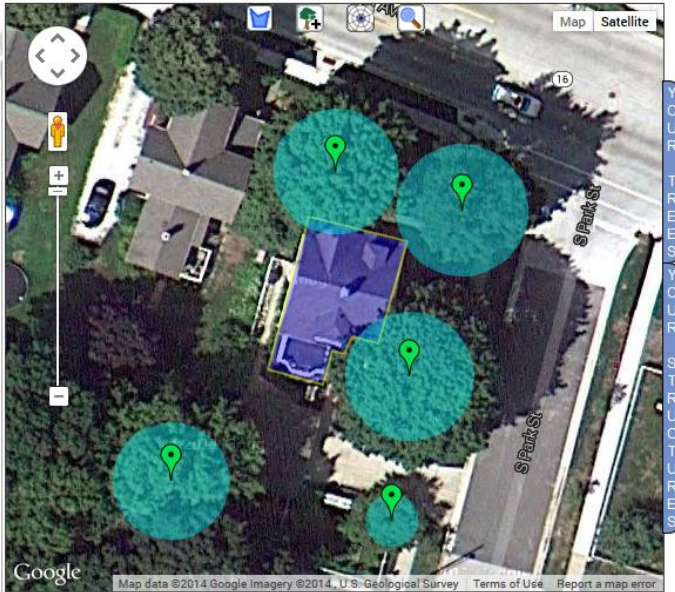# *Energy Efficiency Through Landscape Design*

i-Tree Design

Al Zelaya
The Davey Institute
A division of the Davey Tree Expert Company
Chicago, IL

i-Tree is a Cooperative Initiative among these partners

Talk focus

🌳 Tree benefit-based approach

🌳 Trees and energy effects

🌳 Intro to related i-Tree Tools

Crown Growth Modeler

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i-Tree...

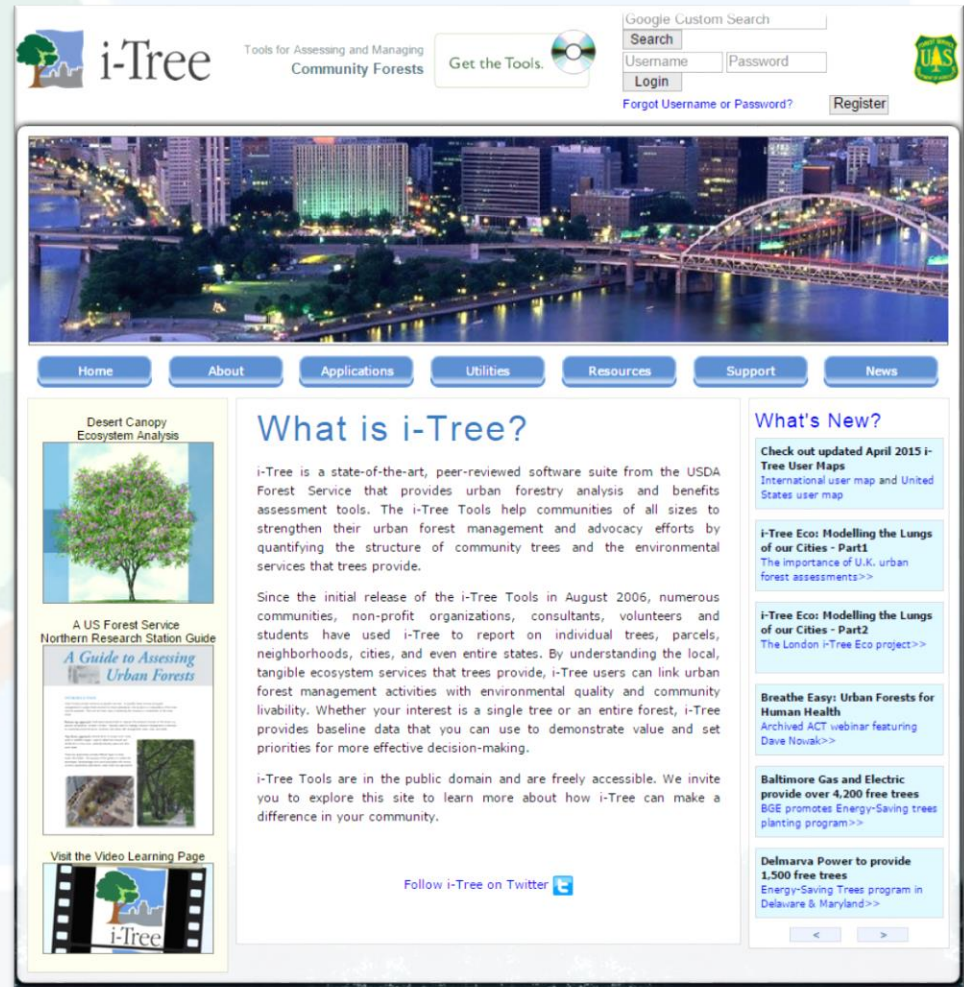### *"Putting USFS Urban Forest science into the hands of users"*

- Free public Domain Software
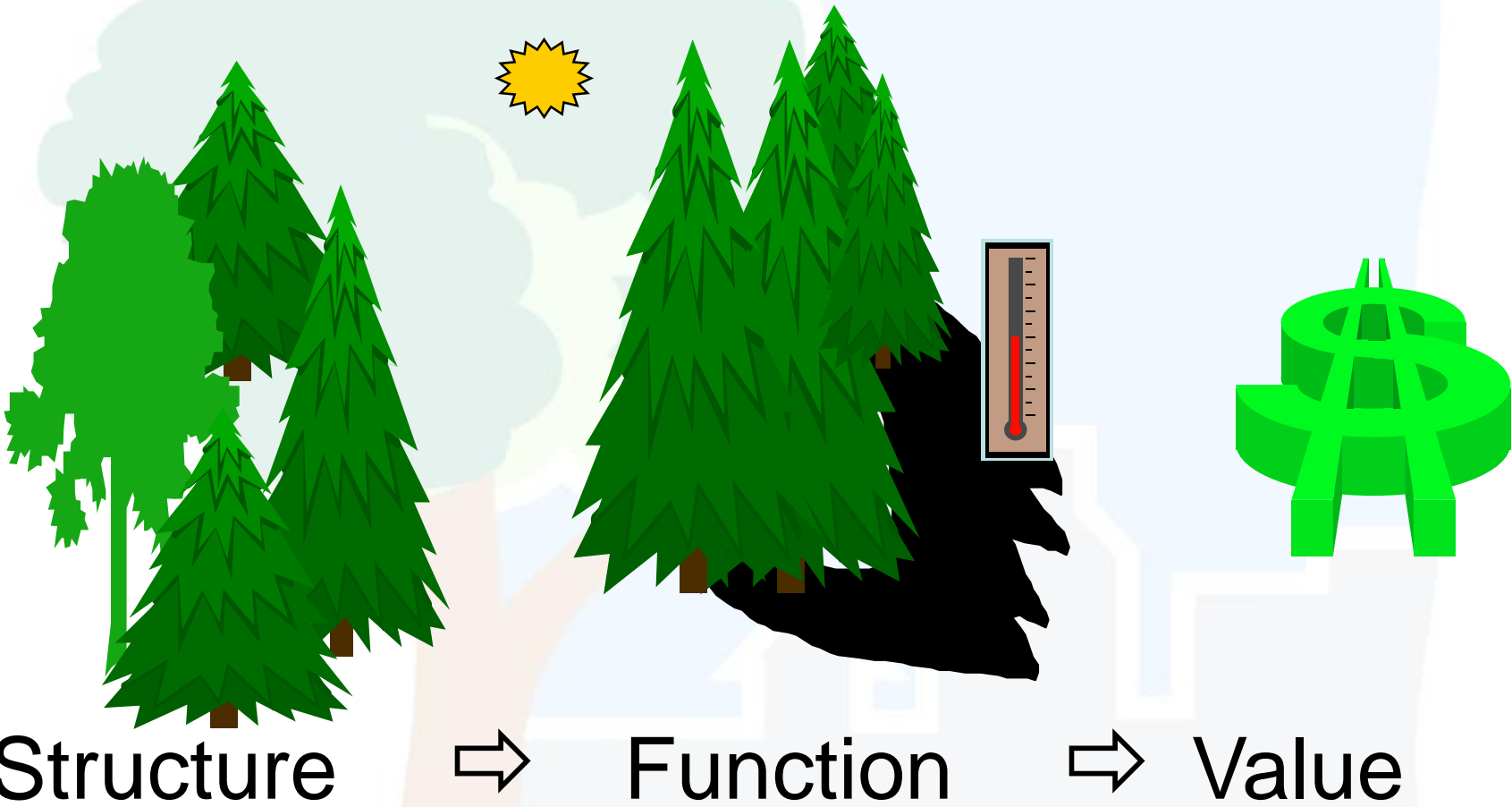
- Based on peer-reviewed research

