International Green Cities Conference
March 16 2016, Vancouver, BC

Four Hats and Four Big Ideas!

Steven W. Peck, GRP, Honorary ASLA
Founder and President, Green Roofs for Healthy Cities
Co-Founder, Green Infrastructure Foundation
Co-Founder, World Green Infrastructure Network
www.greenroofs.org

Overview

- The Four Hats I Wear:
  - Green Roofs for Healthy Cities (GRHC)
  - Green Infrastructure Foundation (GIF)
  - World Green Infrastructure Network
  - GIO Coalition

Overview

Four Big Ideas:

- •Restorative High Performance Buildings
- •The Biophilia Hypothesis
- •Vegetative Technologies are Infrastructure
- •What if you had a billion dollars?

•Conclusion and Next Steps

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BIG IDEA #1 - Rapidly Shift To High Performance, Living Buildings – Use Government Procurement

High performance, living buildings:

- Generate clean/green energy (net zero/ net positive)
- Manage/clean water (net zero)
- Conserve resources
- Provide healthy indoor/outdoor environments – no toxic (red list) materials
- Reconnect people to nature
- Grow food
- Restore biodiversity

ESRI Office Building, Toronto.

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BIG IDEA #1 - Rapidly Shift To High Performance, Living Buildings – Use Government Procurement

High performance, living buildings result from integrated, holistic design processes.

They are hard to design and build.

Regulatory barriers, technical challenges and availability of materials barriers.

Only a handful exist worldwide.

Bullitt Center, Seattle. Living Building. Commerical

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BIG IDEA #1 - Rapidly Shift To High Performance, Living Buildings – Use Government Procurement

Healing buildings!

Ultimate goal for green building movement!

Green roofs and walls make significant contributions to high performance buildings.

See:

www.living-future.org/lbc

Vancouver Island University intensive green roof. Duncan, BC.

Hat Number #1: Develop the Green Roof & Wall Industry

- Its 1997 – Virtually no one in North America has heard of a green roof - no standards, no policy, no best practices.

- A grant to study the benefits and barriers from CMHC led to "Greenbacks from Green Roofs: Forging A New Industry in Canada" – blueprint to start an industry (Brad Bass and Monica Kuhn)

- 1999 – Six companies joined together to develop a research and demonstration project in Toronto on City Hall.

- Opened in 2001 (City of Toronto, the National Research Council Institute for Research in Construction and private money.

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About Green Roofs for Healthy Cities

- 2003 – Held our first CitiesAlive conference in Chicago, under Mayor Daley, a leader.
- 2004 – Incorporated 501(c)(5) non-profit industry organization.
- Mission to develop the green roof and wall industry in North America and around the world
- Industry goal is to complete 1 billion square feet of green roofs in North America by 2022.
- How to achieve this?

Chicago City Hall Green Roof, Conservation Design Forum

Toronto City Hall Green Roof Research and Demonstration Project

Needed Professional Training – Best Practices Started Green Roof Professional Accredition (2008)

Now Offering Online GRP Training:

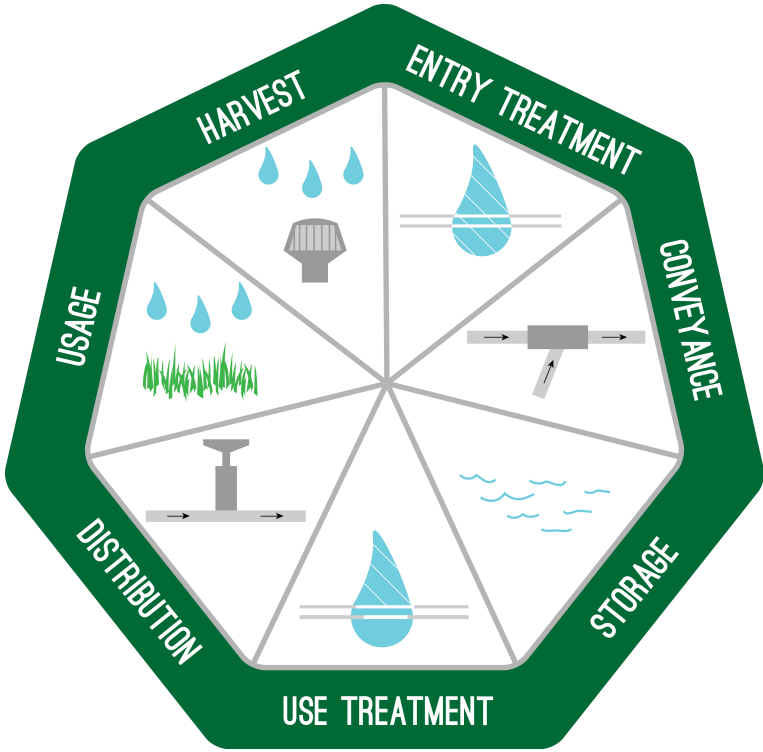
- July 25th to October 2nd
- GRP resource manuals
- Extensive student-instructor interaction
- Student-to-student networking opportunities
- Approved for 17.5 continuing education credits by a wide variety of professional associations
- See www.greenroofs.org

Keynote Building, Calgary, AB
Source: Kerry Ross, Green T Design

Needed to Address Issues – Like Water Scarcity
Net Zero Water for Buildings & Sites (2013)

Online Training Course in Net Zero Water for Buildings and Sites (Sponsored by: Ewing, Jeffrey L Bruce & Co.)

- 8-week online course - March 21st to May 15th
- 450-page resource manual
- Detailed technical information on:
  - water harvesting
  - storage
  - treatment
  - high-efficiency distribution, and more!
- Approved for 12 continuing education credits for landscape and irrigation professionals, landscape architects ...
- See: www.greenroofs.org



Used Conferences to:

- Drive policy and research
- Build communities of designers, researchers, companies
- Share best practices, new research and design
- Build the market

CitiesAlive: 14th Annual Green Roof & Wall Conference, Nov 1-4, 2016

- Stormwater Technical Workshop
- Special Networking Opportunities
- Extensive Trade Show
- Presentations, Forums, & Research

Presented by:

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DEPARTMENT OF ENERGY & ENVIRONMENT

UNIVERSITY OF THE DISTRICT OF COLUMBIA 1851

Supported Ongoing Promotion and Communications

JOURNAL

OF LIVING ARCHITECTURE

A GREEN ROOFS FOR HEALTHY CITIES PUBLICATION

www.livingarchitecturemonitor.com

Celebrate Achievement - Awards Of Excellence (2003)

- We Celebrate People and Projects
  - Policy, research and corporate individual awards.
  - Project awards

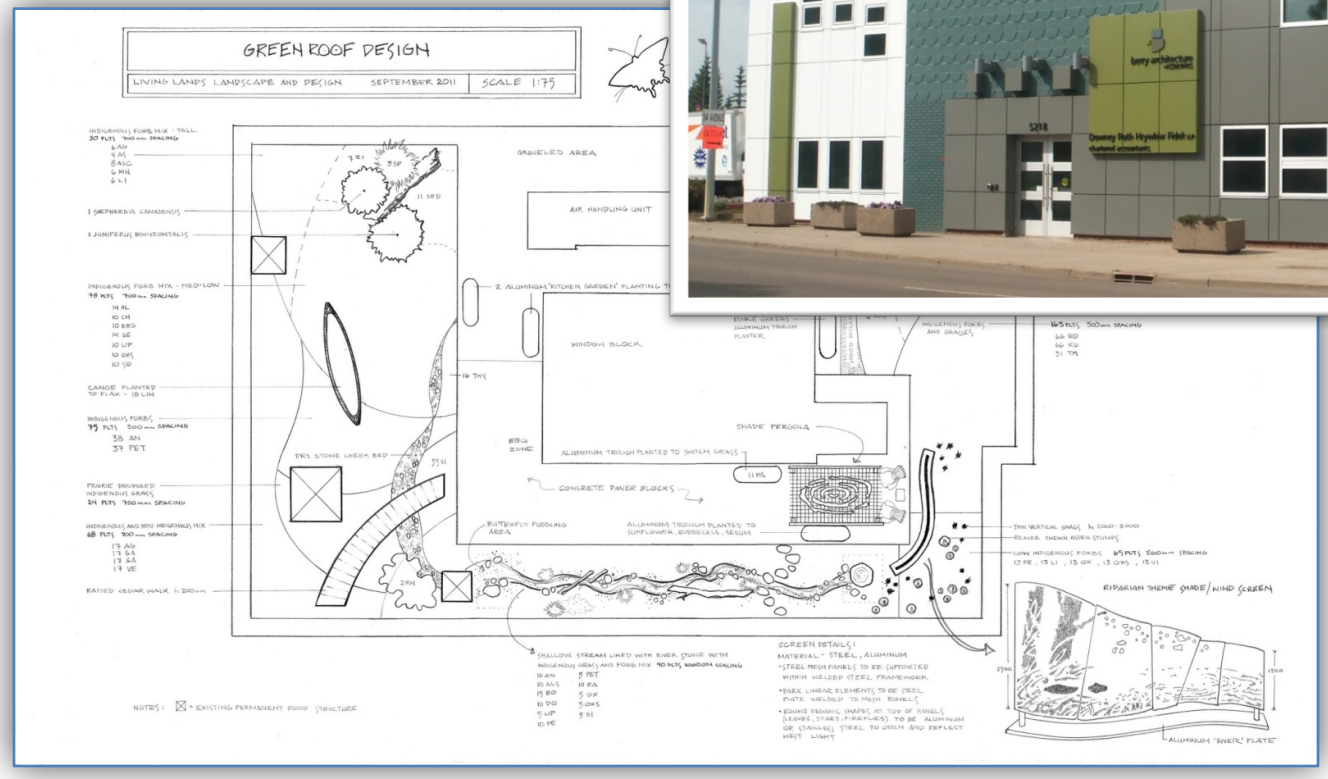
People are nominated and then reviewed by a committee. Focus is on leadership.

