LIVING ARCHITECTURE PERFORMANCE TOOL

Advancing Green Roof and Wall Performance

Version 1.0

GREEN INFRASTRUCTURE FOUNDATION

About the Green Infrastructure Foundation

greeninfrastructurefoundation.org

The Green Infrastructure Foundation partners with communities to shape healthy, resilient, and sustainable places using living green infrastructure.

The Green Infrastructure Foundation (GIF) was founded in 2007 to respond to the need for greater awareness and resources to promote the design, installation, and maintenance of green infrastructure in local communities. GIF is a tax-exempt, charitable 501(c)(3) organization affiliated with Green Roofs for Healthy Cities (GRHC), a membership-based industry association and the leading entity for promoting the green roof and wall industry in the U.S. and Canada.

GIF's programs and activities are designed to promote the positive contributions green infrastructure can make in communities while addressing barriers to green infrastructure, including out-dated regulations, the lack of awareness among policymakers and their constituencies, and the lack of technical knowledge about green infrastructure among contractors and consultants. The Living Architecture Performance Tool is designed to help address many of these issues as they pertain specifically to green roofs and walls either separately or in combination.

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A. Introduction

The Living Architecture Performance Tool (LAPT) is a rating system and resource for green roofs and walls. The primary goal of the Living Architecture Performance Tool is to certify that green roof and wall projects are planned to achieve certain measurable and replicable performance benefits, so that they can be funded, designed, installed, and maintained with a much higher degree of confidence. This is Version 1.0 of the tool, for the use of projects participating in the pilot phase of the program.

B. Project Requirements

Living architecture, as defined in the LAPT, refers to technologies that integrate living systems on or within the building envelope – specifically, green roofs, living walls (interior and exterior), and green facades. For definitions, see appendix E.

A project can be defined with one or a combination of multiple living architecture types for certification. If multiple types are part of the defined project, the performance attributes of each type of living architecture are credited for their aggregated contributions to each strategy area. For example, using a combination of green roofs and living walls to manage a 90th percentile storm event can earn credit under Credit 2.1.

The LAPT is intended to be used in the planning, design, construction, and long-term maintenance and performance monitoring for any green roof, green wall, or combination of the two. Minimum total area for a green roof project is 500 ft^2 (46.5 m^2), and for a green wall project is 50 ft^2 (4.65 m^2). There is no maximum size for a green roof or wall. New construction and retrofits/renovations are both eligible for certification under the LAPT. Projects must achieve all four prerequisites and obtain a minimum number of points to be certified, and achieve various levels of certification (see section G.).

Any party who is involved in the project may submit on behalf of the project, including private-sector architecture/landscape/engineering firms, government agencies, property owners or developers, etc.

A project can be defined with one or a combination of multiple living architecture types for certification. If multiple types are part of the defined project, the performance attributes of each type of living architecture are credited for their aggregated contributions to each strategy area. For example, using a combination of green roofs and living walls to manage a 90th percentile storm event can earn credit under Credit 2.1. The focus areas and proposed credits are described in the table below, with details on each that follow. Not all credits are applicable to all forms of living architecture - consideration has been made of this point with regards to certification levels.

C. Certification Levels

There are a total of 110 points that a project could achieve (100 base points plus 10 innovation points). The levels of potential certification are:

- LAPT Certified – 40+ points
- LAPT Silver – 50+ points
- LAPT Gold – 60+ points
- LAPT Platinum – 80+ points

The *LAPT Certified* level recognizes well-designed, installed, and maintained living architecture systems that should perform effectively over its life-cycle. *LAPT Silver, Gold*, and *Platinum* levels of certification recognize

projects that meet the above requirements, but are also holistic and integrated, and achieve greater levels of performance.

These levels of certification in draft Version 1.0 are preliminary and could be adjusted based on further analysis and data. Different thresholds for certification could also be introduced for new and retrofit projects.

D. How to use the LAPT

Performance Areas and Credits are described in Sections 1-8. This includes:

- Principles: articulates the overarching objectives for each performance area
- Objective: describes the broad strategies for achieving each principle
- Credits: defines the specific action(s) or outcome(s) necessary to achieve the objectives described in each performance area. This also identifies how many points (within the LAPT) given to each credit.
- Intent: the goal of each credit
- Measurement Method: the method and/or actions necessary to demonstrate compliance with each credit
- Strategies for Compliance: tips and suggestions to meet the intent of each credit
- Resources: external information to help meet the intent of each credit

The LAPT is designed to meet the needs of a wide range of professionals, including:

Design, Installation, and Maintenance Professionals

- Use the LAPT as a guideline to increase potential benefits, identify synergies and optimize performance
- Promote healthy and long-lasting living architecture projects through proper design, installation, and long-term maintenance procedures
- Obtain certification for branding and marketing purposes
- Integrate living architecture into building projects to prevent value engineering

Policy Makers

- Adopt the LAPT in whole or in part as a requirement for incentive or regulatory compliance programs (e.g. a stormwater utility or planning department requiring LAPT certification plus minimum performance in *Credit 2.1 Stormwater Management* or *Credit 5.2 Biophilic Design: Accessibility* for a project to be eligible for an incentive)
- Encourage the use of the LAPT by local professionals to improve the performance of living architecture

Manufacturers

- Develop new products and improve existing products to help maximize performance and achieve credits (e.g. using more recycled or local content in a drainage layer, or a greater diversity of species in a pre-vegetated tray).

Credits

1. Process (5)

Principle

Develop living architecture with design processes and procedures known to deliver the greatest potential for success.

Objectives

Plan, design, and construct living architecture systems with close collaboration among all building and site disciplines; engage suitably trained and experienced experts in living architecture; develop programming and design objectives through an open, inclusive process with all potential stakeholders.

1.1 Integrated Design Process (Prerequisite)

Intent

An Eco-Charette to be held early in the design process to map the project to the LAPT's performance areas will help to identify priorities and goals for the project.

Prerequisite

Design teams must hold an Eco-Charette at the outset of the project whether the project is new construction or a retrofit. An Eco-Charrette is an enhanced type of project kick-off meeting. It is an interactive brainstorming and team-building exercise that generates and targets sustainability goals for the project.

Measurement Method

Submit a report outlining the goals of the project specific to the contributions of the living architecture to its underlying building or environment. The report should detail how local policies and requirements will be met, as well as what strategies and technologies will be contemplated to meet the strategic areas in this certification process. In LAPT v1.0, this prerequisite can be met for projects that have already been initiated by providing documentation that demonstrates some form of integrated design process.

Resources

The Eco-Charrette process is referenced in many building resources and standards, including:

- Canadian Standards Association S478
- ASTM E 2136
- USGBC LEED Green Building Rating Systems
- NAHB Research Center's Durability by Design

For further information, see *A Handbook for Planning and Conducting Charrettes* for High-Performance Projects from the National Renewable Energy Laboratory, US Department of Energy available at nrel.gov

1.2 Stakeholder & Community Engagement (3)

Intent

Design processes that engage as many stakeholders as possible early in the project have a higher potential for greater buy-in and successful outcomes. For projects located in residential communities, avoiding design solutions that shortcut the involvement of community members is recommended.

