Climate Justice in Architecture

Design centering both the environmental and social aspects of climate change.

Climate justice in architecture refers to engagement, advocacy, planning, and design that draw down emissions; build resilience and capacity; support human, cultural, and ecological health; and protect all communities in the era of climate change.

Committee on the Environment

AIA Knowledge Community

Frost Terrace, Street View
Image Credit: Robert Benson Photography

Frost Terrace

This case study highlights an exemplary architecture project that prioritized both environmental and social aspects of climate change in its design process, community engagement approach, and final design. It aligns with many aspects of the AIA Climate Justice in Architecture Taxonomy across the building, neighborhood, regional, and global scales.

Frost Terrace

Cambridge, MA

Aerial view showing historic and urban street front transitioning to retaining the tree canopy in the back
Image Credit: Multivista

Summary

Frost Terrace leveraged community priorities around historic and ecological preservation to expand access to two- and three-bedroom affordable housing units in a high rent neighborhood of Cambridge, MA. Over the course of a year, the design and development team collaborated closely with community members, building upon their existing track record with the City of Cambridge, local affordable housing advocates, and neighboring institutions like Lesley University. They successfully integrated a complex set of priorities and requirements into an elegant design for a tight site that enhances housing security and socioeconomic diversity. The project adaptively reuses three historic homes, preserves six landmark trees, and contributes to City of Cambridge's climate change mitigation and resilience goals.

Project overview

BUILDING PROGRAM TYPE(S):
Affordable housing

PROJECT TYPE:
New construction/addition,
Existing building/renovation

TOTAL FLOOR AREA:
49,000 sq. ft.

TOTAL USERS:
40 units: 13 three-bedroom,
13 two-bedroom, 13 one-bedroom,
and one (1) studio

SITE AREA:
22,068 sq. ft.

NUMBER OF FLOORS:
5

PROJECT CLIMATE ZONE:
ICC Climate Zone 6B

PROJECT SITE:
Previously developed land,
Historic structure or district

PROJECT SETTING:
Urban

YEAR OF SUBSTANTIAL COMPLETION:
2021

COST OF CONSTRUCTION (EXCLUDING FURNISHING):
$16.5 million

THIRD PARTY RATING SYSTEM:
LEED Gold

Project team:

OWNER:
CC HRE 1791 Mass Ave Tenant LLC

ARCHITECT:
Bruner/Cott Architects

MP ENGINEERS:
Petersen Engineering, Inc.

ELECTRICAL ENGINEERS:
R.W. Sullivan

STRUCTURAL ENGINEER:
L.A. Fuess Partners

CIVIL ENGINEER:
BSC Group

LANDSCAPE ARCHITECT:
Lemon Brooke LLC

SUSTAINABILITY CONSULTANT:
New Ecology, Inc.

GENERAL CONTRACTOR:
Keith Construction Inc.

"The city of Cambridge has a huge commitment to affordable housing ... and simultaneously to resiliency and climate and sustainability. It's projects like [Frost Terrace] that are the examples of where those connect and help people understand. The historic preservation of the three houses ... and then the modern addition in the middle .... show how you can combine the old in Cambridge with the future of Cambridge."
—Cassie Arnaud, City of Cambridge

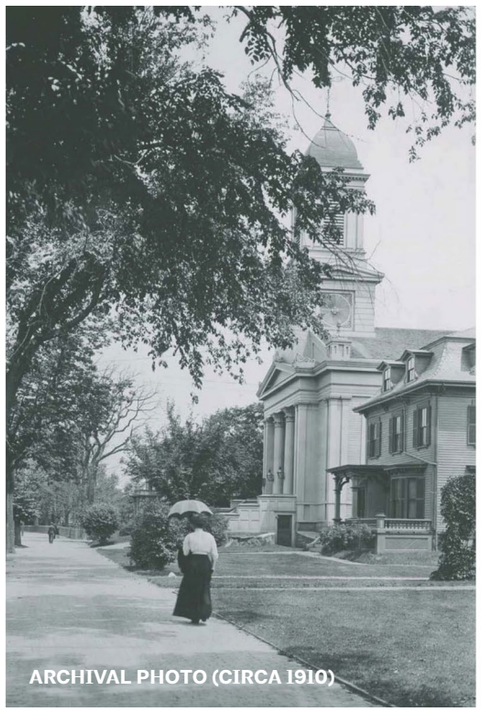


Diagram showing the restoration of the historic street frontage by moving the front building closer to the street
Image Credit: Bruner/Cott Architects

Design Process

Frost Terrace achieved a feat that has eluded many cities: Adding 40 affordable housing apartments to a high rent neighborhood in Cambridge, MA. This success was made possible through a collaborative design process that brought together the design and development team with the City of Cambridge, the historical commission, neighbors, and residents of an adjacent condominium. Together, they navigated competing social, historical, and ecological interests related to the site.

