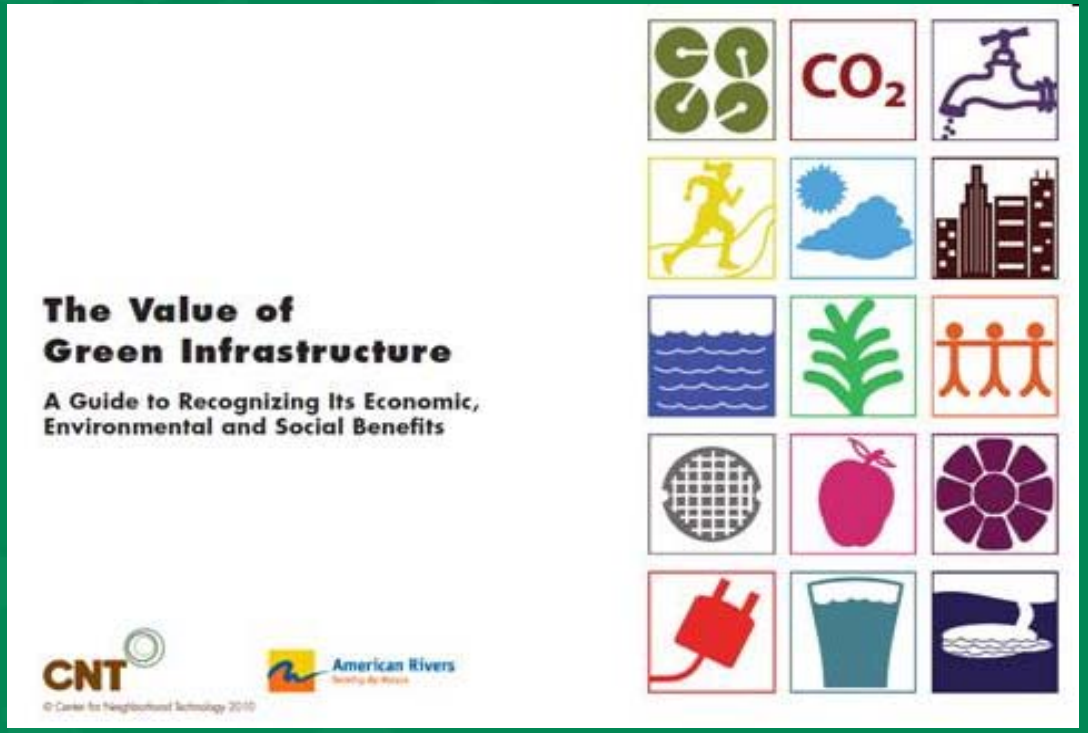


Recognizing Green Infrastructure's Multiple Benefits

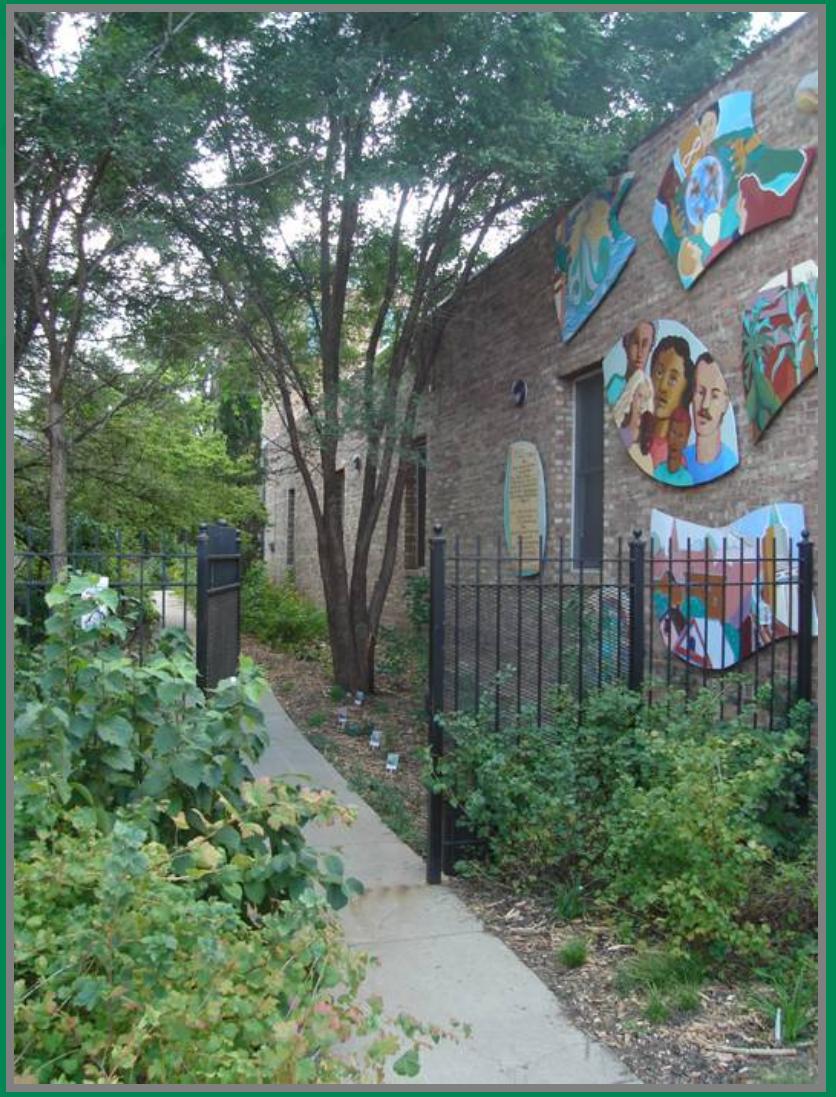
Hal Sprague
Senior Policy Associate - Natural Resources
Center for Neighborhood Technology