"The positive outcomes of constructive collaboration are numerous, and far outweigh the potential challenges of coordinating such an effort. Not only are the chances better for program success, but residents' investment will strengthen the future health of the community." – The Sustainable Cities Institute

Minimum Performance (2)
The design team and stakeholders to the project from the client/user must participate in the Eco-Charette and subsequent design process. If the project is new construction, this should include the architect, landscape architect, civil, structural, and mechanical engineering disciplines. At a minimum, the participants should include an owner/key leader, representation for future building occupants, and a representative who will be responsible for operation and maintenance of the living system.

--- OR ---

Enhanced Performance (3)
Meet the above requirements, AND develop an environmental and social justice (ESJ) plan based on the priorities of community groups in the vicinity of the site OR involve priority-population in design or programming of the living architecture, via community organization partnerships, multi-faceted outreach and approaches to equal involvement, and/or participatory budgeting

Measurement Method
For minimum performance: Submit a roster of attendees at the workshop, identification of their role on the project and a description of any ongoing contributions they will make to the design and construction of the project moving forward.

For enhanced performance: Submit the ESJ plan and/or documentation of partnerships with community organizations, outreach effort, and/or participatory budgeting outcomes

Resources
- King County ESJ tools and resources (kingcounty.gov/elected/executive/equity-social-justice/tools-resources.aspx)

1.3 Living Systems Expertise (2)

Intent
Ensure that living architecture projects are implemented by professionals with knowledge and experience of these systems.

Minimum Performance (2)
Use a design professional with demonstrated expertise in living architecture systems AND/OR a Green Roof Professional (GRP) on the design team.

Measurement Method
If the living systems expert is NOT a Green Roof Professional, submit a resume showing three projects designing or installing living architecture systems on previous projects.

Resources
- Green Roofs for Healthy Cities: Green Roof Professional Training Program (greenroofs.org/grp-training)
- A list of Green Roof Professionals is provided in the Green Pages Green Roof and Wall Directory (issuu.com/grhcna/docs/grhc)

2. Water Management (25)

Principle

Use living architecture as part of an overall approach to balance water flows locally (site, district) to the degree practicable.

Objectives

Slow, cool, cleanse, and evapotranspire rainwater/replicate natural hydrology; help avoid combined sewer overflow events; buffer, treat, and utilize surplus building water; minimize/avoid the use of drinking water/non-renewable energy to maintain lush, healthy vegetation.

Based on the detailed technical review conducted during the SITES development process, runoff retention is used as a proxy for water quality improvements. Essentially, by reducing runoff volume, the overall volume of sediment, nutrients, or contaminants is reduced. Additional actions to improve water quality are required as part of credit 7.1 Operations and Maintenance. Projects that address and measure water quality improvements using sensors or long-term continuous modeling could apply for innovation credits.

2.1 Stormwater Quantity and Quality Management (Prerequisite + 16)

Intent

Design/engineer living surfaces to slow, cool, cleanse, and evapotranspire (and/or utilize) rainwater that falls on those built surfaces in support of stable, natural hydrology.

Prerequisite

Meet all local requirements and codes related to stormwater retention.

Minimum Performance (7)

Retain the volume of water that falls on the building from a 90th percentile precipitation event for the location of the project [Range of 0.5” (Boise, ID) to 1.6” (Atlanta, GA)].

--- OR ---

Enhanced Performance (12)

Retain the volume of water that falls on the building from a 95th percentile precipitation event for the location of the project [Range of 0.8” (Salt Lake City UT) to 2.1” (Atlanta, GA)].

--- OR ---

Outstanding Performance (16)

Retain the volume of water that falls on the building from a 99th percentile precipitation event for the location of the project [Range of 0.8” (Las Vegas, NV) to 3.4” (Atlanta, GA)].

Projects that achieve exceptional performance (for example, a green roof and/or wall that retains water from a 99th percentile rain event AND excess water, such as condensate water, groundwater, water from other buildings or the rest of the site) may be eligible for innovation credits.

- ***Measurement Method***
  Use the method approved by your local regulators. If there are no methods identified by local regulators, use one of the following methods:

- Runoff modeling for rain events using approved models (EPA SWMM with LID Controls; as better models are created in the public realm, they will be incorporated into future versions of the LAPT)
- Determine the target storage volume using the following formula which converts a rain event into a volume of water:

  Target Storage Volume (l) = Roof Area (m^2) x depth of rain (mm)

  Target Storage Volume (gal) = Roof Area (ft^2.) x depth of rain (in) x 0.62337

  Once the target storage volume is determined, determine the volume captured by the entire assembly using the following formula (from the DC Department of Energy and Environment), and ensure it meets the target storage volume:

Equation 3.1 Storage Volume for Green Roofs

$$Sv = \frac{SA \times [(d \times \eta_1) + (DL \times \eta_2)]}{12}$$

where:

Sv	=	storage volume (ft^3)
SA	=	green roof area (ft^2)
d	=	media depth (in.) (minimum 3 in.)
η_1	=	verified media maximum water retention (use 0.15 as a baseline default in the absence of verification data)
DL	=	drainage layer depth (in.)
η_2	=	verified drainage layer maximum water retention (use 0.15 as a baseline default in the absence of verification data)

Verification of growing media water retention should be conducted using ASTM 2399 (Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems). Verification for synthetic layers such as plastic cups, trays, rock wool or other non-growing media materials should be conducted using ASTM 2398 (Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Vegetative (Green) Roof Systems).

Strategies for Compliance

Use the following strategies:

- Maximize growing media depth
- Increase performance characteristics of growing media
- Use water retaining layers such as rock wool or cup-shaped drainage layers
- Maximize evapotranspiration by using a diverse mix of climate-appropriate plants and maximizing biomass
- Incorporate runoff capture and reuse by integrating a cistern and irrigation system or cistern and grey water harvesting system
- Improve water quality by reducing or eliminating fertilizers and pesticides and using integrated pest management approaches

Resources

- Living Architecture Performance Tool Stormwater Quantity Management White Paper (greeninfrastructurefoundation.org/s/LAPT_Stormwater_Quantity_Management_WhitePaper_Draft_11.pdf)

2.2 Irrigation (5)

Intent

Calibrate living architecture to thrive with minimal or zero use of potable water; utilize surplus building water to support lush, healthy vegetation adapted to local conditions.

Refer to the possible performance levels and the table below to determine the appropriate levels of performance for arid/semi-arid and humid climates.

Potable Water Reduction

Reduce potable water use for irrigation by 50 percent from the baseline for the project's peak watering month

--- OR ---

No Potable Water

Use no potable water for irrigation - only captured and re-used water, or treated grey water (if permitted by local municipal codes)

--- OR ---

No Irrigation

Select plants that require no supplemental irrigation beyond rain

	Type of Climate (Köppen-Geiger Classification)	
Level of Performance	**Arid/Semi-Arid**	**Humid**
Minimum (1)	Potable water reduction	N/A
Enhanced (3)	No potable water	Potable water reduction
Outstanding (5)	No irrigation	No potable water

Note: This credit does not apply during the plant establishment period (not to exceed two years).

