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# Latrobe Prize
## Growing Energy/Water: using the grid to get off the grid

**Final Report**
January 31, 2011

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## Growing Energy/Water: using the grid to get off the grid

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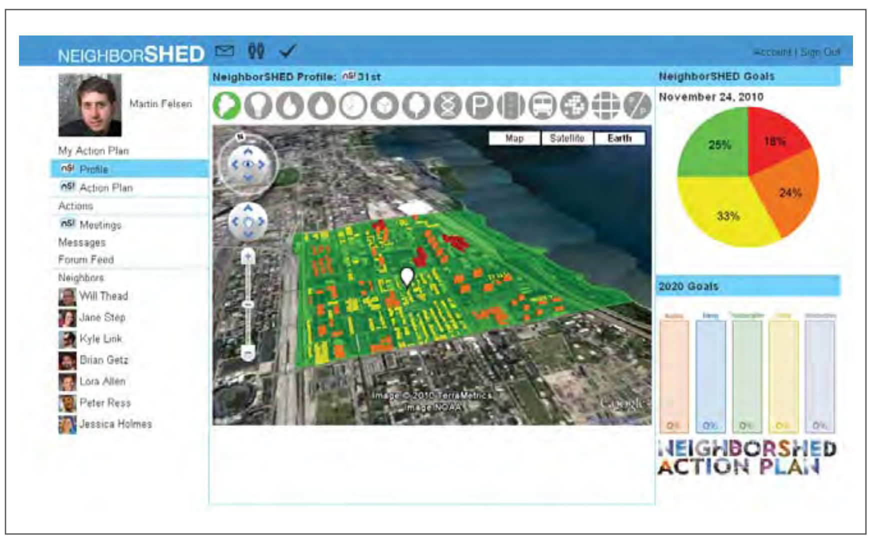
### Research Summary
It is becoming clear that our cities and lifestyles have become unsustainable and that fossil fuel consumption (coupled with global climate change) and water scarcity are threatening to cause great economic and environmental damage to the world. Any solution to this problem will need to include a collective effort by all of us to reduce the amount of energy and water we are using in our lives.

The Growing Energy/Water research project is an effort to develop a tool that makes it simpler for individuals and local governments to work together to reduce environmental impacts associated with energy and water consumption. To this end, the Growing Energy/Water team created a web tool named NeighborSHED, which is a free online web resource to quantify, track, compare and understand the total amount of energy and water needed to support all of the facets of an individual's (and neighborhood's) lifestyle. The objective of the NeighborSHED tool is to help individuals and local governments better understand ways to save energy and water, discover steps needed to help solve climate change, report progress on actions taken, save money, and improve our overall health by conserving valuable natural resources.

### What is a NeighborSHED
A NeighborSHED is an urban neighborhood that is specially designed to manage wastewater and stormwater, mitigate energy use for heating & cooling, produce electricity, manage organic waste & sewage, produce local fresh food, increase the diversity of species that thrive in an urban habitat, provide public (or alternative forms of) transportation, and create green jobs.




NeighborSHED.com

### How the NeighborSHED Tool Works
The NeighborSHED web-based tool allows citizens of local governments to individually engage climate action plans such as the Chicago Climate Action Plan. With NeighborSHED's profile builder, individuals can easily get started by answering a few questions about their buildings (and property), and local governments can get started by answering a few questions about their infrastructure. By examining a few key areas of energy and water use, the profile builder helps individuals understand their baseline usage of power (in watts), water (in gallons) and green house gasses (in metric tons). After individuals sign up and get started, they can identify where (by street address) and how they consume power and

water, then run visualizations showing the magnitude of their energy and water usage, and carbon footprints. Municipal officials can also easily get started by answering a few questions about the buildings and infrastructure their city owns and manages, and also run visualizations showing the magnitude of energy and water usage, and resulting carbon footprints. All inputted information is saved for further use anytime.

After an individual or municipal official calculates their power/water/carbon footprints, the NeighborSHED tool suggests actions that can be taken to benefit from financial incentives and savings related to power/water/carbon mitigation strategies. The NeighborSHED tool reports progress toward reducing environmental impacts (via shared geo-coded Google Earth maps), and allows individuals to connect with people in their neighborhood who are also taking (or interested to take) action to save power, water or green house gas emissions. Through Wikipedia-like data editing, NeighborSHED is looking for people to enter data from their own experiences to help us all understand how we can save energy, water and dollars in our lives.

**NeighborSHED Tool and Climate Action Plans**

The NeighborSHED tool is designed to complement existing Climate Action Plans. Beyond helping to solve a global climate problem, the NeighborSHED tool aligns individual goals to reduce environmental impacts (and save money) with a community's goals of benefiting from reducing green house gas emissions. One result of meeting the specific goals of climate action plans will be better air quality, leading to improved health for everyone. Raising the energy efficiency of buildings saves money, lowers housing costs for families and creates jobs, especially for local economies.

More than 30 states representing two-thirds of the nation's population have implemented or are developing their own climate action plans. Many cities, and more than 300 universities in all 50 U.S. states and eight Canadian provinces have drafted and started acting on climate action plans.

A key goal of the Growing Energy/Water research project is to work with states, cities and universities that have written climate action plans. The NeighborSHED tool engages networks of individuals to help them achieve their (and their community's) goals of reducing climate altering emissions, saving natural resources, and realizing associated financial savings.


NeighborSHED.com

SECTION 02: **Project Abstract**

**Project Summary**

The Growing Energy/Water Team has built a metrically-based predictive model to give individuals, policy and decision makers, and the professional design community the validated information they require to transform the public-way infrastructural grid from a thin grey surface into a thick three-dimensional green-blue architectural matrix. The goal of the research is to change the ways the public-way urban grid is conceptualized and constructed in order to ultimately (1) reduce our reliance on non-renewable, non-local energy, (2) sustain water resources, and (3) contribute to our overall health, financial sustainability and quality of life in cities.

**Blue/Green Infrastructure Model: NeighborSHED.com**

The Model, or “Calculator” is a tool for comparing the performance, costs, and benefits of Blue/Green Infrastructure to conventional “grey infrastructure” practices. The Calculator enables end-users to (virtually, via the web) navigate through a step-by-step process of determining a host of Blue/Green Infrastructure cost-benefit valuation methods within a “NeighborSHED.” A NeighborSHED is an urban neighborhood that is designed to manage wastewater and stormwater, mitigate energy use for heating & cooling, produce electricity, manage organic waste & sewage, produce local fresh food, increase the diversity of species that thrive in an urban habitat, provide public (or alternative forms of) transportation, and create green jobs. The NeighborSHED model is a web-based tool (website) that closely follows urban climate action plans such as the Chicago Climate Action Plan.

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SECTION 03: **Defining a NeighborSHED**

A **NeighborSHED** is an urban neighborhood that is designed to manage wastewater and stormwater, mitigate energy use for heating & cooling, produce electricity, manage organic waste & sewage, produce local fresh food, increase the diversity of species that thrive in an urban habitat, provide public (or alternative forms of) transportation, and create green jobs.

The NeighborSHED concept is a comprehensive strategy to accelerate sustainable development at the sub-neighborhood scale by integrating building and infrastructure projects with community and individual action.

A NeighborSHED is a 20-minute walking district for achieving ambitious sustainability performance goals over time. The process includes engaging community members with the web-based calculator under development in this research project, which will allow a community member to complete an integrated sustainability assessment and action plan of their community and individual property (and lifestyle); and; track and monitor results of queries via the web over time.

The technologies and strategies for achieving ambitious sustainability performance goals, such as district energy systems, green streets, mixed-use development, education, and demand management, are well-known. However, the widespread deployment of these strategies has been slow to develop due to the lack of an implementation framework (or comprehensive policy) at the municipal level.

The NeighborSHED initiative focuses on helping remove these implementation barriers and creating an enabling strategy and tool to accelerate neighborhood-scale sustainability. Ultimate success will require -- in addition to a holistic approach that includes this comprehensive assessment tool -- active citizen engagement and governance, new forms of project and infrastructure capital, and public policy support.

**NeighborSHED Methodology**

Our methodology defines benefits that accrue within a set of common Green/Blue Infrastructure practices: tree planting, alternative renewable energy strategies, water harvesting, and green roofs, etc. Each practice suggests metrics of input units as the basis for benefit calculations, explores variables that affect the accumulation of benefits, and scales at which the benefit occurs. We are exploring the relationship between input units of green infrastructure practice with resource units representing the value of individual benefits.

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Categories of functions, costs and benefits are divided into:

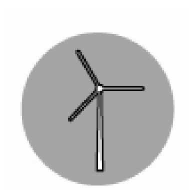
- Carbon Footprint
- Electricity Consumption
- Natural Gas Consumption
- Water Consumption
- Age of Buildings
- Volume of Buildings
- Tree Cover
- Parking Surfaces
- Transportation
- Land Use
- Public / Private Ownership

Each of these metrics is connected via databases to a web-based NeighborSHED model (see SECTION 06 for a more detailed analysis of metrics).

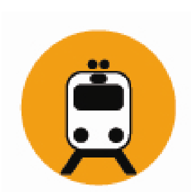
**Blue/Green Infrastructure Practices and Valuation Methodologies (Six Layers)**

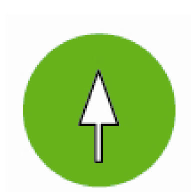
The overall planning and design framework explored in this research project is based on six interdependent systems that describe the social, circulatory, metabolic, biologic, hydrologic, and geologic functions of blue/green infrastructure in the city. Resources associated with each function, including measures of performance as a framework for a NeighborSHED, are collected for the six:


1.Social


2.Metabolic


3.Hydrologic


4.Circulatory


5.Biologic


6.Geologic

1. ***Social System***

Assets: Exterior habitat for people.

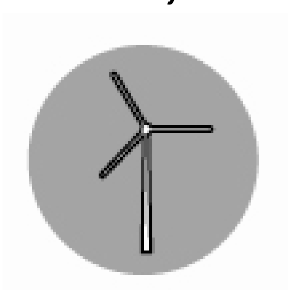
*Social Functions*

Interaction, recreation, cultural expression, commerce, community-building, social cohesion, inclusion.

*Social Performance and Valuation Metrics*

The diversity of exterior activities people desire and value; increased in social cohesion, connectivity and sense of community; psychological development and well being; increase in adjacent property values and rental rates; increased health such as lowering levels of obesity; promotion of a more active and less sedentary population; reduction of community violence.

2. ***Metabolic System***



Assets: Energy or flows related to power supply, food supply, and waste disposal.

*Metabolic Functions*

Energy production, material production, food production, recycling and reuse.

*Metabolic Performance and Valuation Metrics*

Climate impact, carbon footprint, recycling rates, sequestration of water/carbon, and improvement of air quality.

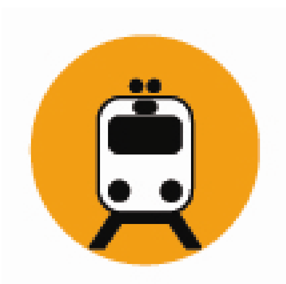
3. ***Hydrologic System***

Assets: Water and stormwater management, and sustainable stormwater design strategies.

*Hydrologic Functions*
Flow control, water quality, groundwater and surface water recharge, water reuse.

*Hydrologic Performance and Valuation Metrics*
Amount of water sequestered/retained/detained; cost savings over conventional grey infrastructure; amount of pervious surface; pollution abatement/removal; hydrologic connectivity at all scales.

4. ***Circulatory System***

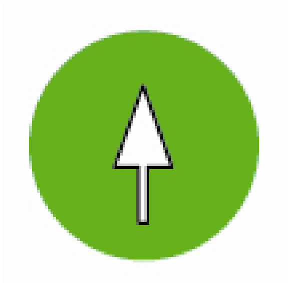


Assets: Elements that connect our communities and move people and goods into, out of, and around the region. The circulatory system is inextricably linked to land use planning (zoning and development controls), as well as impacting human health through air/water quality and fitness.

*Circulatory Functions*
Pedestrian mobility, bicycle mobility, transport of goods.

*Circulatory Performance and Valuation Metrics*
Connectivity; percentage of people getting around without a car; public health benefits due to increased non-motorized alternative mobility, reduction of carbon footprint; health care cost reductions; pollutant removal.

5. ***Biologic System***



Assets: Plant, vegetation and the elements/areas of a green/blue infrastructure network preserved or designed primarily for their benefits to wildlife and biodiversity.

*Biologic Functions*
Photosynthesis, wildlife habitat, habitat connectivity, climate moderation, ecosystem restoration.

*Biologic Performance and Valuation Metrics*
Habitat connectivity; biodiversity; edge to interior ratio; vertical diversity of parcels; inventory of species.

6. ***Geologic System***

Assets: Dynamics and physical history of the earth, the rocks of which it is composed, and the physical, chemical, and biological changes that the earth has undergone or is undergoing.

*Geologic Functions*
Erosion control; substrate creation; soil formation; natural hazard mitigation.

*Geologic Performance and Valuation Metrics*
Soils quality; land/stream degradation; land modification (especially related to slope, pitch, channelization changes of areas/regions).

SECTION 04: **Collaborating with the City of Chicago on NeighborSHED**

The Growing Energy/Water Team continues to work closely with the City of Chicago Department of Environment (CDOE). The NeighborSHED model under development will be used by the CDOE as a tool to connect to and engage residents in the Chicago Climate Action Plan. The NeighborSHED model will allow residents to investigate, plan and report climate/energy/water actions taken at home. The NeighborSHED model also allows residents to understand financial incentives and savings related to climate/energy/water actions taken at home. The City of Chicago NeighborSHED model will be complete in the summer of 2011.

Beyond helping to solve a global climate problem, residents can immediately benefit from their individual efforts to reduce emissions. One result will be better air quality, leading to improved health for everyone. Raising the energy efficiency of buildings saves money, lowers housing costs for families and creates jobs, especially for local businesses. Economic development gets a boost. As people are able to live closer to work, schools and services, they enjoy a better quality of life.

The NeighborSHED model can also be used by city (of Chicago in the case) leaders to investigate, plan and report climate/energy/water actions taken in communities and neighborhoods. The NeighborSHED model is constructed to allow either user (city official or city resident) to input data, retrieve information and report on actions taken.

The NeighborSHED model is organized in five sections (or strategies) available in the Chicago Climate Action Plan, each can be summarized as:

**Energy Efficient Buildings:**
New and retrofit residential buildings, trade in appliances, conserve water.

**Clean and Renewable Energy Sources:**
Promote household renewable power.

**Improved Transportation Options:**
Make walking/biking infrastructure, car share can carpool.

**Reduced Waste and Industrial Pollution:**
Reduce, reuse and recycle; capture stormwater on-site.

**Adaptation:**
Preserve plants and trees, increase urban bio-mass, and engage public.

The Chicago Climate Action Plan is similar to many other city and institutional (universities and large corporations) action plans, so we believe the decision to directly reflect the Chicago Climate Action Plan in the NeighborSHED model makes sense for scalability of the model (bring the model to many other cities). The Chicago Climate Action Plan includes multi-year goals – such as goals for 2020, 2040, etc.—so the NeighborSHED model works within these metrics and parameters. In more detail, the five Chicago Climate Action Plan strategies to reduce green house gasses include (for more information see: http://www.chicagoclimateaction.org):

**Energy Efficient Buildings**

Buildings account for approximately 70 percent of all the city emissions and are the primary target for our reductions. Key opportunities here are improving the energy efficiency of residential, commercial, and industrial buildings.

Many small changes in how motivated individuals use energy can add up to big emissions reductions. It can be as easy as turning off the lights and appliances when not needed, dialing down the thermostat at night or turning off the tap when brushing your teeth. If half of all city residents took easy, low-cost steps like these -- and half of all managers of commercial businesses take similar steps -- they would each reduce their emissions by one metric ton of CO2e.

MITIGATION STRATEGIES FOR 2020

1. Retrofit Commercial and Industrial Buildings

Retrofit 50 percent of commercial and industrial building stock, resulting in a 30 percent energy reduction = 1.3 MMTCO2e reduction*

2. Retrofit Residential Buildings

Improve efficiency of 50 percent of residential buildings to achieve a 30 percent reduction in energy used = 1.44 MMTCO2e reduction*

3. Trade in Appliances

Expand appliance trade-in and light bulb replacement programs = .28 MMTCO2e reduction*

4. Conserve Water

Improve water use efficiency in buildings as part of retrofits = .04 MMTCO2e reduction*

5. Update City Energy Code

Align Chicago’s Energy Conservation Code with the latest international standards = 1.13 MMTCO2e reduction*

6. Establish New Guidelines for Renovations

Require all building renovations to meet green standards = .31 MMTCO2e reduction*

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7. Cool with Trees and Green Roofs

Increase rooftop gardens to a total of 6,000 buildings citywide and plant an estimated 1 million trees = .17 MMTCO2e reduction*

8. Take Easy Steps

Encourage all Chicagoans to take easy steps to reduce their emissions by one metric ton of CO2e per person = .8 MMTCO2e reduction*

*MMTCO2e (million metric tons carbon dioxide equivalent) is the term for the quantity of any greenhouse gas, including carbon dioxide, methane and others, translated CO2 by weighing it by its relative global warming potential. A reduction of 1 MMTCO2e is equivalent to removing nearly 185,000 cars from the road.

**Clean & Renewable Energy Sources**

To address climate change, the world must require higher efficiency from existing energy sources and move to cleaner power sources. Chicago homes and businesses receive power purchased from the larger regional grid of Midwest plants, which includes nuclear, coal-fired, natural-gas fired and renewable-generation plants. Some of these are a significant source of C02 emissions, especially those that use coal. Upgrading or repowering the 21 coal plants in the state of Illinois, including two in Chicago, could yield a significant reductions, Chicago's share of which would be 2.5 million metric tons of C02e. Implementation of a cap and trade system will also help achieve this goal.

MITIGATION STRATEGIES

1. Upgrade Power Plants

Upgrade or repower 21 Illinois power plants = 2.5 MMTCO2e reduction*

2. Improve Power Plant Efficiency

Raise efficiency standards for new and existing power generators = 1.04 MMTCO2e reduction*

3. Build Renewable Electricity

Procure enough renewable energy generation for Chicagoans to reduce electricity emissions by 20 percent = 3.0 MMTCO2e reduction*

4. Increase Distributed Generation

Increase efficient power generated onsite using distributed generation and combined heat and power = 1.12 MMTCO2e reduction*

5. Promote Household Renewable Power

Double current household-scale renewable electricity generation = .28 MMTCO2e reduction*

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**Improved Transportation Options**

Every day, Chicagoans travel to a variety of places – they commute to work, drive to the store, go to the doctor, make a trip to the health club, go out for dinner. Currently 21 percent of the city's greenhouse gas emissions are produced by cars, trucks, buses and trains. (This inventory excludes emissions from air travel, an approach that mirrors that of most other cities.) To lower emissions, a high-quality transportation system must include a mix of public transit, bicycling, walking, car sharing, energy-efficient vehicles and the development of transit-oriented neighborhoods. Chicagoans have many places to go, and they need a variety of convenient, energy-efficient ways to get there.

MITIGATION STRATEGIES

1. Invest more in transit

Invest in transit improvements and boost Chicago's transit system ridership by 30 percent = .83 MMTCO2e reduction*

2. Expand Transit Incentives

Provide incentives for transit use, such as pre-tax transit passes = .03 MMTCO2e reduction*

3. Promote Transit-Oriented Development

Encourage development focused on public transit, walking and bicycle use = .63 MMTCO2e reduction*

4. Make Walking and Bicycling Easier

Increase the number of walking and biking trips to one million a year = .01 MMTCO2e reduction*

5. Car Share and Carpool

Boost car sharing, carpooling and vanpooling = .5 MMTCO2e reduction*

6. Improve Fleet Efficiency

Improve the energy efficiency of fleets in Chicago, including buses, taxis and delivery vehicles = .21 MMTCO2e reduction*

7. Achieve Higher Fuel Efficiency Standards

Advocate for the implementation of higher federal fuel efficiency standards = .51 MMTCO2 reduction*

8. Switch to Cleaner Fuels

Increase the supply and use of sustainable alternative fuels to Chicago vehicles = .68 MMTCO2e reduction*

9. Support Intercity Rail

Support intercity high-speed passenger rail plan

10. Improve Freight Movement

Faster, more efficient freight movement, including support for CREATE = 1.61 MMTCO2e reduction*

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**Reduced Waste & Industrial Pollution**

Few Chicagoans ever see where the city's waste goes, yet an estimated 3.4 million tons of our waste (62 percent of Chicago's total waste) winds up in landfills every year. We must reduce the amount of waste sent to landfills.

A "Three R" initiative – reduce, reuse and recycle – is one way to achieve this goal. It is essential that both individuals and businesses join in the effort, and there are many opportunities to do so. The payoff will be significant: a 90 percent reduction in waste trucked to landfills by the year 2020 could net about a .84 MMTCO2e drop in emissions.

MITIGATION STRATEGIES

1. Reduce, Reuse or Recycle

Reduce, reuse and recycle 90 percent of the city's waste by 2020 = .84 MMTCO2e reduction*

2. Shift to Alternative Refrigerants

Promote use of alternative refrigerants in air conditioners and appliances = 1.16 MMTCO2e reduction*

3. Capture Stormwater on Site

Manage stormwater with green infrastructure = .1 MMTCO2e reduction*

*MMTCO2e (million metric tons carbon dioxide equivalent) is the term for the quantity of any greenhouse gas, including carbon dioxide, methane and others, translated CO2 by weighing it by its relative global warming potential. A reduction of 1 MMTCO2e is equivalent to removing nearly 185,000 cars from the road.

**Adaptation Strategies**

1. Manage Heat

Update the heat response plan, focusing on vulnerable populations; complete furhter research into urban heat island effect and pursue ways to cool hot spots.

2. Pursue Innovative Cooling

Launch an effort to seek out innovative ideas for cooling the city and encourage property owners to make green landscape and energy efficiency improvements.

3. Protect Air Quality

Intensify efforts to reduce ozone-precursors through mitigation programs that reduce driving and emissions from power plants.

4. Mange Stormwater

Collaborate with the Metropolitan Water Reclamation District on Chicago watershed plan that factors into climate change and uses vacant land to manage stormwater.

5. Implement Green Urban Design

Implement key steps in Chicago's' Green Urban Design plan to manage heat and flooding. These steps will enable Chicago to capture rain where it falls and reflect away some of the intensity of the sun on hot days.

6. Preserve Plants and Trees

Publish a new plant growing list that focuses on plants that can thrive on altered climate. Also draft a new landscape ordinance to accommodate plants that can tolerate the altered climate.

7. Engage the Public

Share climate research findings with groups most affected – social service agencies, garden clubs, etc. Help individual households to take their own steps to reduce flooding and manage heat waves, such as installing rain barrels and back-up power for sump pumps and planting shade trees.

8. Engage Businesses

Work with businesses to analyze their vulnerability to climate change and take action.

9. Plan for the Future

Use the Green Steering Committee of City Commissioners to oversee City implementation efforts and the Green Ribbon Committee of business and community leaders to assess how the Plan is being implemented, recommend revisions, report to Mayor and all Chicagoans on progress.

The following PowerPoint presentation was prepared by the City of Chicago Department of Environment in response to the NeighhborSHED website/calculator model.

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SECTION 05: **Taking Action: Energy / Water / Green House Gases / Dollars**

The NeighborSHED website allows residents to investigate, plan and report climate/energy/water actions taken at home. The NeighborSHED model also allows residents to understand financial incentives and savings related to climate/energy/water actions taken at home.

The NeighborSHED model can also be used by city leaders and officials to investigate, plan and report climate/energy/water actions taken in communities and neighborhoods. The NeighborSHED model is constructed to allow either user (city official or city resident) to input data, retrieve information and report on actions taken.

The following "Actions" are available on the NeighborSHED website:

**NeighborSHED Actions**

Building
- Retrofit Commercial and Industrial Buildings
- Retrofit Residential Buildings
- Trade In Appliances
- Update City Energy Code
- New Guidelines for Renovations
- Greenroof
- Tree
- Vine Cover

Energy
- Upgrade Power Plants
- Improve Powerplant Efficiency
- Build Renewable Electricity
- Increase Distributed Generation
- Photovoltaic
- Geo-Thermal
- Wind Energy
- Solar Hot Water

Waste
- Invest more in Transit
- Expand Transit Incentives
- Promote Transit-oriented Development
- Bike Paths
- Pedestrian Paths
- Carshare and carpool
- Improve Fleet Efficiency
- Achieve Higher Fuel Efficiency Standards
- Switch to Cleaner Fuels
- Support Intercity Rail
- Improve Freight Movement

Transportation
- Reduce, Reuse and Recycle
- Shift to Alternative Refrigerants
- Disconnect Downspout
- Flow Through Planter
- Porous Pavement
- Infiltration Planter
- Rain Garden
- Drywell
- Vine Cover

Infrastructure
- Manage Heat
- Pursue Innovative Cooling
- Protect Air Quality
- Manage Stormwater
- Implement Green Urban Design
- Preserve Our Plants and Trees
- Engage the Public
- Engage Business
- Plan for the Future

The following presentation graphically describes the logic and methodology underpinning the NeighborSHED website. Also included are a screenshots of the NeighborSHED website including the interface and Actions (individual and city).

## Latrobe Prize - 2009

# Growing Energy/Water

## using the grid to get off the grid

**Martin Felsen, AIA**, UrbanLab, IIT, Archeworks
**Sarah Dunn**, UrbanLab, UIC, Archeworks

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Douglas Voigt, SOM, Urban Design and Planning
Steve Wise, Center for Neighborhood Technology

Challenge:

# build a tool to help reduce energy + water footprints

we want to...

**get Off-the-Grid**

we want to...

**get On-the-Grid**

we need...

# frameworks for thinking about Climate, Energy, Water, and the Built Environment

we need...

tools to
Measure and Report
progress
we make collectively
(private + public)

Pre-Project

# Eco-Boulevards

Project

# neighborSHED


40%

NY
MN
CH
DC

# If the Great Lakes Basin were its own country...

it would have the **third-largest** economy in the **world**;
only the U.S. and Japanese economies are larger.

1
The United States of America

2
Japan

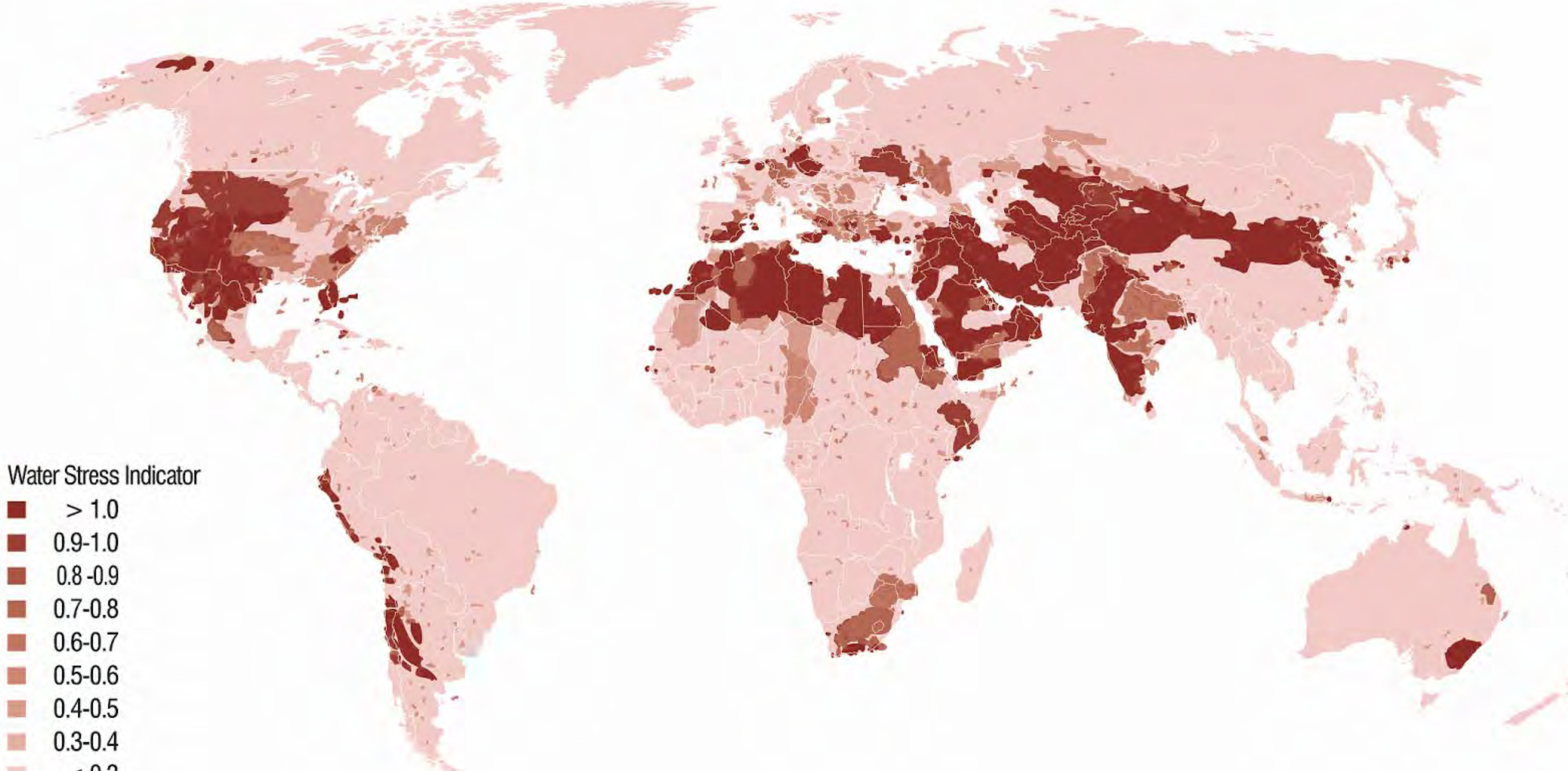
3
Great Lakes Basin

source: Annin, Peter, The Great Lakes Water Wars, 2006

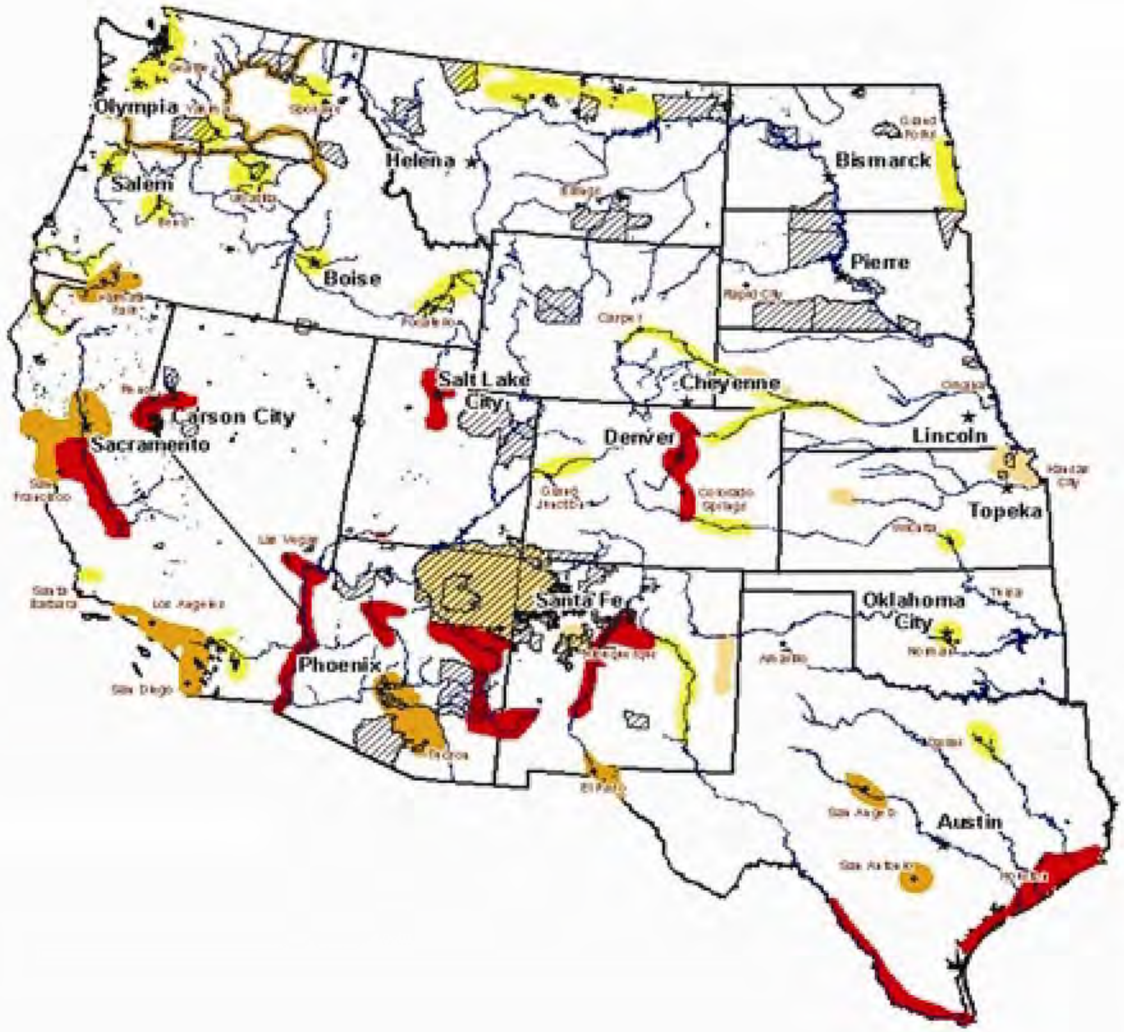
*Fact:*

*"Two out of every three people in the world will be facing water shortages by 2025...*
*global conflict will inevitably result..."*
*- United Nations*

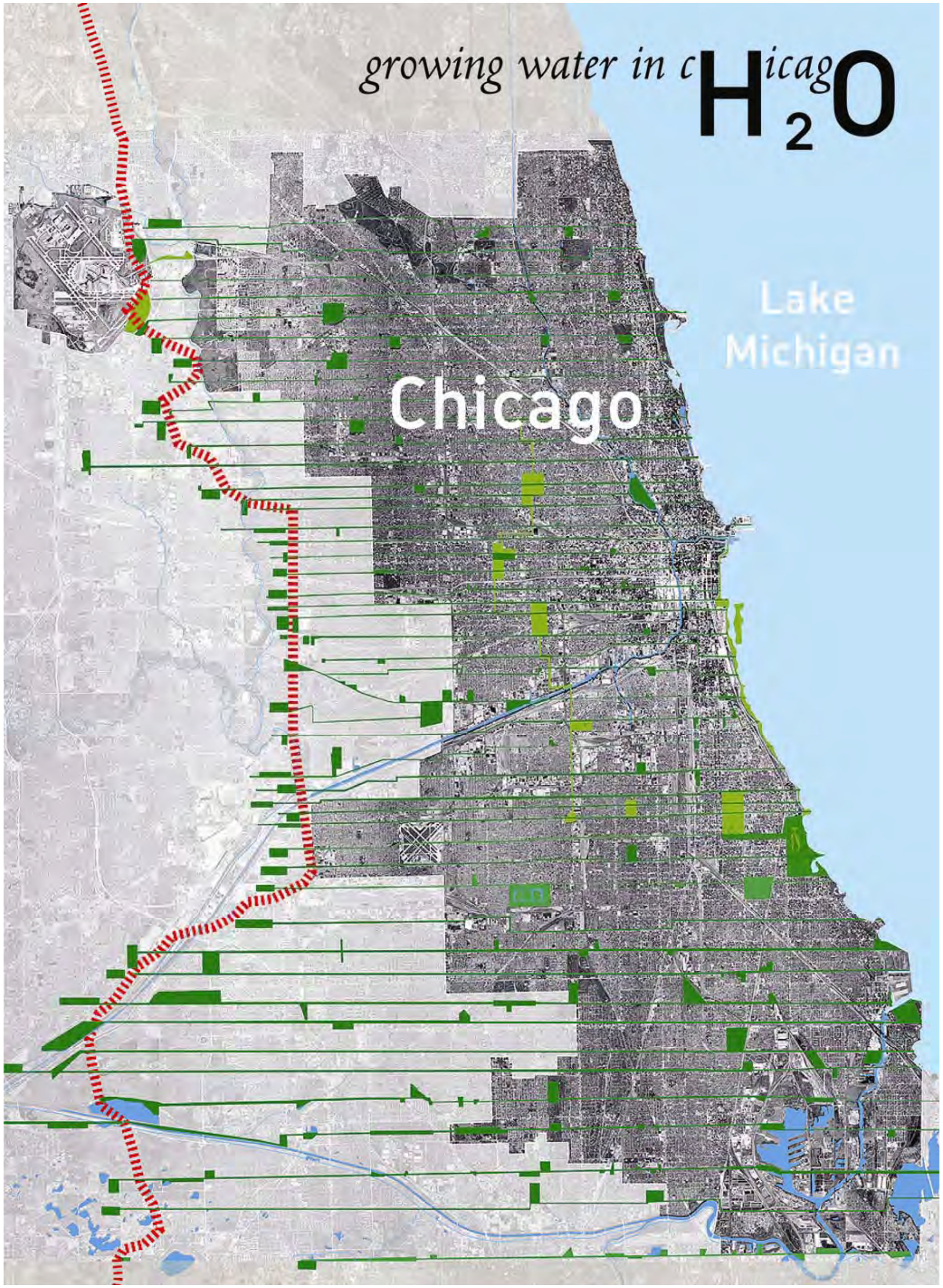
# World Water Availability



# Potential Water Supply Crises by 2025



# Chicago = Model City for growing clean water

*Fact:*

# 20%

*of the Earth's fresh water is on deposit in the Great Lakes*

*Source: Southern Lake Michigan Regional Water Supply Consortium*

*Fact:*

# 95%

*of the United States' fresh water is on deposit in the Great Lakes*

*Source: Southern Lake Michigan Regional Water Supply Consortium*

*Fact:*

# 1,000,000,000

## (billion)

*gallons of Lake water per day are consumed by Chicagoans*

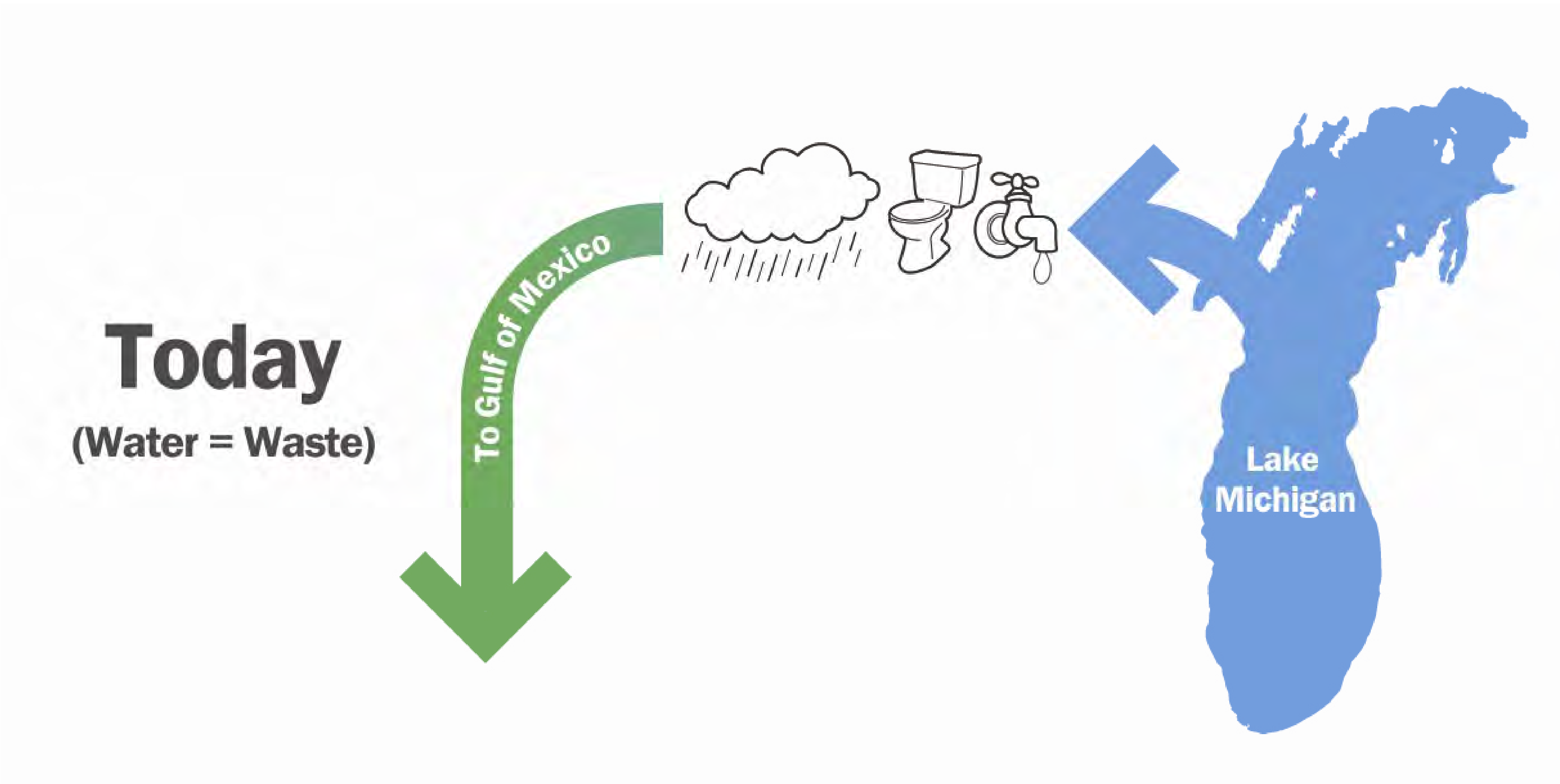
*Source: Water Agenda 2003, City of Chicago*

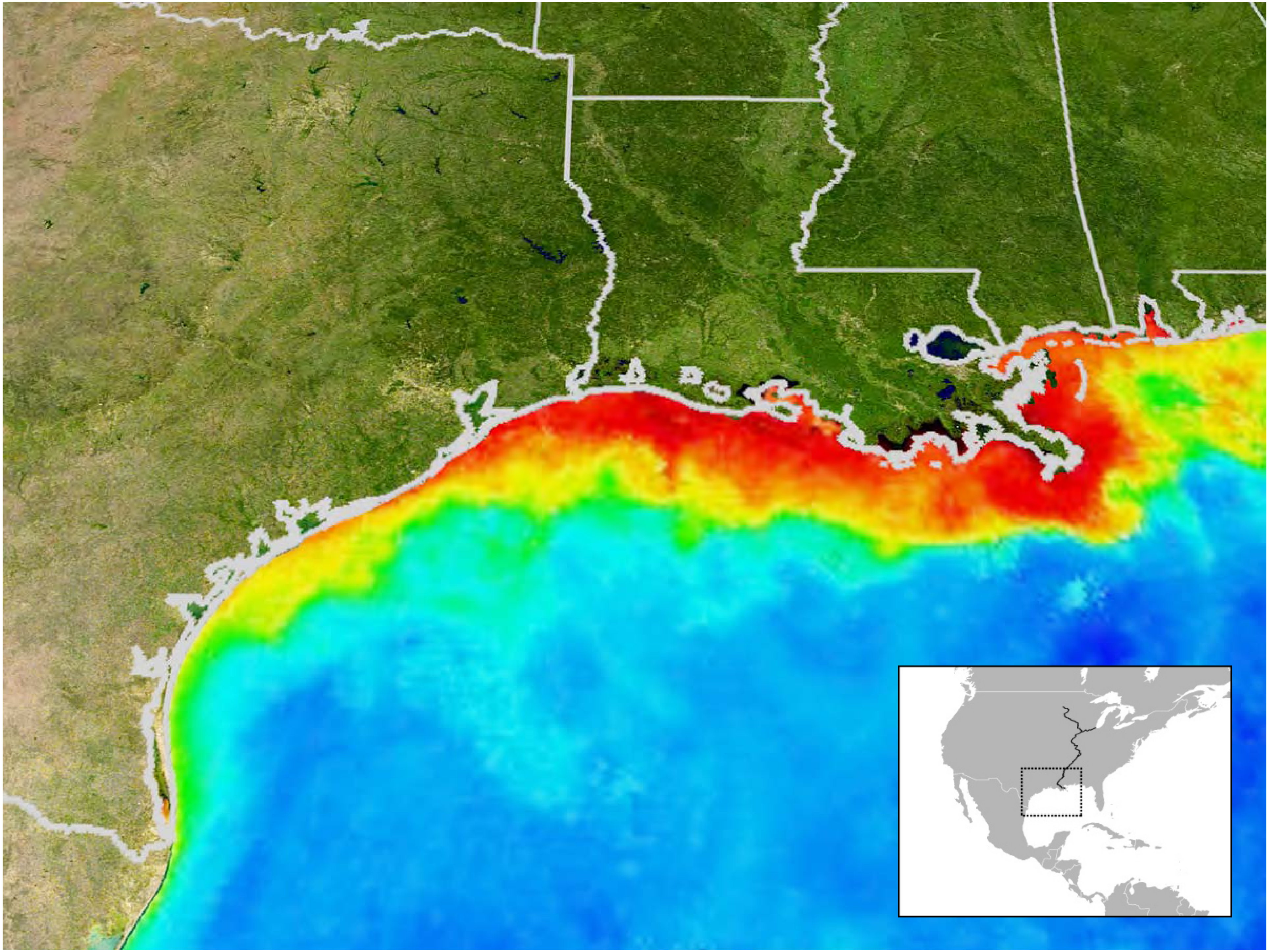
*Fact:*

# <1%

*of drained water*
*is renewed by Chicagoans*

*Source: Water Agenda 2003, City of Chicago*


Today
(Water = Waste)
To Gulf of Mexico
Lake
Michigan



# Largest Inland Water Bodies by Area, 1960

**01** Caspian Sea
Azerbaijan, Russia, Kazakhstan, Turkmenistan, Iran

**02** Huron-Michigan
Canada, U.S

**03** Superior
Canada, U.S

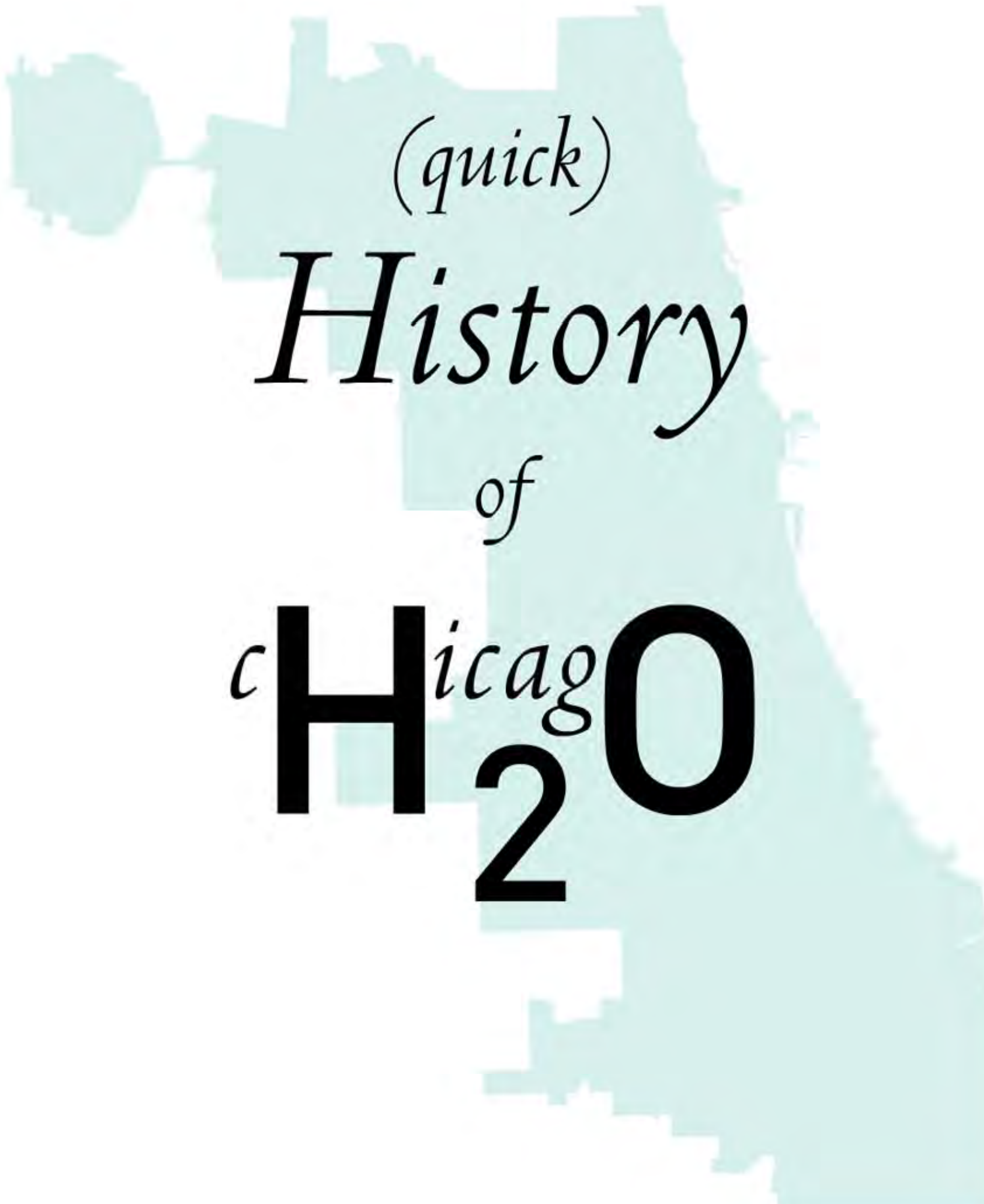
**04** Aral Sea
Kazakhstan, Uzbekistan

**05** Victoria
Kenya, Tanzania, Uganda

# The Changing Shape of the Aral Sea



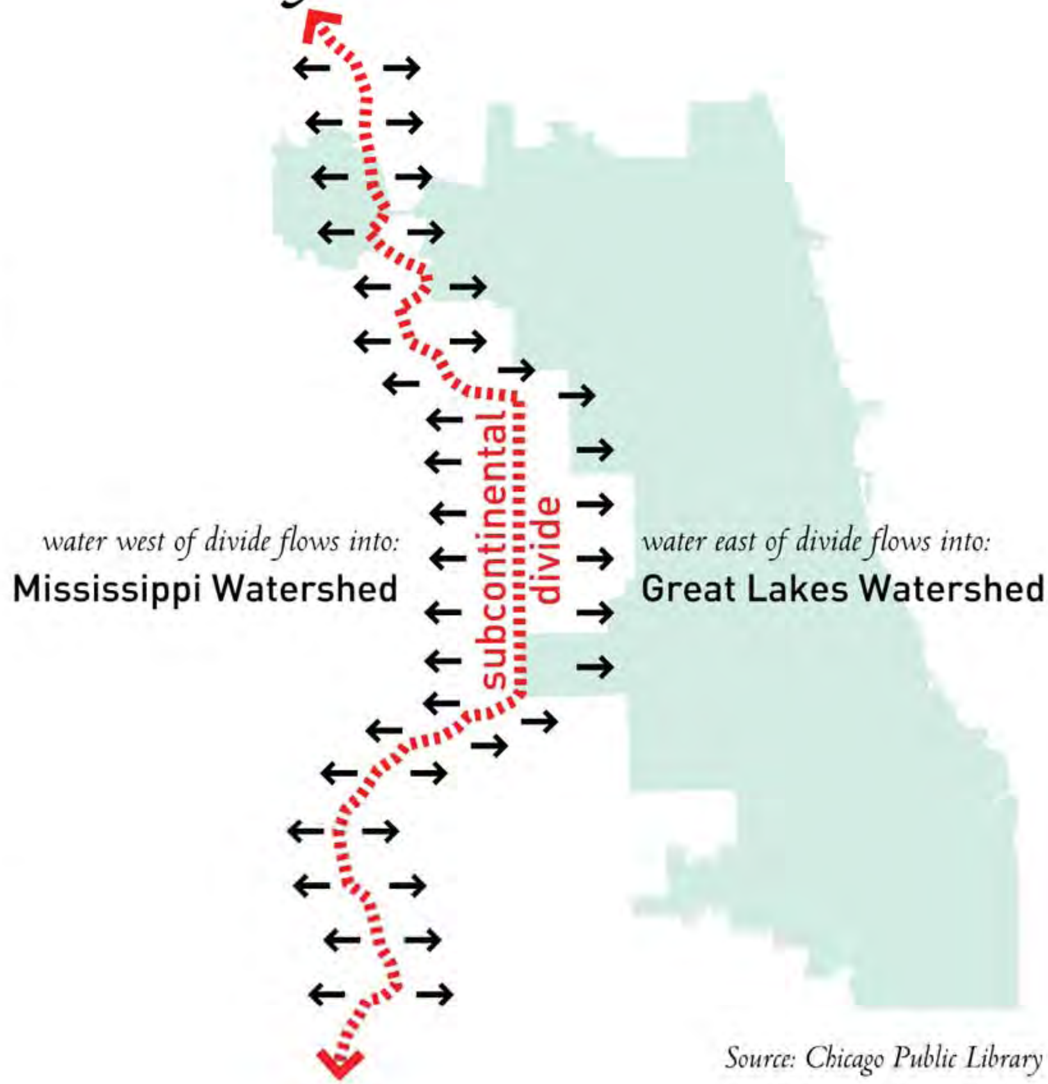
Aral Sea 1989
Aral Sea 2009



# (*quick*) *History* *of* *c*H*icag*$_2$O

# *Chicago, 20,000BC - Today*


North American Subcontinental Divides




*Source: Chicago Public Library*

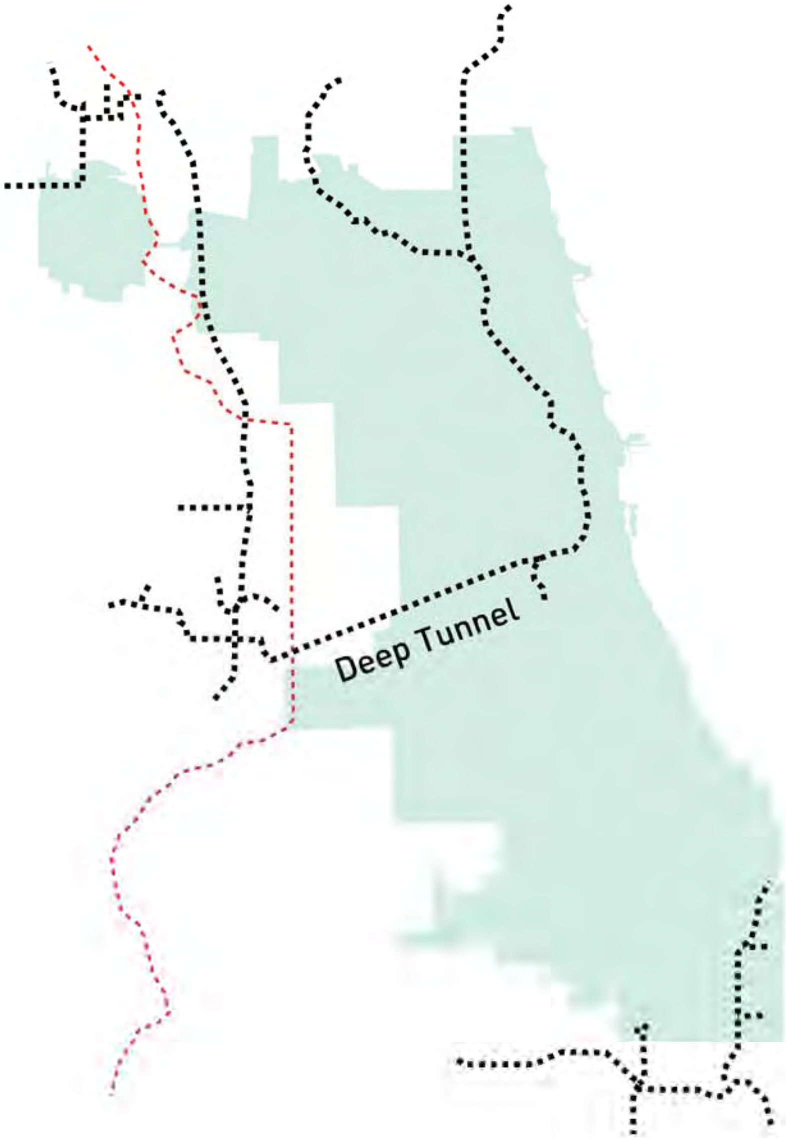
# *Chicago, 1899AD*


An incredible engineering feat of the 19th century reversed the flow of the Chicago River.
The Chicago River is the first river in the world to flow away from its mouth.

A 28-mile canal connects the Chicago River to the Des Plaines River. The river diverts water from the Great Lakes Watershed to the Mississippi Watershed.


*Source: Moses History of Chicago, 1895*

# *Chicago, 2000AD*



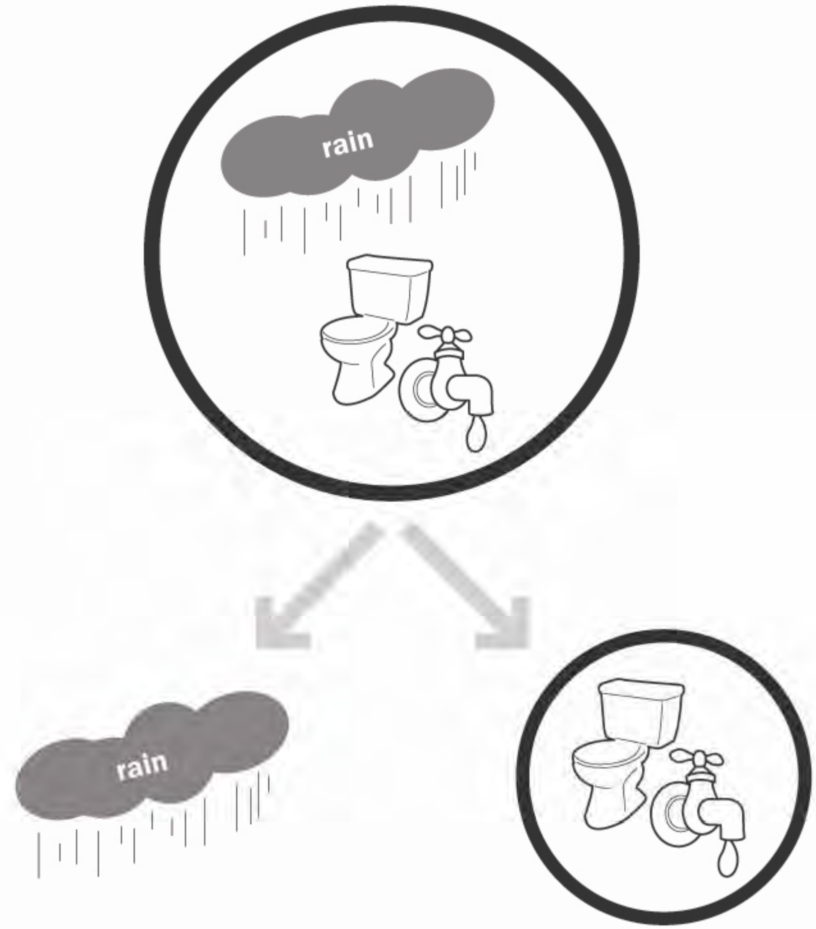

The Deep Tunnel, a 109 mile engineering marvel, "solved" contemporary flooding and water pollution problems by diverting contaminated water to the Mississippi Watershed

The Deep Tunnel intercepts sewer overflow. It conveys overflow to large storage reservoirs and treatment plants before it is routed to the Mississippi.