Webinar for Great Lakes and St. Lawrence Cities Initiative,
Chicago, IL – April 20, 2011

© Copyright Center for Neighborhood Technology

The Center for Neighborhood Technology

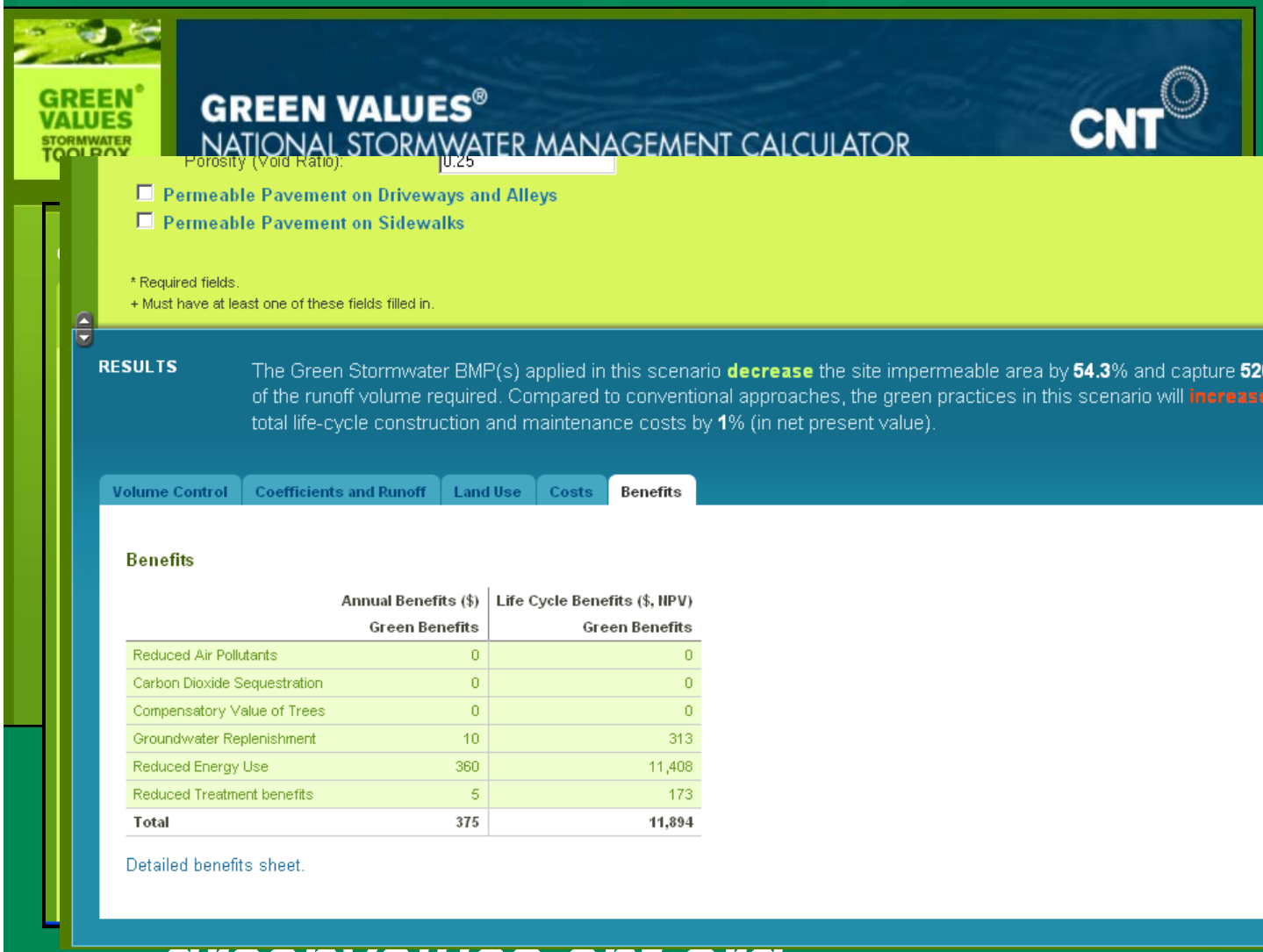
- 32 year old Chicago-based non-profit
- Sustainable energy, transportation, natural resource, climate strategies:
  - Research
  - Advocacy
  - Demonstration projects
  - Scaling up, replication
- Green Infrastructure agenda
  - Planning/Analysis Toolbox
  - Policy
  - Education
  - Practice



© Copyright Center for Neighborhood Technology

CNT

National Green Values Calculator



Compares green & nal

ture:

pact

e to nance ce

greenvalues.cnt.org

© Copyright Center for Neighborhood Technology

CNT

Runoff, Energy, Air, Livability

Benefit	Reduces Stormwater Runoff				Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Community Livability					Improves Habitat	Cultivates Public Education Opportunities
Practice	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding								Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture		
Green Roofs	●	●	●	●	○	○	○	●	●	●	●	●	◒	●	◒	◒	●	●
Tree Planting	●	●	●	●	○	◒	○	●	●	●	●	●	●	●	●	◒	●	●
Bioretention & Infiltration	●	●	●	●	◒	◒	○	○	●	●	●	●	●	◒	◒	○	●	●
Permeable Pavement	●	●	●	●	○	◒	●	◒	●	●	●	○	○	●	○	○	○	●
Water Harvesting	●	●	●	●	●	◒	○	◒	◒	◒	○	○	○	○	○	○	○	●