Projects are reviewed by a multi-disciplinary team of judges

Focus is on innovation and design integration.

Projects come in many shapes and sizes from all over North America.

Extensive Industrial/Commercial, Berry Architecture, Red Deer, Alberta



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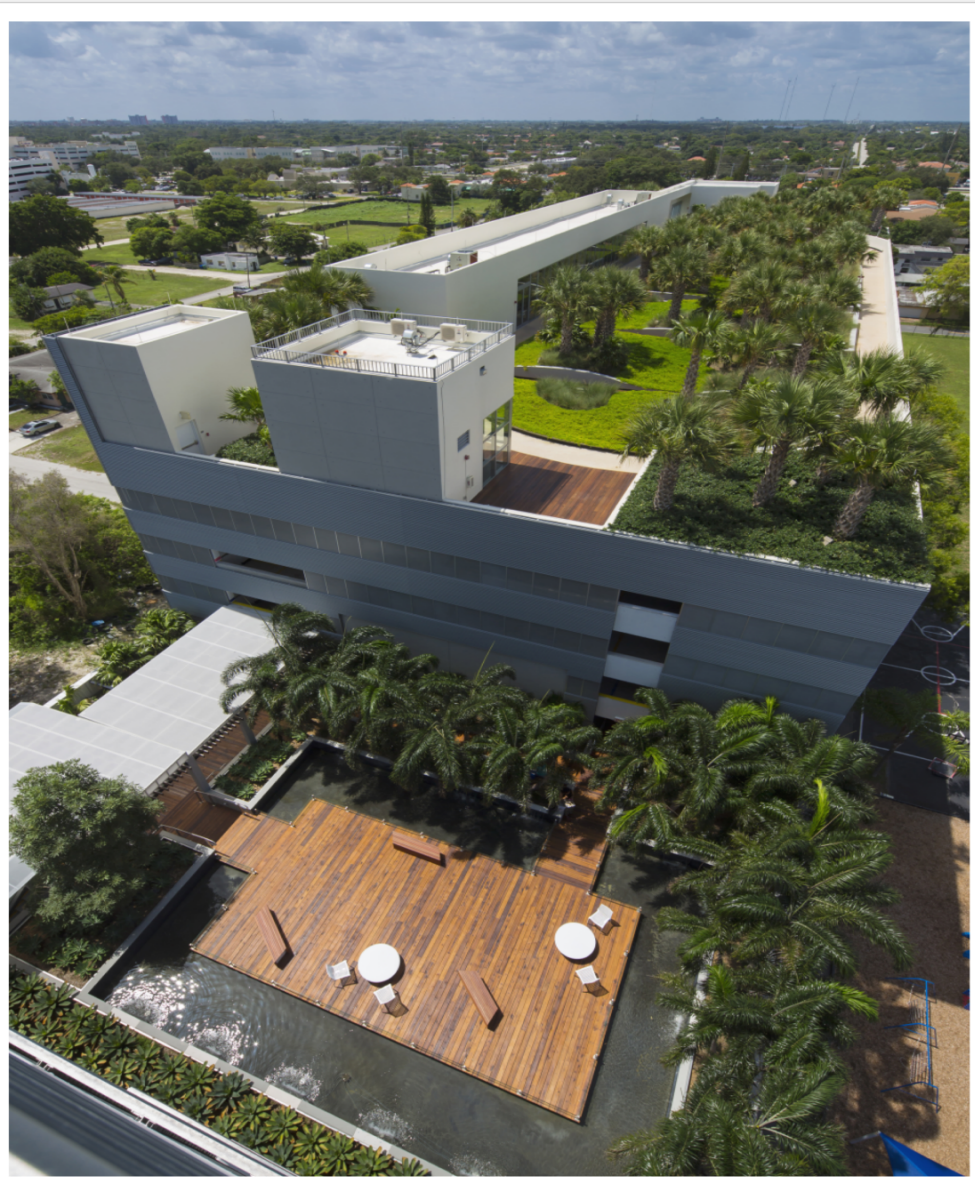
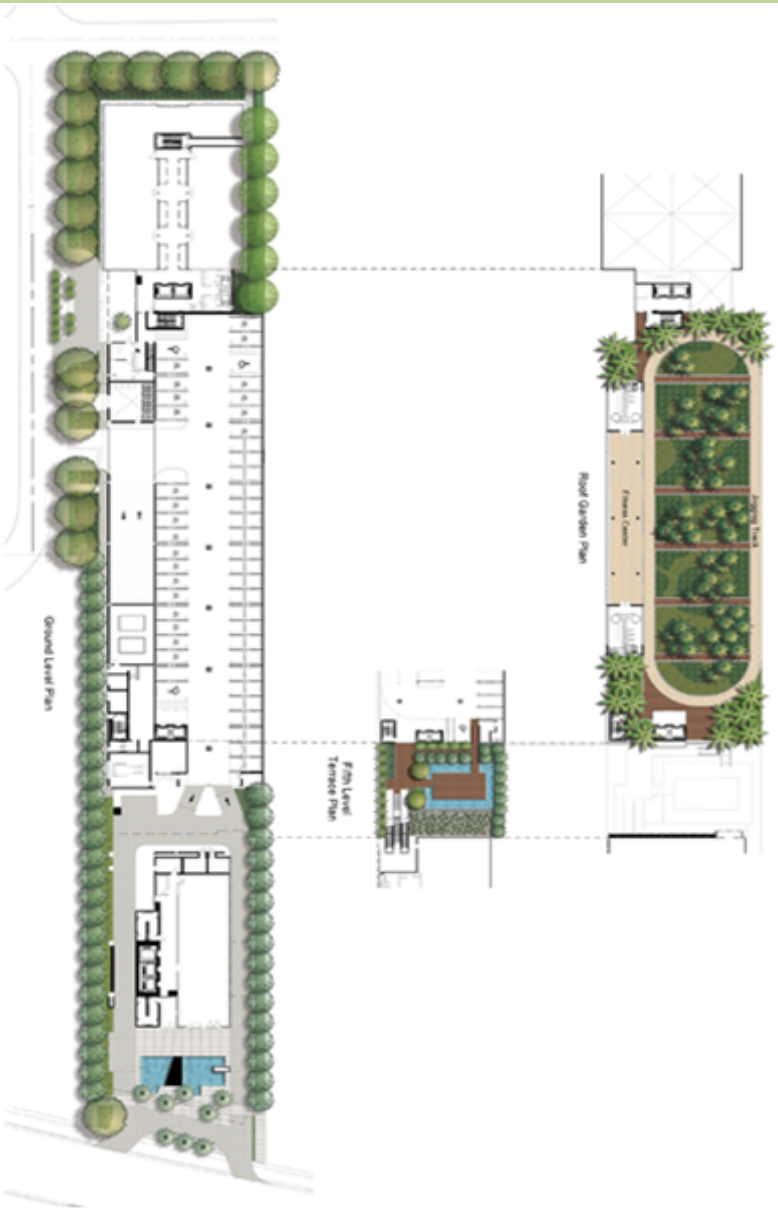
Intensive Industrial/Commerical, Savino & Miller Design Studio





Intensive Residential, New York Green Roofs

External Green Wall, Live Wall LLC

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Big Idea #2 – The Biophilia Hypothesis

We have an innate attraction to nature-life and natural forms.

(Bio + Philia)

The opposite of phobia – our fear of snakes and spiders.

Exposure to nature has many physiological and psychological benefits and is hard wired into our brains.

