Greening the Heights: A Sustainable Roof for UMass

Proposal Seeking Funding for the Design and Implementation of a Green Roof at the W.E.B. Du Bois Library

December 16, 2024

Submitted by Jaydon Ongley

On Behalf of the Green Infrastructure Foundation

Chris Mason
Green Communities Coordinator for Western Mass
Massachusetts Green Communities Division
436 Dwight Street
Springfield, MA 01103

Dear Chris Mason,

The Green Infrastructure Foundation is pleased to submit this proposal for funding to support the installation of a green roof on the W.E.B. Du Bois Library. This project offers an exciting opportunity to advance the university's sustainability initiatives while addressing key environmental challenges in an innovative and impactful way.

As a central and highly trafficked facility, the library faces ongoing issues with energy efficiency, stormwater management, and urban heat retention. Installing a green roof will directly address these challenges by:

- **Reducing Energy Consumption:** The green roof will provide natural insulation, reducing both heating and cooling demands, which will lead to energy savings and a more comfortable indoor environment.
- **Improving Stormwater Management:** By absorbing rainwater, the green roof will reduce runoff, mitigate flooding risks, and relieve pressure on the local stormwater infrastructure.
- **Enhancing Air Quality and Biodiversity:** The green roof will introduce plant life to the urban structure, improving air quality, promoting biodiversity, and offering a habitat for pollinators.

This project supports the goals of the Massachusetts Green Communities Grant Program by delivering significant environmental benefits and providing a visible model for sustainable architecture on campus. We are requesting $500,000 in funding to cover design, materials, and installation. The Green Infrastructure Foundation will collaborate with university departments, local contractors, and sustainability experts to ensure the project's successful completion.

We greatly appreciate your consideration of this proposal. We look forward to the potential of working together to bring this visionary project to life. Please feel free to contact me at 999-999-9999 or FakeEmail@Fakemail.com if you have any questions or need further information.

Sincerely,
Jaydon Ongley

Table Of Contents

Statment Of Need

The W.E.B. Du Bois Library at the University of Massachusetts, Amherst, is a vital resource that serves thousands of students, faculty, and visitors each year. As one of the university's largest and most frequented buildings, it plays an integral role in the academic experience. However, despite its importance, the library faces significant environmental and operational challenges, particularly regarding energy efficiency, stormwater management, and urban heat island effects. These issues not only impact the building's operational costs but also contribute to broader environmental concerns on campus and in the surrounding community. Addressing these concerns is in alignment with the University of Massachusetts' broader sustainability initiatives, such as the goal of achieving carbon neutrality by 2050, as outlined in the UMass Carbon Neutrality program (UMass Carbon Neutrality, n.d.)

Energy consumption in buildings, particularly large public facilities like the W.E.B. Du Bois Library has become a pressing concern, driven by the growing emphasis on sustainability and climate change mitigation. Building energy consumption accounts for a substantial portion of total energy use, especially in urban environments, where high population densities and extensive infrastructure amplify overall demand (Manso, Teotónio, Silva, and Cruz). In large university buildings, this consumption is even more pronounced due to the high foot traffic and the significant energy needs for heating, cooling, and lighting across various spaces. According to Shafique, Kim, and Rafiq, green roofs can alleviate some of this burden by providing natural insulation, which helps regulate the building's temperature and reduces the need for heating and cooling. As a result, the integration of green roofs can lead to notable reductions in both energy demand and operational costs, as well as a decrease in carbon emissions.