● Yes ◒ Maybe ○ No

© Copyright Center for Neighborhood Technology

CNT

2 – Step Process

1. Quantification of Benefits

2. Valuation of Quantified Benefits

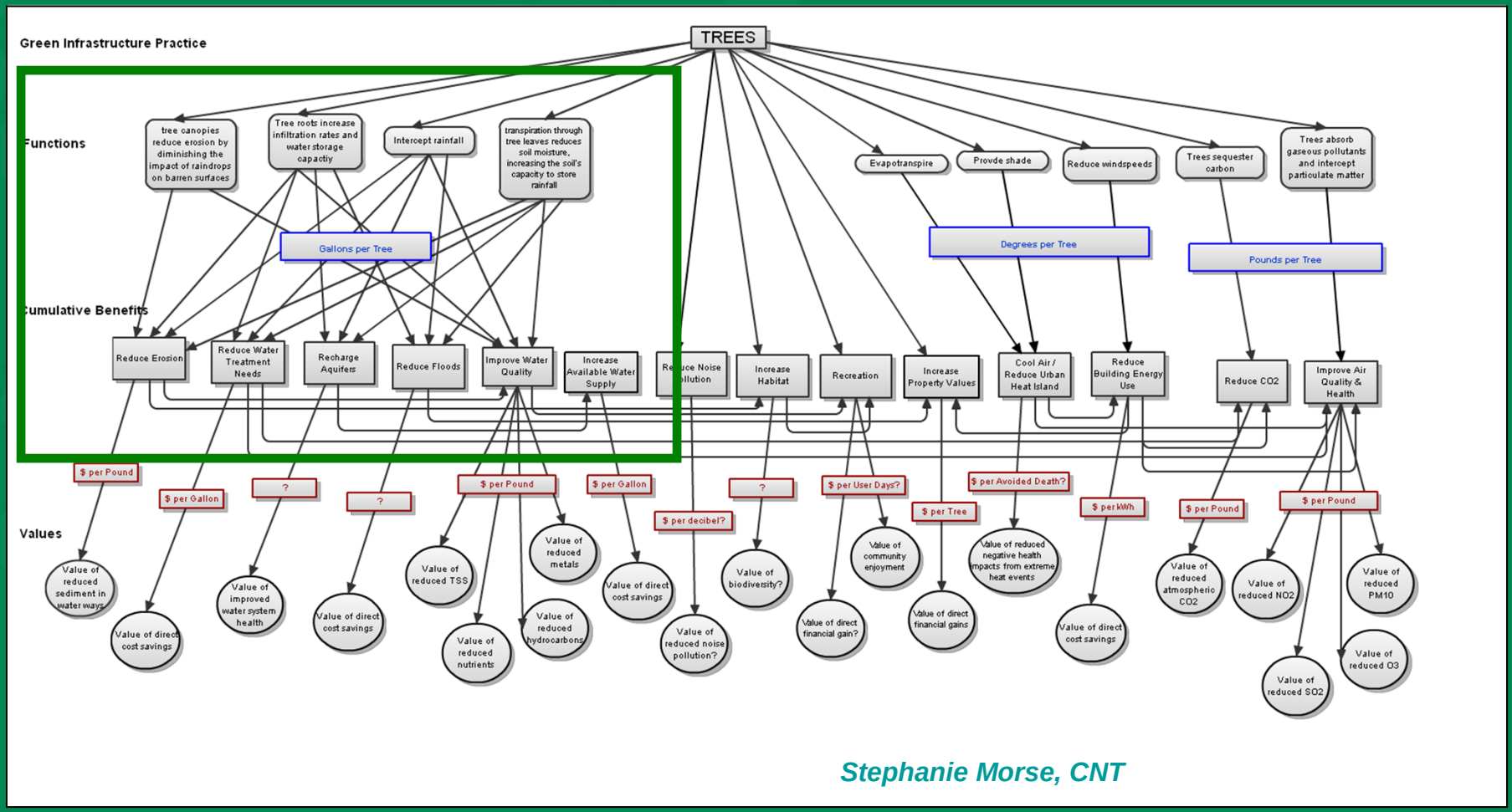
© Copyright Center for Neighborhood Technology

Framework: Benefits by GI practice

Practice	Practice Units	Resource Units
	Square feet	Gallons retained on site; pounds of pollutant removed
	Tree (canopy %)	Gallons; degrees cooling; pounds of pollutants
	Square feet	Gallons; pollutant pounds; decibels
	Square feet	Gallons; pollutant pounds; degrees cooling; decibels
	Gallons	Gallons; kilowatt hours