Living Wall, San Francisco, Patric Blanc

New Design Practice: Patterns of Biophilic Design

Nature in the Space

- Visual Connection with Nature
- Non-Visual Connection with Nature
- Non-Rhythmic Sensory Stimuli
- Thermal & Airflow Variability
- Presence of Water
- Dynamic & Diffuse Light
- Connection with Natural Systems

City of Toronto City Hall Building

Patterns of Biophilic Design

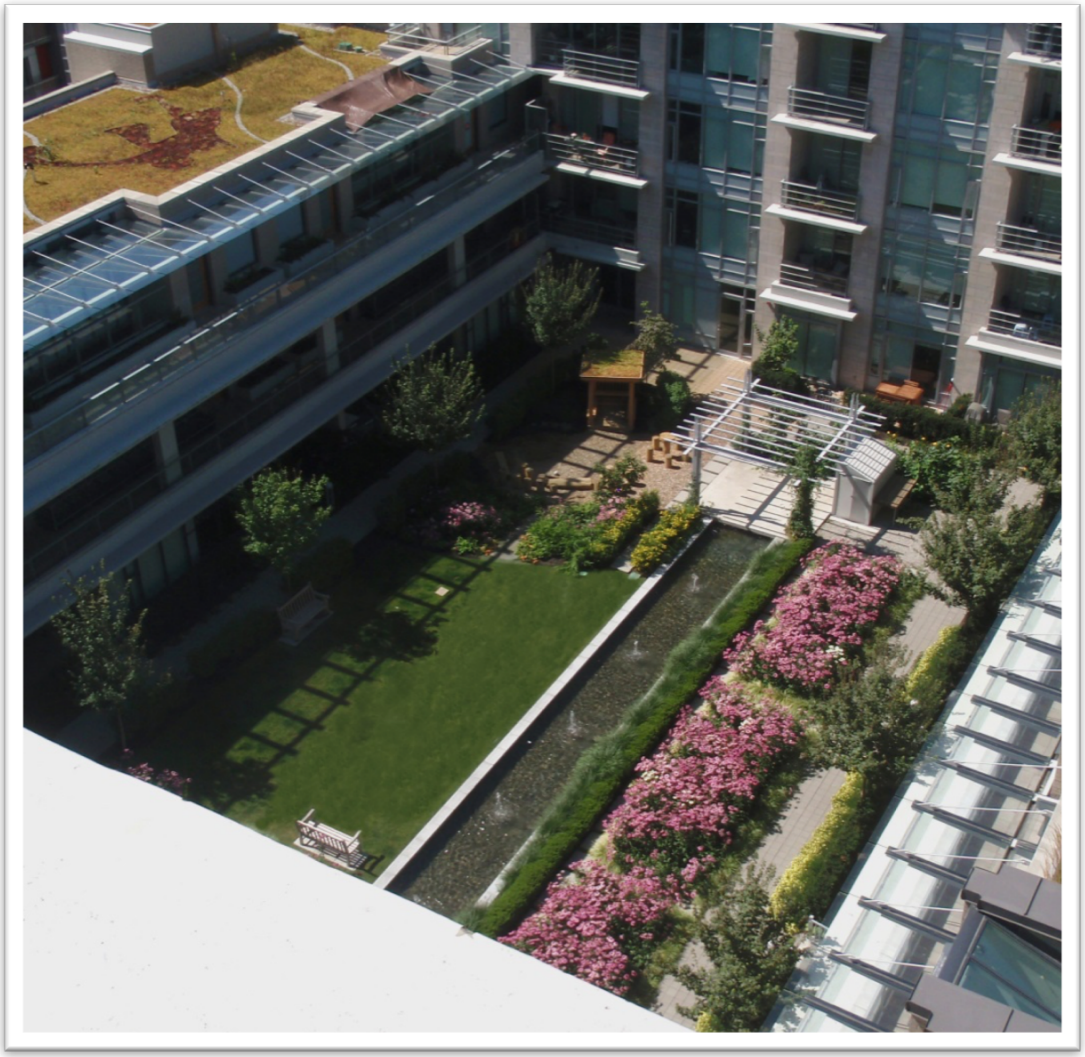
Natural Analogues

- Biomorphic Forms & Fractal Patterns
- Material Connection with Nature Complexity & Order

Patterns of Biophilic Design

Nature of the Space

- Prospect
- Refuge
- Mystery
- Risk/Peril

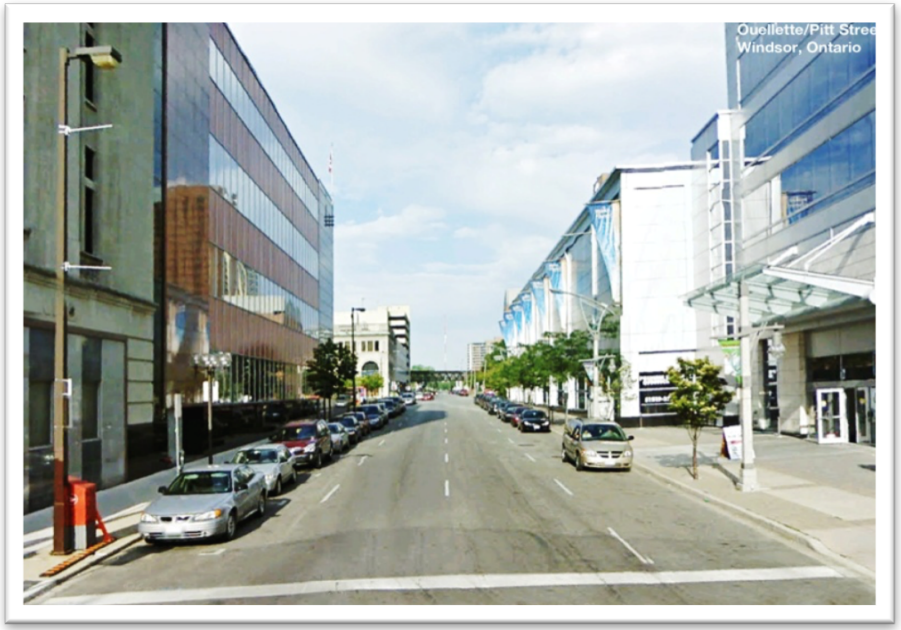


Athletes Village, Vancouver, Xero Flor

Biophilia and Health

GET OUTSIDE!

- Lack of physical activity is a major health issue
- In 1999, the lack of physical activity cost CDN 2.1 billion $ in health care costs
- Green infrastructure provides environments that facilitate exercise
  - Trees
  - Playing fields
  - Gardening opportunities
  - Trails

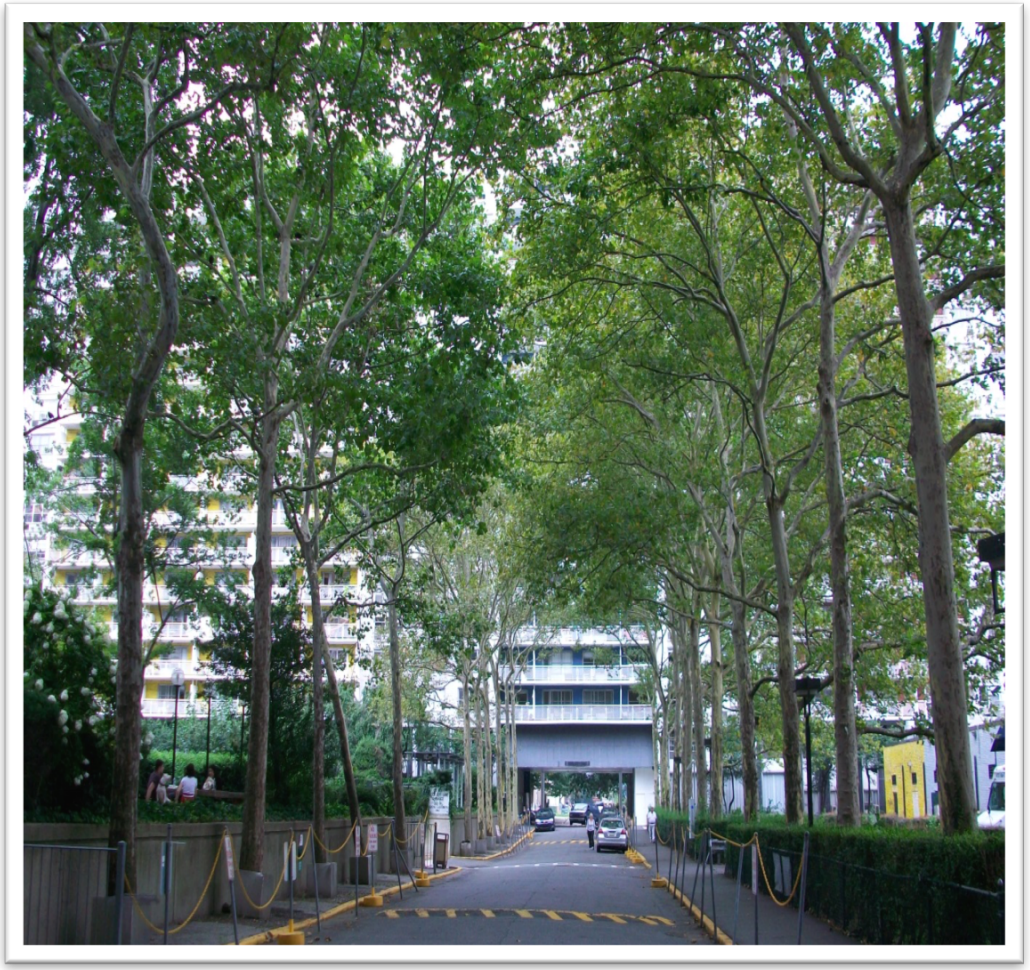


Biophilia and Health

2015 Study by Eco-Health Collaborative

Ten trees per block means:

- improved health
- income increase of $10,000 or
- being 7 years younger.