- Technical support

- Continuously improved

www.itreetools.org

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i-Tree Basis: Benefit based approach

Structure ⇨ Function ⇨ Value

Structure ⟹ Function ⟹ Value

Figure 1.1: Map of Chicago Wilderness Region

Chicago Wilderness Green Infrastructure Vision

Chicago Wilderness Region
Recommended Resource Protection Areas
Protected Land
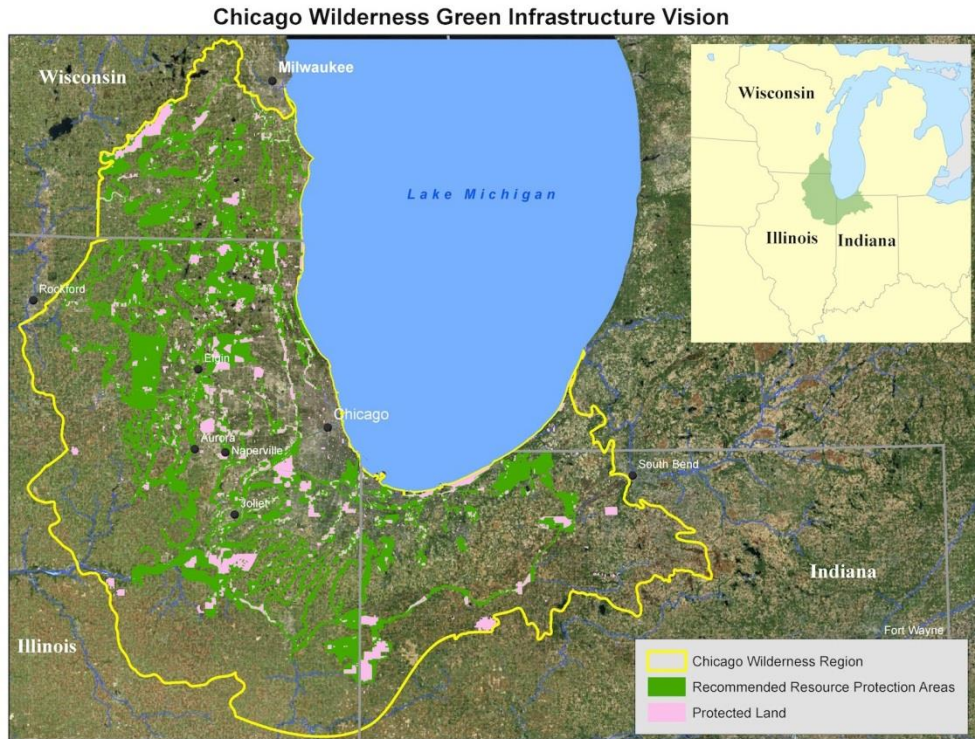
State, regional or city scale
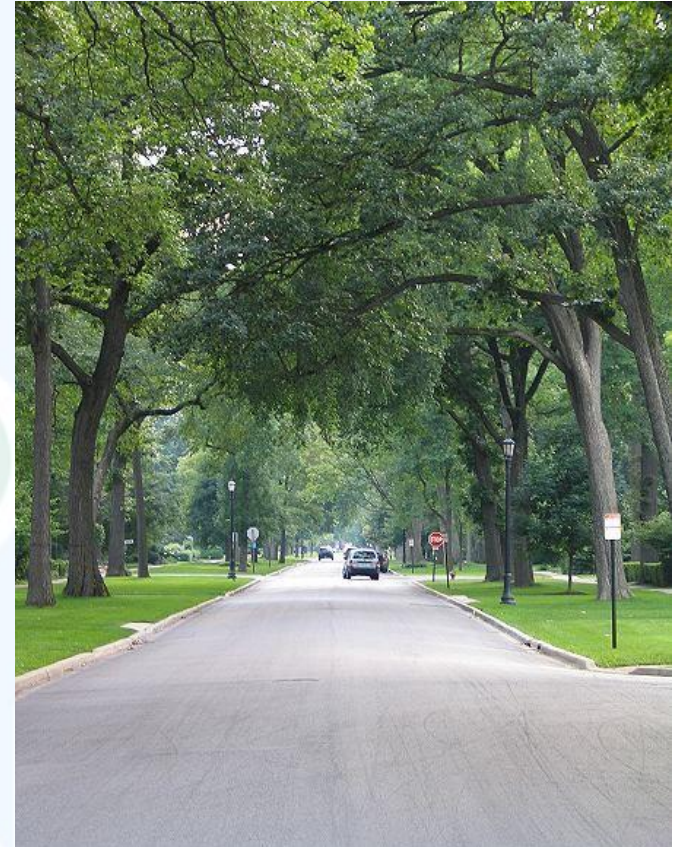
neighborhood scale

Structure ➡ Function ➡ Value

Use conifers on the north and northwest to block winter wind, but not where they will block winter sunshine.

Plant deciduous trees so bare branches allow winter sunshine to warm the house and windows.

N

Plant on the west and northwest to provide mid-to-late afternoon shade in most locations.

Shade east and west windows, but prune lower branches to prevent blocking the view.

Plant shade trees over patios, driveways, and air-conditioning units.

N

Homeowner scale

■ Stormwater   ■ Air Quality
■ CO2   ■ Winter Savings
■ Summer Savings

$91.24

$23.29

$10.06

$31.64

$9.51

Breakdown of tree benefits

Structure ⟹ Function ⟹ Value

Structure ⟹ Function ⟹ Value

Structure ⟹ Function ⟹ Value

Annually **Arboretum Estates** community trees provide[1]...