© Copyright Center for Neighborhood Technology

One Tree

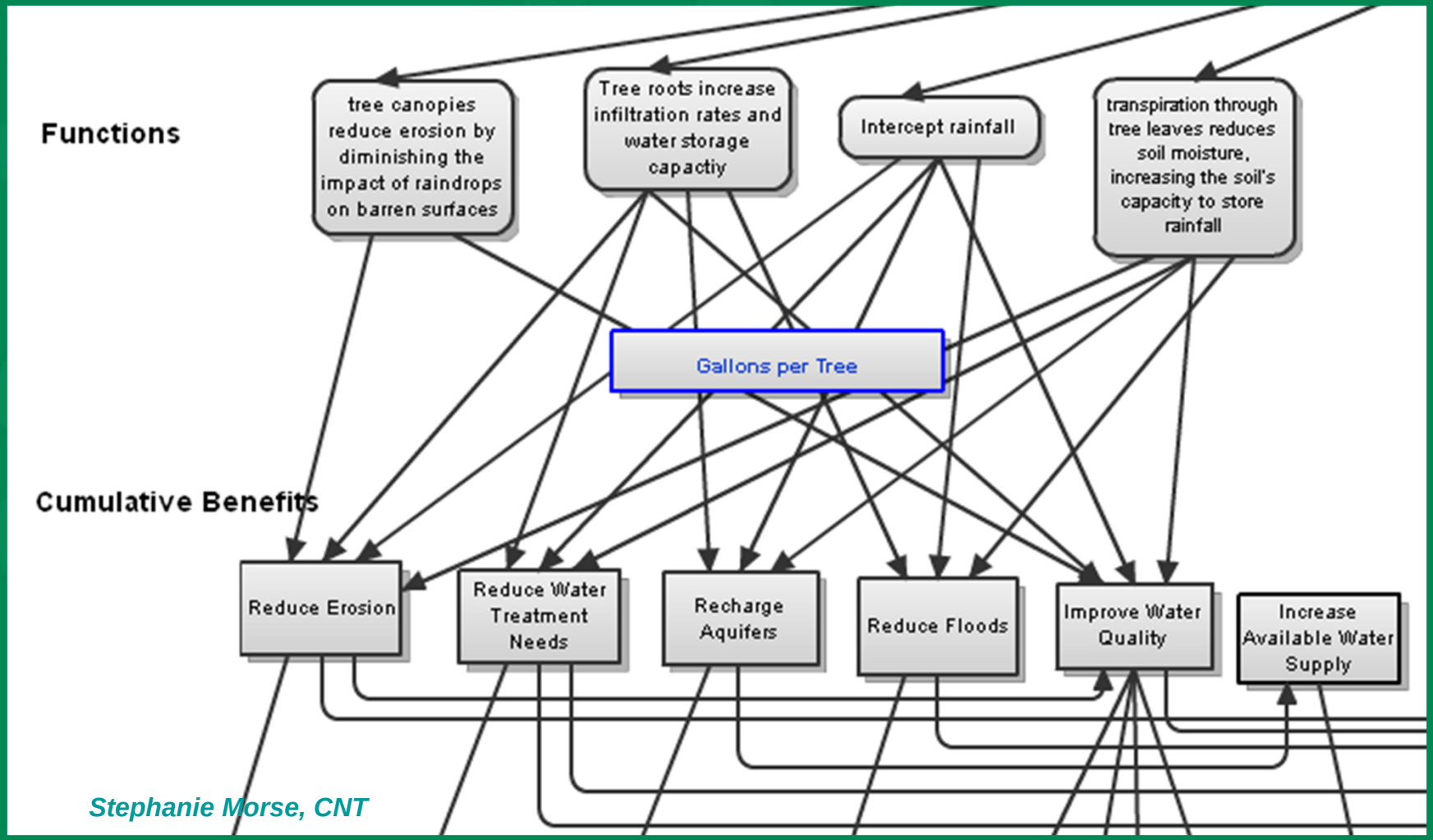


Stephanie Morse, CNT

© Copyright Center for Neighborhood Technology

CNT

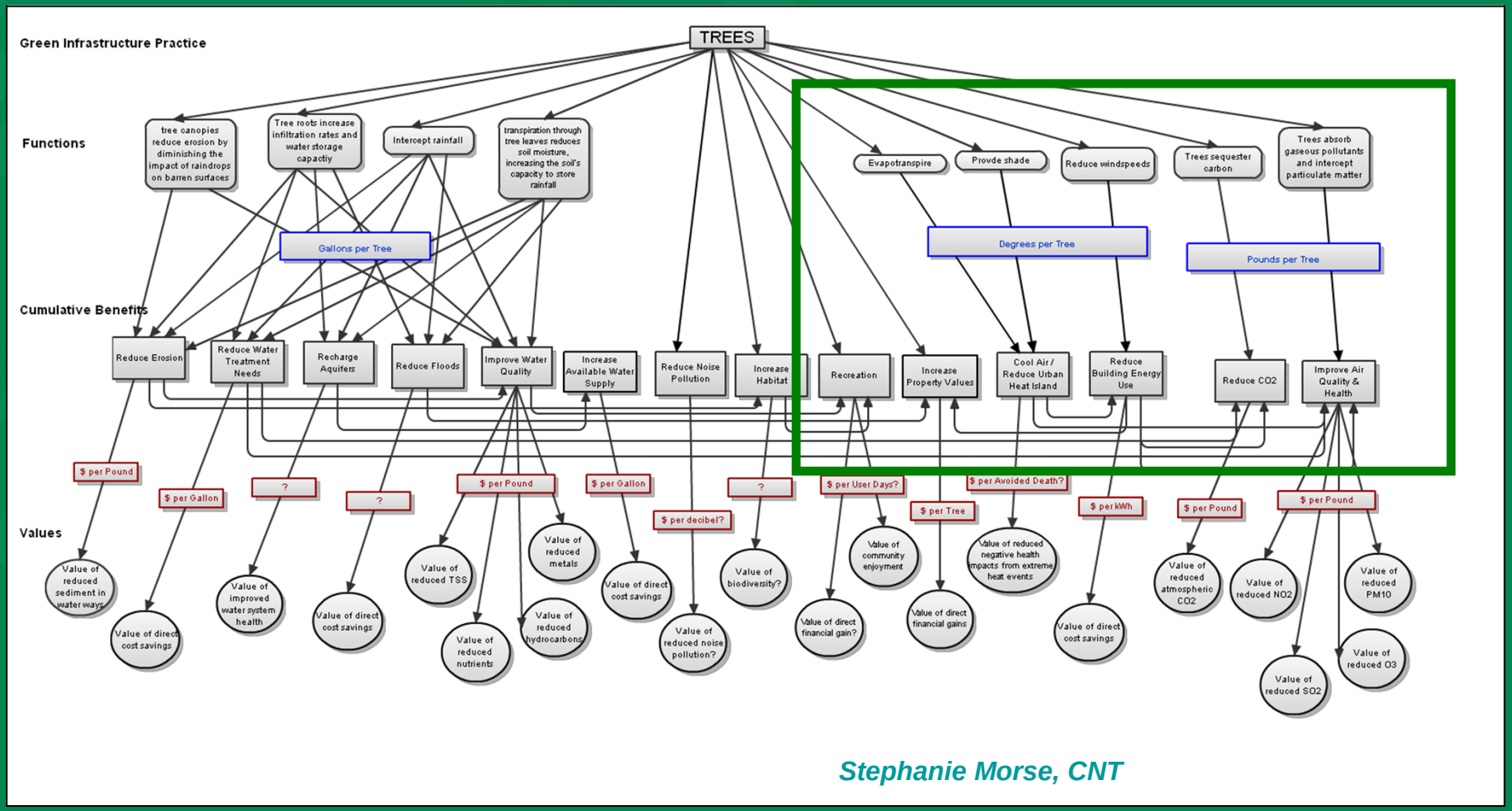
Functions, Benefits: Gallons per Tree



© Copyright Center for Neighborhood Technology

CNT

One Tree