*Source: Metropolitan District of Greater Chicago*


Stickney, IL

# de-coupling



*Proposal:*

*in 2106, Chicago will be*
*a model city for*

# Growing Clean Water

*the city will become a holistic*

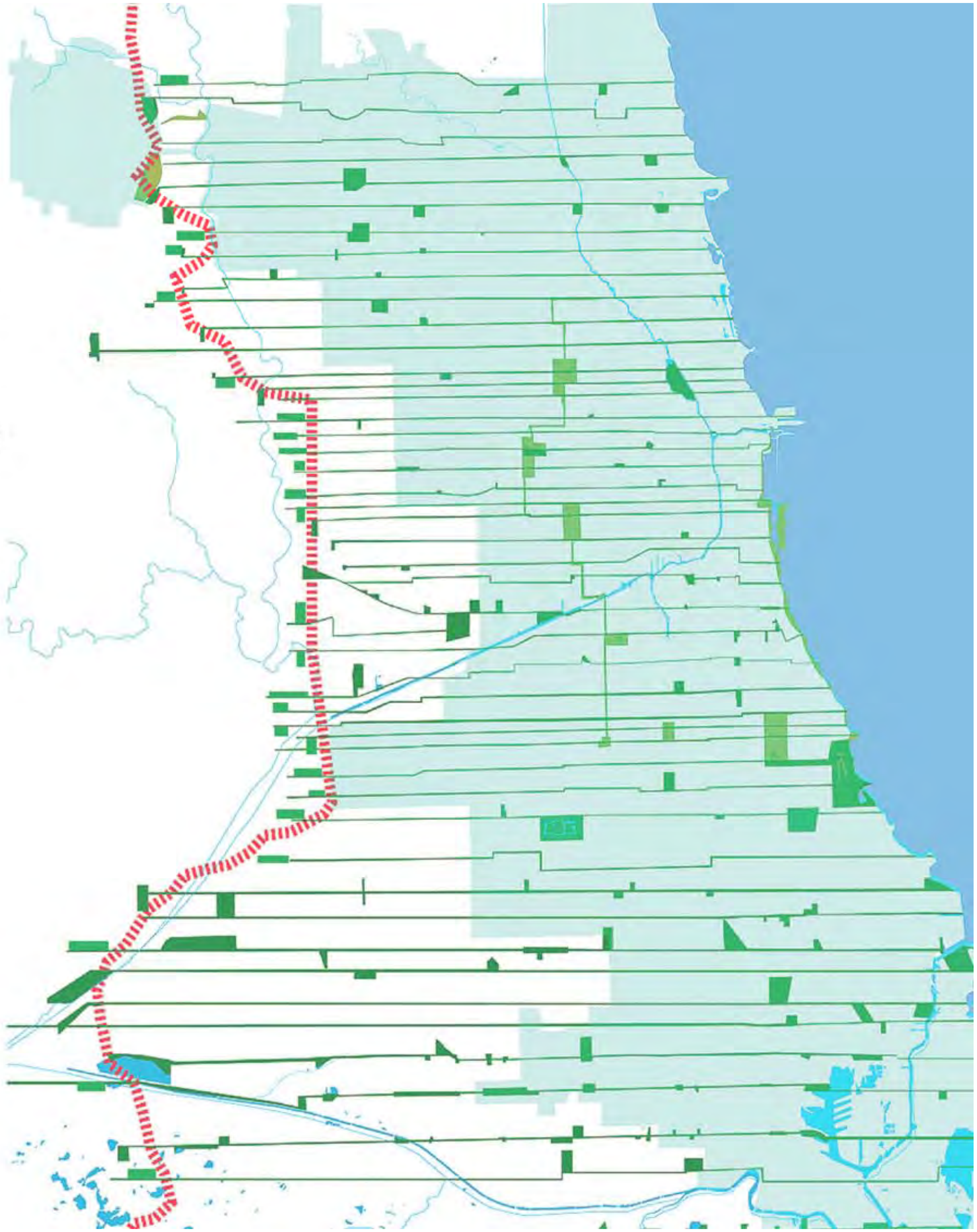
# Living System

*multiplying + intensifiying Chicago's "Emerald Necklace" of parks, boulevards, and waterways;*

*and saving, recycling and "growing"*

## 100%

**of its own water.**

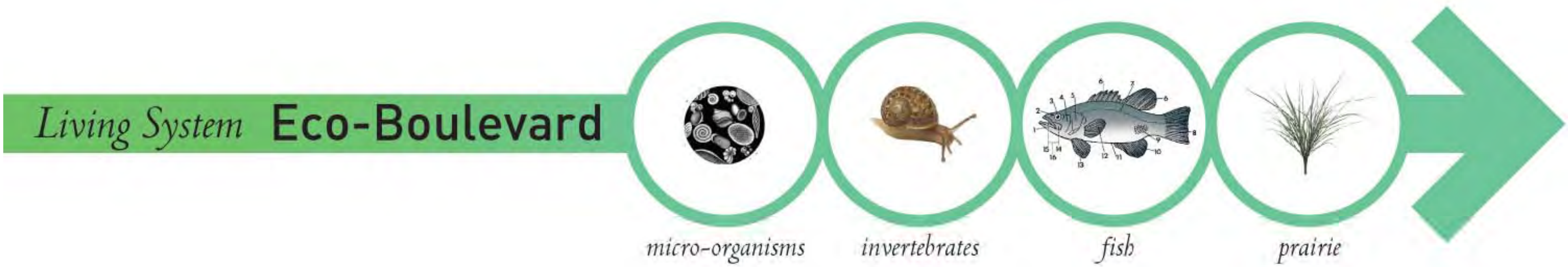


*Chicago as a Living System:*

# How Will It Work?

**As a Living System, Chicago will treat 100% of its wastewater + stormwater naturally, using micro-organisms, small invertebrates (such as snails), fish and plants.**

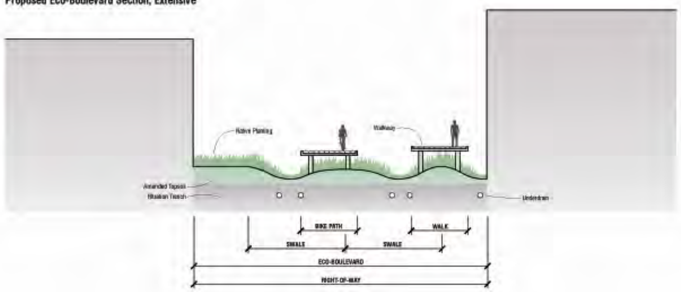
**Treated water will be harvested and/or returned to the Great Lakes Basin.**



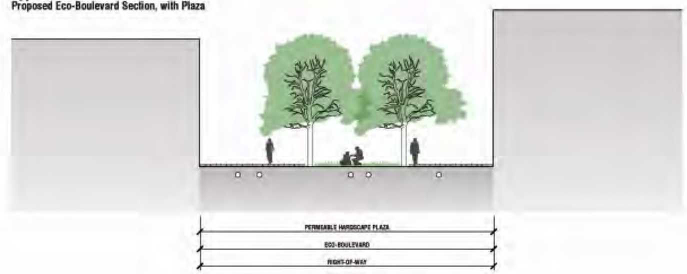
## Design Analysis (For Chicago Department of Transportation)

# Roadway and Sidewalk Sections

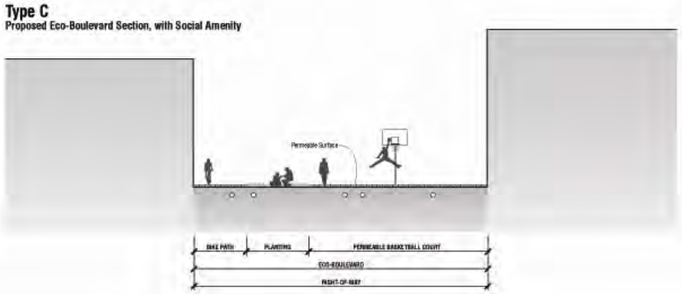
**Type A**
**Proposed Eco-Boulevard Section, Extensive**



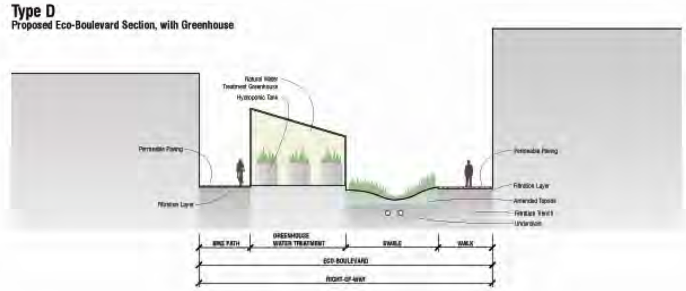

**Type B**
**Proposed Eco-Boulevard Section, with Plaza**



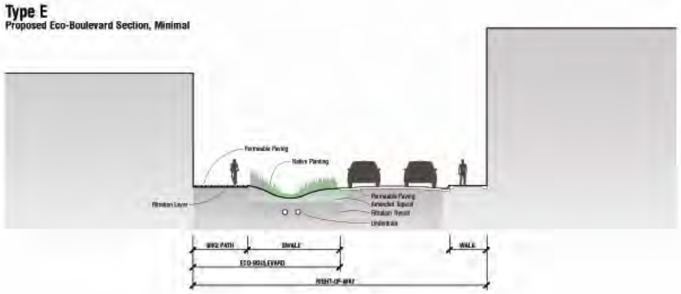

**Type C**
**Proposed Eco-Boulevard Section, with Social Amenity**



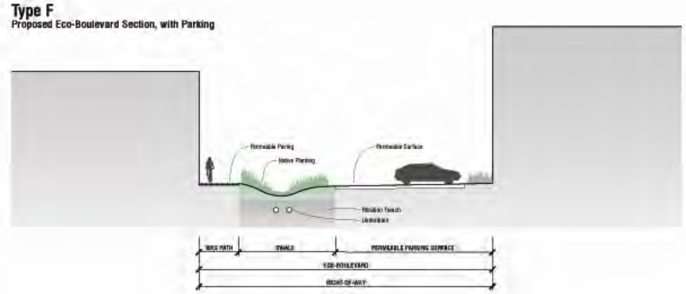

**Type D**
**Proposed Eco-Boulevard Section, with Greenhouse**

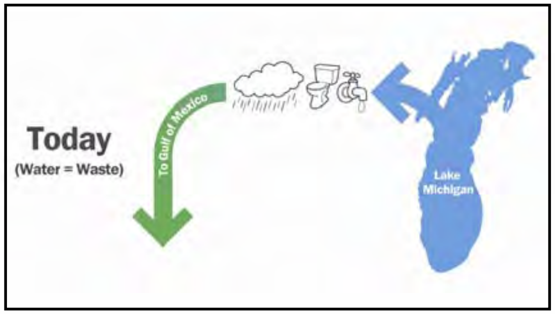



**Type E**
**Proposed Eco-Boulevard Section, Minimal**



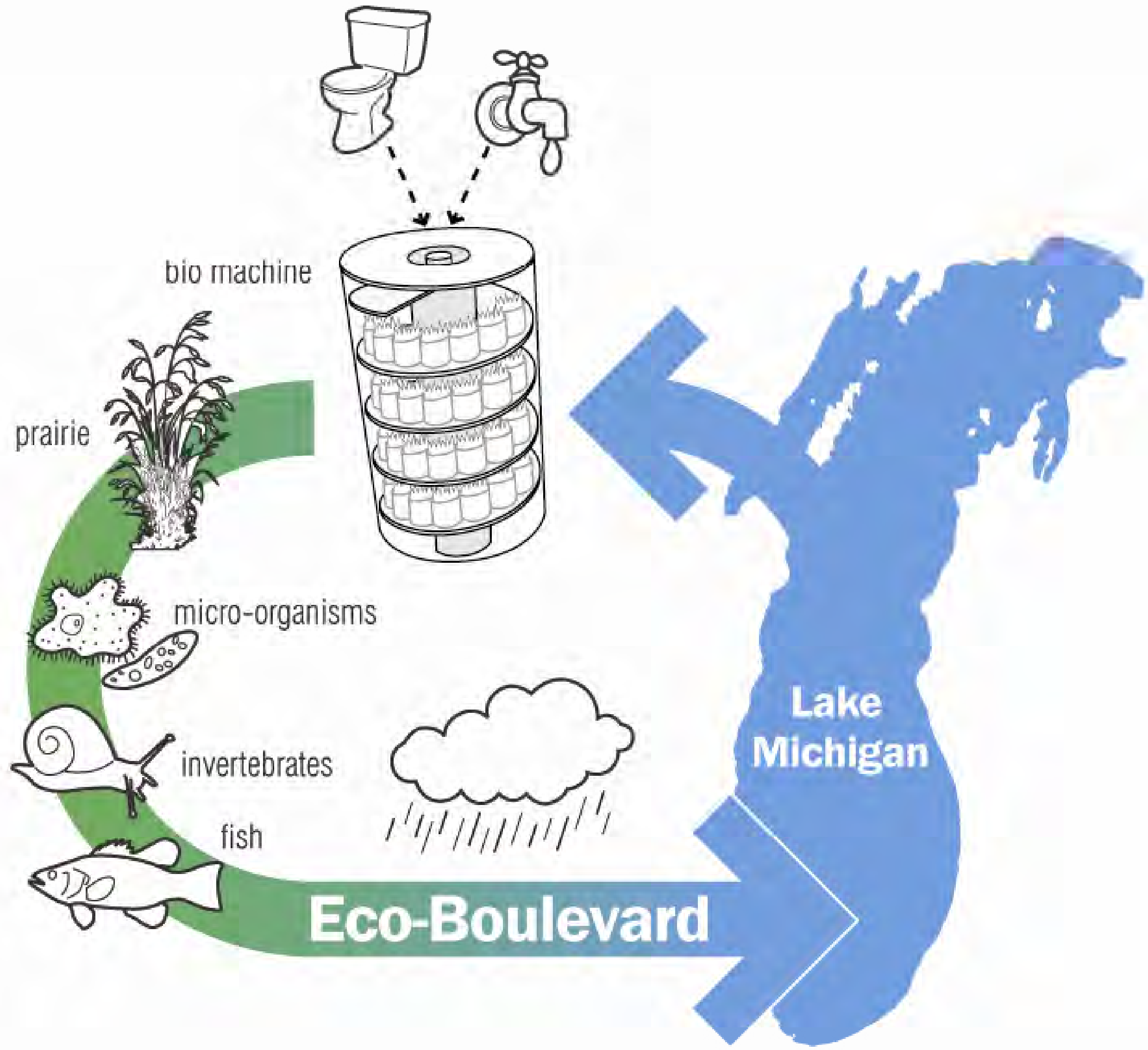

**Type F**
**Proposed Eco-Boulevard Section, with Parking**



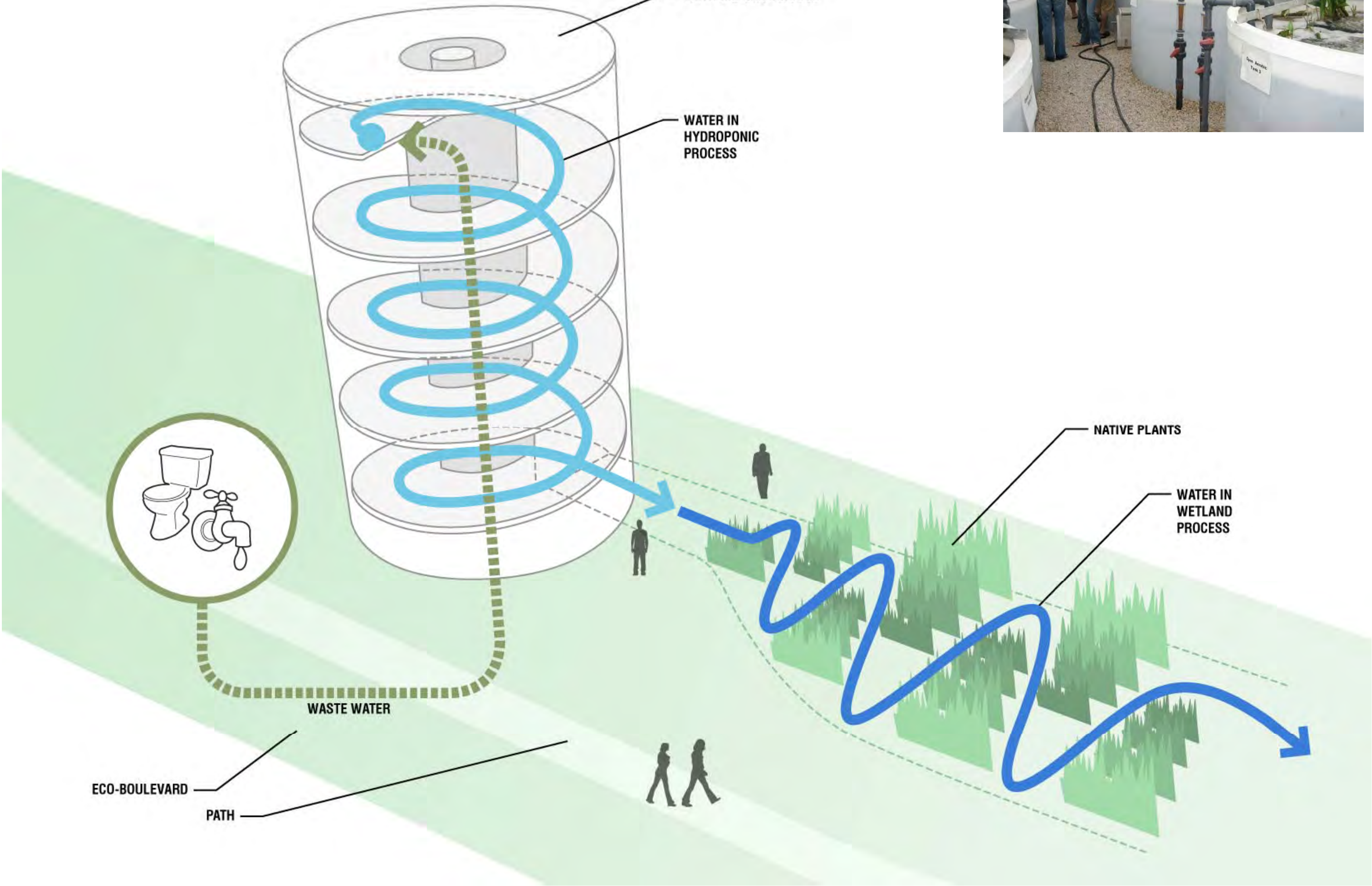



# Tomorrow

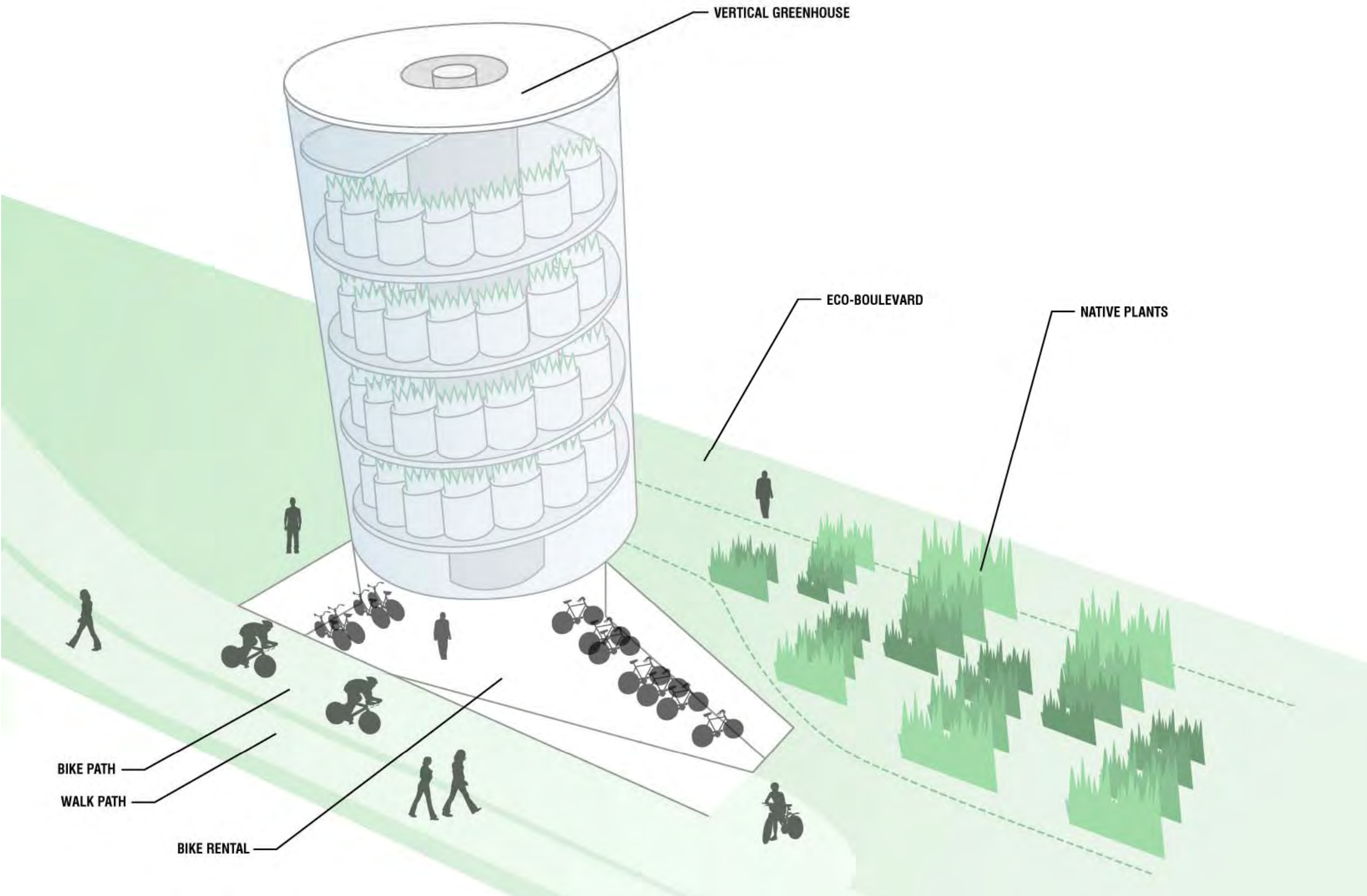
## (Eco-Boulevards)

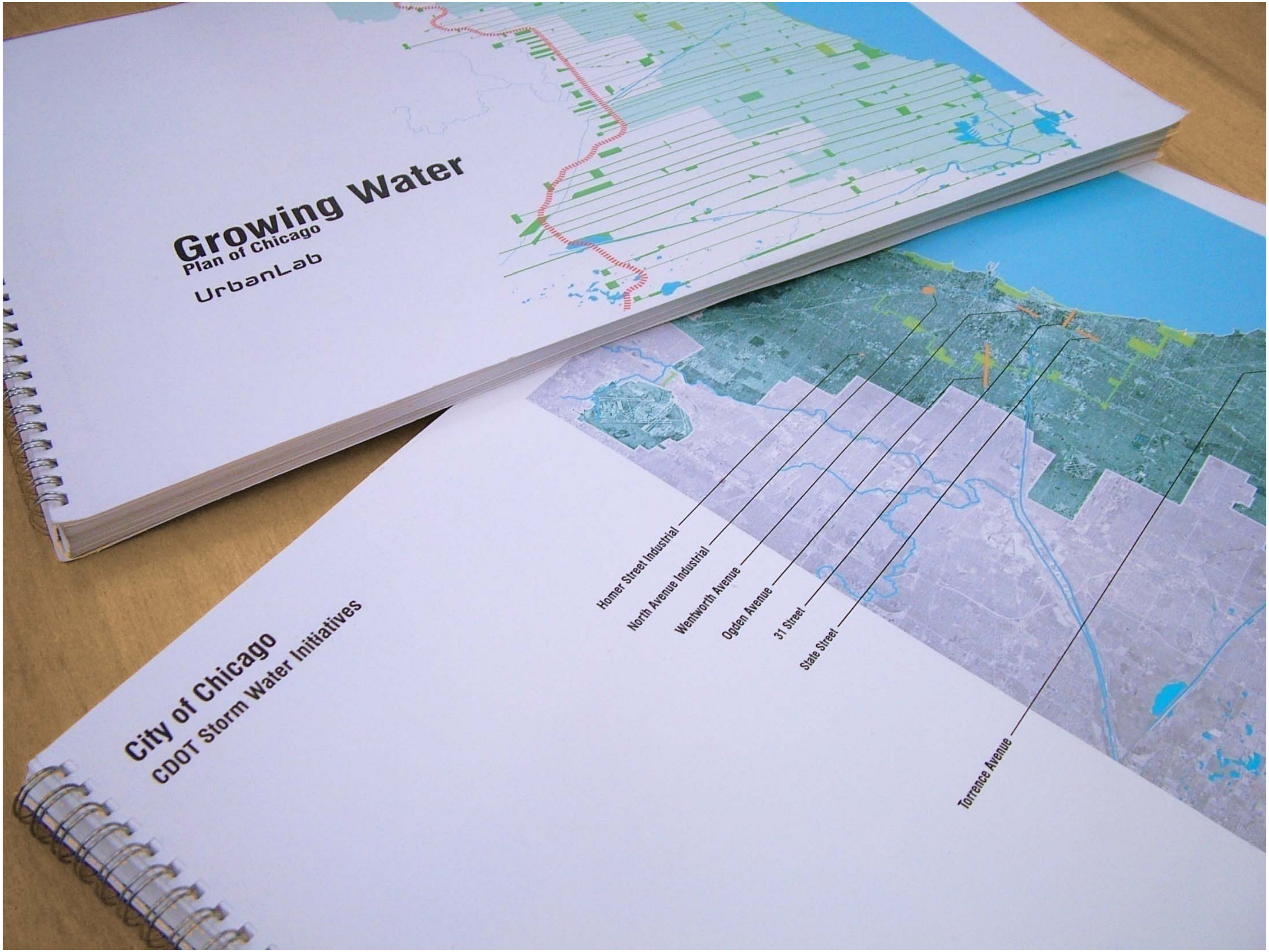


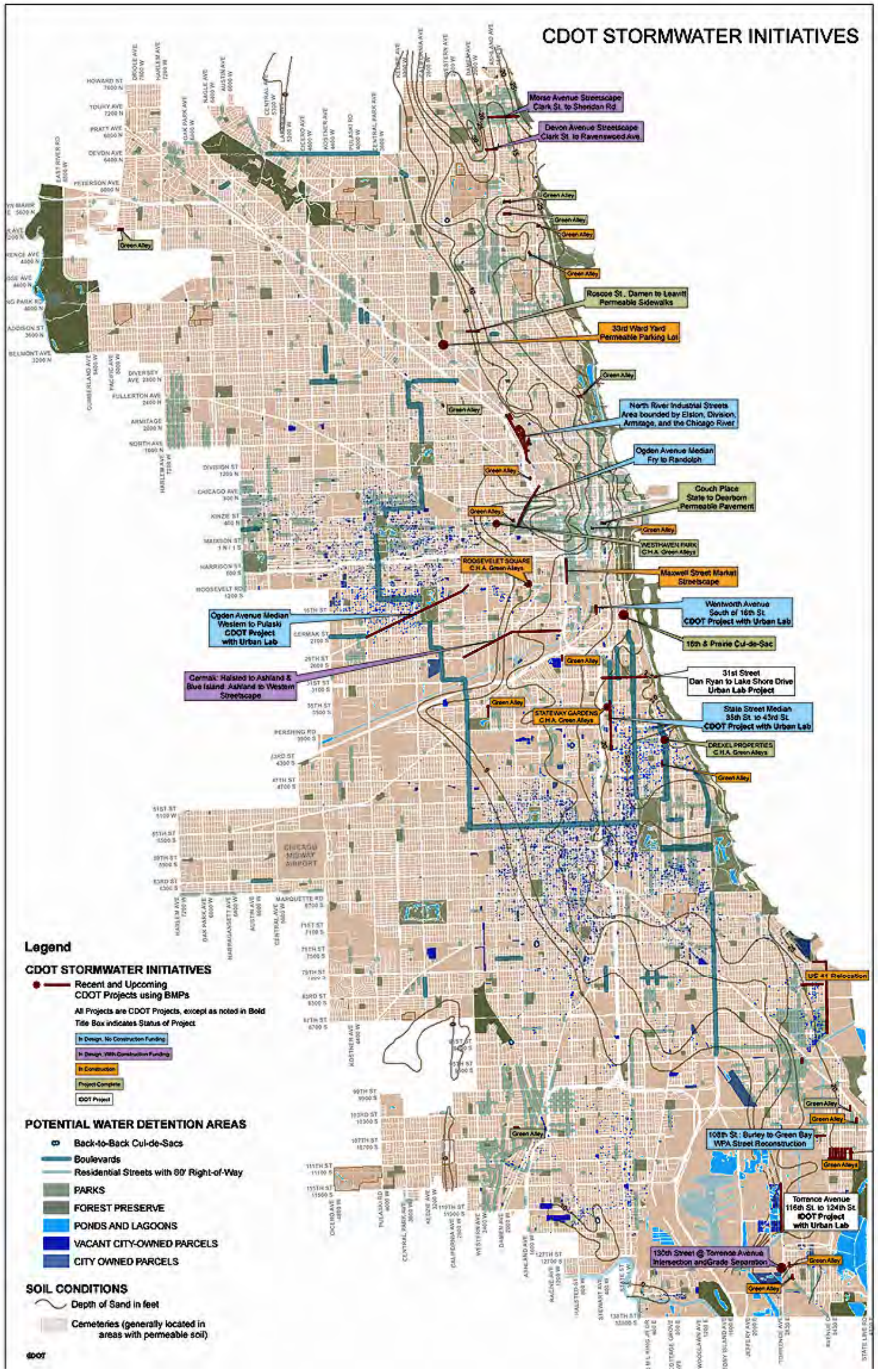
# Vertical Greenhouse Diagram



# Vertical Greenhouse & Bike Rental



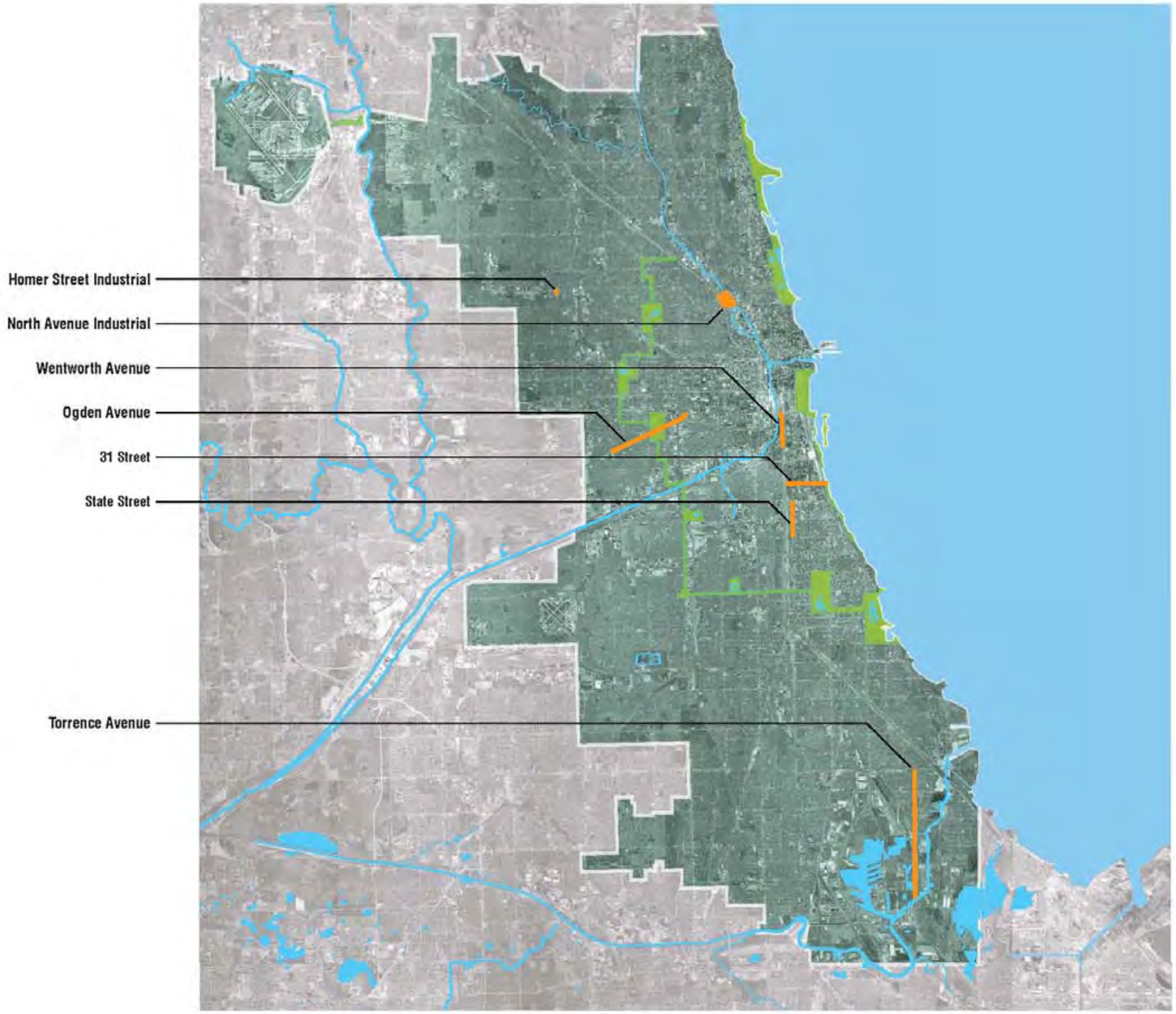

Growing Water
Plan of Chicago
UrbanLab
City of Chicago
CDOT Storm Water Initiatives
Homer Street Industrial
North Avenue Industrial
Wentworth Avenue
Ogden Avenue
31 Street
State Street
Torrence Avenue



CDOT STORMWATER INITIATIVES
Morse Avenue Streetscape Clark St. to Sheridan Rd.
Devon Avenue Streetscape Clark St. to Ravenswood Ave.
Green Alley
Roscoe St., Damen to Leavitt Permeable Sidewalks
33rd Ward Yard Permeable Parking Lot
North River Industrial Streets Area bounded by Elston, Division, Armitage, and the Chicago River
Ogden Avenue Median Fry to Randolph
Couch Place State to Dearborn Permeable Pavement
WESTHAVEN PARK C.H.A. Green Alleys
ROOSEVELT SQUARE C.H.A. Green Alleys
Maxwell Street Market Streetscape
Wentworth Avenue South of 18th St. CDOT Project with Urban Lab
Ogden Avenue Median Western to Pulaski CDOT Project with Urban Lab
18th & Prairie Cul-de-Sac
Cermak: Halsted to Ashland & Blue Island: Ashland to Western Streetscape
31st Street Dan Ryan to Lake Shore Drive Urban Lab Project
STATEWAY GARDENS C.H.A. Green Alleys
State Street Median 35th St. to 43rd St. CDOT Project with Urban Lab
DREXEL PROPERTIES C.H.A. Green Alleys
CHICAGO MIDWAY AIRPORT
US 41 Relocation
108th St.: Burley to Green Bay WPA Street Reconstruction
Torrence Avenue 116th St. to 124th St. IDOT Project with Urban Lab
130th Street @ Torrence Avenue Intersection and Grade Separation
Legend
CDOT STORMWATER INITIATIVES
Recent and Upcoming CDOT Projects using BMPs
All Projects are CDOT Projects, except as noted in Bold
Title Box indicates Status of Project
In Design, No Construction Funding
In Design, With Construction Funding
In Construction
Project Complete
IDOT Project
POTENTIAL WATER DETENTION AREAS
Back-to-Back Cul-de-Sacs
Boulevards
Residential Streets with 80' Right-of-Way
PARKS
FOREST PRESERVE
PONDS AND LAGOONS
VACANT CITY-OWNED PARCELS
CITY OWNED PARCELS
SOIL CONDITIONS
Depth of Sand in feet
Cemeteries (generally located in areas with permeable soil)
CDOT

# City of Chicago

## CDOT Storm Water Initiatives

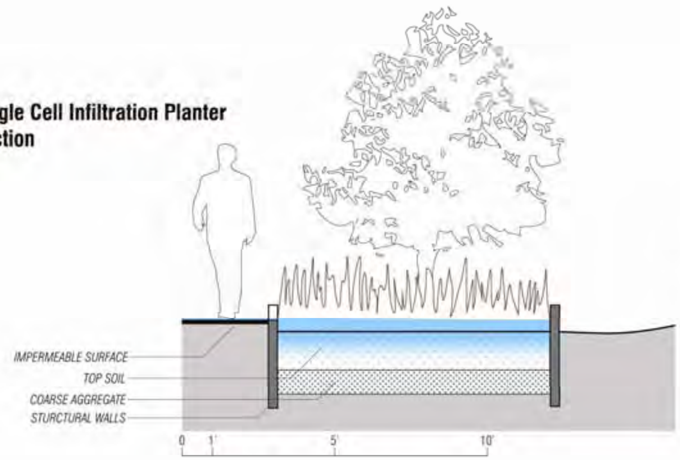


# Storm Water BMP Potential Benefits Table

| | Maintenance | Circulation Speed | Sediment Removal | TSS (Total Suspended Solids) Removal | Phosphate Reduction | Nitrate Reduction | Cost per acre affected area |
|---|---|---|---|---|---|---|---|
| Infiltration Bio Swale | Low | Moderate | High | 30%-65% | 15%-45% | 15%-45% | $22,000 |
| Infiltration Trench | Low | Moderate | High | 30%-65% | 15%-45% | 15%-45% | $22,000 |
| Filter Strip Bio Swale | Moderate | Fast | Moderate | 50%-80% | 15%-45% | 50%-80% | TBD |
| Filter Strip Infiltration Trench | Moderate | Fast | Moderate | 50%-80% | 15%-45% | 50%-80% | TBD |
| Concrete Lined Bio Swale | Low | Fast | High | TBD | Yes | Yes | TBD |
| Single Cell Infiltration Planter | Low | Fast | High | Yes | Yes | Yes | $22,000 |
| Multi Cell Infiltration Planter | Low | Fast | High | Yes | Yes | Yes | TBD |
| Single Cell Infiltration Planter w/ Overflow Drain | Low | Fast | High | Yes | Yes | Yes | $22,600 |
| Single Cell Infiltration Planter w/ Sediment Control Pit | Low | Fast | High | TBD | TBD | TBD | TBD |
| Single Cell Infiltration Planter at Rail | High | Fast | High | TBD | TBD | TBD | TBD |
| Infiltration Planter Between Street and Walkway | Low | Fast | High | TBD | TBD | TBD | TBD |
| Single Cell Infiltration Planter w/ Street Runoff | Low | Fast | High | Yes | Yes | Yes | TBD |
| Sand Filter Storm Drain | High | Fast | High | Yes | Yes | Yes | $12,400 |
| Sand Filter Storm Drain w/ Planter | High | Fast | High | Yes | Yes | Yes | $12,400+ |
| Hydrodynamic Separators | High | Fast | High | 25% | 25% | None | $20,000 |
| Aqua Filter | High | Fast | High | 60% | 25% | None | $31,500 |
| Bioretention Pond | Low | Fast | Low | 100% | 20% | 40% | $13,500 |
| Bioretention System | Low | Fast | High | 100% | 10% | 30% | $18,000 |
| Surface Sand Filter | Low | Fast | High | 50% | 35% | None | $12,500 |
| Gabion Constructed Wetland | 3-5% Const. Cost/ yr | Slow | High | 50-80% | 30% | 15%-45% | $57,100 acre-foot |
| Permeable Paving | High | Fast | High | 100% | 80% | 0% | $50,000 |

# Storm Water Infiltration Planters

## Single Cell Infiltration Planter Section




Potential Benefits

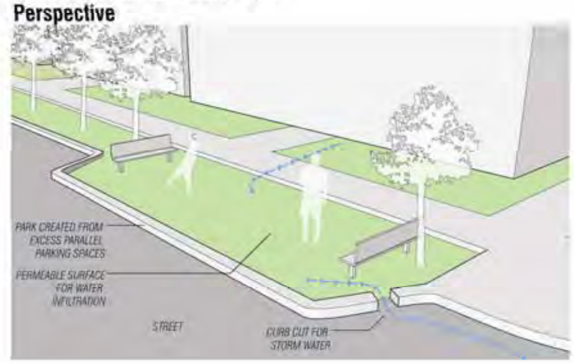
| | |
|---|---|
| Maintenance: | Low |
| Circulation Speed: | Fast |
| Sediment Removal: | High |
| TSS Removal: | Yes |
| Phosphate Reduction: | Yes |
| Nitrate Reduction: | Yes |
| Cost: | $22,000 per acre |
| Additional Benefits: | |

Visual Appearance
Uses Minimal Space at Right of Way
Slows Storm Water Runoff


*details and images obtained from the Portland Bureau of Environmental Studies

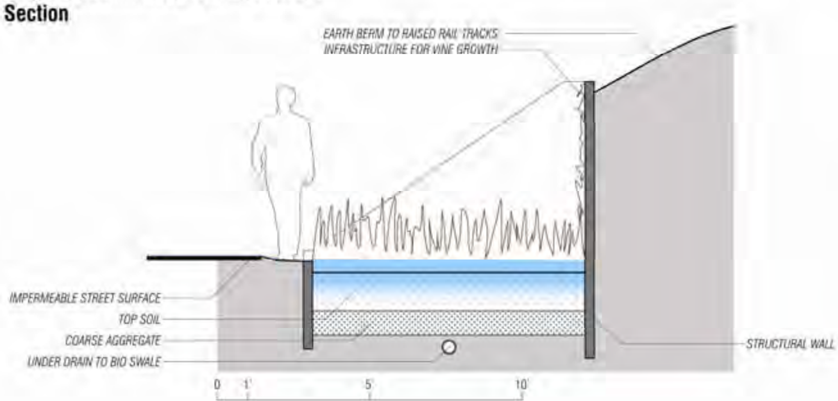
## Single Cell Infiltration Planter Plan


## Infiltration Planter Pocket Park Perspective



# Storm Water Infiltration Planter

## Single Cell Infiltration Planter at Rail Section

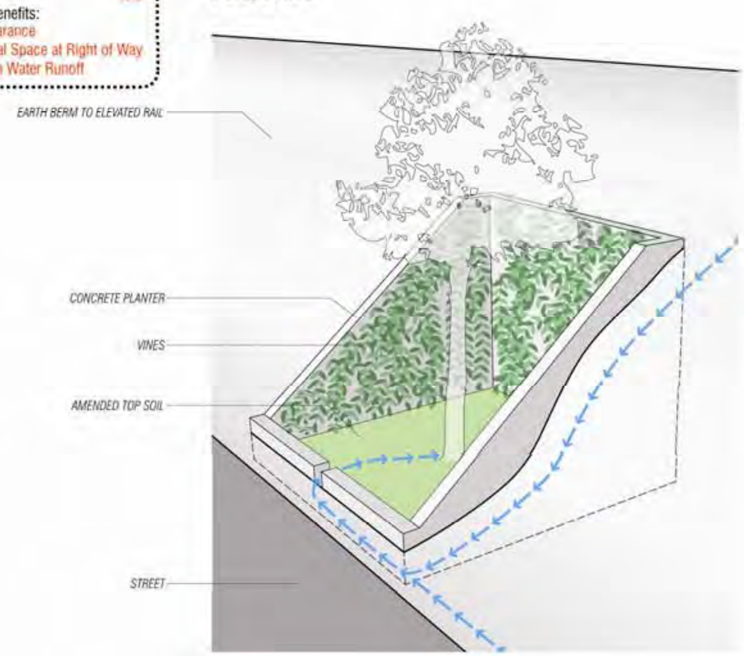



Potential Benefits

| | |
|---|---|
| Maintenance: | Low |
| Circulation Speed: | Fast |
| Sediment Removal: | High |
| TSS Removal: | TBD |
| Phosphate Reduction: | TBD |
| Nitrate Reduction: | TBD |
| Cost: | TBD |

Additional Benefits:
Visual Appearance
Uses Minimal Space at Right of Way
Slows Storm Water Runoff

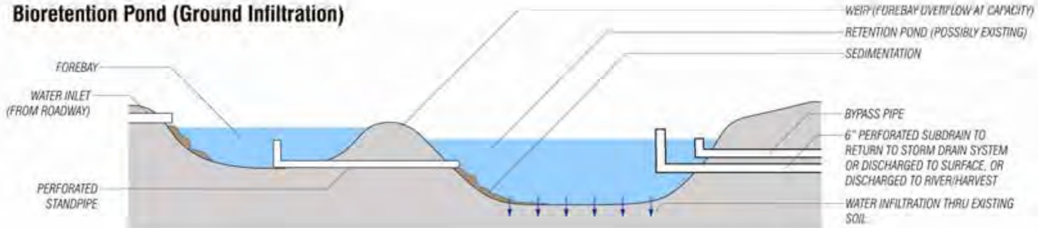
## Single Cell Infiltration Planter at Rail Perspective




## Single Cell Infiltration Planter at Rail Plan

# Bioretention Systems

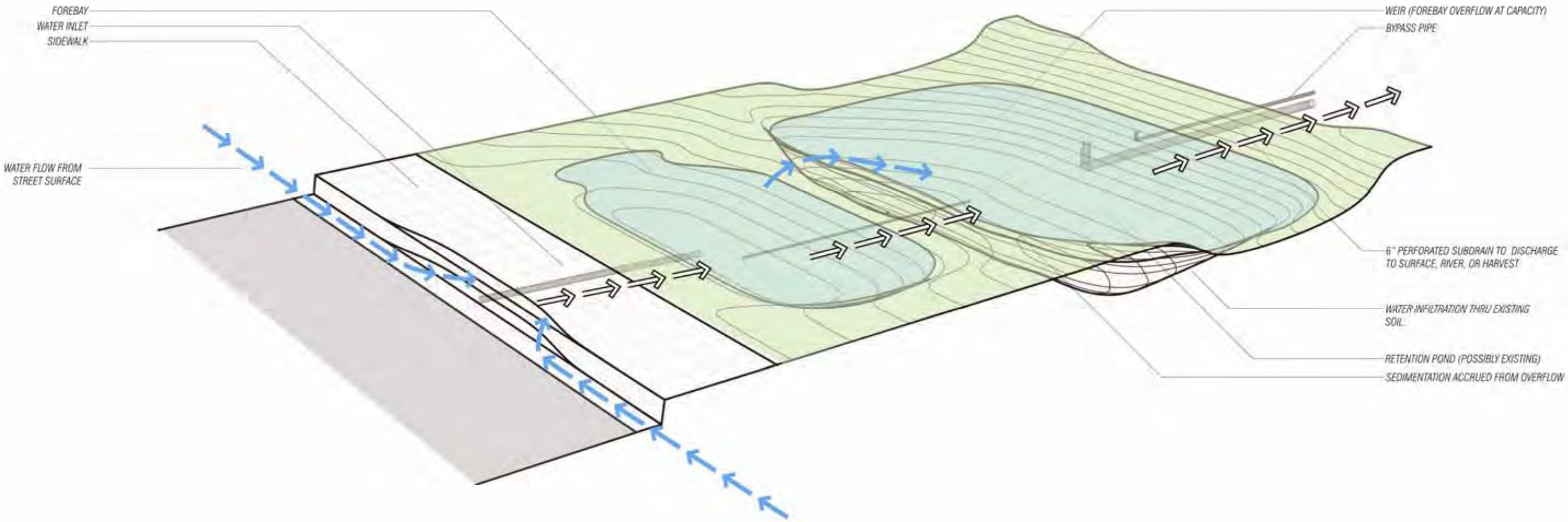
## Bioretention Pond (Ground Infiltration)

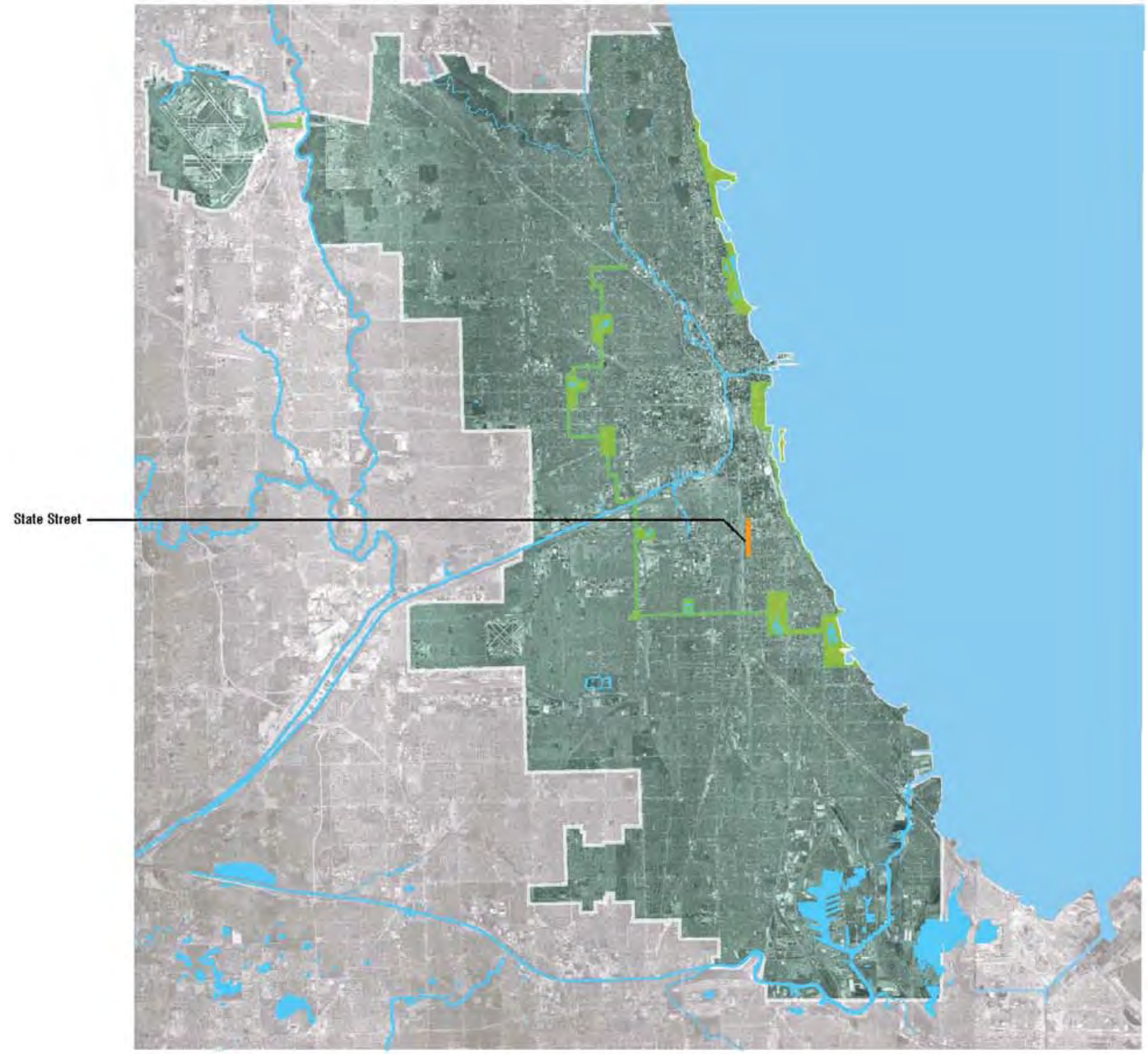



### Potential Benefits

| | |
|---|---|
| Maintenance: | Low |
| Circulation Speed: | Fast |
| Sediment Removal: | Low |
| *TSS Removal:* | 75% |
| Phosphate Reduction: | 20% |
| Nitrate Reduction: | 40% |
| Cost: | $13,500 per acre |
| Additional Benefits: | |
| Public Water Feature | |
| High Volume Retention | |

*details/images obtained from the University of New Hampshire




State Street

## State Street Eco-Boulevard

**Existing Condition**


UrbanLab
CDOT Storm Water Initiatives

## State Street Eco-Boulevard

**Proposed Condition**

0 miles — 0.1 miles

Scale

**Key**

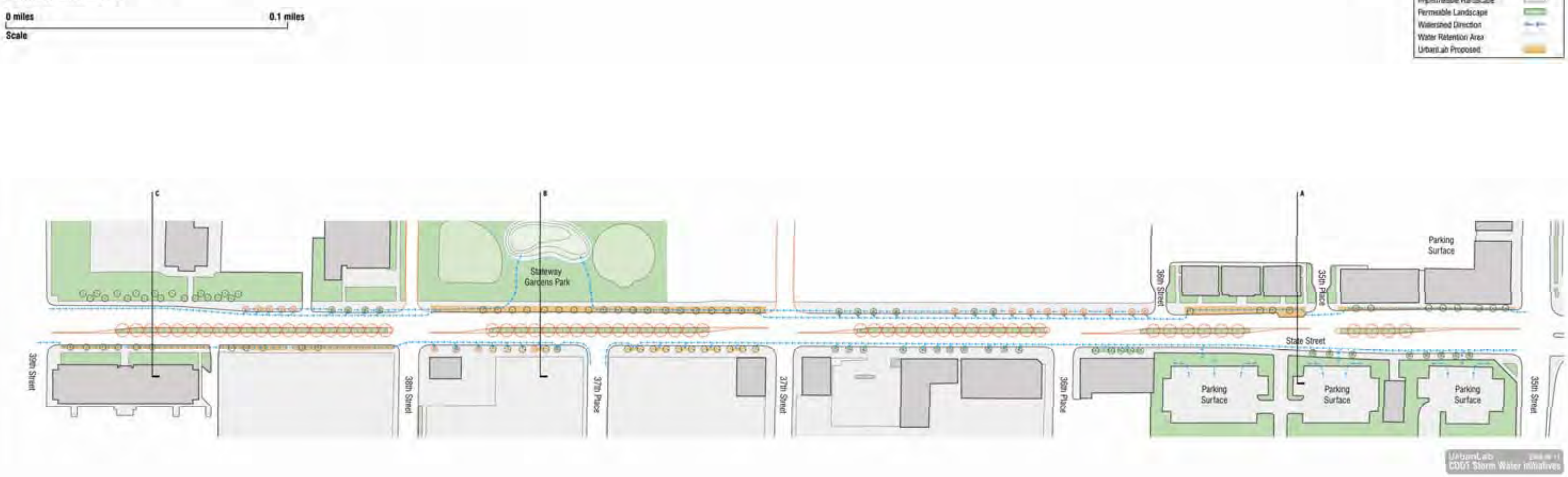
City Proposed Improvements

Impermeable Hardscape

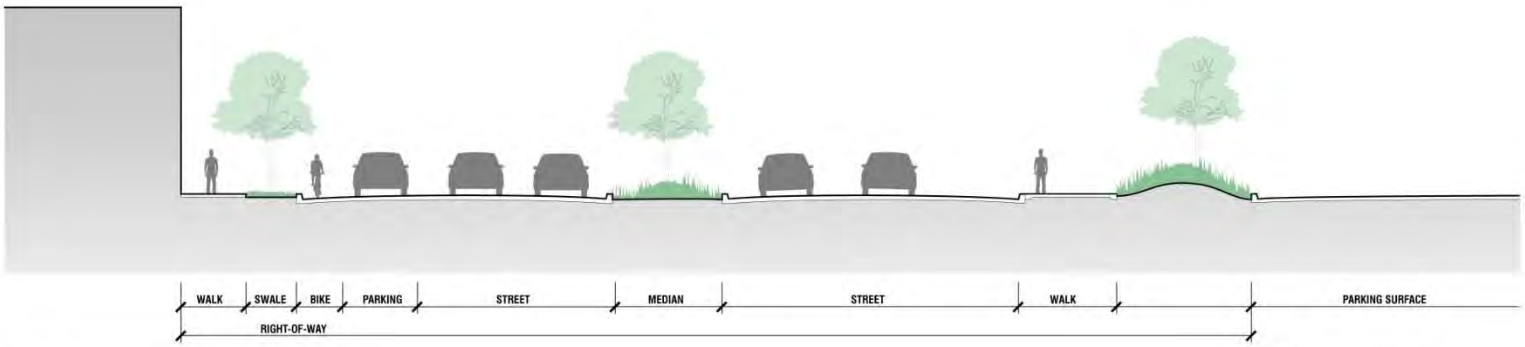
Permeable Landscape

## State Street Eco-Boulevard

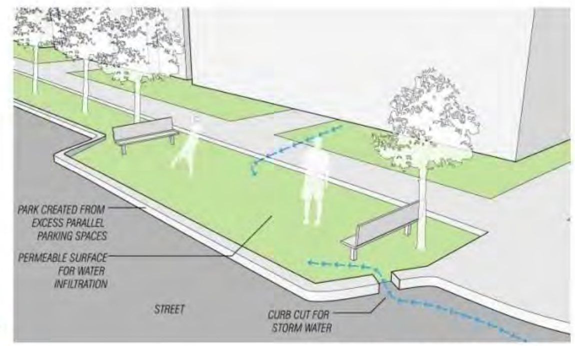
**Proposed Condition with BMPs**



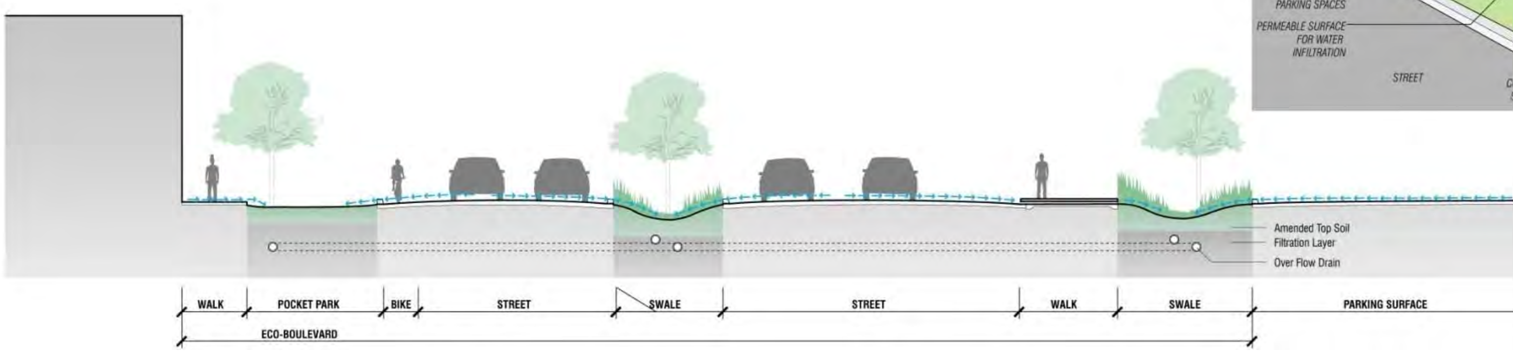
# State Street
**Storm Water BMPs**



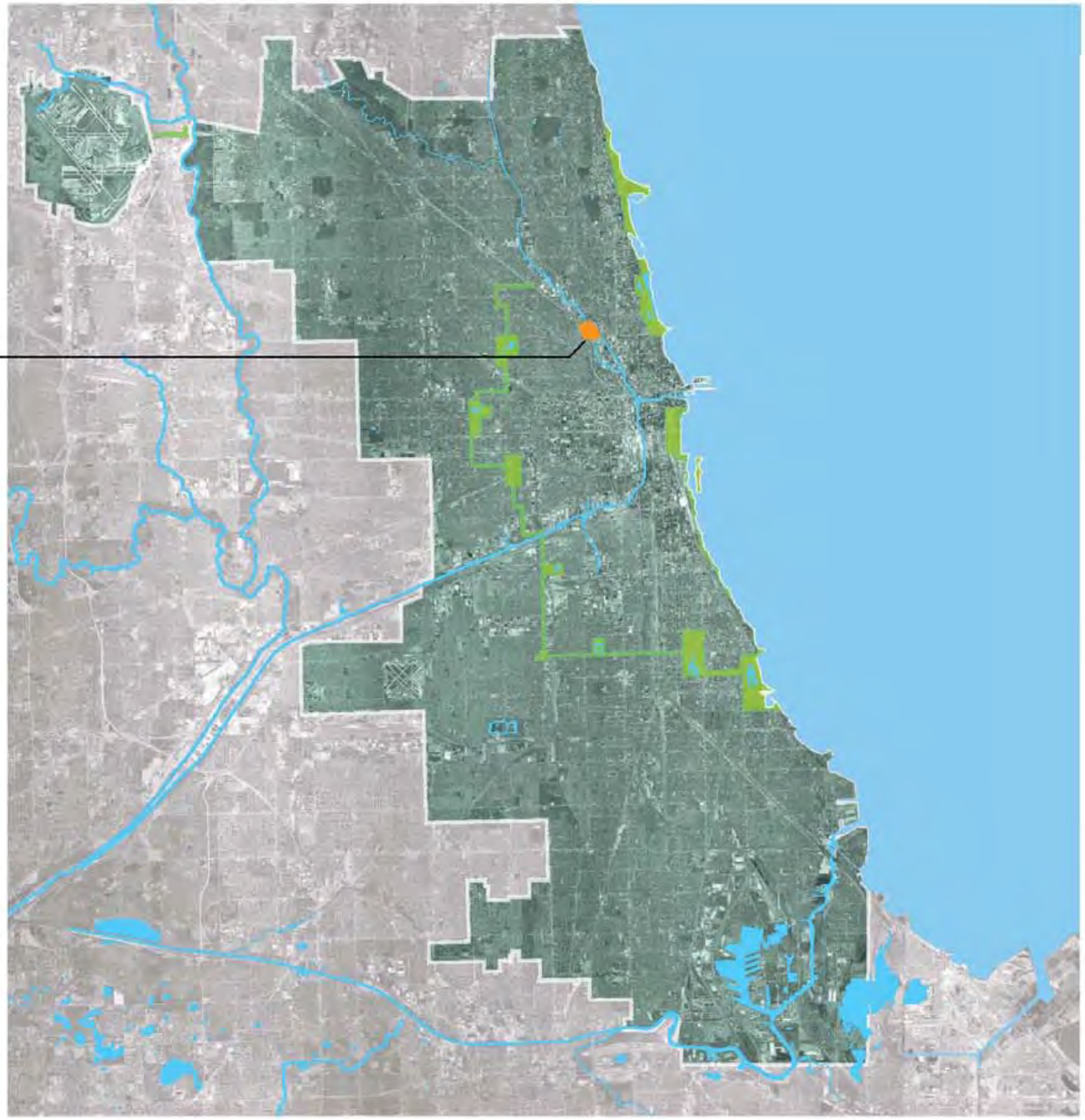

**City Proposed Conditions Section A**




**Perspective of Pocket Park**




**UrbanLab Proposed Conditions Section A**


North Avenue Industrial

# North Avenue Industrial

**Existing Condition**

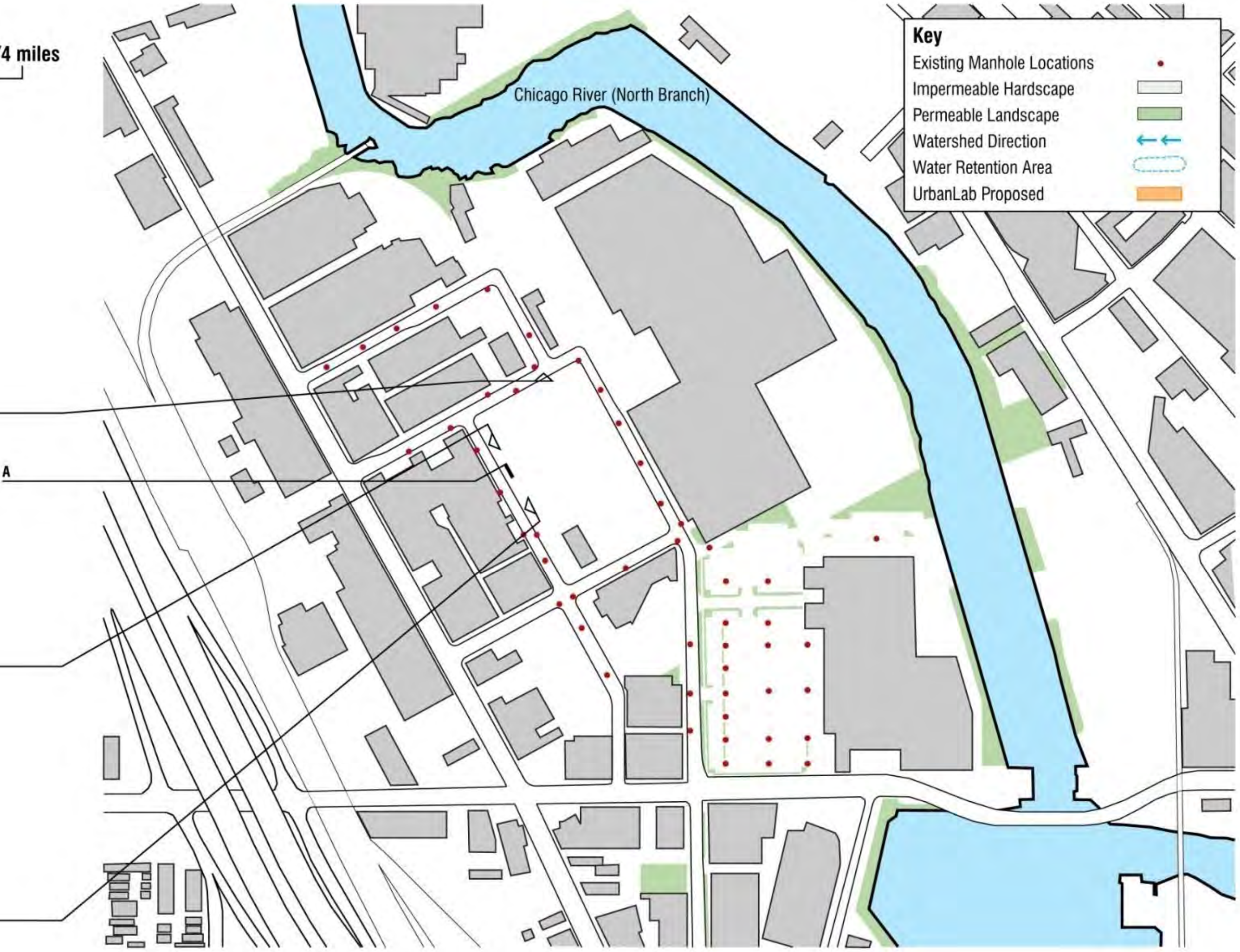
**0 miles** **1/4 miles**

**Scale**

**North Throop Street & West Wabansia Street**

**Concord Place & Ada Street**

**Concord Place & Ada Street**

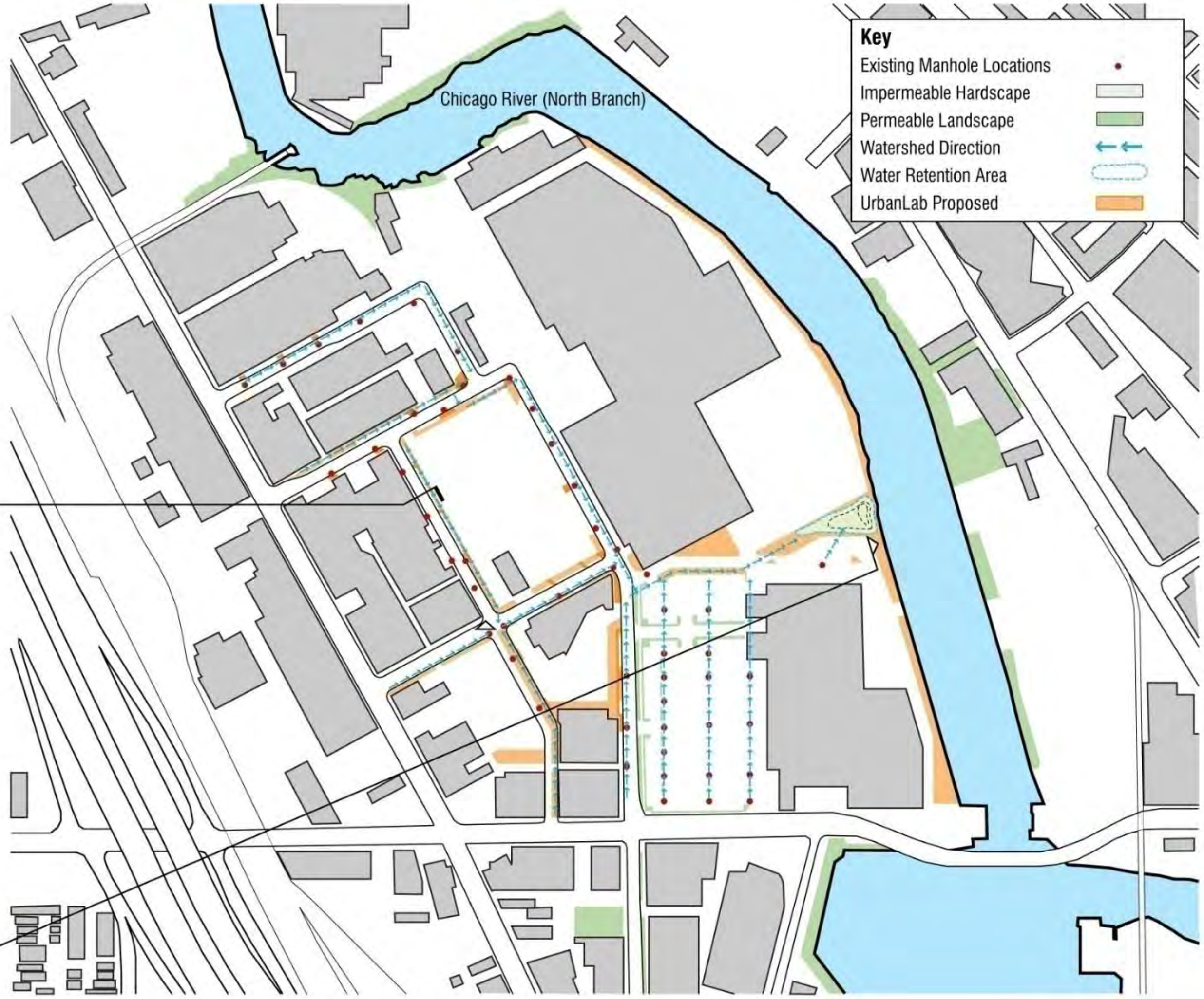


# North Avenue Industrial

**Proposed Condition with BMPs**

0 miles — 1/4 miles

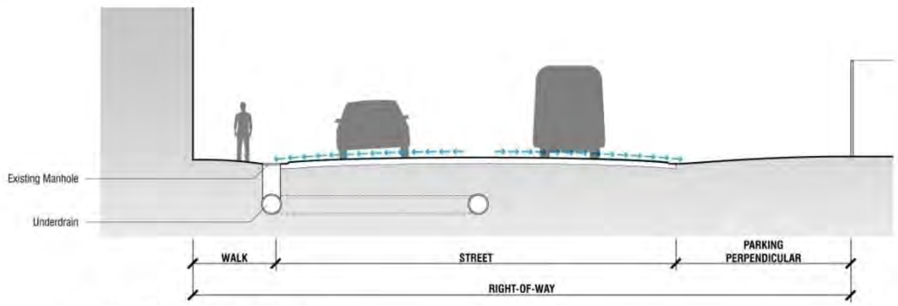
Scale



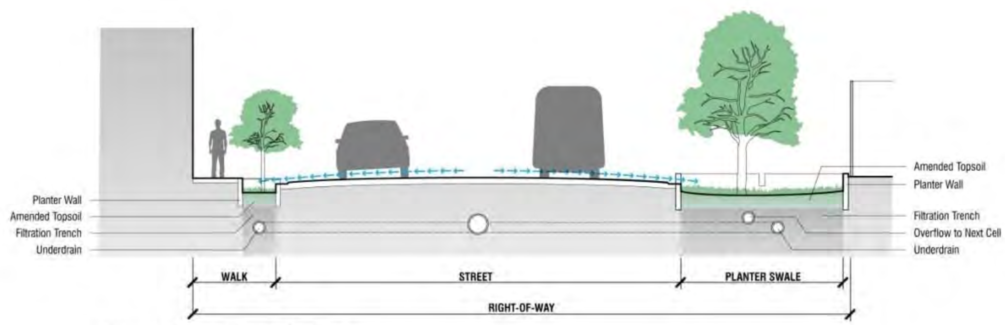

Concord Place & Ada Street

# North Avenue Industrial

## Industrial Storm Water BMP Sections




### Existing Conditions Section




### Proposed Conditions Section

**Tool Box: Single Cell Infiltration Planter**


### Proposed Conditions Plan

challenge:

# reduce our Water & Energy footprint

we need...

tools to
Measure and Report
progress
we make collectively
(private + public)

solution

## neighborSHED model

tool to:
develop/report knowledge via social networks
crowd source community assets/goals

because in an "Age of Austerity,"
solving energy/climate/water challenges requires everyone's help

# neighborSHED

**neighbor SHED**

ecoSHED

that area of land, a bounded system, within which all things are inextricably linked by their common resources and where, as humans settled, simple logic demanded that they become part of a community.

NEIGHBORhood

- the area around or near some place or thing; vicinity.
- a district or locality, often with reference to its character or inhabitants.
- a number of persons living near one another or in a particular locality.
- nearness, proximity, especially within walking distance.

neighborSHED

# the model measures + reports

how much power can I/we save?
how much water can I/we save?
how much $CO_2$ can I/we save?
how much $ can I/we save?

neighborSHED

# the model reports goals

- reduce power needs for heating/cooling
- produce renewable power (reduce GHG)
- manage stormwater
- manage organic waste and gray water
- produce food
- provide habitat for urban bio-diversity
- provide personal/public transportation options
- create green jobs

neighborSHED

# the model measures metrics

| | | |
|---|---|---|
| power | = | watts |
| water | = | gallons |
| $CO_2$ | = | mt / lbs |
| $ | = | $ saved |

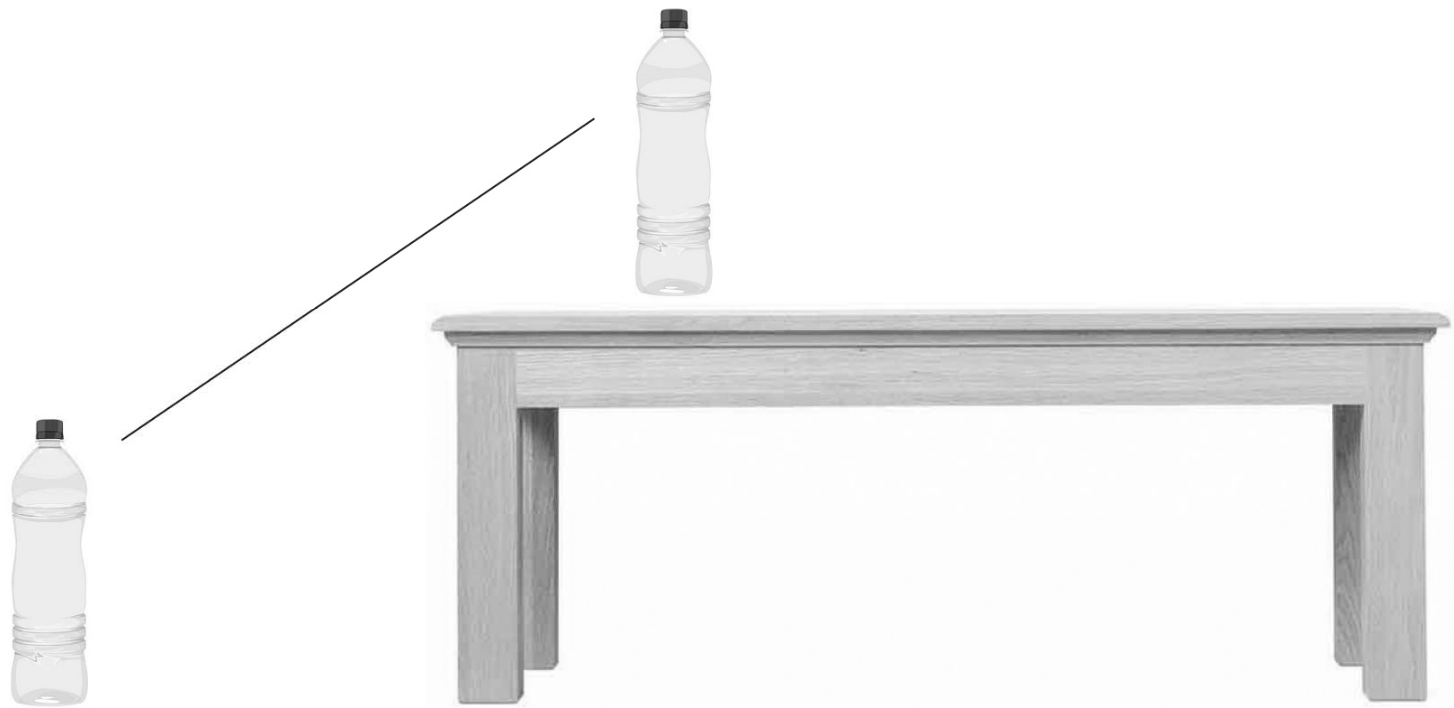
## measure

Power: how much do we use?
how much can we save?