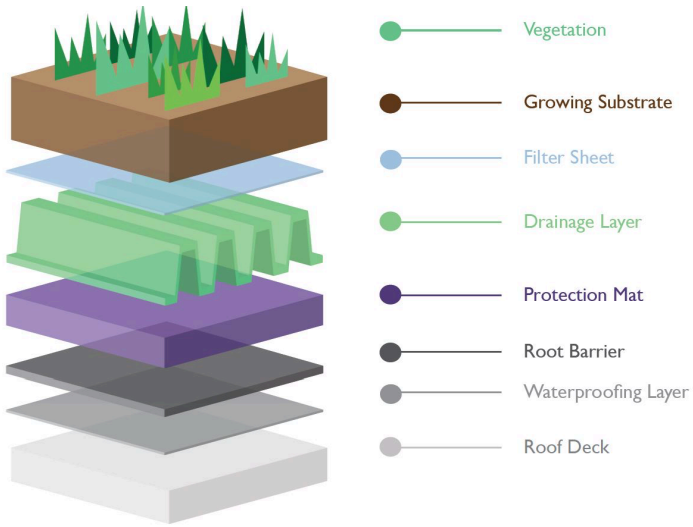

Fig. 1

The installation of a green roof on the W.E.B. Du Bois Library would offer several benefits, particularly in reducing energy consumption. Green roofs provide natural insulation, helping to lower both heating and cooling costs by absorbing sunlight and minimizing heat transfer. This contributes to a more stable indoor temperature, reducing the strain on HVAC systems, which are typically responsible

for a significant portion of energy use in large buildings (Antrop et al.). As a result, the adoption of a green roof would not only reduce overall energy demand but also align with the university's sustainability goals, especially its commitment to achieving carbon neutrality by 2050 (UMass Carbon Neutrality, n.d.).

Stormwater management is another critical concern for the W.E.B. Du Bois Library and other large buildings on the UMass Amherst campus. Runoff from impervious surfaces, such as roofs and pavements, can overwhelm local drainage systems, causing flooding, water pollution, and added stress on infrastructure. This issue is especially pressing during periods of heavy rainfall, which have become more frequent as a result of climate change. Without effective management, stormwater runoff can lead to significant environmental and infrastructural challenges, making it essential for the university to address this growing concern.

A green roof can play a pivotal role in mitigating these effects. By capturing and storing rainwater, green roofs reduce runoff by allowing water to be absorbed by the plants and soil. Studies have shown that green roofs can capture between 50% to 75% of annual rainfall, depending on the size and design of the roof (Li & Yeung). This captured water can either evaporate or gradually flow into the drainage system, preventing it from becoming overloaded and reducing the risk of flooding. Additionally, the reduction in runoff helps protect local water quality by filtering pollutants before they can enter stormwater systems.

Fig. 2

Implementing a green roof on the W.E.B. Du Bois Library would help alleviate the strain on the campus's stormwater infrastructure. Given the frequent instances of localized flooding in the area, especially after heavy rains, the green roof would provide a practical solution to these issues, protecting both the library and surrounding areas from the damaging effects of stormwater runoff. This would contribute to the broader campus sustainability goals and demonstrate leadership in stormwater management strategies, in line with the university's commitment to sustainability and carbon neutrality (UMass Carbon Neutrality, n.d.).

The urban heat island (UHI) effect is a growing concern in cities and campuses across the United States. As urban areas continue to develop, natural landscapes are replaced by impervious surfaces, such as concrete and asphalt, which absorb and retain heat. This phenomenon raises ambient temperatures, creating pockets of intense heat in urban areas, especially during summer months. UHI not only exacerbates local heat conditions but also increases energy demand for cooling systems, contributing to further environmental degradation.

The installation of a green roof on the W.E.B. Du Bois Library could mitigate the UHI effect on the UMass Amherst campus. Green roofs, through their ability to reduce the amount of heat retained by buildings and surrounding areas, help lower the surrounding temperature and counteract the UHI effect. According to research by Shafique, Kim, and Rafiq (2006), green roofs can significantly lower surface temperatures, thereby reducing the heat absorbed by buildings and surrounding urban areas. This cooling effect can help to combat rising temperatures on campus and provide a more comfortable environment for students and faculty.

Moreover, by lowering the UHI effect, the green roof would reduce the need for air conditioning, which in turn reduces energy consumption. This positive feedback loop of cooling and energy efficiency benefits the university's sustainability goals by both lowering operational costs and improving environmental quality, supporting the university's long-term commitment to carbon neutrality (UMass Carbon Neutrality, n.d.).

The W.E.B. Du Bois Library is a crucial part of the University of Massachusetts Amherst's academic community. However, it faces significant environmental challenges that impact both its operational efficiency and the broader sustainability goals of the university. A green roof offers a comprehensive solution to these problems by enhancing energy efficiency, mitigating stormwater runoff, and reducing the urban heat island effect. Through this project, the university can not only improve the sustainability of one of its key buildings but also set a positive example for the campus and the community at large. This proposal seeks funding to help address these critical environmental challenges and contribute to the long-term sustainability of the University of Massachusetts Amherst.