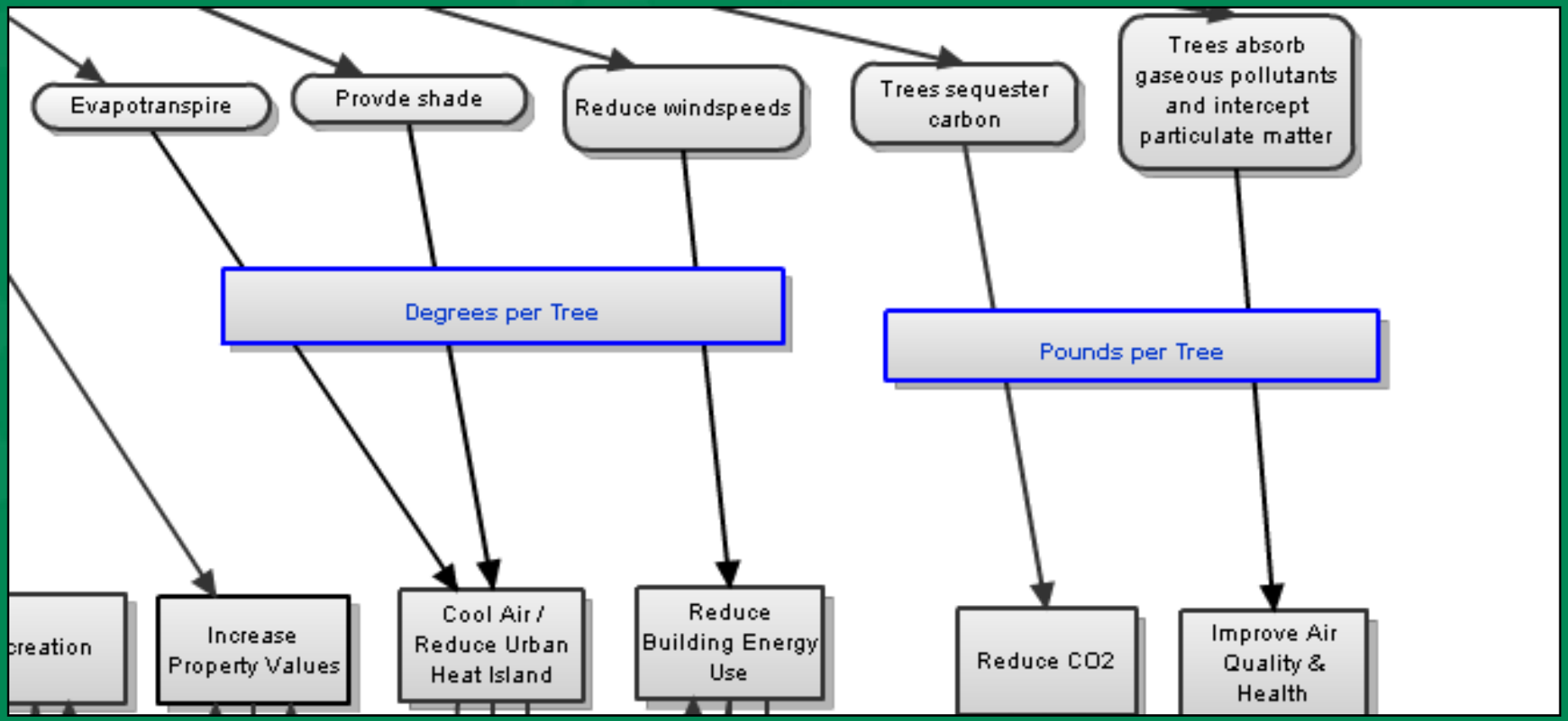


Stephanie Morse, CNT

© Copyright Center for Neighborhood Technology

CNT

Functions: Degrees and lbs. per tree

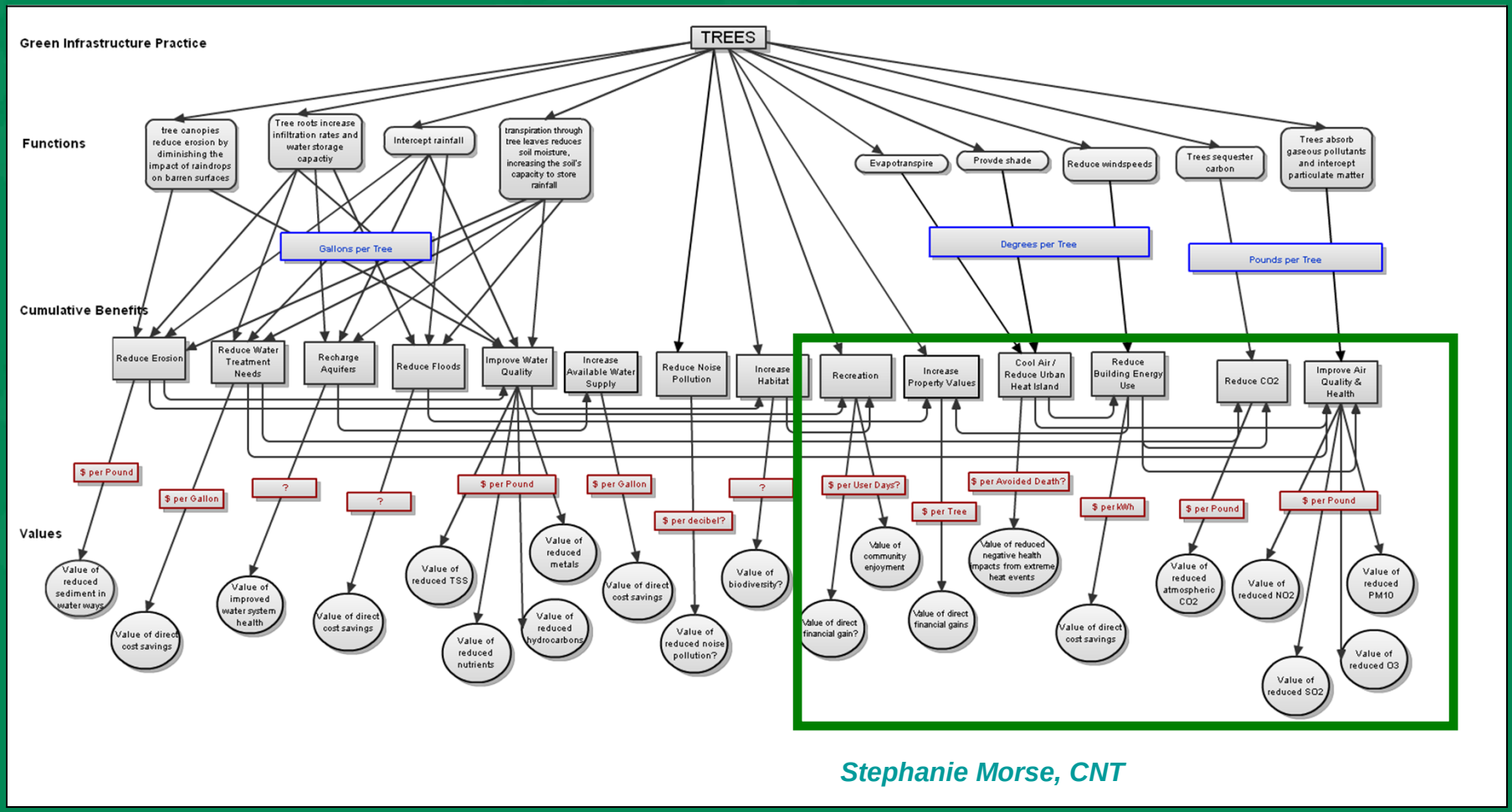


Stephanie Morse, CNT

© Copyright Center for Neighborhood Technology

CNT

One Tree

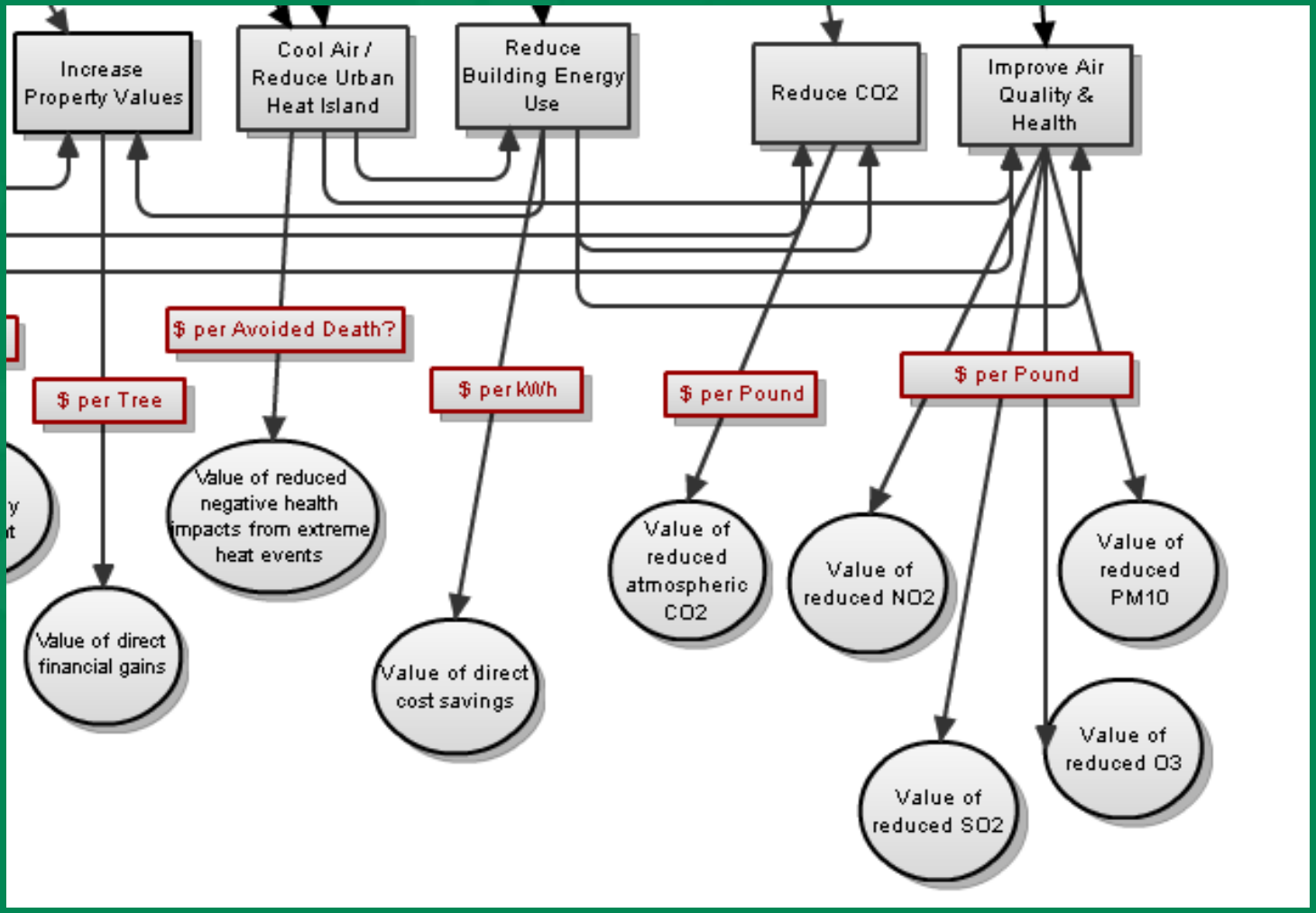


Stephanie Morse, CNT

© Copyright Center for Neighborhood Technology

CNT

Trees, Benefits, Monetization



© Copyright Center for Neighborhood Technology

CNT

Benefit Valuation Groupings

Water – Runoff, **treatment costs**, quality, erosion, flooding, groundwater and stream recharge, drinking water supply, grey infrastructure needs, de-icing