The property faces Massachusetts Avenue, one of the busiest thoroughfares in Cambridge. It's bounded on the north by a historic church that Lesley University converted into a library and on the south by a row of condominiums that face the Frost Terrace property as they stretch back to the eastern boundary of their parcel. Initially, the site was divided into three parcels: The front half facing the avenue and two twin parcels in the back, which were accessed by an easement along the boundary with the condos. All three parcels were zoned residential and hosted an existing 19th-century house.

The City of Cambridge initially purchased the front half of the site from a landowner who had realized it would be difficult to change the zoning designation on the property. The city transferred the property to a for-profit developer with a track record of building high-quality affordable housing developments in Cambridge. The initial design called for a 27-unit, 6-story apartment building facing Massachusetts Avenue—a building type that aligns with the height and density of many 19th- and early 20th-century apartment buildings in that part of Cambridge. However, that design would have required demolishing the existing second empire house facing Massachusetts Avenue and eliminated most, if not all, the open space on the property—including the removal of a horse chestnut tree that is beloved in the neighborhood. Luckily, the owners of the back two parcels decided to sell their properties to the city when they learned about the developer's plans. Over more than a year, the design team met with stakeholder groups to listen to their concerns and revise the design accordingly.

The additional land made it possible to add 13 more units to the project while also reducing the overall height of the structure; preserving all three historic buildings, the horse chestnut tree, and an immense oak tree toward the rear of the site; as well as maximizing plantings and shade on the south side of the property. The tradeoff was the installation of two units in the basement of the new multifamily building and the provision of only three accessible parking spots.

> "The people involved [in the design] were wonderful to work with. They were very collaborative. We felt listened to in the whole process, and they addressed a lot of our concerns about the building ...which we own."—Matt Brownell, Lesley University, Public Comment at Planning Review Meeting

Affordable housing overlay

The developer's proposal to build entirely affordable housing on the property was central to its success in the regulatory and community engagement process. The Commonwealth of Massachusetts has instituted a comprehensive permit process for affordable housing projects that allows the local zoning board to issue all relevant approvals, including zoning waivers, in one step—rather than working through the more arduous special permit process involving approval by many separate boards. Frost Terrace utilized this process—known as Chapter 40B—to rezone the property, increase its height and density, and limit the number of on-site parking spaces, while maintaining 45% open space on the site. Furthermore, discussions with surrounding landowners about tradeoffs focused on how the proposed design change might affect the number of affordable apartment units that could be included in the scheme.

"I have been involved in the public community process of this project from the very beginning and I have been so incredibly impressed with this team's ability to listen and learn from residents and change the design."—Adrian Musgrave, Resident, Public Comment at Planning Review Meeting

Historic preservation

Purchasing the back half of the site opened enough space to both increase the total number of affordable housing units and allow for the renovation of the three historic buildings on the property rather than tearing them down. The final design places the higher-density multifamily portion of the project behind the renovated Second Empire home at the front of the property and links it to the two renovated historic homes at the rear of the property. The apartment building intentionally serves as a backdrop, shifting focus to the historic home and its position next to the church. Protecting the three homes and two equally historic trees demonstrated the design and development team's commitment to addressing community priorities for the site.

Project financing

Like all affordable housing projects, Frost Terrace required complex financing, drawing from 10 sources. The City of Cambridge was an essential partner, contributing over $7 million in land acquisition to the project. The Chapter 40B process allowed the development to increase density beyond currently zoned allowances, which boosted operating income and helped the project meet federal low-income housing tax requirements related to cost per unit. The project was also eligible for utility rebates for energy efficiency measures and both utility incentives and Inflation Reduction Act funding for rooftop solar.

Low-income housing tax credits and other public financing mechanisms also facilitated planning board approval by mandating public oversight of building and landscape maintenance for the first 15 years of operations.