Statement Of Request

The Green Infrastructure Foundation is seeking funding through the Massachusetts Green Communities Grant to install a green roof on the W.E.B. Du Bois Library at UMass Amherst. The proposed project aims to address the environmental challenges of energy consumption, stormwater management, and urban heat island effects by leveraging the sustainable technology

of green roofs. This installation will align with the university's broader sustainability goals, specifically its commitment to achieving carbon neutrality by 2050, as outlined in the UMass Carbon Neutrality program (UMass Carbon Neutrality, n.d.). The green roof will provide multiple environmental and operational benefits, including reducing energy usage, improving stormwater management, and mitigating the urban heat island effect, all of which are critical components of the university's commitment to sustainable development.

The primary goals of this project are to enhance the sustainability of the W.E.B. Du Bois Library, improve campus resilience to climate change, and contribute to the university's broader sustainability objectives. These objectives include:

1. **Reducing energy consumption**: By providing natural insulation, a green roof will help regulate the temperature of the library, thereby reducing the need for heating and cooling and lowering overall energy consumption. According to research, green roofs can lead to significant reductions in both heating and cooling energy use by as much as 25-50% in some cases (Li & Yeung).
2. **Mitigating stormwater runoff**: Green roofs absorb rainwater, reducing the volume of stormwater runoff and minimizing the risk of flooding and water pollution. Studies have shown that green roofs can capture up to 75% of annual rainfall, significantly reducing strain on local drainage systems and improving water quality (Antrop et al.).
3. **Alleviating urban heat island effects**: Green roofs help reduce surface temperatures, combatting the urban heat island effect that contributes to higher ambient temperatures and increased energy demand. By lowering temperatures in and around the library, the green roof will provide a cooling effect that benefits both the building and its surrounding environment. According to Getter and Rowe (2006), green roofs can significantly lower surface temperatures, providing cooling benefits to surrounding areas.

This project is a critical step toward enhancing the sustainability of the W.E.B. Du Bois Library and helping UMass Amherst achieve its sustainability and carbon neutrality goals. By integrating green infrastructure, the library will serve as a model for other campus buildings, demonstrating the potential for green roofs to contribute to environmental improvements while providing operational cost savings. The UMass Carbon Neutrality program outlines the university's ambition to significantly reduce its carbon emissions, and this green roof installation will directly support these efforts by lowering the building's energy consumption and improving stormwater management (UMass Carbon Neutrality, n.d.).

The green roof will be designed to integrate seamlessly with the existing structure, utilizing locally sourced materials and plant species that are well-suited to the campus climate. By

choosing plants that thrive in the local environment, the roof will require minimal maintenance and provide long-term benefits for both the building and the surrounding ecosystem. Additionally, the green roof will offer educational opportunities for students and faculty to learn about sustainability and environmental stewardship, further aligning with the university's mission to foster environmental awareness.

The Green Infrastructure Foundation is requesting a grant of $500,000 to cover the costs of designing, installing, and maintaining the green roof. The proposed budget will be allocated as follows:

- **Design and Planning**: $75,000 for architectural and engineering services to ensure the roof meets all building codes, structural requirements, and sustainability standards.
- **Materials and Installation**: $350,000 for the procurement of high-quality green roofing materials, including plants, soil, drainage systems, and waterproofing membranes.
- **Maintenance and Monitoring**: $75,000 for the first five years of maintenance, including regular inspections, plant replacement, and performance monitoring to track the roof's environmental impact.