STORMWATER RUNOFF REDUCTION
$10,305

PROPERTY VALUE INCREASE
$13,738

$38,765
Thousand per Year
TOTAL BENEFITS

CO_2 REDUCTION
$1,224

AIR QUALITY IMPROVEMENT
$1,846

ENERGY SAVINGS
$11,652

18%	Crabapple	
14%	River birch	Top 5 Tree Species
11%	Hawthorn	
9%	Austrian pine	
8%	Douglas fir	
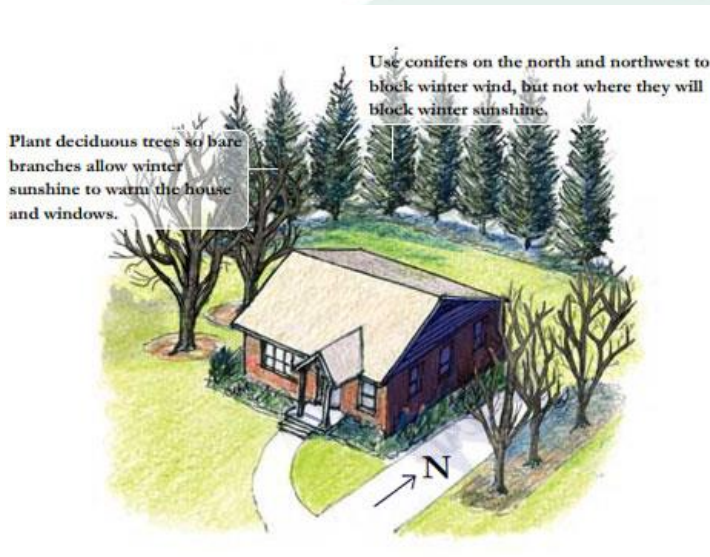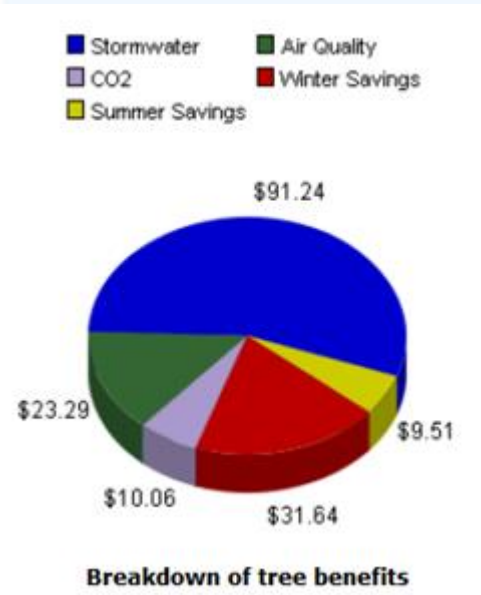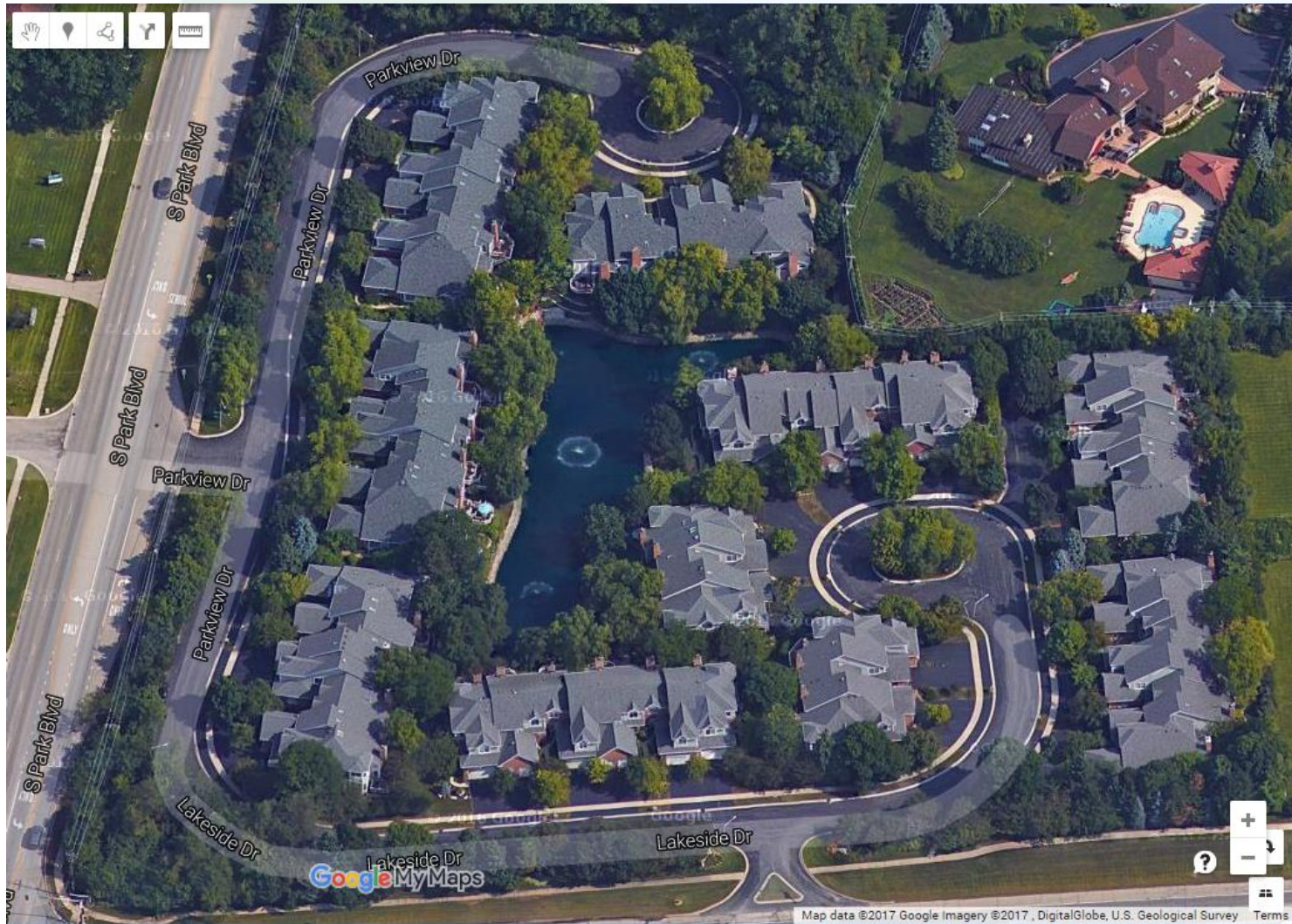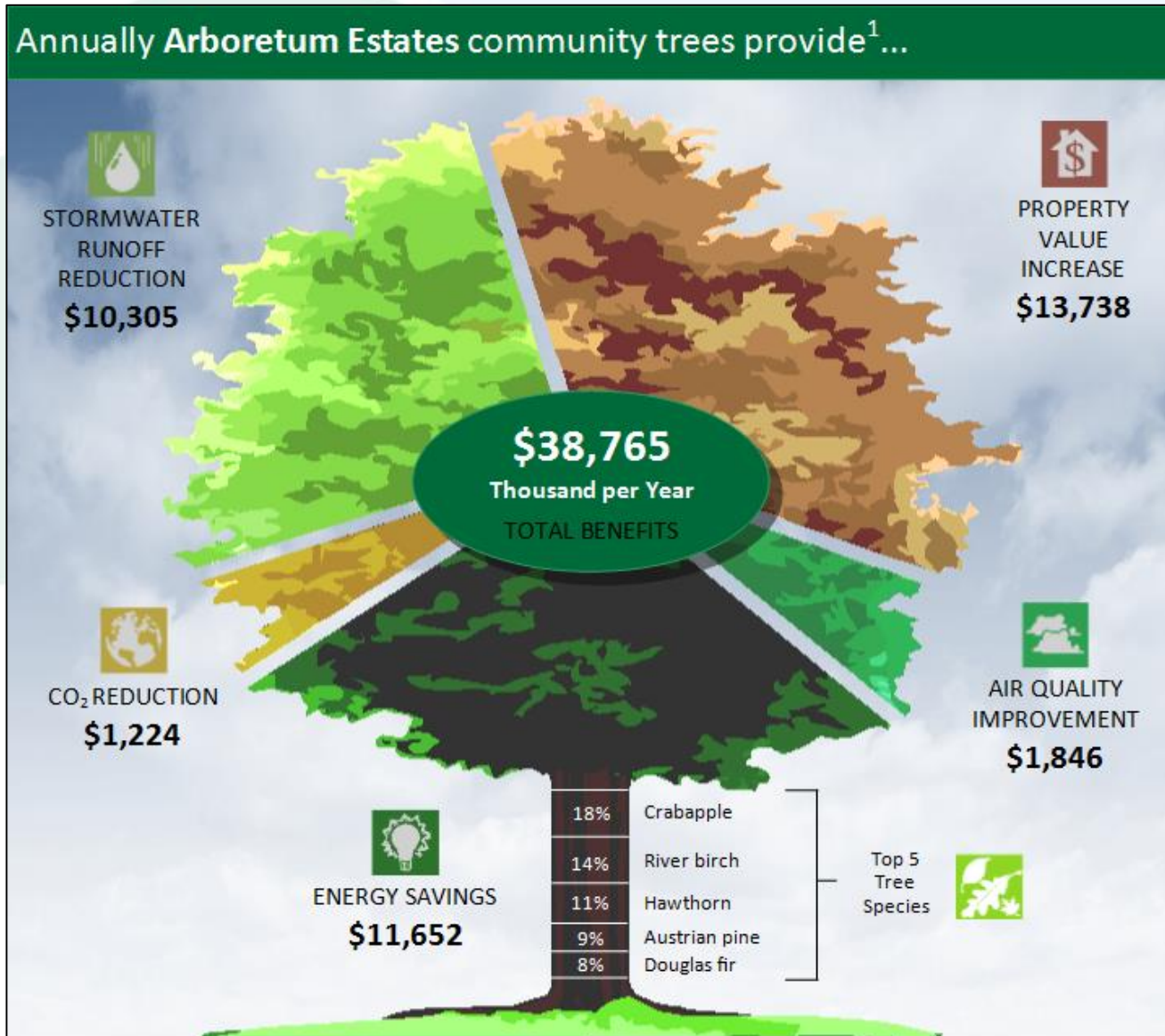
i-Tree is a Cooperative Initiative among these partners

Benefit 1: Improve air quality

- Absorb pollutants through leaf surfaces
  - O_3 (ozone)
  - NO_2 (nitrogen dioxide)
  - SO_2 (sulfur dioxide)

- Intercept dust and/or particulate matter (PM10 and PM2.5)

- Reduction in **energy** production needs reduces creation of many pollutants

- Release oxygen

Shade on Paved Surfaces and Parked Cars Reduces Evaporative Hydrocarbon Emissions and Ozone Formation

Oxygen and Volatile Organic Compounds Released Through the Leaves

Gaseous Pollutants Absorbed Through Leaf Stomates and Lenticels

Small Particles Adhere to Surfaces

Trees Save Energy for Cooling and Heating, Thereby Reducing Pollutant Emissions from Power Plants