"The trust you built. You had completed one project in Cambridge before this. , … you [now] have a well of trust among the funders, as well as a lot of folks in the community, which will serve you well as you do your next project."—Cassie Arnaud, City of Cambridge

Essential climate justice design components include:

1. Building long-term community and regulatory trust for flexibility, creativity, and unconventional financing: Both the design and development teams were known quantities to community groups and regulatory bodies before attempting to rezone this underutilized site in a high-rent neighborhood as a LEED Gold affordable housing development. The City of Cambridge and local non-profits trusted the developer based on a previous affordable housing development they had spearheaded in the city. Next-door neighbor Lesley University vouched for the architect, who had renovated the adjacent historic church.
2. Prioritizing affordable housing as the main driver for decision-making: Design decisions that provided climate mitigation and resilience co-benefits—such as energy efficiency and green infrastructure—were prioritized for their positive impact on future residents and the surrounding neighborhood.
3. Aligning seemingly conflicting environmental and social priorities to find innovative solutions: Frost Terrace successfully integrates the City of Cambridge's goal of expanding access to affordable housing with the historic commission's priority to renovate three existing structures; the neighbors' desire to preserve daylight, air, and views of nature, and the city and state's climate mitigation goals—all within a single, elegant design.

AIA Climate Justice in Architecture Taxonomy

Climate change creates new, and amplifies existing, environmental, and social challenges across the following seven themes or categories: social determinants of health, cultural connection to place, economic development without displacement, environmental justice, ecosystem health, climate change health and resilience, and decarbonization. The Climate Justice in Architecture Taxonomy centers both the environmental and social aspects of climate change and helps teams respond with an architectural design impacting the themes across three scales: building occupants, the surrounding neighborhood, and regionally and globally. The taxonomy aligns and connects with the AIA Framework for Design Excellence, which represents the defining principles of design excellence in the 21st century. The Framework is comprised of 10 principles and informs progress toward four outcomes – a zero-carbon, healthy, resilient, and equitable built environment.

Frost Terrace addresses all three scales in the taxonomy, with particular emphasis on the building and neighborhood scales.

Overview of AIA Climate Justice in Architecture Taxonomy themes and spatial scales: Frost Terrace. Source: Biositu, LLC

Historic cottages at the rear of the property
Image Credit: Robert Benson Photography

Social determinants of health

Prioritizing efficient design strategies to reduce the risk of housing insecurity: The savings from high-efficiency wall and roof insulation, energy- and water-efficient strategies, and on-site solar power generation are passed directly to low-income residents through reduced utility bills.

Centering universal and barriers-free design: Both the buildings and landscaping prioritize accessibility for mobility-impaired residents. Additionally, the three on-site parking spaces provided are designated for special needs. The resident services coordinator will also help residents with physical disabilities access public transportation services for mobility-impaired riders.

Creating a healthy living environment for residents: In stark contrast to many moderately priced rentals, Frost Terrace was designed with a budget for maintaining the building and grounds in support of resident health and well-being. Strategies include 100% outdoor air ventilation, enhanced filtration, and the use of low emitting paints, coatings, flooring, adhesives, sealants, and composite wood.

"I'm a big fan of residents paying for as many utilities as possible. They get a reduction in their rent accordingly. It helps encourage them conserve resources. ... We want the residents to be on the same page as us [in terms of building operations and maintenance]."—Jason Korb, Developer

Constructing 40 affordable housing units in a high-rent, transit-oriented neighborhood: The developer petitioned the planning review board to restrict Frost Terrace as affordable rental housing in perpetuity to permanently increase affordable housing options in a high-rent neighborhood of Cambridge. Examples of the neighborhood's advantaged socioeconomic status include its low social vulnerability and environmental justice scores (0.16 and 0.21, respectively, with 1.0 indicating perfect vulnerability), low rate of food insecurity (6.3% compared with 8.3% in Cambridge and 13.9% in the U.S.), and low rate of housing insecurity (6.9% compared with 8.5% in Cambridge, 14.9% in Boston, and 11.8% in the U.S.).

Designing family-friendly units for low- and moderate-income families: Most of the units are two- and three-bedroom because high rents have disproportionately displaced families from Cambridge. The development includes a play space for children in the lower level of the main building, as well as a part-time service coordinator offering family-friendly programming and help accessing social services.