# energy + power basics

## energy: measured in Joules (J)
## energy is a measurable amount: a quantity

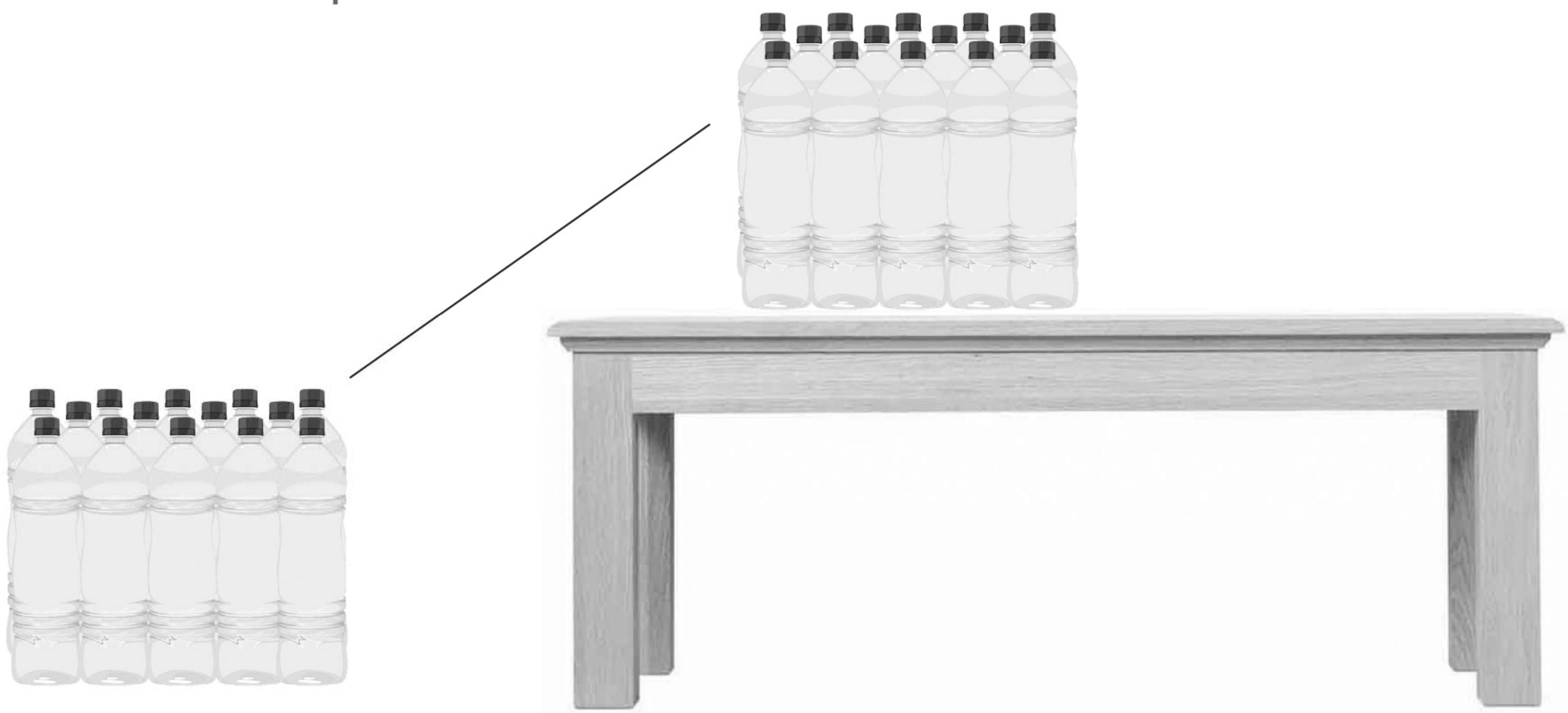
lifting a bottle from the
floor to desk = 1 Joule



# energy + power basics

power: measured in Watts (W)
1 Watt = 1 Joule/second
power: rate of using energy

lifting 40 bottles per second from
the floor to desk = 40 Watts



## power

| | |
|---|---|
| 10 w | iphone |
| 100 w | us sitting |
| 1,000 w = 1kw | kettle |
| 1,000,000 w = 1mw | locomotive/wind turbine |
| 1,000,000,000 w = 1gw | hoover dam/city of .5m |
| 1,000,000,000,000 w = 1tw | world power - 1890 |

# why measure power?

using units of power allows comparisons between things that happen on markedly different time scales = yearly + monthly + daily

power, in watts, is an average - the average amount of energy, in joules, used each second

power monthly: electricity bill contributes -

$$\frac{122 \text{ kw hours}}{1 \text{ month}} \times \frac{1 \text{ month}}{2{,}592{,}000 \text{ seconds}} \times \frac{3.6 \text{ megajoules}}{1 \text{ kw hour}} = \frac{170 \text{ joules}}{\text{second}} = 170 \text{ watts}$$

+

power daily: one energy drink contributes -

$$\frac{1 \text{ energy drink}}{1 \text{ day}} \times \frac{1 \text{ day}}{86{,}400 \text{ seconds}} \times \frac{7.94 \text{ megajoules}}{1 \text{ bottle}} = \frac{90 \text{ joules}}{\text{second}} = 90 \text{ watts}$$

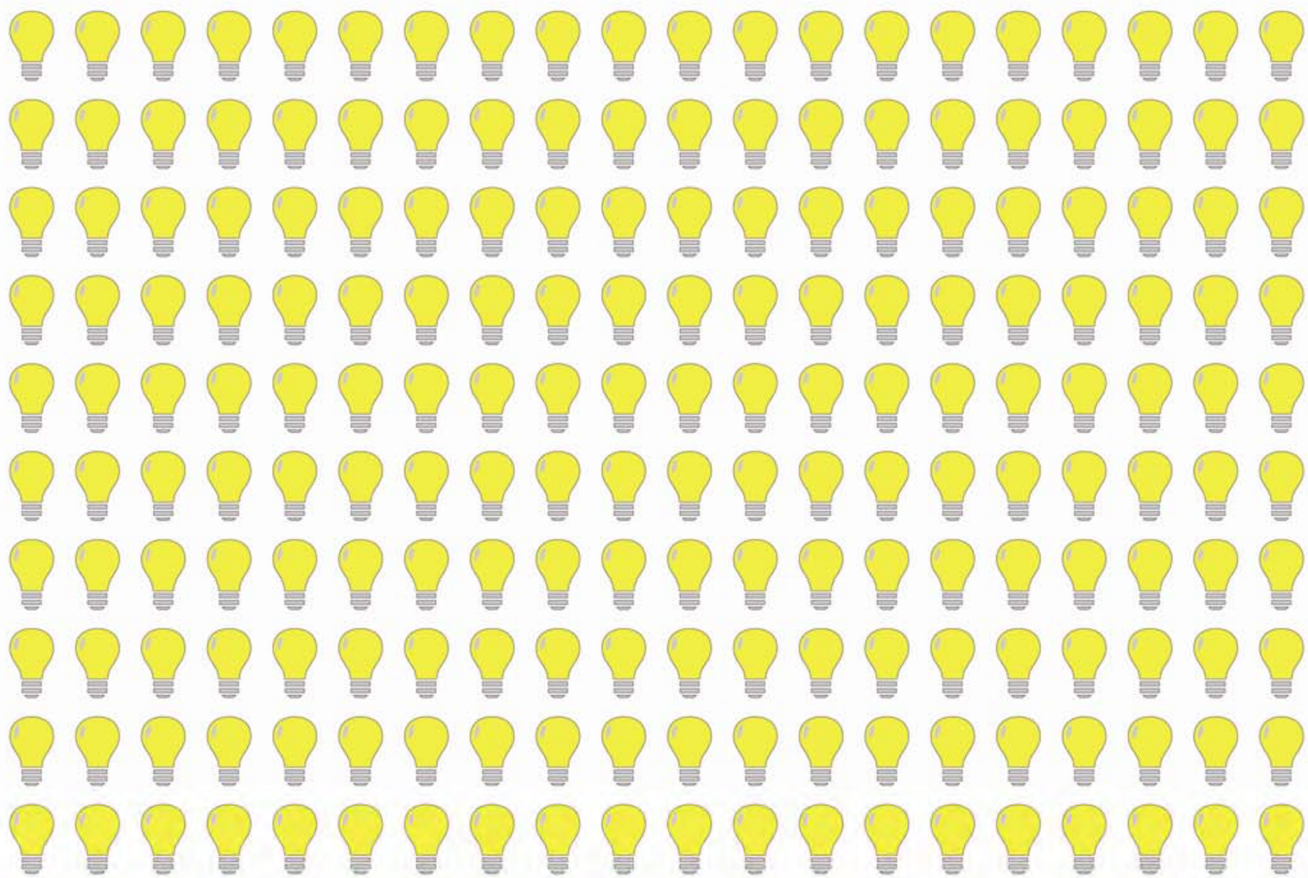
(+ all watts)

=

Lifestyle

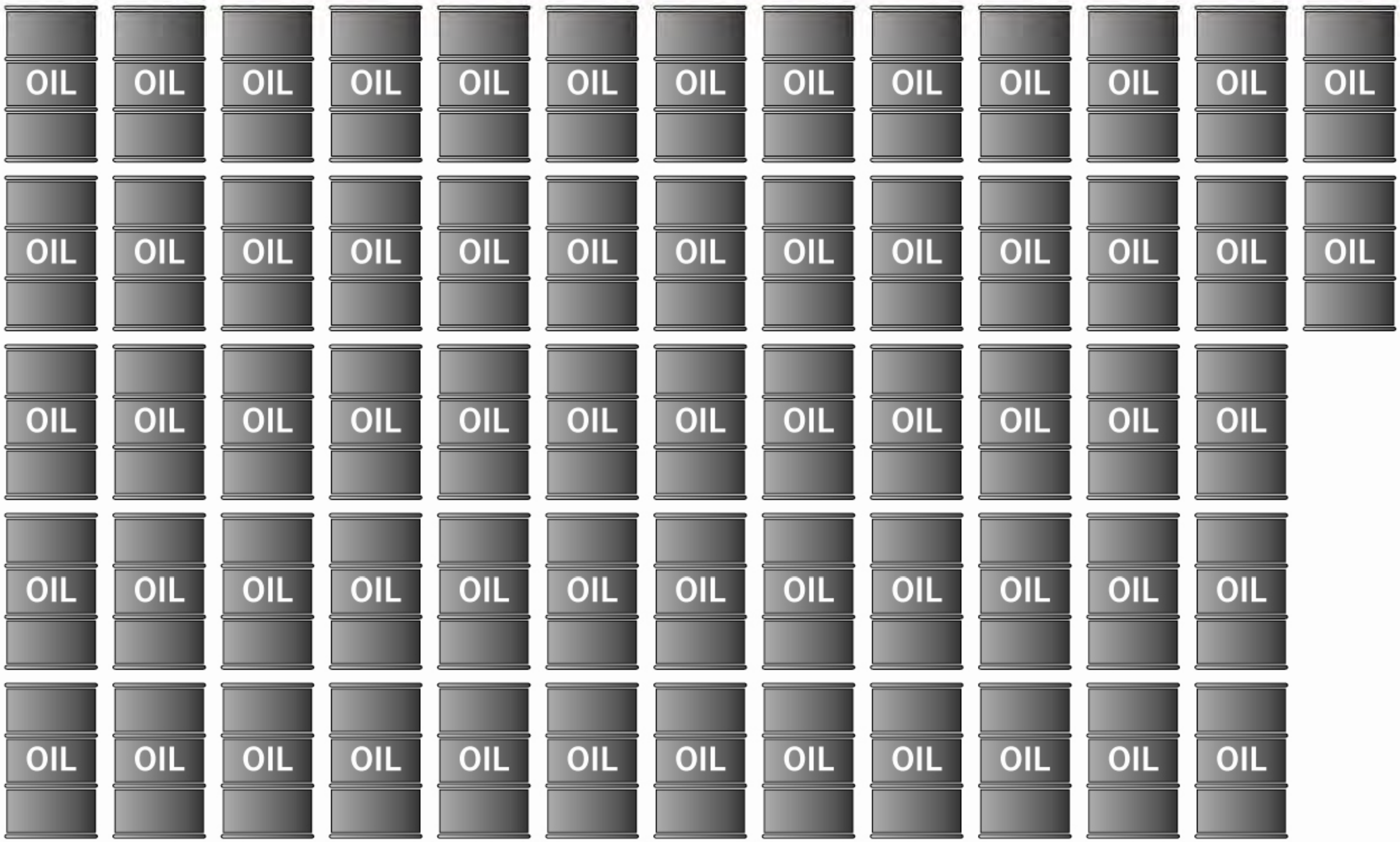
my life in watts:

# a 12,000 watt lifestyle



my life in oil:

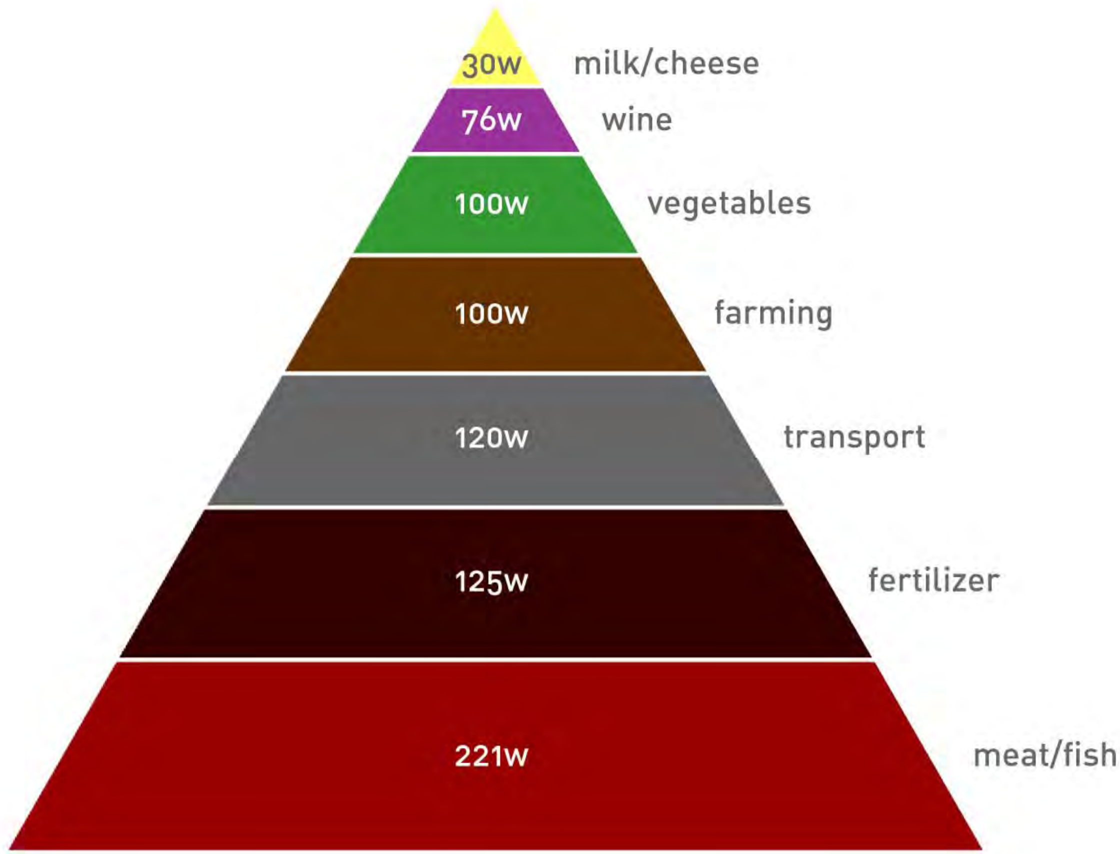
# a 2,600 gallon lifestyle



# power metrics

| Energy Use | MySQL Row Name | | | | | |
|---|---|---|---|---|---|---|
| Short Range Flight | sflight | 1 mile = 25.3510 watts | | | | |
| Mid Range Flight | mflight | 1 mile = 83.6583 watts | | | | |
| Long Range Flight | lflight | 1 mile = 456.3182 watts | | | | |
| Bus Miles | busmile | 1 mile = 7.583714 watts | | | | |
| Light Rail Mile | lrmile | 1 mile = 1.782838 watts | | | | |
| Subway Mile | submile | 1 mile = 4.390571 watts | | | | |
| Commuter Rail Mile | commile | 1 mile = 3.698724 watts | | | | |
| Ferry Mile | ferrymile | 1 mile = 14.395752 watts | | | | |
| Car Mile | carmile | 1 mile = 9.3156 watts | for 21.5 mpg | | | |
| kWh/Month | kwhmon | 1 kwh/mon = 1.368955 watts | | | | |
| Therms/Month | thermmon | 1 thrm/mon = 40.1201 watts | | | | |
| Heating Oil Gal/Month | oilmon | 1 gal/mon = 55.6423 watts | | | | |
| Propane Gal/Month | propanemon | 1 gal/mon = 36.5623 watts | | | | |
| Kerosene Gal/Month | keromon | 1 gal/mon = 53.8358 watts | | | | |
| Wood cords/year | cordyear | 1 cord/year = 735.5488 watts | | | | |
| People Living at address | persons | divides watts used for housing by the number of people living there. | | | | |
| Meat/Eggs | meat | 0 = 0 watts | 1 = 78 watts | 2 = 156 watts | 3 = 233 watts | 4 = 311 watts |
| Dairy | dairy | 0 = 0 watts | 1 = 26 watts | 2 = 53 watts | 3 = 79 watts | 4 = 106 watts |
| Fats/Oils | fatoil | 0 = 0 watts | 1 = 15 watts | 2 = 30 watts | 3 = 44 watts | 4 = 59 watts |
| Fruits/Vegetables/Nuts | fruit | 0 = 0 watts | 1 = 47 watts | 2 = 93 watts | 3 = 140 watts | 4 = 177 watts |
| Cereals/Grain | grain | 0 = 0 watts | 1 = 6 watts | 2 = 11 watts | 3 = 17 watts | 4 = 22 watts |
| Sugar | sugar | 0 = 0 watts | 1 = 48 watts | 2 = 96 watts | 3 = 145 watts | 4 = 193 watts |
| Beer/Wine/Liquor | wine | 0 = 0 watts | 1 = 28 watts | 2 = 57 watts | 3 = 85 watts | 4 = 113 watts |

# food in watts




772w

measure

Water: how much do we use?
how much can we save?

types of water?

## economics + power of water

## California: water related energy use consumes -

19% of state's electricity
30% of state's natural gas
88 billion gallons of diesel fuel

california energy commission - 2005

## water basics

types

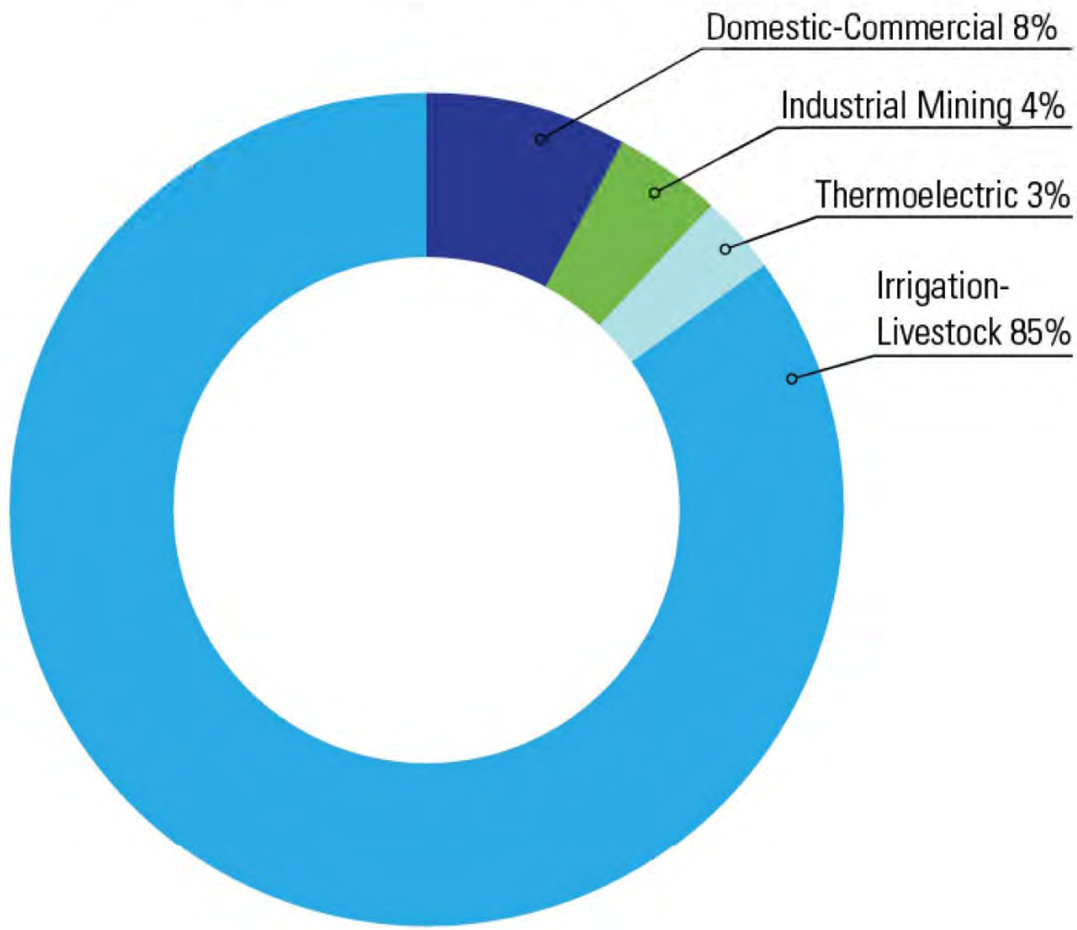
| | |
|---|---|
| Blue | - surface/ground |
| Green | - in soil/soil moisture |
| Gray | - non-potable but disease free |
| Black | - unhealthy (for us) |

usage

| | |
|---|---|
| indirect | - food / goods |
| direct | - inside buildings |
| | - outside |
| | - private (buildings/property) |
| | - public (grey/green infrastructure) |

# 85% of water use: food

## U.S. Consumptive Water Use



# water footprints

**25** *litres of water for* **one single** (100 g) **potato**

A bag of potato crisps (200 gr) has a water footprint of about 185 litres.

**62** *litres of water per* **person per day** (typical) **leaked**

An estimated 12% per cent of Metro Vancouver's water supplies are leaking out of aging pipes. Thus, about 22.732 litres of water is leaked annually for every person supplied.

**76** *litres of water per* **one day** (typical) use of **toilets**

Standard toilets use between 14 to 20 litres of water per flush - accounting for approx. 30% of household water. Low-flow toilets only use 6 litres per flush.

**135** *litres of water for* **one single** (40 g) **egg**

As a global average, eggs require 3300 m3 of water per ton. Most of the water is required for feeding the chickens.

**200** *litres of water for* **one glass** (200 ml) of **milk**

Drying 1 litre of milk produces 0.2 kilogram of milk powder. Thus, the water footprint of milk powder is 5 times higher than that of milk, i.e. 5000 litres/kg vs. 1000 litres/kg.
Most of the water behind the milk is in feeding the cow that produces the milk.

**35** *litres of water for* **one cup** (250 ml) of **tea**

Most of the water comes from growing the tea leaves necessary to flavour the drink.

**70** *litres of water for* **one single** (100 g) **apple**

We assume here a hundred-grams apple. One glass of apple juice (200 ml) costs about 190 litres of water.

**120** *litres of water for* **one glass** (125 ml) of **wine**

Most of the water behind the wine is for producing the grapes.

**140** *litres of water for* **one cup** (125 ml) of **coffee**

It costs about 21,000 litres of water to produce 1 kg of roasted coffee. Thus, the world population requires about 120 cubic kilometres of water per year to be able to drink coffee. This is equivalent to about 107% the annual Fraser River water volume and constitutes 2% of the global water use for crop production. Among all the crop and livestock products coffee stands at the top position in the list of global virtual water flows.

**2400** *litres of water for* **one single** (150 g) **hamburger**

Most of the water is needed for producing the beef contained in the hamburger. In an industrial beef production system, it takes in average three years before the animal is slaughtered to produce about 200 kg of boneless beef. The animal consumes approx. 24 cubic meter of water for drinking and 7 cubic meter of water for servicing.

**40** *litres of water for* **one slice** (30 g) of **bread**

Producing wheat costs 1300 litres of water per kg (global average).
One slice of bread has a weight of about 30 gram, which implies a water footprint of 40 litres.
If the bread is consumed together with 1 slice of cheese (10g), then it all together costs 90 litres of water.

**75** *litres of water for* **one glass** (250 ml) of **beer**

Most of the water behind the beer is for producing the barley.

**130** *litres of water for a* **ten-minute** (typical) **shower**

Standard showerheads dispense between 5.7 to 18.9 litres per minute - accounting for about 20% of household water. Low-flow shower heads can save up to 75 litres of water during a 10 minute shower.

**150** *litres of water for* **one load** (typical) of **laundry**

Standard laundry machines use about 23% of household water.

**4100** *litres of water for* **one single** (medium-sized, 500 g) **cottonT-shirt**

In order to get 1 kg of final cotton textile, one requires 11,000 litres of water (as a global average). Thus, when we have a shirt with a weight of 250 gram, this shirt costs 2700 litres. Of this total water volume, 45% is irrigation water consumed (evaporated) by the cotton plant; 41% is rainwater evaporated from the cotton field during the growing period; and 14% is water required to dilute the wastewater flows that result from the use of fertilisers in the field and the use of chemicals in the textile industry.

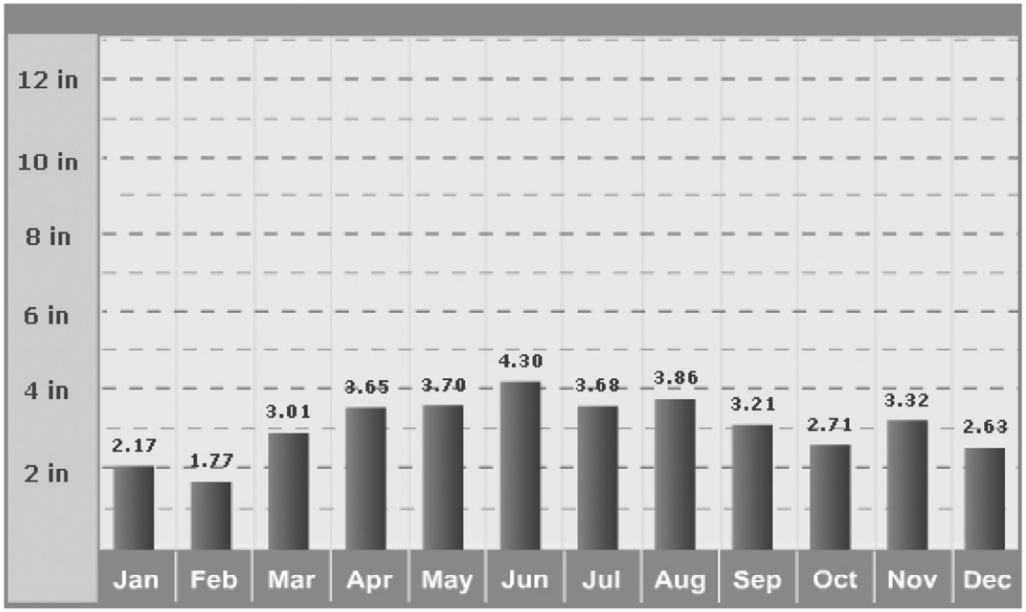
# water use: inside buildings

| | daily | monthly | annually |
|---|---|---|---|
| toilet | 19g | 570g | 6,840g |
| bathing | 15g | 450g | 5,400g |
| laundry | 8g | 240g | 2,880g |
| kitchen | 7g | 210g | 2,520g |
| housekeeping | 1g | 30g | 360g |
| totals | 50g | 1,500g | 18,000g |

# water use: outside buildings

## outside

- private (buildings/property)
- public (grey/green infrastructure)



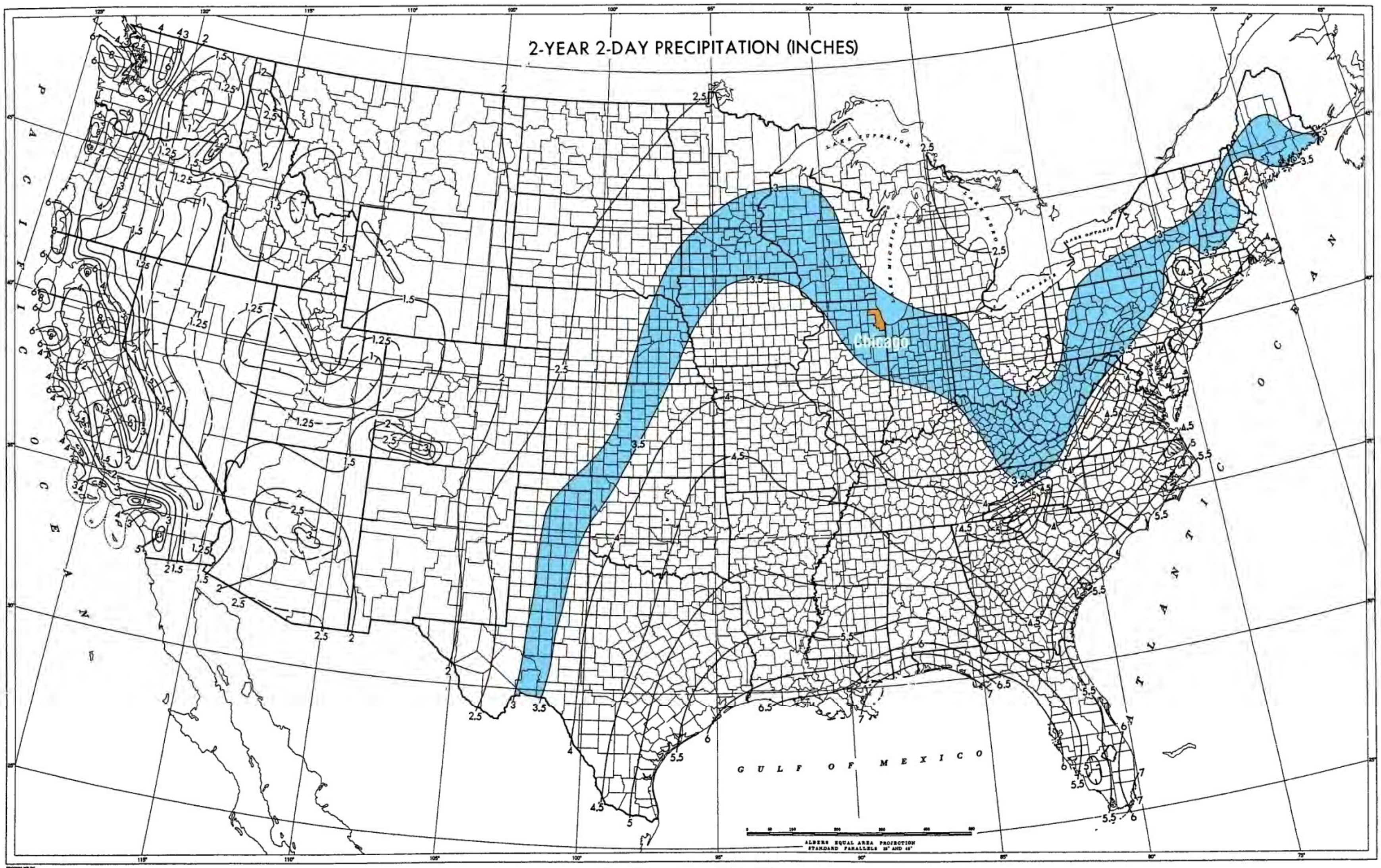



FIGURE 12.—2-year 2-day precipitation (in.).



2 Year Storm over 2 days in Chicago = 3-3.5 Inches of Precipitation

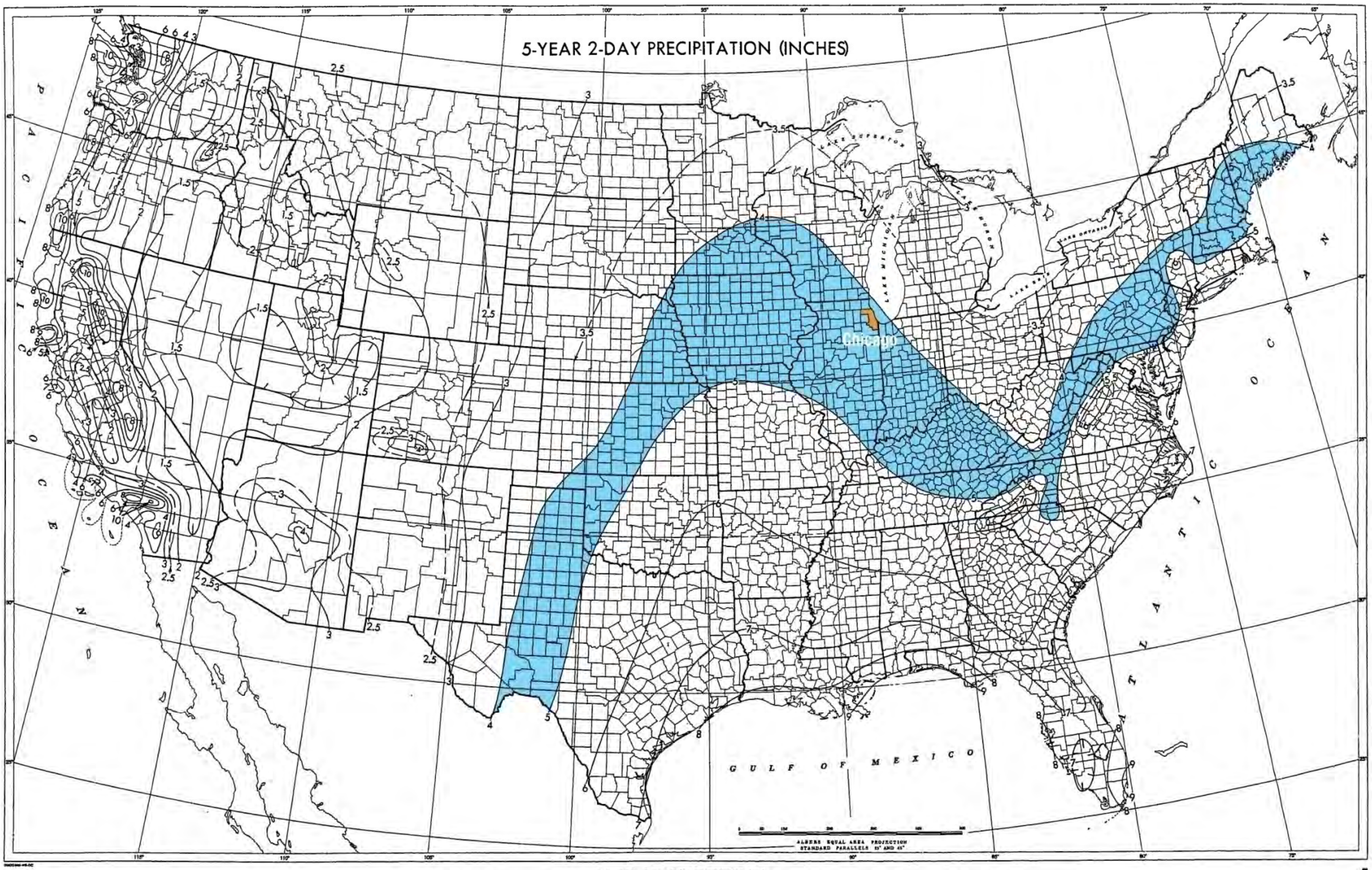



FIGURE 13.—5-year 2-day precipitation (in.)



# 5 Year Storm over 2 days in Chicago = 4-5 Inches of Precipitation

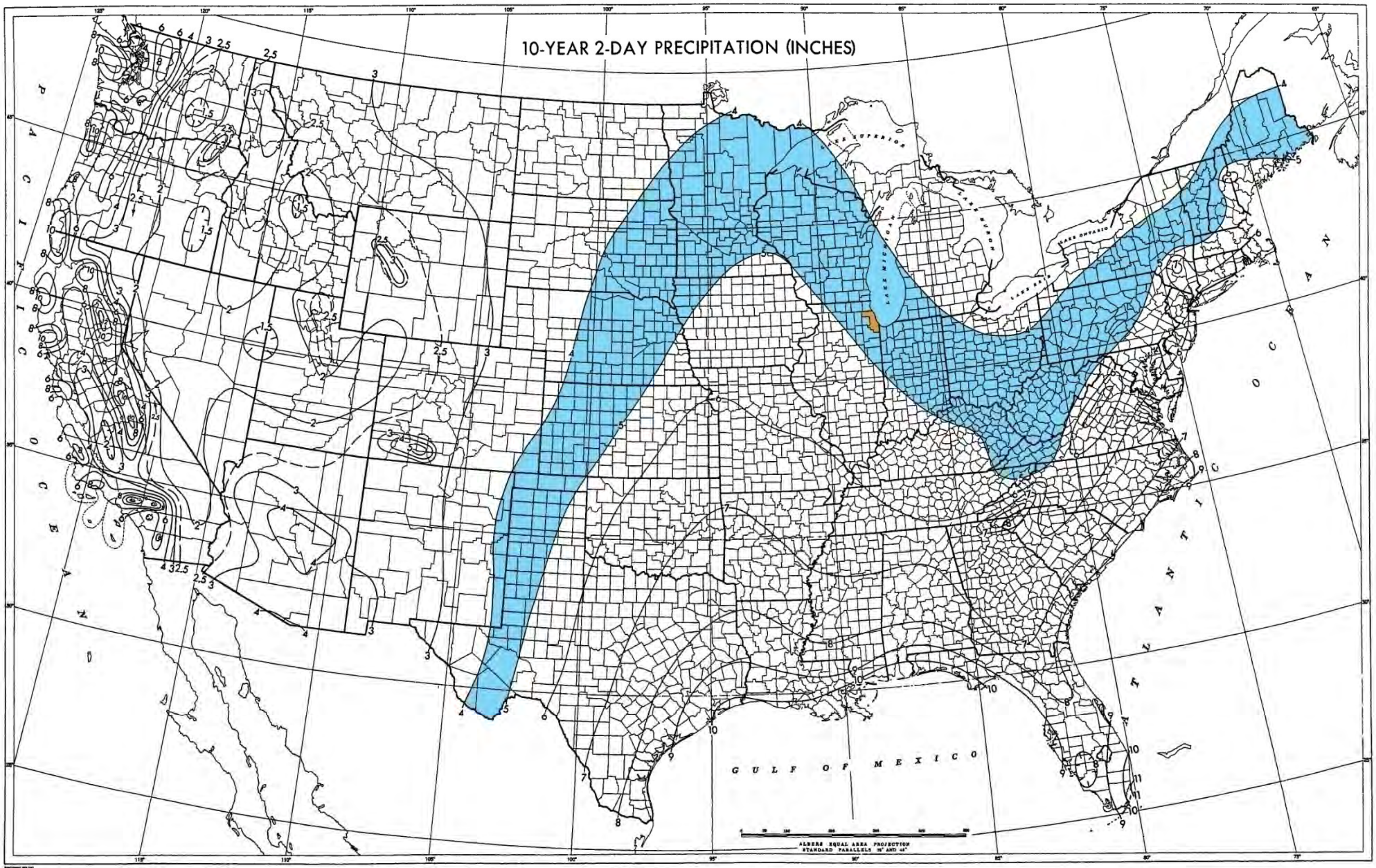





FIGURE 14.—10-year 2-day precipitation (in).

10 Year Storm over 2 days in Chicago = 4-5 Inches of Precipitation

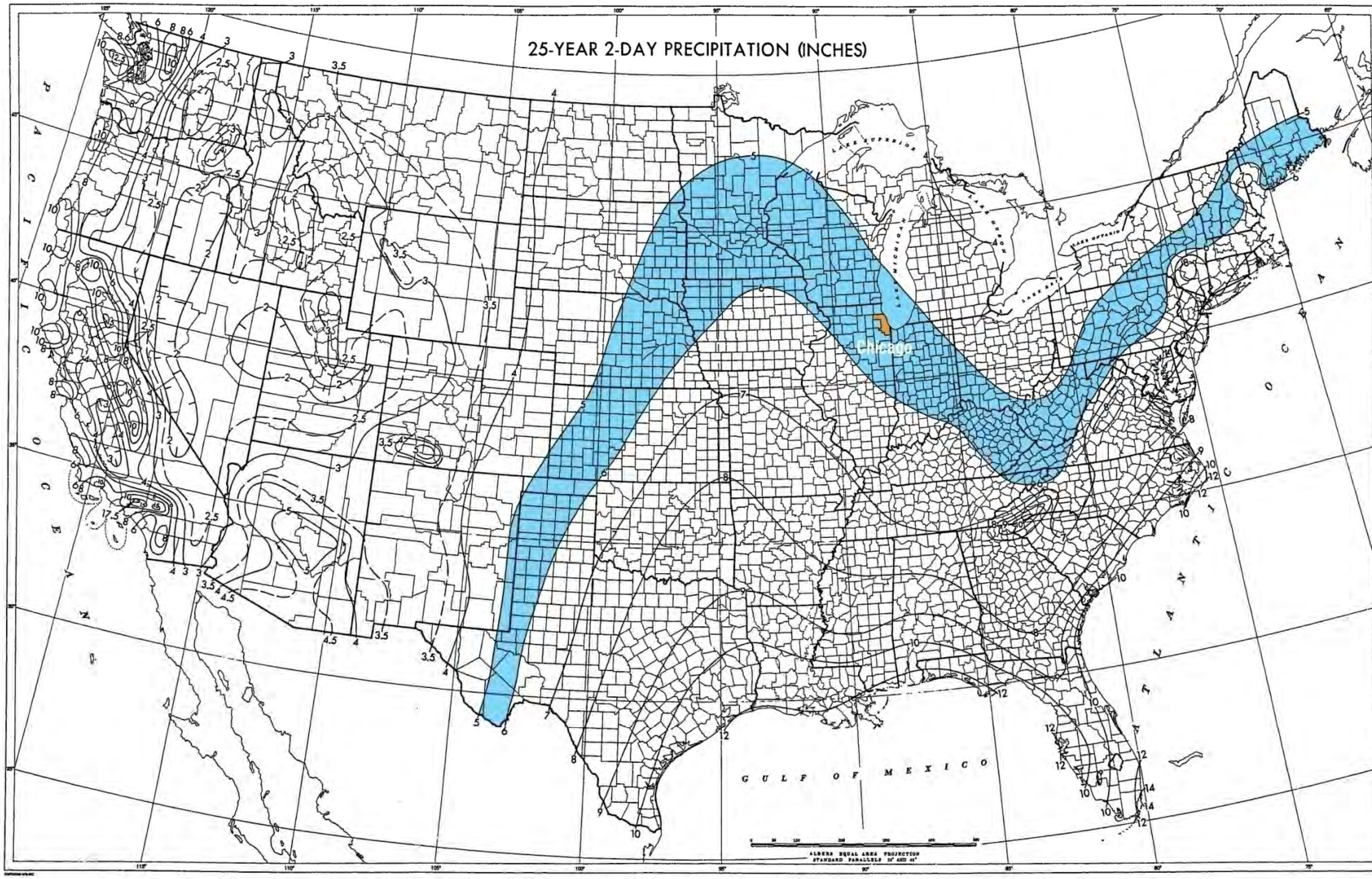



FIGURE 15.—25-year 2-day precipitation (in.).



25 Year Storm over 2 days in Chicago = 5-6 Inches of Precipitation

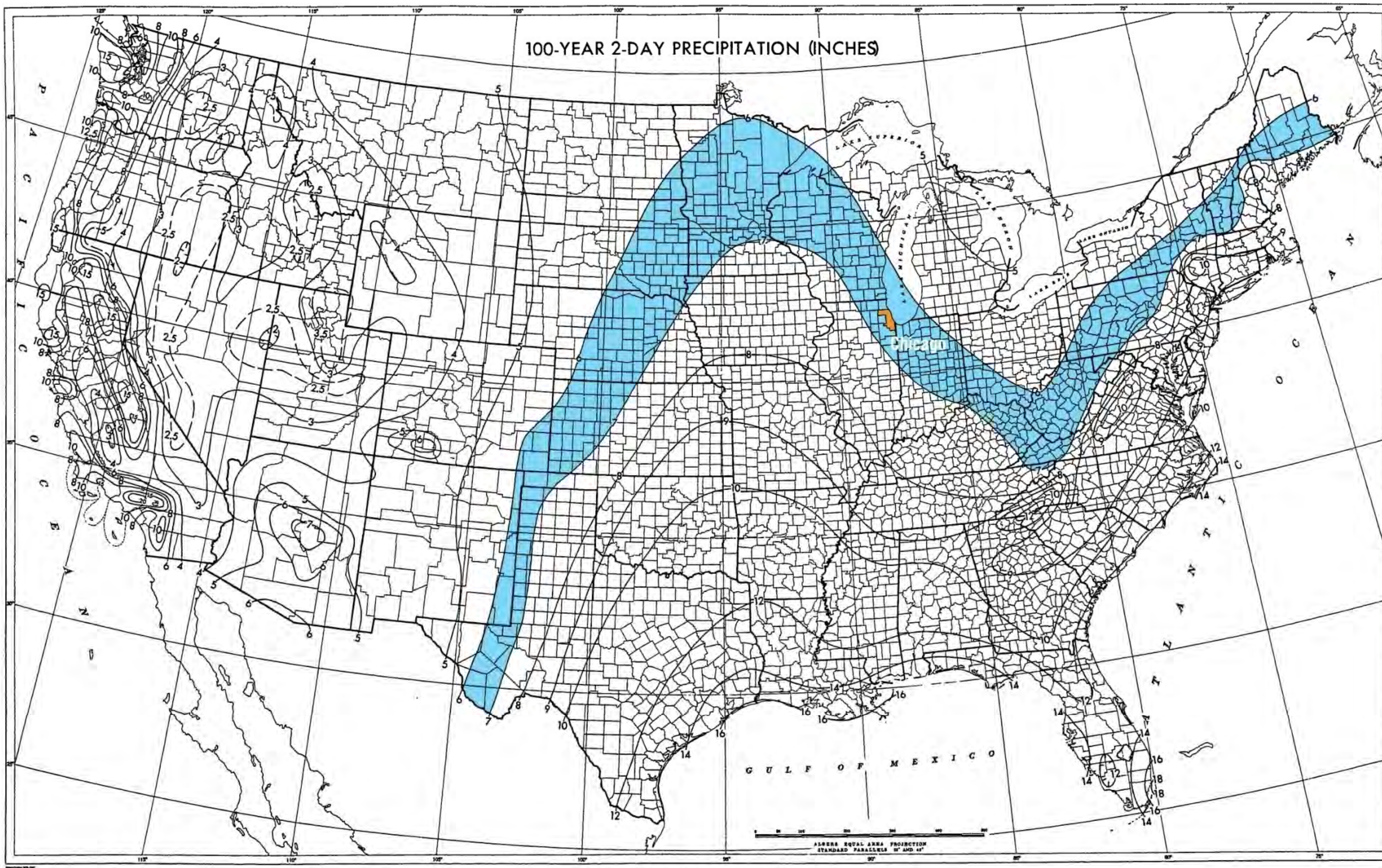



FIGURE 17.—100-year 2-day precipitation (in.).



100 Year Storm over 2 days in Chicago = 6-7 Inches of Precipitation

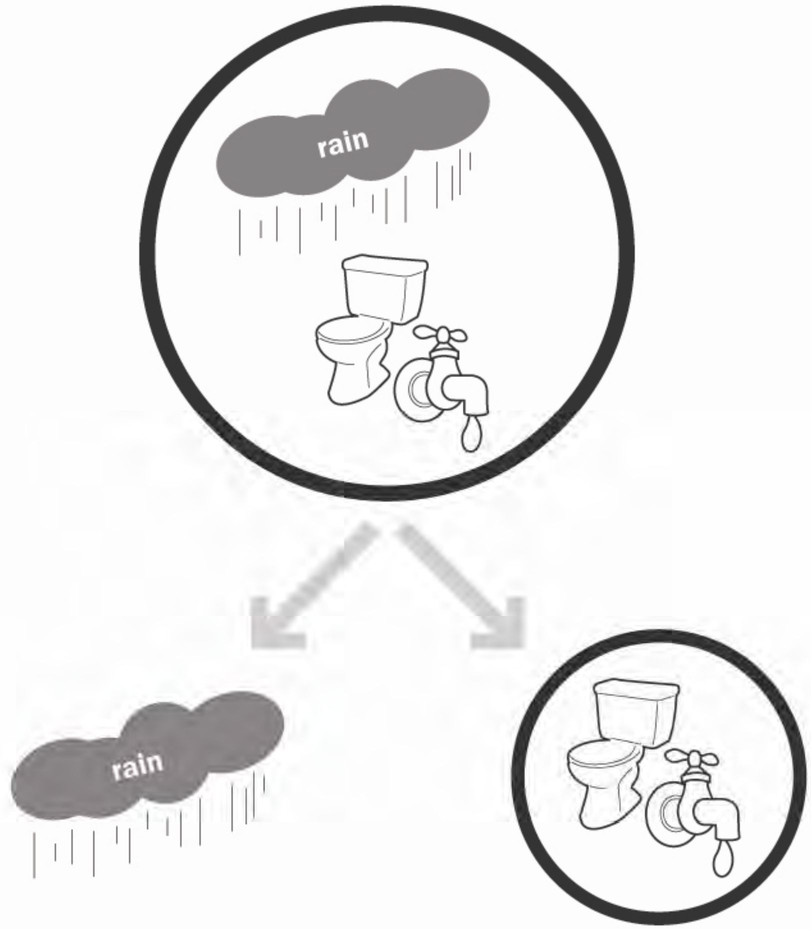
# water flow per acre

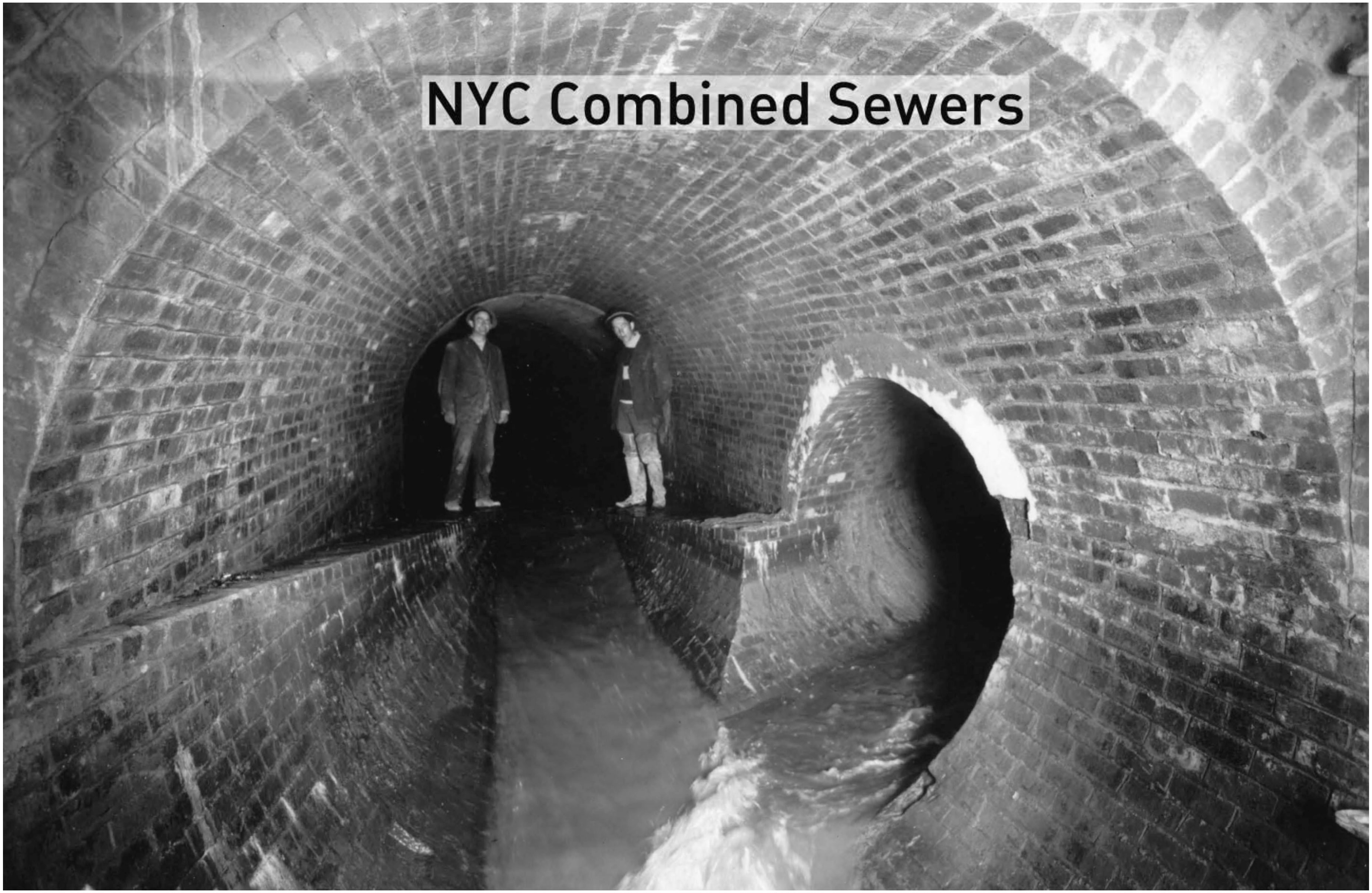
| | grass field | roof |
|---|---|---|
| 1 year storm | 630 gpm | 1,932 gpm |
| 2 year storm | 942 gpm | 2,424 gpm |
| 10 year storm | 1,932 gpm | 3,588 gpm |
| 25 year storm | 2,556 gpm | 4,266 gpm |
| 100 year storm | 3,588 gpm | 5,388 gpm |

# water metrics

| | Water Use | MySQL Row Name | | | |
|---|---|---|---|---|---|
| 31 | Property Area | proparea | sf Area of the Property | 22.601987 gal/year stormwater | (36.27 annual inches) |
| | Building Area | builtarea | sf area of the Building | | |
| | | | type - soil (permeable type to impermeable type) | | |
| | | | type - surface | | |
| | | | number of parking spaces | | |
| | | | number of sides with sidewalks | | |
| | | | driveway dimensions (non alley) | | |
| 32 | Infrastructure Area | infraarea | sf Area of Infrastructure | 22.601987 gal/year stormwater | (36.27 annual inches) |
| | | | type - soil (permeable type to impermeable type) | | |
| | | | type - infrastructure | | |
| | | | roadway | | |
| | | | sidewalk | | |
| | | | alleyway | | |
| | | | parking | | |
| | | | park | | |
| 33 | Shower | shower | 1 shower minute a day = 4.368 cubic meter per year | 1153.90352 gal/year | |
| 34 | Bathing | bath | 1 bath a week = 4.68 cubic meter per year | 1236.32521 gal/year | |
| 35 | Water spent grooming | sink | 1 minute grooming a day = 7.28 cubic meters a year | 1923.17254 gal/year | |
| 36 | Load of Laundry | laundry | 1 load of laundry a week = 6.7636 cubic meters a year | 1786.75409 gal/year | |
| 37 | Handwashing Dishes | dishhand | 1 load = 20 gallons a week x 52 weeks | 1040 gal | |
| 38 | Machinewash Dishes | dishmach | 1 load = 8 gallons a week x 52 weeks | 416 gal | |
| 39 | Washing your car | carwash | 1 minute a week = 7.8036 cubic meters | 2061.49303 gal | |
| 40 | Time spent watering garden | garden | 1 minute a week = 2.2396 cubic meters | 591.639728 gal | |
| 41 | Rinsing Equipment | rinse | 1 minute a week = 2.2396 cubic meters | 591.639728 gal | |
| 42 | Industrial | waterindust | 1 Dollar a year = 0.0246 cubic meters cap @ 5439 cubic meters | 6.49863249 gal | |

# de-coupling

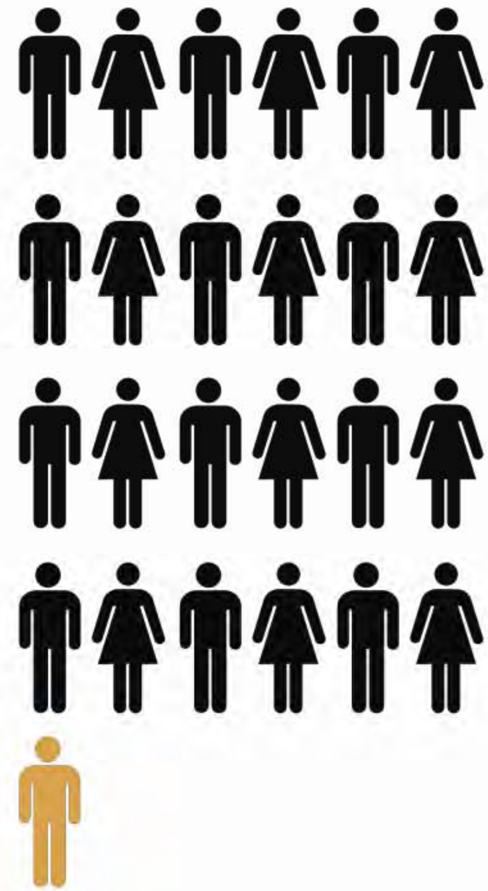



NYC Combined Sewers


27,000,000,000 (billion)
gallons/year of untreated water into NYC Harbors
(4% total waste water)

**1 of 25 flushes**

flows into NYC Harbors

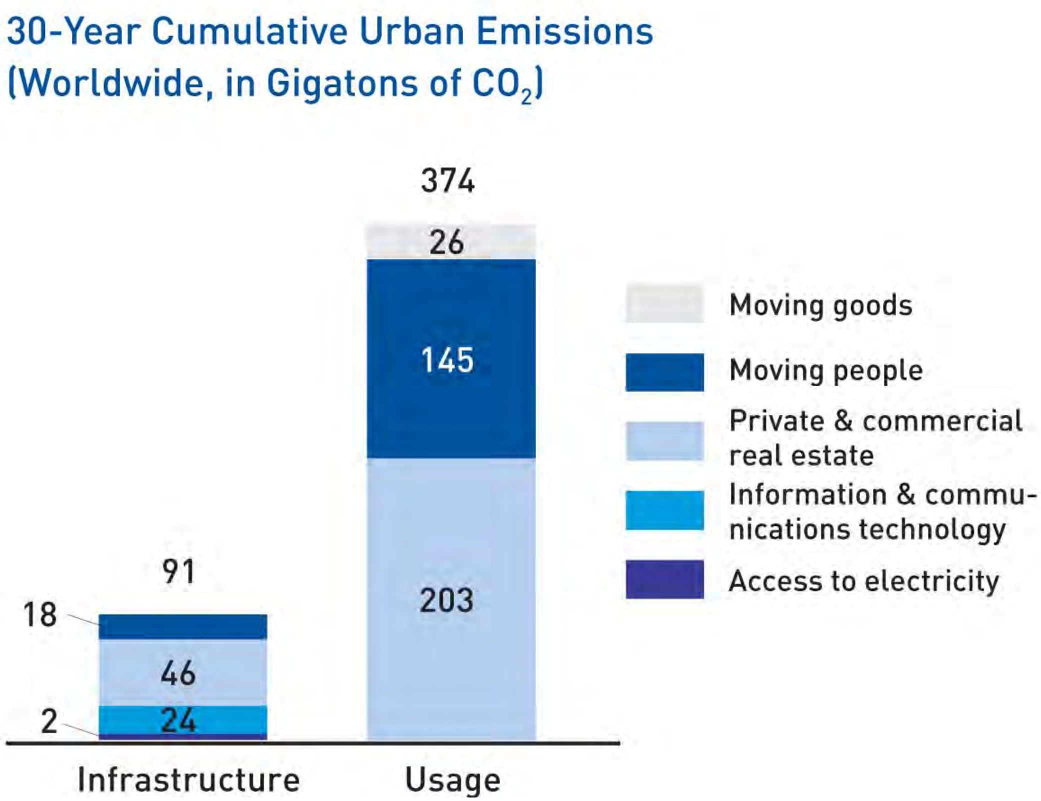


## measure

$CO_2$: how much do we create?
how much can we save?

measure

# $CO_2$: urban infrastructure and usage emissions



measure

## $CO_2$: why?

### to meet economic and public health challenges posed by rising temperatures and increased pollution levels.

Priority:
shift spending from high-carbon infrastructure to blue/green infrastructure that features low emissions.

how?:
establish Climate Action Plans to guide capital investments (and that offer attractive returns):

- reduced running costs (or net-positive power costs)
- low (or zero) carbon/water footprints
- lower air/water pollution levels
- provide community benefits

# CHICAGO CLIMATE ACTION PLAN

OUR CITY. OUR FUTURE.

# CHICAGO CLIMATE ACTION PLAN

## Problem:

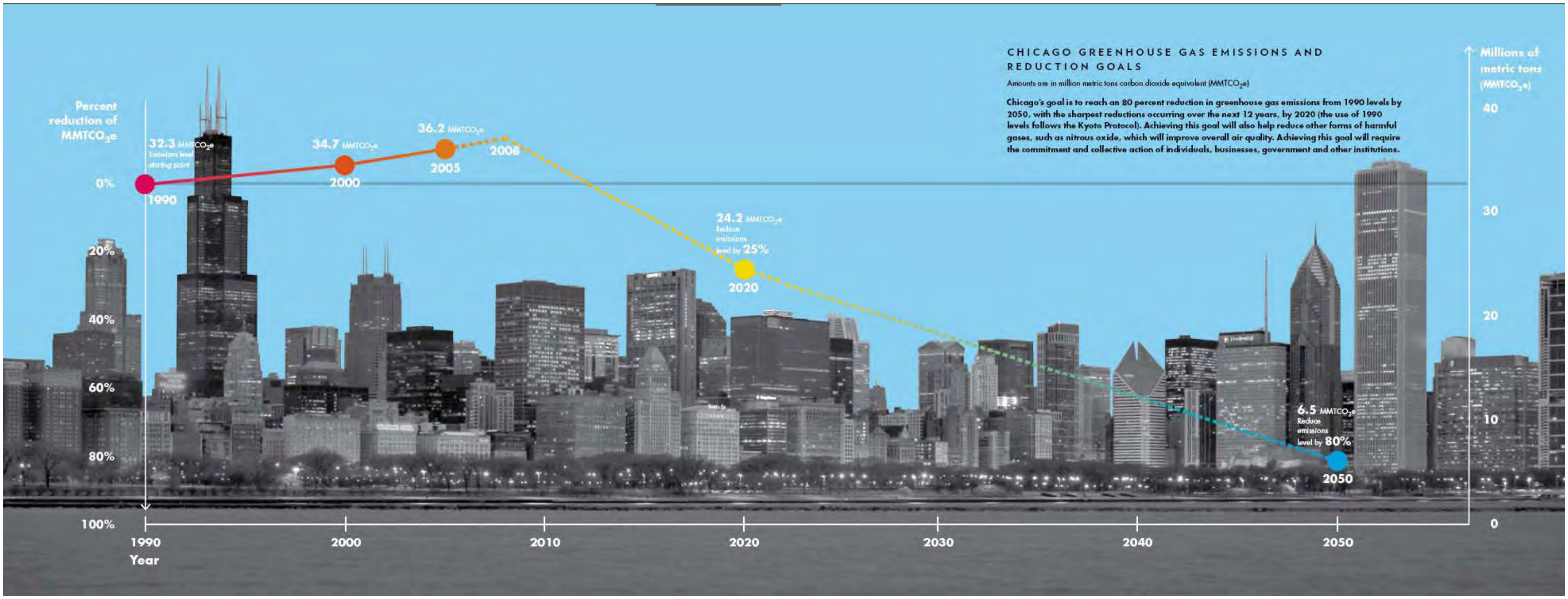
Greenhouse gas emissions could increase 35 percent by the year 2050

# CHICAGO CLIMATE ACTION PLAN

**Problem:**

- Extreme heat in the summer
- Many more heavy rain storms
- Growing flood risks
- Stresses on our public health
- Threats to the city's economy.

# CHICAGO CLIMATE ACTION PLAN



# CHICAGO CLIMATE ACTION PLAN

**Goals:**

2020: 25 percent reduction
(below 1990 GHG levels)

2050: 80 percent reduction
(below 1990 GHG levels)

# CHICAGO CLIMATE ACTION PLAN

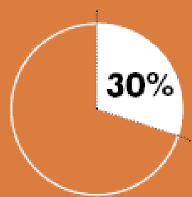
## Solution:

- Better air quality, leading to improved health for everyone
- Raising the energy efficiency of buildings saves money, lowers housing costs for families and creates jobs, especially for local businesses
- Economic development gets a boost
- As people are able to live closer to work, schools and services, they enjoy a better quality of life

# CHICAGO CLIMATE ACTION PLAN

Five Strategies:

- Energy Efficient Buildings
- Clean & Renewable Energy Sources
- Improved Transportation Options
- Reduced Waste & Industrial Pollution
- Adaptation




| Strategy | Action | Target (Government, Business, Residential) |
|---|---|---|
| ENERGY EFFICIENT BUILDINGS<br>30% of Total Chicago GHG Reductions = 4.6 $MMTCO_2e$ | 1 Retrofit commercial and industrial buildings | G B R |
| | 2 Retrofit residential buildings | G R |
| | 3 Trade in appliances | G B R |
| | 4 Conserve water | G B R |
| | 5 Update City energy code | G B R |
| | 6 Establish new guidelines for renovations | G B R |
| | 7 Cool with trees and green roofs | G B R |
| | 8 Take easy steps | G B R |

| Description | $MMTCO_2e$ Reduction |
|---|---|
| Retrofit 50 percent of commercial and industrial building stock, resulting in a 30 percent energy reduction. | 1.3 |
| Improve efficiency of 50 percent of residential buildings to achieve a 30 percent reduction in energy used. | 1.44 |
| Expand appliance trade-in and lightbulb replacement programs. | 0.28 |
| Improve water use efficiency in buildings as part of retrofits. | 0.04 |
| Align Chicago's Energy Conservation Code with latest international standards. | 1.13 |
| Require all building renovations to meet green standards. | 0.31 |
| Increase rooftop gardens to total of 6,000 buildings citywide and plant an estimated 1 million trees. | 0.17 |
| Encourage all Chicagoans to take easy steps to reduce their emissions by one metric ton of $CO_2e$ per person. | 0.8 |

# CHICAGO CLIMATE ACTION PLAN

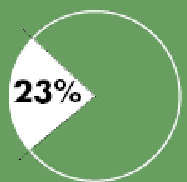
## CLEAN & RENEWABLE ENERGY SOURCES


**of Total Chicago GHG Reductions = 5.33 MMTCO$_2$e**

| | | |
|---|---|---|
| 9 | Upgrade power plants | G B |
| 10 | Improve power plant efficiency | G |
| 11 | Build renewable electricity | G B R |
| 12 | Increase distributed generation | G B |
| 13 | Promote household renewable power | G B R |

| | MMTCO$_2$e Reduction |
|---|---|
| Upgrade or repower 21 Illinois power plants. | 2.5 |
| Raise efficiency standards for new and existing power generators. | 1.04 |
| Procure enough renewable energy generation for Chicagoans to reduce electricity emissions by 20 percent | 3.0 |
| Increase efficient power generated on-site using distributed generation and combined heat and power. | 1.12 |
| Double current household-scale renewable electricity generation. | 0.28 |

## IMPROVED TRANSPORTATION OPTIONS




**of Total Chicago GHG Reductions = 3.61 $MMTCO_2e$**

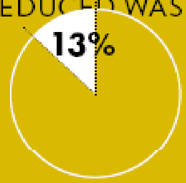
0.006*

| | | | | |
|---|---|---|---|---|
| 14 | Invest more in transit | G | B | |
| 15 | Expand transit incentives | G | B | |
| 16 | Promote transit-oriented development | G | B | R |
| 17 | Make walking and biking easier | G | B | R |
| 18 | Car share and carpool | G | B | R |
| 19 | Improve fleet efficiency | G | B | R |
| 20 | Achieve higher fuel efficiency standards | G | B | R |
| 21 | Switch to cleaner fuels | G | B | R |
| 22 | Support intercity rail | G | B | |
| 23 | Improve freight movement | G | B | |

| | MMTCO$_2$e Reduction |
|---|---|
| Invest in transit improvements and boost Chicago transit system ridership by 30 percent. | 0.83 |
| Provide incentives for transit use, such as pre-tax transit passes. | 0.03 |
| Encourage development focused on public transit, walking and bicycle use. | 0.63 |
| Increase the number of walking and bicycle trips to one million a year. | 0.01 |
| Boost car sharing, carpooling and vanpooling. | 0.5 |
| Improve the energy efficiency of fleets in Chicago, including buses, taxis and delivery vehicles. | 0.21 |
| Advocate for implementation of higher federal fuel efficiency standards. | 0.51 |
| Increase the supply and use of sustainable alternative fuels for Chicago vehicles. | 0.68 |
| Support intercity high-speed passenger rail plan. | |
| Foster more efficient freight movement, including support for CREATE. | 1.61 |

# CHICAGO CLIMATE ACTION PLAN

## REDUCED WASTE & INDUSTRIAL POLLUTION




**of Total Chicago GHG Reductions**
**= 2.03 $MMTCO_2e$**

| | | | | |
|---|---|---|---|---|
| 24 | Reduce, reuse and recycle | G | B | R |
| 25 | Shift to alternative refrigerants | G | B | R |
| 26 | Capture stormwater on-site | G | B | R |

| | MMT$CO_2$e Reduction |
|---|---|
| Reduce, reuse and recycle 90 percent of the city's waste by 2020. | 0.84 |
| Promote use of alternative refrigerants in air conditioners and appliances. | 1.16 |
| Manage stormwater with green infrastructure. | 0.1 |

| Strategy | Action | Description |
|---|---|---|
| Infrastructure | 27 Manage heat | Update the heat response plan, focusing on vulnerable populations; complete further research into urban heat island effect and pursue ways to cool hot spots. |
| | 28 Pursue innovative cooling | Launch an effort to seek out innovative ideas for cooling the city and encourage property owners to make green landscape and energy efficiency improvements. |
| | 29 Protect air quality | Intensify efforts to reduce ozone-precursors through mitigation programs that reduce driving and emissions from power plants. |
| | 30 Manage stormwater | Collaborate with the Metropolitan Water Reclamation District on a Chicago watershed plan that factors in climate change and uses vacant land to manage stormwater. |
| | 31 Implement Green Urban Design | Implement key steps in Chicago's Green Urban Design plan to manage heat and flooding. These steps will enable Chicago to capture rain where it falls and reflect away some of the intensity of the sun on hot days. |
| | 32 Preserve our plants and trees | Publish a new plant-growing list that focuses on plants that can thrive in altered climate. Also draft a new landscape ordinance to accommodate plants that can tolerate the altered climate. |
| | 33 Engage the public | Share climate research findings with groups most affected—social service agencies, garden clubs, etc. Help individual households to take their own steps to reduce flooding and manage heat waves, such as installing rain barrels and back-up power for sump pumps and planting shade trees. |
| | 34 Engage businesses | Work with businesses to analyze their vulnerability to climate change and take action. |
| | 35 Plan for the future | Use the Green Steering Committee of City Commissioners to oversee City implementation efforts and the Green Ribbon Committee of business and community leaders to assess how the Plan is being implemented, recommend revisions, report to the Mayor and all Chicagoans on our progress. |

## measure

$: how much and how can we save?
Benefits: how can neighborhoods improve?