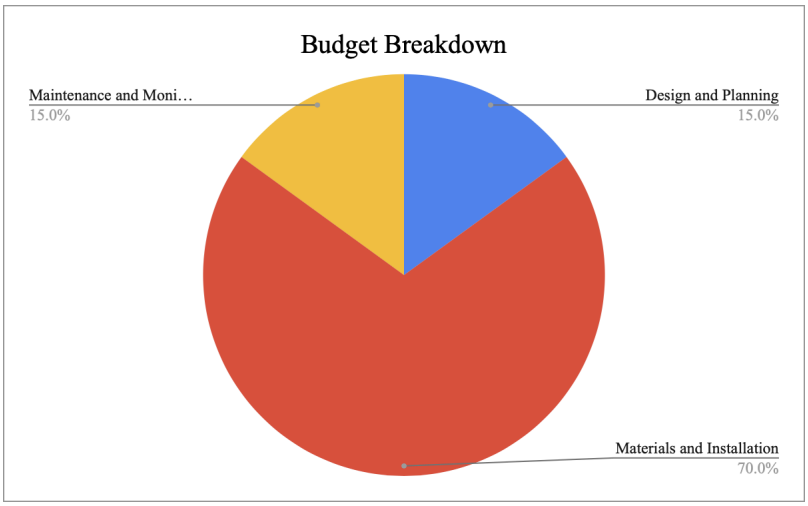

Fig. 3

The budget will ensure the successful implementation and long-term sustainability of the project, ensuring that the green roof continues to provide benefits for many years to come. This investment will support the university's broader environmental goals and demonstrate leadership in sustainable building practices.

The installation of a green roof on the W.E.B. Du Bois Library is a strategic and impactful step toward advancing sustainability at the University of Massachusetts Amherst. By addressing key environmental challenges such as energy consumption, stormwater management, and urban heat island effects, this project will not only improve the efficiency and sustainability of the library but also contribute to the university's broader efforts to achieve carbon neutrality by 2050. We respectfully request your support in making this project a reality and in helping UMass Amherst lead the way in green infrastructure solutions for higher education.

Green Roof Design and Installation for W.E.B. Du Bois Library

The design of the green roof will be led by experienced architects, engineers, and horticulturists, all of whom specialize in green infrastructure. The initial step will involve a comprehensive evaluation of the library's structural integrity to ensure that the existing roof can support the additional weight of the green roofing materials, including soil, plants, and water retention systems. Structural assessments will be performed to determine any necessary reinforcements and to ensure the building meets all local building codes and regulations.

The design will also focus on selecting appropriate plant species that are native to the region and capable of thriving in the local climate. These plants will require minimal maintenance and water while providing a habitat for local wildlife and contributing to the overall sustainability of the project. A combination of drought-tolerant plants and low-maintenance ground cover will be selected to ensure that the green roof functions effectively throughout the year, with minimal upkeep required.

The integration of a high-quality drainage system will also be a key component of the design. This system will ensure that excess water is effectively captured and directed into the building's stormwater management infrastructure, reducing runoff and mitigating the risk of flooding in surrounding areas. The green roof will be designed to capture up to 75% of the rainfall, based on existing research and industry standards (Li & Yeung).

Fig. 4

The installation process will be carried out by a team of skilled contractors with experience in green roof construction. The installation will be phased to ensure minimal disruption to the daily activities of the library and surrounding campus. The process will involve several key steps:

1. **Preparation of the Roof Surface**: The roof will be cleaned and prepared to receive the green roofing materials. Any repairs needed to the existing roof will be made to ensure a secure and durable foundation for the green roof.
2. **Waterproofing and Drainage Systems**: A waterproof membrane will be installed to protect the building from potential water infiltration. Following this, a drainage system will be laid out to manage water flow, allowing excess water to be absorbed or directed

into the stormwater system. This will be essential in reducing the risk of water damage and ensuring the long-term health of the plants on the green roof.

3. **Soil and Plant Installation**: A specialized lightweight growing medium will be spread across the roof to support plant growth. This medium will be carefully selected to ensure it is both durable and conducive to healthy plant life. Once the soil is in place, native plants will be installed, focusing on species that are well-suited to the UMass Amherst climate and will require minimal irrigation and maintenance.
4. **Final Inspections and Adjustments**: After the green roof is fully installed, a thorough inspection will be conducted to ensure all systems are functioning as intended. Any necessary adjustments will be made to optimize the performance of the roof, ensuring its long-term sustainability and functionality.

Once the green roof is installed, the Green Infrastructure Foundation will work with UMass Amherst's sustainability team to implement a maintenance plan. This plan will include regular inspections, plant care, and monitoring of the roof's environmental performance. Specific tasks will include:

- **Monthly Inspections**: To check plant health, soil conditions, and the integrity of the drainage and waterproofing systems.
- **Seasonal Plant Replacement**: Over time, plants may need to be replaced to ensure the roof continues to provide benefits. The replacement of plants will be done according to a planned schedule, with a focus on low-maintenance, drought-resistant species.
- **Performance Monitoring**: The green roof's impact on energy savings, stormwater management, and temperature regulation will be monitored. Data will be collected to track energy usage in the library, the volume of stormwater runoff, and surface temperatures, providing valuable information to refine future green infrastructure projects on campus.