Encouraging active living by making a walkable, transit-oriented neighborhood accessible to low- and moderate-income families: While Frost Terrace faces Massachusetts Avenue along a corridor that is ranked among the top 5% of bicycle and pedestrian crash clusters in Massachusetts, the location received a 97 on walk score, 73 on transit score, and 99 on bike score in pre-development. Over 50% of neighborhood residents commute to work using public transit, walking, or cycling (compared with 6.7% in the U.S.). The wide sidewalk in front of the development along Massachusetts Avenue encourages multi-model forms of transportation. The property further encourages active transportation by providing only three handicapped parking spaces and offering indoor bike parking for 48 bikes.

"The City of Cambridge has a really big prioritization for affordable housing. We lost rent control in the mid-nineties. And, ever since then we've gone through a series of ever increasing interventions... openly driven by needs of preserving socioeconomic diversity, race diversity, and ... kids in schools. A lot of communities want senior affordable housing, because that feels least impactful. Cambridge is kind of the reverse. Cambridge really wants to see kids and families and the most vulnerable served in in the housing that we support."—Cassie Arnaud, City of Cambridge

Cultural connection to place

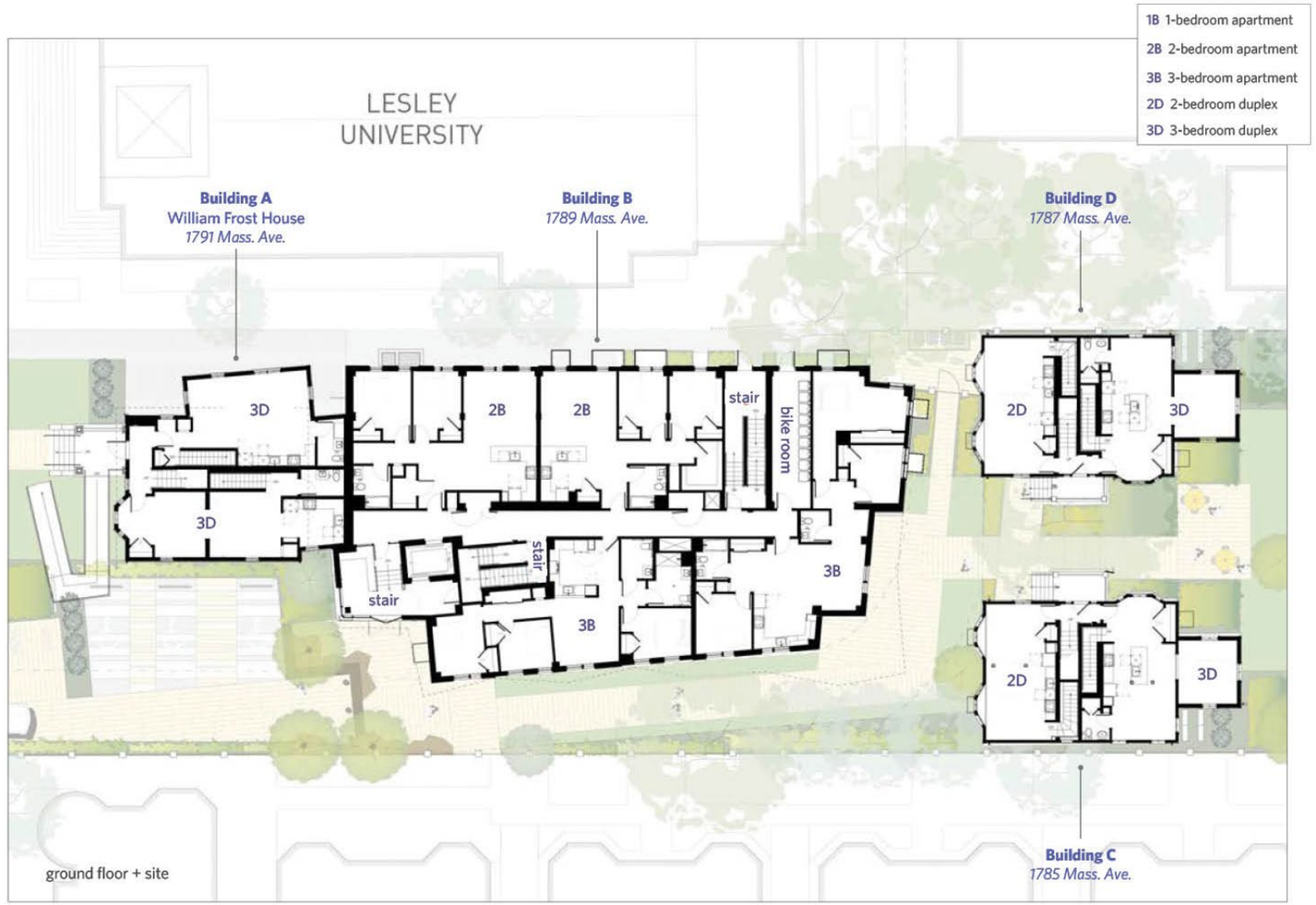
Foregrounding the historic structure at the front of the site to increase density while simultaneously enhancing the neighborhood's architectural heritage: The new multifamily building is designed as a backdrop for the second empire house facing Massachusetts Avenue. The masonry and clapboard materials on its façade echo other 3- to 5-story apartment buildings along the avenue.