Energy – **Building heating/cooling**, conveyance, treatment and storage

Air Quality – **Pollutant sequestration**, carbon sequestration

Climate – Carbon sequestration, other GHGs

Heat Island – Morbidity, mortality, comfort

Community Livability – Noise, recreation, property value, aesthetics, community cohesion, urban agriculture

Habitat – Biodiversity, ecological health

Public Education

© Copyright Center for Neighborhood Technology

CNT

Example: Green Roof Benefits

Water: gallons retained

Equation:

Annual rainfall (inches/year) x green roof area (square feet) x % stormwater retained x 144 square inches/square foot x 0.00433 gallons/cubic inch = **Total Runoff Retained** (gallons/year)

Hypothetical calculation:

(38”/year)(5,000 SF)(60%)(144 SI/SF)(0.00433 gal./CI) = **71,081 gallons/year**

© Copyright Center for Neighborhood Technology

CNT

Example: Green Roof Benefits
Energy: Reduced Use

Heating degree days (°F days) x green roof area (SF) x 24 hours/day x ΔU = **Reduced Heating Energy** (Btu/SF)

Where

U = heat transfer coefficient, or 1/R; and

R = a measure of thermal resistance

© Copyright Center for Neighborhood Technology

Example: Green Roof Benefits
Energy: reduced use

$\Delta U = 1/R_{cr} - 1/R_{gr}$ = Btu/11.34(SF)(°F)(hrs) – Btu/23.4(SF)(°F)(hrs)

6,630°F(Chicago heating degree days) x 24 hr/day x ΔU = 7,231.75 (Btu/SF)

Hypothetical:
7,231.75 x 5,000 SF = **36,158,750 Btu/year**

© Copyright Center for Neighborhood Technology
CNT

Example: Green Roof Benefits

Air Quality: Reduced Criteria Pollutants

Green roof area (SF) x avg. annual pollutant uptake/deposition (lbs/SF/yr) = **Total Air Pollutant Uptake/Deposition** (lbs/yr)

Nitrogen oxide:

5,000 SF x 0.0003885 lbs/SF = 1.9425 lbs/yr

© Copyright Center for Neighborhood Technology

CNT

Monetizing the Benefits

Water (treatment cost saved):

Chicago: 71,081 gal. x $0.0000919/gal. = $6.53 ann. savings (MWRD)

Portland, OR: 71,091 gal x $0.0005/gal = $35.54 ann. savings

Grand Rapids, MI: 71,091 gal x $0.00263/gal = $186.97 ann. savings

© Copyright Center for Neighborhood Technology

Monetizing the Benefits

Energy (cost): 36,158,750 Btu x
$0.0000123/Btu = $444.75 ann. savings

Air Quality (pollutant removal cost):
1.9425 lbs NO_2 x $3.34/lb = $6.49 ann. savings

© Copyright Center for Neighborhood Technology

Monetizing the Benefits

<u>More examples</u>: Water (treatment cost saved):

- Chicago City Hall Green Roof = 20,300 sq. ft., retaining about 288,590 gal/yr
- Using MWRD cost, this building alone provides $26/yr in savings to MWRD
- In Portland, this building would save $144/yr
- Chicago has well over 2 million sq. ft. of green roof currently installed, saving MWRD about $2,588/yr

© Copyright Center for Neighborhood Technology

Monetizing the Benefits

Energy (cost saved):

Chicago City Hall Green Roof = 20,300 sq. ft.

With 7,231.75 Btu/sf saved x 20,300 x $0.0000123/Btu = $1806 in annual energy savings for the City

With 2 million sq ft of green roof installed, building owners in Chicago are collectively saving $177,901/yr!

[Note: in Chicago there are >7M sq. ft. of green roof completed or under permit review.]

© Copyright Center for Neighborhood Technology

CNT

Monetizing the Benefits

Air Quality (pollutant removal cost):

Chicago City Hall Green Roof = 20,300 sq. ft.

0.0003885 lbs/SF x 20,300 = 7.9 lbs NO_2 x $3.34/lb = $26 annual savings

With 2 million sq. ft. green roof in Chicago, the community is saving about $2,595/yr in NO_2 removal costs

Note: This does not include benefits of reducing other criteria pollutants, such as SOx, PM, HC, CO

© Copyright Center for Neighborhood Technology

CNT

Monetizing the Benefits

Groundwater Recharge: main. of stream min. flow; source water reliability; prevention of land subsidence

Improved Water Quality: ecosystem health; land value; aesthetics

Reduced Flooding: property damage cost mitigation

Reduced CSO Mitigation: infrastructure rehabilitation cost reduction

Reduced De-icing: annual reduction in cost of de-icing labor and material

© Copyright Center for Neighborhood Technology

Cost of Flooding: Chicago, IL

Flood damage cost estimate

- *Through October 2010, there were almost 15,000 phone calls about basement flooding received by Chicago's 3-1-1 assistance hotline.*
- *That number probably represents a fraction of the basements that were flooded, since not everyone calls 311 to complain.*
- *If the actual number were only 15,000 flooded basements, and the average property damage per basement was $500, the resulting total cost of the damage for that 10-month period would have been about $7.5 Million.*

© Copyright Center for Neighborhood Technology

ANY QUESTIONS??