Measurement Method

Use the EPA WaterSense calculator (or equivalent if you are outside the U.S.) to determine living architecture water needs

- If reducing water use; identify what strategies the project is taking to reduce water use, including plant selection and irrigation methods
- If using non-potable water sources, provide documentation that demonstrates this

Strategies for Compliance

Use high-efficiency irrigation; use predictive irrigations systems that use real-time weather forecasting, soil moisture sensors, or other controls; design for resilience and low water use; capture and reuse rainfall, AC condensate, sump pump water, or building grey/black water (if permitted by local codes).

Resources

- EPA WaterSense Calculator (https://www.epa.gov/watersense/watersense-calculator)
- Köppen-Geiger Climate Maps (http://koeppen-geiger.vu-wien.ac.at/present.htm)

2.3 Water Balance (4)

Intent

Use living architecture as part of an overall approach to balancing water flows locally to the degree practicable.

Minimum Performance (4)

Demonstrate that an analysis has been conducted to measure all site/building water inputs and outputs and that green roof and/or wall performance is factored into the overall model.

Measurement Method

Provide a worksheet indicating all water flows. The analysis should include:

- stormwater assumptions as part of an overall stormwater permit
- rainwater harvesting/reuse calculations
- other surplus building water (e.g. air conditioning condensate, building process water, etc. buffered/attenuated/utilized)
- water needs of vegetation

Strategies for Compliance

Consider the following strategies when identifying how to incorporate living architecture into overall site water balance: use plants that are appropriate for the site environment and water availability; utilize surplus building water; integrate green roofs and/or walls with rainwater harvesting; use a stormwater treatment train approach; consider pre-development hydrology and how to best mimic it.

Living architecture that contributes to net-zero water on site and/or treats greywater or blackwater may be eligible for innovation credits.

Resources

- Green Roofs for Healthy Cities Net Zero Water for Buildings and Sites Training Course (greenroofs.org/education)
- Living Building Challenge Water Petal (living-future.org/lbc/water-petal/)
- EPA Water Sense calculator (epa.gov/watersense/watersense-calculator)
- EPA Stormwater Calculator (epa.gov/water-research/national-stormwater-calculator)

3. Energy Conservation (14)

Principle

Incorporate living architecture on building surfaces to optimize energy performance of a building, site, or district.

Objectives

Maximize building envelope effectiveness; integrate living systems into the HVAC system where possible; minimize the urban heat island; integrate living systems with on-site renewable energy.

3.1 Envelope Thermal Moderation (5)

Intent

Analyze the impacts of living systems on the performance of the buildings into which they are placed. This will assist owners and designers to more deeply understand their potential benefits and more highly value their contributions.

Minimum Performance (2)

Integrate performance characteristics of living building system into whole building energy model, such as EnergyPlus, and report positive or negative impacts. If impacts are negative, demonstrate efforts to mitigate those impacts.

--- OR ---

Enhanced Performance (4)

Reduced annual modelled energy requirements of underlying building by 1 percent.

--- OR ---

Outstanding Performance (5)

Reduced annual modelled energy requirements of underlying building by 2 percent.

Measurement Method

Submit documentation from an energy model or calculator isolating performance contributions of living systems to underlying building.

Strategies for Compliance

Maximize growing media depth; use a diverse mix of plants and ensure water availability (preferably with non-potable water) to maximize evapotranspiration; use living walls or green facades on south or west walls to provide shade and evapotranspirative cooling in the hottest months.

Resources

- Environment Canada, Portland State University, and Green Roofs for Healthy Cities developed a simplified calculator that will provide basic information on thermal energy performance for several building types, new and old, across 100 cities. (sustainability.asu.edu/urban-climate/green-roof-calculator/)
- There is a Green Roof Model available for EnergyPlus Building Energy Modeling software (https://bigladdersoftware.com/epx/docs/8-0/engineering-reference/page-029.html)
- Living Architecture Performance Tool Energy Conservation and Generation White Paper (https://greeninfrastructurefoundation.org/s/LAPT_Energy_Conservation_and_Generation_WhitePaper_Draftv1.pdf)

3.2 Urban Heat Island (4)

Intent

Use green roofs and exterior green walls to contribute both to the moderation of microclimates of individual buildings and the larger patterns of urban heat island. This effect is particularly pronounced once enough structures utilize them to moderate the heat potential of inorganic structures.

Minimum Performance (1)
Achieve 50 percent green roof coverage on a building (not including areas occupied by mechanical systems, walkways, or renewable energy technologies) OR provide 50 percent green façade or living wall coverage (excluding window area) on a south or west facing façade.

--- OR ---

Enhanced Performance (2)
Achieve 75 percent green roof coverage on a building (not including areas occupied by mechanical systems, walkways, or renewable energy technologies) OR provide 75 percent wall coverage (excluding window area) on a south or west facing façade.

--- OR ---

Outstanding Performance (4)
Achieve 100 percent green roof coverage on a building (not including areas occupied by mechanical systems, walkways, or renewable energy technologies) OR provide 100 percent wall coverage (excluding window area) on a south or west facing façade.

Green roof projects that are designed with water features, reflective materials, or to maximize evapotranspiration through plant selection and use of non-potable water sources may be eligible for innovation credits. The presence of water is essential to maximizing the urban heat island reduction potential of living architecture.

Measurement Method
Submit green roof or wall plan or exterior elevations or photos demonstrating compliance.

3.3 Renewable Energy (2)

Intent
Use photovoltaic panels and green roofs in combination to contribute to lower carbon communities. When used together, the efficiency of the photovoltaic panels is improved while the photovoltaic panels can provide shade for the plants.

Minimum Performance (2)
Integrate green roof(s) with on-site photovoltaic panels to enhance efficiency of solar energy production

Measurement Method
Provide a roof plan to show the integration of the two systems

Strategies for Compliance
Use an integrated green roof and photovoltaic panel system

Resources
- Living Architecture Performance Tool Energy Conservation and Generation White Paper (https://greeninfrastructurefoundation.org/s/LAPT_Energy_Conservation_and_Generation_WhitePaper_Draftv1.pdf)

3.4 HVAC Integration (3)

Intent
Integrate living systems into HVAC systems to increase their value to owners and increase the understanding of their potential to contribute to reduced energy costs and healthy environments.

Minimum Performance (3)
Integrate living architecture with the HVAC system to reduce temperature of intake air OR integrate interior living wall with the HVAC system to treat return air stream.

Type of Metric
Prescriptive

Measurement Method
Submit documentation to demonstrate the integration of the two systems

Strategies for Compliance
Place HVAC intake less than 3 feet (0.9 m) from the green roof or wall surface so that the temperature of intake air is cooler. For interior living walls, design return-air to utilize the living wall to remove particulates so that a higher percentage of air can be re-circulated.