Integrating a private pocket park: Cambridge is known for hidden gardens and pocket parks tucked into its deep lots. Frost Terrace follows that typology, wrapping around a welcoming, landscaped area in the interior of the site. This creates an outdoor community space and access to a quiet and nature-filled place steps from one of the busiest streets in Cambridge.

"We are working with an arborist and landscape architect … to make attempts to … restore six of the existing significant trees on the site, including the most significant tree, which a lot of people can see in the neighborhood, but they don't really know where it's coming up from. [It's] the multistory 39-inch red oak. It's enormous. And … we've actually designed our building around the 24-inch horse-chestnut tree. That's the reason why the building comes in and then comes back out, because of the concerns we heard about the tree."—Jason Korb, Developer, Public Comment at Planning Review Meeting

Restoring the historic street view: The project restored one of the few remaining examples of a Victorian residential street front in Cambridge by moving a second empire-style house, built in 1865, closer to Massachusetts Avenue. This move aligned it with a neighboring historic church that had also been relocated.

Designing the height and massing to enhance the transition from a major avenue at the front to a single-family residence at the back: Retaining shingle-style houses at the rear of the property helps transition from the higher density of Massachusetts Avenue to lower density residential development to the east. The larger apartment building, weaving between the houses and the Massachusetts Avenue property line, mimics the size and massing of other multifamily apartment buildings along the urban street. The south facing façade folds back and forth in a modern interpretation of bay windows, echoing the articulation of the condos next door.



Frost Terrace ground floor and site plan
Image Credit: Bruner | Cott Architects

"Just like the rest of Cambridge, our design is a mixture of old and new that responds to the layers and grain of the city along this part of Massachusetts Avenue."
—Jason Forney, Architect, Bruner/Cott Architects

Economic development without causing displacement

Integrating energy and water efficiency for housing security: The design prioritizes lowering out-of-pocket operational expenses for tenants through energy and water efficiency strategies.

Increasing affordable housing units in a high-rent neighborhood: Only 15% of housing units in Cambridge are affordable for families with low- and moderate incomes. Two- and three-bedroom units are in particularly short supply, leading to families either living in overcrowded conditions or moving away from Cambridge.

"On my street over the past ten years, 16 [of the 17 rental units] have been forced out due to increasing rents. ... I live at less than two blocks from Central Square subway station and ... off of Mass. Ave. Ten years ago ...-- we went car free my family, and we were the first person on the block to do it. Everybody else on the block has since followed with the exception of the four people who have parking spaces. If you build it, they will come. For all of us, having a place to live is more important than having a place to park our car."—Bill McAvinney, Resident, Public Comment at Planning Review Meeting

Ecosystem health

Preserving and enhancing the existing ecosystem: 30% of the property's open space is landscaped. The landscape design preserved six out of the nine on-site mature trees. New plantings are native, drought tolerant species.

Community open space at the rear of the property
Image Credit: Robert Benson Photography

Designing the natural features to enhance the neighborhood's ecosystem health: The landscaping and civil engineering was designed to retain the neighborhood tree canopy and all on-site stormwater using green infrastructure strategies. Green infrastructure is also an effective mechanism for reducing exposure to disease-carrying vectors, such as the two that are most prevalent in Middlesex County: Dengue, a mosquito-borne illness, and Lyme Disease, a tick-borne disease.The landscape architect's goal for the design was to "leave this place a leafier, greener, shadier space than it is currently."