The performance monitoring data will be made publicly available as part of the university's commitment to sustainability and transparency. This data will also be used for educational purposes, providing students and faculty with an opportunity to learn about the benefits of green roofs and their role in sustainable building practices.

The project will be completed in several phases over a span of approximately 12 months. The timeline for the project is as follows:

1. **Months 1-3**: Design and planning, including structural assessments, finalizing plant selection, and obtaining necessary permits.
2. **Months 4-6**: Preparation of the roof, including cleaning, repairs, and installation of the waterproofing and drainage systems.

3. **Months 7-9**: Soil and plant installation, followed by the first round of inspections.
4. **Months 10-12**: Final adjustments and ongoing maintenance and monitoring preparations.

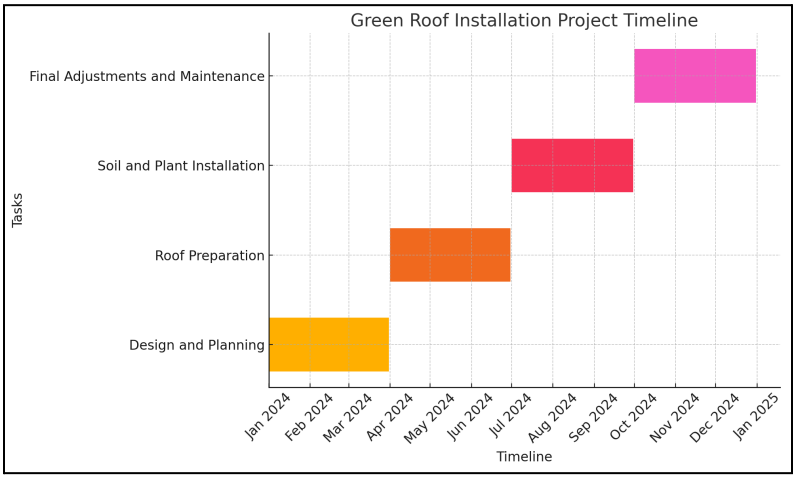

Fig. 5

The installation of a green roof on the W.E.B. Du Bois Library will significantly enhance the sustainability of UMass Amherst, aligning with the university's carbon neutrality and environmental stewardship goals. Through careful design, expert installation, and ongoing maintenance, the green roof will provide lasting benefits in terms of energy efficiency, stormwater management, and climate resilience. This project not only serves as a vital step toward a greener campus but also positions UMass Amherst as a leader in sustainable building practices within the higher education sector.

i. Evaluation Metrics for Green Roof Success

The success of the proposed green roof installation on the W.E.B. Du Bois Library will be evaluated through a combination of environmental, economic, and educational metrics. These measures are designed to ensure that the project meets its intended goals of sustainability, resource efficiency, and academic engagement.

One of the primary indicators of success will be the green roof's environmental performance. This includes its ability to retain stormwater and mitigate runoff. Research has shown that green roofs can reduce stormwater runoff by up to 75% during the growing season, easing the strain on urban drainage systems and reducing the risk of flooding (Li & Yeung). Data collection will involve measuring rainfall and runoff volumes to determine the percentage retained by the roof.

Another key measure will be temperature regulation. Green roofs are effective at lowering ambient temperatures and improving insulation, which reduces the urban heat island effect. Regular temperature readings, both on the roof and in surrounding areas, will demonstrate its cooling impact. Additionally, the selected vegetation will contribute to carbon sequestration, an essential metric for aligning the project with UMass's broader carbon neutrality goals (Lazzarin, Castellotti, & Busato).

The economic success of the project will be assessed by its impact on energy savings and long-term financial viability. The green roof is expected to reduce the library's energy consumption by providing better insulation, leading to lower heating and cooling costs. Monthly utility bills will be compared pre- and post-installation to quantify savings. Over time, the lifecycle cost-benefit analysis will evaluate whether the initial investment and maintenance costs are offset by these savings, as well as by the extended lifespan of the roof itself (Rand PC).

The green roof will provide an invaluable platform for educational and research activities. Success will be measured by the extent to which the roof is utilized in academic programs. This includes the number of courses integrating it into their curriculum, the volume of student-led research projects conducted, and the publications or presentations that emerge as a result.