Resources

- Living Architecture Performance Tool Energy Conservation and Generation White Paper (https://greeninfrastructurefoundation.org/s/LAPT_Energy_Conservation_and_Generation_WhitePaper_Draftv1.pdf)

4. Habitat and Biodiversity (11)

Principle

Use living architecture to improve habitats, reconcile the built and natural environments, and optimize urban ecology.

Objectives

Design and maintain vegetative systems (growing medium, hydrology, maintenance/stewardship regime) to optimize conditions for the greatest range of locally adapted and/or native plantings as appropriate for the setting; design and maintain vegetated surfaces as complex living systems that support beneficial species of bees, butterflies, birds, and other organisms; optimize the amount of biomass on building surfaces and in support of building programming and uses. Diversity of plant species has been demonstrated to increase long-term resilience and performance of green roofs and walls, and can be used as a surrogate for total species diversity.

4.1 Plants (4)

Intent
Design and maintain vegetative systems (growing medium, hydrology, and maintenance/stewardship regime) to optimize conditions for the greatest range of locally adapted and/or native plantings as appropriate for the setting.

Species Variety (1)
Include at least 20 species of plants and commensurate growing conditions to support these plant species.

--- AND ---

Plant Families (1)
Include at least five families of plants and commensurate growing conditions to support these plant families.

--- AND ---

Native/Locally Adapted Plants (1)
Use native or locally-adapted plants to maximize habitat.

--- AND ---

Pollinator Support (1)
Use a wide variety of plants attractive to pollinators, that foliate, flower and shed leaves at different rates and seasons, using both deciduous and evergreen species to ensure a horticultural ‘presence’ throughout growth and senescent seasons with diversity over time.

Measurement Method
Submit a planting plan demonstrating compliance with any or all of the credit areas.

4.2 Growing Media Diversity of Depth and Composition (2)

Intent
Research has demonstrated that a variety of different growing media conditions (depth and composition) has the ability to support a wide array of plant communities and species. Doing so creates a number of niches that can be occupied by plants that require different growing conditions (depth, nutrient availability, water availability, etc.). The intent of this credit is to establish a wide variety of growing conditions to support a diverse array of plant communities and species.

Minimum Performance (2)
Utilize growing media depth and composition variety to support intended vegetation AND optimize plant diversity for the given loading

Measurement Method
Submit documentation or schematic design that demonstrates growing media depth and composition variety

Strategies for Compliance
Strategically incorporate supplemental irrigation (from harvested rainwater/building water); optimize depth of growing media based on available structural capacity (i.e. deeper growing media over columns and beams)

4.3 Habitat Elements (2)

Intent
Use living architecture to improve habitat for humans and other species; design and maintain vegetated surfaces as complex living systems that provide habitat and support beneficial species of bees, butterflies, birds, and other organisms.

Minimum Performance (2)
Create habitat elements for insects and birds by using habitat elements such as water, perches, logs, and stones

Measurement Method
Submit documentation, schematic design, or photos showing habitat elements

Resources
- City of Toronto guidelines for Biodiverse Green Roofs (https://web.toronto.ca/wp-content/uploads/2017/08/8d24-City-of-Toronto-Guidelines-for-Biodiverse-Green-Roofs.pdf)

4.4 Biomass (3)

Intent
Maximize the amount of biomass on building surfaces as practicable and in support of building programming and uses.

Minimum Performance (1)
Achieve a biomass level of 0.2, based on the method below

Enhanced Performance (2)
Achieve a biomass level of 0.4, based on the method below

Outstanding Performance (3)
Achieve a biomass level of 0.6, based on the method below

Measurement Method

1. Determine the total roof area of a building (not including areas occupied by mechanical systems, walkways, or renewable energy technologies)
2. Calculate the area of each proposed planting type, and multiply by the assigned multiplier (below) to determine the weighted square footage of each planting type
3. Add the weighted square footages together
4. Divide this number by the total roof area to determine the project's biomass

Multipliers	
Ground covers, or plants less than 2 feet (0.6m) tall at maturity	0.2
Plants at least 2 feet (0.6m) tall at maturity	0.3
Tree canopy for all new trees with mature canopy spread of 40 feet or less	0.5
Tree canopy for new trees with mature canopy spread of greater than 40 feet	0.6
Green facades or living walls	0.6

For example, if your site is 1000 square feet, and you have 500 sq ft of sedums (below 2 ft), 200 sq ft of shrubs (above 2 ft), and 100 sq ft of living wall:

1. Total site area: 1000 sq ft
2. Sedums: 500 sq ft x 0.2 = 100
   Shrubs: 200 sq ft x 0.3 = 60
   Living Wall: 100 sq ft x 0.6 = 60
3. Total weighted square footage: 220
4. Site biomass: 1000/220 = 0.22

The project is eligible for Minimum Performance (1) in this area.

Provide documentation demonstrating that the planting plan provides for an appropriate level of biomass to meet the intent and requirement of the credit.

Strategies for Compliance
Ensure adequate water, nutrients, and growing media depth is present to support the desired plant density

Resources
- Washington, D.C. Green Area Ratio (https://doee.dc.gov/service/green-area-ratio-overview)
- Seattle Green Factor (http://www.seattle.gov/dpd/codesrules/codes/greenfactor/default.htm)

5. Health and Well-Being (21)

Principle

Use living architecture to improve and enhance the quality of living spaces for people.

Objectives

Improve the connection between people and living systems in the built environment by providing visual access to plants, water, and other natural elements from occupied spaces within buildings; provide physical access to green walls or green rooftop/terrace spaces. Optimize the use of building surfaces to produce beneficial products and services; reduce environmental stress from excessive/artificial noise; improve air quality.

5.1 Biophilic Design – Visibility (2)

Intent
Deploy living architecture surfaces to maximize its biophilic impact by optimizing visibility from occupied spaces within a building and adjacent structures and spaces.

Minimum Performance (2)
Locate living architectural elements for maximum visibility for site occupants on either the interior or the exterior of the building.

Measurement Method
Submit documentation or schematic designs that demonstrate the visual connection between living architecture and its surroundings.

Strategies for Compliance
Site green roofs adjacent to well-used building spaces; use a diverse mix of plants, including those that flower and move in the wind; site interior living walls so as to be viewed by a maximum number of building occupants; install a green wall or facade on a visible exterior façade.

5.2 Biophilic Design - Accessibility (4)

Intent
Integrate living surfaces into the form and function of built spaces and maximize its biophilic impact by allowing physical access to living architecture.

Minimum Performance (2)
The green roof or green wall is accessible to building occupants.

--- OR ---

Enhanced Performance (3)
The green roof or green wall is accessible to building occupants AND space is provided for both quiet respite and social interaction.

--- OR ---

Outstanding Performance (4)
The green roof or living wall is accessible to building occupants AND the public AND space is provided for both quiet respite and social interaction.