Benefit 2: Stormwater reduction

🌳 Intercepts and holds rain on leaves, branches, and other surfaces

🌳 Reduces stormwater runoff

🌳 **Increases storage in soil**

🌳 Reduces erosion
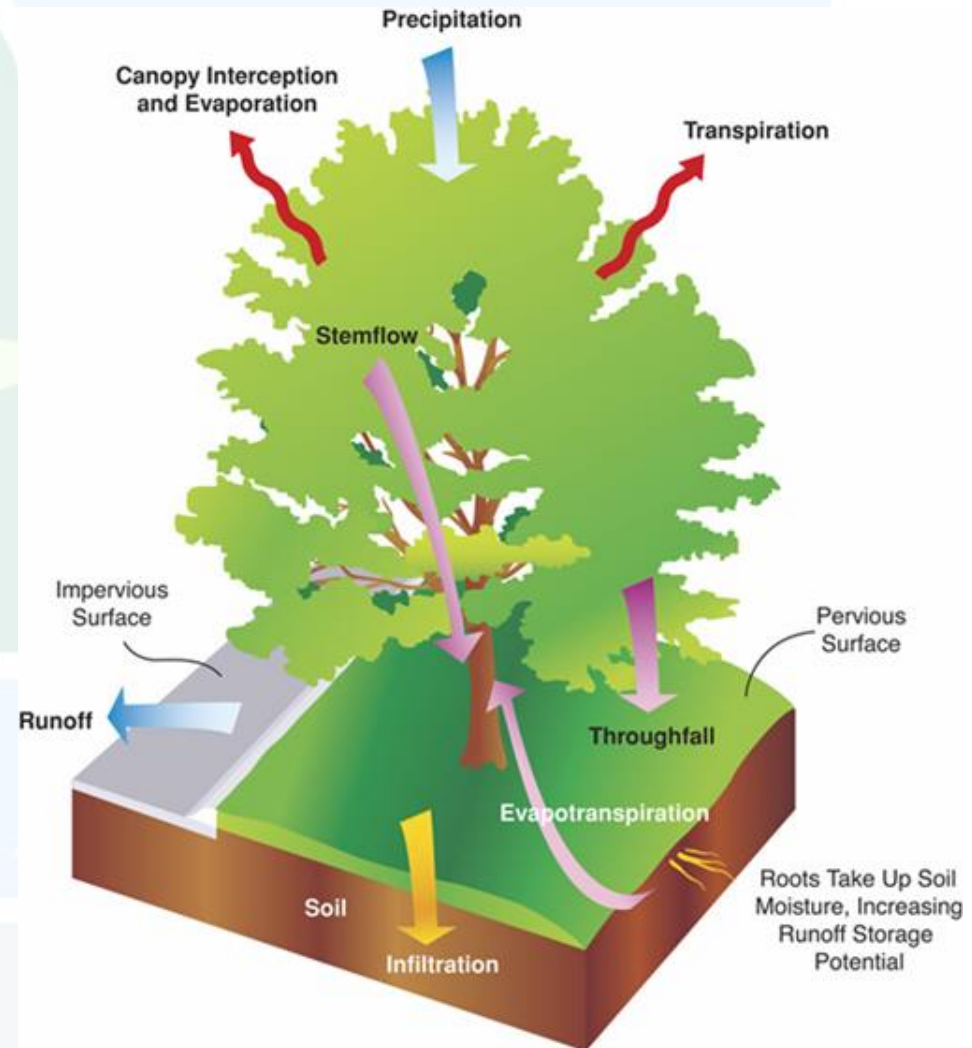
Benefit 3: CO_2 Reduction

🌳 Trees are largely made of carbon so they take carbon out of the air and turn it into tissue (bark, leaves, wood, etc.)

🌳 Reduce **energy** needs and help avoid carbon release in the first place

Trees Save Energy for Cooling, Thereby Reducing CO_2 Emissions from Power Plants

Trees Sequester CO_2 in Trunk, Branches, Leaves, and Roots as They Grow

Mulch

CO_2 is Released Via Tree Care Activities

CO_2 is Released Via Decomposition of Dead Wood and Mulch

Trees & Energy – Summer Effects

Plant on the west & northwest to provide mid-to-late afternoon shade in most locations

Shade east & west windows, but prune lower branches to prevent blocking the view.

Plant shade trees over patios, driveways, and air conditioning units

Image courtesy of Arbor Day Foundation

Trees & Energy – Winter Effects

Tree windbreak can reduce a 35 mph open wind velocity to about 10mph near here
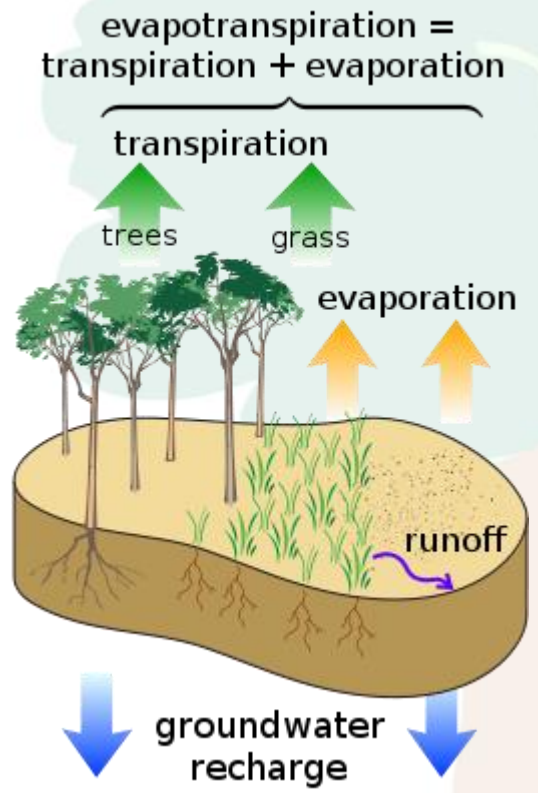
…and about 15mph here
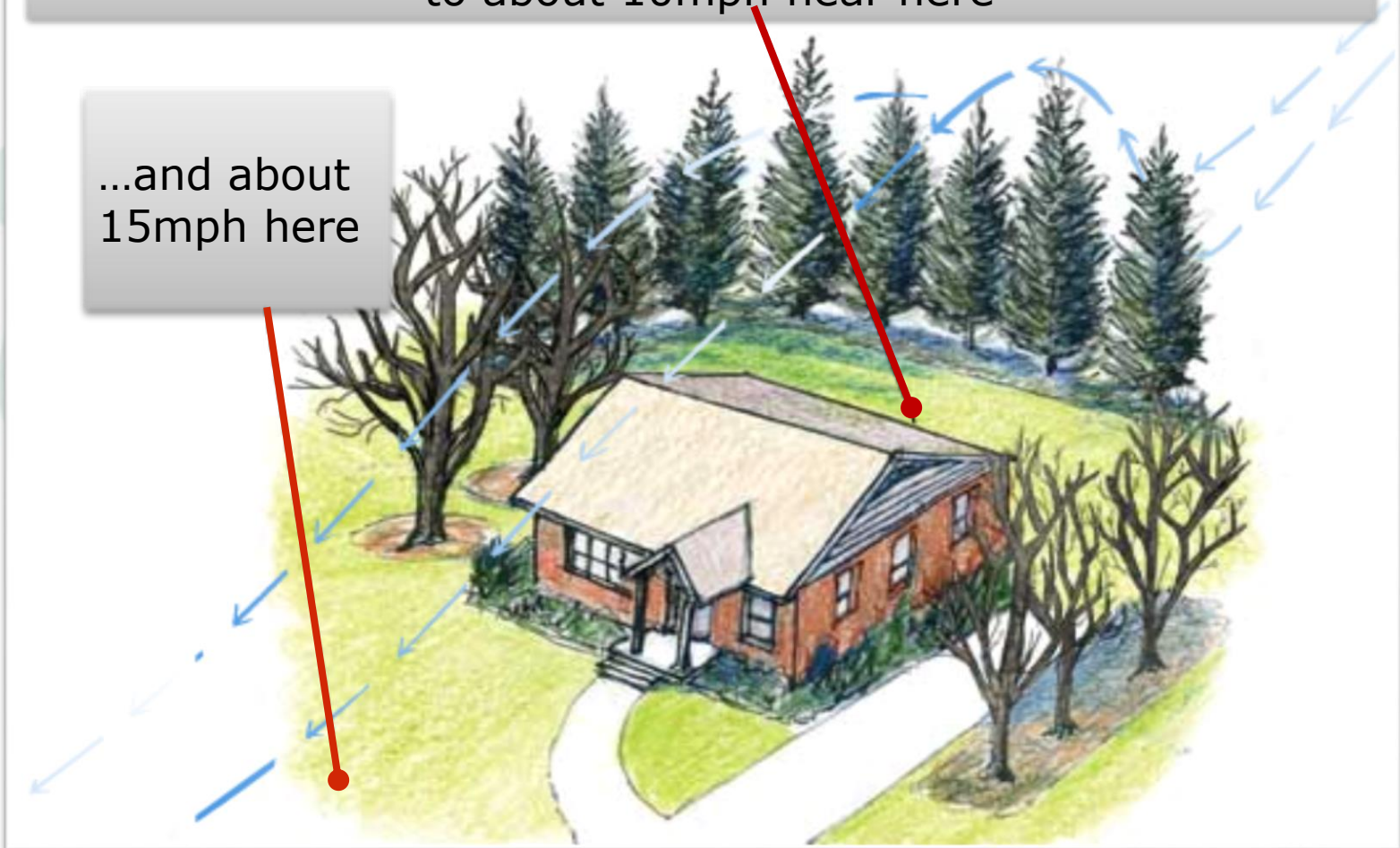
Image courtesy of Arbor Day Foundation