Biophilia and Hospital Recovery

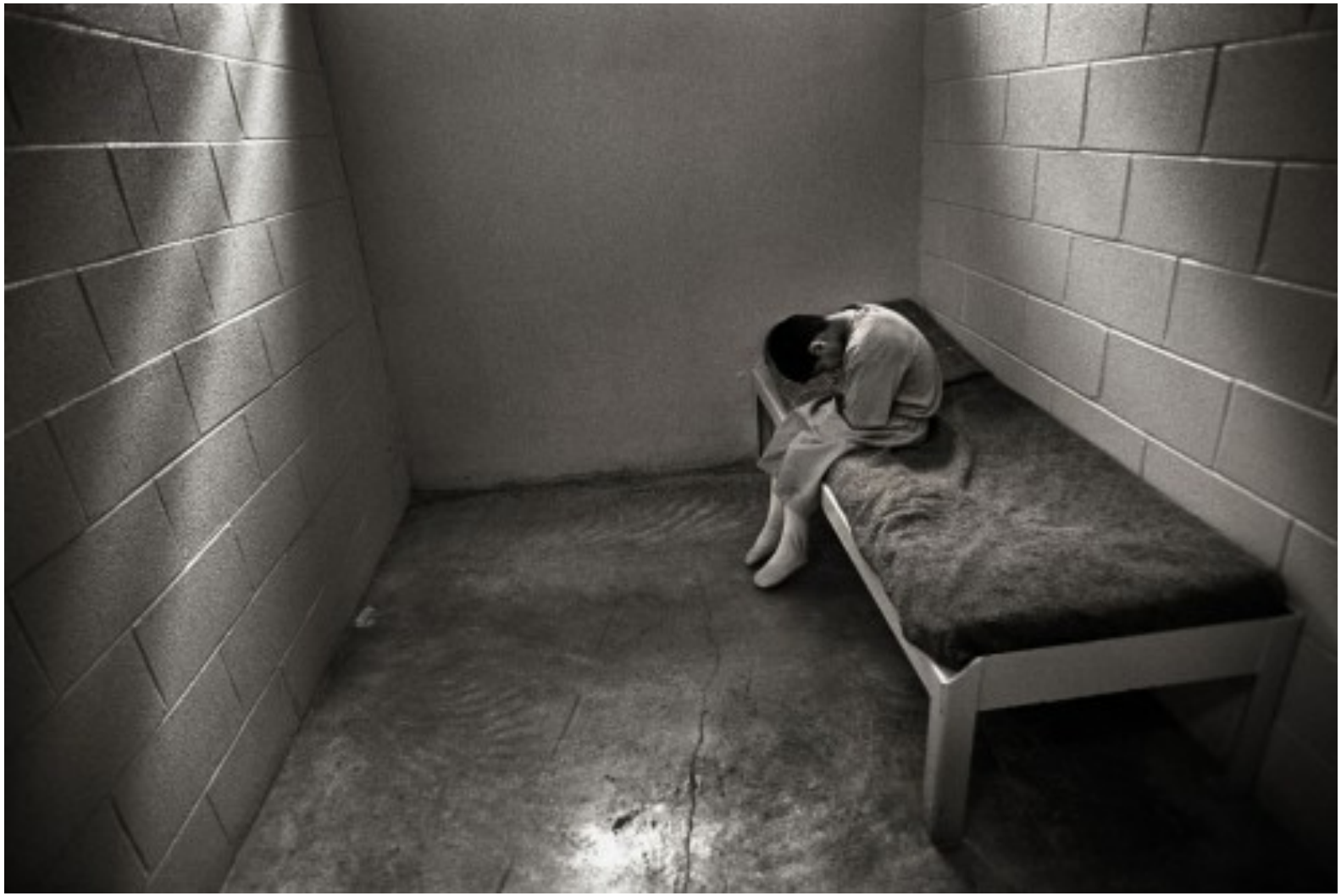
Views of nature means:

- shorter hospital stays,
- fewer painkillers,
- fewer nurse visits,
- lower staff down time, and
- less staff turnover!

Biophilic Design = Better Mental Health

Contact with nature can reduce stress, a major contributing factor for depression, impaired immune systems and infections

No Biophilic Elements = Terrible Mental Health



Biophilic Design = Better Productivity = $$

Benefits of exposure to nature:

- reduced illness and absenteeism,
- better employee retention,
- better classroom learning rates,
- improved retail sales from greener streets and natural lighting and
- reduced levels of crime and violence.

Hat # 2 – Green Infrastructure Foundation

- In 2007, GRHC established a tax-exempt, 501(c)(3) charitable organization active across N.A.

- Mission to promote and educating communities about the benefits of green infrastructure.

About the Green Infrastructure Foundation (GIF)

- Training and Workshops – Over 35 Cities
- Green Infrastructure Charrettes
- Living Architecture Performance Tool – Standards Setting

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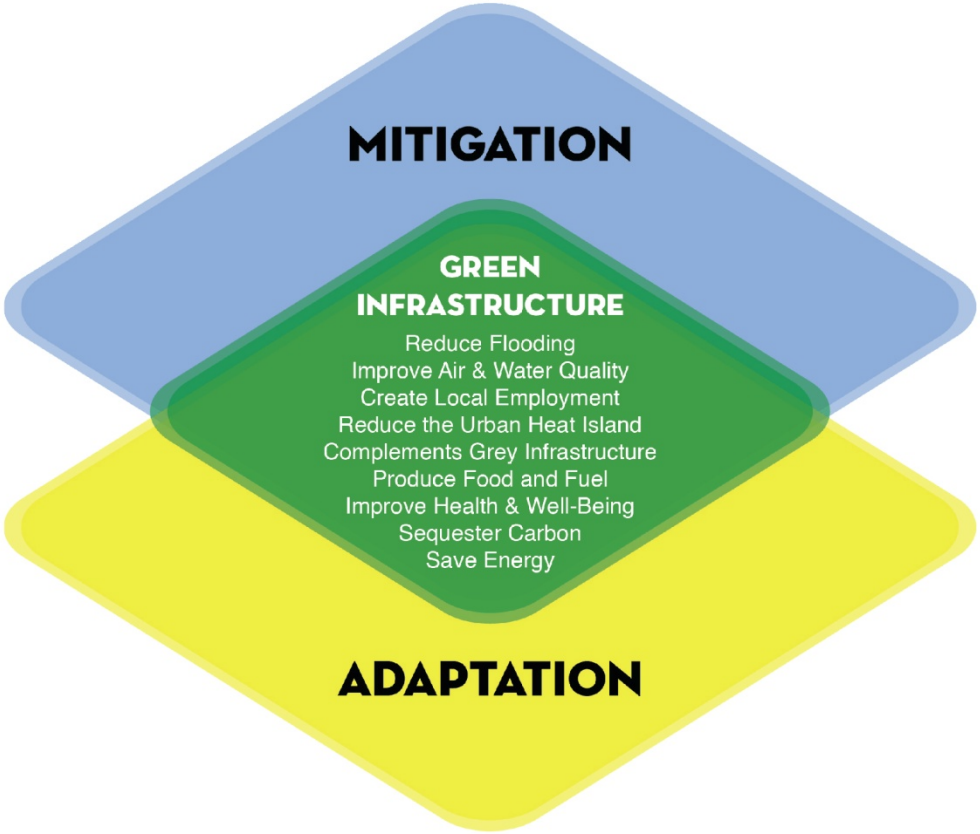
How Living Green Infrastructure Addresses Climate Change



GREY TO GREEN

Addressing Climate Change with Green Infrastructure

Toronto | June 1-4, 2016 | greytogreenconference.org

A Green Roofs for Healthy Cities Event

GREY TO GREEN CONFERENCE

Addressing Climate Change
With Green Infrastructure

Toronto, ON | June 1-4, 2016

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greenroofs.com

Green Infrastructure Ontario Coalition

landscape ontario.com Green for Life!