Measurement Method
Submit documentation or schematic designs that demonstrate compliance and identify points of access.

Strategies for Compliance
Program the living architecture with social or work events or provide for interactive elements like volunteer days for planting, weeding, watering, etc.

5.3 Food Production (10)

Intent
Encourage the integration of food production in urban and suburban areas.

Projects are eligible to receive credits for either Minimum or Enhanced Performance, AND Food Production Management Plan AND Education and Outreach.

Minimum Performance (2)
Dedicate an area of a green roof or living wall to food production. The minimum area dedicated to food production, must be 100 ft^2 (9.3 m^2) or 10 percent of the area of the living system, whichever is greater.

--- OR ---

Enhanced Performance (5)
Dedicate an area of a green roof or living wall to food production. The minimum area dedicated to food production, must be 1000 ft^2 (93 m^2) or 50 percent of the area of the living system, whichever is greater.

--- AND ---

Food Production Management Plan (4)
Develop and submit a food production management plan that addresses at least five of the following nine criteria:

- A responsible Party who will manage food production operations
- Access to the roof top or green wall food production area through the underlying building
- Erosion prevention of beds in non-growing seasons
- Fertilizer and pesticide regimes (see *Credit 7.2 Fertilizer and Pesticides*)
- Filtration and disinfection of harvested water for use in irrigation, if applicable
- Nutrient loss in soil (with strategic irrigation and/or microbe management)
- Provision or location of pollinators to ensure crop development

- Food safety area to manage and prepare harvests
- Waste management planning including provisions for composting and recycling as permitted by local jurisdictions

--- AND ---

Education and Outreach (1)
Conduct hands on, interactive programs for the public to provide education on food production. Provide an area to conduct these educational programs in an area on the rooftop if production is provided on a rooftop or adjacent to a green wall food installation.

Measurement Method
Submit photographic evidence of food area production installation with accompanying narrative describing the goals for the project. Submit a Food Production Management Plan addressing at least five of the eight criteria outlined above. Submit a plan for Interactive Educational Programming as described above with plans for where and how programming will be accomplished.

Resources
- Green Roofs for Healthy Cities: Introduction to Rooftop Urban Agriculture Training Course (greenroofs.org/education) and Manual (https://greenroofs.org/greeninfrastructurestore/)

5.4 Air Quality Improvements (3)

Intent
Optimize green roof and wall surfaces to improve air quality of occupied spaces and the surrounding area.

Minimum Performance (1)
Maximize air quality benefits provided by plants and root systems for green roofs OR exterior or interior living walls. For minimum performance, provide a list of plants with information about their contributions to air quality.

For enhanced performance, provide a building HVAC schematic demonstrating integration with interior living wall.

--- OR ---

Enhanced Performance (3)
Interior living walls are integrated into building HVAC systems

Measurement Method
For minimum performance, provide a list of plants with information about their contributions to air quality

Strategies for Compliance
Use living wall systems, or trees and grasses that have demonstrated greater effectiveness at filtering pollutants; optimize leaf surface to maximize the amount of particulate material filtered.

5.5 Acoustics (2)

Intent
Optimize green roof and wall surfaces to improve the audio quality of occupied spaces and the surrounding area.

Minimum Performance (2)
Use living architecture to reduce noise levels in occupied spaces

Measurement Method
Provide a document which identifies dominant noise sources, and illustrates the components of living architecture which intercepts the noise path to the occupants of the building and exterior spaces (rooftops, balconies, courtyards, etc.)

Strategies for Compliance
Use a minimum of 3 inches (7.5 cm) of growing media to reduce sound transmission. To reduce impact noise, material layers such as growing media should be placed in under pavers to cushion the impact of people walking on them. To best absorb noise from mechanical equipment and streets, use a higher proportion of organic material and ensure long-term porosity through particle size distribution, avoidance of compaction, and avoidance of moss and plant species which retain water at surface level.

Innovation credits may be awarded to projects that demonstrably reduce reverberation time, or use living architecture to establish natural sounds that are at least 6dBA louder than mechanical or ambient sounds.

6. Materials and Construction (14)

Principle

Develop living architecture systems with sustainable materials and construction practices.

Objectives

Specify materials that are locally sourced, durable, bio-based, have transparent Material Ingredient Reporting and are less toxic (ingredients and production process). Reduce construction and demolition waste disposed of in landfills and incinerators by recovering, reusing, and recycling materials. Consider equity and maximize benefits to the community by supporting local businesses and employing disadvantaged individuals through the construction process.

Credits *6.2 Environmentally Sensitive Materials* and *6.3 Sustainable Materials* are based on using a certain percentage of desirable materials. This percentage is based on the total cost of all permanently installed materials, with the exception of plants and growing medium(e.g. drainage layers, irrigation systems, waterproofing membranes, hardscape elements, geotextiles, etc.).

6.1 Structural Soundness (Prerequisite)

Intent
Meet local codes and ensure public safety with respect to structural capacity, wind uplift, and fire safety. Ensure leak-free waterproofing.

Prerequisite
All structural and safety aspects of the living systems must be confirmed and documented. Conduct a leak detection procedure prior to installing green roof components over waterproofing membrane.

Measurement Method
Submit documentation demonstrating compliance with codes; submit documentation demonstrating testing for leaks.

Strategies for Compliance
Demonstrate compliance with ANSI standards for wind uplift and fire design for vegetated roofs; install a leak detection system; develop a strategy to protect the waterproofing membrane during construction and maintenance.

6.2 Environmentally Sensitive Materials (4)

Intent
Living Architecture systems have human-made components, which often contain ingredients with negative effects on humans and the natural world. This credit is intended to foster greater transparency on the health impacts of those materials, encourage manufacturers to use ingredients which are healthier, and to give project stakeholders the ability to choose materials with greater knowledge.

Material Ingredient Reporting – Minimum Performance (1)

Use permanently installed materials and products with one or more of the following, representing 10 percent of the total material cost of the project, based on LEED credits for materials. For green roof systems, all components above the structural deck are included, except plants and growing medium. For green walls, all components outside the building envelope except for plants and growing medium are included.