# $ + benefits: blue/green infrastructure

## benfits and $ savings basic categories

- Individual ($ savings)
- Community (benefits via amenities)
- Ecosystem Services (clean air/water, biodiversity, food, etc)

# $ + benefits: Chicago $800 Challenge

## HAVE YOU TAKEN THE **$800 SAVINGS CHALLENGE?**

| Measure | Cost | $CO_2e$ Impact/ Participant (metric tons) | Annual Savings/ Participant or Household |
|---|---|---|---|
| **ENERGY EFFICIENT BUILDINGS** | | | |
| ☐ Reduce heating temperature by three degrees.* | None | 0.522 | **$129** |
| ☐ Increase cooling temperature by three degrees.* | None | 0.075 | **$13** |
| ☐ Turn off three 60-watt bulbs for two hours per day. | None | 0.080 | **$14** |
| ☐ Save four gallons of water a day, by turning off the water while brushing teeth or reducing shower time by one minute. | None | 0.003 | **$5** |
| ☐ Replace nine incandescent bulbs with CFLs. | Low | 0.602 | **$108** |
| ☐ Replace home air conditioner filter. | Low | 0.083 | **$15** |
| ☐ Plug all appliances that use standby settings (like TV and stereo) into power strips and turn off the power strips when not in use. | | 0.128 | **$23** |
| ☐ Plant one tree. | Low | 0.021 | – |
| **CLEAN & RENEWABLE ENERGY SOURCES** | | | |
| ☐ Replace outdoor lighting with solar lights.† | Low | 0.268 | **$48** |
| **IMPROVED TRANSPORTATION OPTIONS** | | | |
| ☐ Eliminate 10 miles of driving per week.** | None | 0.223 | **$99** |
| ☐ Keep car tuned up and tires properly inflated.*** | Low | 0.799 | **$360** |
| **REDUCED WASTE & INDUSTRIAL POLLUTION** | | | |
| ☐ Add a rain barrel. | Low | 0.018 | **$8** |
| ☐ Recycle every Sunday newspaper instead of throwing it in the trash. | Low or None | 0.012 | – |
| TOTAL | | 2.82 | **$823** |

# $ + benefits: blue/green infrastructure

## Energy Savings and Carbon Footprint Reduction

Green space helps lower ambient temperatures and, when incorporated on and around buildings, helps shade and insulate buildings from wide temperature swings, decreasing the energy needed for heating and cooling.

Diverting stormwater from wastewater collection, conveyance, and treatment systems reduces the amount of energy needed to pump and treat water.

Reduced energy demands in buildings, and increased carbon sequestration by added vegetation, result in a lower carbon footprint (reduced $CO_2$ emissions).

Trees and green roofs directly reduce building energy use.

Valuation of Reduced Energy Use:

- Calculated using the market price (via local utilities) of natural gas (BTUs) and electricity (kWh).

- The economic impact of climate change values carbon dioxide emissions at $85/ton (Stern Report 2006).

# $ + benefits: blue/green infrastructure

## Heat Stress Reduction

Blue/green infrastructure (trees, green roofs, and bio-retention areas) creates shade, reduces the amount of heat absorbing materials and emits water vapor – all of which cool hot air.

This cooling effect will be sufficient to reduce heat stress-related fatalities in the City during extreme heat wave events.

Valuation of a Human Life:

- Stanford economists have demonstrated that the average value of a year of quality human life is $129,000.

# $ + benefits: blue/green infrastructure

## Recreation

Recreational opportunities increase as a result of infiltration area restoration and riparian buffer improvements.

Recreation improves in other parts of the City due to the general increase in vegetated and treed acreage in the City.

Valuation of Parks:

- Hedonic price method (increases in property values adjacent to parks)
- Travel-Cost Method (a measurement of market demand)
- Contingent Valuation (willingness to pay)

# $ + benefits: blue/green infrastructure

## Increased Community Aesthetics, Reflected in Higher Property Values

Trees and plants improve urban aesthetics and community livability.

Property values are higher when trees and other vegetation are present.

Valuation of Property:

- A review of the literature suggests a 20% guideline for increased property value for those properties fronting or abutting (or within a certain distance) a public/private park.

# $ + benefits: blue/green infrastructure

## Blue/Green Infrastructure (Water Quality and Aquatic) Ecosystem Improvements

Traditional infrastructure options (e.g., plant expansions, tunnels) are aimed at reducing the number of overflow episodes, but do little to directly improve the physical riparian area environment (i.e., riparian and aquatic ecosystems and habitat areas) or otherwise enhance living resources in many of the City's watershed environments.

In contrast, blue/green infrastructure options, in conjunction with the related watershed restoration efforts, are expected to generate important improvements to these living natural resources.

Valuation of avoided gray infrastructure costs:

- The value of single-family residential sewer service fees (which cover the capital, operation, and improvements of citywide sewer and stormwater management systems) is $3.43 per 100 cubic feet, or $0.0046 a gallon

- Control / Cost to manage 10 m gallons: Surface storage = $38.56; Deep tunnels = $53.33; Detention basins = $369,797; Retention basins = $470,899

# $ + benefits: blue/green infrastructure

## Wetland Creation and Enhancement

Added and enhanced wetland acres will provide a range of services in the urban area watersheds.

Valuation of Wetlands:

- A large treatment facility spends $8.50 to remove a pound of suspended solids, and $6 to $12 to remove a pound of phosphorus; avoided costs are $29.94 per acre foot of runoff reduced, or $0.0000765 per gallon.

## $ + benefits: blue/green infrastructure

# Poverty Reduction from Local Green Jobs

Blue/green infrastructure creates the opportunity to hire local unskilled – and otherwise unemployed – laborers for landscaping and restoration activities.

Valuation of Jobs and Training:

- The benefits of providing local green jobs include the avoided costs of social services that the City would otherwise provide on behalf of some people if they remained unemployed.

- The average unemployment check in America is $293 which, when multiplied by fifty-two weeks, is $15,236 per year.

# $ + benefits: blue/green infrastructure

## Air Quality Improvement

Trees and vegetation improve air quality by filtering some airborne pollutants (e.g., particulate matter and ozone).

Reduced energy consumption results in decreased emissions (e.g., $SO_2$ and $NO_x$) from power generation facilities.

Air quality improvements can reduce the incidence and severity of respiratory illness and mitigate community health care costs.

Valuation of Air Quality Improvements:

- The Urban Forest Effects (UFORE) model gives dollar values for gaseous pollutants and particulate matter on a per-Metric tons (t) basis as follows: $NO_2$= $6,752 t, $PM_{10}$ = $4,508 t, $SO_2$ = $1,653 t, and CO = $959 t

- EPA estimates health benefits (fewer premature deaths; fewer cases of chronic bronchitis) of reduced $NO_2$ emissions at $1680 to $6380 per metric ton.

# $ + benefits: blue/green infrastructure

## Construction and Maintenance Related Disruption

Social costs of disruption can include traffic delays, limited access to places of business, increased noise and pollution, and other inconveniences.

Levels of disruption are considerably less for the blue/green infrastructure options than many of the traditional gray infrastructure alternatives.

Valuation of Congestion:

- The annual cost of congestion for each driver is $1000 in large cities, $550 in medium cities and $200 in small cities.

- The impact of road and aircraft noise on property values find average reductions in property value per one decibel increase in noise level of 0.55% and 0.86%, respectively.

neighborSHED

# the model measures + reports

how much power do I/we use?
how much water do I/we use?
how much $CO_2$ do I/we create?
how many $ can I/we save?


1 Mile (20 Minute Walk)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neighbor SHED
Email
Password
Sign In
NeighborSHED helps you take environmental action and connect with people in your area.
Get Started!
First Name
Last Name
Your Email
Create Password
Re-enter Password
Get Started!
Done


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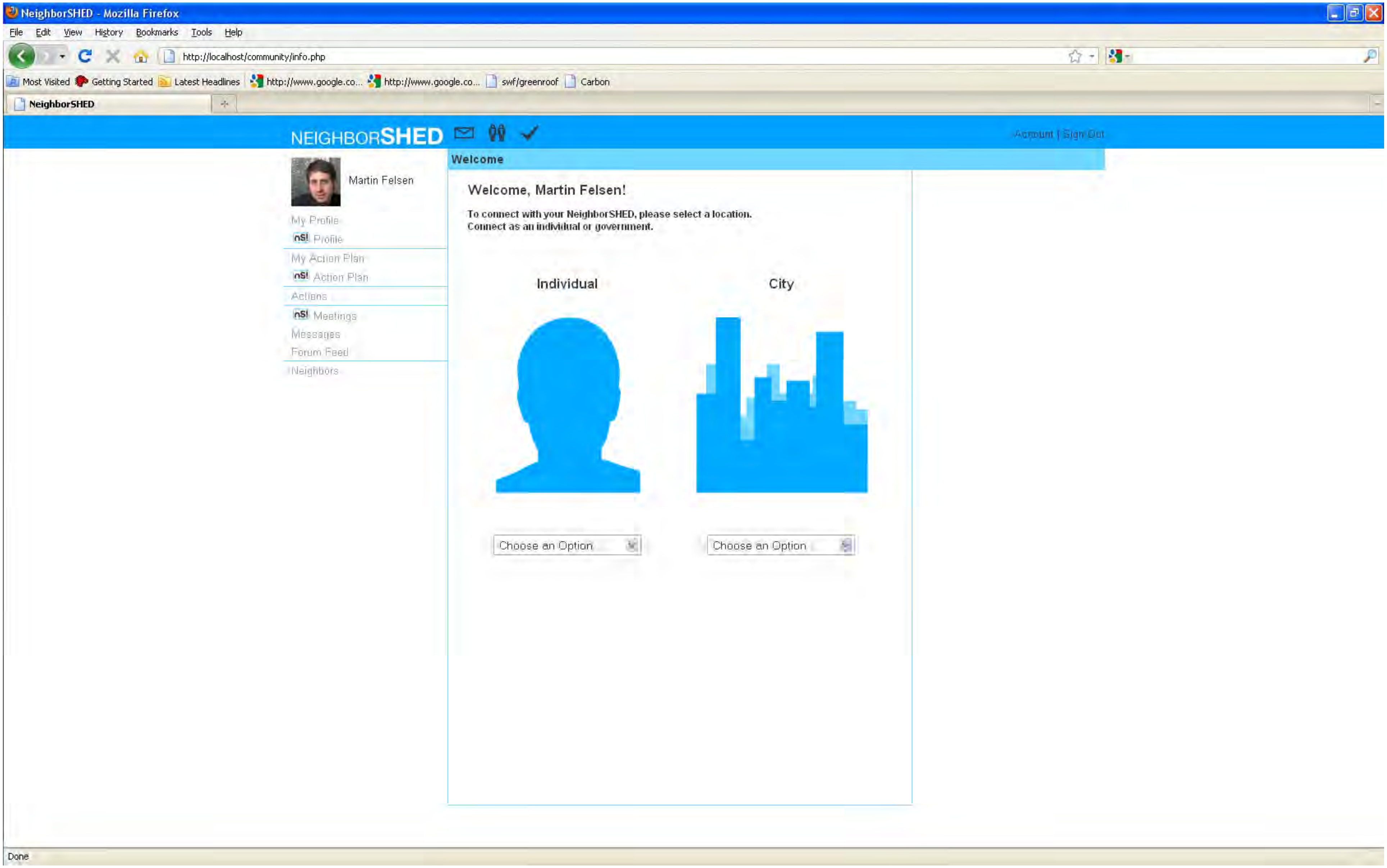
Welcome to NeighborSHED!
neighbor SHED
Email
Password
Sign In
NeighborSHED helps you take environmental action and connect with people in your area.
nS!
Get Started!
First Name Martin
Last Name Felsen
Your Email felsen@urbanlab.com
Create Password ●●●●●●●●
Re-enter Password ●●●●●●●●
Get Started!
Done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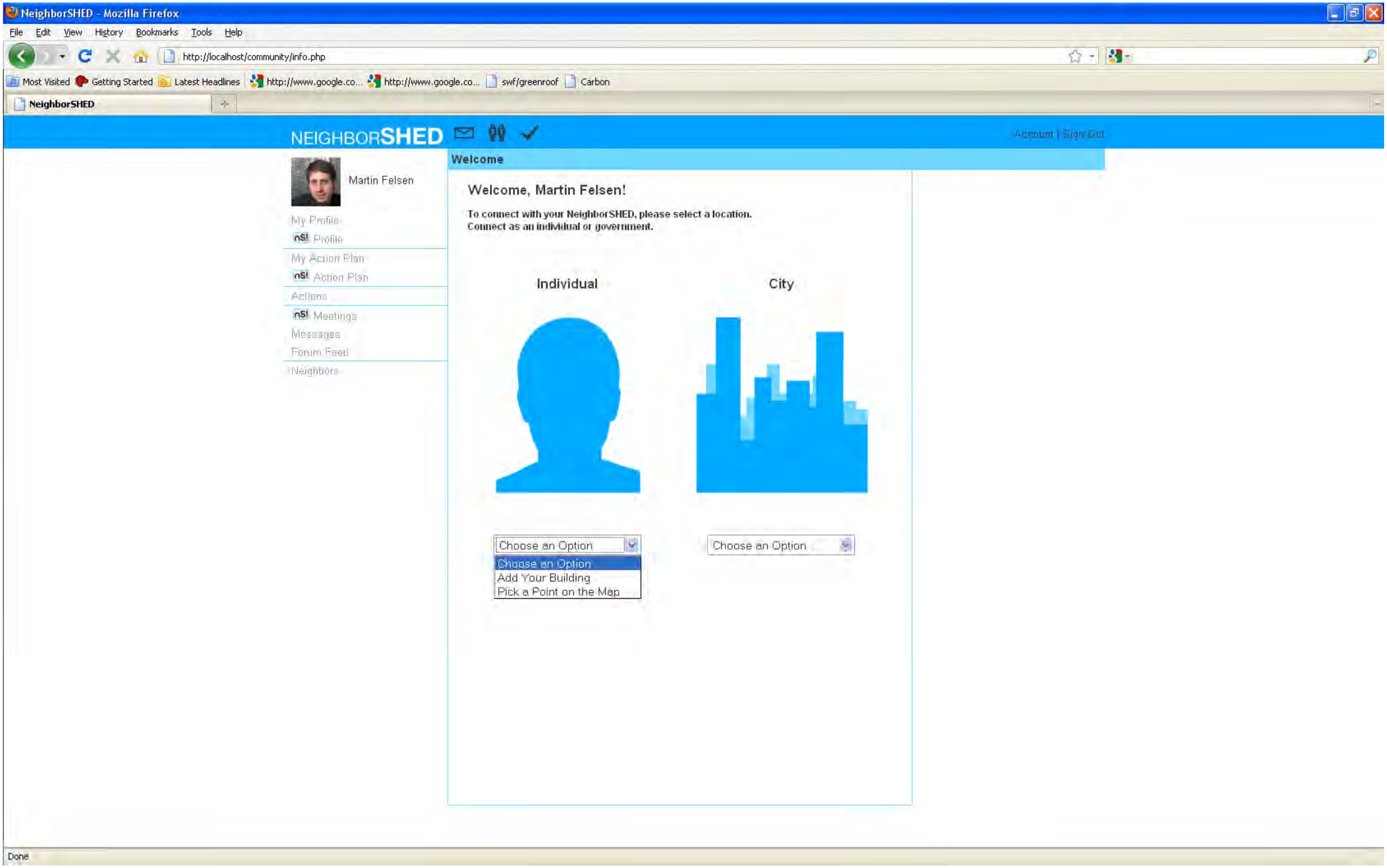
nS! Profile
My Action Plan
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Welcome
Welcome, Martin Felsen!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
Individual
City
Choose an Option
Choose an Option
Done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Welcome
Welcome, Martin Felsen!
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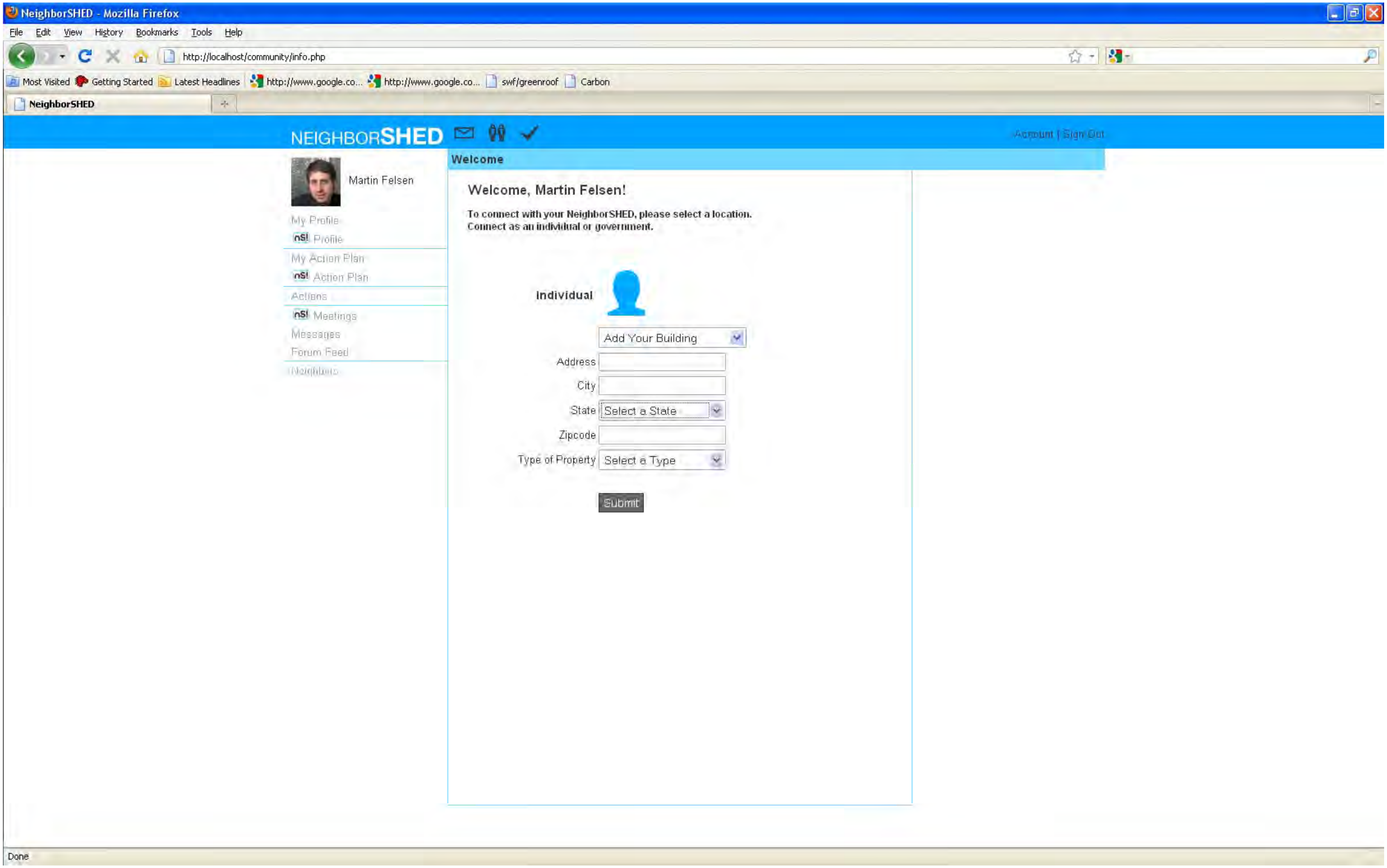
Connect as an individual or government.
Individual
City
Choose an Option
Choose an Option
Add Your Building
Pick a Point on the Map
Choose an Option
Done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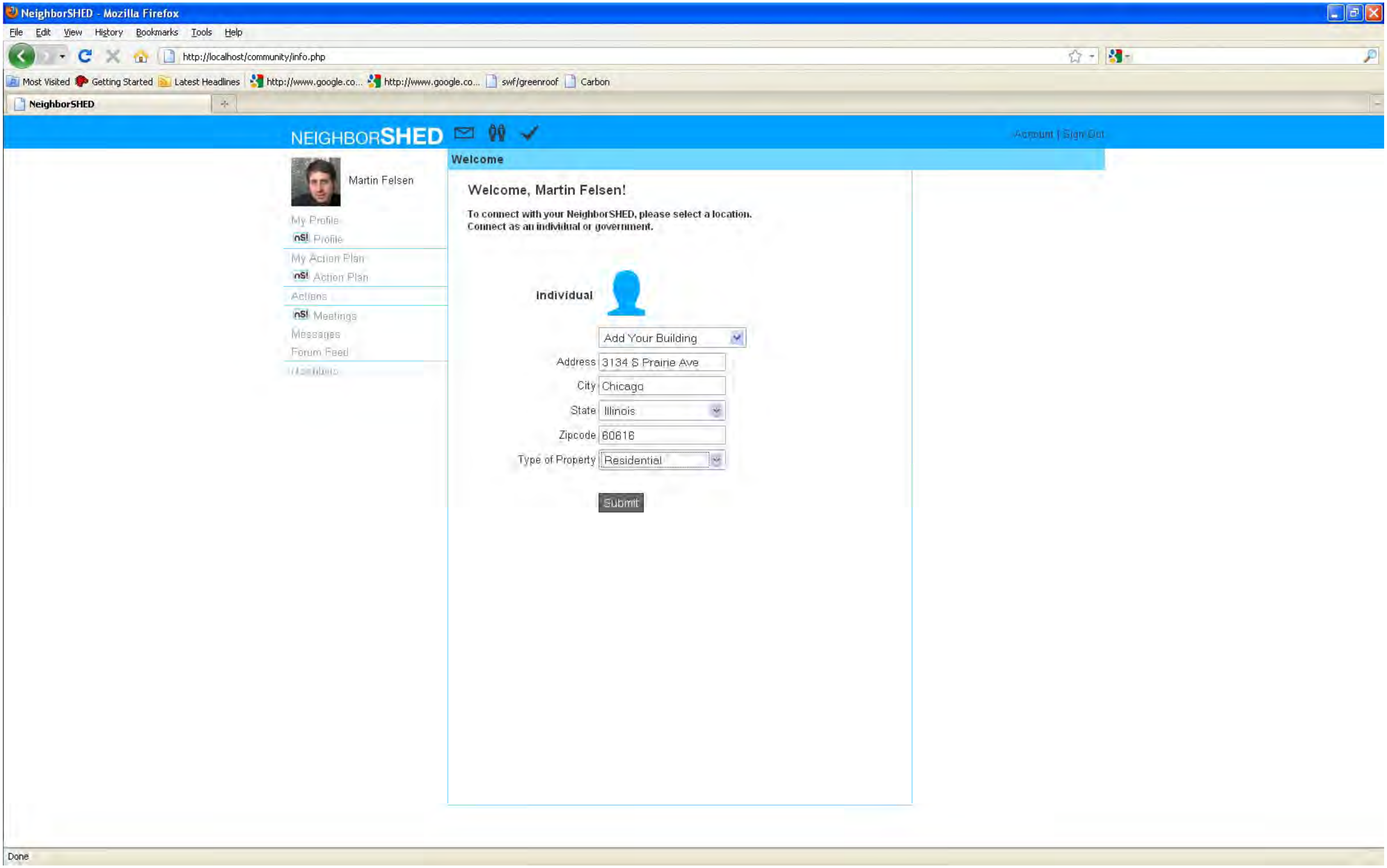
Messages
Forum Feed
Welcome
Welcome, Martin Felsen!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
Individual
Add Your Building
Address
City
State
Select a State
Zipcode
Type of Property
Select a Type
Submit
Done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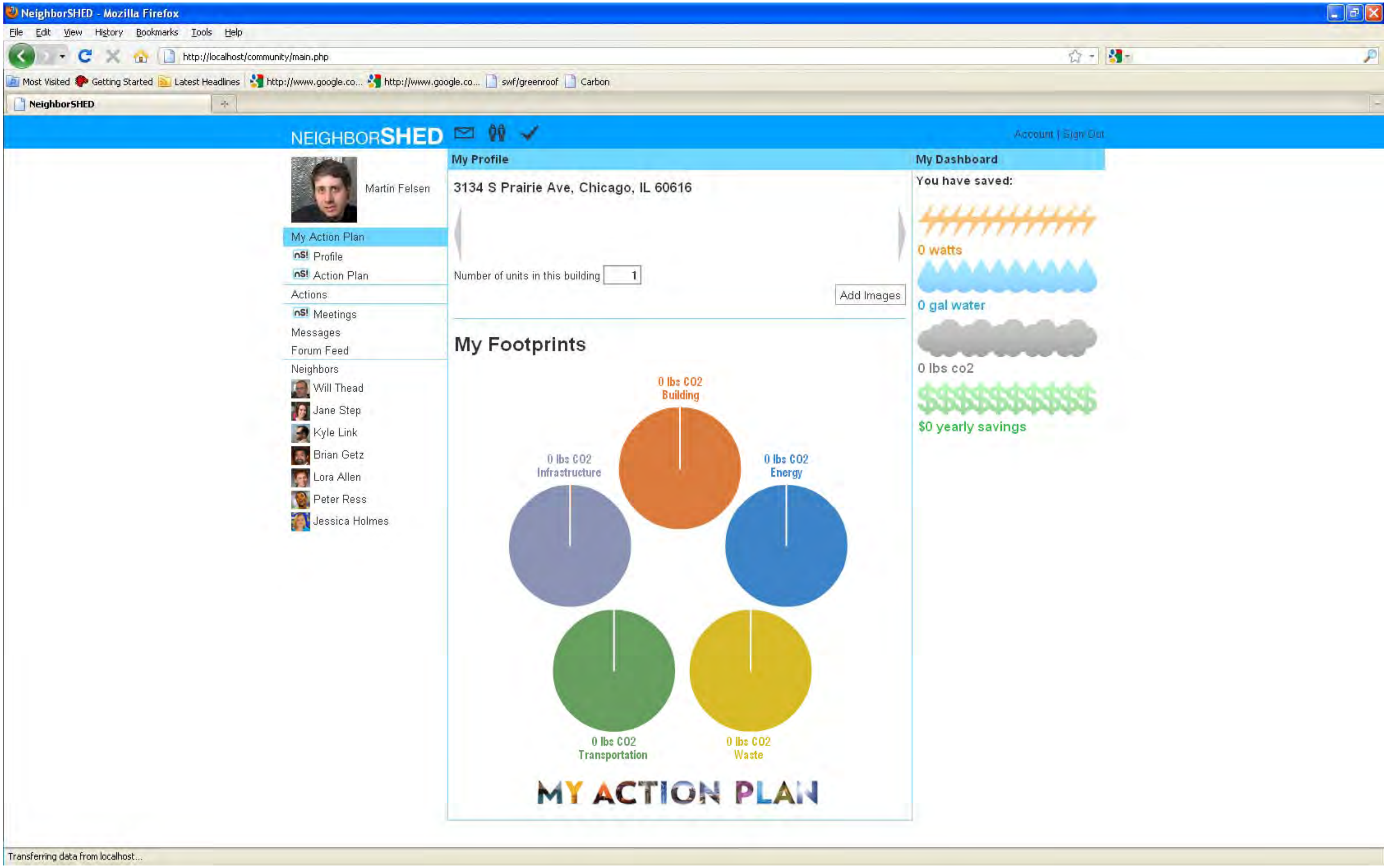
Actions
nS! Meetings
Messages
Forum Feed
Welcome
Welcome, Martin Felsen!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
Individual
Add Your Building
Address 3134 S Prairie Ave
City Chicago
State Illinois
Zipcode 60616
Type of Property Residential
Submit
Done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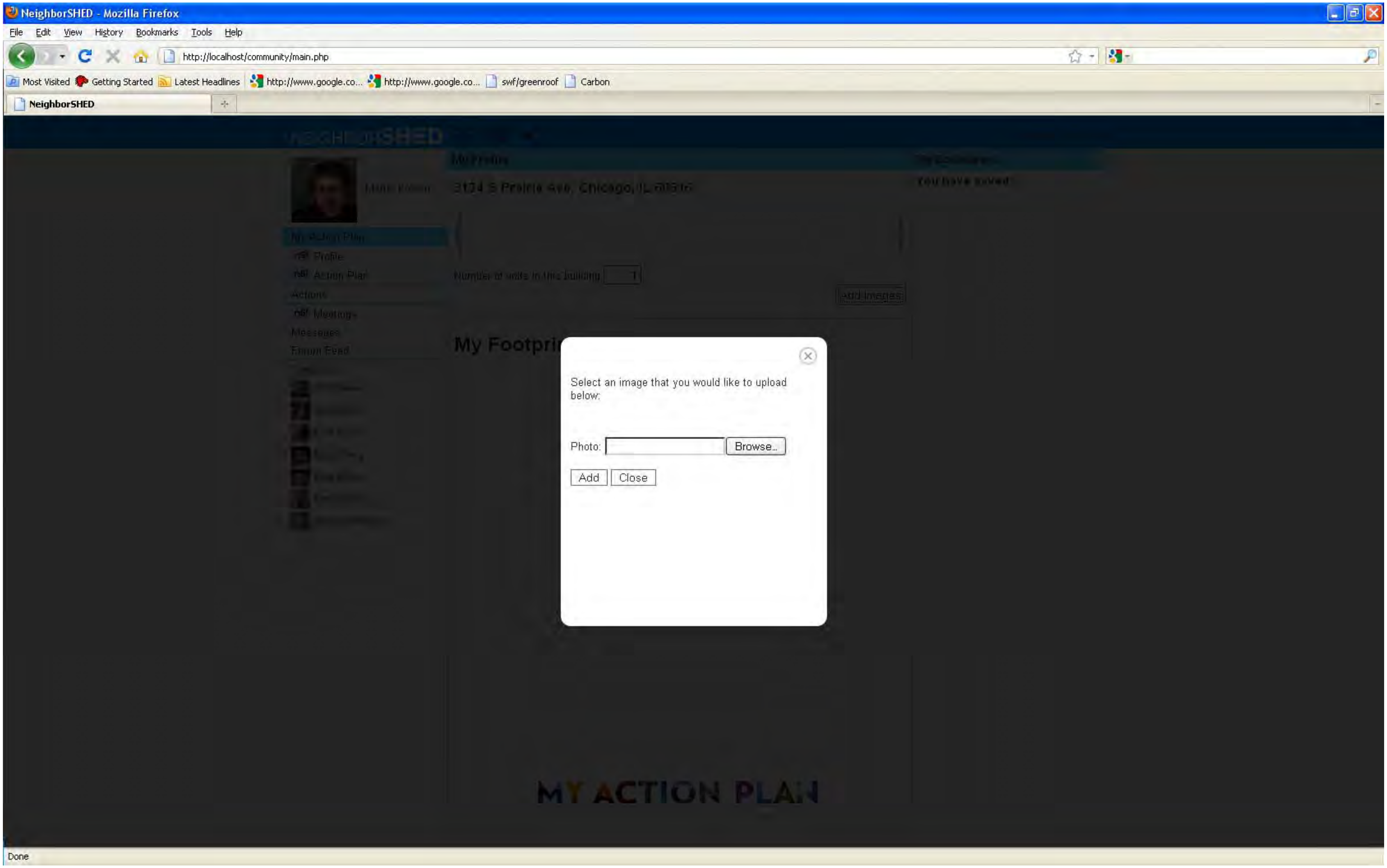
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 1
Add Images
My Footprints
0 lbs CO2 Building
0 lbs CO2 Infrastructure
0 lbs CO2 Energy
0 lbs CO2 Transportation
0 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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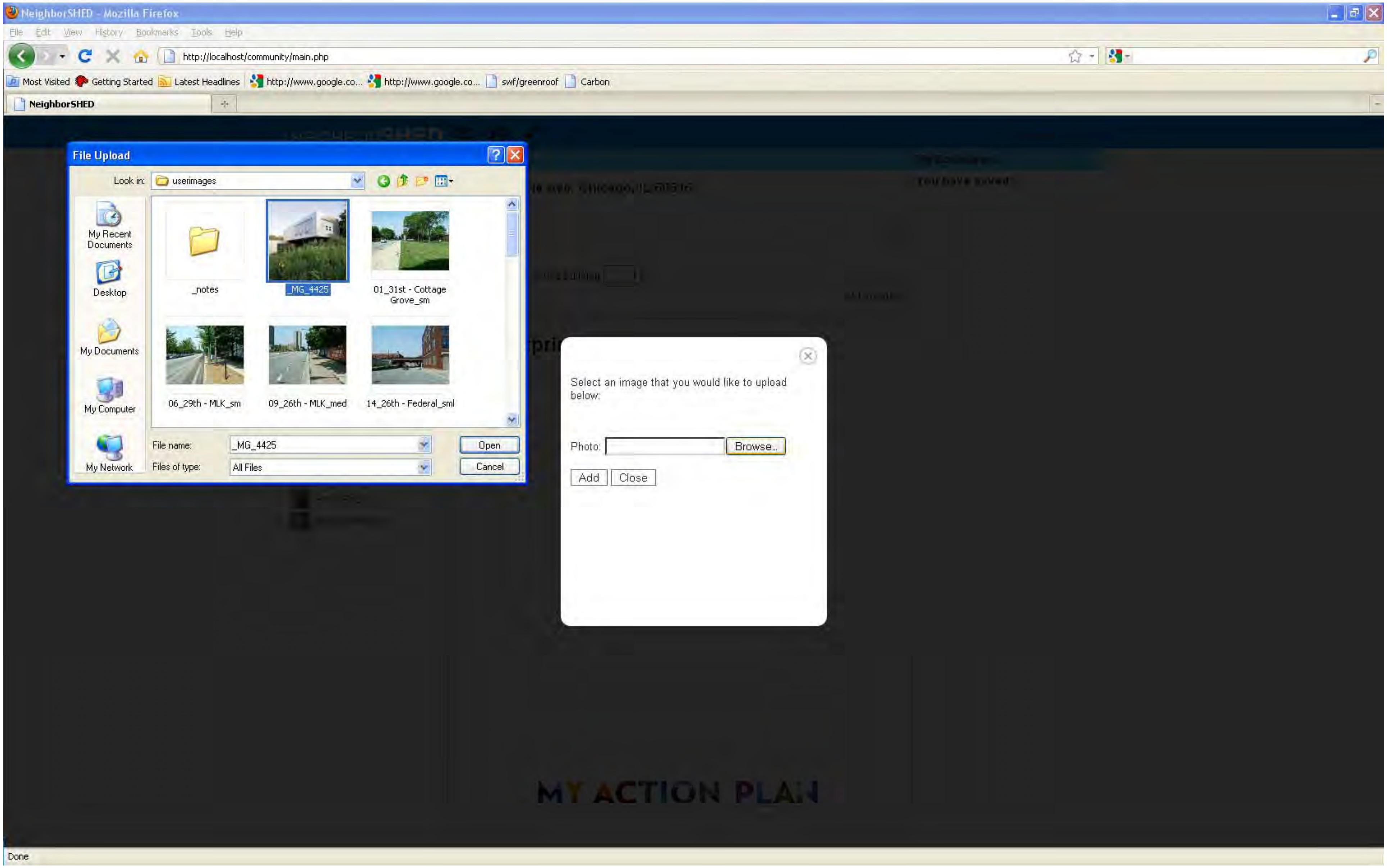
Select an image that you would like to upload below:
Photo:
Browse...
Add
Close
MY ACTION PLAN
Done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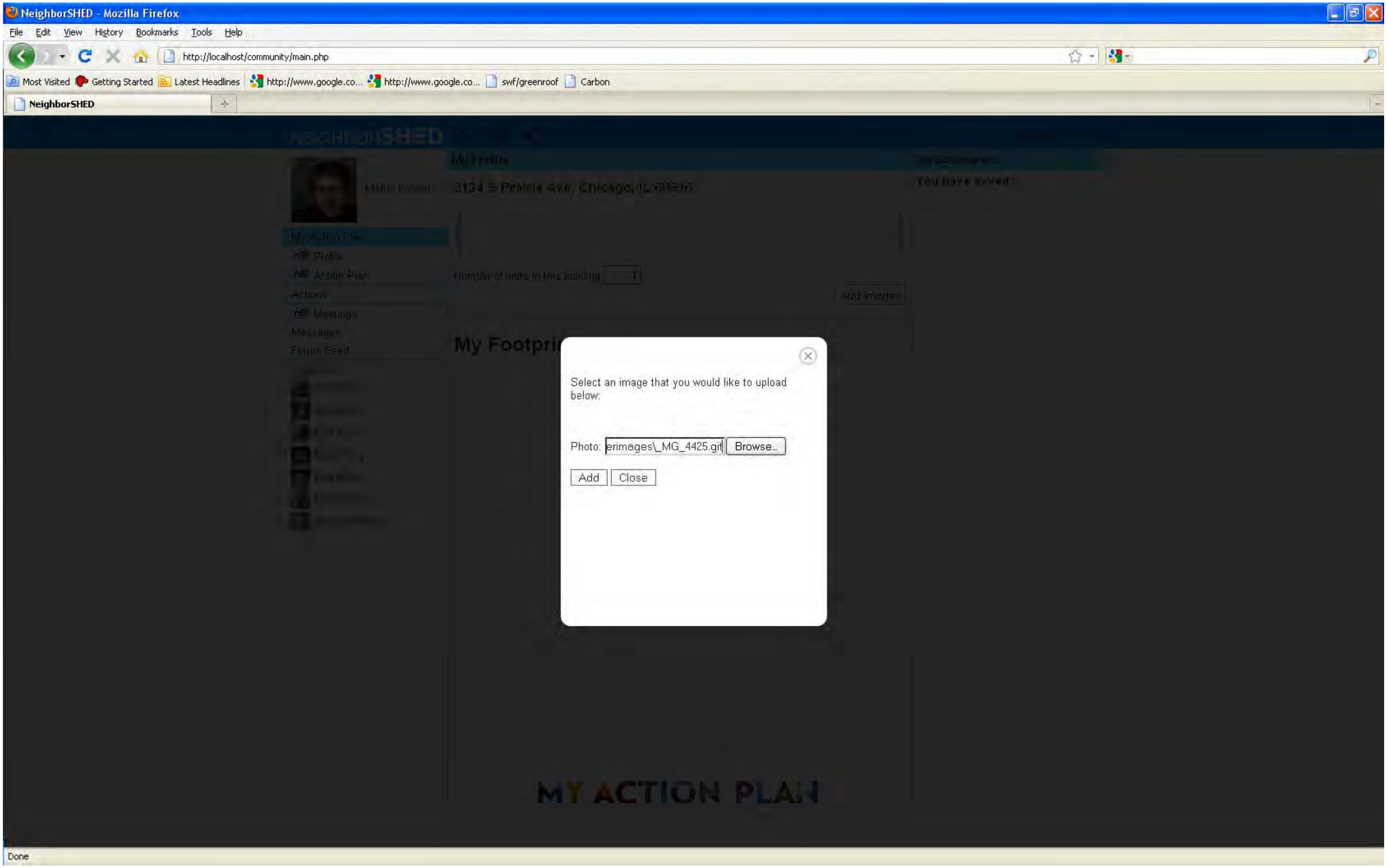
File Upload
Look in: userimages
My Recent Documents
Desktop
My Documents
My Computer
My Network
_notes
_MG_4425
01_31st - Cottage Grove_sm
06_29th - MLK_sm
09_26th - MLK_med
14_26th - Federal_sml
File name: _MG_4425
Files of type: All Files
Open
Cancel
Select an image that you would like to upload below:
Photo:
Browse...
Add
Close
MY ACTION PLAN
Done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swf/greenroof
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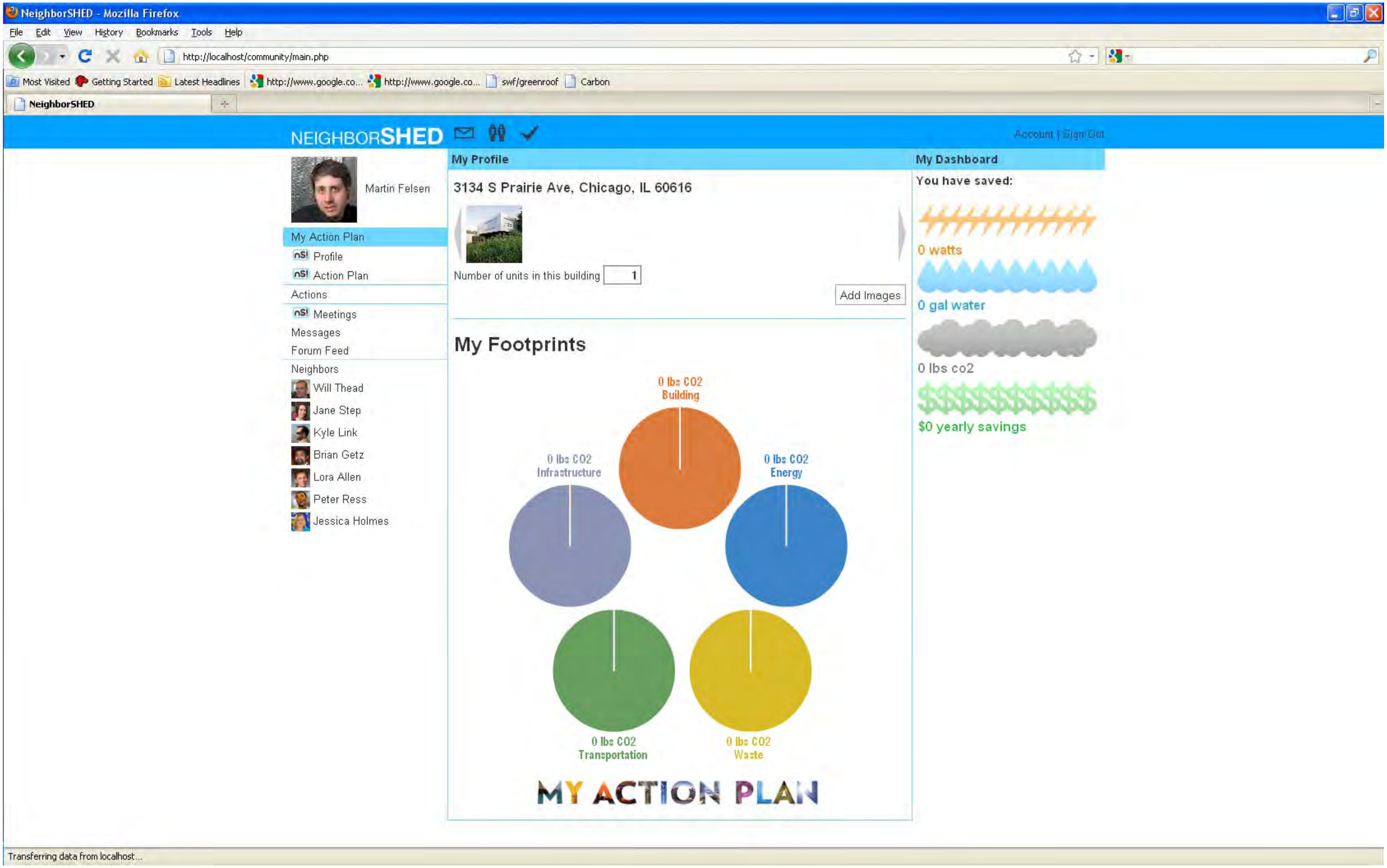
Select an image that you would like to upload below:
Photo: erimages_MG_4425.gif
Browse...
Add
Close
MY ACTION PLAN
Done