LiveRoof Hybrid Green Roof System Natural Function Natural Beauty

OALA Ontario Association of Landscape Architects

ReNew Canada The Infrastructure Magazine

Department of Architectural Science Ryerson

TD Friends of the Environment Foundation

Toronto Environmental Alliance

Itea

Toronto and Region Conservation for The Living City

TREMCO ROOFING & BUILDING MAINTENANCE

WATER CANADA THE COMPLETE WATER MAGAZINE

Hat # 3: World Green Infrastructure Network

- Launched in 2007 and incorporated in Canada as a non-profit organization.

- Mission is to help develop the capacity of industry associations around the world to develop green roof and wall markets.

Hat # 3: World Green Infrastructure Network

- Membership based – approximately 28 member countries.

WORLD GREEN INFRASTRUCTURE NETWORK
vegetation makes it possible!

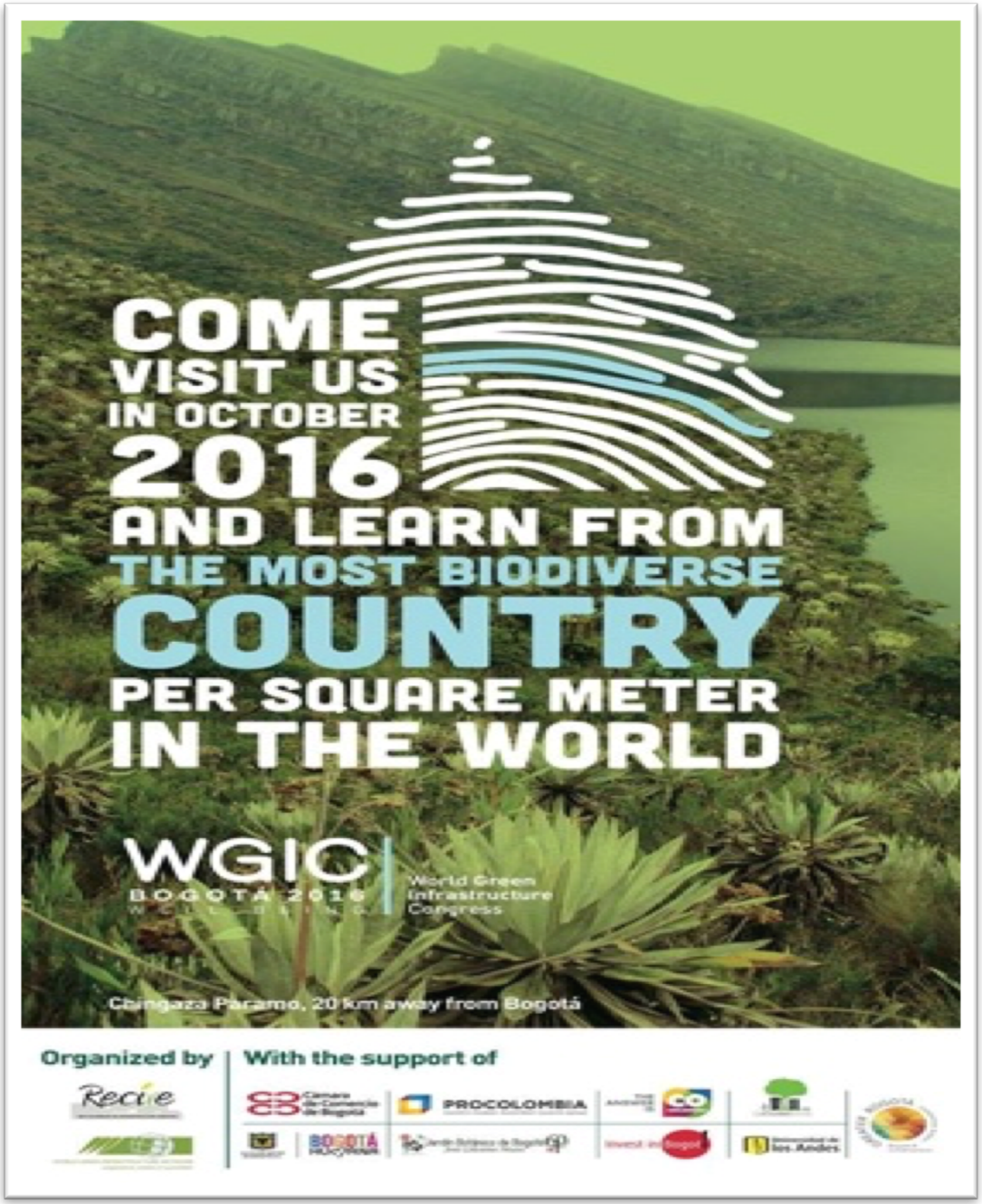
- Published Green Cities Book full of information for dozen of countries

Hat # 3: World Green Infrastructure Network

- Hold annual World Congress and regional conferences.

- Next World Congress is in Bogota, Columbia

October 19-21, 2016



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BIG IDEA 3: Vegetative Technologies are 'Infrastructure' and **must** be funded by senior levels of government.

Senior governments spend billions on grey infrastructure, such as roads, bridges, water treatment plants..... but almost nothing on living green infrastructure technologies such as wetlands, urban forests, bioswales, green roofs and walls....

Fifteen Generic Green Infrastructure Types

- Extensive Green Roof
- Intensive Green Roof
- Green Façade
- Living Wall – Interior
- Living Wall – Exterior
- Rain Garden
- Bioswale
- Permeable Surface/ Porous Pavers
- Street Tree (Small, Medium, Large)
- Wetlands
- Planting Beds
- Turf (Active and Naturalized)

These are generic types of living green infrastructure based on literature review and commonly accepted terminology

Green Infrastructure is...

- Grossly undervalued relative to our traditional methods of asset management and valuation

- Rapidly deployable

- Generates more employment per dollar spent on grey infrastructure and often better value for money

- Addresses multiple issues we face – rather than being single purpose

- Often complements grey infrastructuring, improving performance

- Is critical in helping us mitigate and adapt to the growing impacts of climate change...

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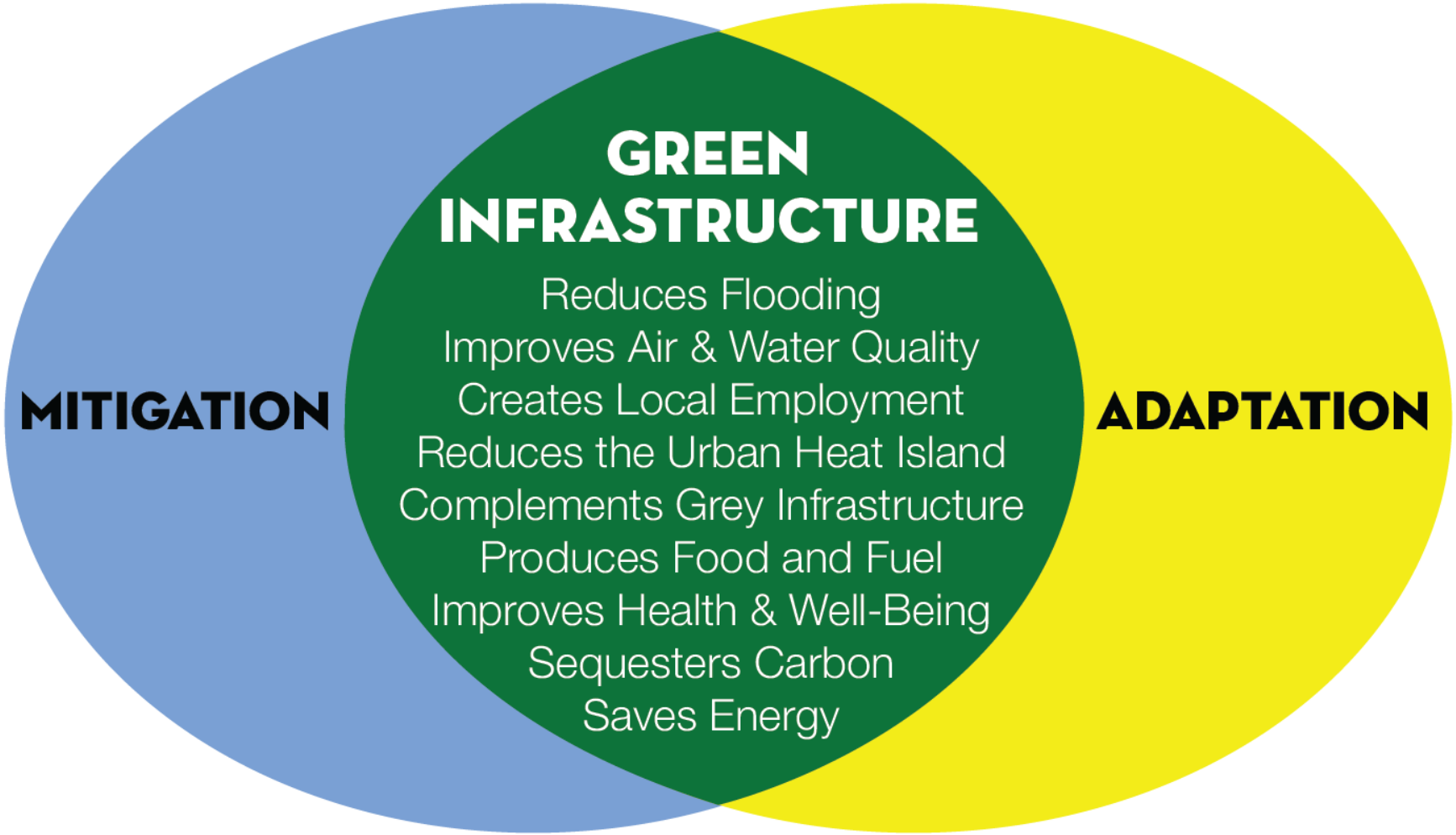
How Living Green Infrastructure Addresses Climate Change