Materials purchased will meet at least one of the following criteria:

- **GreenScreen v1.2 Benchmark.** Products that have fully inventoried chemical ingredients to 100 ppm that have no Benchmark 1 hazards.
    - If any ingredients are assessed with the GreenScreen List Translator, value these products at 100 percent of cost.
    - If all ingredients have undergone a full GreenScreen Assessment, value these products at 150 percent of cost.
- **Health Product Declaration.** The end use product has a published, complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard. All ingredients must be characterized and screened. Must include role for all materials. Consideration of residuals and impurities for all materials must be documented.
    - Ingredients reported to 1,000 ppm: value these products at 100 percent of cost
    - Ingredients reported to 100 ppm and without Benchmark 1, LT-1 or LT-P1 ingredients: value these products at 150 percent of cost
- **Cradle to Cradle Certified.** End use products are certified Cradle to Cradle. Products will be valued as follows:
    - Cradle to Cradle v2 Gold: value these products at 100 percent of cost
    - Cradle to Cradle v2 Platinum: value these products at 150 percent of cost
    - Cradle to Cradle v3 Silver: value these products at 100 percent of cost
    - Cradle to Cradle v3 Gold or Platinum: value these products at 150 percent of cost
- **Cradle to Cradle Material Health Certificate.** The product has been certified at the Bronze level or higher and at least 90 percent of materials are assessed by weight: value these products at 100 percent of cost
- **Declare Label Certification.** The Declare product label must indicate that all ingredients have been evaluated and disclosed down to 100 ppm. Products will be valued as follows:
    - Declared: value these products at 50 percent of the cost
    - LBC Compliant: value these products at 100 percent of the cost

- LBC Red List Free: value these products at 150 percent of cost
    - Processes are in place to communicate, receive and evaluate chemical ingredient safety and stewardship information along the supply chain
    - Safety and stewardship information about the chemical ingredients is publicly available from all points along the supply chain

--- OR ---

Material Ingredient Reporting – Enhanced (2)

Use permanently installed materials and products with one or more of the following, representing 25 percent of the total material cost of the project, based on LEED credits for materials. For green roof systems, all components above the structural deck are included except plants and growing media. For green walls, all components outside the building envelope except for plants and growing medium are included.

--- AND ---

Material Ingredient Optimization (1)

Use permanently installed materials and products representing for at least 25 percent of the total material cost of the project that meet the criteria below. For green roof systems, all components above the structural deck are included, except plants. For green walls, all components outside the building envelope except for plants are included.

- **Product Manufacturer Supply Chain Optimization.** Products are valued at 100 percent of their cost. Use products that:
    - Are sourced from product manufacturers who engage in validated and robust safety, health, hazard, and risk programs which at a minimum document at least 99 percent (by weight) of the ingredients used to make the building product or building material, and
    - Are sourced from product manufacturers with independent third party verification of their supply chain that at a minimum verifies:
        - Processes are in place to communicate and transparently prioritize chemical ingredients along the supply chain according to available hazard, exposure and use information to identify those that require more detailed evaluation
        - Processes are in place to identify, document, and communicate information on health, safety and environmental characteristics of chemical ingredients
        - Processes are in place to implement measures to manage the health, safety and environmental hazard and risk of chemical ingredients
        - Processes are in place to optimize health, safety and environmental impacts when designing and improving chemical ingredients

Measurement Method

Submit documentation outlining all materials used on the project, including cost, which demonstrates the target percentage of environmentally sensitive materials is being used.

Strategies for Compliance

Consult resources section for certified products

Resources

- GreenScreen v1.2 Benchmark (https://www.greenscreenchemicals.org/method)
- GreenScreen List Translator (https://www.greenscreenchemicals.org/learn/greenscreen-list-translator)
- Health Product Declaration Collaborative (https://www.hpd-collaborative.org/)
- Cradle to Cradle (http://www.c2ccertified.org/)
- Declare (https://living-future.org/declare/)

6.3 Sustainable Materials (3)

Intent

Select materials with sustainable attributes such as recycled content, regionally sourced, or renewable ingredients to assist in lessening the negative impacts of industrial materials on the environment and on human health.

Minimum Performance (2)

Use permanently installed materials and products with one of the following representing 25 percent of the total material cost of the project. Materials purchased will meet at least one of the following criteria:

- **Recycled content.** Recycled content is the sum of post-consumer recycled content plus 50 percent of the pre-consumer recycled content.
- **Wood products.** Wood products must be certified by the Forest Stewardship Council (FSC) or approved equivalent. Products are valued at 100 percent of their cost based on the percentage of material that is FSC-certified.
- **Plant and Bio-based materials**. Bio-based products must meet the Rainforest Alliance Sustainable Agriculture Standard. Bio-based raw materials must be tested using ASTM Test Method D6866 and be legally harvested, as defined by the exporting and receiving country. Products are valued at 100 percent of their cost based on the percentage of plant or bio-based material.
- **Materials reuse.** Reuse includes salvaged, refurbished, or reused products. Products valued at 100 percent of their cost as if they were purchased new.
- **Extended producer responsibility**. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products are valued at 50 percent of their cost.

--- OR ---

Enhanced Performance (3)

Use permanently installed materials and products with one of the following criteria noted above representing 50 percent of the total material cost of the project.

Measurement Method

Submit documentation outlining all materials used on the project, including cost, which demonstrates the target percentage of sustainable materials being used.

Strategies for Compliance

Consult resources section for certified products; identify materials that can be salvaged or reused early in the integrated design process; identify acceptable recycled and/or plant-based alternatives to specified products.

Resources

- Forest Stewardship Council Products (https://us.fsc.org/en-us/market/find-products)
- Rainforest Alliance Sustainable Agriculture Standard (https://www.rainforest-alliance.org/business/sas/)

6.4 Construction Waste Management (2)

Intent

Design and construct projects to generate less waste and divert the waste created from landfills, reducing the downstream production of methane, a greenhouse gas and reducing the need to land to store waste.

Exclude excavated soil, land-clearing debris, and alternative daily cover. Include wood waste converted to fuel (biofuel) in the calculations; other types of waste-to-energy are not considered diversion for this credit.

Minimum Performance (1)

Diversion: Divert at least 50 percent of the total construction and demolition material; diverted materials must include at least two material streams.

--- OR ---

Enhanced Performance (2)

Diversion: Zero Waste produced from the installation of living architecture systems on project.

Measurement Method

Submit a construction waste management plan. The plan should detail what streams will be generated from the installation of the living system and how these waste streams will be diverted from landfills. If the plan calls for recycling of waste materials, identify who will receive and recycle the waste materials.

Strategies for Compliance

Consider construction waste early in the process; identify opportunities for recycling; separate waste and recyclable materials at the construction site

6.5 Equity-Focused Sourcing and Hiring (3)

Intent

Social equity is one of the foundational principles of sustainability. Support buying and hiring practices that foster greater engagement of disadvantaged communities to achieve downstream social and economic benefits.

Credit can be earned for either or both areas of performance:

Equity-Focused Sourcing (1)

Select materials and equipment that have pro-equity upstream and supply-chain effects (e.g. local suppliers)

--- AND ---

Equity-Focused Hiring (2)

Advance economic justice via priority hire, project labor agreements, apprenticeships, and/or awarding contracts to social enterprises, minority and women owned businesses, and community-based organizations that advance economic justice.

Measurement Method
Submit documentation of equity-focused sourcing or hiring practices.

Strategies for Compliance
Partner with community organizations to identify opportunities for jobs and workforce development for individuals from underserved communities; identify equity as a factor during the contracting process; identify equity as a priority during the pre-design stage and identify opportunities to incorporate equity throughout the construction and post-construction phases.