Beyond academics, the green roof will serve as a public engagement tool. Workshops, guided tours, and community outreach programs will be organized to share the project's benefits and inspire broader adoption of green infrastructure. Attendance numbers at these events and feedback surveys will provide data on the project's success in fostering awareness and involvement.

Fig. 6

Finally, the project will be evaluated based on its contribution to UMass Amherst's carbon neutrality objectives. The amount of CO_2 offset through reduced energy use and stormwater management will be tracked and reported annually. These results will be compared to the benchmarks set by the UMass Carbon Neutrality Plan (UMass Carbon Neutrality, n.d.).

The combined environmental, economic, and educational metrics will be compiled into annual reports to ensure transparency and accountability. These reports will also serve as a resource for other institutions interested in pursuing similar sustainability projects.

ii. Description of Available Facilities

The University of Massachusetts Amherst has robust infrastructure and resources to support the installation of a green roof on the W.E.B. Du Bois Library. This iconic building, located at the

heart of the UMass Amherst campus, is a suitable candidate for the project due to its structural design, central location, and existing commitment to sustainability initiatives.

The W.E.B. Du Bois Library was constructed with a steel-reinforced concrete framework designed to withstand significant weight loads. Preliminary evaluations have indicated that the roof can be retrofitted to support the additional weight of a green roof system, including soil, plants, and drainage mechanisms. This structural resilience minimizes the need for extensive modifications, thereby reducing overall project costs (Rand PC).

Fig. 7

UMass Amherst has a strong track record in sustainability research and implementation. The university houses several centers and departments focused on environmental innovation, including the School of Earth and Sustainability and the Physical Plant Department. These entities offer technical expertise and operational support for the green roof project. For example, the UMass Physical Plant team can assist with the logistical aspects of installation, maintenance, and stormwater management (UMass Carbon Neutrality, n.d.).

The green roof project also aligns with the campus's Carbon Neutrality Plan, which leverages existing facilities and personnel to reduce greenhouse gas emissions. Utilizing these resources ensures seamless integration with ongoing sustainability efforts.

The W.E.B. Du Bois Library offers unparalleled potential as an educational resource. Its central location makes it an accessible hub for students, researchers, and visitors. With its proximity to multiple academic buildings, the library can serve as a hands-on learning space for courses and projects focused on green infrastructure. In particular, the Environmental Science and Landscape Architecture programs will benefit from using the green roof as a living laboratory, fostering interdisciplinary collaboration and innovation (Lazzarin, Castellotti, & Busato).

UMass Amherst also provides logistical advantages for the project. The campus has access to materials and equipment needed for construction, including cranes and specialized roofing tools, through existing partnerships with local contractors. Additionally, the university's commitment to

sourcing sustainable materials ensures that the green roof installation will align with environmental best practices.

iii. Essential Personnel for Project Success

The success of the proposed green roof project on the W.E.B. Du Bois Library relies heavily on the expertise and qualifications of the personnel involved. The project team will include experienced professionals in the fields of sustainable architecture, green infrastructure, landscape design, and environmental science. The collaborative effort of these professionals, combined with the available campus resources and institutional support, will ensure the project's smooth execution and long-term success.

The project will be overseen by a dedicated project manager with extensive experience in large-scale environmental projects, particularly green infrastructure initiatives. This individual will have a background in sustainable urban planning and a proven track record of successfully managing similar projects on university campuses. Their role will involve coordinating the various stakeholders, ensuring the project meets all deadlines and regulatory requirements, and providing day-to-day oversight of all operations.

The project manager will work in close coordination with the UMass Physical Plant Department, which has successfully carried out numerous sustainability projects on campus. This department brings significant expertise in logistics, construction, and maintenance, which will be invaluable during the planning and installation phases of the green roof project. Their knowledge of campus infrastructure and commitment to sustainability initiatives will be key assets in facilitating the smooth integration of the green roof into the existing structure of the library.

The design team will include architects and landscape designers with specific experience in designing and implementing green roofs. These professionals will work closely with experts in stormwater management and energy efficiency to ensure the green roof system meets the university's environmental and sustainability goals. The design team will incorporate cutting-edge techniques and materials to ensure the green roof is efficient, aesthetically pleasing, and functional in improving the building's environmental footprint.