Join over 60 expert speakers as they talk about how green roofs and walls, the

Hat # 4: Green Infrastructure Ontario Coalition

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BIG IDEA #4:
Green Infrastructure Leaders Need to Think and Act Like Grey Infrastructure Leaders

Quantify in monetary terms our value proposition!

Green infrastructure benefits that remain difficult to quantify:

- Improved human health and well-being
- Reduced flooding
- Improved productivity
- Improved soundscapes
- Waste diversion
- Increased retail sales
- Improved grey infrastructure performance and lifespan
- Reduced crime
- Improved sense of community

Think Big – Grey Infrastructure Scale Big

What does a billion dollars of infrastructure buy you these days?

Anywhere from $6 million to $180 million per kilometer of highway

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What would happen if we invested one billion dollars in green infrastructure in your community?

- Intensive green infrastructure generates more benefits through project integration and economics of scale.
- Philadelphia is spending 2.4 billion dollars on projects to reduce combine sewer overflows by 85 per cent.

The Green Infrastructure Charrette

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CHALLENGES

- How would it transform your community?
- What would it look like?
- How many jobs would get created?
- How much would it cost?
- What would the benefits be?
- What's the Return on Investment?

How do we answer these questions with limited resources?

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Charrette History & Components

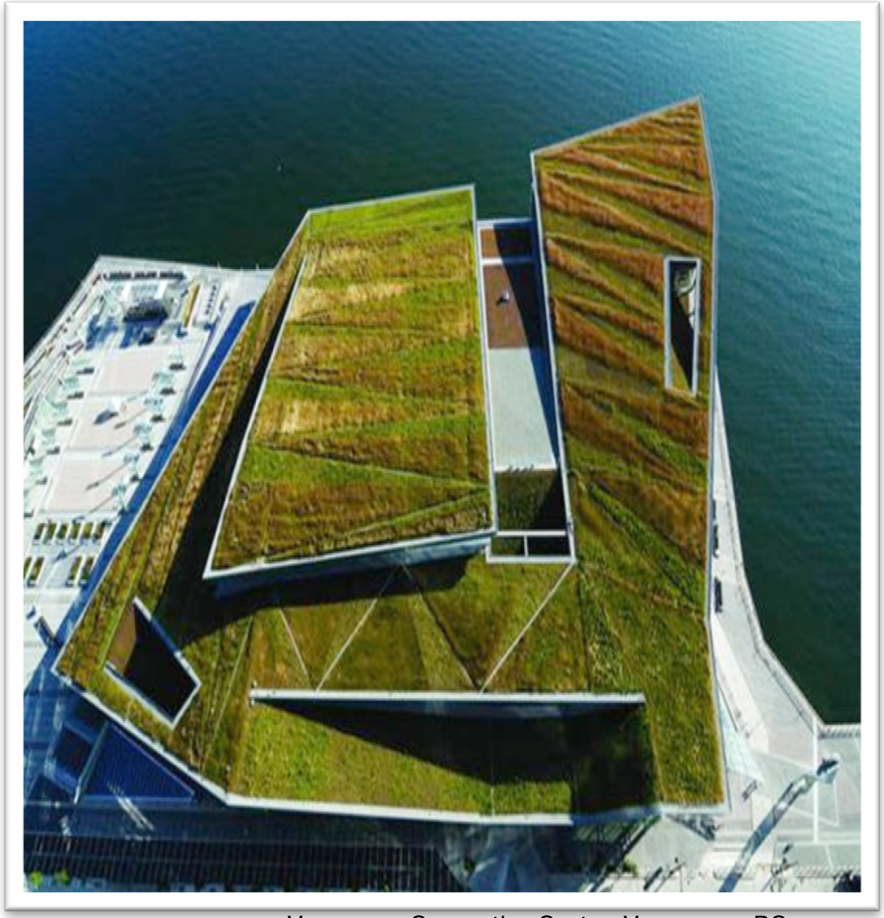
• 2014 - Developed Charrette and Cost Benefit Methodology in partnership with Ontario Parks Association, Landscape Ontario, and Green Roofs for Healthy Cities.

• 2015 - Implemented Charrettes in Six Cities

• Worked out the best approach to the Charrette and the Cost-Benefit Matrix.

• 2016---Pilot phase is over – we are now **rolling out of the program**.

http://greenroofs.org/resources/Charrette_Final-Report.pdf



Vancouver Convention Center, Vancouver, BC.

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Two Major Project Components

- **Cost-Benefit Matrix:** To generate a more holistic understanding of the potential costs and benefits that will result from their realization using the customized Green Infrastructure Cost-Benefit Matrix for your community

- **Design Charrette:** To facilitate the creation of compelling plans of intense living green infrastructure applications on two to three real sites from within your community

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About The Cost-Benefit Matrix

- Based on an extensive review of the literature, input from those in the field, and market research in your community

- Provides return on investment: 1-year, 5-year, 25-year and 50-year analysis for the designs emerging from the charrette

City of Toronto extensive green roof at podium. Toronto,

Kauffman Performing Arts Center intensive green roof. Kansas City, MO.

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About the Cost-Benefit Matrix

• The Matrix is a tool that provides an **AGGREGATE cost-benefit analysis**, it is **not** for specifying **exact project based costs.**

• The Matrix values are derived by **aggregating and simplifying costs and benefits** associated with:

- **15 generic types of green infrastructure** in order to produce a rough estimate for
- **11 benefits and 2 costs represented** in
- **dollars/ft² or dollars/m²**

Corus Entertainment interior living wall. Toronto, ON.

Brooklyn Grange urban agriculture green roof. Brooklyn NY.

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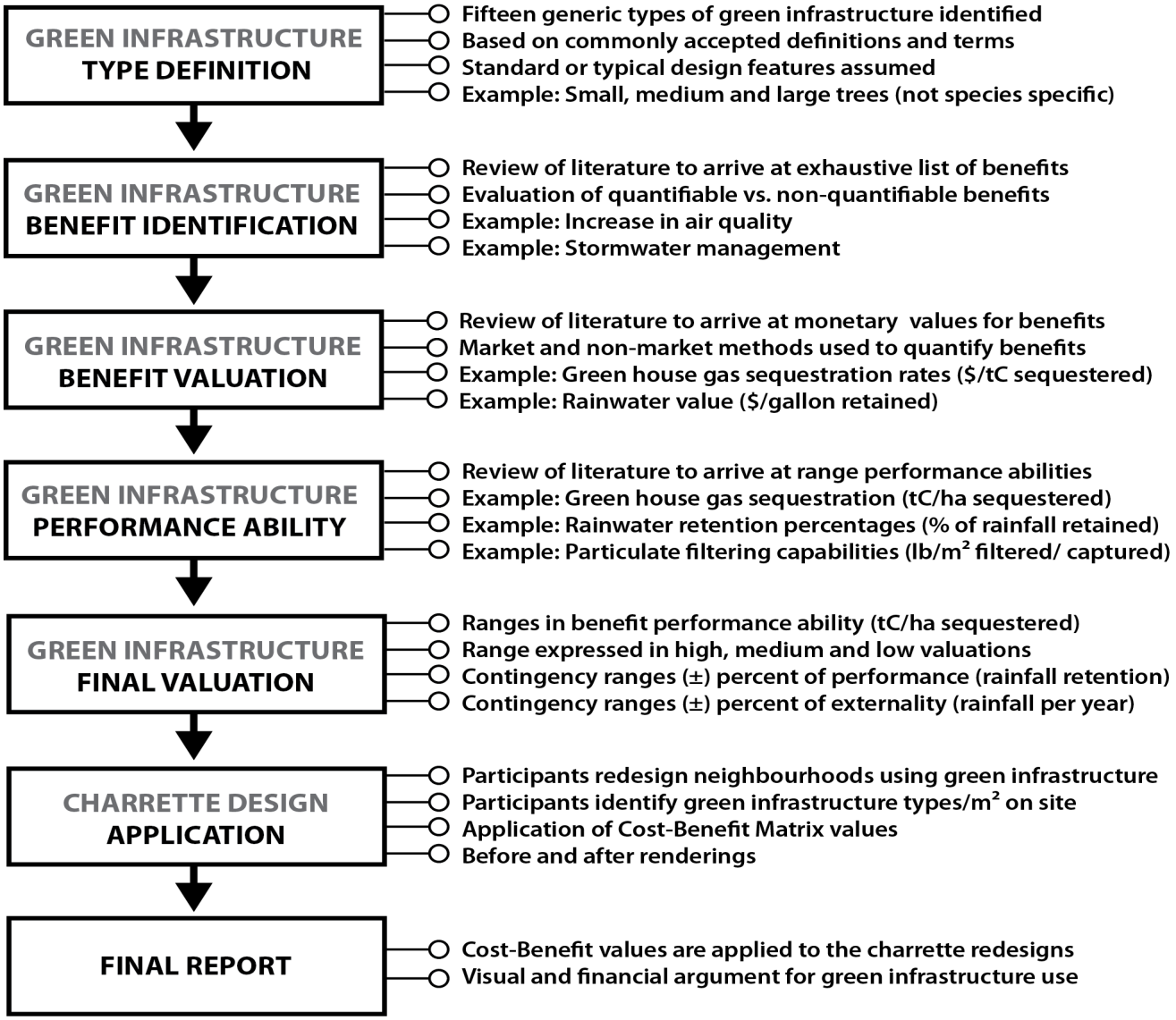
Cost-Benefit Matrix: Data Aggregation