6.6 Bird-Safe Glass (3)

Intent
Millions of birds die every year from collisions with buildings because they do not see glass – they see reflections of open sky or vegetation or through glass to vegetation on the other side. While green roofs can provide bird habitat, they can also pose a danger to birds when vegetation is reflected on glass. The intent of this credit is to minimize the impact of glass adjacent to the living architecture on bird fatalities

Minimum Performance (3)
Use bird-safe treatments on all glass elements associated with the living architecture (railings, etc.) that are located at least 13 feet (4 m) above the top of any vegetation, as well as at least 8 feet (2.4 m) below, and on either side of any vegetation.

Measurement Method
Submit a schematic design or photographs documenting the use of bid-safe glass in areas adjacent to green roofs or walls.

Strategies for Compliance
Use fritted, etched, or film patterns on glass; use translucent or opaque glass; use awnings and overhangs

Resources
- City of Toronto Bird Friendly Guidelines: https://www.toronto.ca/wp-content/uploads/2017/08/8d1c-Bird-Friendly-Best-Practices-Glass.pdf
- NYC Audobon Bird Safe Guidelines: http://www.nycaudubon.org/pdf/BirdSafeBuildingGuidelines.pdf
- American Bird Conservancy Bird Smart Glass: https://abcbirds.org/get-involved/bird-smart-glass/

7. Post-Construction (10)

Principle

Create living architecture with close attention to long-term success and performance.

Objectives

Develop design and construction plans for living architecture in concert with a long-term maintenance, monitoring, and operations plan that outlines the basic requirements to ensure performance of the system for its intended design life; develop and install systems that require minimal or zero use of fertilizers, herbicides, and pesticides, high use of non-renewable energy or other resources; provide initial post-construction commissioning and monitor performance of the system over time to ensure continual performance relative to stated objectives.

7.1 Operations & Maintenance— Prerequisite + 2

Intent

Living Architecture is vulnerable if not established and nurtured in its naissance. Plan for and maintain living architecture systems for at least their first five years to ensure their viability and increase their contributions to the underlying architecture they support.

Prerequisite

Create a plan for sustainable site maintenance for at least five years. Maintenance plans must address the following:

- A funding source for maintenance
- A responsible party (a contracted third party or a member of the owner's organization)
- Access to the roof or wall
- Plant health and weeding
- Schedule of inspections and areas to be inspected
- Irrigation
- Growing media management, including erosion control and nutrient management

--- AND ---

Minimum Performance (2)

Submit an annual maintenance report for at least five years that includes:

- A schedule of maintenance tasks performed
- Plant performance including survival and coverage
- Integrity of any supporting elements (waterproofing, irrigation, growing media, etc.)
- A narrative outlining how maintenance is contributing to the project's design objectives
- Challenges faced and strategies implemented to overcome them
- Photos of the project
- Any other relevant lessons learned

Measurement Method

For prerequisite, submit a copy of the maintenance plan. If a third party is responsible, include a contract. Alternatively, if a member of an owner's organization will be tasked with maintenance, submit the expertise of the person responsible for upkeep of the system.

For enhanced performance, commit to submitting a maintenance report on an annual basis for a minimum of five years.

Resources

- Green Roofs for Healthy Cities: Advanced Green Roof Maintenance Training Course (greenroofs.org/education)
- Sample maintenance plans (https://green-roofs-pkx2.squarespace.com/s/LAPT_maintenance_plans.pdf)

7.2 Fertilizer and Pesticide (2)

Intent

Many fertilizers and pesticides have deleterious environmental and human health impacts. Minimize or eliminate these impacts.

Minimum Performance (2)

Minimize pesticide and fertilizer use

Measurement Method

Submit details of fertilizer and pesticide minimization strategies as part of the maintenance plan for the living architecture system (see *Credit 7.1 Operations and Maintenance*).

Strategies for Compliance

Design for supportive growing media biology; use growing media testing to determine nutrient needs; only supply the necessary nutrients for plant health; use slow-release fertilizer; use an integrated pest management approach.

7.3 Monitoring (3)

Intent

Monitor the performance of living architecture systems to build knowledge about their contributions to the places they are installed. This may also help to increase their usage as a commonplace element of the spaces we create.

Minimum Performance (3)

Monitor site performance on a pre-determined basis. Monitoring may be done to measure numerous factors from the living system including water retention, water quality, plant health, temperature sensors for heat island mitigation, etc. Sampling practices should be consistent with state, local, or EPA sampling procedures (or equivalent if outside the U.S.). Monitoring must take place for at least five years.

Measurement Method

Submit a monitoring plan outlining what characteristics the project team is proposing to monitor, identifying the responsible party, the frequency of measurements to be read, and how and when reporting will occur.

Strategies for Compliance

Consider how information from monitoring can inform maintenance procedures, as well as future projects; identify and secure a budget for monitoring.

7.4 Education (3)

Intent

Build knowledge about living architecture and its contributions to the built environment.

Minimum Performance (1)

Communicate intent and performance benefits of living architecture elements using a combination of signage, web-based information, tours, and other methods.

--- OR ---

Enhanced Performance (3)

Meet the above requirements AND establish a partnership with a non-profit or educational organization.

Measurement Method
For minimum performance, submit an educational/communication plan outlining how educational information will be disseminated. For enhanced performance, submit a contract or documentation demonstrating a partnership has been established with a non-profit or educational organization

Strategies for Compliance
Conduct outreach to interested potential partners early in the process, identify opportunities to engage and educate youth and/or disadvantaged communities

8. Innovation (10)

Principle

Achieve exceptional or innovative performance.

Objectives

Advance the living architecture industry by using an approach or strategy not addressed in the LAPT, and/or achieve an exemplary level of performance, over and above levels outlined by the LAPT. Only 10 total points can be achieved for the following:

8.1 New Approaches or Strategies (5)

Intent
Use an approach or strategy not addressed in the LAPT, including addressing regional approaches (extreme water scarcity, extreme precipitation, habitat loss, etc.), unique architectural approaches, meeting unique regulatory requirements, etc.

Measurement Method
Identify approach and/or strategy, provide a narrative on the project's innovative aspects, and identify proposed metrics to measure this performance.

8.2 Exemplary Performance (5)

Intent
Achieve an exemplary level of performance in one or more credit areas.

Measurement Method
Credit is typically earned for achieving double the requirements or the next incremental percentage threshold.

Appendices

A. Rationale and Background

A.1 About Living Architecture

Over the last two decades, tens of thousands of building owners and professionals have been incorporating an increasing number of vegetative technologies on building envelopes and the interiors of new and existing structures. Public policies such as mandatory requirements and various regulatory and incentive programs, along with voluntary standards/rating systems such as LEED, SITES, WELL, and the Living Building Challenge support the growth of these living architecture projects.

Living Architecture is a subset of green infrastructure that is defined as the integration of inorganic, non-living structures with organic, living structures for superior ecological, social and economic performance. Living architecture includes technologies such as green (vegetative) roofs, green facades, and interior and exterior living walls. There are multiple performance benefits provided by living architecture technologies that cut across social, economic and ecosystem domains. However, some of the performance benefits of living architecture are extremely complex to quantify, and this complexity can act as a barrier to its widespread use and optimal performance.