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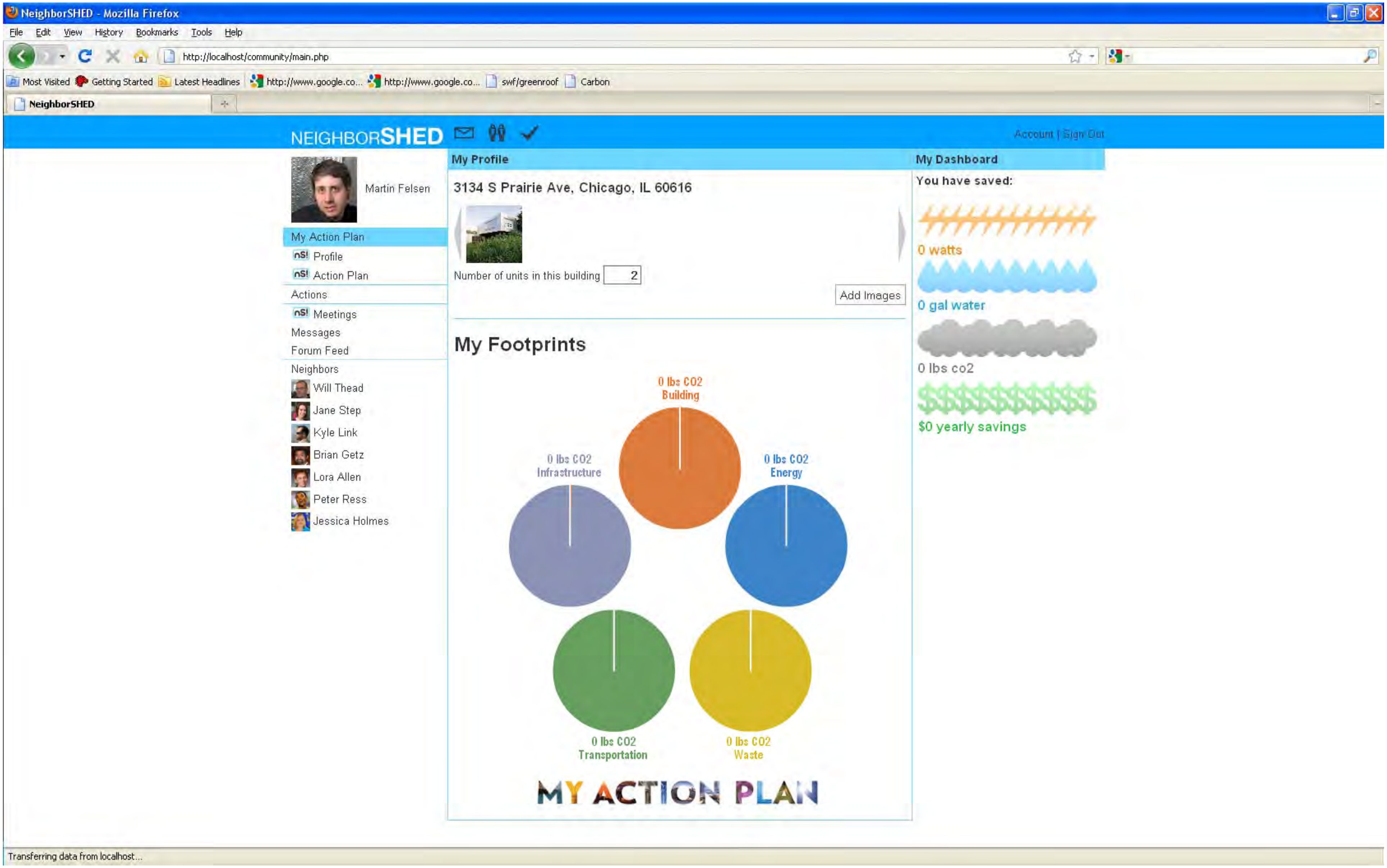
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 1
Add Images
My Footprints
0 lbs CO2 Building
0 lbs CO2 Infrastructure
0 lbs CO2 Energy
0 lbs CO2 Transportation
0 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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Will Thead
Jane Step
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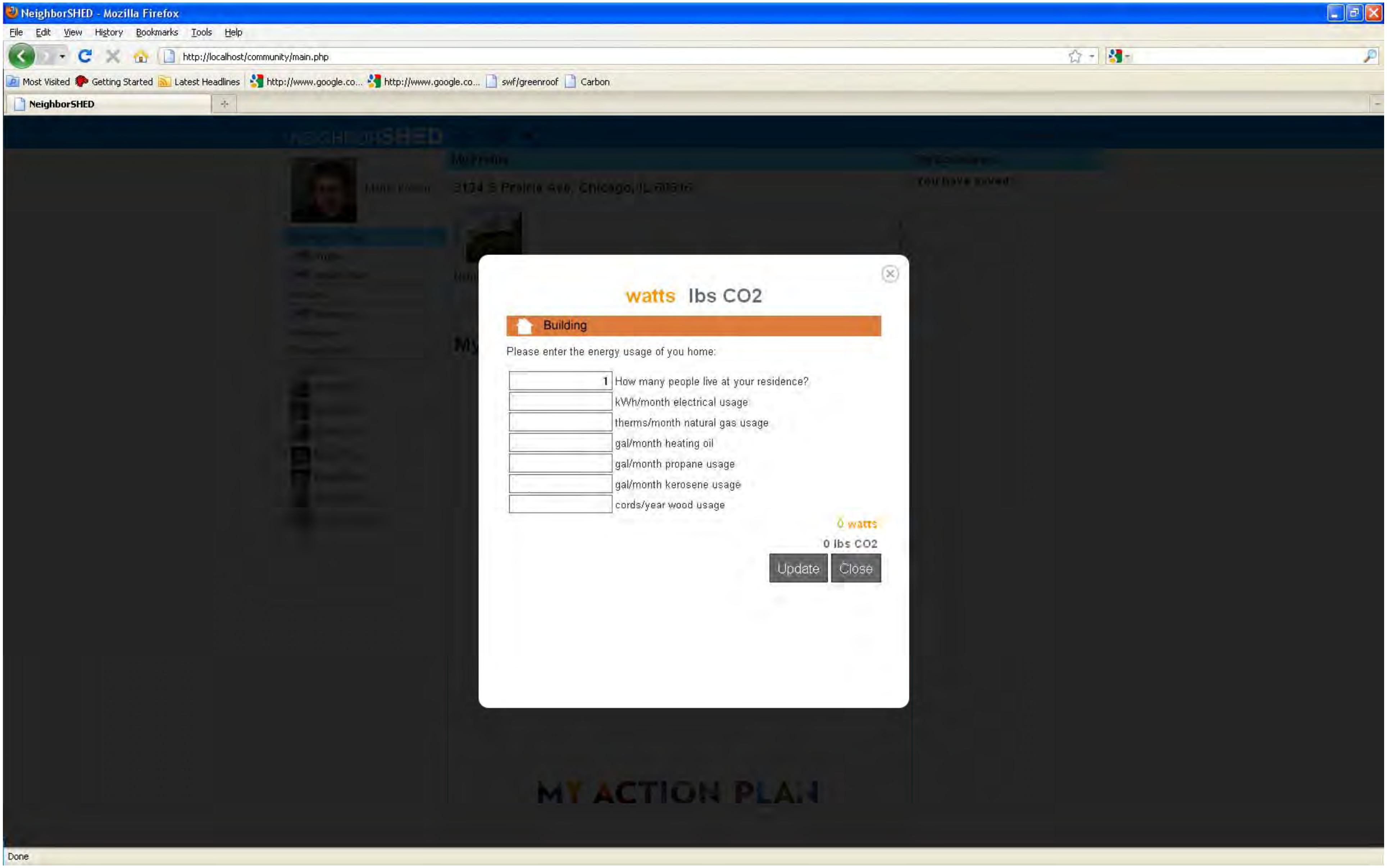
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
0 lbs CO2 Building
0 lbs CO2 Infrastructure
0 lbs CO2 Energy
0 lbs CO2 Transportation
0 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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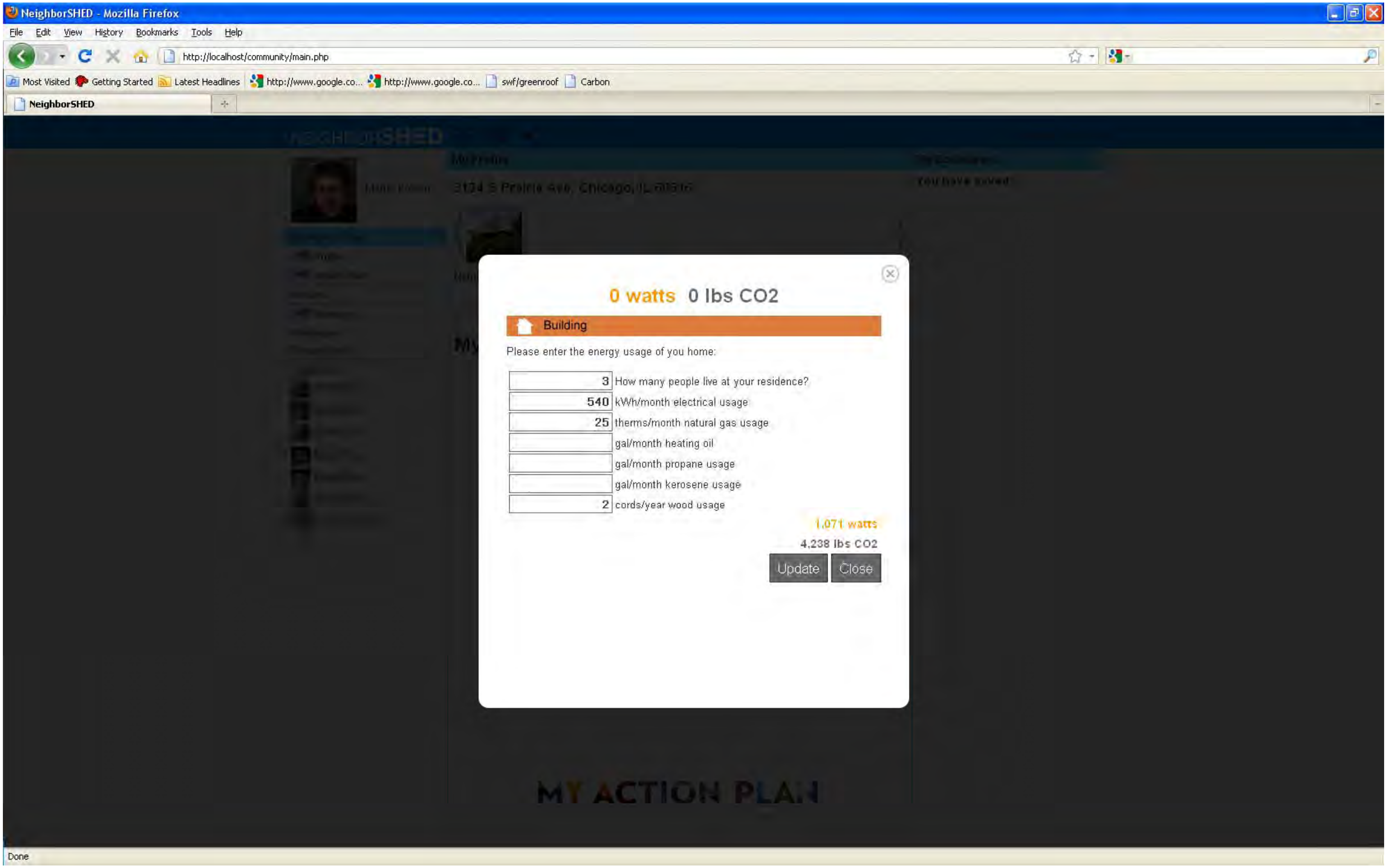
NeighborSHED
watts lbs CO2
Building
Please enter the energy usage of you home:
1
How many people live at your residence?
kWh/month electrical usage
therms/month natural gas usage
gal/month heating oil
gal/month propane usage
gal/month kerosene usage
cords/year wood usage
0 watts
0 lbs CO2
Update
Close
MY ACTION PLAN
Done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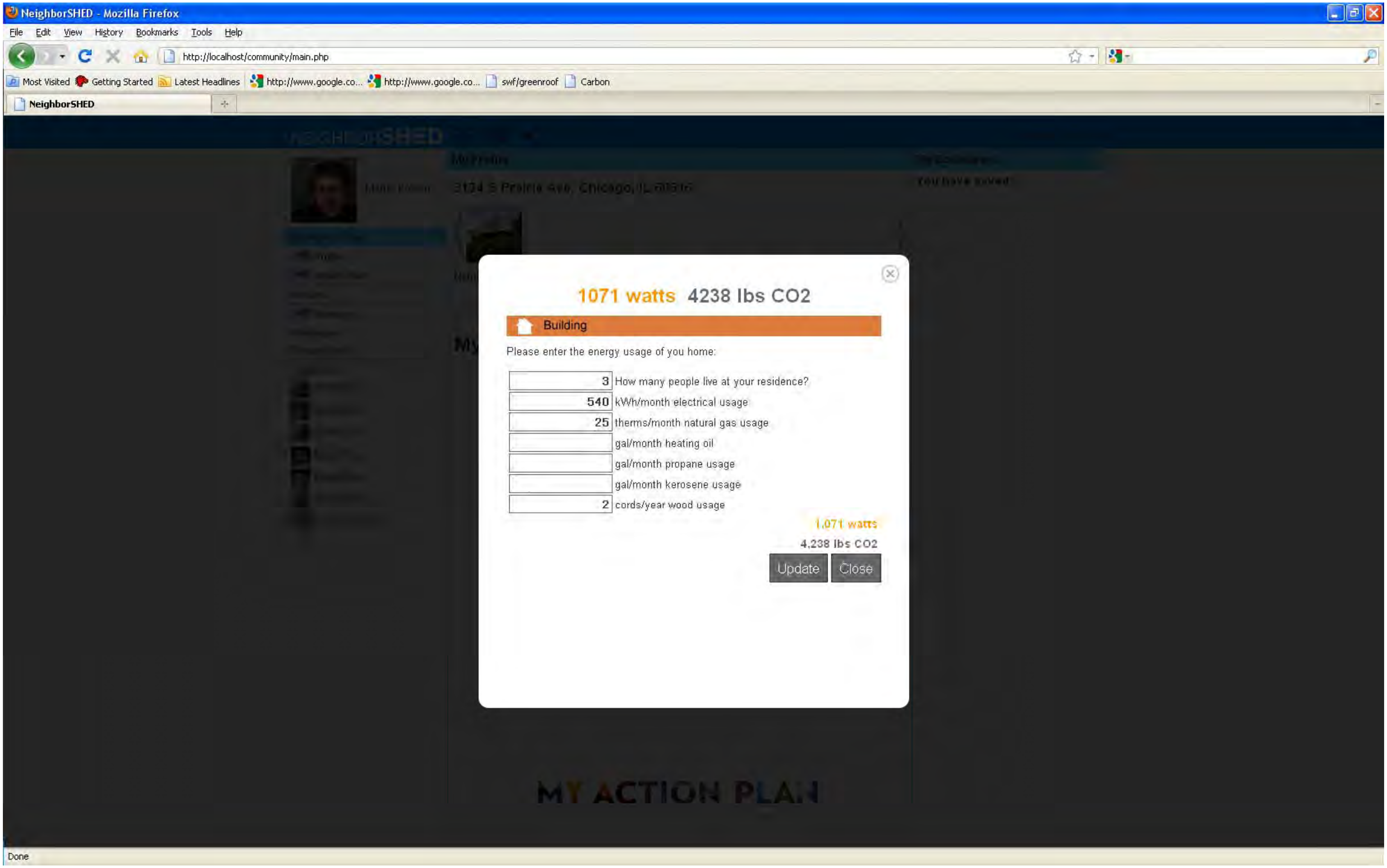
swf/greenroof
Carbon
NeighborSHED
3124 S Prairie Ave, Chicago, IL 60616
0 watts 0 lbs CO2
Building
Please enter the energy usage of you home:
3 How many people live at your residence?
540 kWh/month electrical usage
25 therms/month natural gas usage
gal/month heating oil
gal/month propane usage
gal/month kerosene usage
2 cords/year wood usage
1,071 watts
4,238 lbs CO2
Update
Close
MY ACTION PLAN
Done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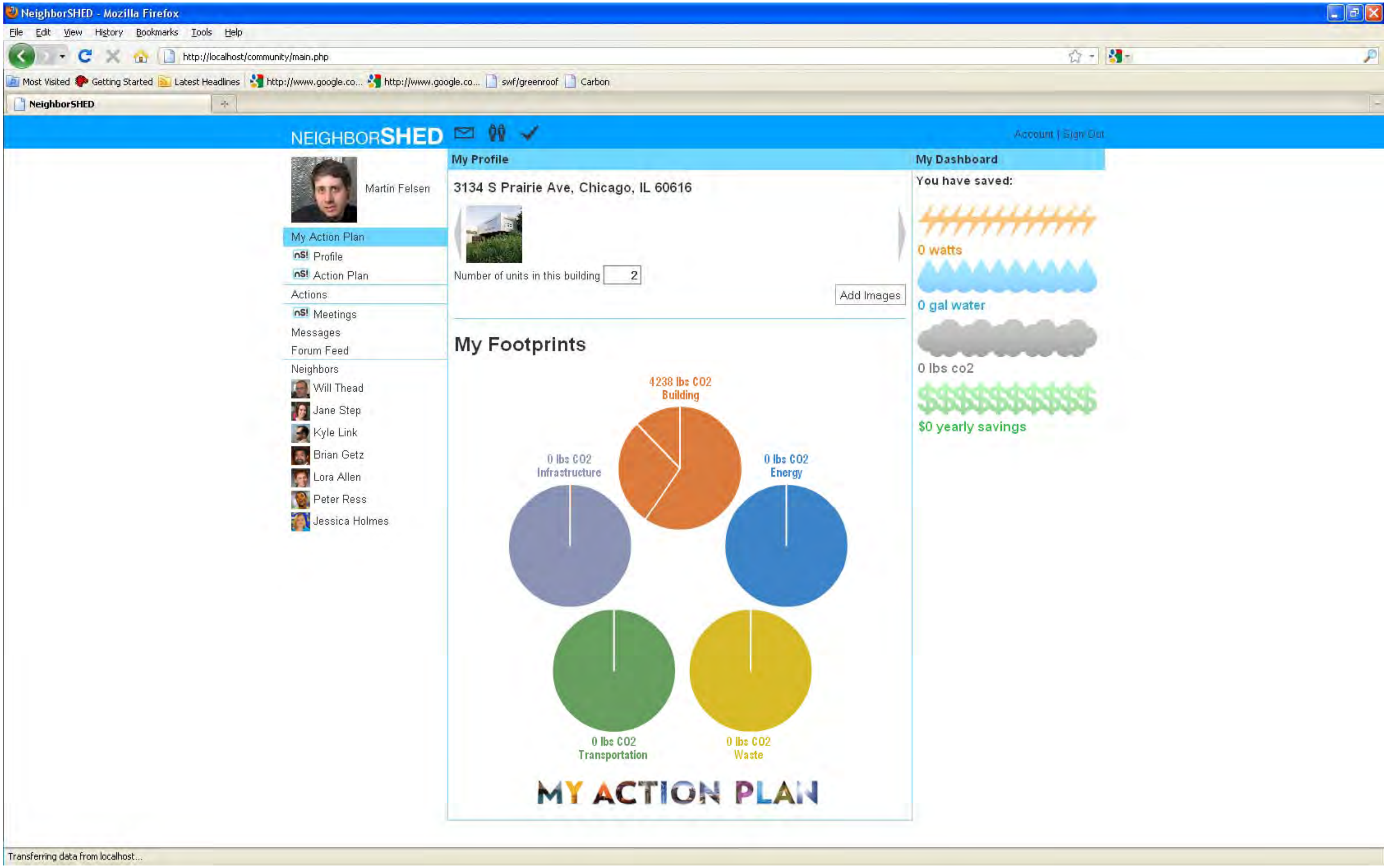
1071 watts 4238 lbs CO2
Building
Please enter the energy usage of you home:
3 How many people live at your residence?
540 kWh/month electrical usage
25 therms/month natural gas usage
gal/month heating oil
gal/month propane usage
gal/month kerosene usage
2 cords/year wood usage
1,071 watts
4,238 lbs CO2
Update
Close
MY ACTION PLAN
Done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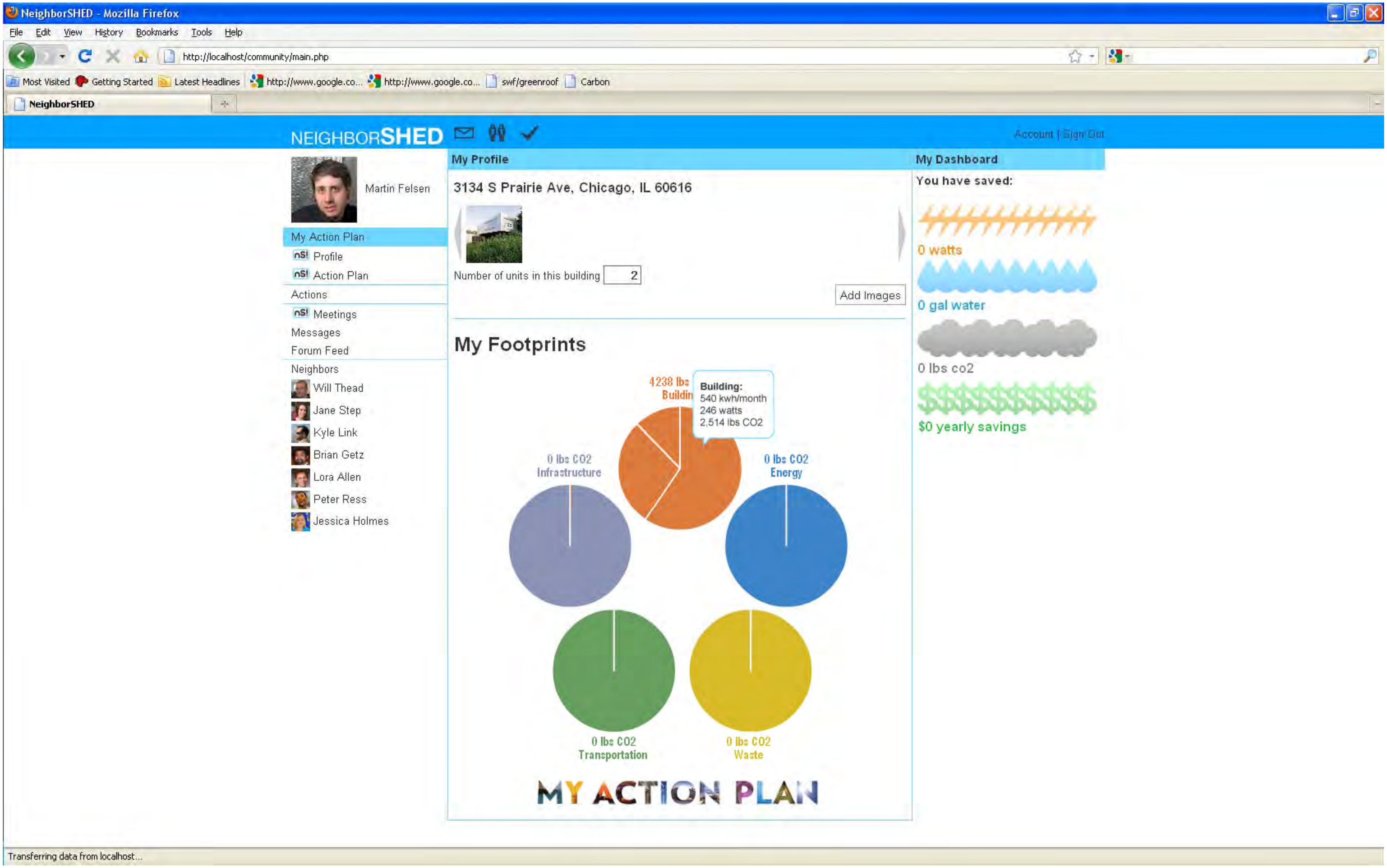
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building
2
Add Images
My Footprints
4238 lbs CO2
Building
0 lbs CO2
Infrastructure
0 lbs CO2
Energy
0 lbs CO2
Transportation
0 lbs CO2
Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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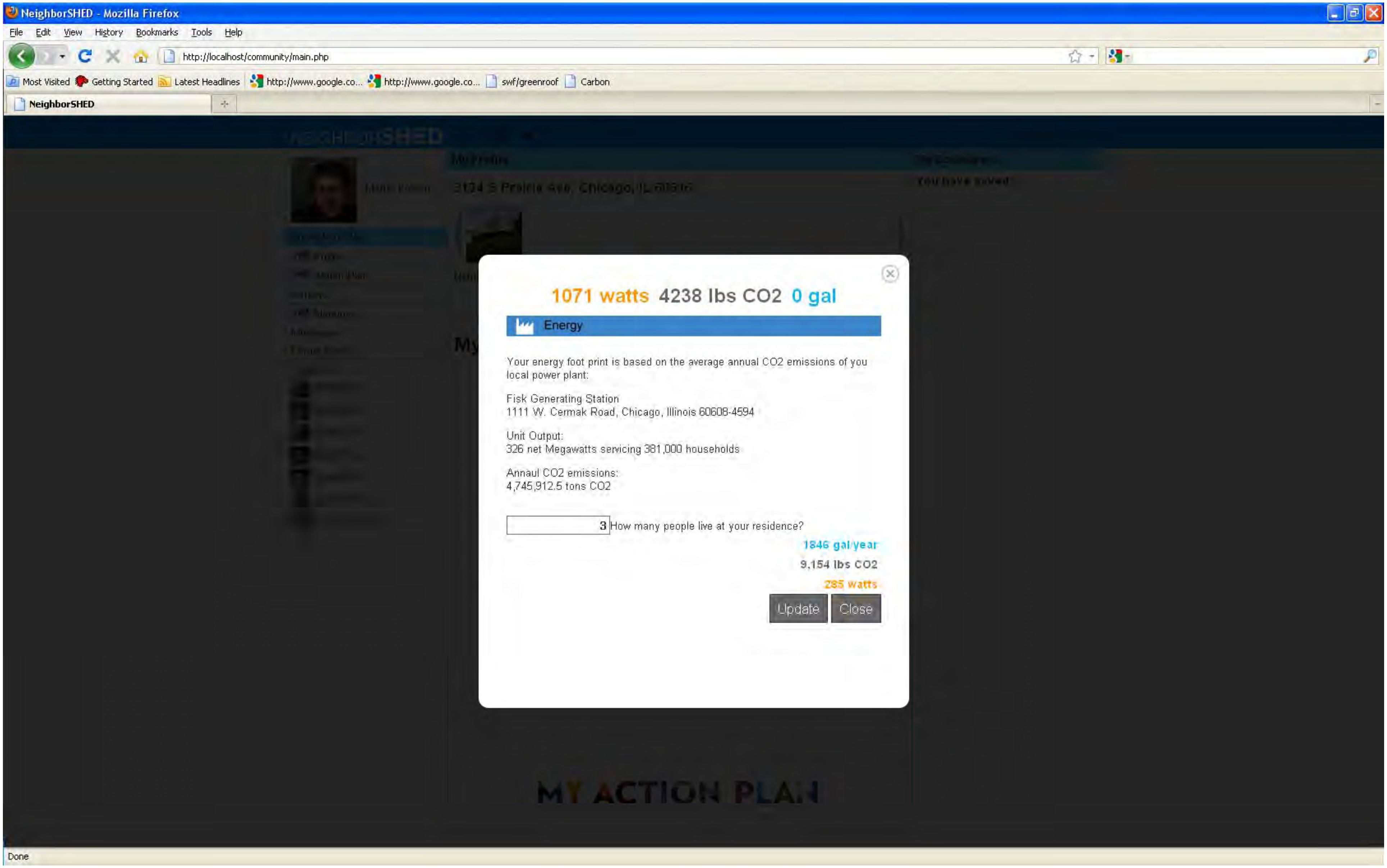
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
4238 lbs
Buildin
Building:
540 kwh/month
246 watts
2,514 lbs CO2
0 lbs CO2
Infrastructure
0 lbs CO2
Energy
0 lbs CO2
Transportation
0 lbs CO2
Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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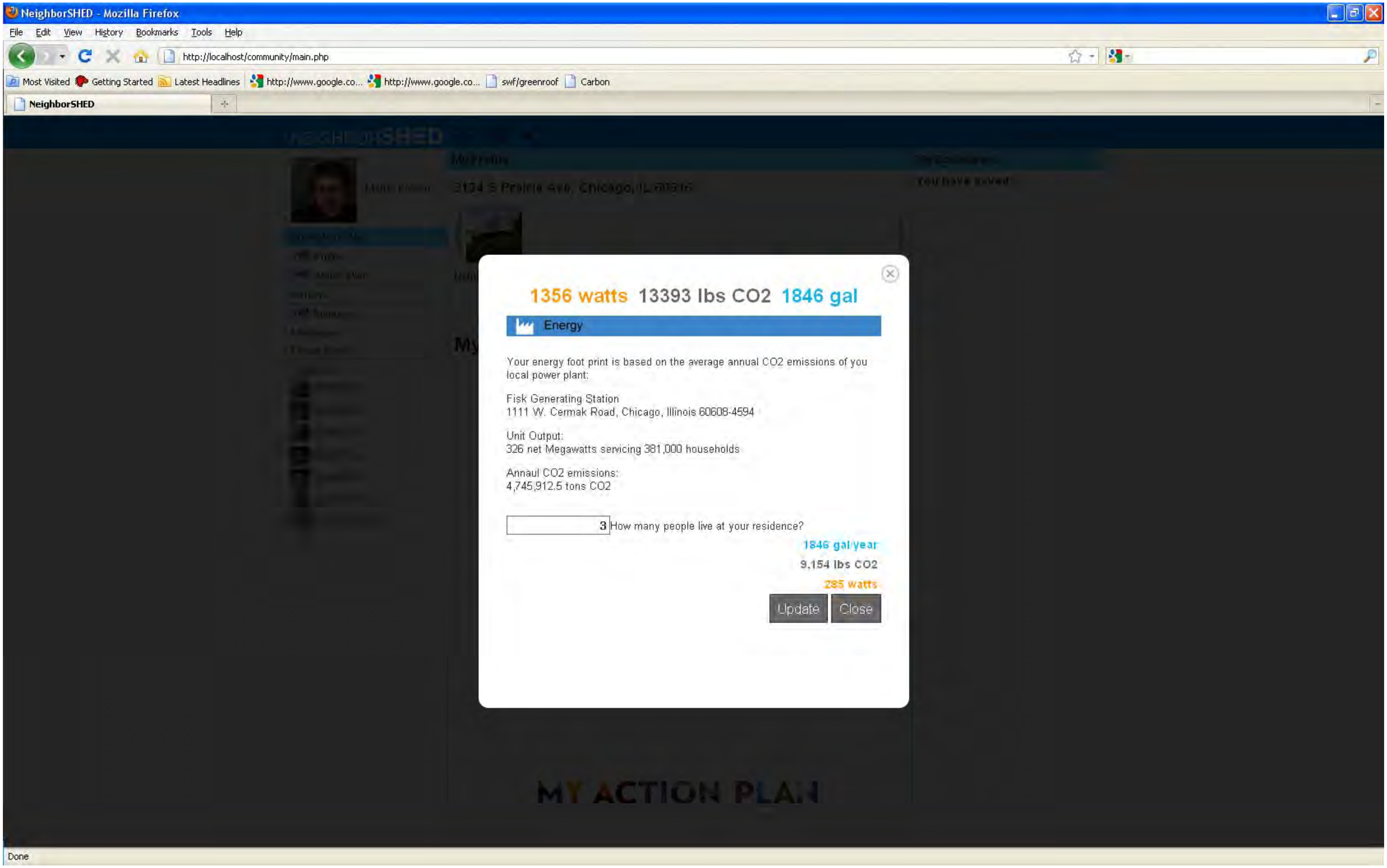
NeighborSHED
1071 watts 4238 lbs CO2 0 gal
Energy
Your energy foot print is based on the average annual CO2 emissions of you local power plant:
Fisk Generating Station
1111 W. Cermak Road, Chicago, Illinois 60608-4594
Unit Output:
326 net Megawatts servicing 381,000 households
Annaul CO2 emissions:
4,745,912.5 tons CO2
3 How many people live at your residence?
1846 gal/year
9,154 lbs CO2
285 watts
Update
Close
MY ACTION PLAN
Done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NeighborSHED
1356 watts 13393 lbs CO2 1846 gal
Energy
Your energy foot print is based on the average annual CO2 emissions of you local power plant:
Fisk Generating Station
1111 W. Cermak Road, Chicago, Illinois 60608-4594
Unit Output:
326 net Megawatts servicing 381,000 households
Annaul CO2 emissions:
4,745,912.5 tons CO2
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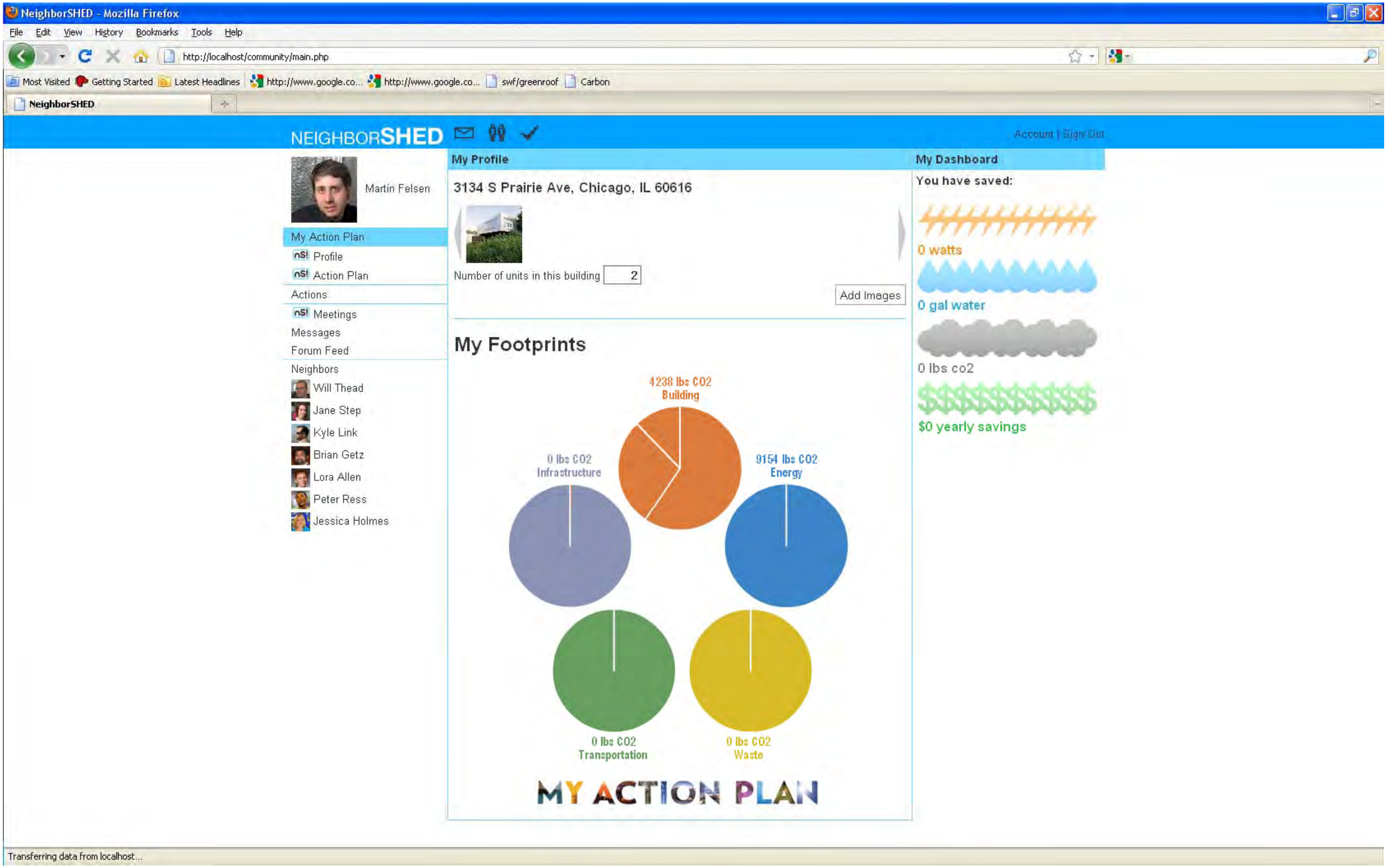
1846 gal/year
9,154 lbs CO2
285 watts
Update
Close
MY ACTION PLAN
Done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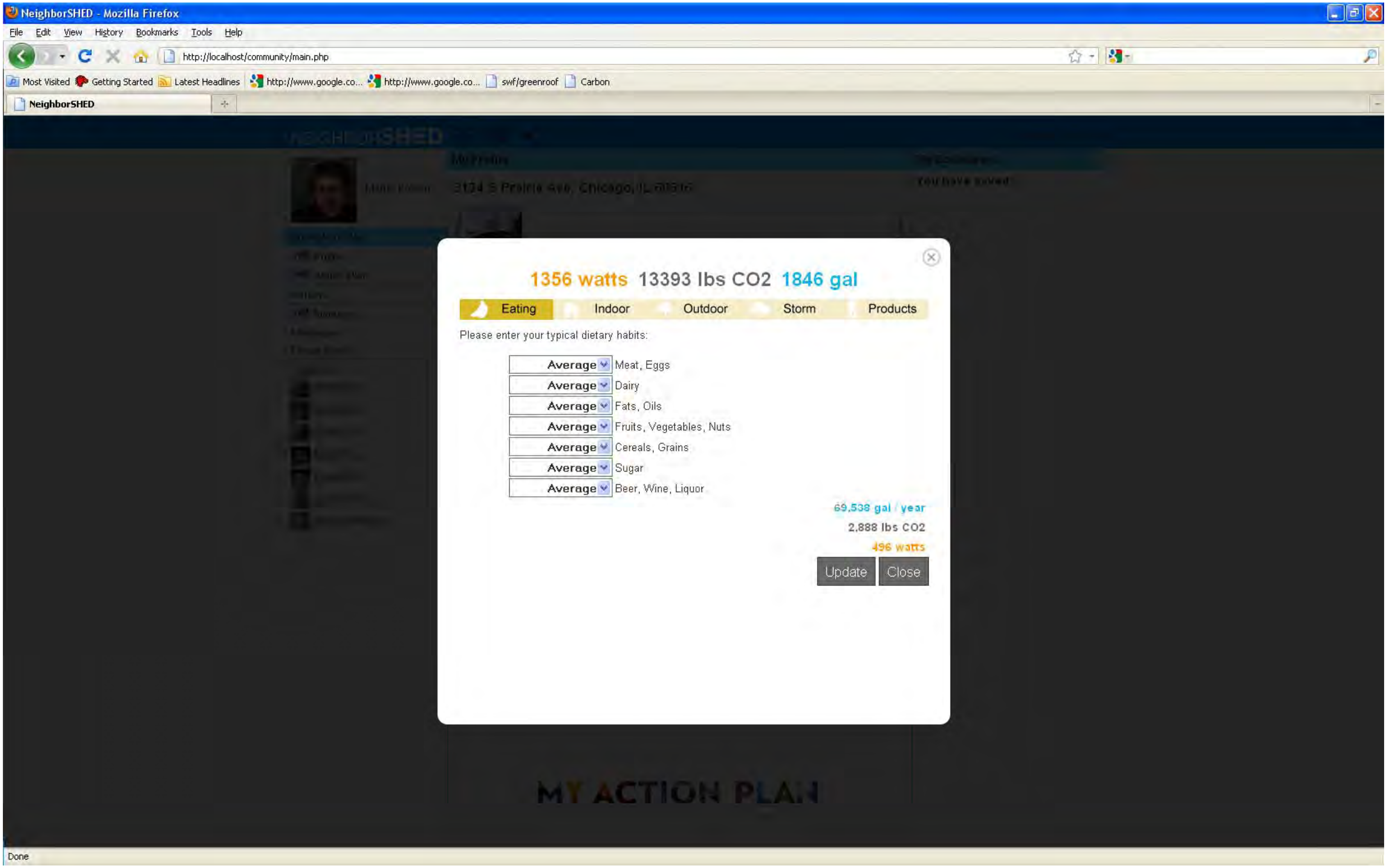
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
4238 lbs CO2 Building
0 lbs CO2 Infrastructure
9154 lbs CO2 Energy
0 lbs CO2 Transportation
0 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...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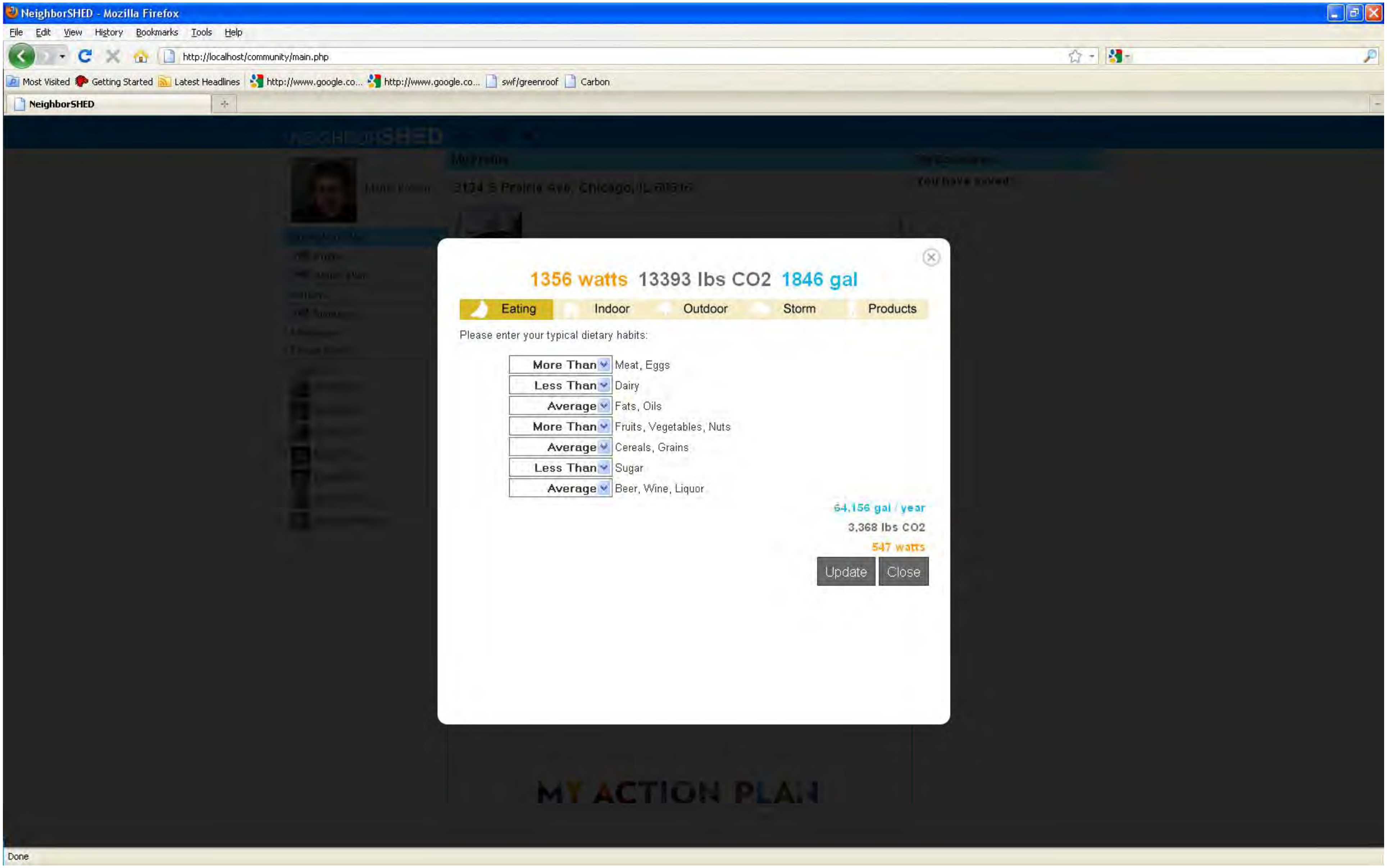
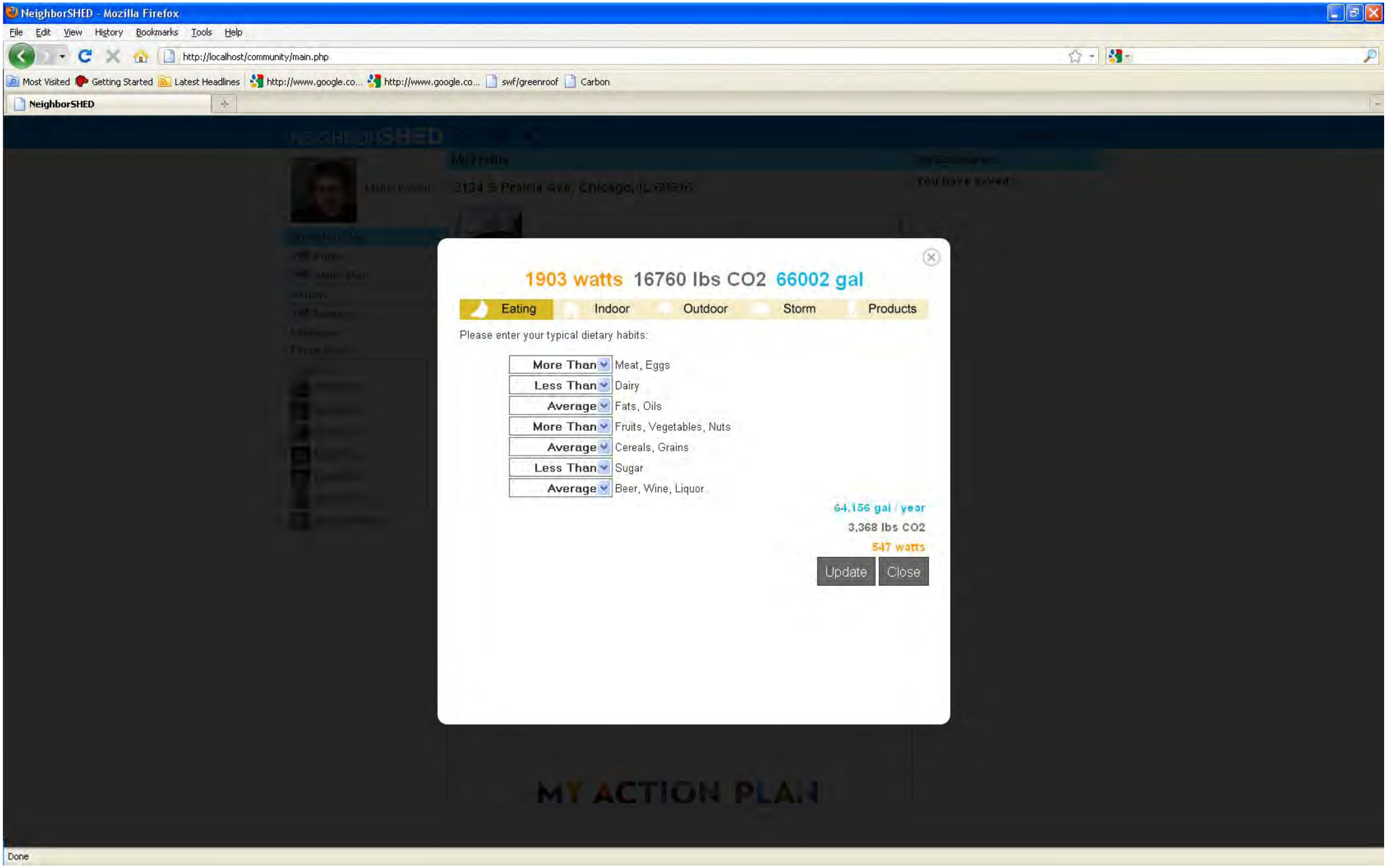
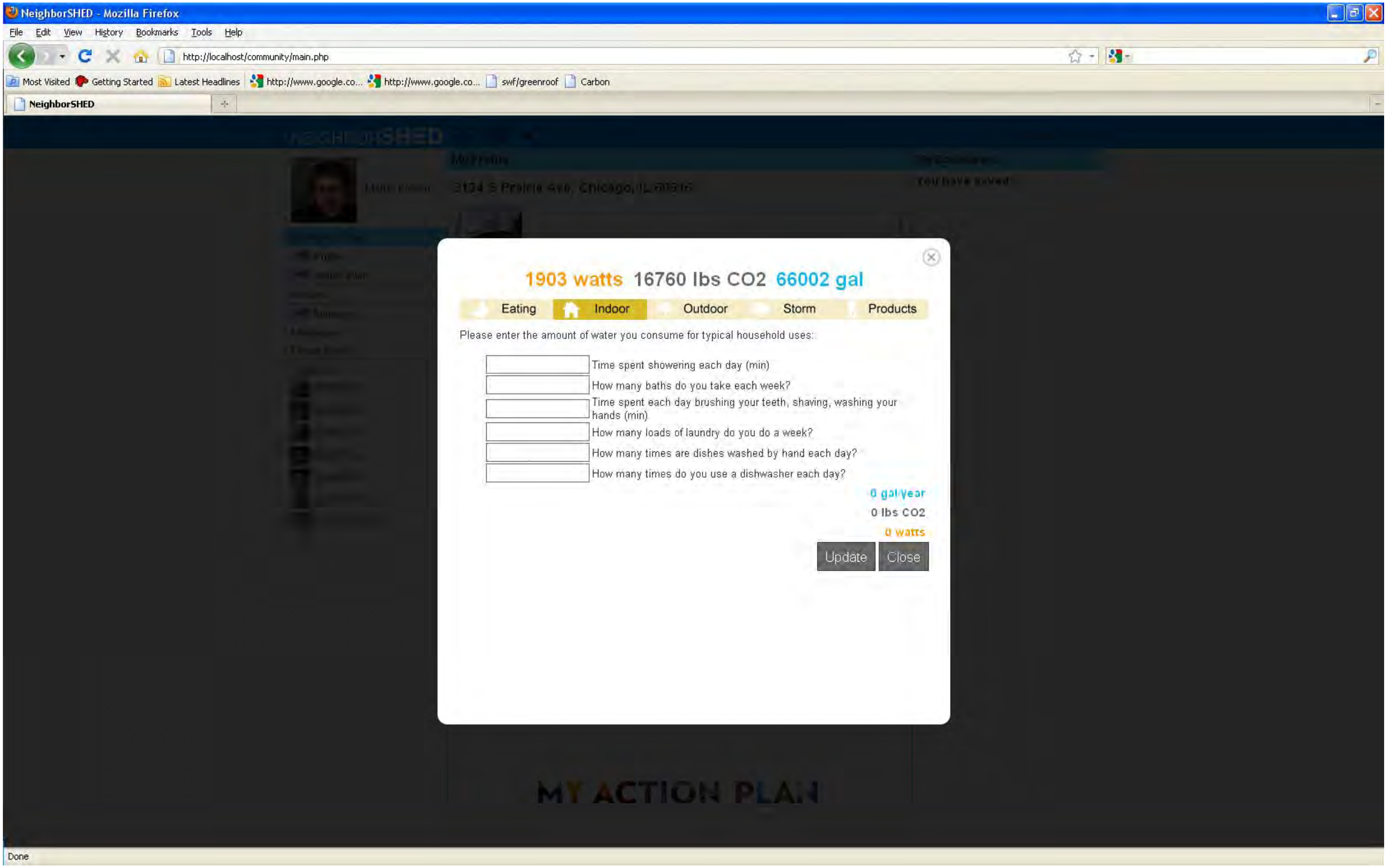
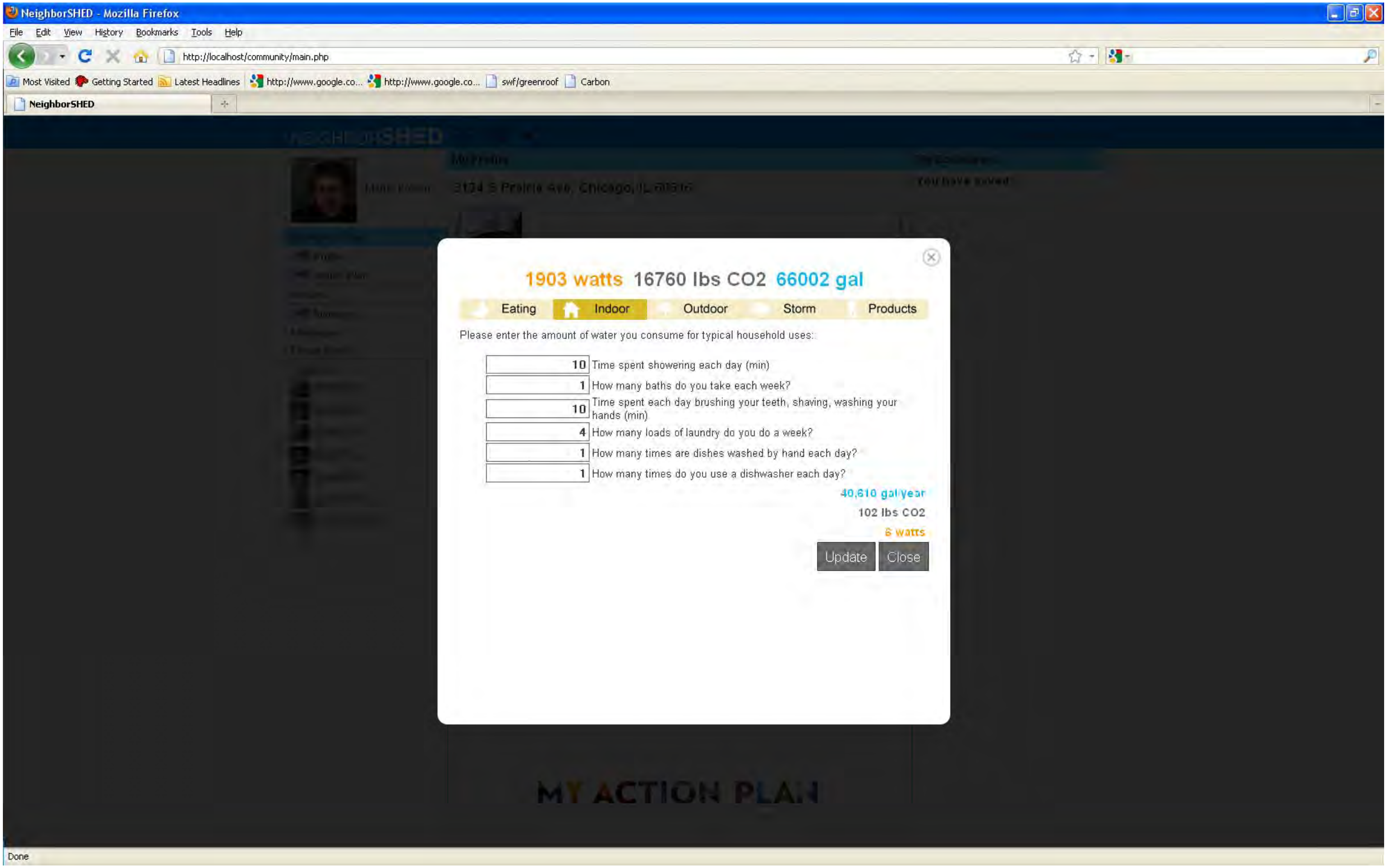
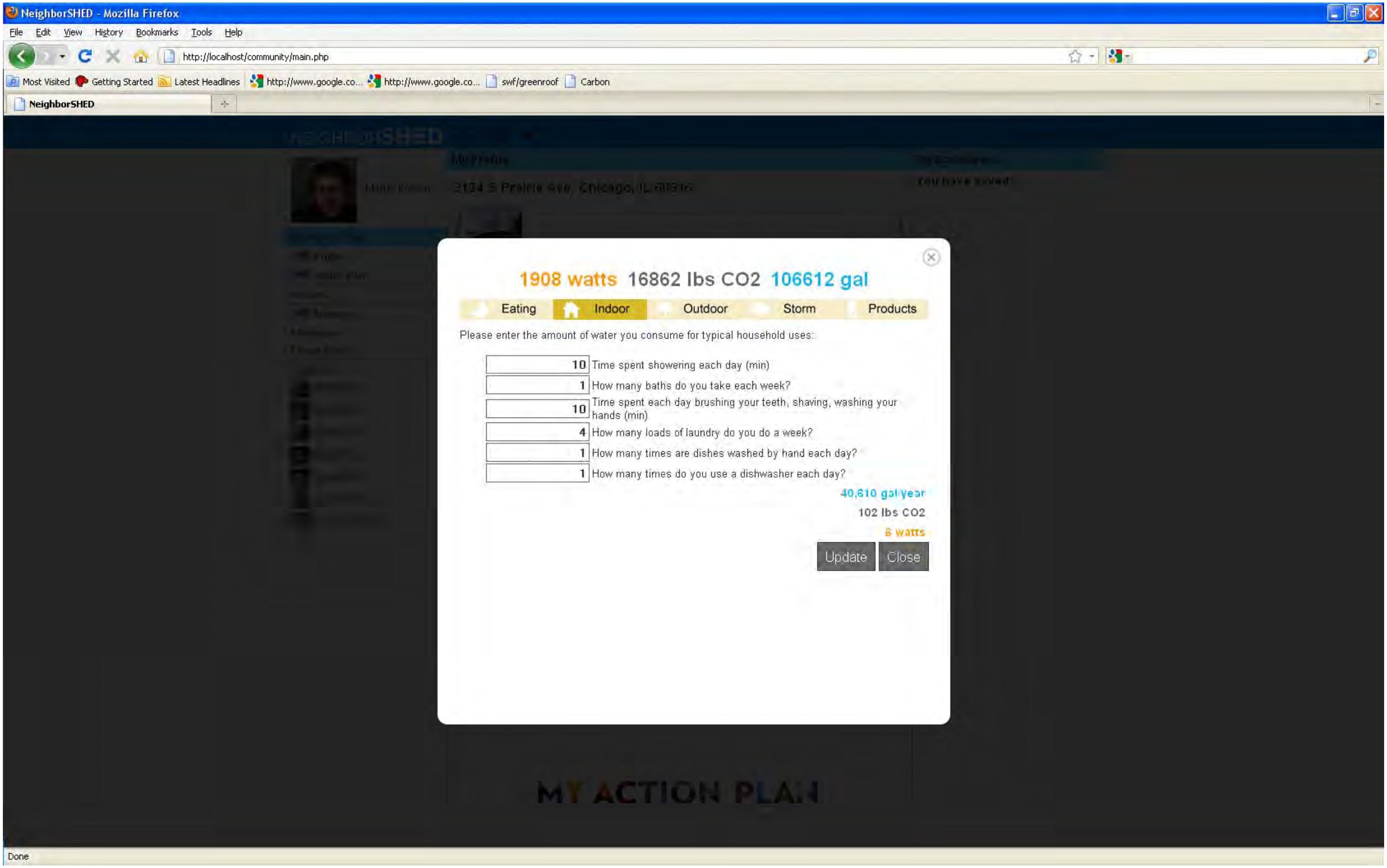
NeighborSHED
1356 watts 13393 lbs CO2 1846 gal
Eating Indoor Outdoor Storm Products
Please enter your typical dietary habits:
Average Meat, Eggs
Average Dairy
Average Fats, Oils
Average Fruits, Vegetables, Nuts
Average Cereals, Grains
Average Sugar
Average Beer, Wine, Liquor
69,538 gal / year
2,888 lbs CO2
496 watts
Update Close
MY ACTION PLAN
Done

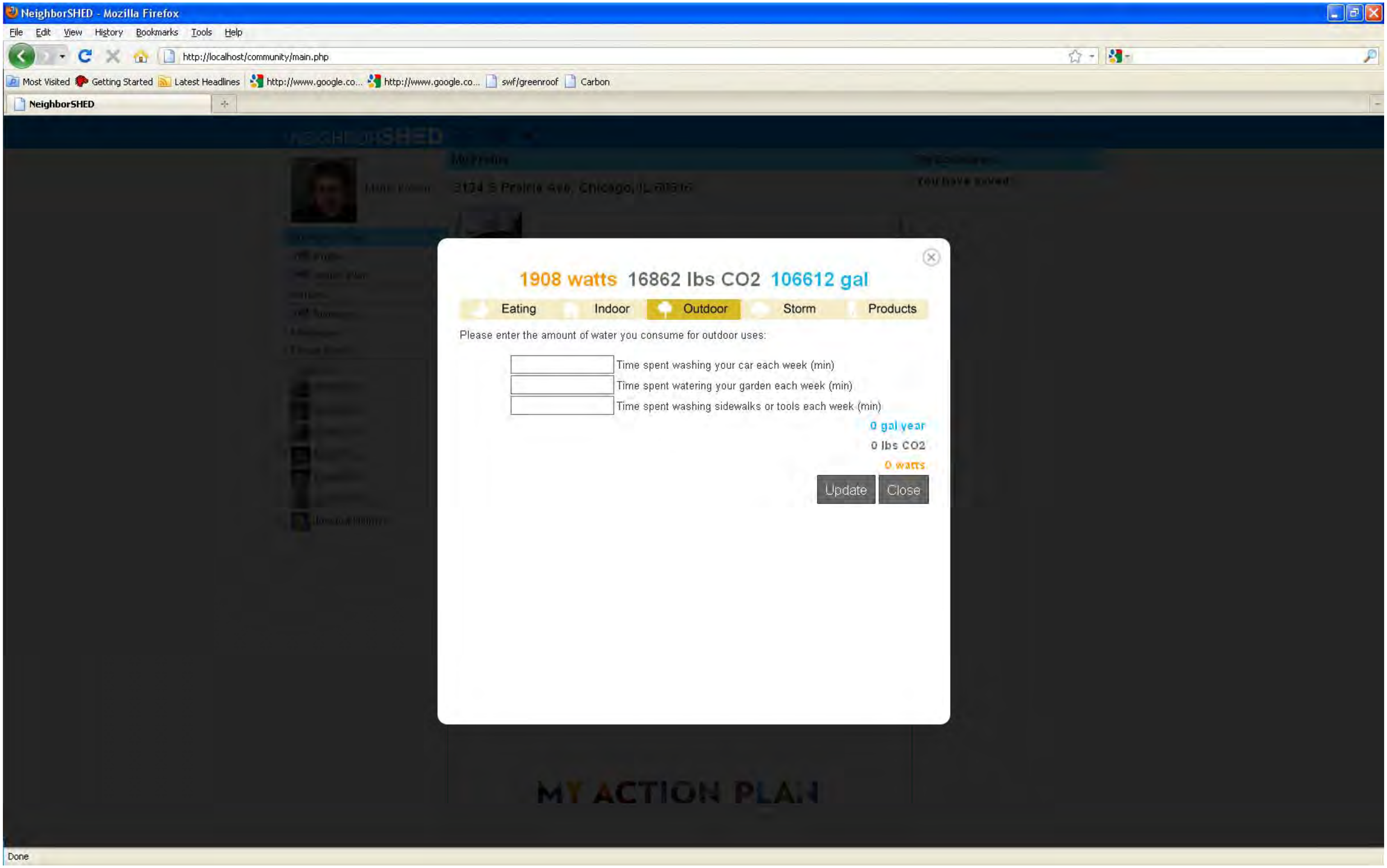

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
1356 watts 13393 lbs CO2 1846 gal
Eating
Indoor
Outdoor
Storm
Products
Please enter your typical dietary habits:
More Than Meat, Eggs
Less Than Dairy
Average Fats, Oils
More Than Fruits, Vegetables, Nuts
Average Cereals, Grains
Less Than Sugar
Average Beer, Wine, Liquor
64,156 gal / year
3,368 lbs CO2
547 watts
Update
Close
MY ACTION PLAN
Done

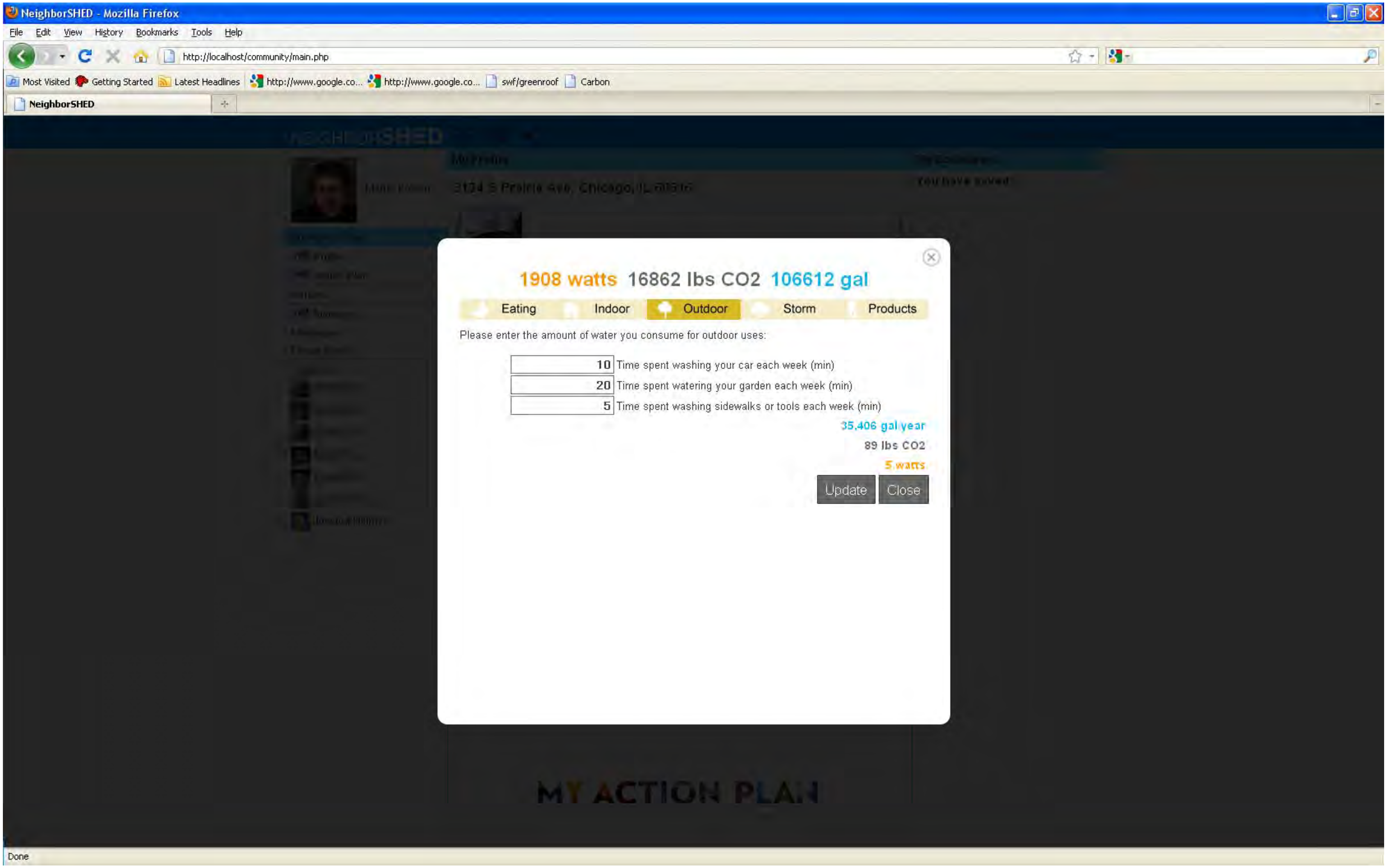

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1903 watts 16760 lbs CO2 66002 gal
Eating Indoor Outdoor Storm Products
Please enter your typical dietary habits:
More Than Meat, Eggs
Less Than Dairy
Average Fats, Oils
More Than Fruits, Vegetables, Nuts
Average Cereals, Grains
Less Than Sugar
Average Beer, Wine, Liquor
64,156 gal / year
3,368 lbs CO2
547 watts
Update Close
MY ACTION PLAN
Done

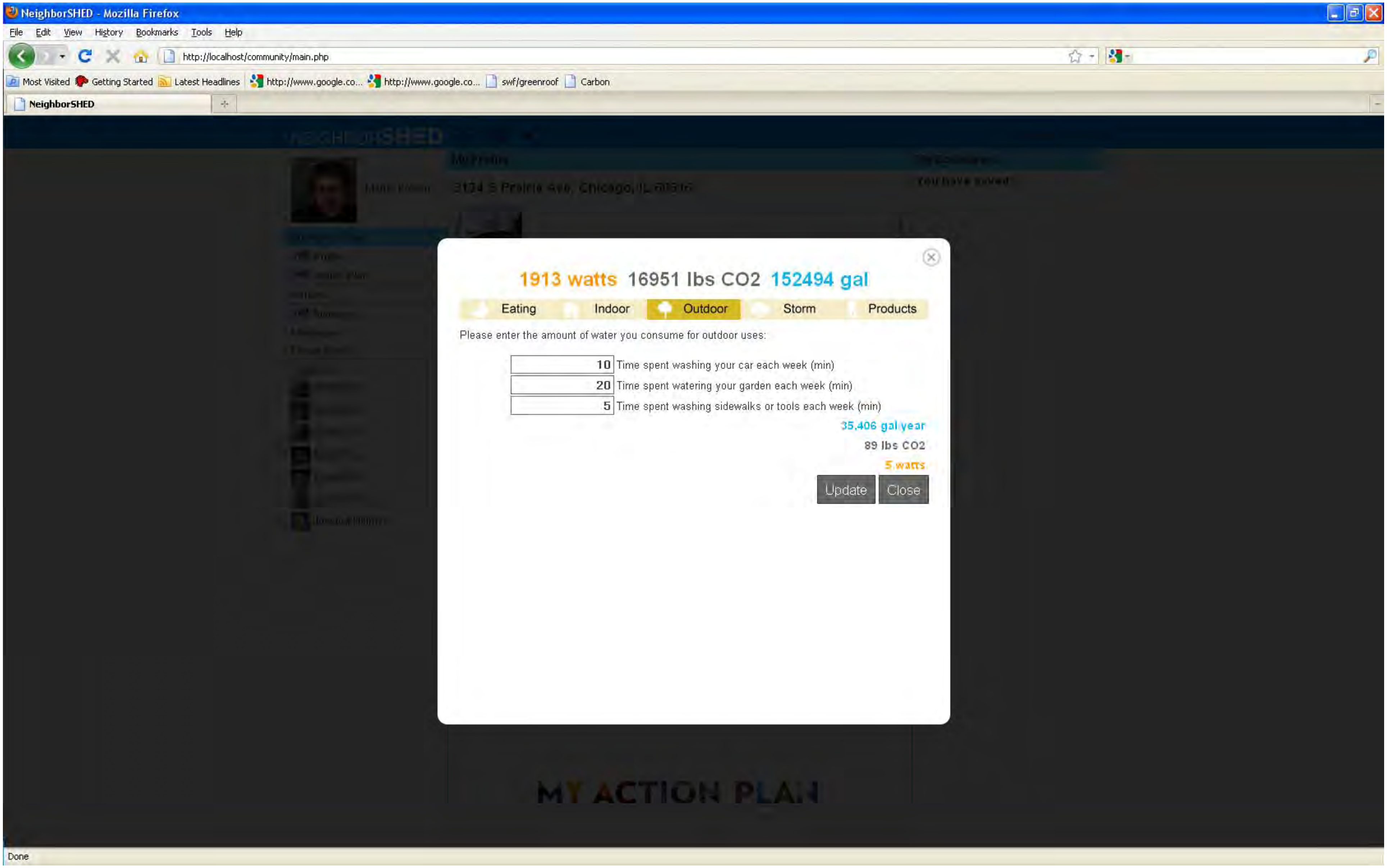

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1903 watts 16760 lbs CO2 66002 gal
Eating Indoor Outdoor Storm Products
Please enter the amount of water you consume for typical household uses:
Time spent showering each day (min)
How many baths do you take each week?
Time spent each day brushing your teeth, shaving, washing your hands (min)
How many loads of laundry do you do a week?
How many times are dishes washed by hand each day?
How many times do you use a dishwasher each day?
0 gal/year
0 lbs CO2
0 watts
Update
Close
MY ACTION PLAN
Done

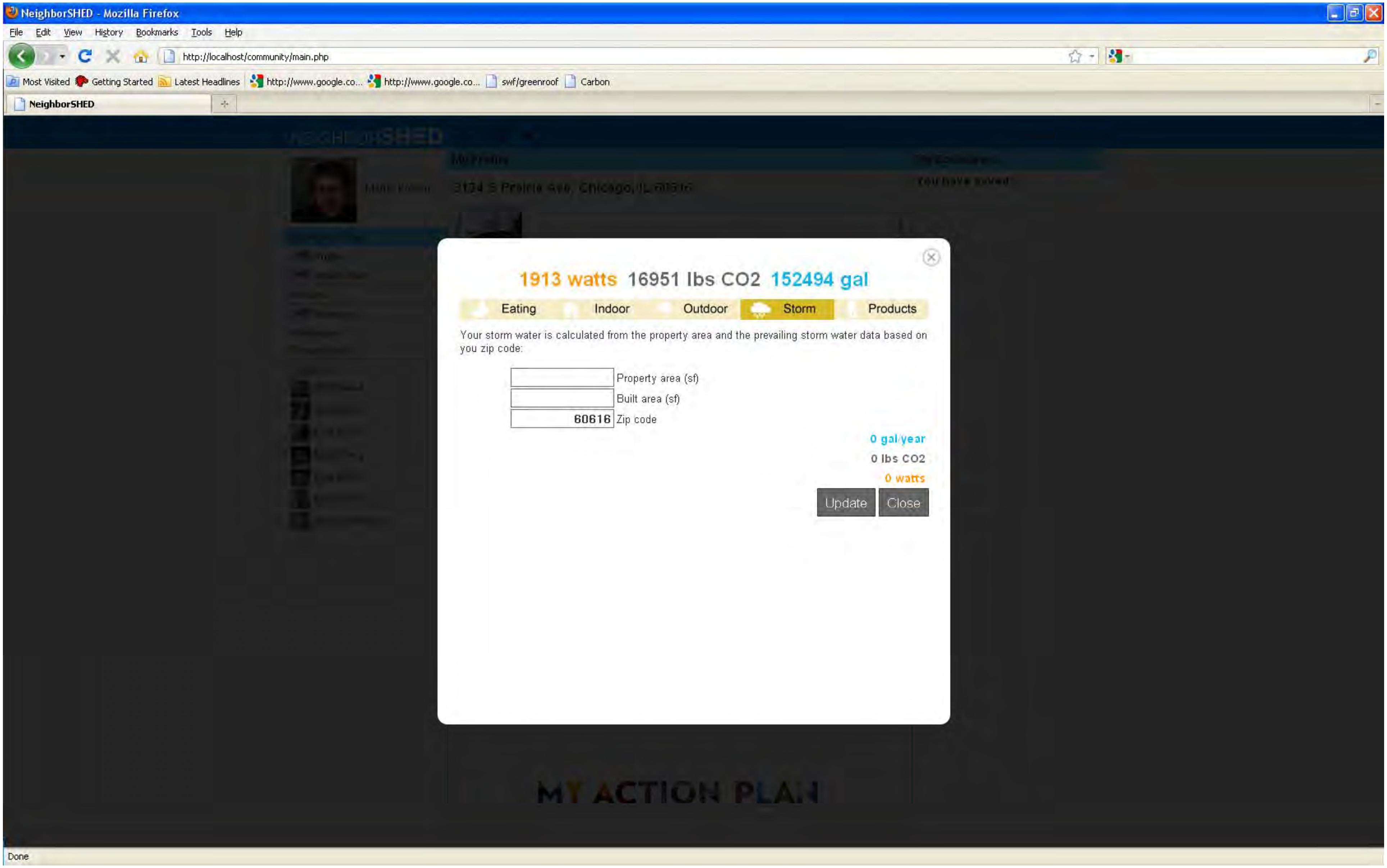

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1903 watts 16760 lbs CO2 66002 gal
Eating
Indoor
Outdoor
Storm
Products
Please enter the amount of water you consume for typical household uses:
10 Time spent showering each day (min)
1 How many baths do you take each week?
10 Time spent each day brushing your teeth, shaving, washing your hands (min)
4 How many loads of laundry do you do a week?
1 How many times are dishes washed by hand each day?
1 How many times do you use a dishwasher each day?
40,610 gal/year
102 lbs CO2
6 watts
Update
Close
MY ACTION PLAN
Done

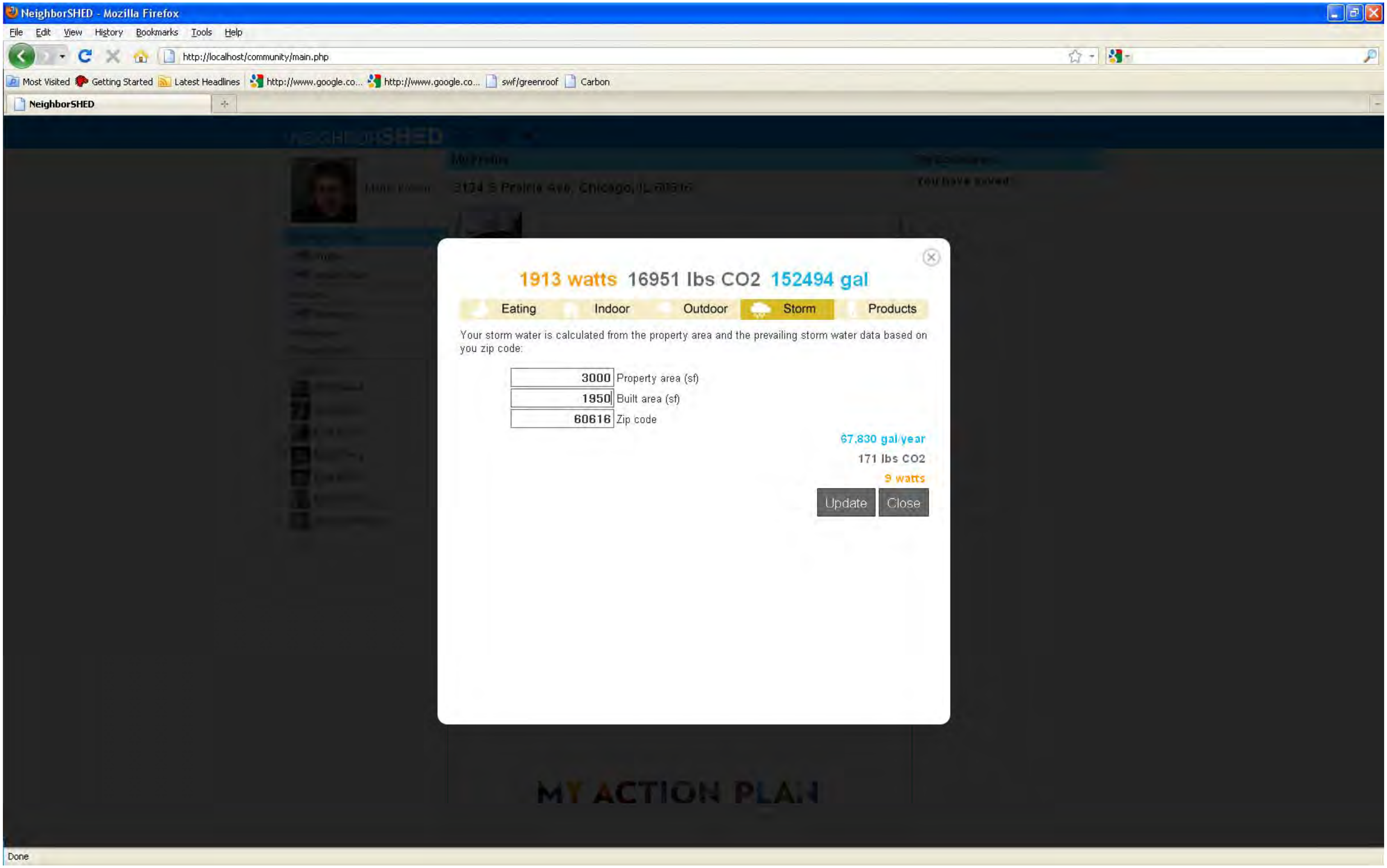

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1908 watts 16862 lbs CO2 106612 gal
Eating Indoor Outdoor Storm Products
Please enter the amount of water you consume for typical household uses:
10 Time spent showering each day (min)
1 How many baths do you take each week?
10 Time spent each day brushing your teeth, shaving, washing your hands (min)
4 How many loads of laundry do you do a week?
1 How many times are dishes washed by hand each day?
1 How many times do you use a dishwasher each day?
40,610 gal/year
102 lbs CO2
6 watts
Update Close
MY ACTION PLAN
Done

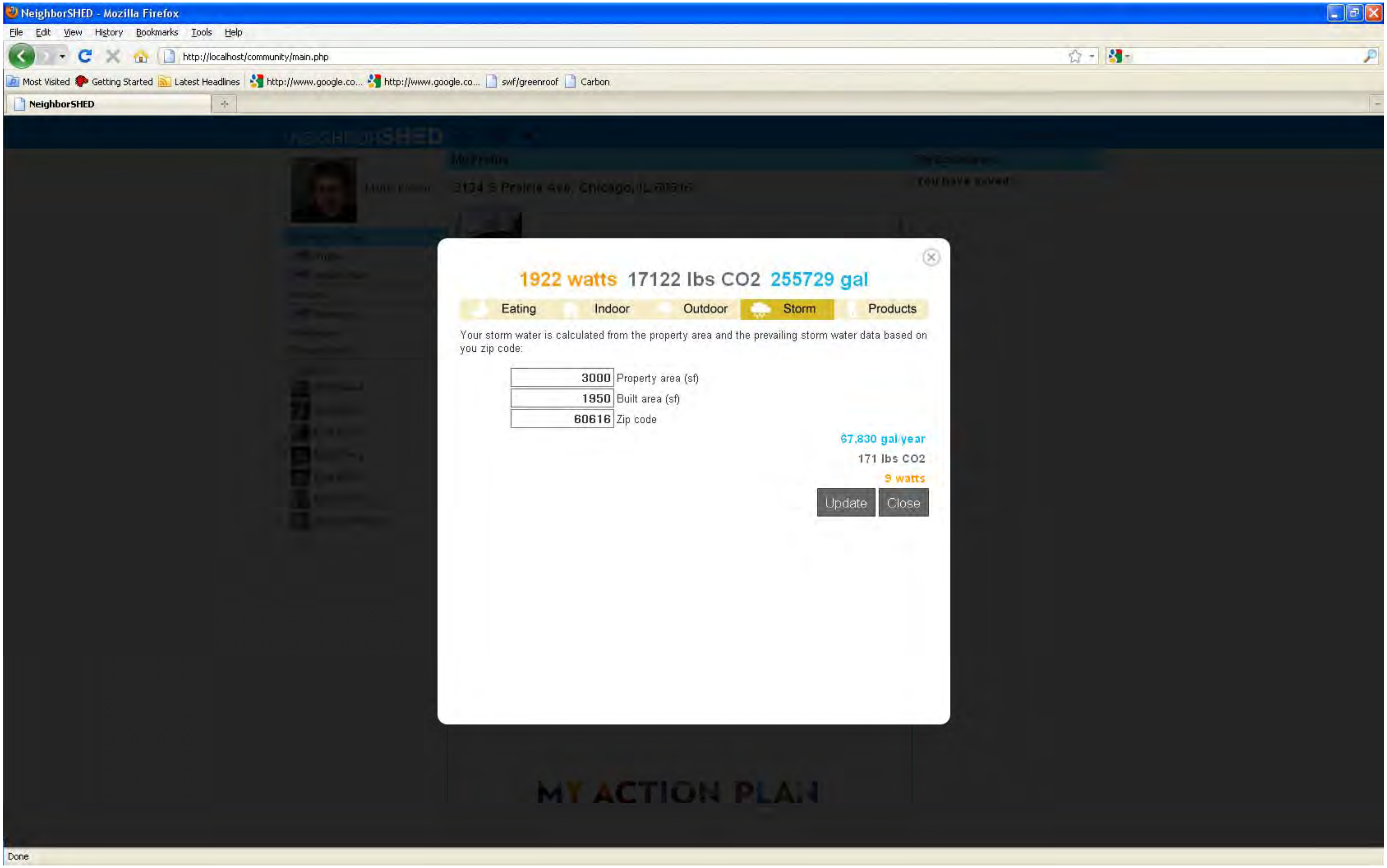

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1908 watts 16862 lbs CO2 106612 gal
Eating Indoor Outdoor Storm Products
Please enter the amount of water you consume for outdoor uses:
Time spent washing your car each week (min)
Time spent watering your garden each week (min)
Time spent washing sidewalks or tools each week (min)
0 gal year
0 lbs CO2
0 watts
Update Close
MY ACTION PLAN
Done

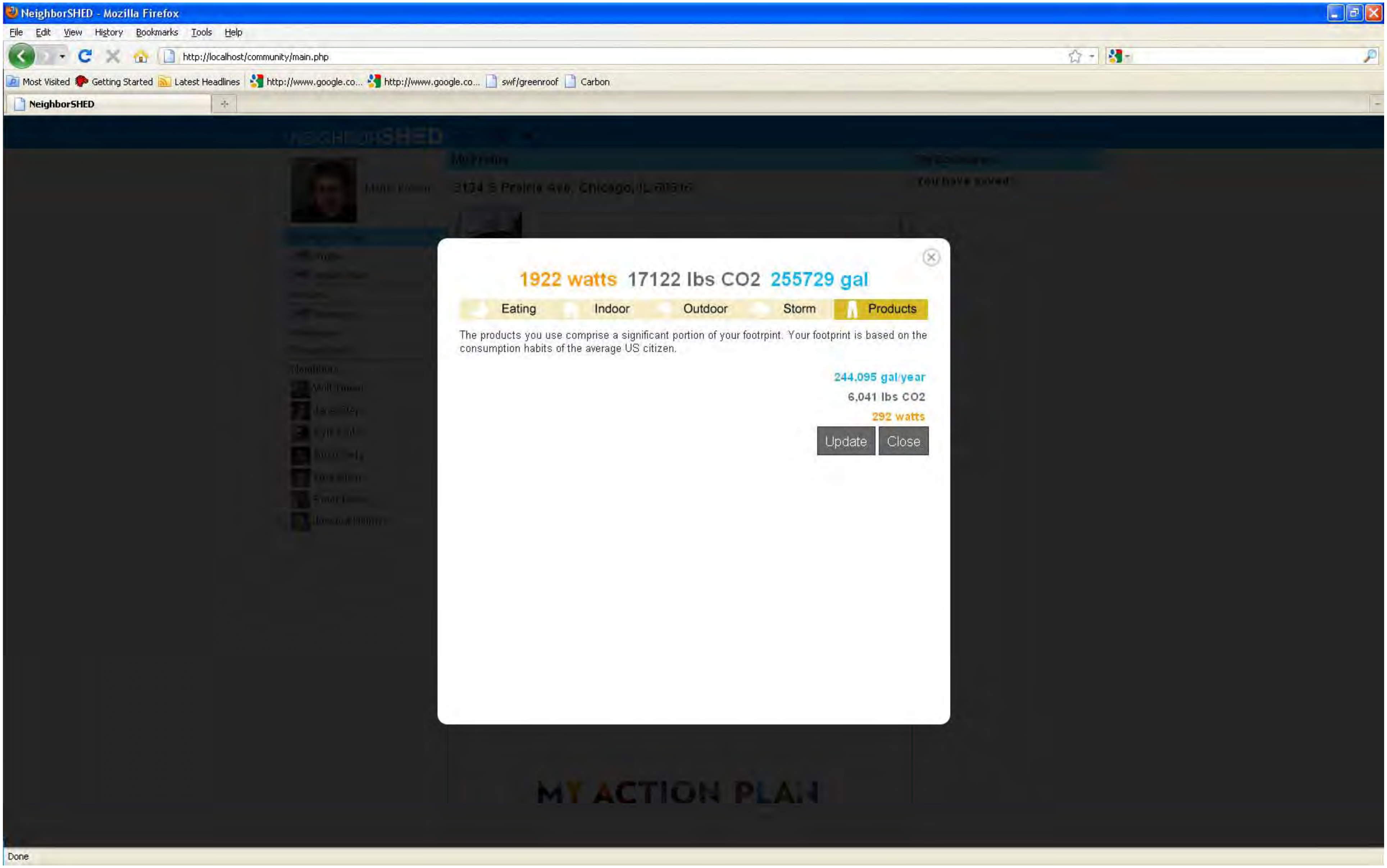

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1908 watts 16862 lbs CO2 106612 gal
Eating
Indoor
Outdoor
Storm
Products
Please enter the amount of water you consume for outdoor uses:
10 Time spent washing your car each week (min)
20 Time spent watering your garden each week (min)
5 Time spent washing sidewalks or tools each week (min)
35,406 gal/year
89 lbs CO2
5 watts
Update
Close
MY ACTION PLAN
Done

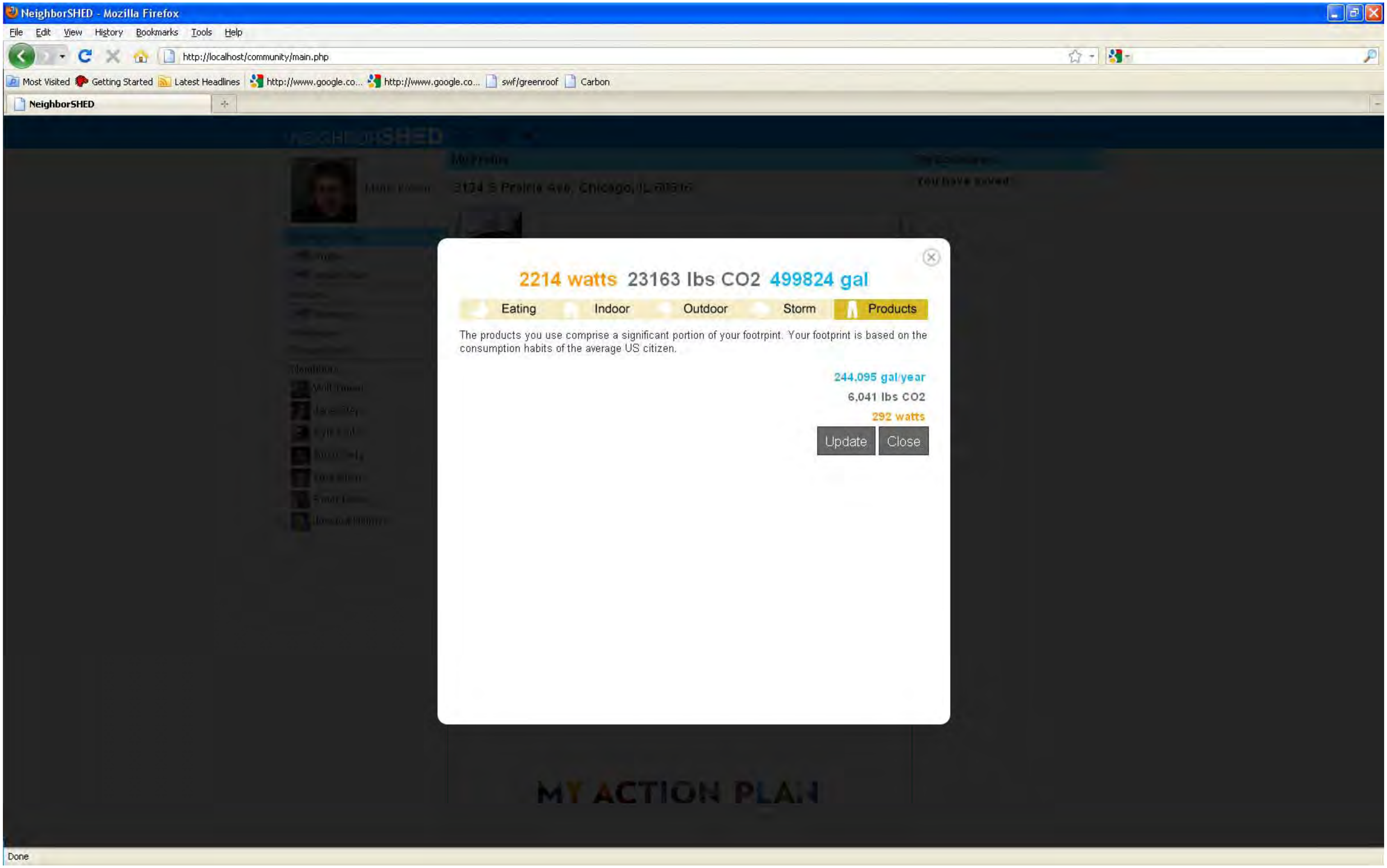

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1913 watts 16951 lbs CO2 152494 gal
Eating Indoor Outdoor Storm Products
Please enter the amount of water you consume for outdoor uses:
10 Time spent washing your car each week (min)
20 Time spent watering your garden each week (min)
5 Time spent washing sidewalks or tools each week (min)
35,406 gal/year
89 lbs CO2
5 watts
Update Close
MY ACTION PLAN
Done