Costs and Benefits Covered in Cost-Benefit Matrix

- **The costs and benefits currently covered include:**
  - Cost: Total Capital Cost
  - Cost: Annual Maintenance
  - Benefit: Capital - Biodiversity and Creation of Habitat
  - Benefit: Annual - Stormwater Management
  - Benefit: Annual - Increase in Air Quality
  - Benefit: Annual - Green House Gas Sequestration
  - Benefit: Annual - Reduction in Urban Heat Island
  - Benefit: Annual - Reduction in Building Energy
  - Benefit: Capital - Job Creation
  - Benefit: Annual - Job Creation
  - Benefit: Annual - Property Value/ Taxation Revenue
  - Benefit: Annual - Urban Food Production
  - Benefit: Annual – Increase in Roof Lifespan
- **Selected on the basis of ability to quantify, given current research**
- **Costs and benefits are expressed as high, medium, low values in terms of $ per square foot**

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About the Cost-Benefit Matrix

- **The areas of each type of green infrastructure are applied to the cost and benefit ratios to generate a simple payback**

Generic Green Infrastructure Type	Costs		Benefits									
	$/m^2 (Capital)	$/m^2 (Annual)	$/m^2 (Annual)	$/m^2 (Capital)	$/m^2 (Annual)	$/m^2 (Annual)	$/m^2 (Annual)	$/m^2 (Annual)	job years/m^2 (Capital)	job years/m^2 (Annual)	$/m^2 (Annual)	$/m^2 (Annual)
	Total Capital Investment	Annual Maintenance	Stormwater Management	Creation of Habitat/ Biodiversity	Increase in Air Quality	Green House Gas Sequestration	Reduction in Urban Heat Island Effect	Reduction in Building Energy	Job Creation from Capital Expenditure	Job Creation from Annual Expenditure	Property Value/ Taxation Revenue	Urban Food Production
Extensive Green Roof												
Intensive Green Roof												
Green Façade												
Living Wall - Interior												
Living Wall - Exterior												
Rain Garden												
Bioswale												
Permeable Surface - Porous paver												
Tree - Small												
Tree - Medium												
Tree - Large												
Wetland												
Planting Bed												
Turf - Active												
Turf - Naturalized												

The Charrette – Creating a Vision

- Attendees are divided into 2-3 multidisciplinary working groups, with the attendees being comprised of: community leaders, architects, landscape architects, planners, engineers, developers, decision makers, etc

- Each group consists of 8-10 individuals per specific site

- Can be adapted to large sites 10 to 20 blocks in size or an individual site

- Community leaders will float among groups

- Various site design options will be identified using the Green Infrastructure Typologies, and the opportunities and constraints presented by the site

- Area per type of green infrastructure will be calculated to allow for a cost-benefit analysis to be conducted the with the Green Infrastructure Cost-Benefit Matrix

Streetscape revitalization using green infrastructure intervention. Hamilton, ON

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Charrette Deliverables

By end of the day each group has the following tasks completed

- To scale plan-view site plan (final polished copy)
- Renderings/ perspective sketches (can be created by hand or digitally)
- Design objectives/ site intervention write up – strenghts and weaknesses
- Completion of *Green Infrastructure Workbook* (ft^2 quantification of each type)
- Identify next steps – priorities for action!

Streetscape revitalization using green infrastructure intervention. Windsor, ON.

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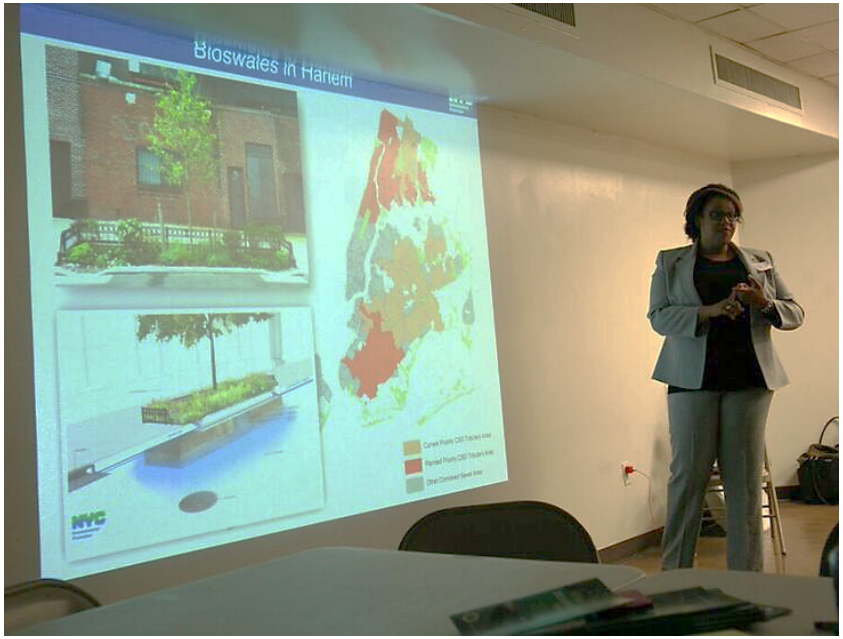
Example – Harlem, NY – November 2015



- Outreach was conducted, and we found many local non-profit and for-profit partners
- Project partners selected sites and collected background materials
- The Canaan Baptist Church was a primary partner – an analysis of specific technology opportunities was conducted on the Church's building portfolio and several larger areas in the community