A.2. Reasons for Complexity

Some of the main reasons for complexity related to living architecture performance are as follows:

- A wide diversity of performance benefits, technologies, design, products, and maintenance regimes
- A variety of spatial scales on which benefits result, from building-level to citywide
- Differences in climate and precipitation impact performance
- Different and often overlapping public and private benefits
- Different building and site applications.

Better managing this complexity is one of the goals of the Living Architecture Performance Tool.

A.3 Barriers to Living Architecture

As the market for living architecture continues to evolve, barriers to its more rapid growth have emerged. These include:

- Inconsistent, incomplete or non-existent policy
- Policies and voluntary standards that contravene the use of living architecture
- Insufficient product testing and agreed-upon test methods
- A lack of clear, measurable performance benchmarks
- A lack of clear, detailed representations of living architecture in existing building rating systems
- A lack of understanding of the full range of possible social, economic and ecological performance benefits
- Inadequate maintenance practices

This lack of a comprehensive framework of clear performance benefit metrics for living architecture threatens the growth and long-term application on buildings and sustainable sites, thereby jeopardizing the many unrealized benefits for building owners and the public.

B. Primary Goal

The primary goal of the Living Architecture Performance Tool is to assure that all living architecture projects will achieve certain measurable and replicable performance benefits, so that they can be funded, designed, installed, and maintained with a much higher degree of confidence by the many stakeholders that use them.

C. Keys to Success

- Be the recognized benchmark for living architecture systems as paths to compliance for other rating systems such as LEED, WELL, SITES, etc.
- Obtain the support of the policy, design, installation, maintenance, and engineering communities, who can use this tool as a resource to better promote, design, build, and maintain living architecture and to more clearly articulate their benefits to clients.

D. Objectives

- Articulate the many social, economic and ecological benefits of living architecture
- Help guide future research
- Support the development of policy aimed at increasing implementation
- Encourage continuous improvement through testing and feedback
- Align with other building rating systems such as LEED and SITES
- Recognize and reward high quality products and services while encouraging innovation
- Encourage industry growth by proving performance
- Support innovation while remaining cost effective to implement

This is Version 1.0 of the Living Architecture Performance Tool. It has been under development for the past five years, beginning with the commissioning of a number of white papers on different subjects. The LAPT is designed to focus the conversation on ensuring that the performance benefits around living architecture can be quantified. The performance thresholds here are based on existing rating systems where possible, as well as information from the white papers completed on the following subjects:

- stormwater management
- energy conservation and generation
- biophilic design
- biodiversity

Five workshops were convened where subject matter experts gathered and provided their input on the LAPT.

For each of the major performance areas, such as water management and energy, credits are provided, along with goals, metrics, proposed methods of measurement, and strategies for accomplishing the goals. (See table below and sections that follow)

The LAPT can be applied to multiple forms of living architecture, either applied together in one project, or as separate elements. It is important to note that the LAPT does not deal with the costs of green roofs or walls, but rather seeks to guide their manufacture, design, installation and maintenance in order to meet the stated performance objectives.

E. Definitions

In 2003, Green Roofs for Healthy Cities, the North American industry association defined green roofs (vegetative roofs, eco-roofs, garden roofs, living roofs) as a contained green space on top of a human made structure below, above, or at grade. Green roofs are typically built upon high quality waterproofing and generally include root repellency, drainage layer, filter fabric, engineered growing media and plants. Some green roofs also incorporate water retention and delay layers. Green roof areas are defined as vegetated areas, and do not include walkways or other hardscape elements.

Green Roofs for Healthy Cities' Technical Committee on Green Walls has divided green walls into three major living architecture types which apply to the LAPT: living walls, green facades, and interior green walls.

- *Living walls* can be monolithic, built-up systems comprised of hydroponic fabric membranes or can be modular systems made of various housing materials containing organic or inorganic substrate to support plant life. Modular systems can be made of plastic, polystyrene, synthetic fabric, metal or concrete and most are supported with a rack or bracketing system to attach to an existing structure or wall surface. Most living walls require an irrigation system to support the plants in the vertical substrate, and generally support a diverse range of plant life.
- *Green facades* are systems in which vines and climbing plants or cascading ground covers grow up or down on supportive structures attached to walls. Plants growing on green facades are generally rooted in soil beds at the base, or in elevated planters at intermediate levels or even on rooftops. Green facades can be attached to existing walls or built as freestanding structures that support the ability of plants to grow and climb. Two primary sub-types of these systems are modular trellis panels, and wire, rope or cable net materials. Modular trellis panels typically use preformed lattices made of stainless steel that affix to the building envelope and lock into each other, and the ground. Rope or cable net systems use flexible stainless steel to create a mesh that plants can climb.
- *Interior living walls* incorporate plants on walls within buildings. Active interior living walls (biowalls/biofilters) are integrated into building HVAC systems - they pull indoor air through their leaves and root systems to improve indoor air quality by removing contaminants, as well as to save energy by reducing outside air exchanges. Passive interior living walls are similar to exterior living walls and could include both hydroponic, monolithic walls and modular living walls which are not integrated into the building systems.

New types or applications of living systems that do not conform exactly to the LAPT can be accommodated through innovation credits. There are many variations and new approaches to integrating living systems and building technology that continue to emerge as the industry evolves. Innovation credits will help facilitate the incorporation of these systems.

Performance Areas and Credit Summary

Focus Area/Credit	Points: 110
1. Process	**5**
1.1 Integrated Design Process	Prerequisite
1.2 Stakeholder and Community Engagement	3
1.3 Living Systems Expertise	2

2. Water Management	**25**
2.1 Stormwater Management	Prerequisite + 16
2.3 Irrigation	5
2.4 Water Balance	4
3. Energy Conservation	**14**
3.1 Envelope Thermal Moderation	5
3.2 Urban Heat Island Reduction	4
3.3 Renewable Energy	2
3.4 HVAC Integration	3
4. Habitat and Biodiversity	**11**
4.1 Plants	4
4.2 Growing Media Depth and Composition	2
4.3 Habitat Elements	2
4.4 Biomass	3
5. Health and Well-Being	**21**
5.1 Biophilic Design – Visibility	2
5.2 Biophilic Design – Accessibility	4
5.3 Food Production	10
5.4 Air Quality Improvements	3
5.5 Acoustics	2
6. Materials and Construction	**14**
6.1 Structural Soundness	Prerequisite
6.2 Environmentally Sensitive Materials	3
6.3 Sustainable Materials	3
6.4 Construction Waste Management	2
6.5 Equity-Focused Sourcing and Hiring	3
6.6 Bird-Friendly Glass	3
7. Post-Construction	**10**
7.1 Operations and Maintenance	Prerequisite + 2
7.2 Fertilizer and Pesticide Use	2
7.3 Monitoring	3
7.4 Education	3
8. Innovation	**10**
8.1 New Approaches or Strategies	10
8.2 Exemplary Performance	
TOTAL	**110**