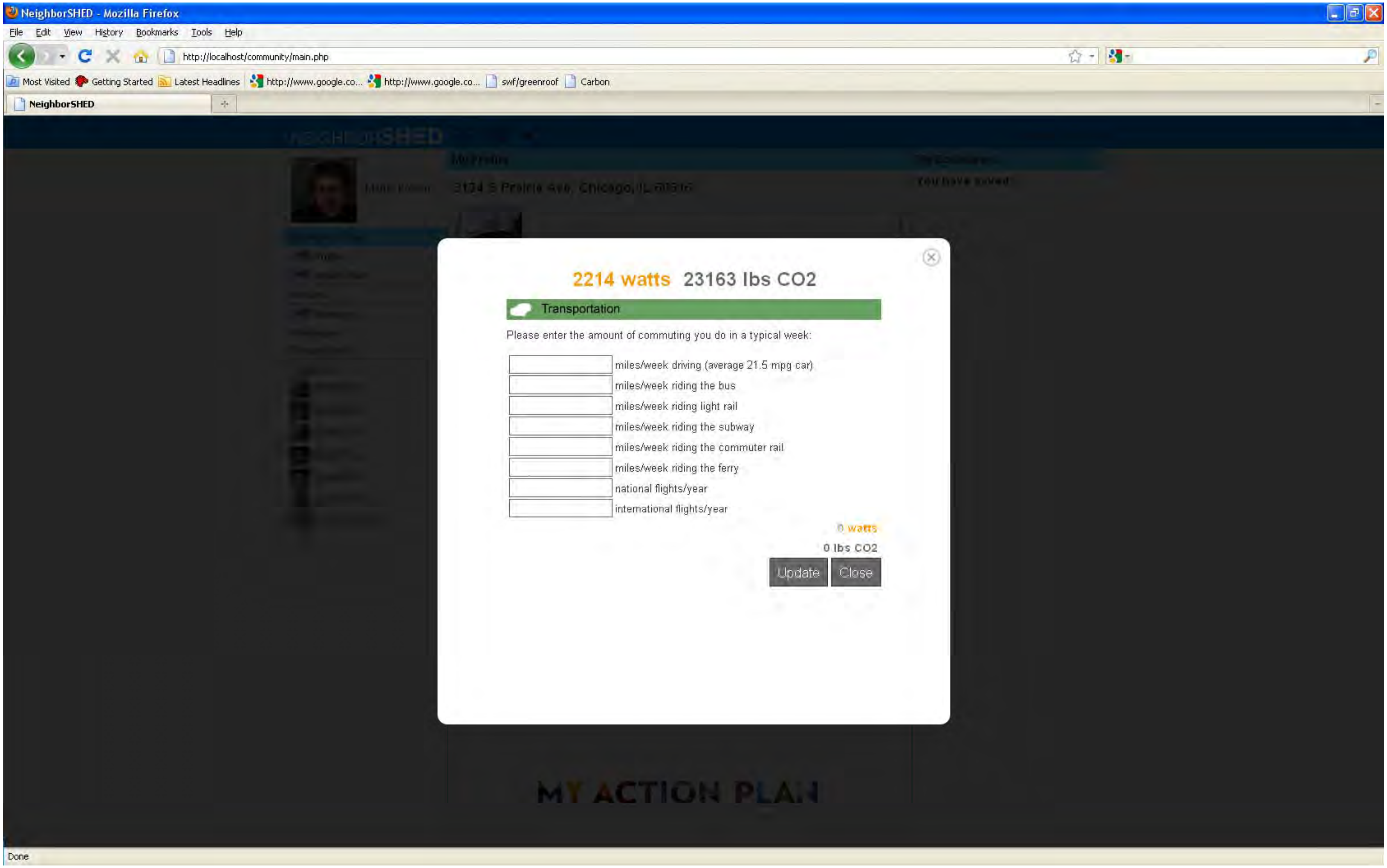

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1913 watts 16951 lbs CO2 152494 gal
Eating Indoor Outdoor Storm Products
Your storm water is calculated from the property area and the prevailing storm water data based on you zip code:
Property area (sf)
Built area (sf)
60616 Zip code
0 gal/year
0 lbs CO2
0 watts
Update Close
MY ACTION PLAN
Done

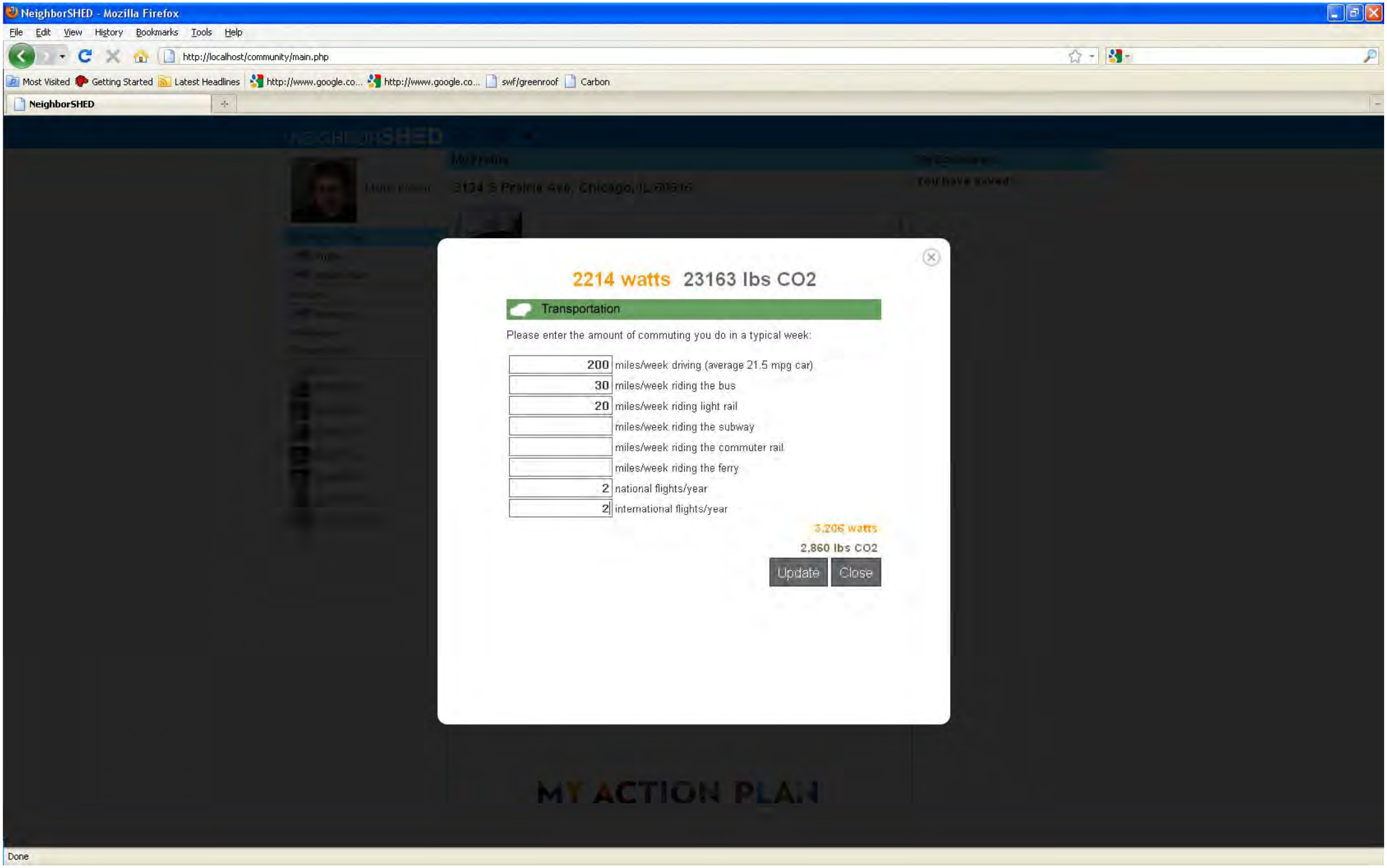

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
1913 watts
16951 lbs CO2
152494 gal
Eating
Indoor
Outdoor
Storm
Products
Your storm water is calculated from the property area and the prevailing storm water data based on you zip code:
3000
Property area (sf)
1950
Built area (sf)
60616
Zip code
67,830 gal/year
171 lbs CO2
9 watts
Update
Close
MY ACTION PLAN
Done

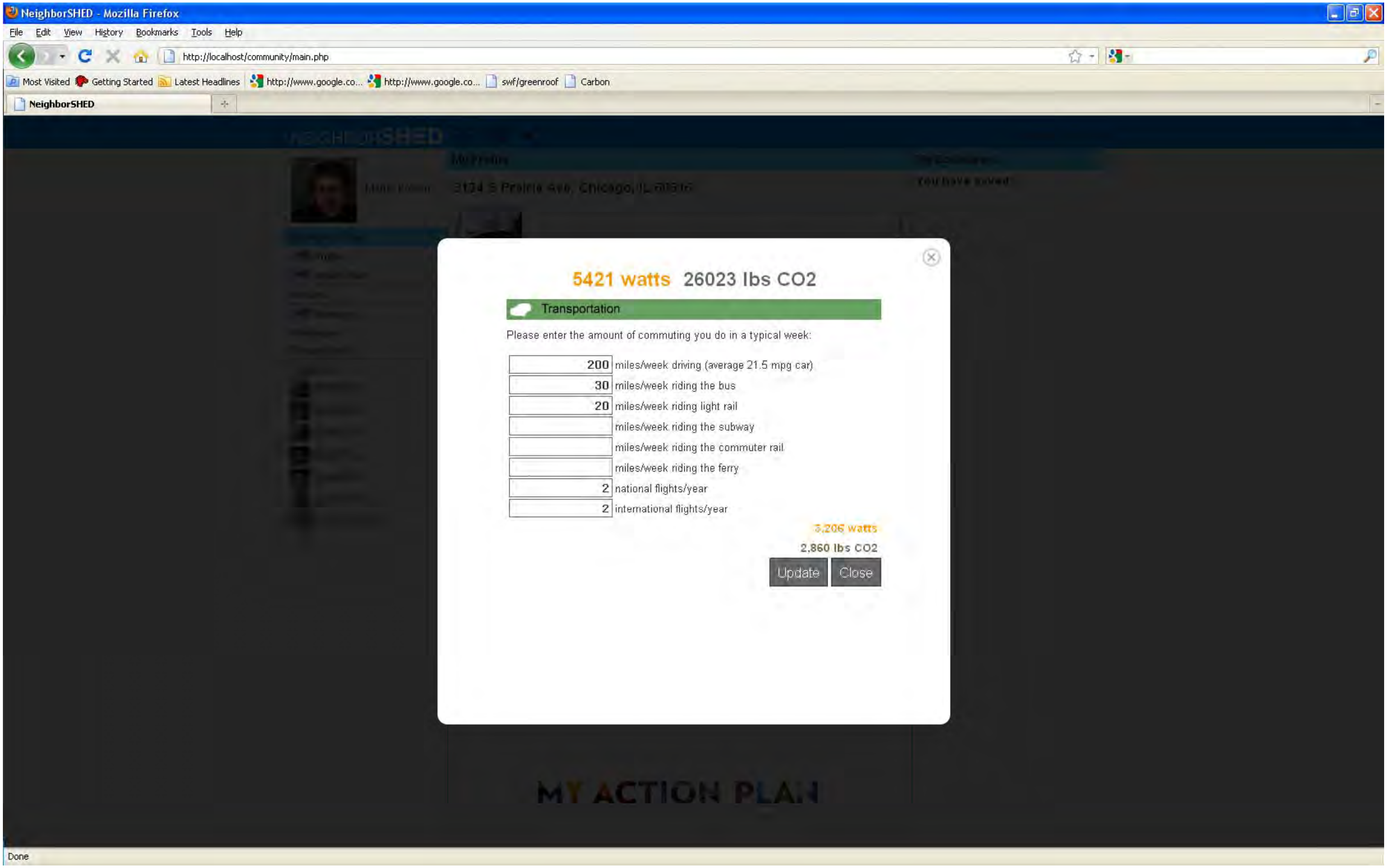

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
1922 watts 17122 lbs CO2 255729 gal
Eating
Indoor
Outdoor
Storm
Products
Your storm water is calculated from the property area and the prevailing storm water data based on you zip code:
3000 Property area (sf)
1950 Built area (sf)
60616 Zip code
67,830 gal/year
171 lbs CO2
9 watts
Update
Close
MY ACTION PLAN
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
1922 watts 17122 lbs CO2 255729 gal
Eating Indoor Outdoor Storm Products
The products you use comprise a significant portion of your footprint. Your footprint is based on the consumption habits of the average US citizen.
244,095 gal/year
6,041 lbs CO2
292 watts
Update Close
MY ACTION PLAN
Done

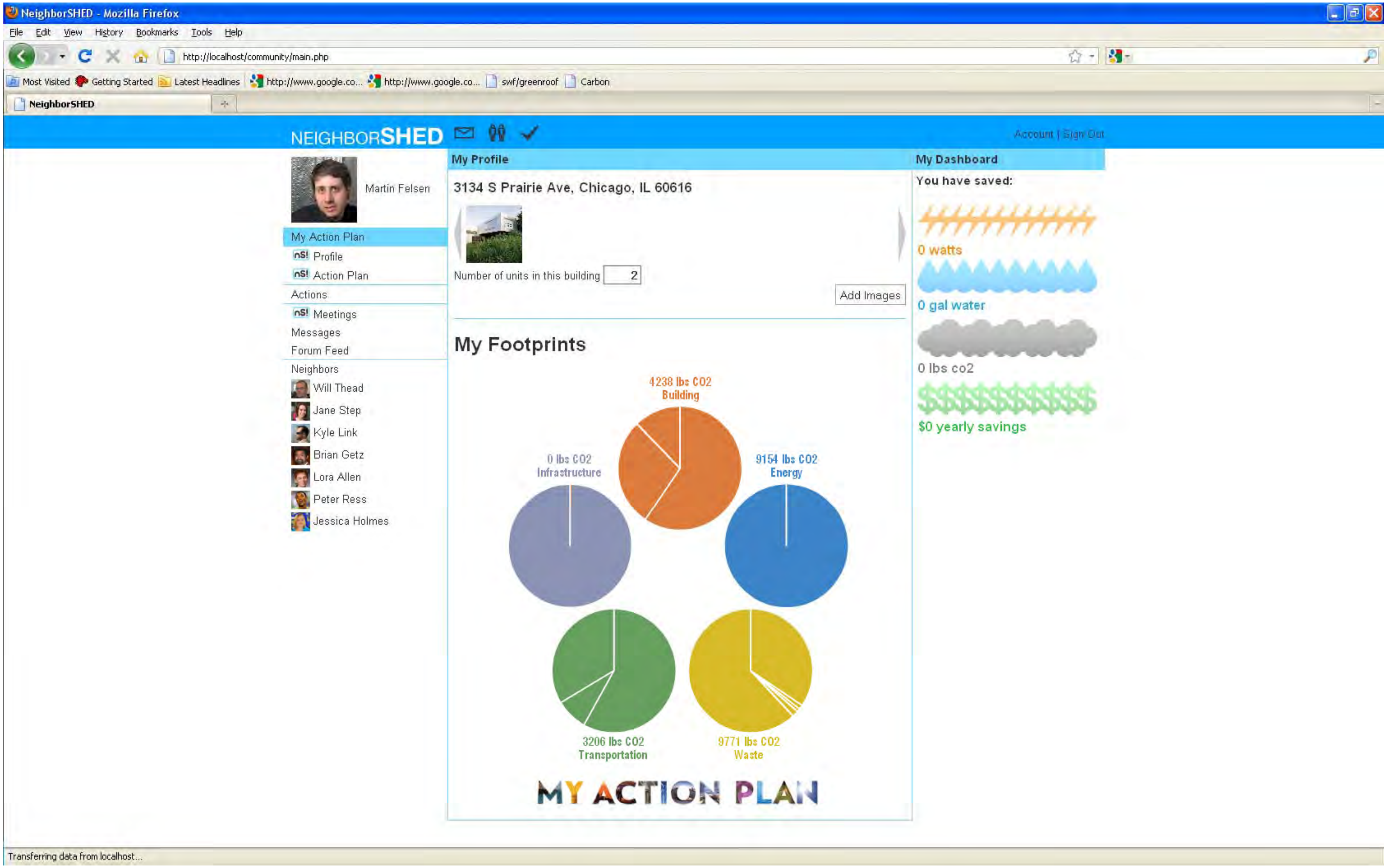

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
2214 watts 23163 lbs CO2 499824 gal
Eating Indoor Outdoor Storm Products
The products you use comprise a significant portion of your footprint. Your footprint is based on the consumption habits of the average US citizen.
244,095 gal/year
6,041 lbs CO2
292 watts
Update Close
MY ACTION PLAN
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
2214 watts 23163 lbs CO2
Transportation
Please enter the amount of commuting you do in a typical week:
miles/week driving (average 21.5 mpg car)
miles/week riding the bus
miles/week riding light rail
miles/week riding the subway
miles/week riding the commuter rail
miles/week riding the ferry
national flights/year
international flights/year
0 watts
0 lbs CO2
Update
Close
MY ACTION PLAN
Done

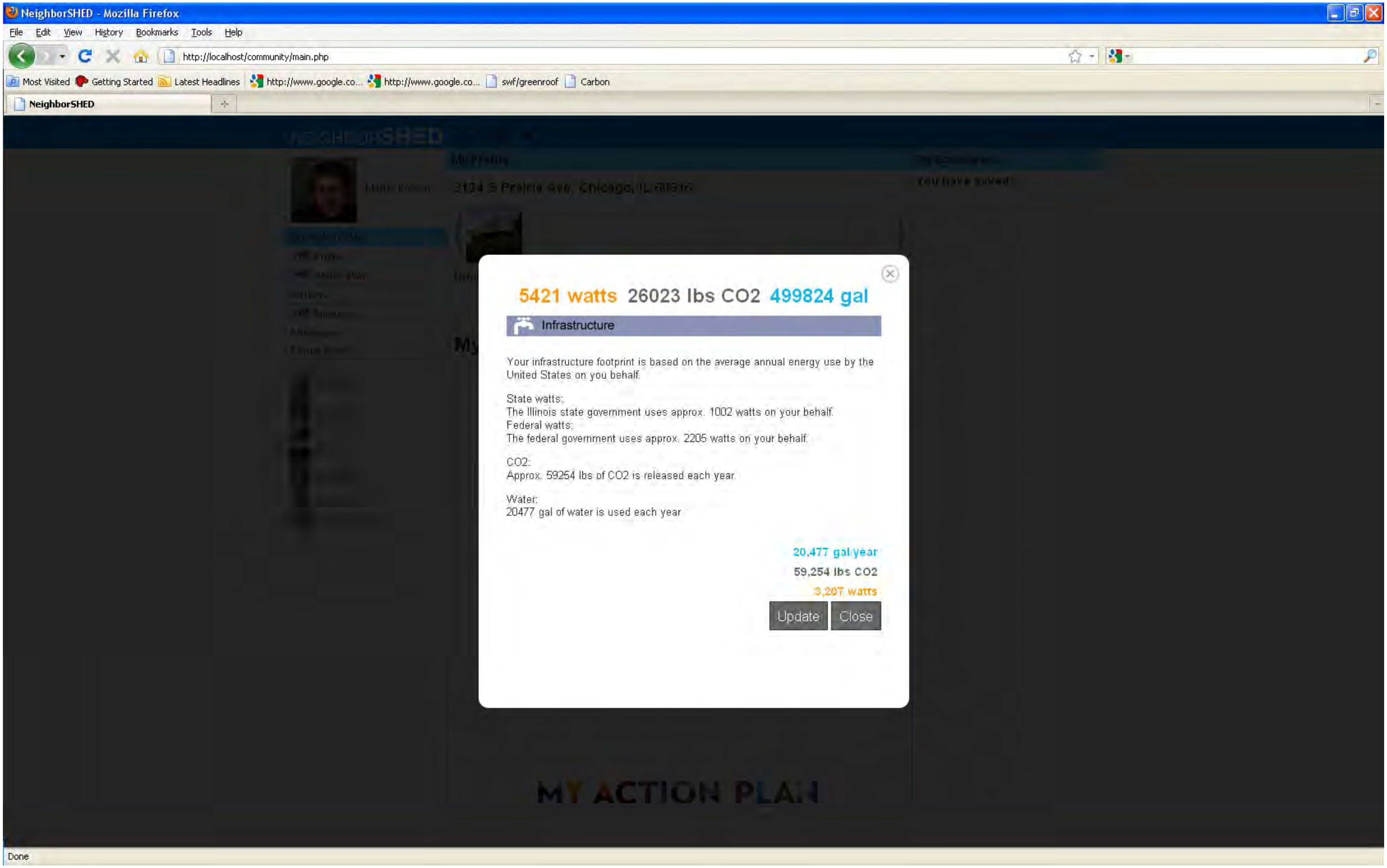

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
2214 watts 23163 lbs CO2
Transportation
Please enter the amount of commuting you do in a typical week:
200 miles/week driving (average 21.5 mpg car)
30 miles/week riding the bus
20 miles/week riding light rail
miles/week riding the subway
miles/week riding the commuter rail
miles/week riding the ferry
2 national flights/year
2 international flights/year
3,206 watts
2,860 lbs CO2
Update Close
MY ACTION PLAN
Done

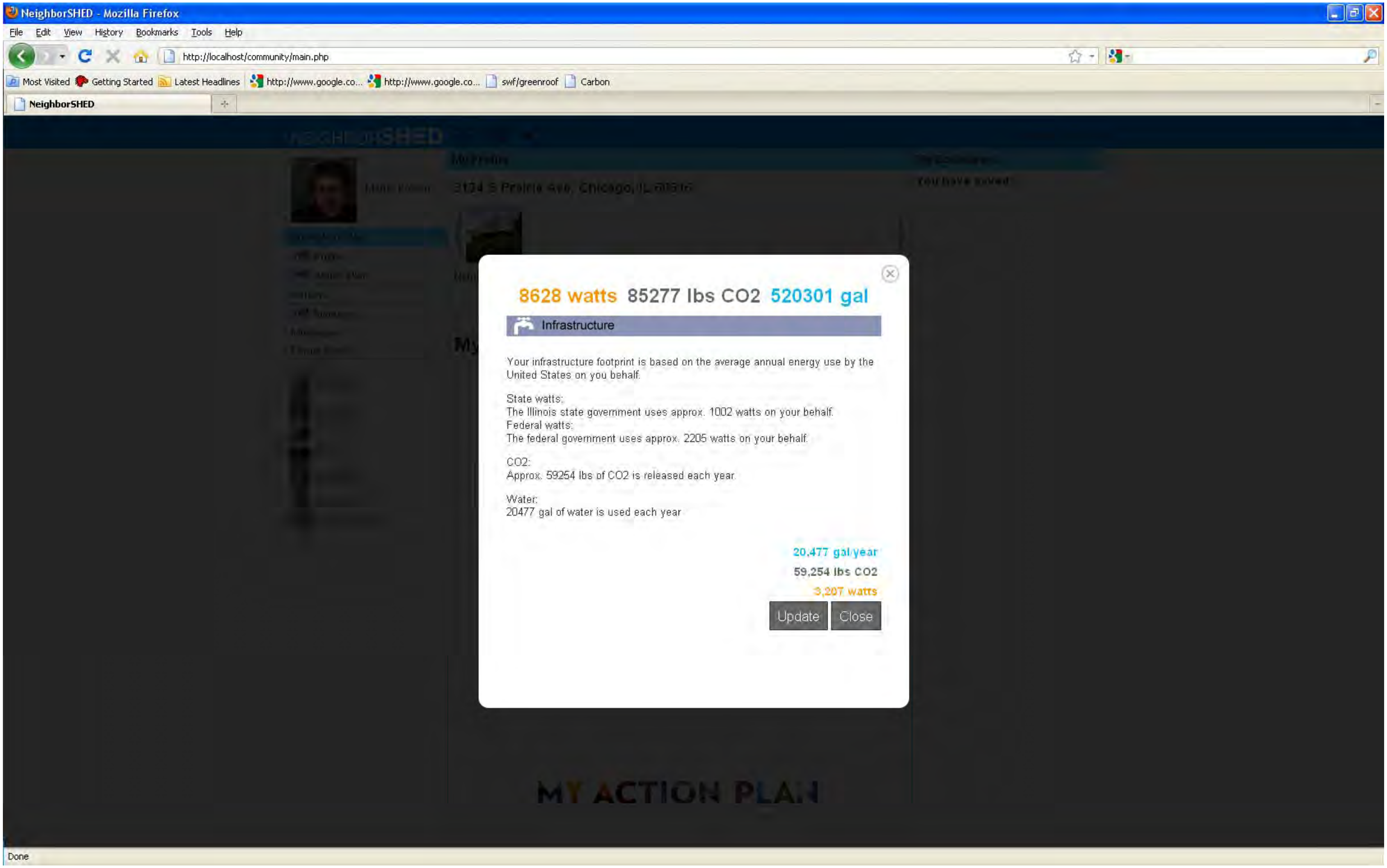


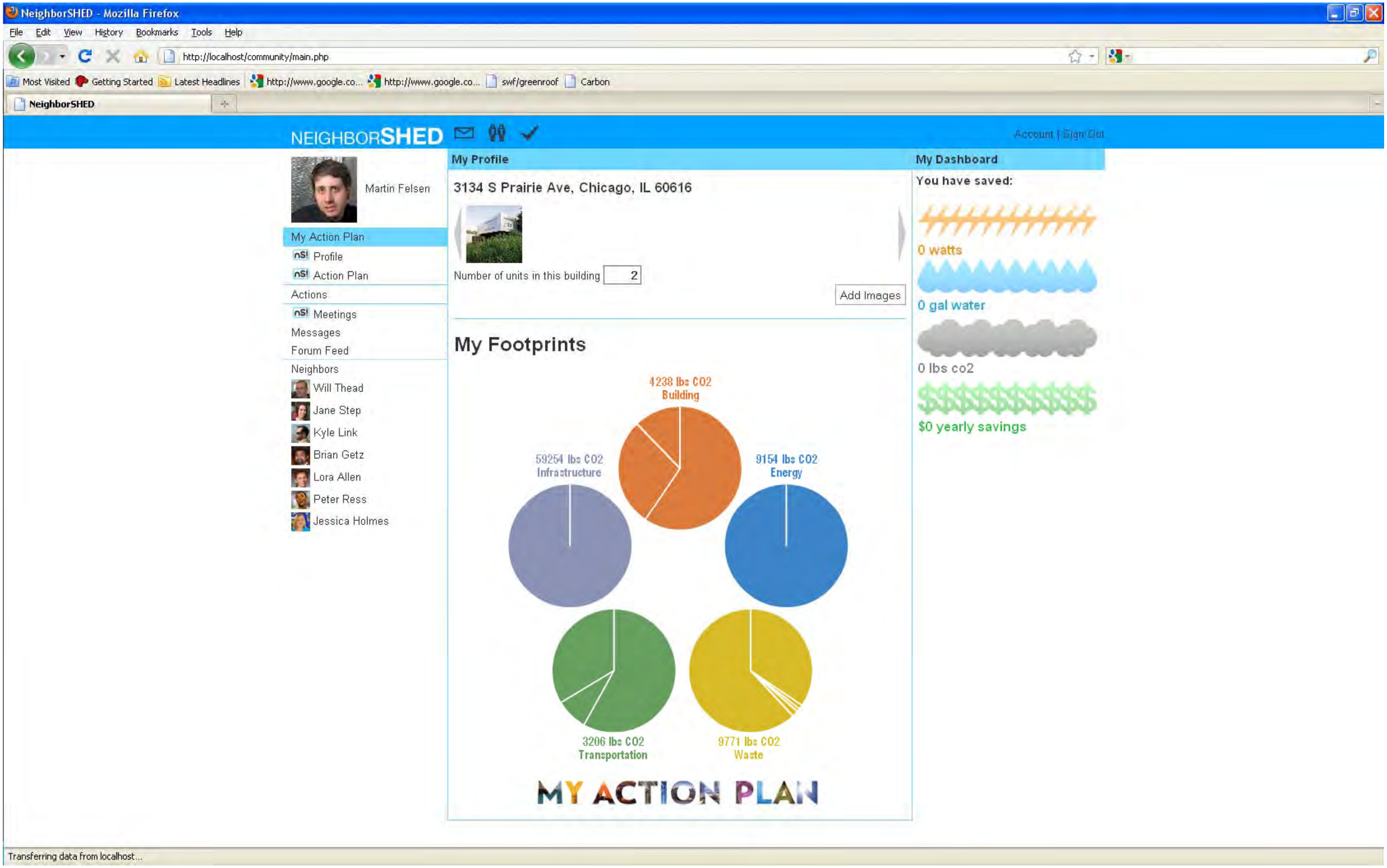
NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
5421 watts 26023 lbs CO2
Transportation
Please enter the amount of commuting you do in a typical week:
200 miles/week driving (average 21.5 mpg car)
30 miles/week riding the bus
20 miles/week riding light rail
miles/week riding the subway
miles/week riding the commuter rail
miles/week riding the ferry
2 national flights/year
2 international flights/year
2,860 lbs CO2
Update
Close
MY ACTION PLAN
Done



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
4238 lbs CO2 Building
0 lbs CO2 Infrastructure
9154 lbs CO2 Energy
3206 lbs CO2 Transportation
9771 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
5421 watts 26023 lbs CO2 499824 gal
Infrastructure
Your infrastructure footprint is based on the average annual energy use by the United States on you behalf.
State watts:
The Illinois state government uses approx. 1002 watts on your behalf.
Federal watts:
The federal government uses approx. 2205 watts on your behalf.
CO2:
Approx. 59254 lbs of CO2 is released each year.
Water:
20477 gal of water is used each year.
20,477 gal/year
59,254 lbs CO2
3,207 watts
Update
Close
MY ACTION PLAN
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
8628 watts 85277 lbs CO2 520301 gal
Infrastructure
Your infrastructure footprint is based on the average annual energy use by the United States on you behalf.
State watts:
The Illinois state government uses approx. 1002 watts on your behalf.
Federal watts:
The federal government uses approx. 2205 watts on your behalf.
CO2:
Approx. 59254 lbs of CO2 is released each year.
Water:
20477 gal of water is used each year
20,477 gal/year
59,254 lbs CO2
3,207 watts
Update
Close
MY ACTION PLAN
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/main.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
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NEIGHBORSHED
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Action Plan
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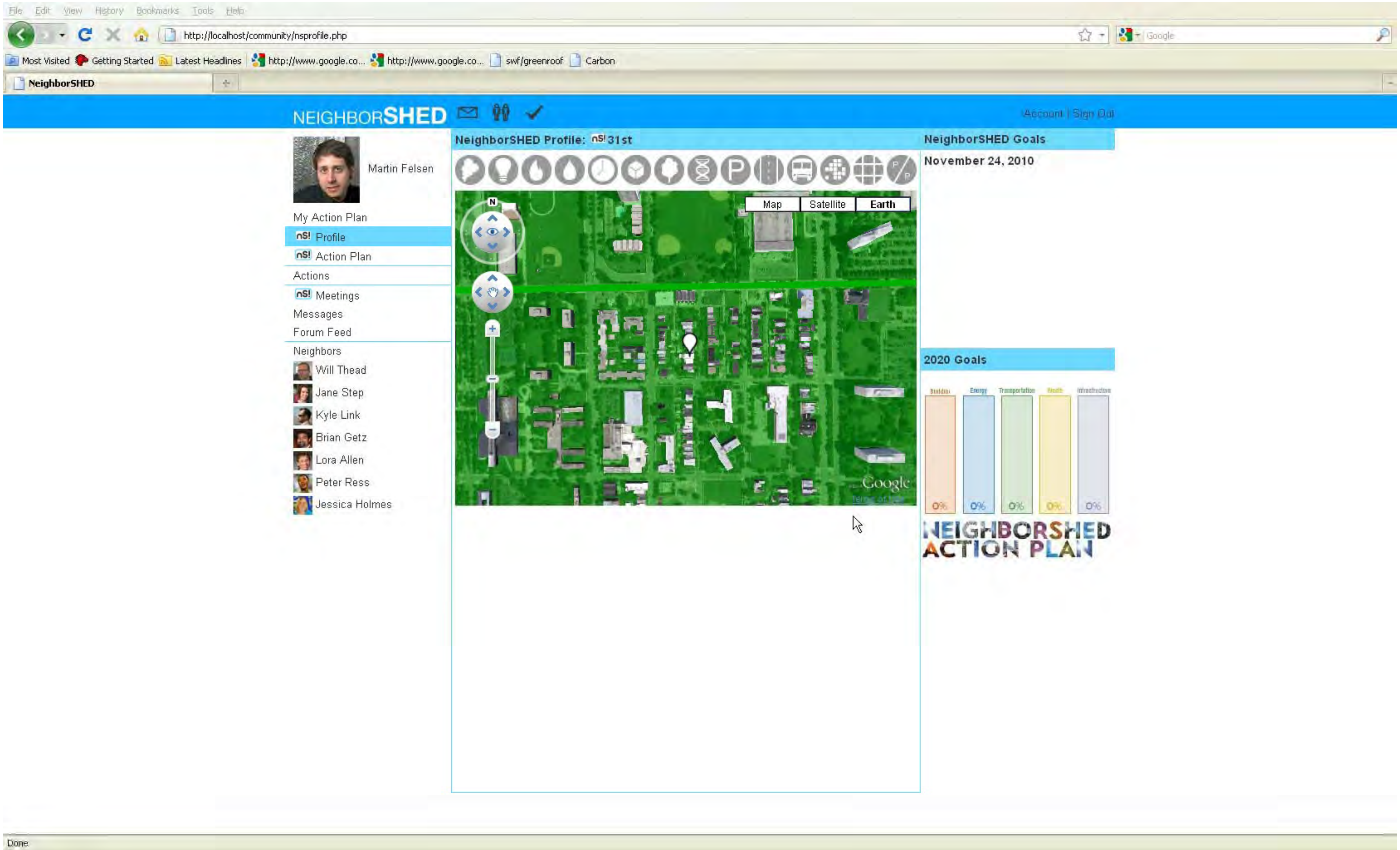
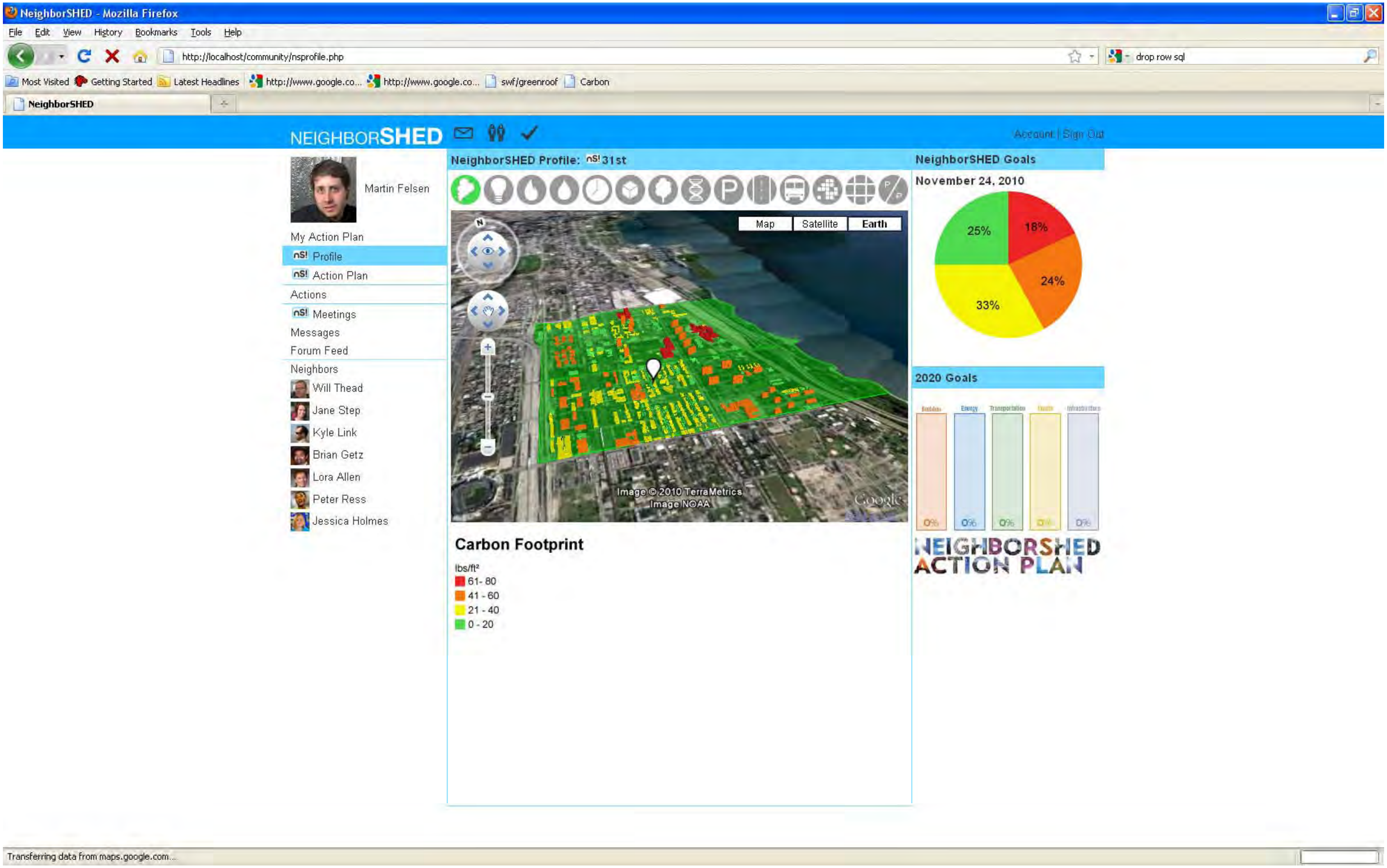
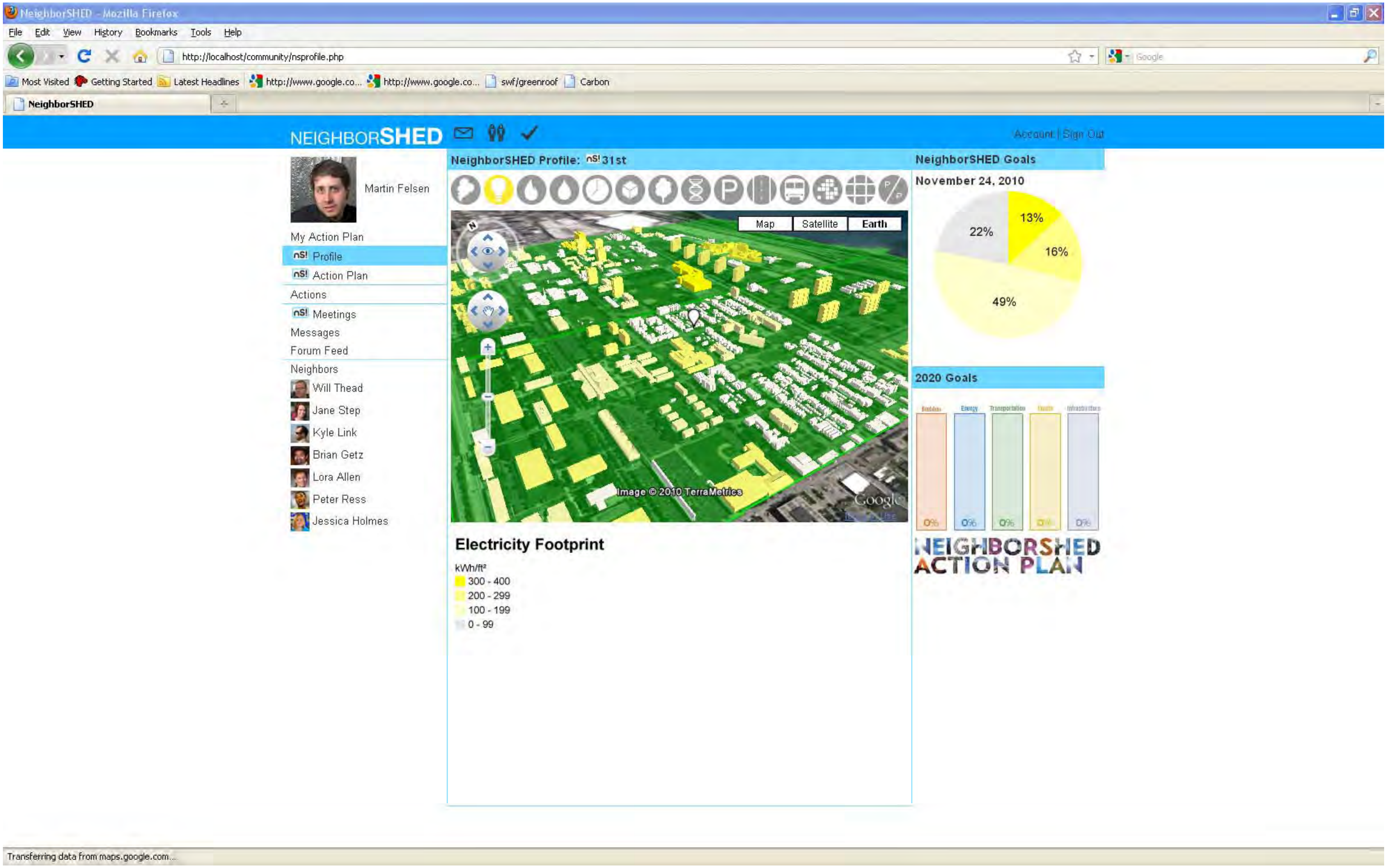
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
4238 lbs CO2 Building
59254 lbs CO2 Infrastructure
9154 lbs CO2 Energy
3206 lbs CO2 Transportation
9771 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
Transferring data from localhost...


File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Google
NeighborSHED Goals
November 24, 2010
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED
ACTION PLAN
Done



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
drop row sql
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Image NOAA
Carbon Footprint
lbs/ft²
61- 80
41 - 60
21 - 40
0 - 20
NeighborSHED Goals
November 24, 2010
25%
18%
24%
33%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED
ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
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My Action Plan
nS! Profile
nS! Action Plan
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nS! Meetings
Messages
Forum Feed
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Will Thead
Jane Step
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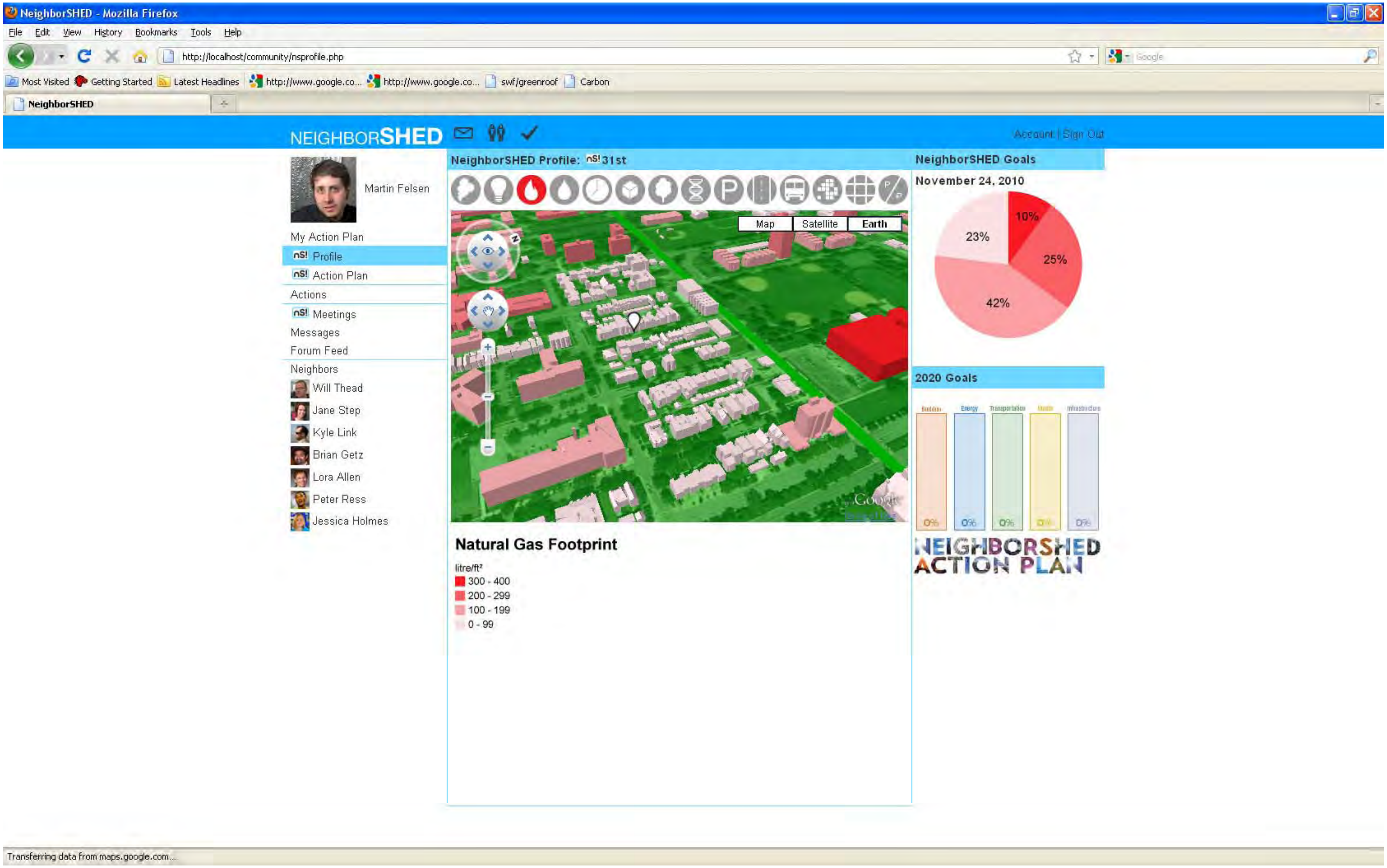
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Google
Electricity Footprint
kWh/ft²
300 - 400
200 - 299
100 - 199
0 - 99
NeighborSHED Goals
November 24, 2010
13%
16%
22%
49%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
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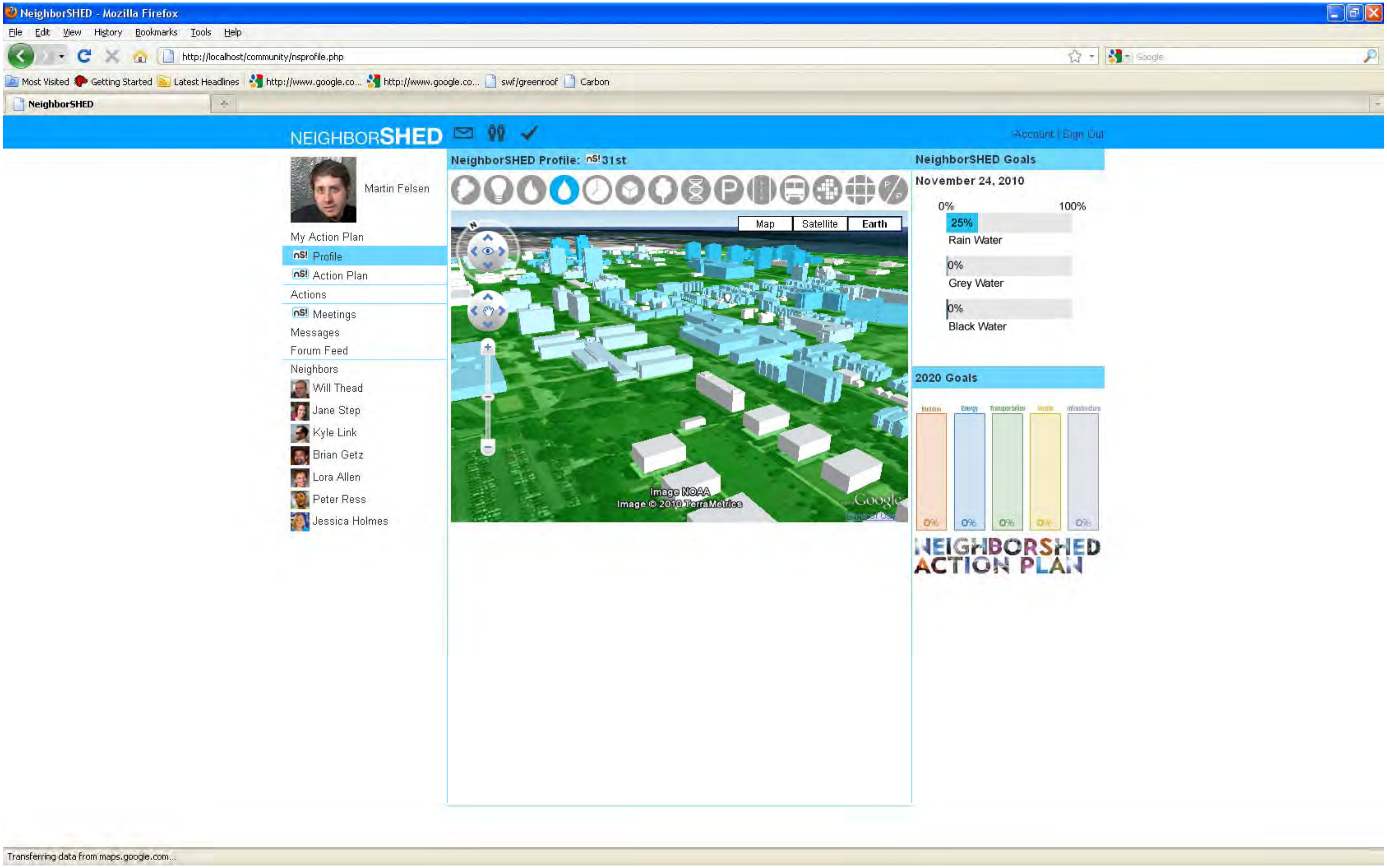
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Natural Gas Footprint
litre/ft²
300 - 400
200 - 299
100 - 199
0 - 99
NeighborSHED Goals
November 24, 2010
10%
25%
42%
23%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
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nS! Meetings
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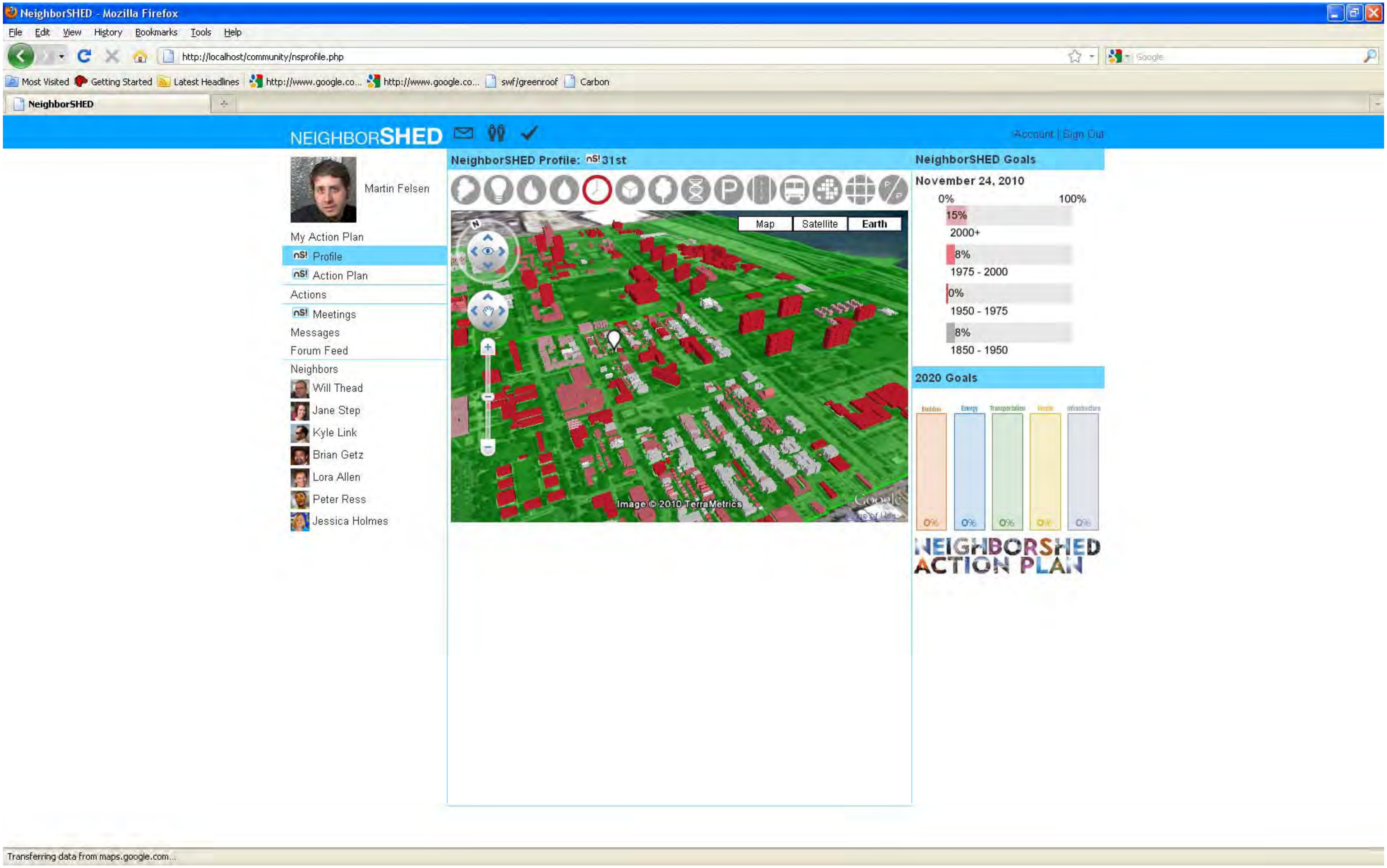
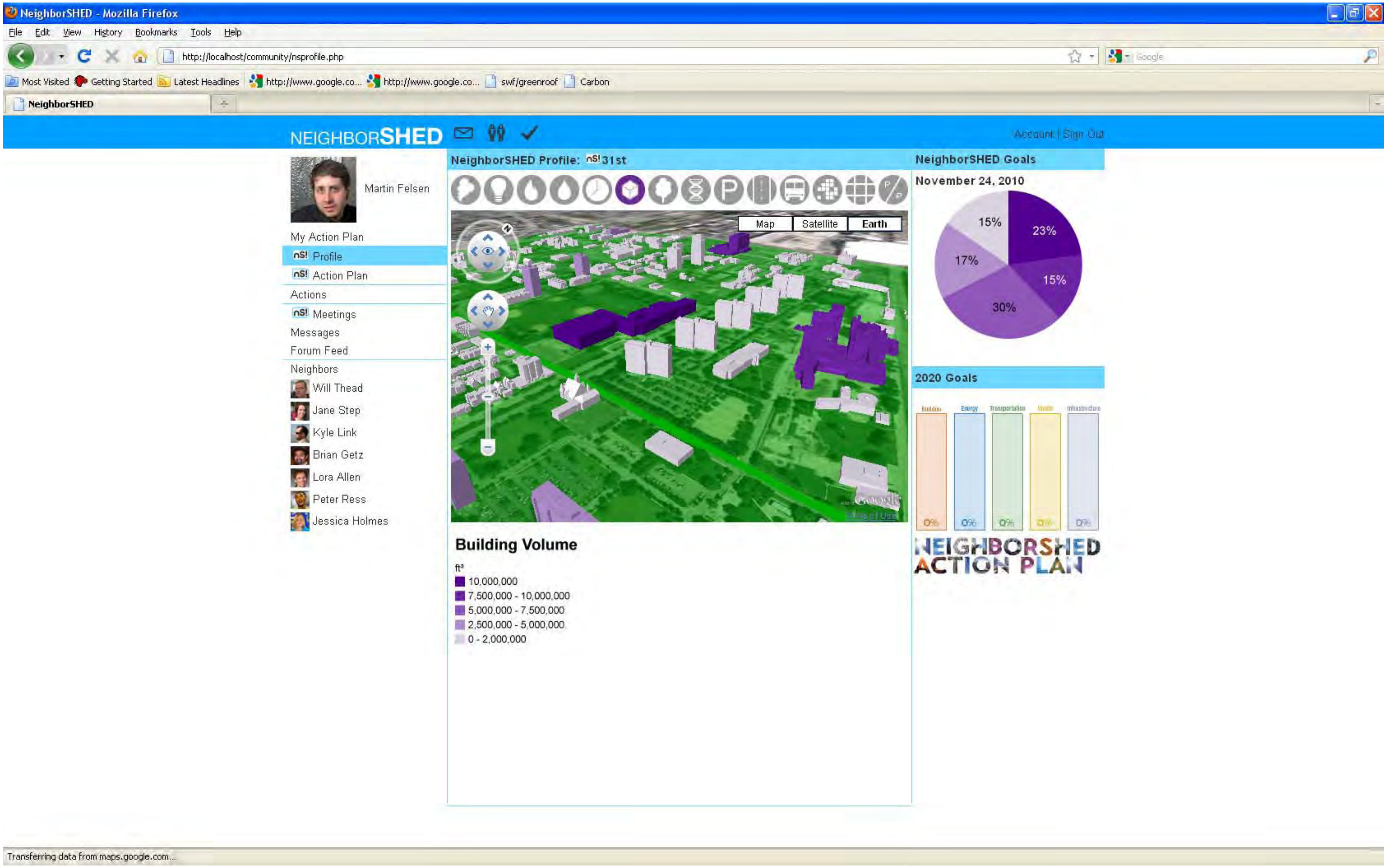
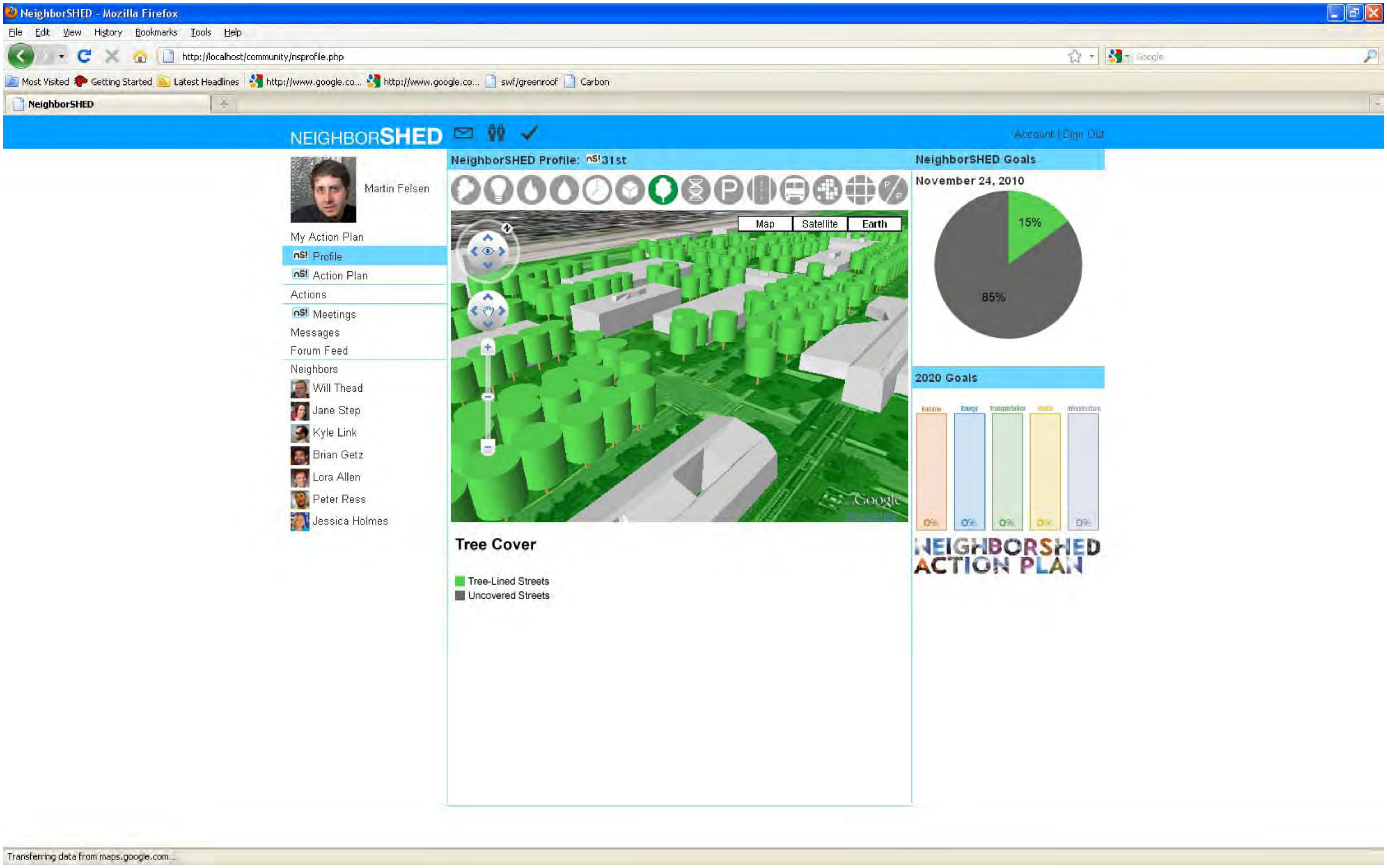
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image NOAA
Image © 2010 TerraMetrics
Google
NeighborSHED Goals
November 24, 2010
0%
100%
25%
Rain Water
0%
Grey Water
0%
Black Water
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
NeighborSHED Goals
November 24, 2010
0%
100%
15%
2000+
8%
1975 - 2000
0%
1950 - 1975
8%
1850 - 1950
2020 Goals
Energy
Transportation
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Building Volume
ft³
10,000,000
7,500,000 - 10,000,000
5,000,000 - 7,500,000
2,500,000 - 5,000,000
0 - 2,000,000
NeighborSHED Goals
November 24, 2010
15%
23%
17%
15%
30%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Google
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
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Will Thead
Jane Step
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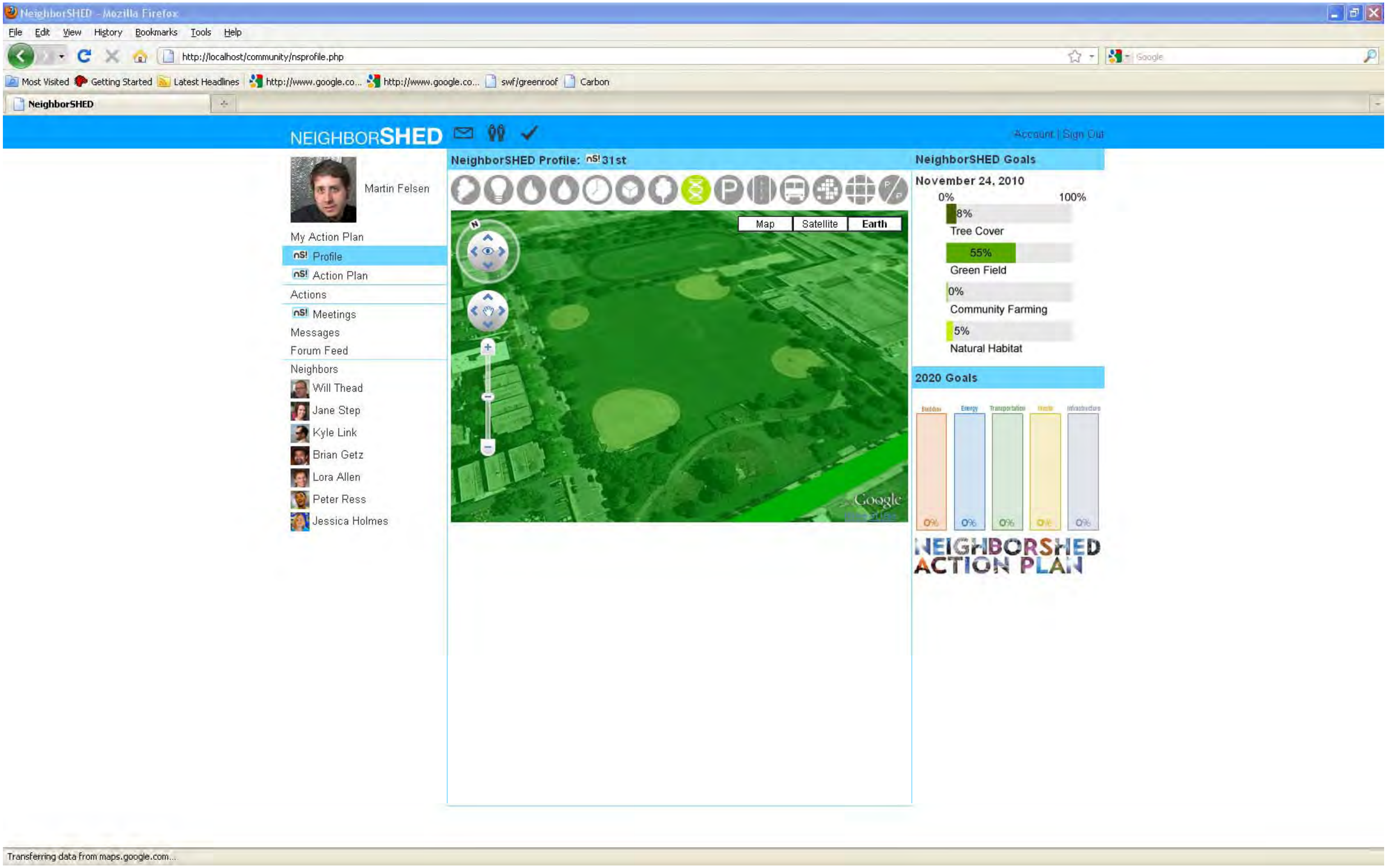
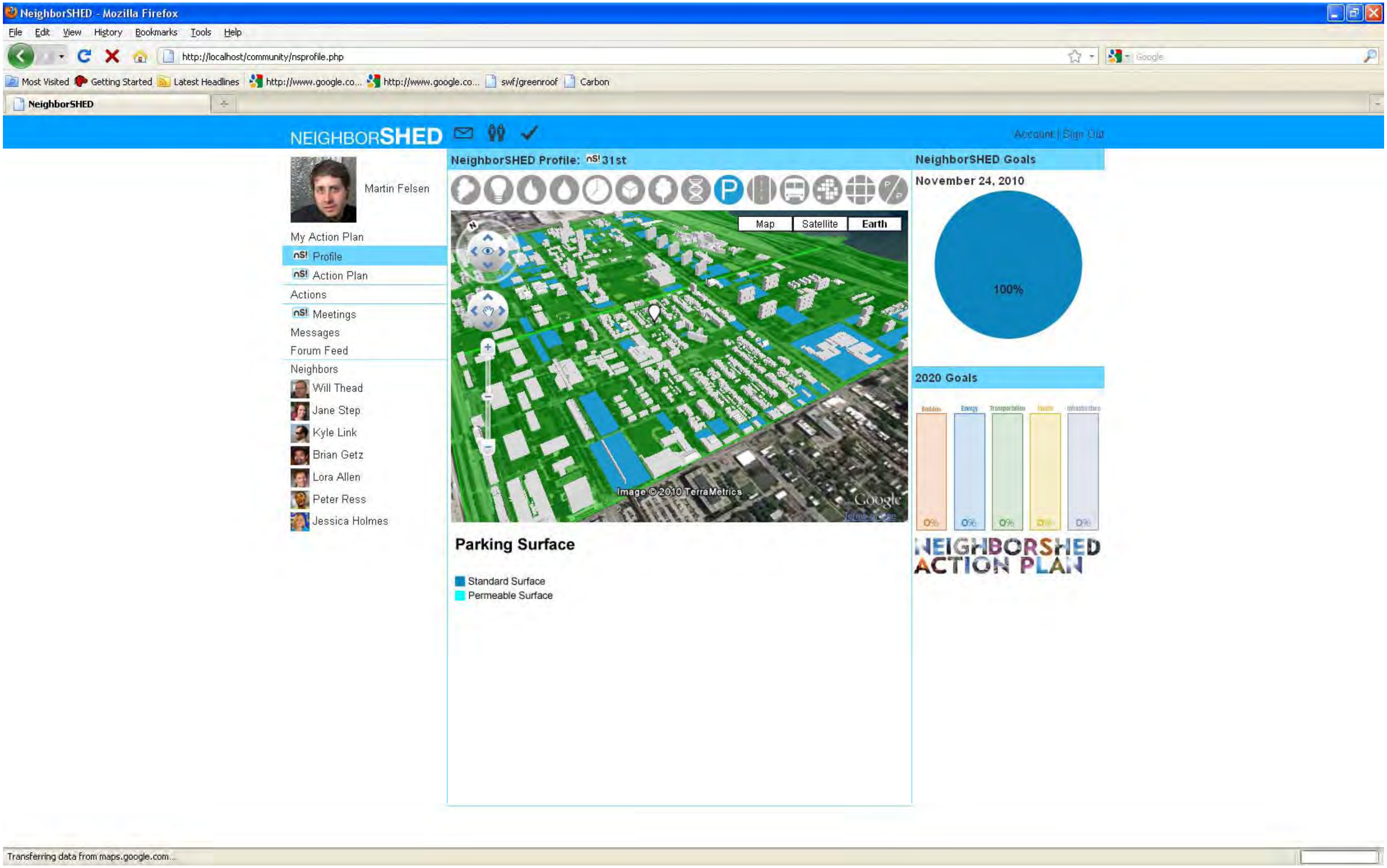
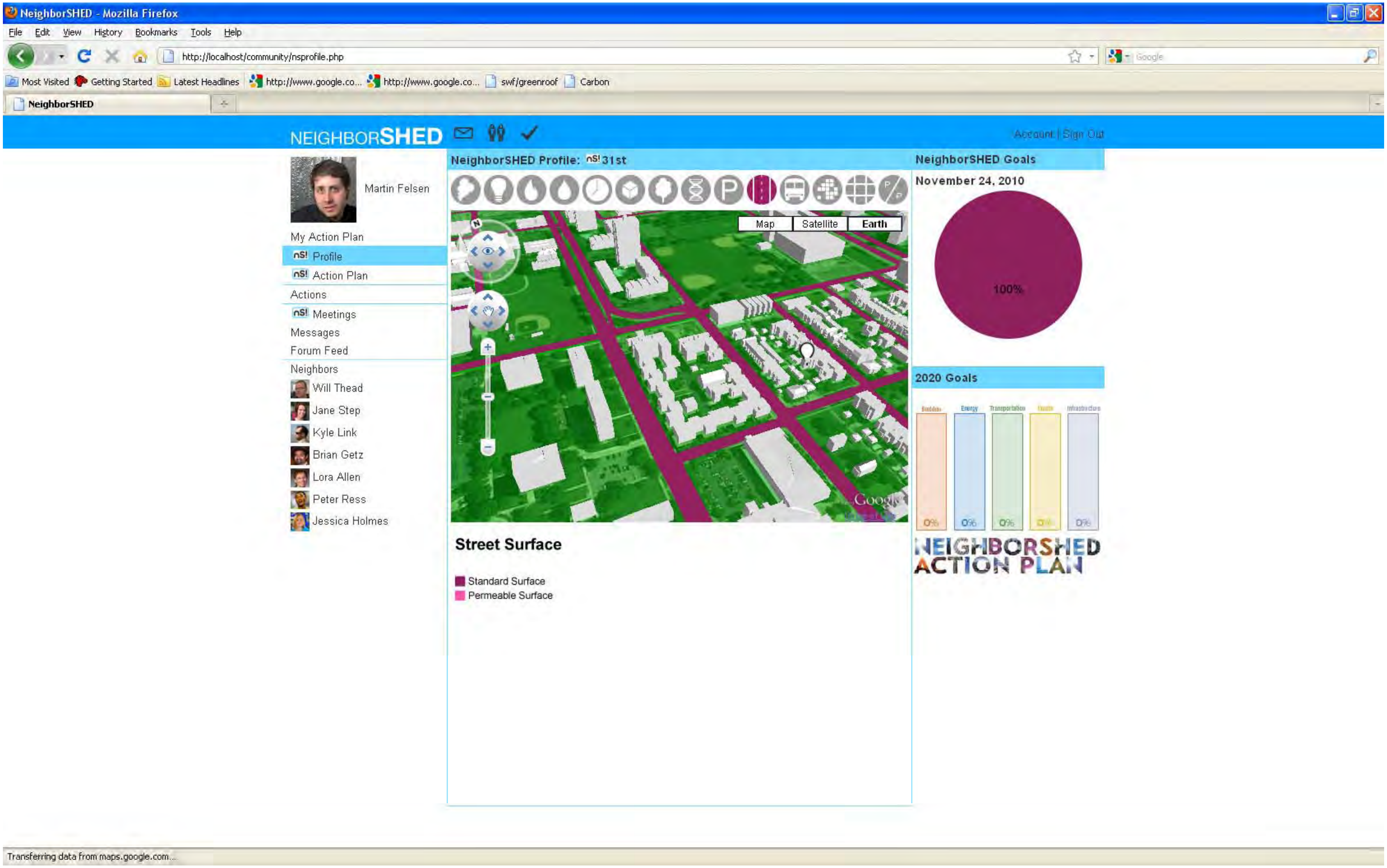
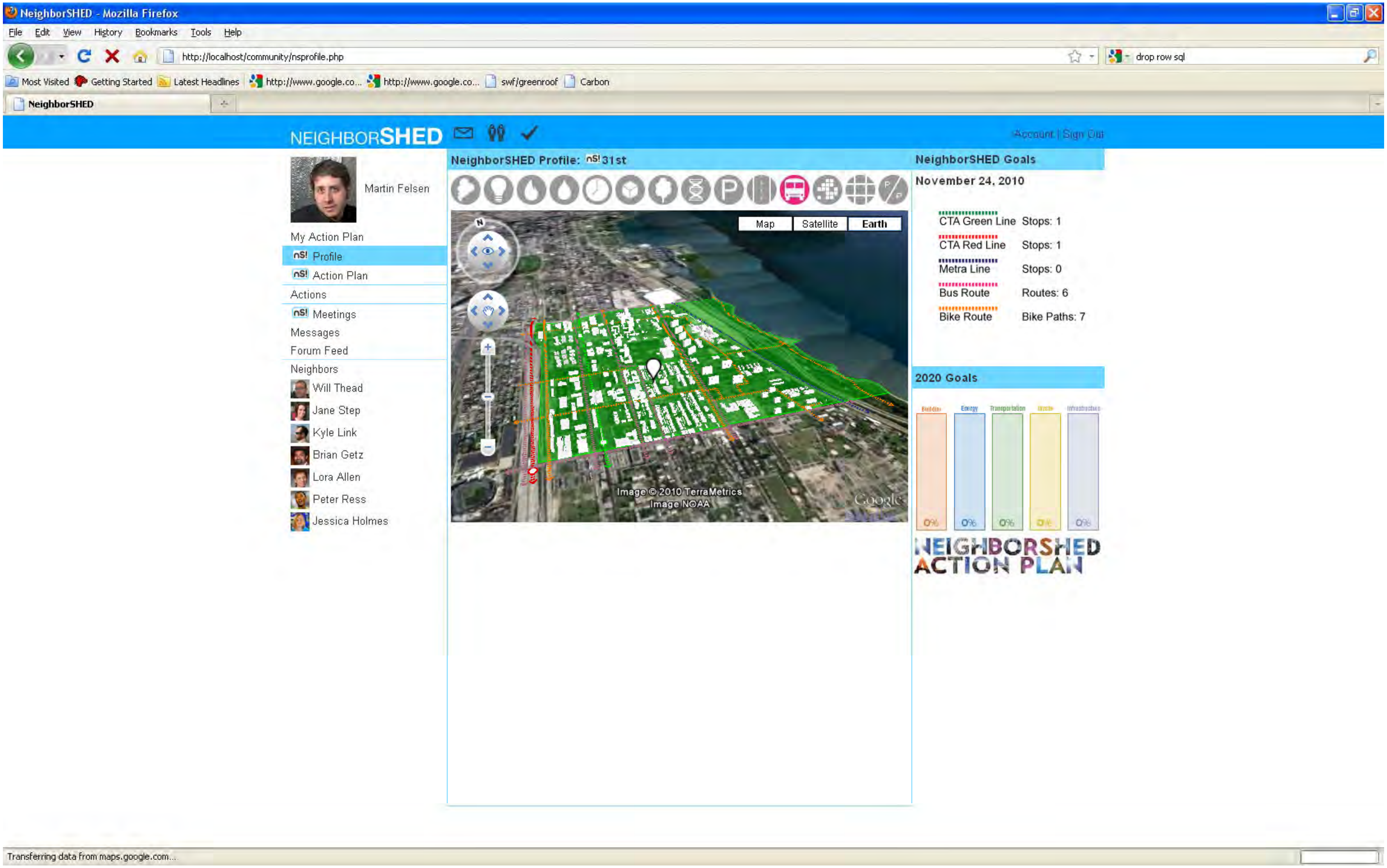
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Google
Tree Cover
Tree-Lined Streets
Uncovered Streets
NeighborSHED Goals
November 24, 2010
15%
85%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...