Trees & Energy – Combined Climate Effects

Combined effects of transpirational cooling along with shading of below canopy built surfaces can reduce air temps by as much as 9°F.
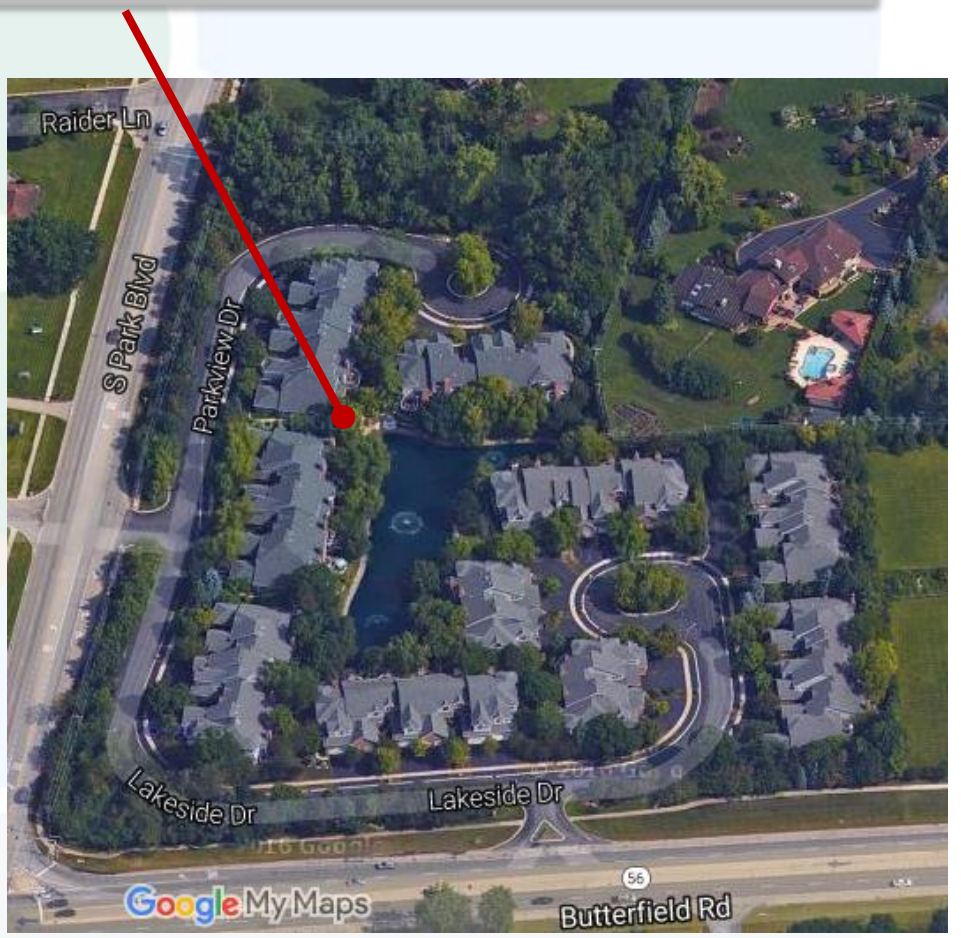
evapotranspiration = transpiration + evaporation

transpiration

trees   grass

evaporation

runoff

groundwater recharge

Source: Akbari et al.,1992. Cooling Our Communities: A Guide on Tree Planting and Light Colored Surfacing.

i-Tree is a Cooperative Initiative among these partners

Trees & Energy – Indirect Effects

Reducing energy use at home lessens energy production demand – and associated emissions at power generation source

Source: Akbari et al.,1992. Cooling Our Communities: A Guide on Tree Planting and Light Colored Surfacing.

Benefit 4: Trees & Energy Summary

- Shade air conditioned buildings (summer)

- Act as a wind break reducing heat loss in (winter)

- Transpiration cools the air – (climate effect)

- Reduce energy demand at power generation source (indirect)

Wind Speed Reduction Reduces Air Infiltration

Transpiration by Trees in the Aggregate Cools the Air

Direct Shading Reduces Irradiance on Buildings

Shading Paved Surfaces Reduces Urban Heat Island Effect and Ozone Formation

i-Tree Design

- Analysis of individual trees associated with structures

- Calculates benefits over time

- Designed for general public use

- Web accessible

http://design.itreetools.org
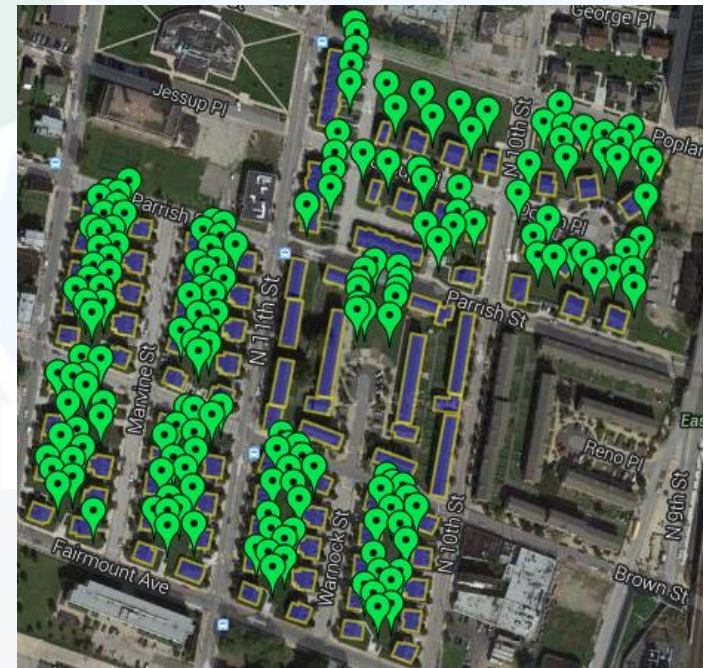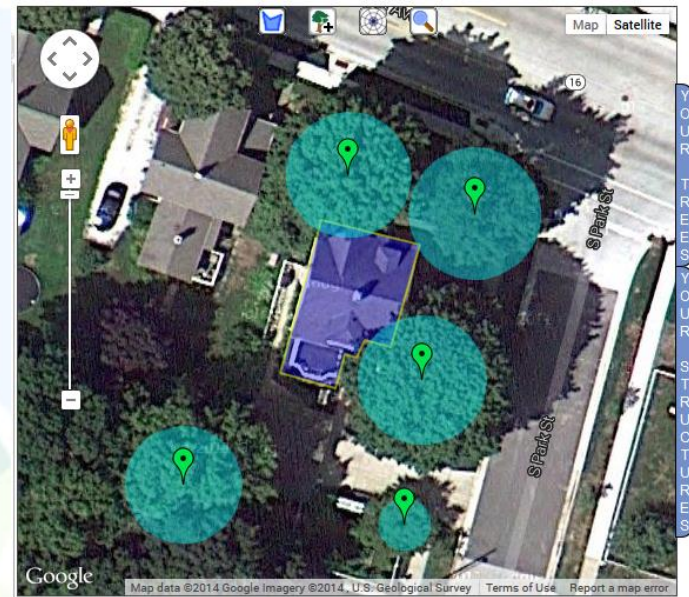
i-Tree Design

Estimates 4 core ecosystem services

> ➤ Stormwater interception

> ➤ Energy (impacts on heating/cooling)