One key individual in the design team is an experienced landscape architect who has worked on similar projects that focus on integrating green infrastructure in urban settings. They will ensure the project’s alignment with ecological principles, addressing factors such as the selection of

suitable plant species and the integration of biodiversity features, which will help meet sustainability goals such as reducing the urban heat island effect and improving air quality.

The green roof installation will be carried out by licensed contractors who specialize in green roof systems. These contractors will have experience with the installation of vegetation-based roofing systems, including the installation of necessary irrigation and drainage systems. They will also ensure that all necessary structural reinforcements are made to accommodate the green roof, in accordance with building code requirements.

After installation, the maintenance of the green roof will be managed by the UMass Physical Plant Department, which has experience maintaining sustainable infrastructure across campus. This team will ensure that the green roof is properly cared for, with regular inspections, plant care, and necessary adjustments to maintain its health and functionality. The collaboration between the maintenance team and the design experts will ensure that the roof continues to perform optimally, both as a sustainable feature and as a long-term asset to the university.

The green roof project will also be supported by faculty members from the School of Earth and Sustainability and the Department of Environmental Science, who will provide research support for monitoring the green roof's effectiveness in real-world applications. These experts will evaluate the environmental and energy-saving benefits of the green roof, contributing to the academic goals of the university while also enhancing the project's credibility. The data collected through this ongoing research will help to refine future green infrastructure projects on campus and offer valuable insights for other institutions interested in similar initiatives.

This team of qualified professionals, in conjunction with the campus's existing resources and commitment to sustainability, provides the ideal foundation for the successful installation and operation of the green roof. By bringing together expertise from various disciplines, UMass Amherst ensures that the project will have a meaningful and lasting impact on the campus's sustainability efforts.

iv. Budget

The proposed project to install a green roof on the W.E.B. Du Bois Library will require a carefully planned budget that accounts for both initial installation costs and long-term maintenance. Based on the benefits of green roofs outlined by both Oberndorfer et al. and Niu et al. (2010), the investment in a green roof is expected to deliver significant environmental and financial returns over time. These sources highlight the value of green roofs not only in providing

ecological benefits but also in improving energy efficiency and stormwater management, which will be factored into the long-term cost projections.

The initial costs for the project will primarily include materials, labor, and design. Materials will consist of lightweight growing media, waterproofing layers, drainage systems, and plants that are best suited for the climate in Massachusetts. Labor costs will include the installation of these components as well as consulting from green roof specialists to ensure optimal performance. The total estimated installation cost is around $25 per square foot, which includes both the construction of the underlying structure and the green roof installation itself (Rand PC).

Additional expenses will involve long-term maintenance, which is necessary to ensure the green roof continues to function effectively throughout its lifespan. Regular inspections, plant replacement, and irrigation system upkeep will contribute to annual maintenance costs. These are projected to be lower than traditional roof maintenance, given the green roof's ability to protect the building from weathering and damage due to its insulating properties (Li & Yeung). Niu et al. (2010) support this notion by demonstrating the long-term cost savings associated with green roofs in sustainable design, as their insulating properties reduce the need for heating and cooling.

The green roof will also help mitigate stormwater runoff, which could lead to savings for the University in terms of reduced stormwater management fees. According to Oberndorfer et al., green roofs can significantly reduce runoff by absorbing and filtering rainwater, thus alleviating the pressure on local stormwater infrastructure.

Summary

This grant proposal outlines the plan for the installation of a green roof on the W.E.B. Du Bois Library at the University of Massachusetts, a project that aligns with the university's goals for sustainability and environmental responsibility. The proposed green roof will offer numerous benefits, including reducing energy consumption through improved insulation, managing stormwater runoff, enhancing biodiversity, and improving the overall aesthetics and functionality of the building. Additionally, it will contribute to the University's broader commitment to carbon neutrality as outlined on their official sustainability platform (UMass Carbon Neutrality, n.d.).

The installation will be carried out with careful planning and expert consultation to ensure high-quality execution. The project will require an initial investment in materials and labor, with an estimated cost of $25 per square foot, which will include the installation of a waterproofing membrane, growing medium, and plantings (Rand PC). However, these upfront costs will be

offset by long-term savings related to reduced energy expenditures and decreased stormwater management fees, as highlighted by previous studies on green roofs (Li & Yeung). Furthermore, the green roof will contribute to the University's goals for sustainable campus development, furthering its commitment to reducing its environmental impact.