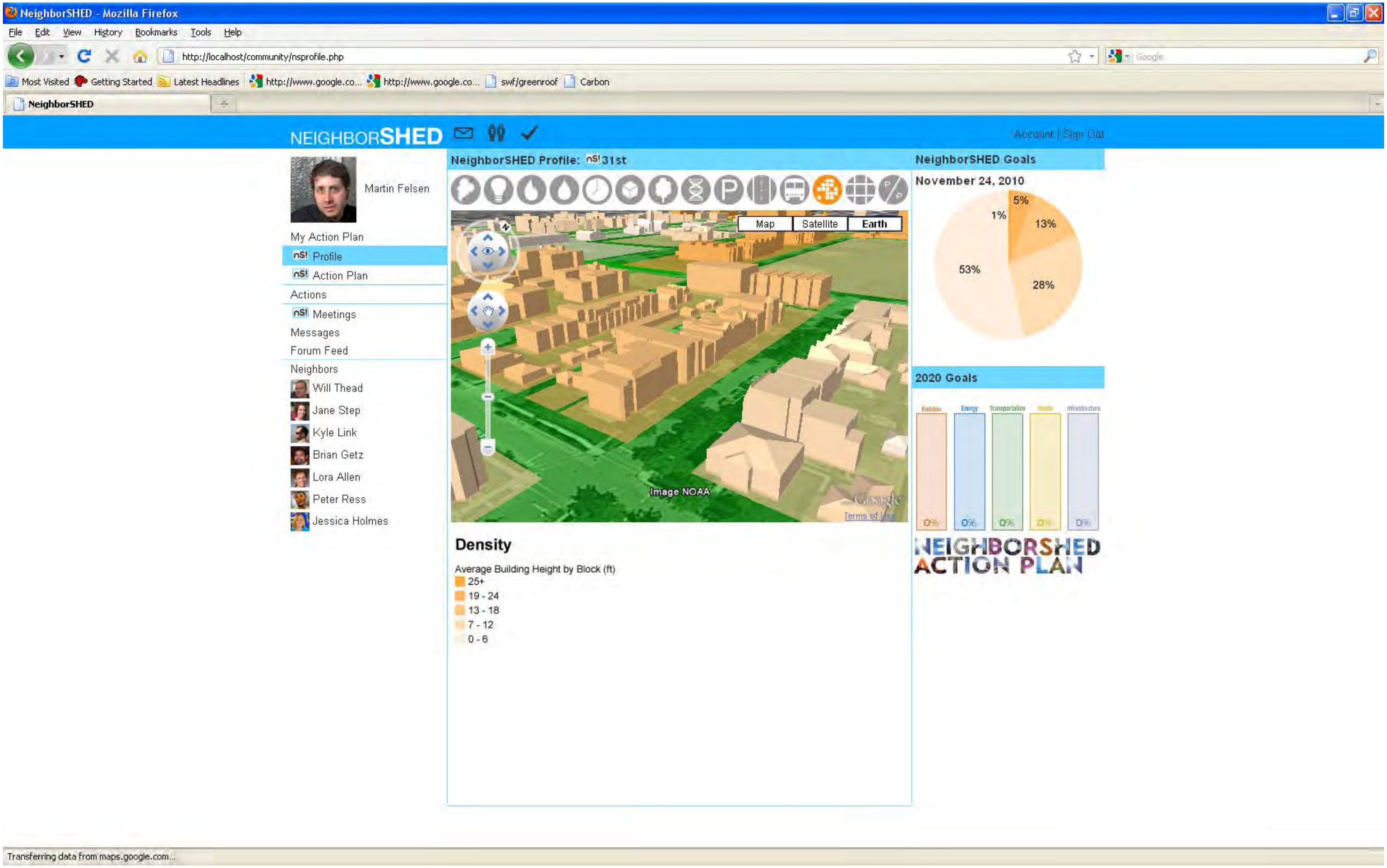

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Google
NeighborSHED Goals
November 24, 2010
0%
100%
8%
Tree Cover
55%
Green Field
0%
Community Farming
5%
Natural Habitat
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Google
Parking Surface
Standard Surface
Permeable Surface
NeighborSHED Goals
November 24, 2010
100%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...



NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Street Surface
Standard Surface
Permeable Surface
NeighborSHED Goals
November 24, 2010
100%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
drop row sql
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Image NOAA
Google
NeighborSHED Goals
November 24, 2010
CTA Green Line Stops: 1
CTA Red Line Stops: 1
Metra Line Stops: 0
Bus Route Routes: 6
Bike Route Bike Paths: 7
2020 Goals
Energy
Transportation
0%
0%
0%
0%
0%
NEIGHBORSHED
ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
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Martin Felsen
My Action Plan
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Action Plan
Actions
Meetings
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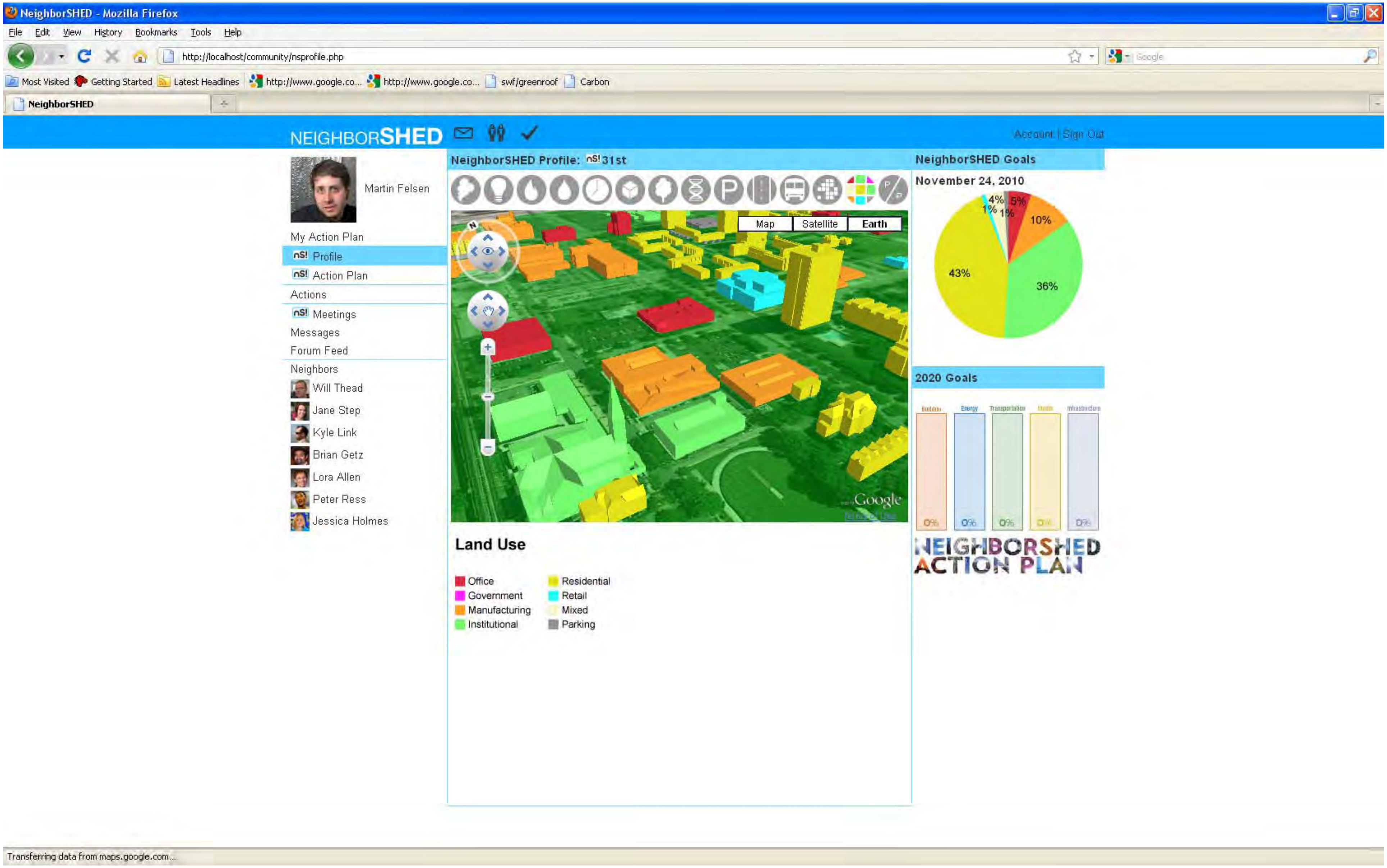
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image NOAA
Density
Average Building Height by Block (ft)
25+
19 - 24
13 - 18
7 - 12
0 - 6
NeighborSHED Goals
November 24, 2010
5%
1%
13%
53%
28%
2020 Goals
NEIGHBORSHED
ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
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My Action Plan
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Action Plan
Actions
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Messages
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Neighbors
Will Thead
Jane Step
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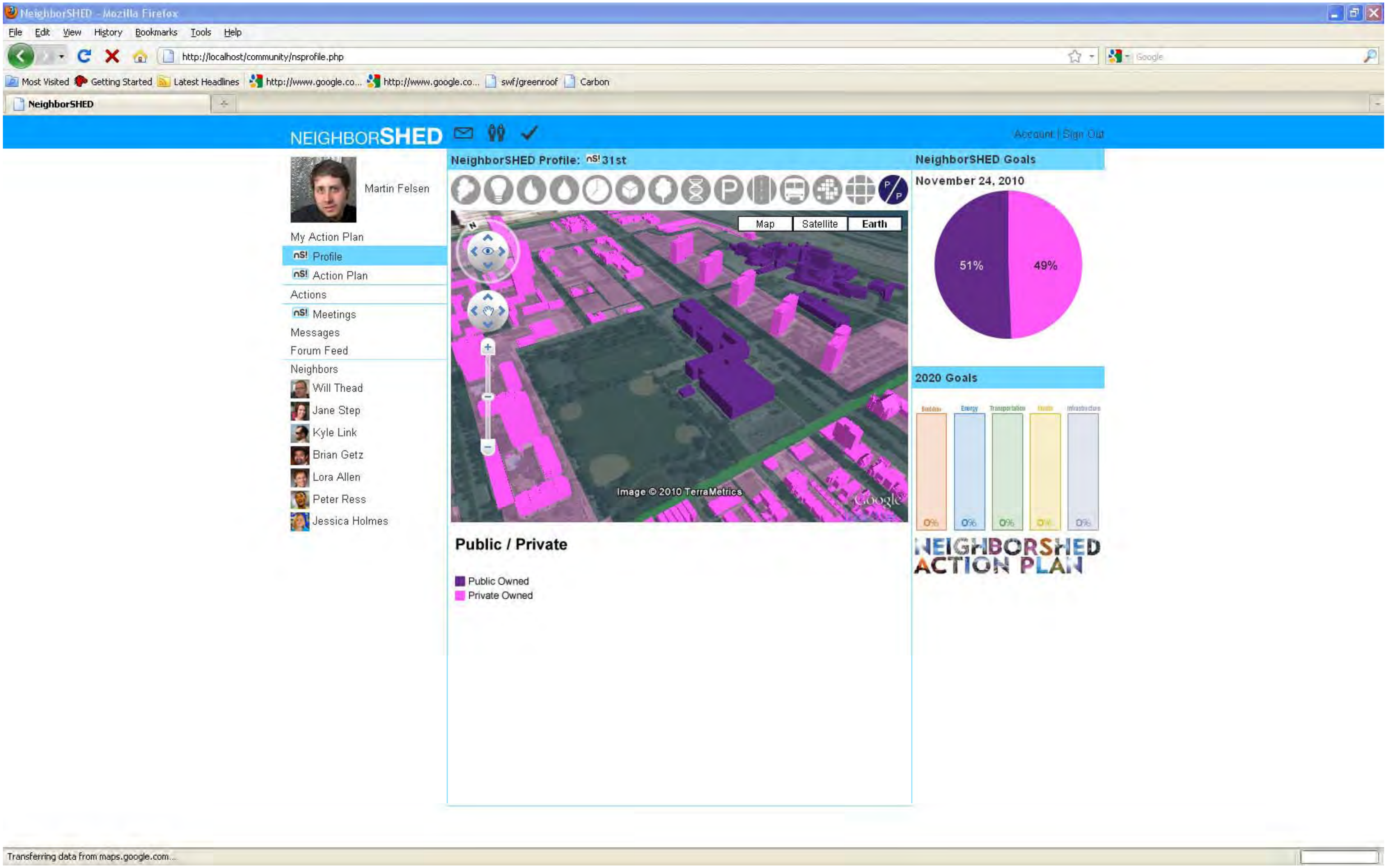
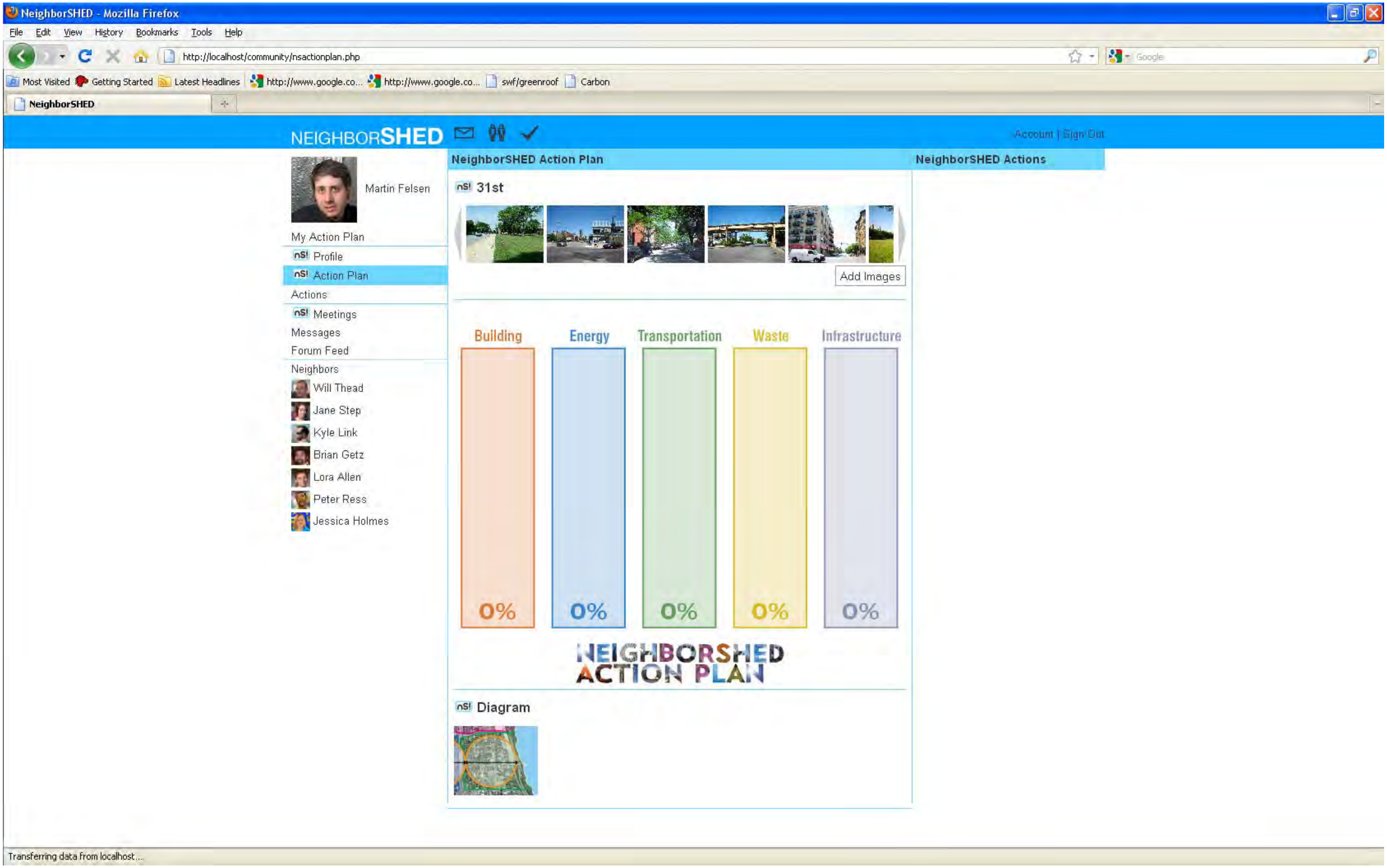
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Google
Land Use
Office
Government
Manufacturing
Institutional
Residential
Retail
Mixed
Parking
NeighborSHED Goals
November 24, 2010
4%
5%
1%
1%
10%
43%
36%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED
ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofile.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Google
Public / Private
Public Owned
Private Owned
NeighborSHED Goals
November 24, 2010
51%
49%
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Google
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
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Martin Felsen
My Action Plan
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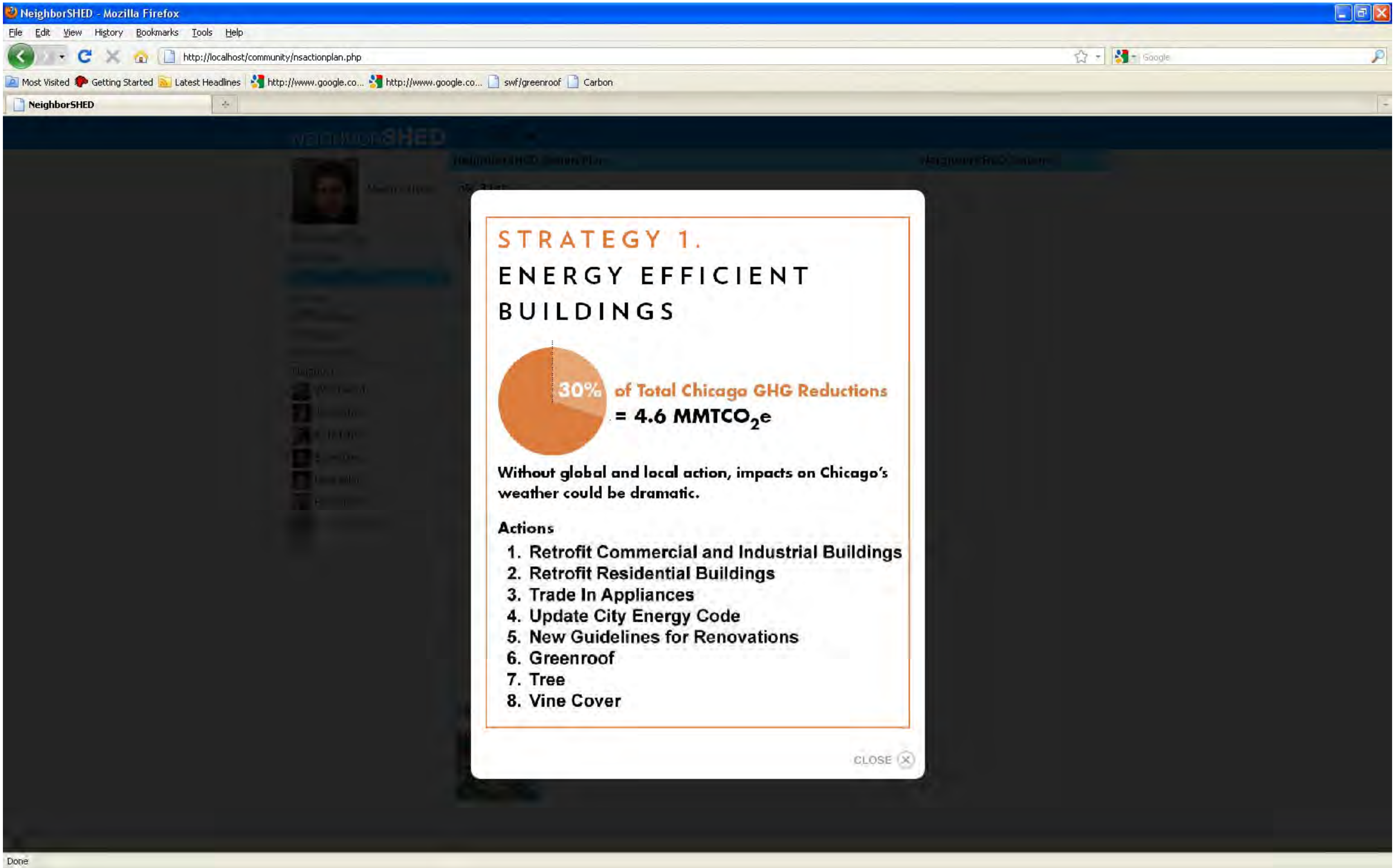
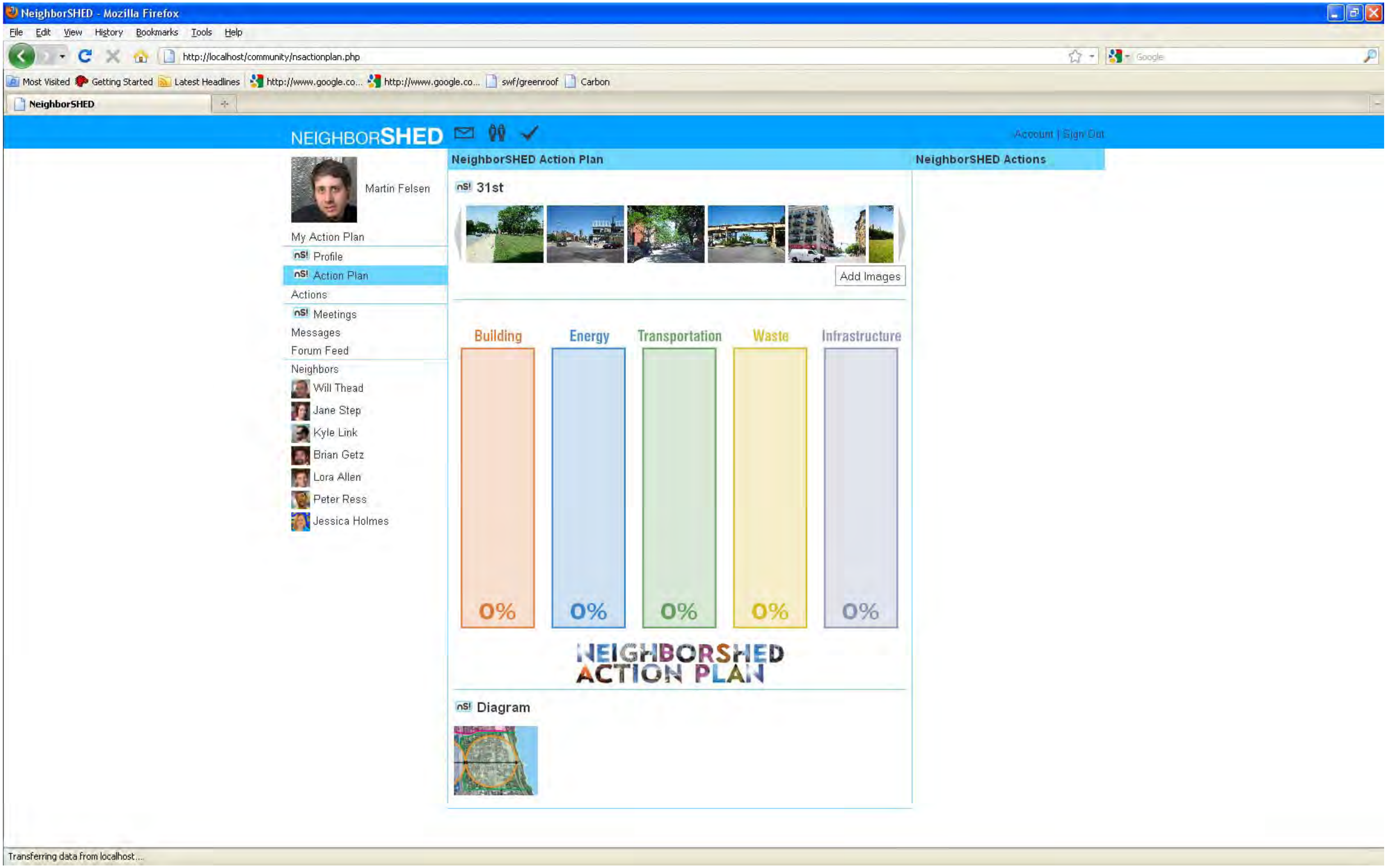
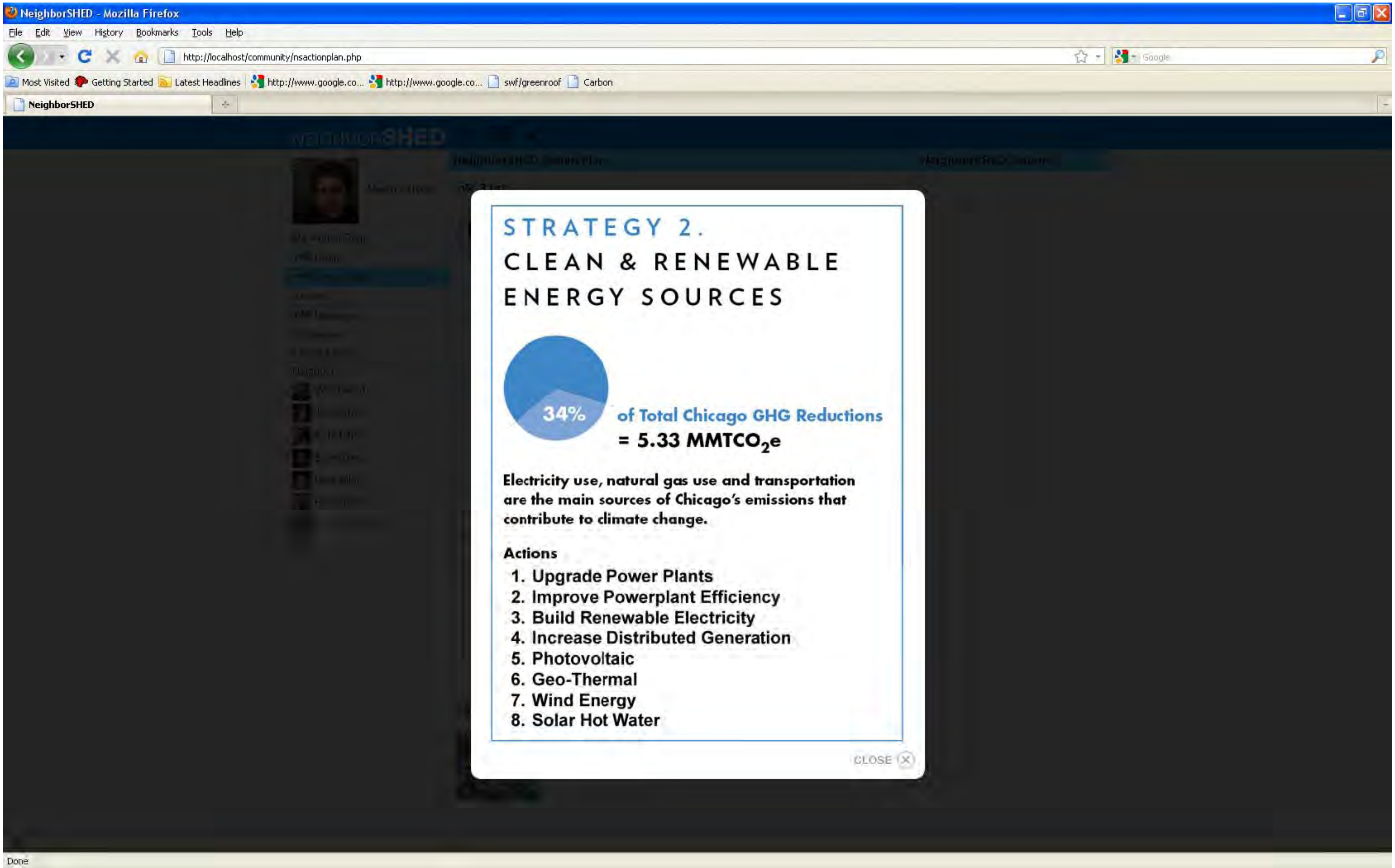
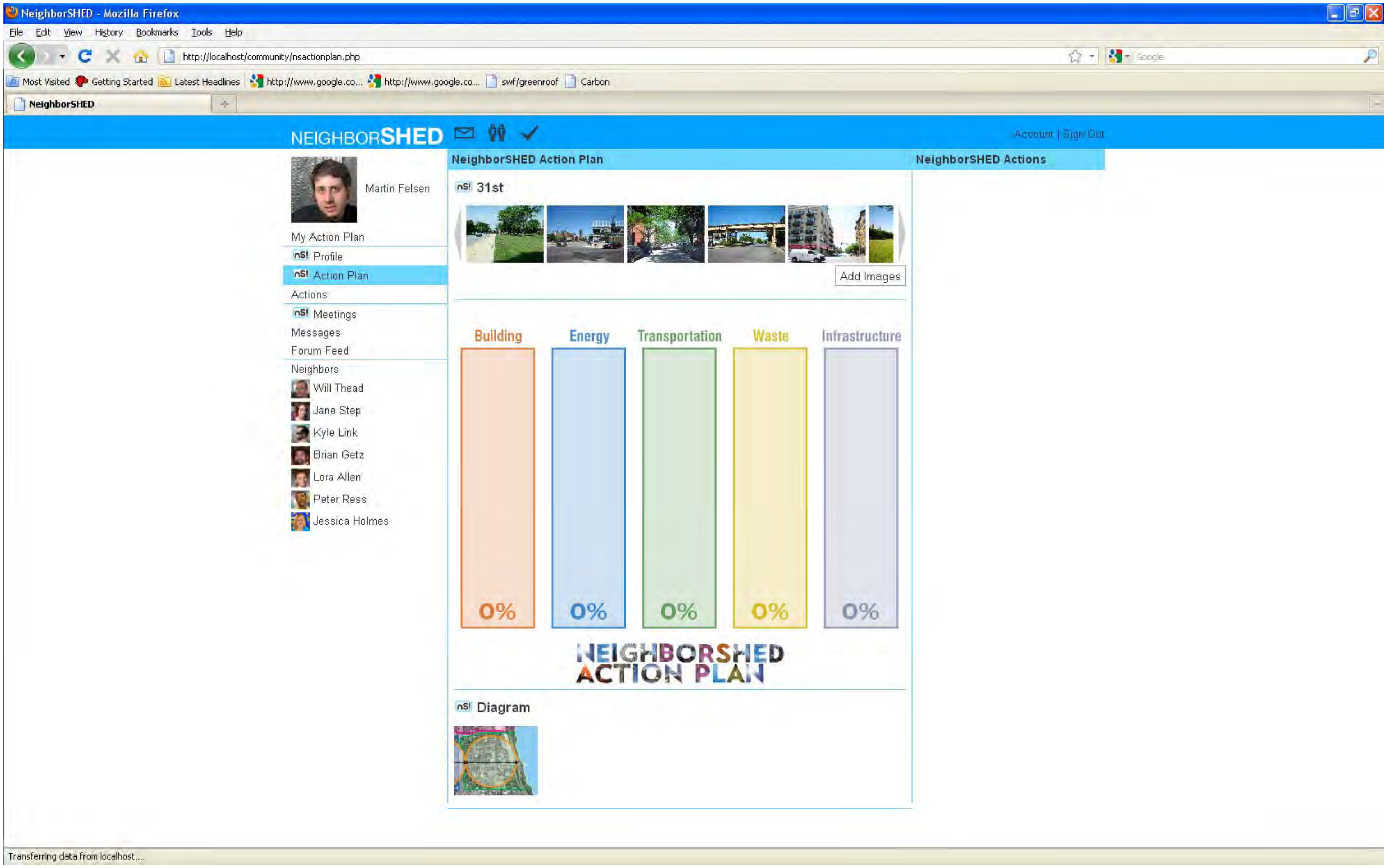
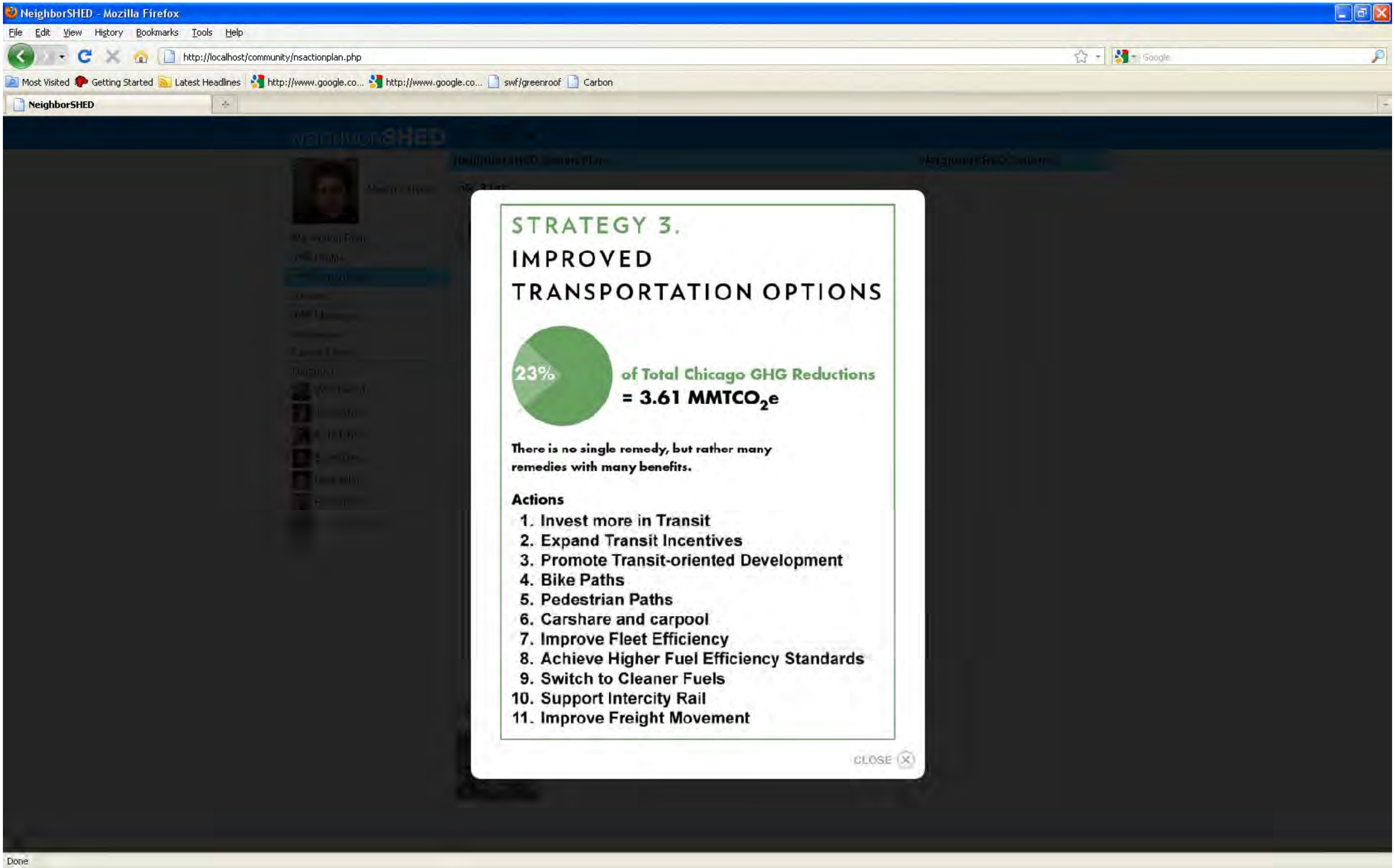
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...

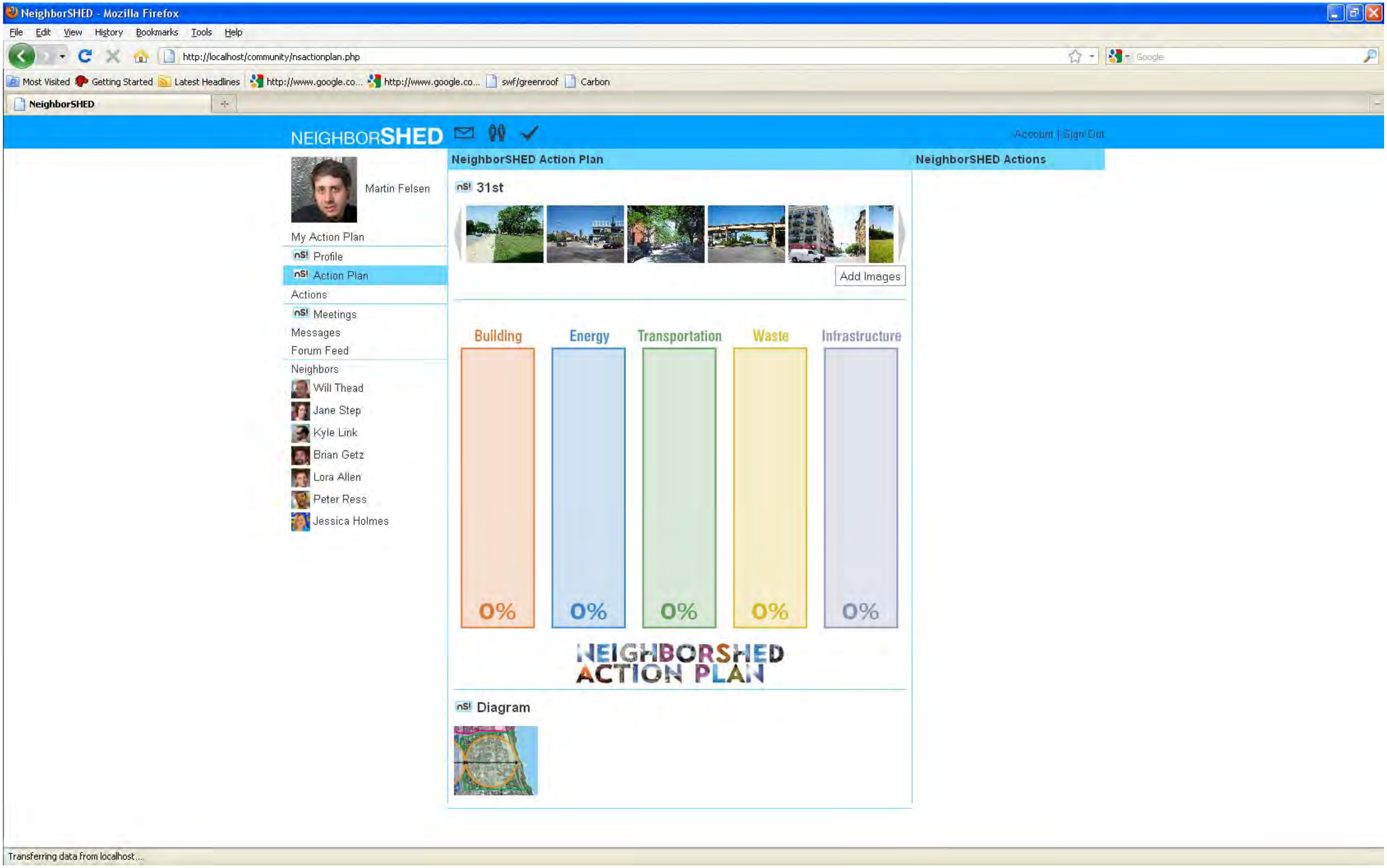

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
STRATEGY 1.
ENERGY EFFICIENT BUILDINGS
30% of Total Chicago GHG Reductions
= 4.6 MMTCO2e
Without global and local action, impacts on Chicago's weather could be dramatic.
Actions
1. Retrofit Commercial and Industrial Buildings
2. Retrofit Residential Buildings
3. Trade In Appliances
4. Update City Energy Code
5. New Guidelines for Renovations
6. Greenroof
7. Tree
8. Vine Cover
CLOSE
Done

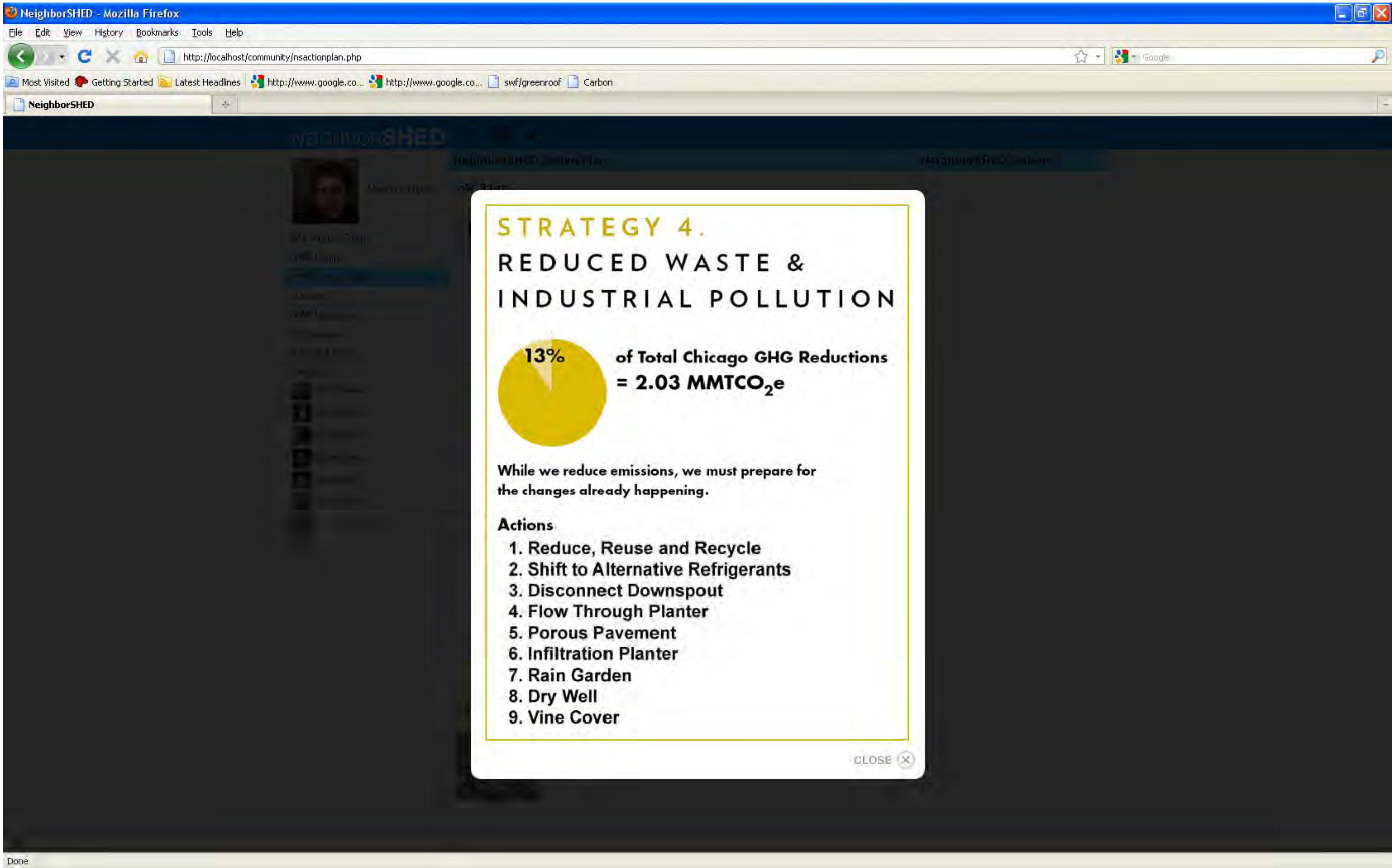

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...

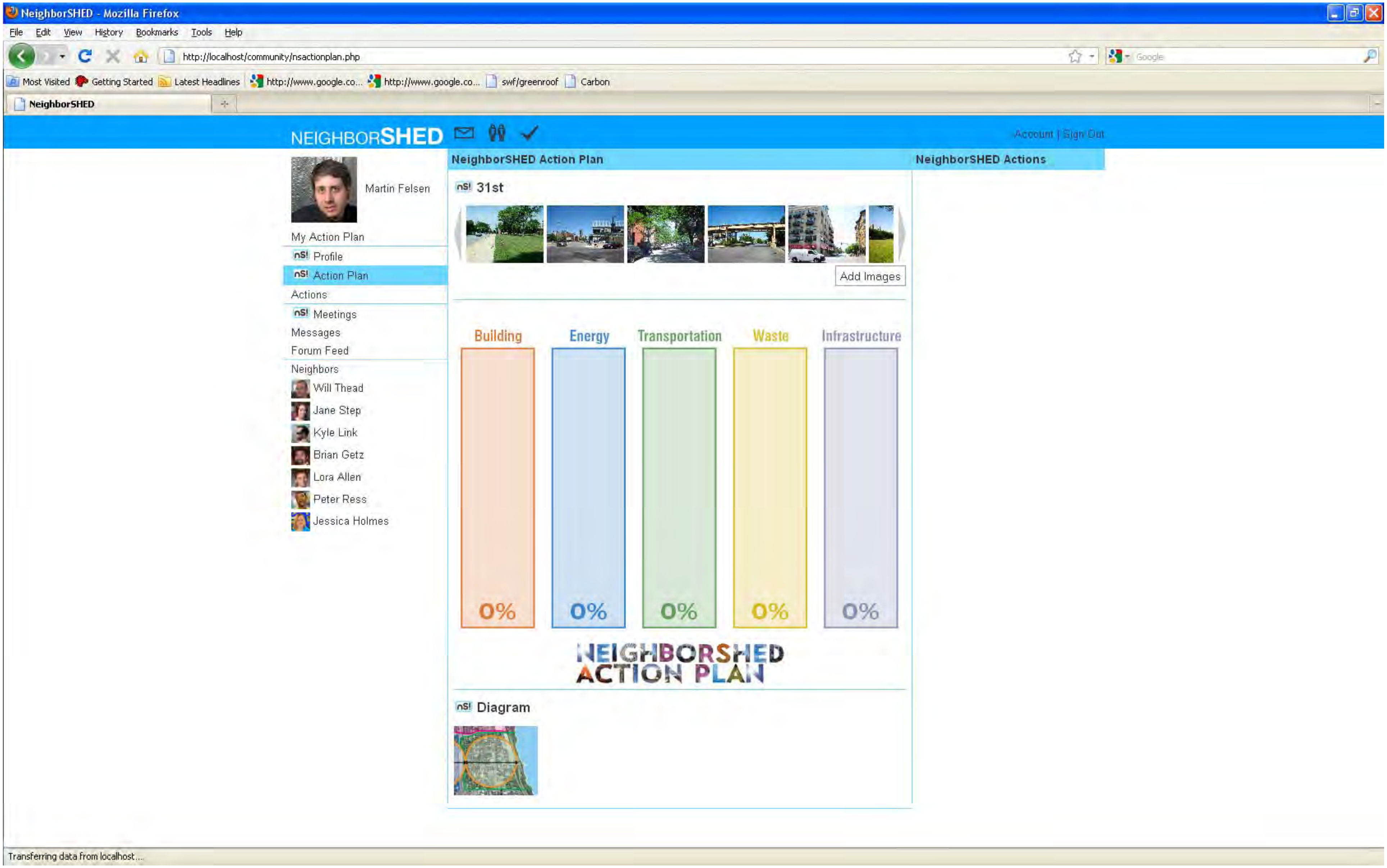

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
STRATEGY 2.
CLEAN & RENEWABLE ENERGY SOURCES
34%
of Total Chicago GHG Reductions
= 5.33 MMTCO$_2$e
Electricity use, natural gas use and transportation are the main sources of Chicago's emissions that contribute to climate change.
Actions
1. Upgrade Power Plants
2. Improve Powerplant Efficiency
3. Build Renewable Electricity
4. Increase Distributed Generation
5. Photovoltaic
6. Geo-Thermal
7. Wind Energy
8. Solar Hot Water
CLOSE
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...

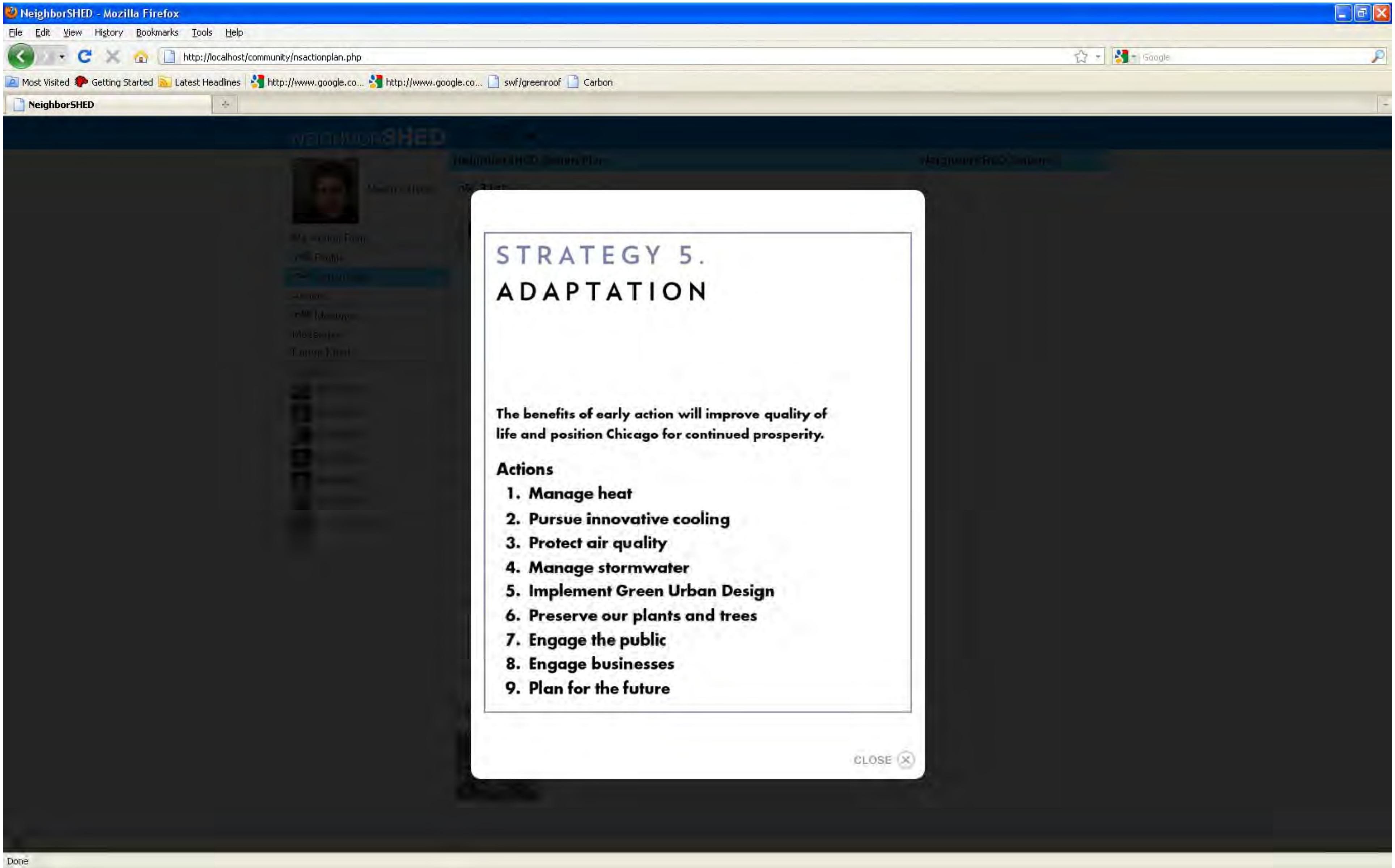

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
STRATEGY 3.
IMPROVED
TRANSPORTATION OPTIONS
23%
of Total Chicago GHG Reductions
= 3.61 MMTCO2e
There is no single remedy, but rather many remedies with many benefits.
Actions
1. Invest more in Transit
2. Expand Transit Incentives
3. Promote Transit-oriented Development
4. Bike Paths
5. Pedestrian Paths
6. Carshare and carpool
7. Improve Fleet Efficiency
8. Achieve Higher Fuel Efficiency Standards
9. Switch to Cleaner Fuels
10. Support Intercity Rail
11. Improve Freight Movement
CLOSE
Done

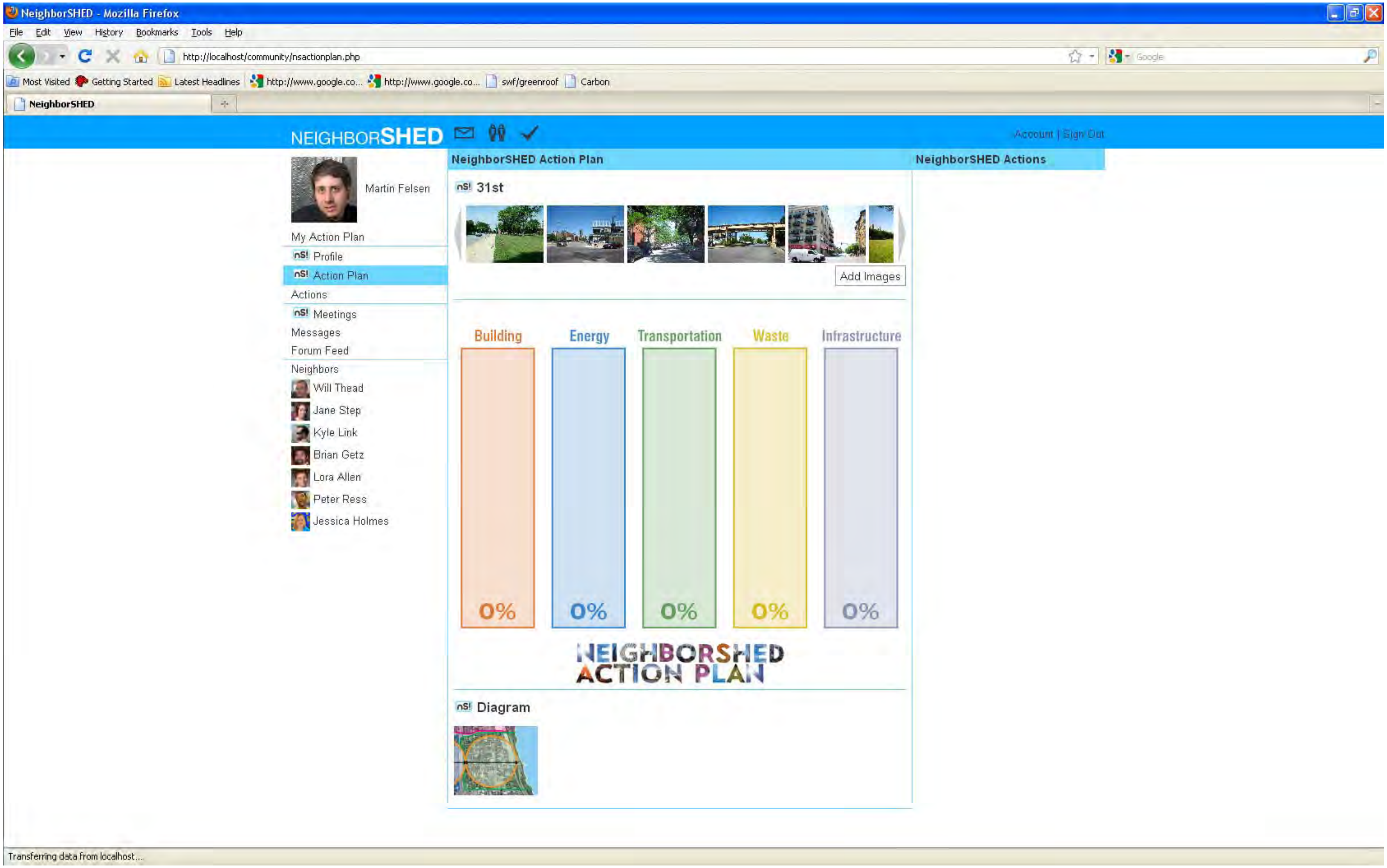

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...