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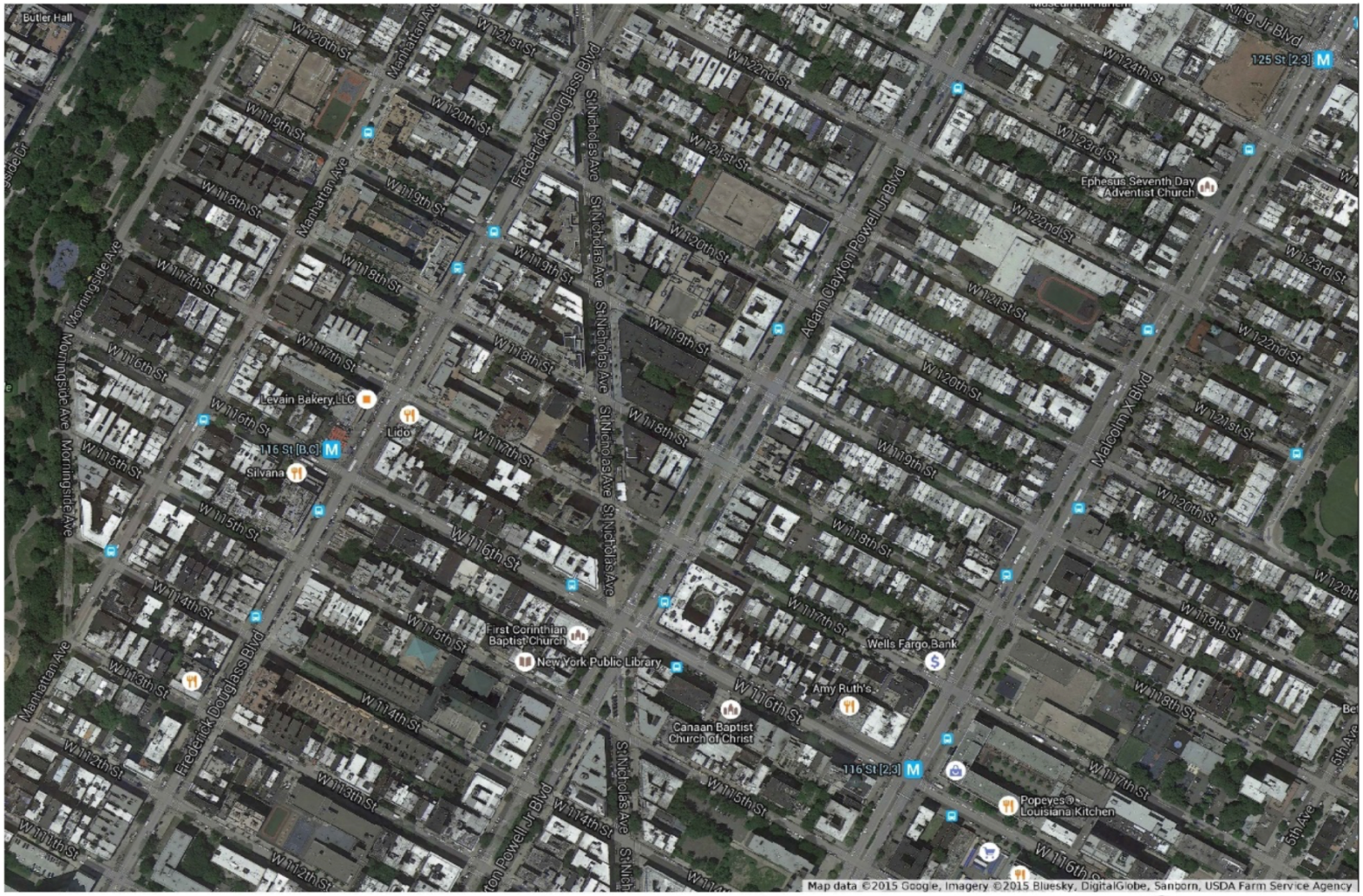
Charrette Example – Harlem, New York



115st – 121st STREET
between FREDERICK DOUGLASS BLVD & MALCOLM X BLVD

Charrette Example – New Harlem Lane

Example – New Harlem Lane

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Example – New Harlem Lane Cost-Benefit Summary

- Cost and benefit values were customized for the unique circumstances of New York City's market. This customization adds to the robustness of the financial analysis.

Generic Green Infrastructure Type	Area (ft^2)	COSTS (Public and Private)		BENEFITS (Public and Private)	
		Construction (Capital)	Maintenance (Annual)	One-Time	Annual
Intensive Green Roof	130,000	$2,726,493	$129,833	$52,151	$339,660
Rain Garden	2,250	$270,480	$3,291	$905	$713
Bioswale	23,000	$5,634,300	$141,267	$9,051	$12,594
Permeable Pavement	46,500	$924,500	$44,763	$0	$8,643
Tree - Small	39,700 (36 trees)	$35,853	$1,073	$15,947	$16,236
Tree - Large	1,401,000 (460 trees)	$459,712	$14,366	$562,886	$817,349
Neighbourhood Green Infrastructure: Property Value Increases	N/A	N/A	N/A	13,500,000	N/A
Neighbourhood Green Infrastructure: Property Tax Increases	N/A	N/A	N/A	N/A	158,387
TOTAL	**1,642,450**	**$10,051,338**	**$334,593**	**$14,140,940**	**$1,195,195**
	ft^2 of Green Infrastructure	Capital ($)	Annual ($)	One-time ($)	Annual ($)

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Example – Harlem Lane Cost-Benefit Summary

- Cost and benefit values were customized for the unique circumstances of New York City's market. This customization adds to the robustness of the financial analysis.

Generic Green Infrastructure Type	PUBLIC RETURN ON INVESTMENT (ROI) AND/OR LATENT RETURN				JOB CREATION (person years of employment [direct, indirect and induced])	
	YEAR 1 (capital)	YEAR 5 (capital + annual)	YEAR 25 (capital + annual)	YEAR 50 (capital + annual)	CONSTRUCTION (One-time)	MAINTENANCE (Annual)
Intensive Green Roof	-626,876	337,168	4,193,345	9,013,565	46.350	3.477
Rain Garden	-269,575	-148,151	-334,016	-398,457	4.598	0.022
Bioswale	-5,625,249	-6,268,612	-8,842,064	-12,058,878	95.782	2.402
Permeable Pavement	-924,500	-1,105,100	-1,827,500	-2,730,500	15.716	0.761
Tree - Small	-35,853	-17,054	236,596	614,523	0.609	0.018
Tree - Large	-459,712	564,022	13,991,145	33,985,026	7.815	0.244
Neighbourhood Green Infrastructure – Property Tax Increases	0	79,194	2,771,780	5,939,528	N/A	N/A
TOTAL ROI FOR SITE REDESIGN	**$-7,941,764**	**$-6,558,533**	**$10,189,286**	**$34,364,806**	**170.87 FTE**	**6.96 FTE**

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Conclusion

- Biophilia Hypothesis and Biophilic Design are tools to design better buildings and communities which contribute to our physical and mental health.

- Restorative, high performance living buildings have the potential to heal our communities and our environment by giving back more than they take. They will also offer us islands of resiliency by being independant of the water and power infrastructure.

- Senior levels of government need to invest scarce infrastructure dollars wisely and this means investing in green infrastructure.

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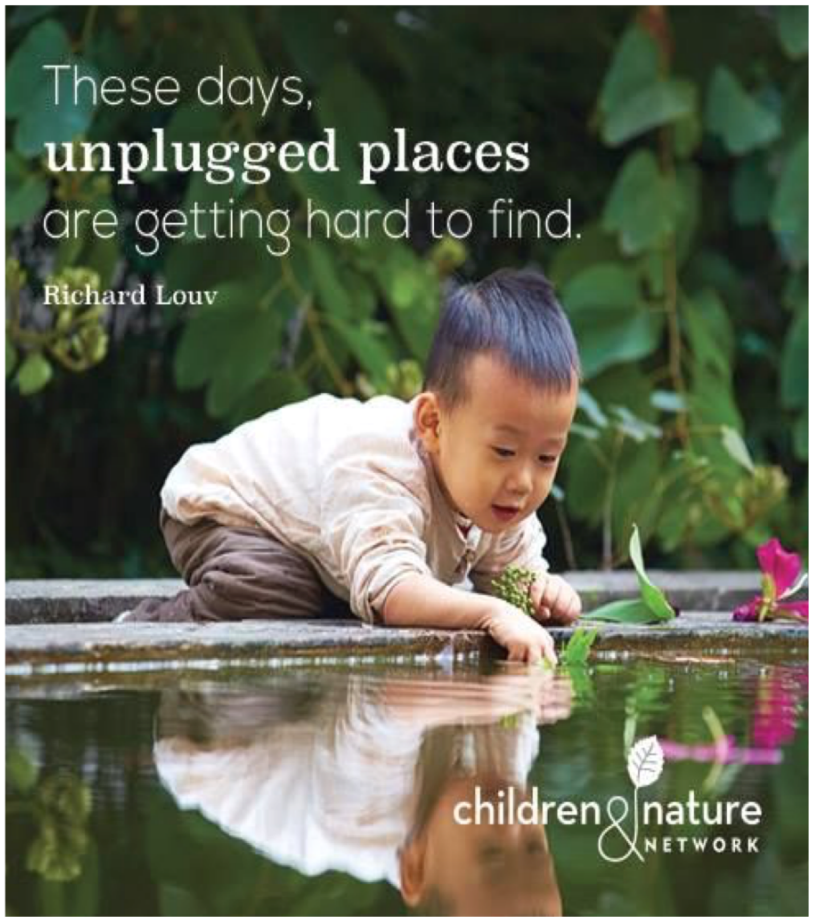
Conclusion

- To make our case we need new tools to measure and monetize the many values of green infrastructure. Then we need to make sure they are incorporated into public policy.

- Part of this means thinking big... Billion dollar big, and understanding what it means to invest at that scale in our communities.

- You are all in the Living Green Infrastructure Business – the Health Business!!!



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- Government procurement of restorative high performance buildings and regulatory support for net zero water/energy
- Senior government investment in green infrastructure and living buildings
- Interdisciplinary research
- Performance metrics and valuation methods for health benefits and other benefits of green infrastructure

Thank you !

www.greenroofs.org
www.livingarchitecturemonitor.com
www.worldgreenroof.org
www.greeninfrastructurefoundation.org
www.greeninfrastructureontario.org

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