov/buildings/service-providers/design/step-step-process/evaluate-target/epa%E2%80%99s-target-finder-calculator

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WALLS & ROOFS

- Cool Roofs
    - » U.S. Department of Energy (DOE) - “Guide to Cool Roofs” https://energy.gov/sites/prod/files/guide_to_cool_roofs.pdf
- Weatherization
    - » D.C. Department of Energy & Environment (DOEE) Weatherization Field Guide & Assistance Program: https://doee.dc.gov/service/weatherization-assistance-program
    - » Provides technical and financial assistance to help low-income residents reduce their energy bills by making their homes more energy efficient. Field guide provides best practices for installation of weatherization measures (note: not all guidance will be appropriate for historic resources)
    - » NPS Technical Preservation Services - Weatherization guide https://www.nps.gov/TPS/sustainability/energy-efficiency/weatherization.htm
    - » EnergyStar - Seal and Insulate Guide https://www.energystar.gov/index.cfm?c=home_sealing.hm_improvement_seal_insulate
- DC HPO Walls and Foundations of Historic Buildings: https://planning.dc.gov/sites/default/files/dc/sites/op/publication/attachments/DC%20Walls%20and%20Foundations.pdf
- Historic Preservation Maintenance and Repair Guidelines For Masonry: http://chrs.org/wp-content/uploads/2016/03/HPOmasonryBrief0316.pdf
- Roofs on Historic Buildings: https://planning.dc.gov/sites/default/files/dc/sites/op/publication/attachments/DC%20Roof%20Guidelines.pdf

WINDOWS & DOORS

- National Trust for Historic Preservation, “Saving Windows, Saving Money: Evaluating the Energy Performance of Window Retrofit and Replacement”: http://forum.savingplaces.org/connect/community-home/librarydocuments/viewdocument?DocumentKey=59eab0e4-f0f4-45c5-97c8-147a8def82ae&CommunityKey=00000000-0000-0000-0000-000000000000&tab=librarydocuments
- Window Repair and Replacement Preservation and Design Guidelines: https://planning.dc.gov/sites/default/files/dc/sites/op/publication/attachments/HPO%20Window%20Guidelines.%2010%202011.pdf

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SYSTEMS

- Green Building Advisor, Calculating Cooling Loads: http://www.greenbuildingadvisor.com/blogs/dept/musings/calculating-cooling-loads
- DC Sustainable Energy Utility (DCSEU), Discounts and rebates on energy efficiency: https://www.dcseu.com/for-my-home

LANDSCAPE, SITE FEATURES, & WATER EFFICIENCY

- Green Roofs
    - DOEE "Green Roofs in the District of Columbia" – information, tips, and resources: https://doee.dc.gov/greenroofs
    - NPS, Technical Preservation Services, Interpreting the Standards Number 54: "Installing Green Roofs on Historic Buildings": https://www.nps.gov/tps/standards/applying-rehabilitation/its-bulletins/ITS54-GreenRoofs.pdf
    - NPS, Technical Preservation Services, "Green Roofs on Historic Buildings", provides considerations for historic buildings, resources, and case studies: https://www.nps.gov/tps/sustainability/new-technology/green-roofs.htm
    - Whole Building Design Guide - "Extensive Vegetative Roofs", information on design and construction of green roofs: https://www.wbdg.org/resources/extensive-vegetative-roofs
    - DOEE, Riversmart Rooftops Program, provides rebates for installation of green roofs within the District: http://anacostiaws.org/green-roofs
- Stormwater Management and Green Infrastructure
    - DOEE - Residential stormwater and flooding information: https://doee.dc.gov/node/19712
    - DOEE – Green Infrastructure: https://ddot.dc.gov/GreenInfrastructure
    - DOEE – Green Area Ratio: https://doee.dc.gov/GAR
- Landscaping, Landscape Features and Secondary Buildings in Historic Districts" : https://planning.dc.gov/sites/default/files/dc/sites/op/publication/attachments/DC%20Landscape%20Guidelines.pdf

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- Stormwater management guidebook:
  https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Second%20Proposed%20SWMG_Changes%20Accepted.pdf
- Rainwater harvesting:
  https://doee.dc.gov/sites/default/files/dc/sites/ddoe/publication/attachments/Section%203.3%20%20Rainwater%20Harvesting.pdf

ON-SITE RENEWABLE ENERGY

- U.S. Department of Energy, "Planning for Home Renewable Energy Systems":
  https://energy.gov/energysaver/planning-home-renewable-energy-systems
- Solar PV
  - DCRA Solar guidelines:
    https://www.buildgreendc.org/solar/
  - NPS, "Solar Panels on Historic Properties":
  - https://www.nps.gov/tps/sustainability/new-technology/solar-on-historic.htm
  - DOEE, Solar initiatives and resources:
    https://doee.dc.gov/solar
- Solar Thermal
  - DCRA solar system guidelines:
    https://static1.squarespace.com/

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