> ➤ Air quality improvement

> ➤ Carbon sequestration

Assesses value ($) of current and future benefits
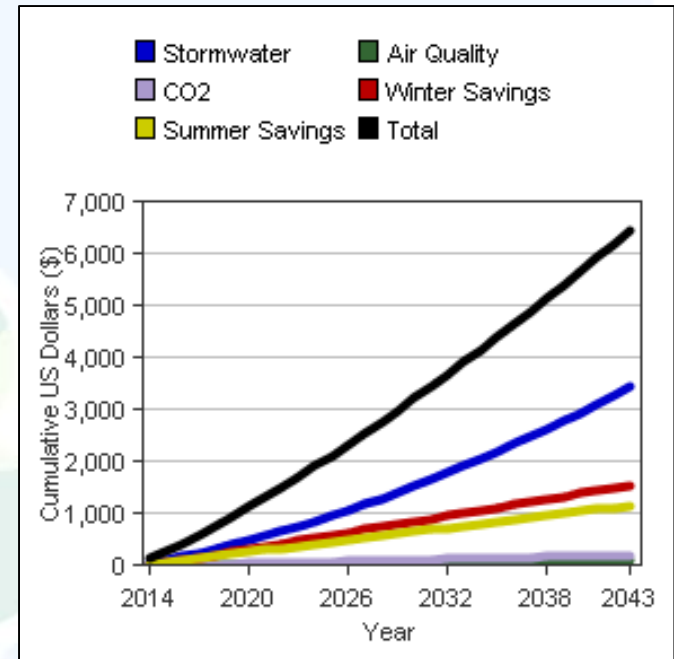
$6,476 worth of benefits over the next 30 years …and growing

Provides a $ value for tree benefits
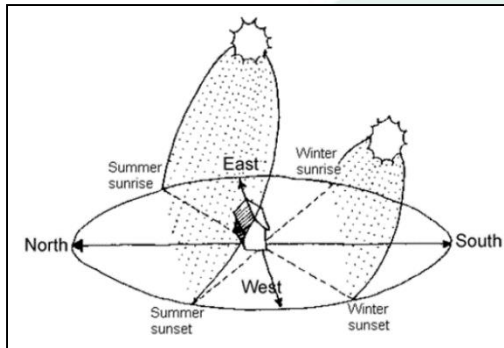
Energy
305.7 kwh = $35.85
21.6 therms = $35.00

Stormwater
5,714 gallons = $56.57
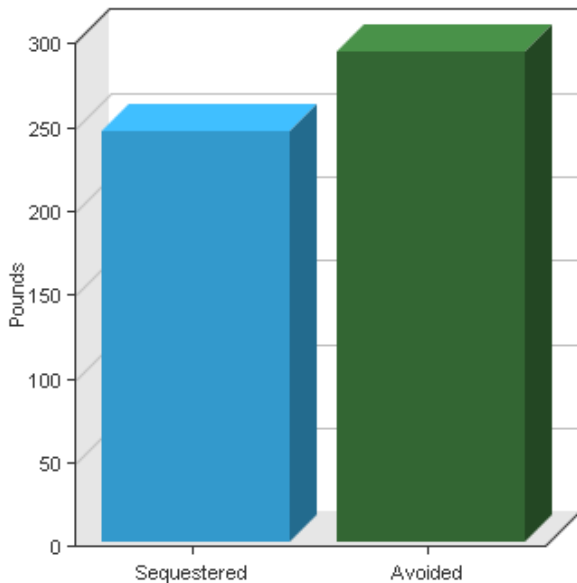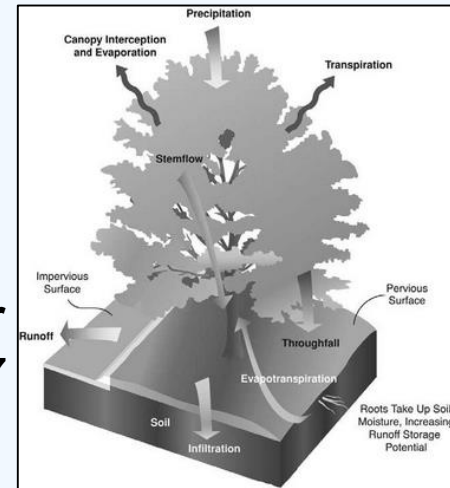
Carbon dioxide
612 lbs = $5.95

Air Quality
Improved health = $2.23
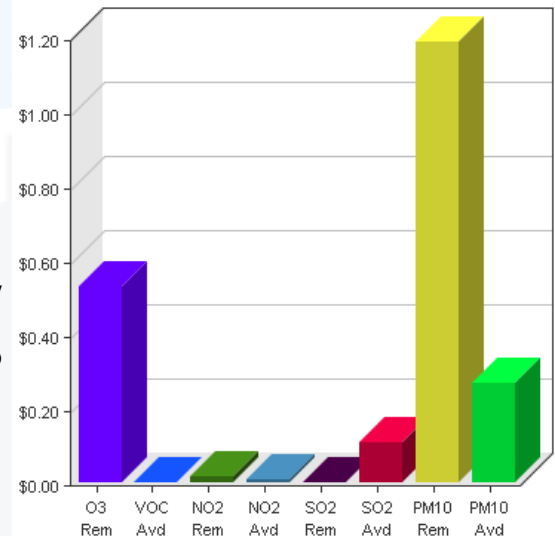
Total benefits this year = $136

Shows trees are an investment
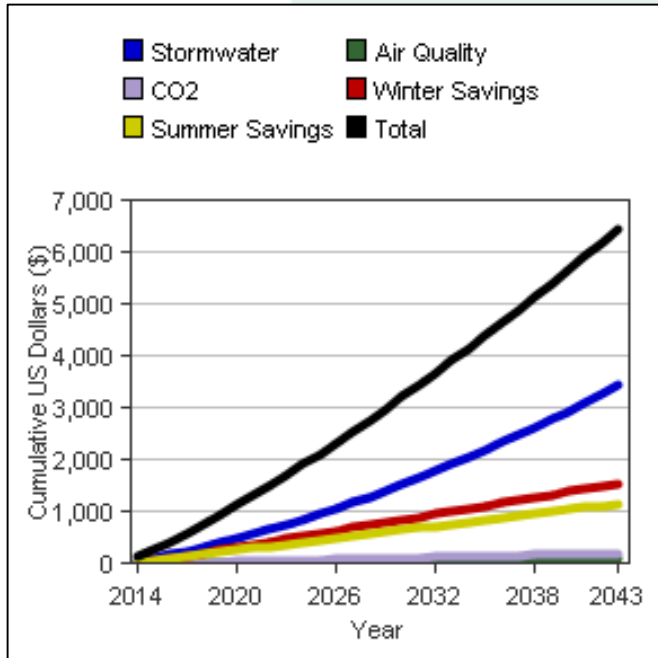
$6,476 worth of benefits over the next 30 years …and growing

Benefits in 2044 = **$272**   To date = **$2,470**

Start Over
Return to Setup
View Report
Print
Save Result
About

i-Tree Design v6.0   7615 Arcadia Street, Morton Grove, IL 60053, USA
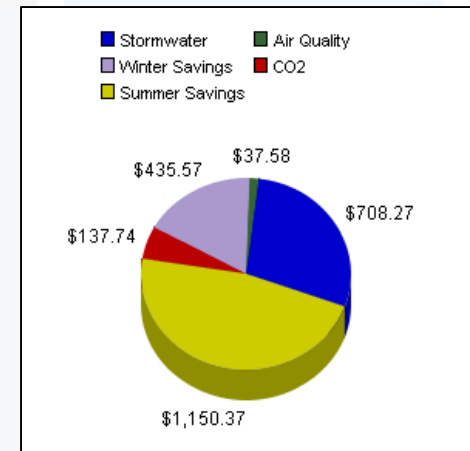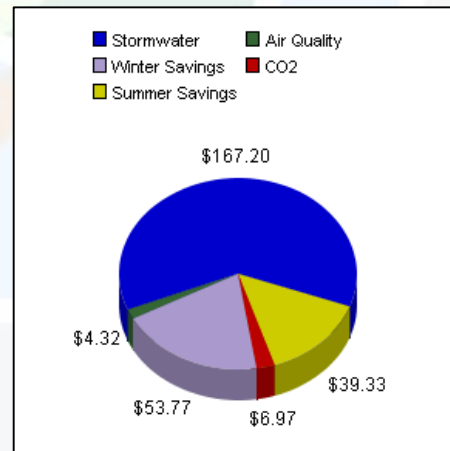
Display results for: All Trees ▼

Overall Benefits | Stormwater | Energy | Air Quality | Carbon Dioxide

Current Year (2013)
Future Year (2038)
Total (2013-2038)
Total to Date

Legend
- ■ Stormwater
- ■ Air Quality
- ■ CO2
- ■ Winter Savings
- ■ Summer Savings

$1,289.32

$358.47

$159.07

$540.61

$276.17
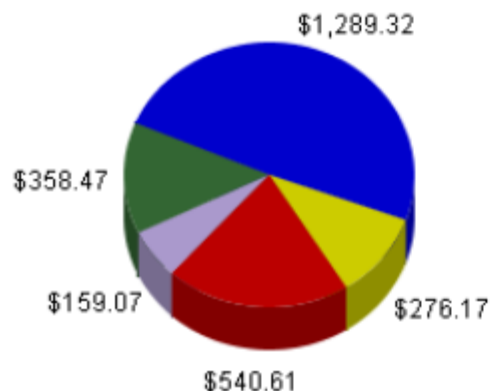
Breakdown of tree benefits

Click on one of the tabs above for more detail

To date, these trees have provided overall benefits of $2,617.