© Copyright Center for Neighborhood Technology

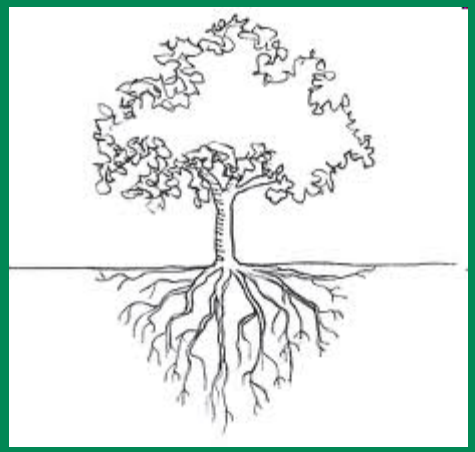
Three More Examples in Using the Guide

1. 100 trees in a neighborhood
2. 3 porous alleys (18000 sq ft) in a neighborhood
3. Vegetated swales in a 1-acre parking lot

© Copyright Center for Neighborhood Technology

Tree Planting

	Small tree	Medium tree	Large tree
Rainfall interception	292 gallons	1,129 gallons	2,162 gallons



Equation for quantifying the benefit:

Number of trees x average annual runoff retained per tree (gallons/tree/yr) = total runoff retained per year (gallons/yr)

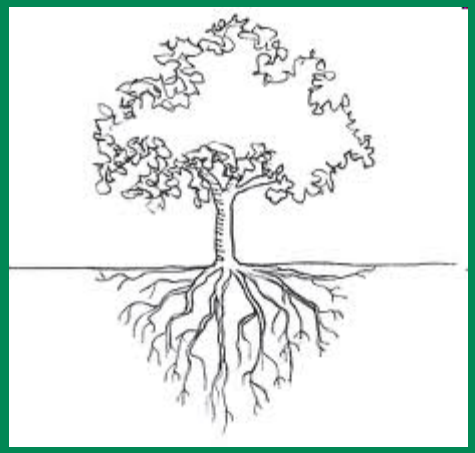
Example: 100 x 1,129 = 112,900 gallons/yr

© Copyright Center for Neighborhood Technology

CNT

Planting 100 Trees

Valuation of Quantified Benefits:



Runoff reduced (gallons/yr) x avoided treatment cost per gallon (dollars/gallon) = avoided stormwater treatment cost (dollars/yr)

Examples:
Chicago: 112,900 gal x $0.0000919/gal = $10
Portland: 112,900 gal x $0.0005/gal = $56
Grand Rapids: 112,900 gal x $0.00263/gal = $297

© Copyright Center for Neighborhood Technology
CNT

Porous Alleys

Quantifying the Benefits:

Annual precipitation (inches) x area
of GI feature + drainage area (sq ft)
x percent retained (%) x 144
sq in/sq ft x 0.00433 gal/cu in =
Total runoff reduction (gallons/yr)

Example: 38” x 18,000 sq ft (3 alleys) x 80% x 144
sq in/sq ft x 0.00433 gal/cu in = 341,190 gal/yr

© Copyright Center for Neighborhood Technology

Three Porous Alleys

Valuing the Quantified Benefits:
Runoff reduced (gallons/yr) x avoided treatment cost per gallon (dollars/gallon) = avoided stormwater treatment cost (dollars/yr)

Examples:
Chicago: 341,190 gal x $0.0000919/gal = $31/yr
Portland: 341,190 gal x $0.0005/gal = $171/yr
Grand Rapids: 341,190 gal x $0.00263/gal = $897

© Copyright Center for Neighborhood Technology

Vegetated Swales

Quantifying the Benefits:

Annual precipitation (inches) x area of GI feature + drainage area (sq ft) x percent retained (%) x 144 sq in/sq ft x 0.00433 gal/cu in = Total runoff reduction (gallons/yr)

Example: 38” x 43,560 sq ft (1-acre) x 80% x 144 sq in/sq ft x 0.00433 gal/cu in = 825,680 gal/yr

© Copyright Center for Neighborhood Technology

Swales in a 1-acre Parking Lot

Valuing the Quantified Benefits:

Runoff reduced (gallons/yr) x avoided treatment cost per gallon ($$/gallon) = avoided stormwater treatment cost (dollars/yr)

Examples:
Chicago: 825,680 gal x $0.0000919/gal = $75
Portland: 825,680 gal x $0.0005/gal = $412
Grand Rapids: 825,680 gal x $0.0023 = $2,172

© Copyright Center for Neighborhood Technology
CNT

Valuation Note

The following benefits must be added to the above values:

- Value of improved water quality
- Reduced infrastructure capital and O& M costs
- Reduced costs from basement flooding
- Value of reliable regulatory compliance
- Value of reliable clean water supply sources
- Value of groundwater recharge for surface waters

© Copyright Center for Neighborhood Technology

Valuation Note

More benefits:

- Reduced cost of winter de-icing materials
- Reduced treatment energy costs
- Reduced heating energy costs
- Reduced cooling energy costs
- Reduced health care costs from improved air quality
- Improved health of aquatic ecosystems and of associated terrestrial ecosystems

© Copyright Center for Neighborhood Technology

Valuation Note

Still more benefits:

- Increased property values
- Value of increased recreational opportunities
- Value of increased habitat for flora and fauna
- Value of improved community aesthetics
- Value of reduced noise pollution
- Value of public education opportunities

© Copyright Center for Neighborhood Technology

Thank You

http://www.cnt.org/water/

hal@cnt.org

Benefit Guide link:

http://www.cnt.org/repository/gi-values-guide.pdf

American Rivers: http://www.americanrivers.org/

© Copyright Center for Neighborhood Technology

CNT