In conclusion, this project represents a significant step toward the University's sustainability objectives. It promises long-term ecological and financial benefits, making it a valuable investment for the future. By implementing this green infrastructure solution, the University of Massachusetts will set an example for other academic institutions, demonstrating the tangible benefits of green roofs in urban settings.

Bibliography

Akbari, H., et al. "Experimental Measurements and Numerical Modelling of a Green Roof." *Energy and Buildings*, Elsevier, 7 Apr. 2005, www.sciencedirect.com/science/article/pii/S0378778805000514.

Akbari, H., et al. "Experimental Measurements and Numerical Modelling of a Green Roof." *Energy and Buildings*, Elsevier, 7 Apr. 2005, www.sciencedirect.com/science/article/pii/S0378778805000514.

Antrop, M., et al. "Green Roof Benefits, Opportunities and Challenges – A Review." *Renewable and Sustainable Energy Reviews*, Pergamon, 24 Apr. 2018, www.sciencedirect.com/science/article/pii/S136403211830217X.

Berardi, U., et al. "Green Roof and Green Wall Benefits and Costs: A Review of Quantitative Evidence." *Renewable and Sustainable Energy Reviews*, Pergamon, 8 Aug. 2020, www.sciencedirect.com/science/article/pii/S1364032120304020.

Clark, Corrie, et al. "ACS Publications: Chemistry Journals, Books, and References Published ..." *ACS Publications*, pubs.acs.org/doi/full/10.1021/cr010012i. Accessed 17 Dec. 2024.

Hathaway, A. M., et al. "A Field Study of Green Roof Hydrologic and Water Quality Performance." *Transactions of the ASABE*, American Society of Agricultural and Biological Engineers, 1 Jan. 1970, elibrary.asabe.org/abstract.asp?aid=24225.

Niu, Hao, et al. *ACS Publications: Chemistry Journals, Books, and References Published ...*, 12 May 2010, pubs.acs.org/doi/full/10.1021/cr010012i.

Oberndorfer, Erica, et al. "Green Roofs as Urban Ecosystems: Ecological Structures, Functions, and Services." *BioOne Complete*, American Institute of Biological Sciences, 1 Nov. 2007, bioone.org/journals/bioscience/volume-57/issue-10/B571005/Green-Roofs-as-Urban-Ecosystems--Ecological-Structures-Functions-and/10.1641/B571005.full.

Rand Engineering and Architecture, DPC. "Green Roof Fact Sheet." *RAND Engineering & Architecture, DPC*, randpc.com/articles/energy-efficiency/green-roof-fact-sheet#:~:text=Green%20roof%20cost%20approximately%20$25,roof%20and%20new%20underlying%20roof. Accessed 16 Dec. 2024.

"UMass Carbon Zero." *UMass Carbon Zero : UMass Amherst*, www.umass.edu/carbon-neutrality/. Accessed 16 Dec. 2024.

W.C., W.C., and K.K.A. Yeung. "A Comprehensive Study of Green Roof Performance from Environmental Perspective." *International Journal of Sustainable Built Environment*, Elsevier, 29 May 2014, www.sciencedirect.com/science/article/pii/S2212609014000211.

Image Credit

Cover Image. “Warsaw University Library.” *Greenroofs.Com*, www.greenroofs.com/projects/warsaw-university-library/. Accessed 17 Dec. 2024.

Figure 1. “Advantages of Green Roofs.” *Cool Ideas in Photos*, en.idei.club/33782-advantages-of-green-roofs.html. Accessed 17 Dec. 2024.

Figure 2. “Advantages of Green Roofs.” *Cool Ideas in Photos*, en.idei.club/33782-advantages-of-green-roofs.html. Accessed 17 Dec. 2024.

Figure 4. *Sempergreen*, www.sempergreen.com/en/solutions/green-roofs/installation. Accessed 17 Dec. 2024.

Figure 6. CollegeSimply. “Public Four Year Colleges in Massachusetts.” *CollegeSimply*, www.collegesimply.com/colleges/massachusetts/public-four-year-colleges/. Accessed 17 Dec. 2024.

Figure 7. “UMass Amherst: Du Bois Library Renovation.” *Tighe & Bond*, www.tighebond.com/project/umass-amherst-du-bois-library-renovation/. Accessed 17 Dec. 2024.