While some functional benefits of trees are well documented, others are difficult to quantify (e.g., human social and communal health). Trees' specific geography, climate, and interactions with humans and infrastructure are highly variable and make precise calculations that much more difficult. Given these complexities, the results presented here should be considered initial approximations to better understand the environmental and economic value associated with trees and their placement.

Benefits of trees do not account for the costs associated with trees' long-term care and maintenance.

Strategy: Evaluating tree planting energy effects

Pennsylvania Horticultural
Society planting for the
Philadelphia Housing Authority

Savings over the next 30 yrs
- **$108,000** in winter
- **$87,000** in summer

Legend:
- Stormwater
- Winter Savings
- Summer Savings
- Air Quality
- CO2

$692.32
$9,171.48
$7,543.46
$4,859.62
$903.91

Benefits in year 30

Strategy: Evaluating tree planting energy effects

Energy Saving Trees

Arbor Day Foundation

- Dynamic tree suitability modeling

- Utility partnerships
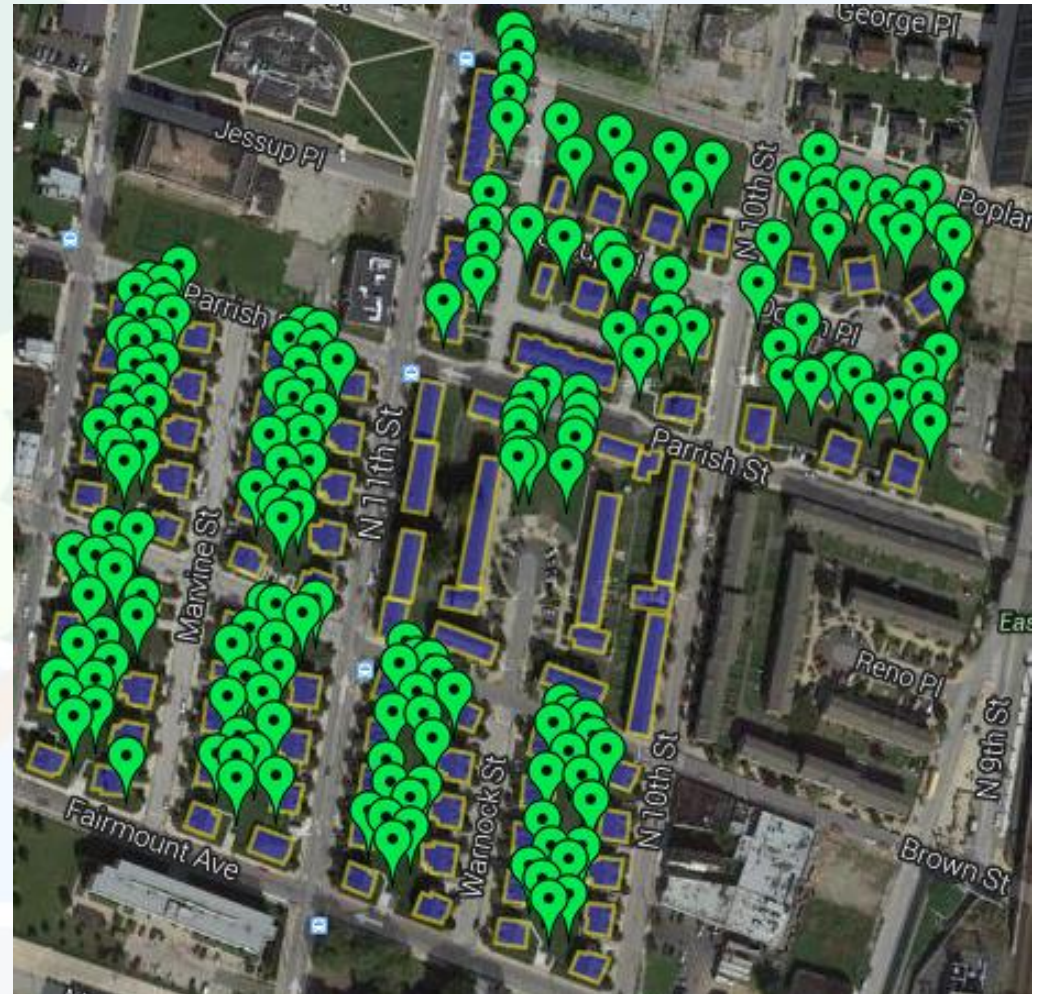
- Consumer oriented

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Strategy: Tree preservation scenarios
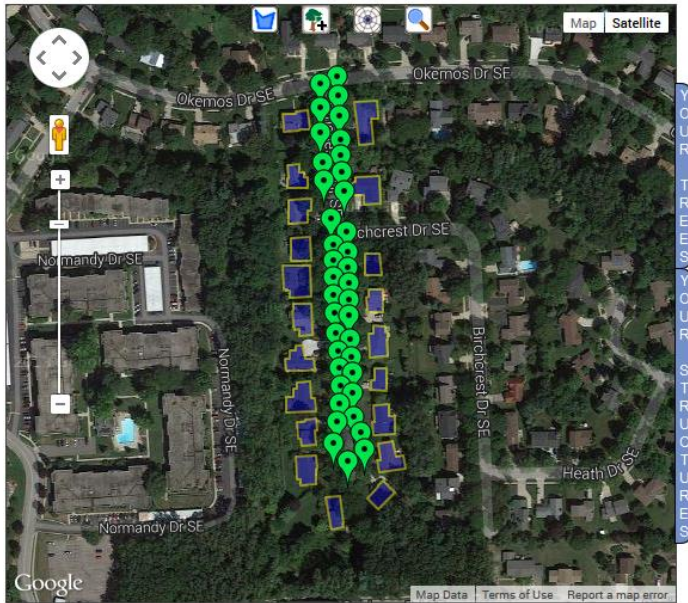
From Google Street View

The 39 Ash trees will provide $76k worth of benefits over the next 20 yrs.