"The landscape works to be a good neighbor. ... Along the south side of the property several large mature trees ... provide cover, visual privacy down into the site from the adjacent buildings. ... all the spaces where people might congregate to have a conversation or a small social gathering [are in] the interior of the site. And so ... the periphery is ... meant as a buffer for the privacy of the neighbors but also to be good neighbors to our abutters."
—Jason Forney, Architect, Bruner/Cott Architects, Public Comment at Planning Review Meeting

Climate change health & resilience

Integrating indoor air quality features to protect from infectious disease, ozone action days, and wildfire air pollution: The ventilation system introduces 100% outdoor air to the residential units and uses MERV 13 filtration media, which protected residents during COVID and continues to support respiratory health on air pollution days caused by traffic and/or wildfire smoke.

Using air conditioning to reduce exposure to extreme heat events: Many apartments in the greater Boston area do not have access to air conditioning, although extreme heat is one of the region's most deadly climate change exposures. Frost Terrace integrates passive and active systems to reduce resident exposure to extreme heat. Enhanced wall and roof insulation reduce cooling demand. All units are equipped with ERV heat recovery systems and high efficiency air source heat pump systems to provide low-cost air conditioning and heating.

Raising the ground floor and placing mechanical equipment on the roof to increase flood resilience: The ground floor apartments are lifted three feet above ground level, which reduces their risk of flooding during heavy rain events. Similarly, placing mechanical equipment on the roof reduces the risk that a flood event will result in a power outage.

"When we're building a building, we don't fight [climate change]. We adapt to it." —Jason Korb, Developer

Preserving the tree canopy on-site reduces the urban heat island in the larger neighborhood: The tree canopy in the neighborhood surrounding Frost Terrace averages just over 20%. Mature trees can contribute to mitigating the urban heat island beyond the edge of the site. Several of the heritage trees that Frost Terrace preserved reduce the urban heat island effect beyond the property line by offering direct and indirect shade for large swathes of the residential neighborhood to the east of the development.

Installing green infrastructure contributes to neighborhood flood risk mitigation: The neighborhood surrounding Frost Terrace has a high percentage of impervious surface, ranging from 65-82% imperviousness. The civil and landscape design uses plantings, permeable paving, and sub-grade retention to retain 100% of storm water on site, thereby mitigating the development's contribution to neighborhood flood risk.

"The storm water on this site is being dealt with on site. We live further down Mass. Ave. and the storm water's a huge problem, because the building development is on Mass. Ave. The fact that they actually have a comprehensive process to deal with their storm water is a great thing relative to other properties."
—Bhupesh Patel, Resident, Public Comment at Planning Review Meeting

Increasing solar power capacity in Cambridge: The 20kw solar ready roof is available to expand solar power generation in the greater Boston area when the time is right

"Some of the "decarbonization" was driven by the State of Massachusetts and the city of Cambridge having very high standards. ... [Frost Terrace has] robust envelopes like R30 walls, R60 roof, and that's both for the new building and the existing. We didn't let the historic nature of [the existing] buildings be an excuse to not do well."
—Jason Forney, Architect, Bruner/Cott Architects

Decarbonization

Restoring three historic structures on the property reduces the development's embodied carbon: Restoring existing buildings reduces the amount of new material used on the project, thereby reducing its embodied carbon.

Coordinating the project location with surrounding active transportation infrastructure encourages residents to choose low carbon transportation options: Frost Terrace is located less than ¼ mile from bus, metro, and commuter rail stops in a dense neighborhood with amenities like grocery stores, schools, and medical care. The design encourages residents to take advantage of its transit-oriented location by making only three accessible parking spaces available on site and accommodating 48 indoor bike parking spaces.

Meeting local and regional sustainability standards contributes to regional and global decarbonization efforts: Enhanced insulation, a white reflective roof, and energy and water efficient building systems and fixtures resulted in a 40% reduction in energy use intensity and 46% water use reduction compared with the baseline. The campus is also entirely electric except for water heating.

Lead Author

Biositu, LLC, biositu.com/

Contributors:

COTE Knowledge Community and AIA staff.

Special thanks

Bruner/Cott Architects, interview participants

Additional information;

ARCHITECT Magazine | Frost Terrace Affordable Housing

Boston Society of Architects | Frost Terrace – BSA Design Awards

Housing Finance Magazine | Development to Bring New Affordable Homes to Cambridge, Mass.

HUD USER | Providing Affordable Housing Through Historic Preservation in Cambridge, Massachusetts

Cambridge Day | 'Frost-Terrace' affordable housing OK'd will bring 40 units to Porter Square area Cambridge Day

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