Residents decides they are worth protecting
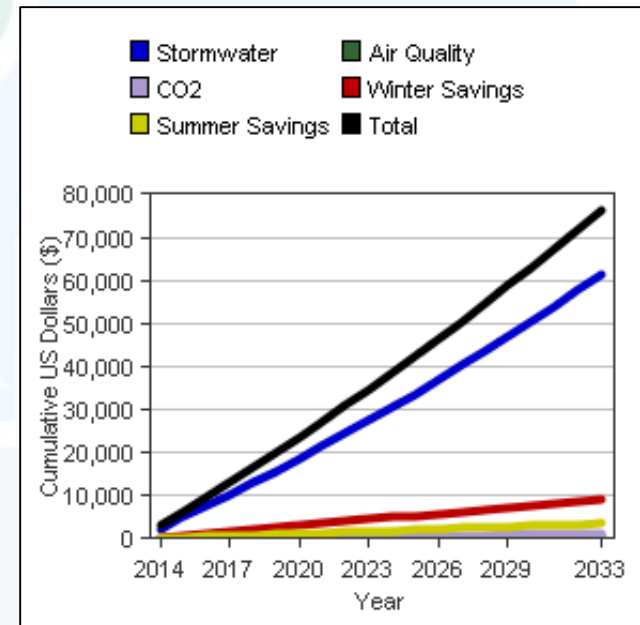
Strategy: Community sustainability programs
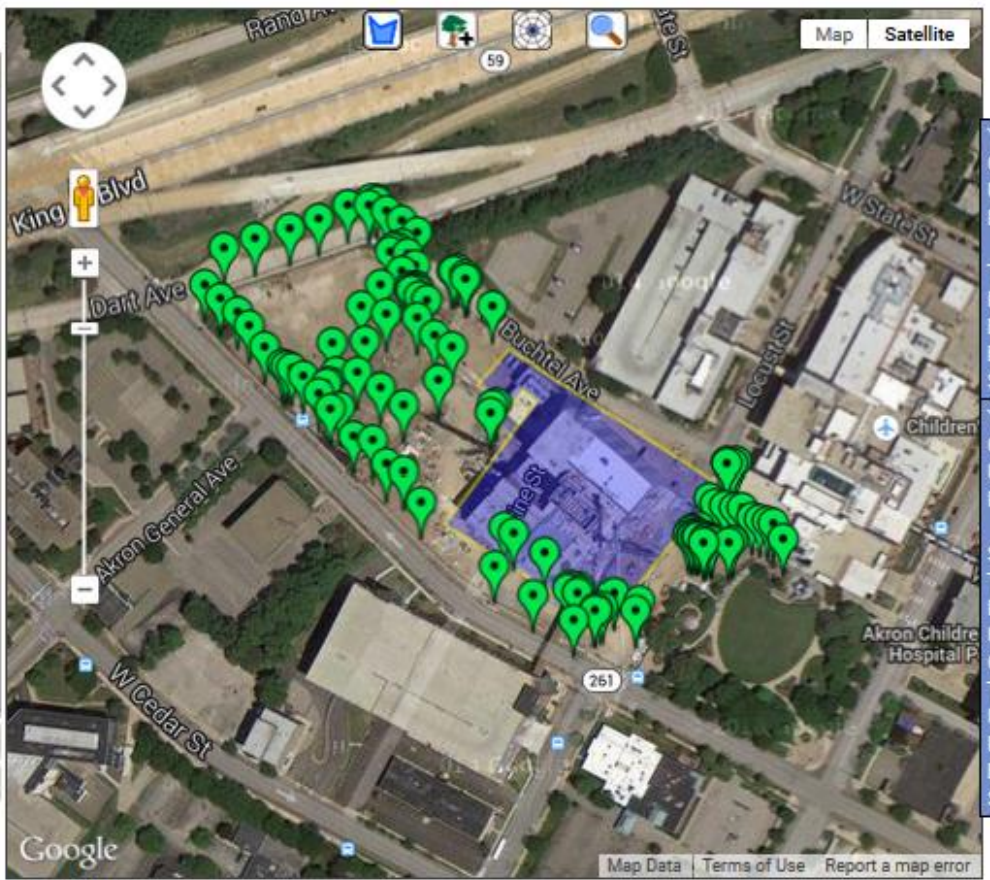
Strategy: Advocacy and Outreach

From very simple…

… to more involved

i-Tree MyTree *beta - new*
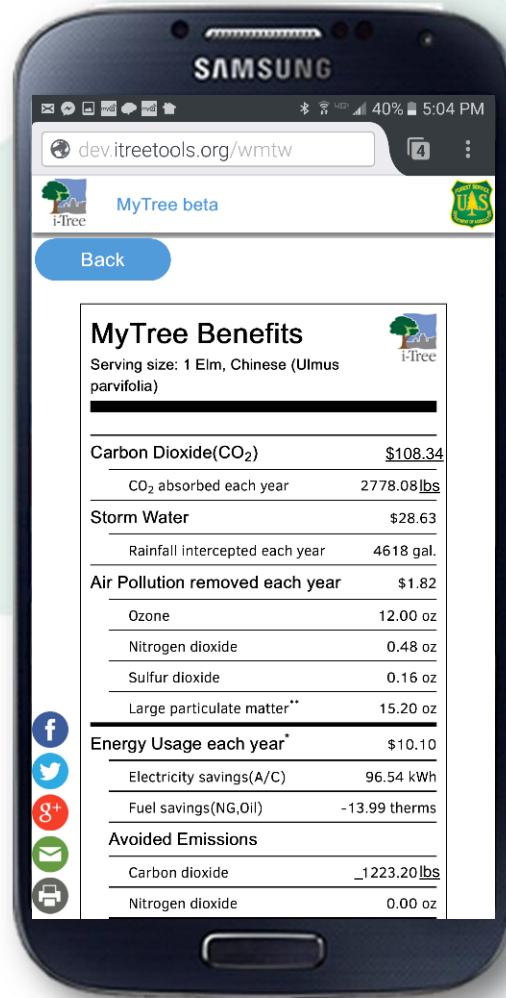
🌱 i-Tree on the go!

➢ Running on the i-Tree Design engine

www.itreetools.org/MyTree

i-Tree Species *version 2.0 - new*
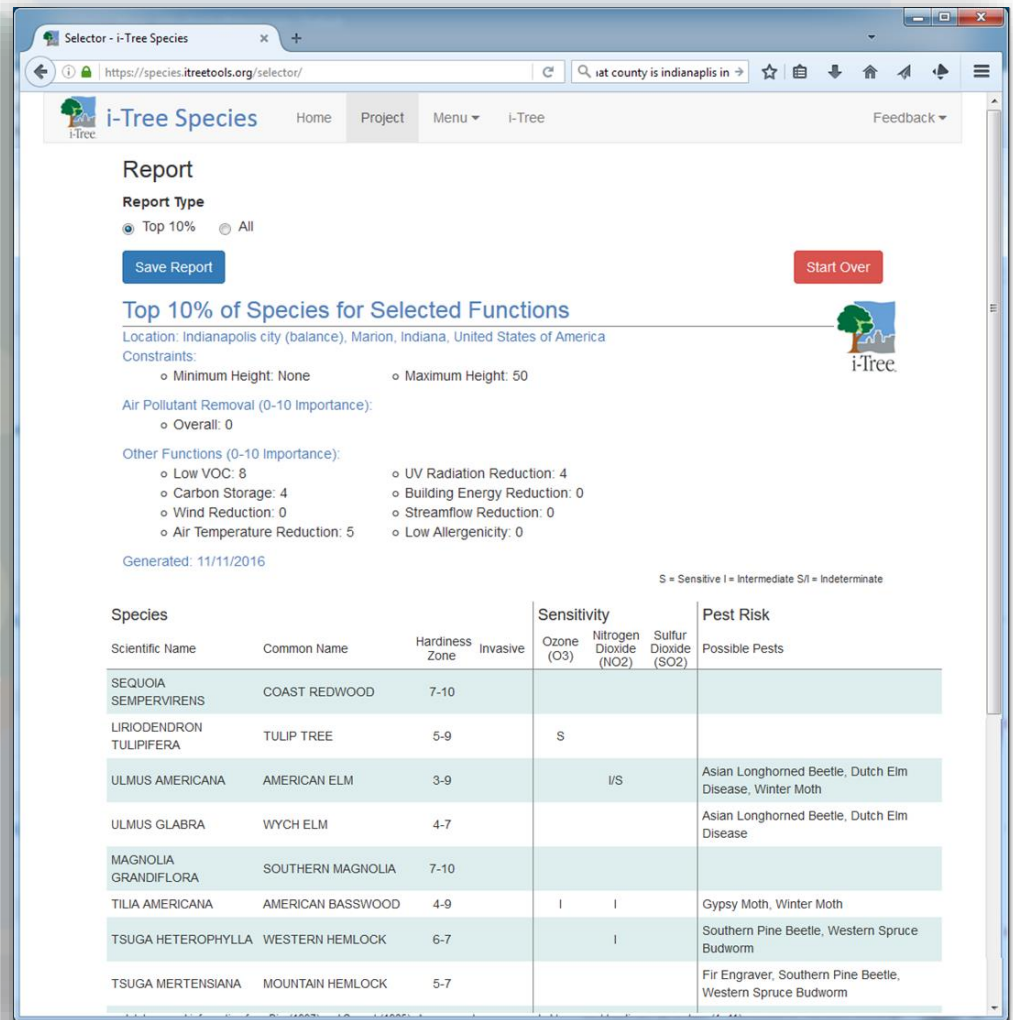
🌳 Web version replaces previous desktop version
  ➤ And ready for Mobile – smartphone or tablet!

🌳 New features
  ➤ Hardiness zones
  ➤ Pest / Host
  ➤ Invasive designation
  ➤ Bug fixes!

www.species.itreetools.org

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Additional i-Tree learning resources

www.itreetools.org

- Videos

- Documentation

- Online tools

- Newsletter

- Support

- Examples

- Downloads

info@itreetools.org or al.zelaya@davey.com

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