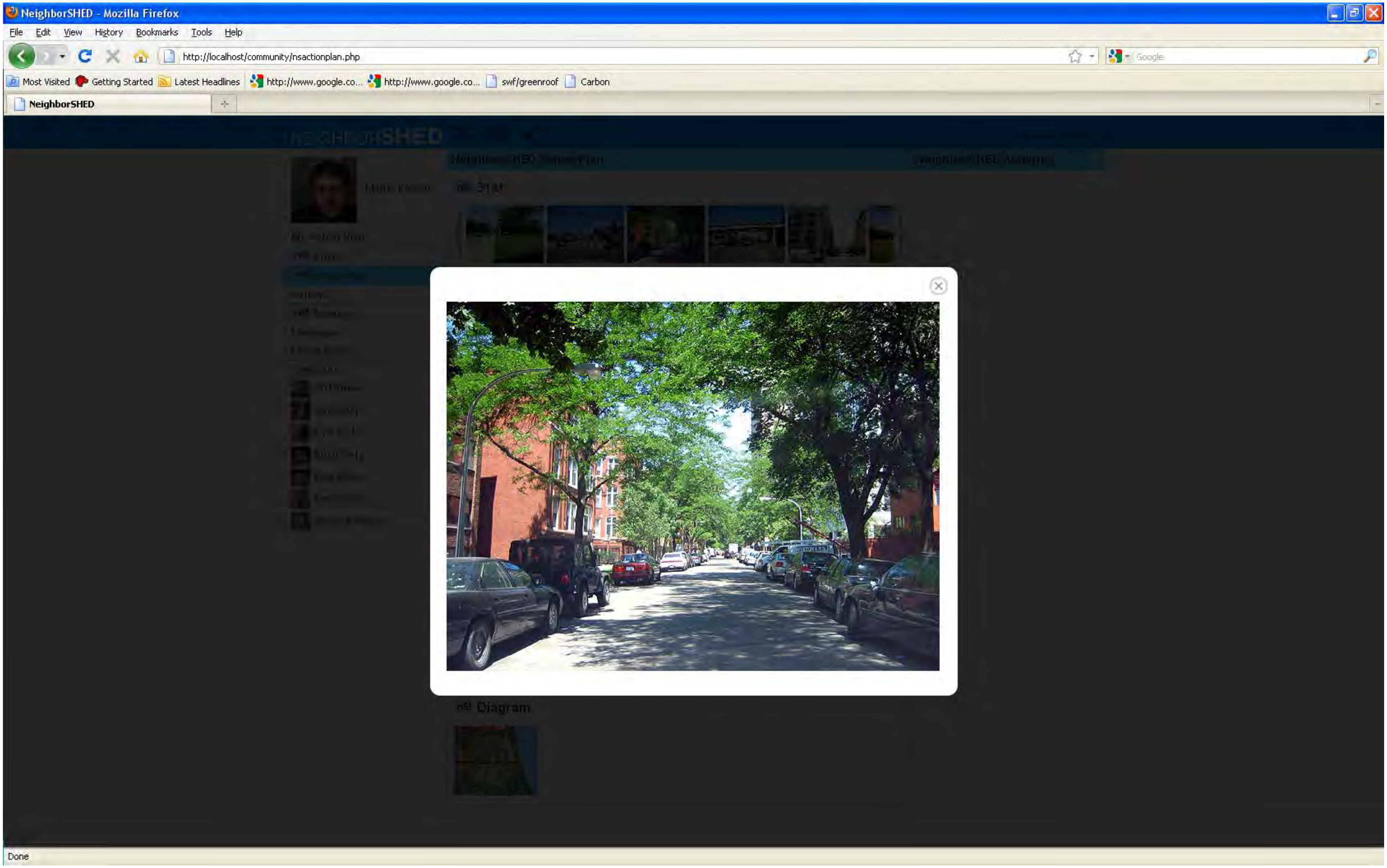

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
STRATEGY 4.
REDUCED WASTE &
INDUSTRIAL POLLUTION
13%
of Total Chicago GHG Reductions
= 2.03 $MMTCO_2e$
While we reduce emissions, we must prepare for the changes already happening.
Actions
1. Reduce, Reuse and Recycle
2. Shift to Alternative Refrigerants
3. Disconnect Downspout
4. Flow Through Planter
5. Porous Pavement
6. Infiltration Planter
7. Rain Garden
8. Dry Well
9. Vine Cover
CLOSE
Done

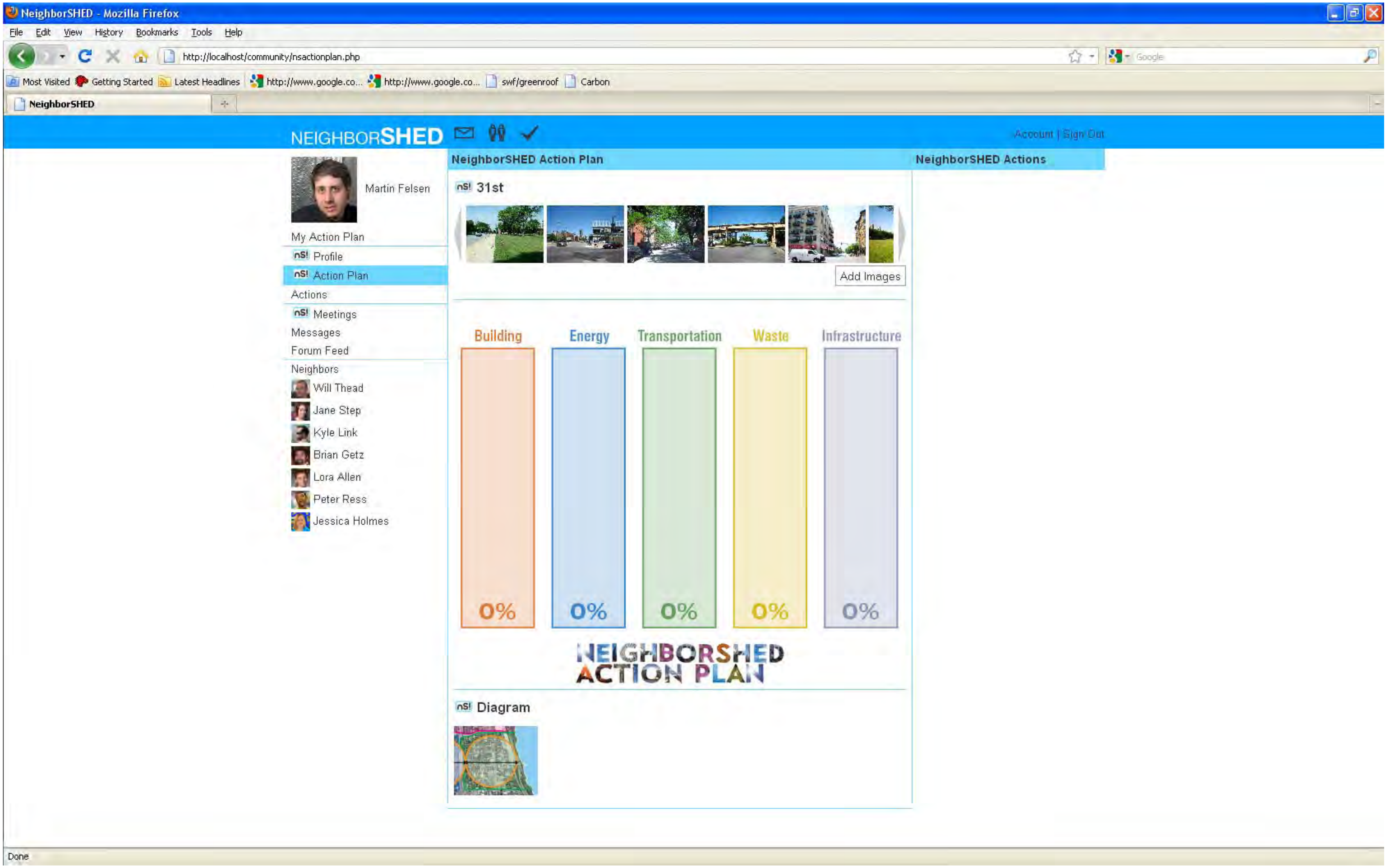


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Google
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
STRATEGY 5.
ADAPTATION
The benefits of early action will improve quality of life and position Chicago for continued prosperity.
Actions
1. Manage heat
2. Pursue innovative cooling
3. Protect air quality
4. Manage stormwater
5. Implement Green Urban Design
6. Preserve our plants and trees
7. Engage the public
8. Engage businesses
9. Plan for the future
CLOSE
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplan.php
Google
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
Diagram
Done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Brian Getz
Lora Allen
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Jessica Holmes
NeighborSHED Action Plan
31st
Add Images
Building
Energy
Transportation
Waste
Infrastructure
0%
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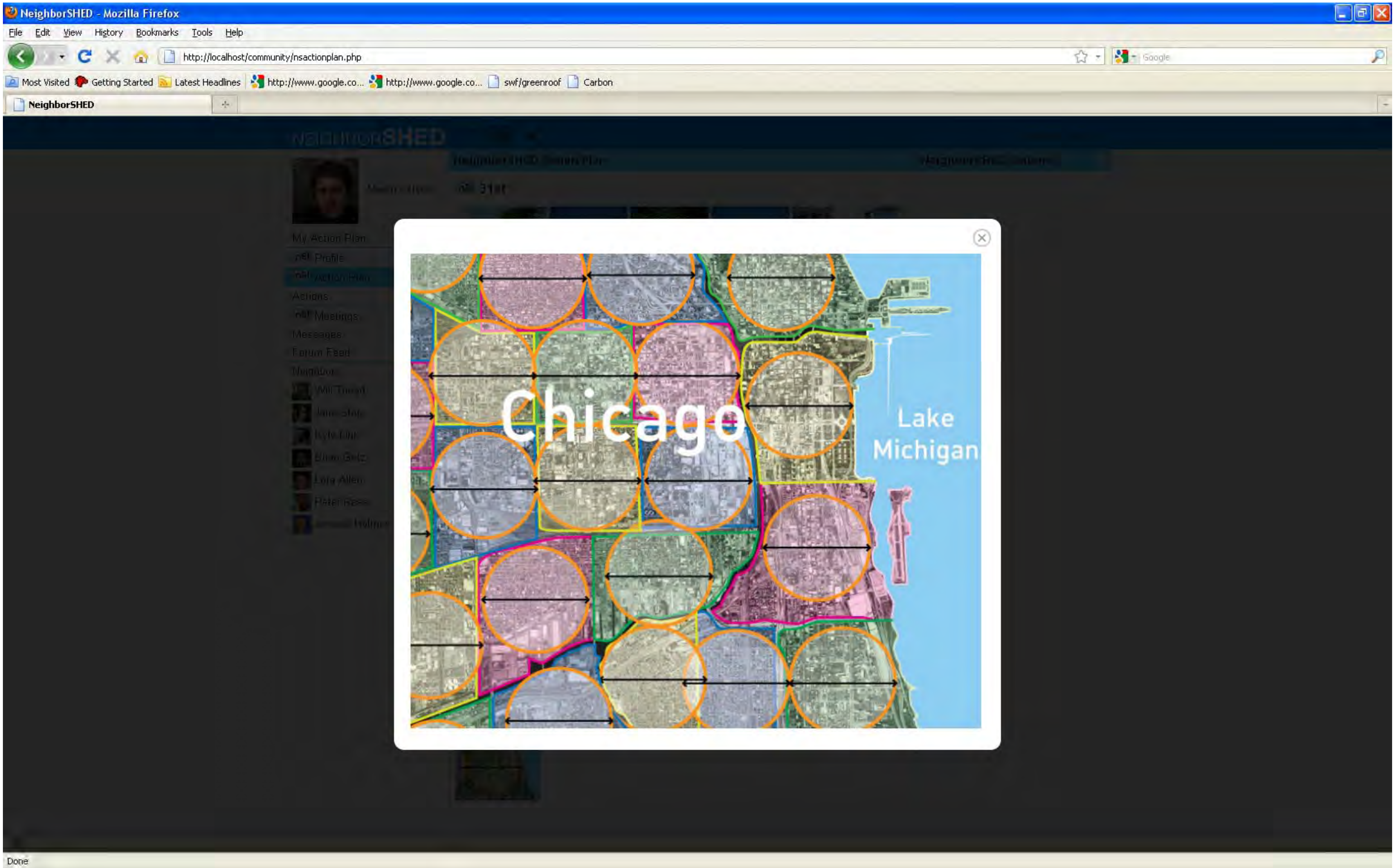
0%
NEIGHBORSHED
ACTION PLAN
Diagram
NeighborSHED Actions
Done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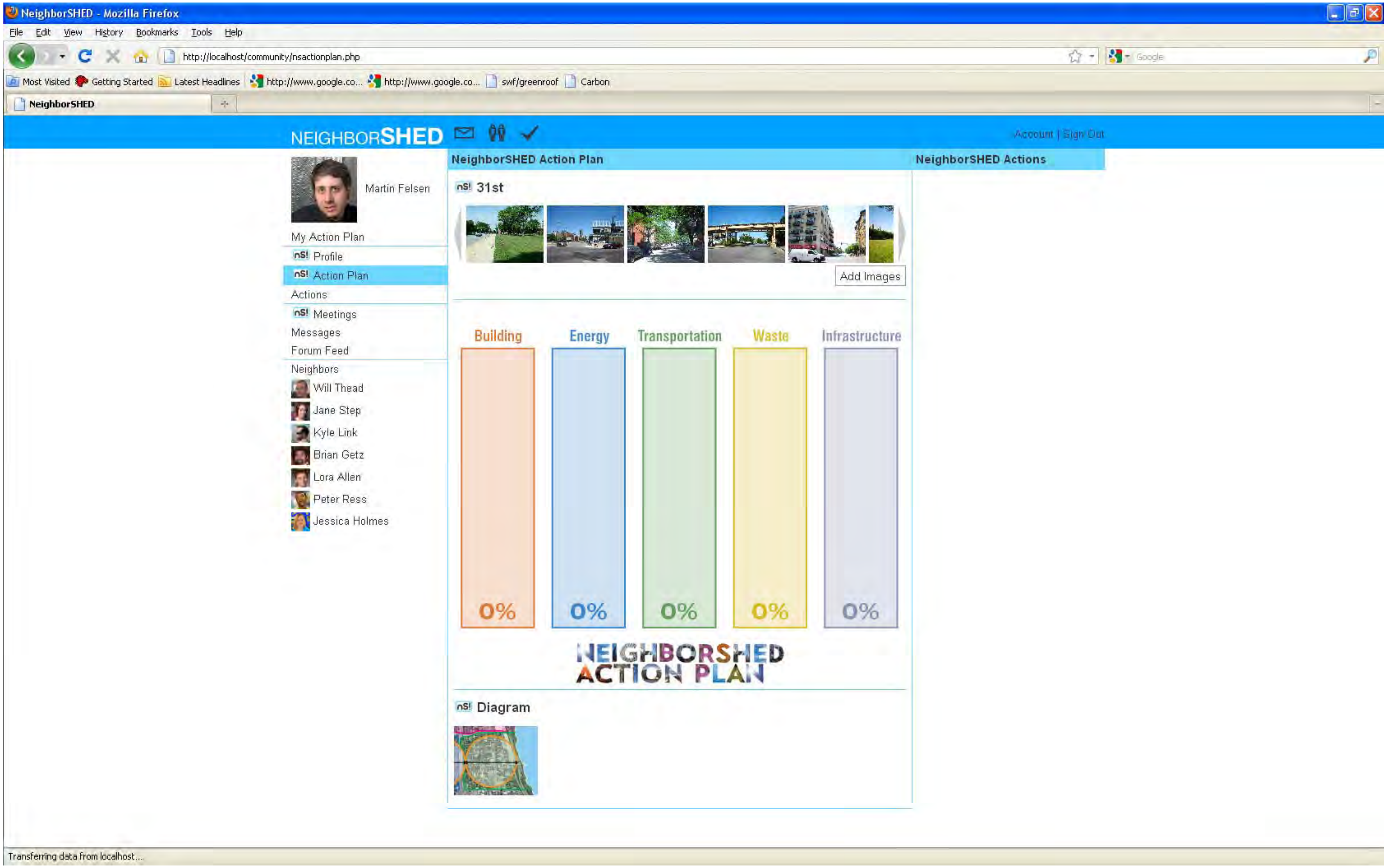
NeighborSHED
Chicago
Lake Michigan
Done



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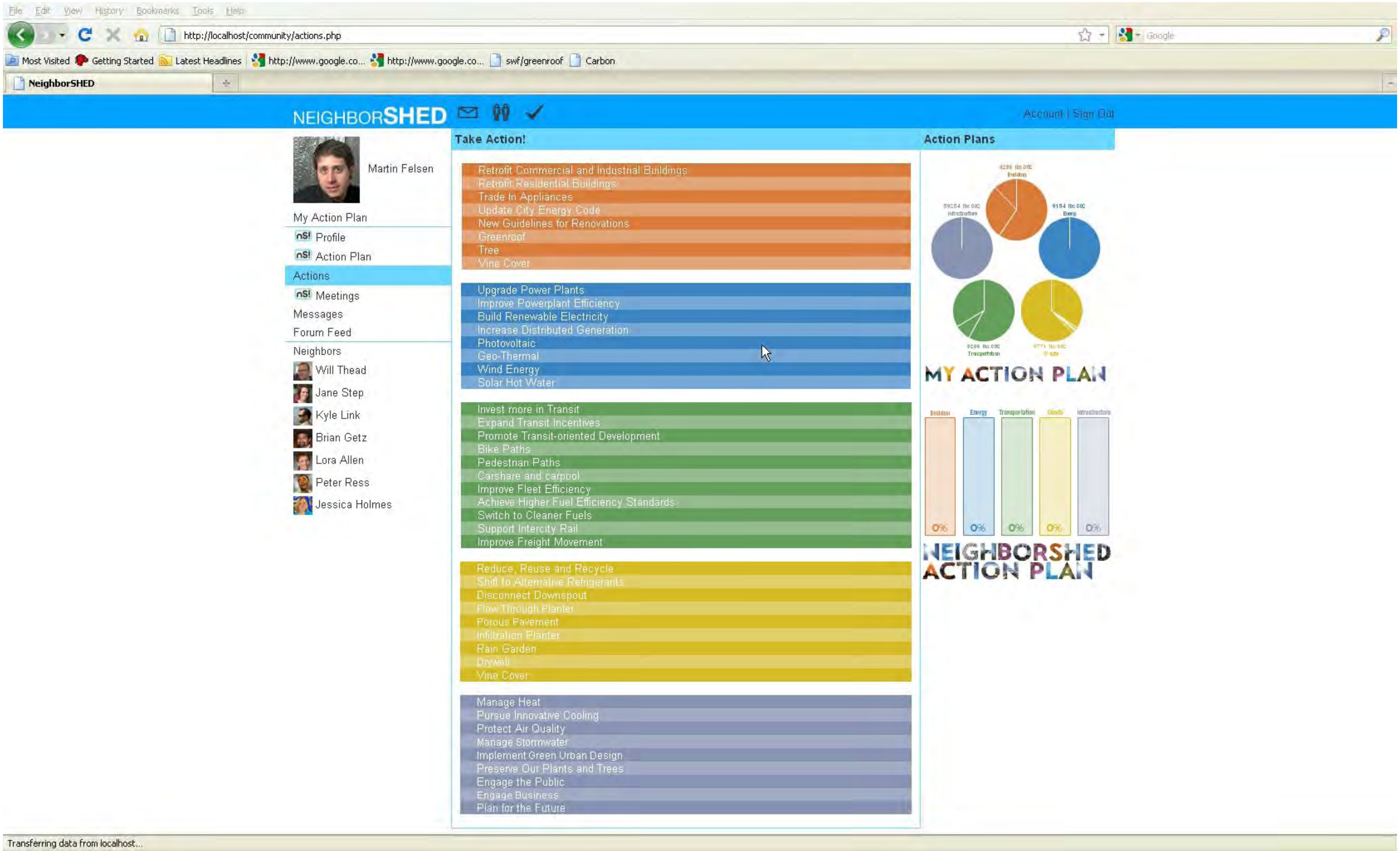
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...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Rain Garden
Drywell
Vine Cover
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Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
Action Plans
MY ACTION PLAN
Energy
Transportation
0%
0%
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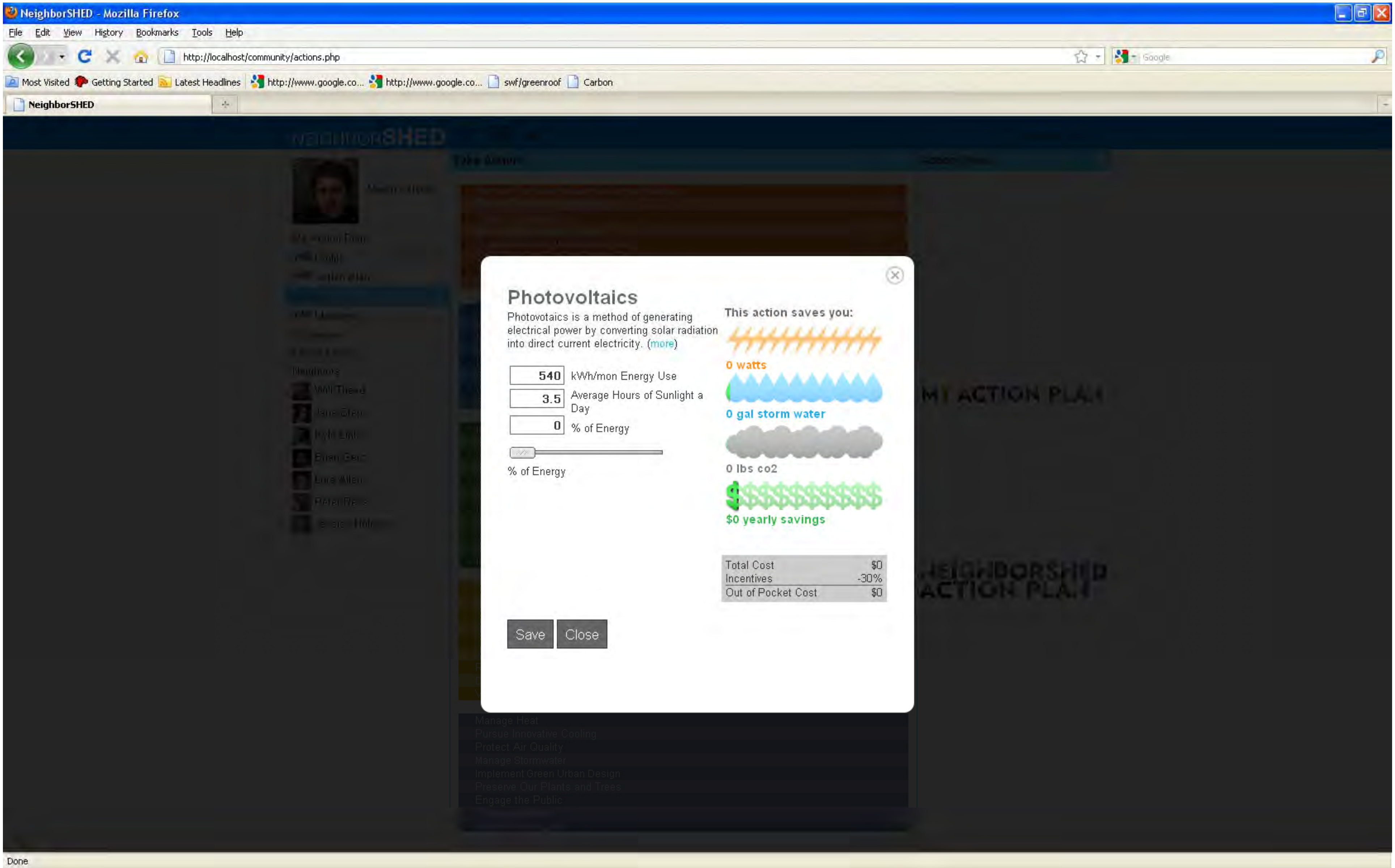
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...



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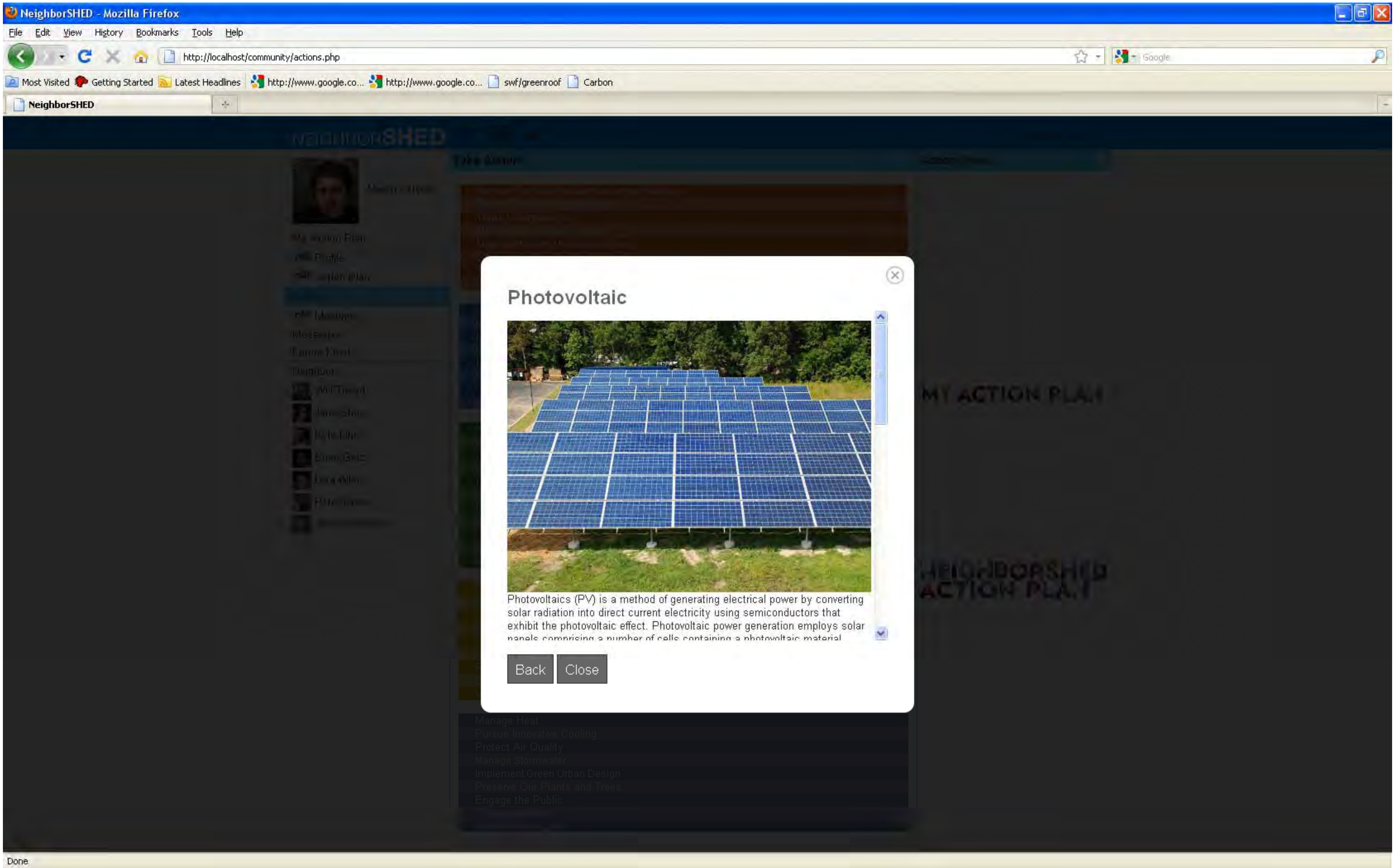
NeighborSHED
Photovoltaics
Photovotaics is a method of generating electrical power by converting solar radiation into direct current electricity. (more)
540 kWh/mon Energy Use
3.5 Average Hours of Sunlight a Day
0 % of Energy
% of Energy
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives -30%
Out of Pocket Cost $0
Save
Close
Done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Photovoltaic
Photovoltaics (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels comprising a number of cells containing a photovoltaic material
Back
Close
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
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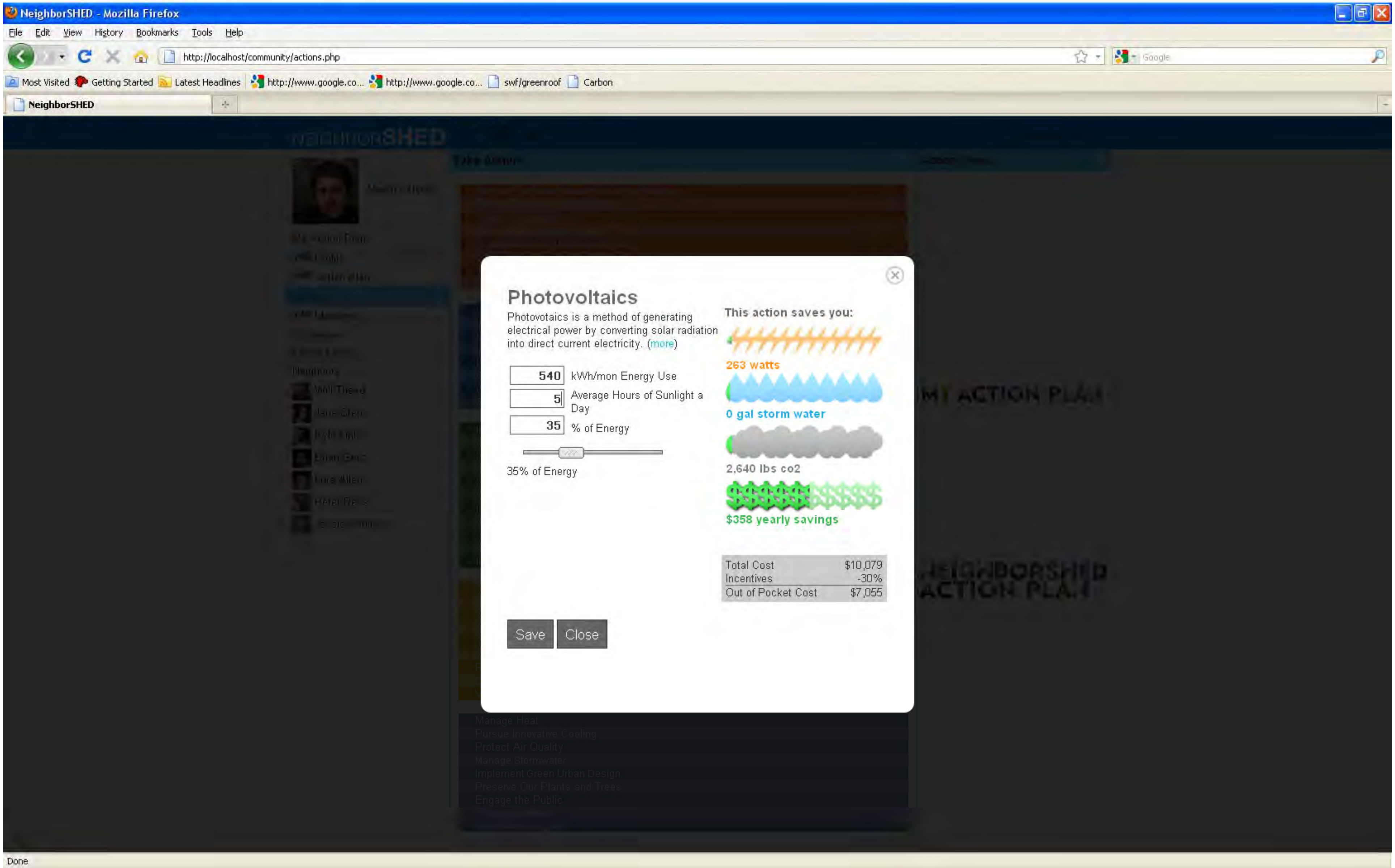
Engage the Public
Done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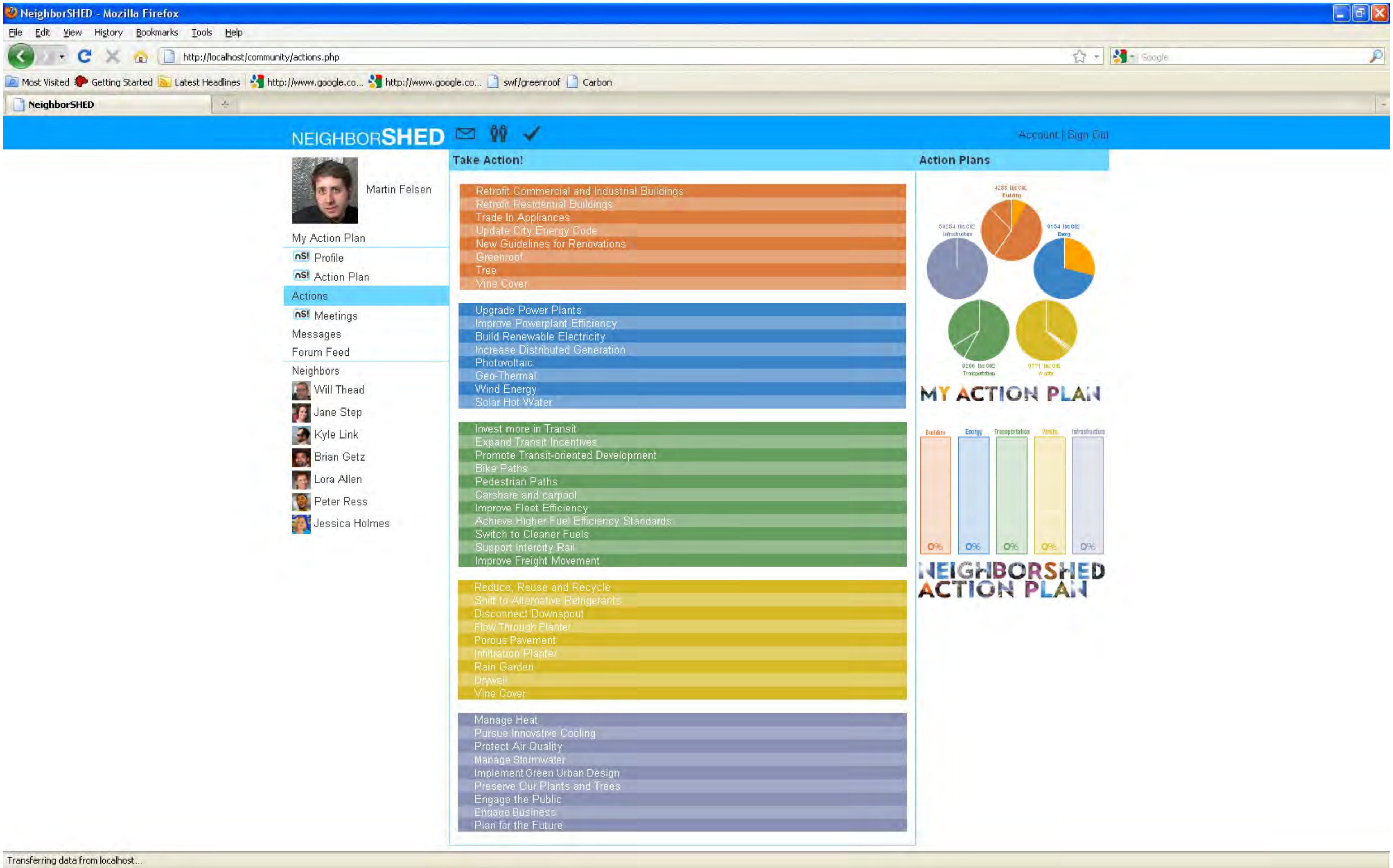
NeighborSHED
Photovoltaics
Photovotaics is a method of generating electrical power by converting solar radiation into direct current electricity. (more)
540 kWh/mon Energy Use
5 Average Hours of Sunlight a Day
35 % of Energy
35% of Energy
This action saves you:
263 watts
0 gal storm water
2,640 lbs co2
$358 yearly savings
Total Cost $10,079
Incentives -30%
Out of Pocket Cost $7,055
Save
Close
Done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MY ACTION PLAN
0% 0% 0% 0% 0%
NEIGHBORSHED ACTION PLAN
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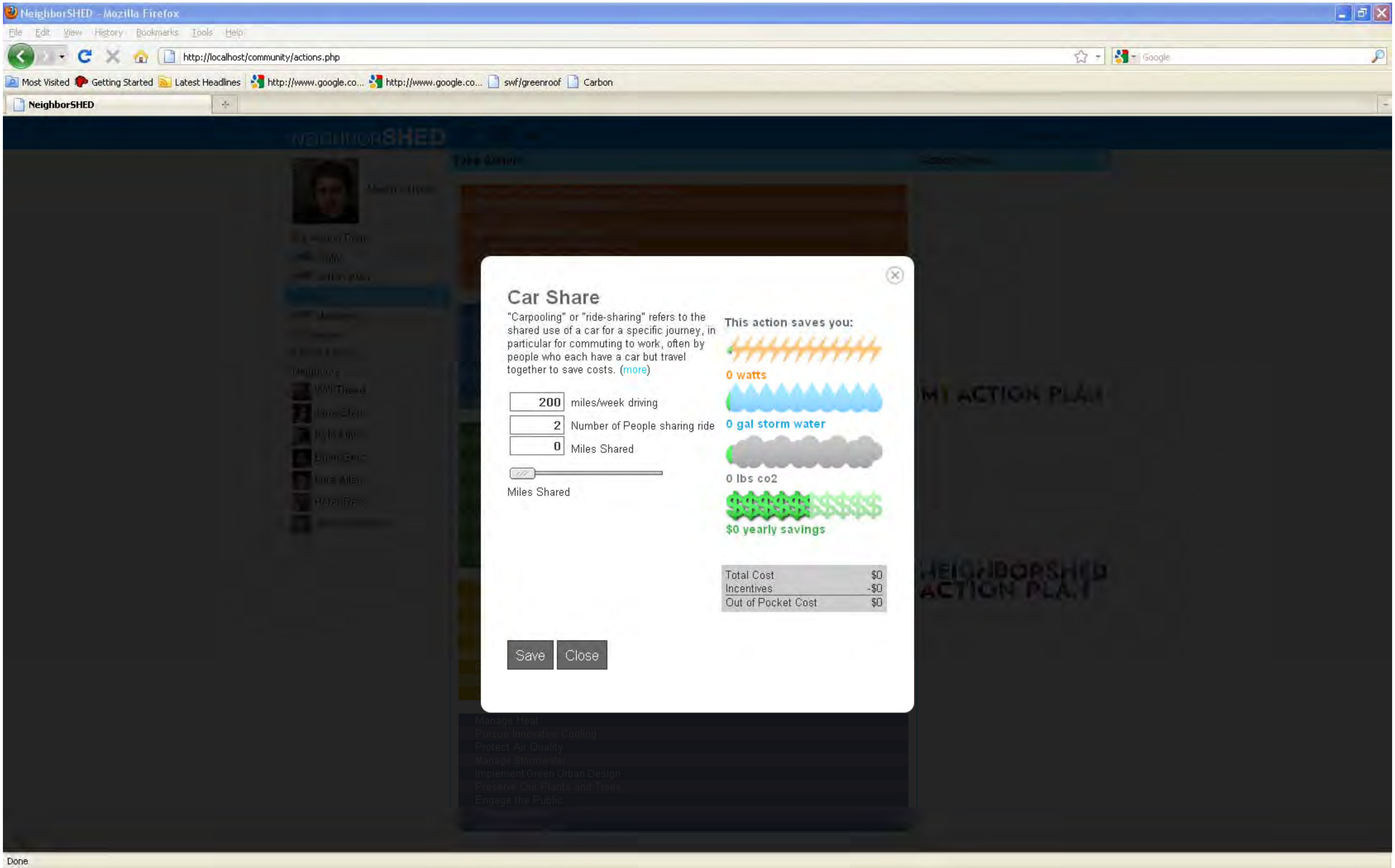
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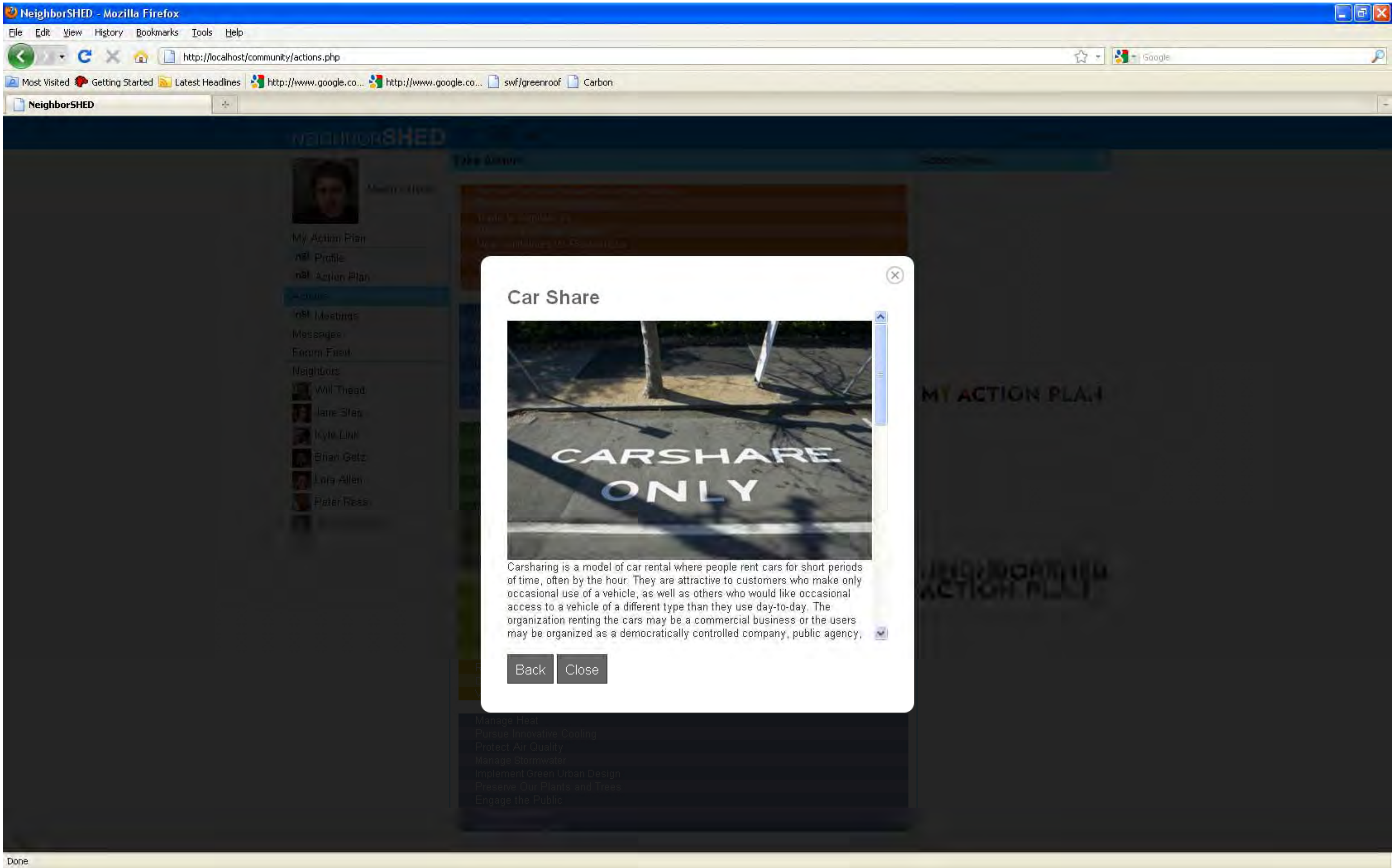
NeighborSHED
Car Share
"Carpooling" or "ride-sharing" refers to the shared use of a car for a specific journey, in particular for commuting to work, often by people who each have a car but travel together to save costs. (more)
200 miles/week driving
2 Number of People sharing ride
0 Miles Shared
Miles Shared
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives -$0
Out of Pocket Cost $0
Save
Close
Done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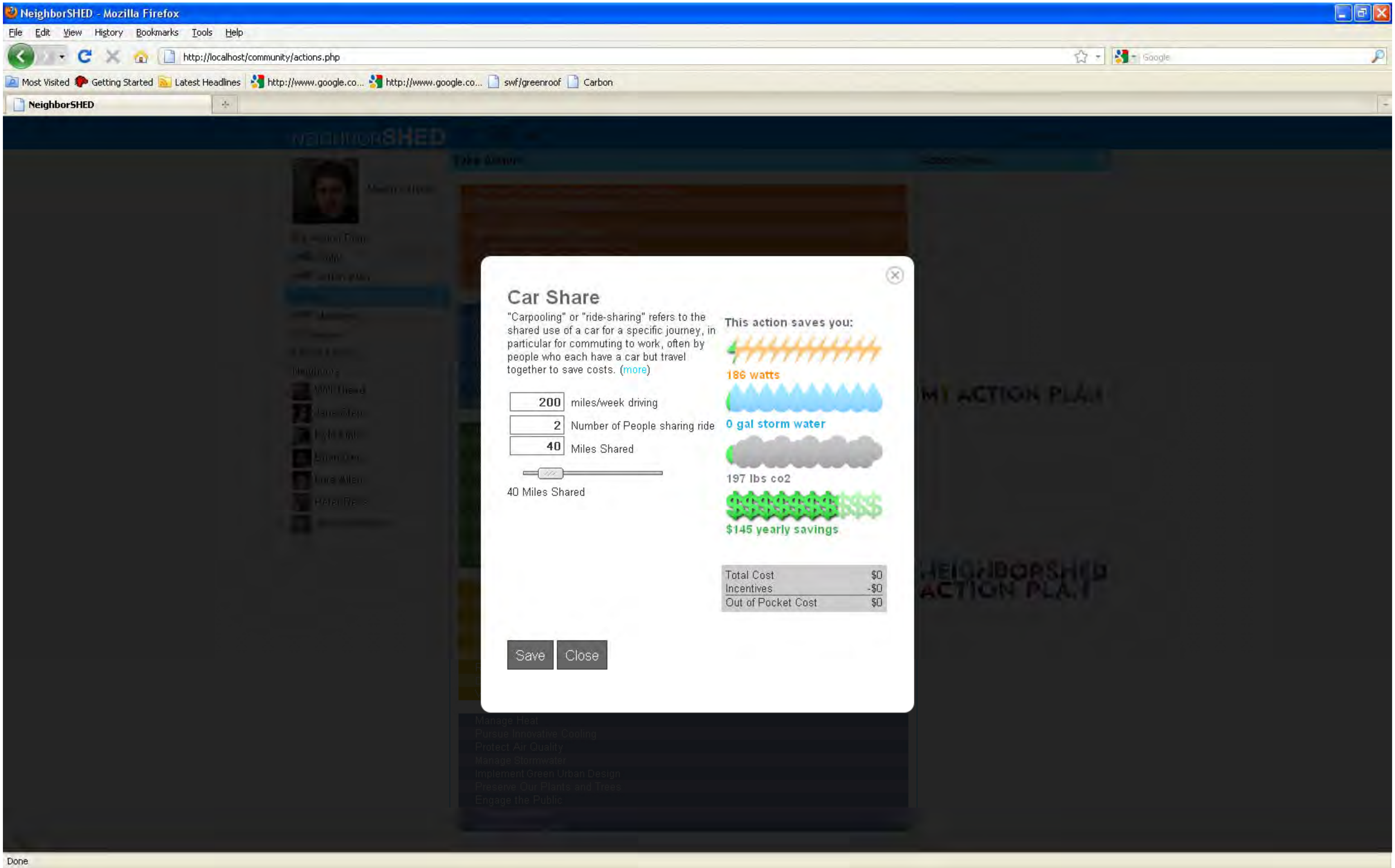
Car Share
CARSHARE ONLY
Carsharing is a model of car rental where people rent cars for short periods of time, often by the hour. They are attractive to customers who make only occasional use of a vehicle, as well as others who would like occasional access to a vehicle of a different type than they use day-to-day. The organization renting the cars may be a commercial business or the users may be organized as a democratically controlled company, public agency,
Back
Close
Done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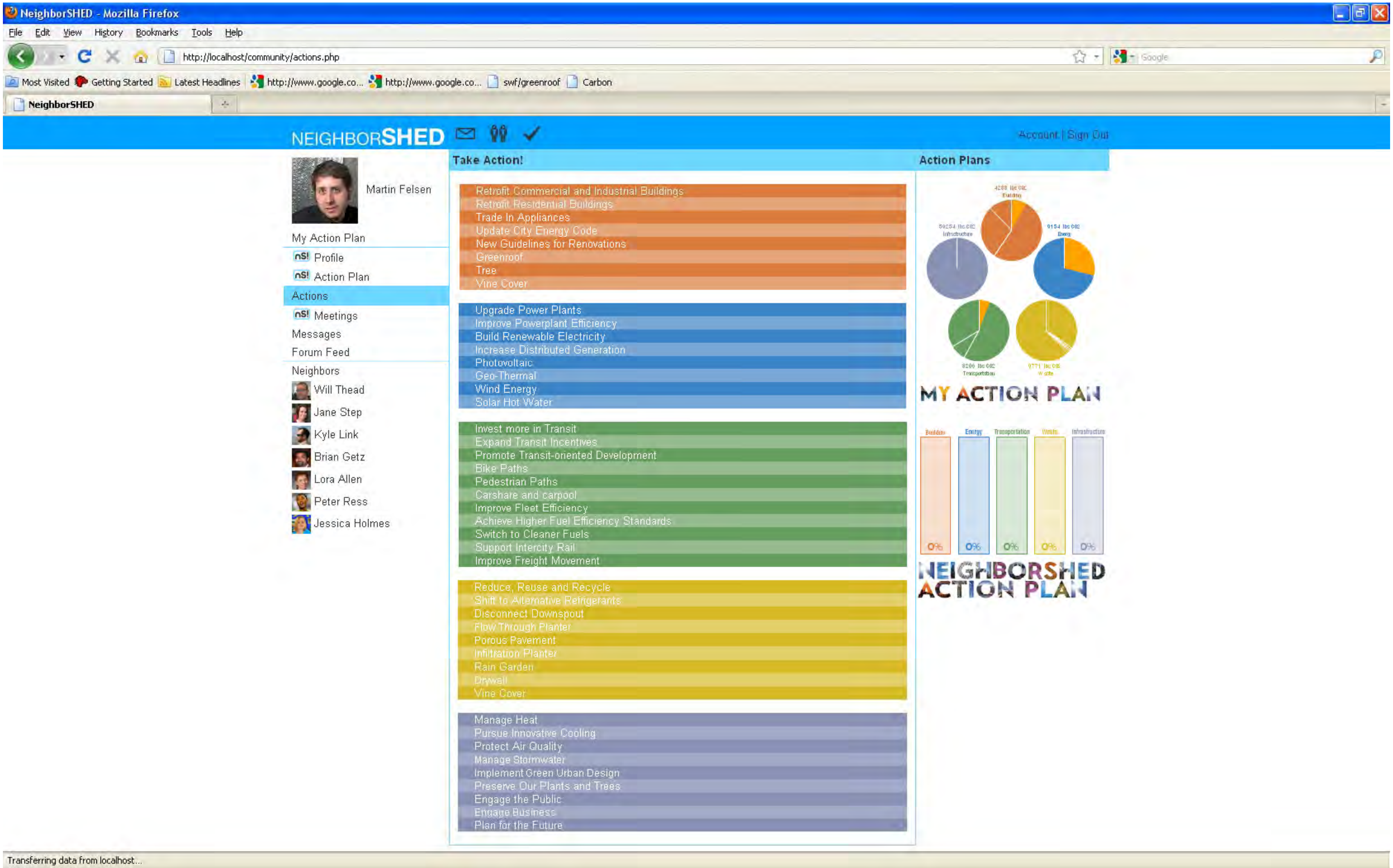
NeighborSHED
Car Share
"Carpooling" or "ride-sharing" refers to the shared use of a car for a specific journey, in particular for commuting to work, often by people who each have a car but travel together to save costs. (more)
200 miles/week driving
2 Number of People sharing ride
40 Miles Shared
40 Miles Shared
This action saves you:
186 watts
0 gal storm water
197 lbs co2
$145 yearly savings
Total Cost $0
Incentives -$0
Out of Pocket Cost $0
Save
Close
Done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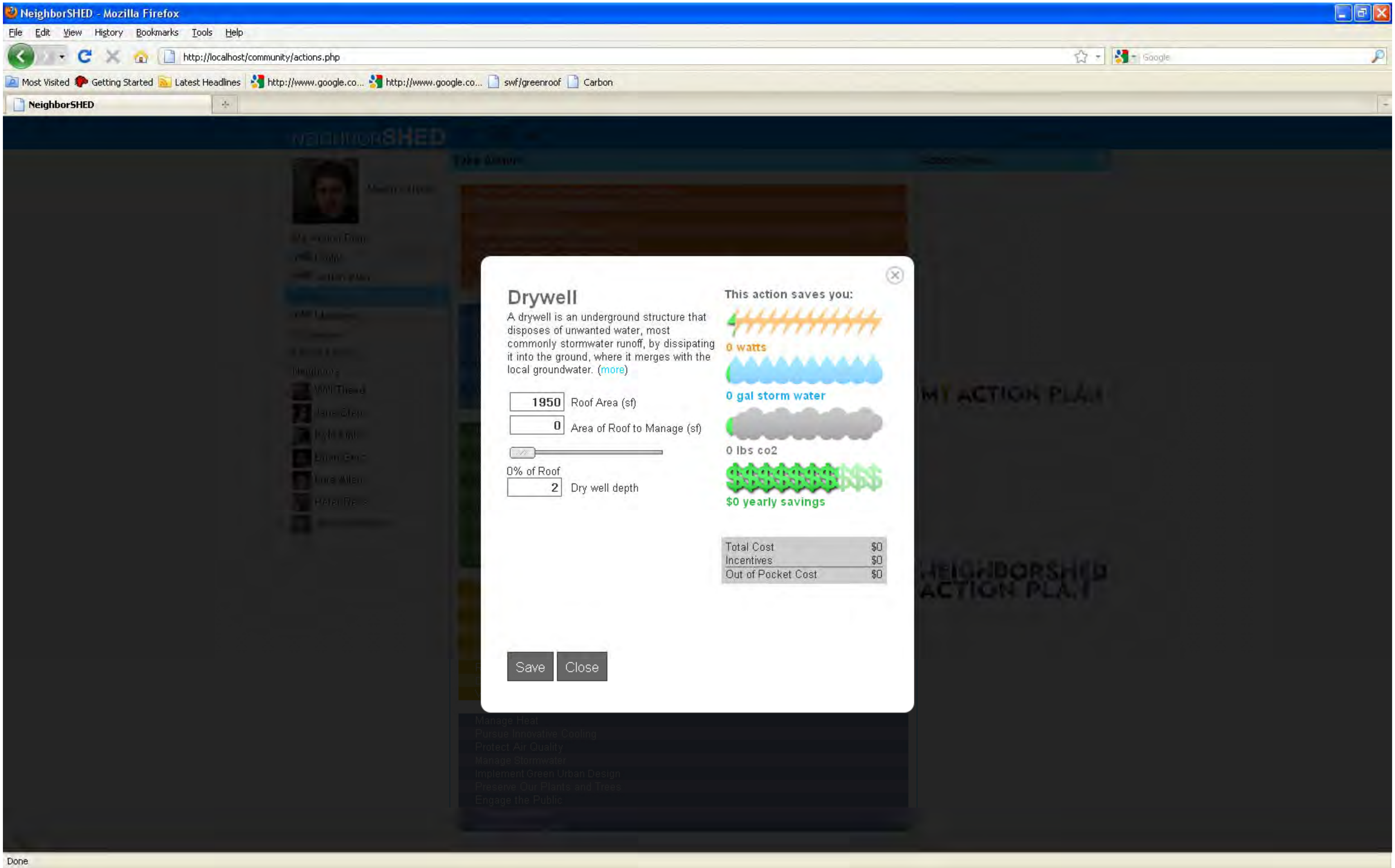
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
Action Plans
MY ACTION PLAN
0% 0% 0% 0% 0%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...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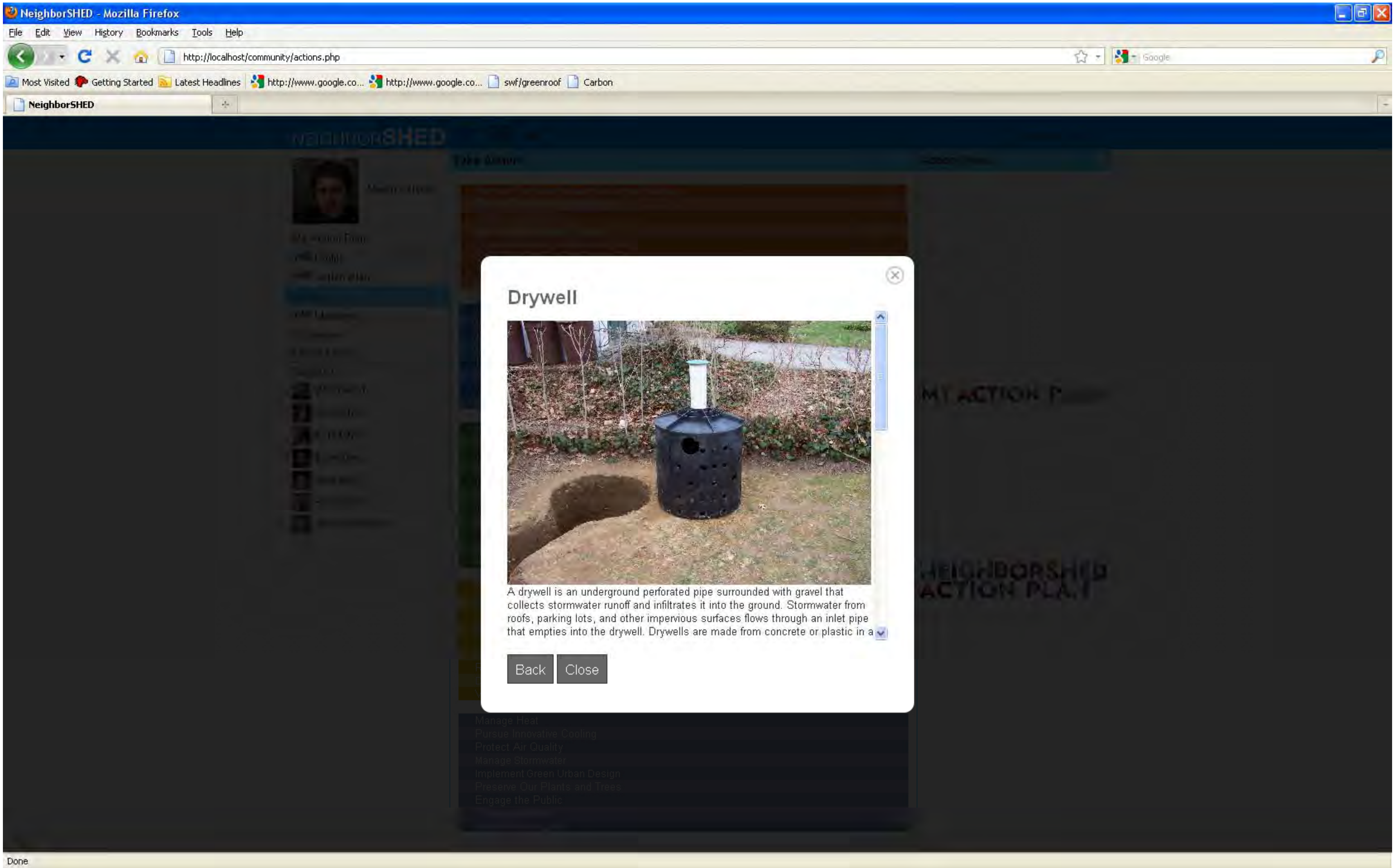
Drywell
A drywell is an underground structure that disposes of unwanted water, most commonly stormwater runoff, by dissipating it into the ground, where it merges with the local groundwater. (more)
1950 Roof Area (sf)
0 Area of Roof to Manage (sf)
0% of Roof
2 Dry well depth
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives $0
Out of Pocket Cost $0
Save
Close
Done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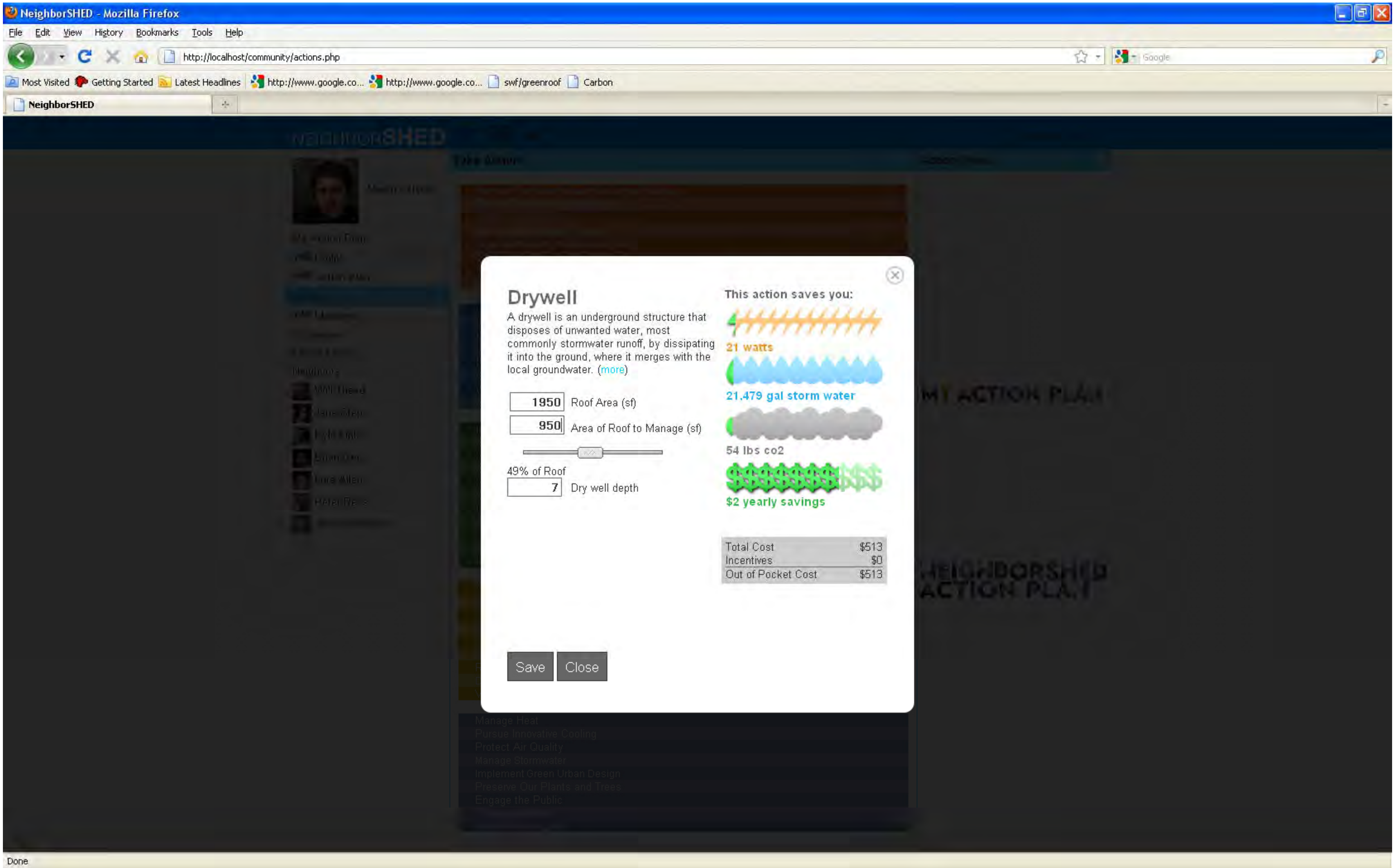
NeighborSHED
Drywell
A drywell is an underground perforated pipe surrounded with gravel that collects stormwater runoff and infiltrates it into the ground. Stormwater from roofs, parking lots, and other impervious surfaces flows through an inlet pipe that empties into the drywell. Drywells are made from concrete or plastic in a
Back
Close
Done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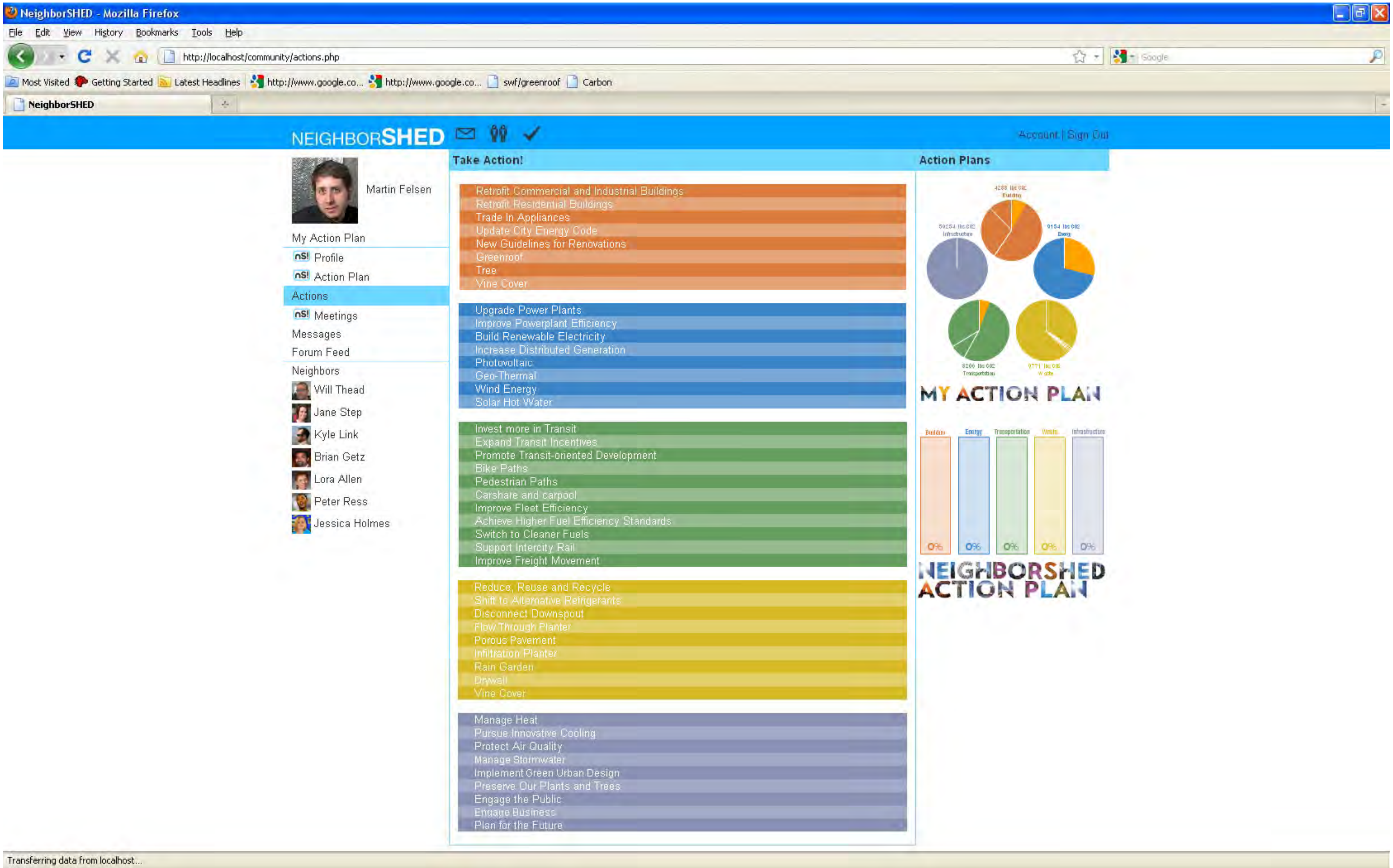
NeighborSHED
Drywell
A drywell is an underground structure that disposes of unwanted water, most commonly stormwater runoff, by dissipating it into the ground, where it merges with the local groundwater. (more)
1950 Roof Area (sf)
950 Area of Roof to Manage (sf)
49% of Roof
7 Dry well depth
This action saves you:
21 watts
21,479 gal storm water
54 lbs co2
$2 yearly savings
Total Cost $513
Incentives $0
Out of Pocket Cost $513
Save
Close
Done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Protect Air Quality
Manage Stormwater
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Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
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MY ACTION PLAN
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0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
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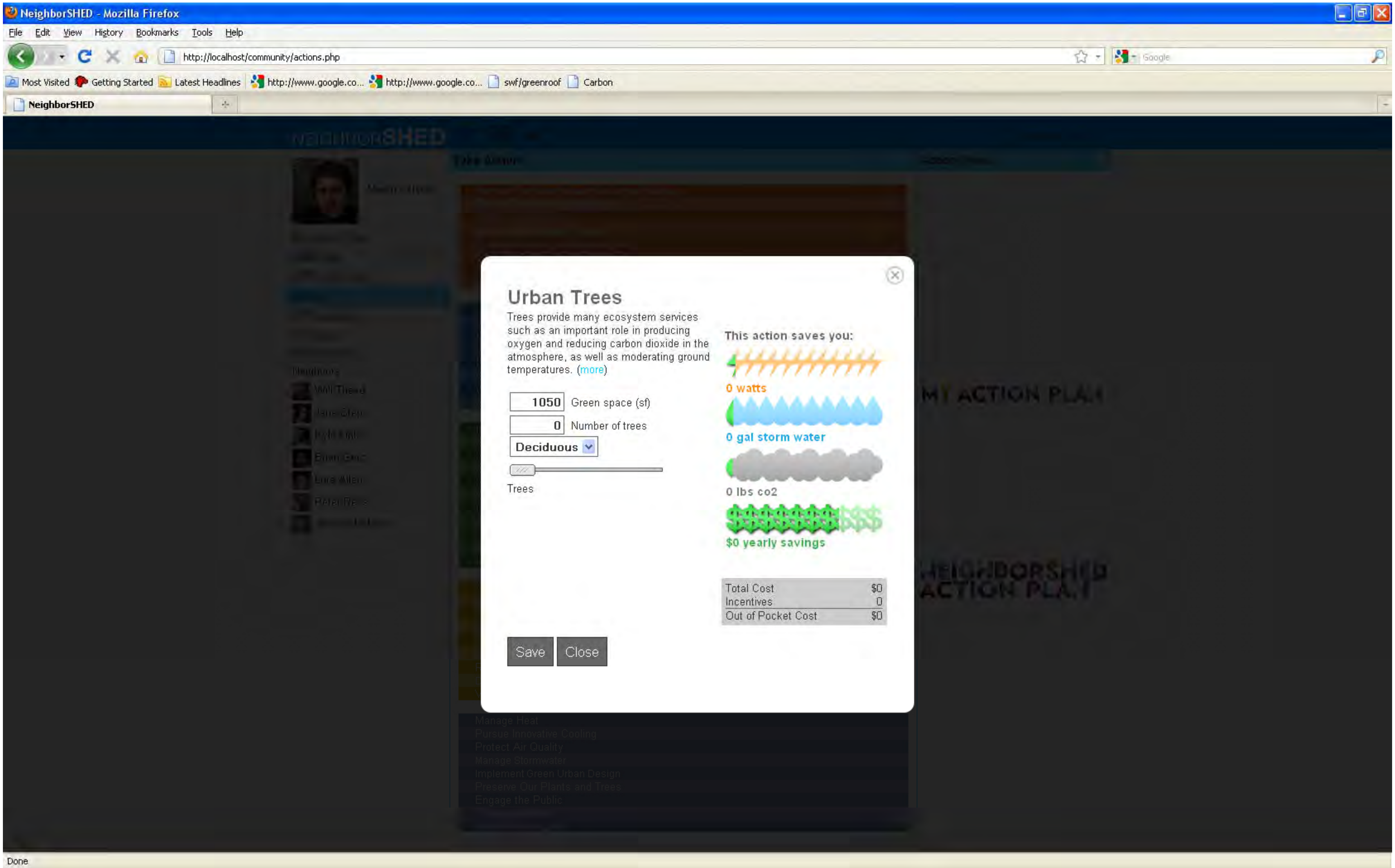
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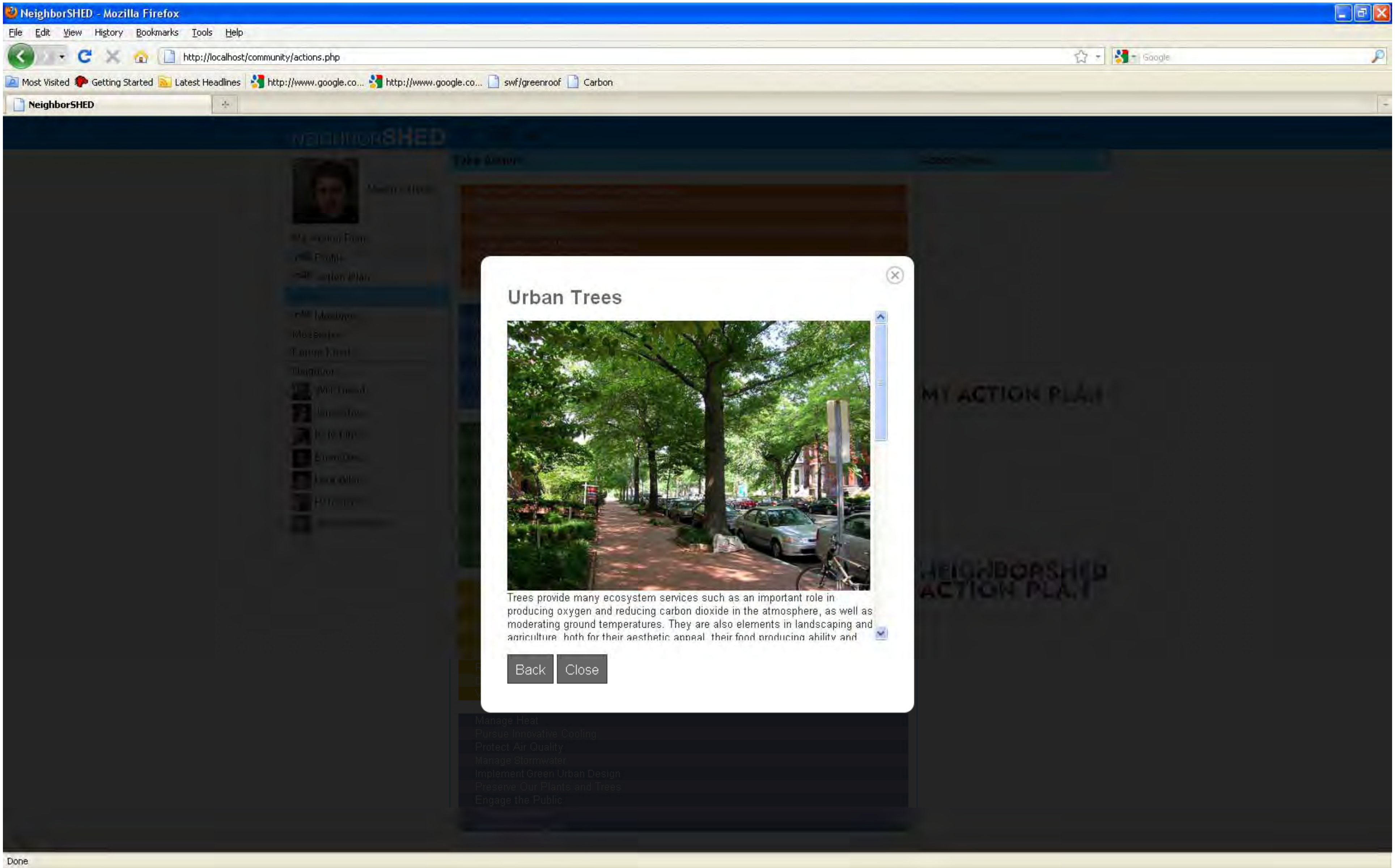
NeighborSHED
Urban Trees
Trees provide many ecosystem services such as an important role in producing oxygen and reducing carbon dioxide in the atmosphere, as well as moderating ground temperatures. (more)
1050 Green space (sf)
0 Number of trees
Deciduous
Trees
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives 0
Out of Pocket Cost $0
Save
Close
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Done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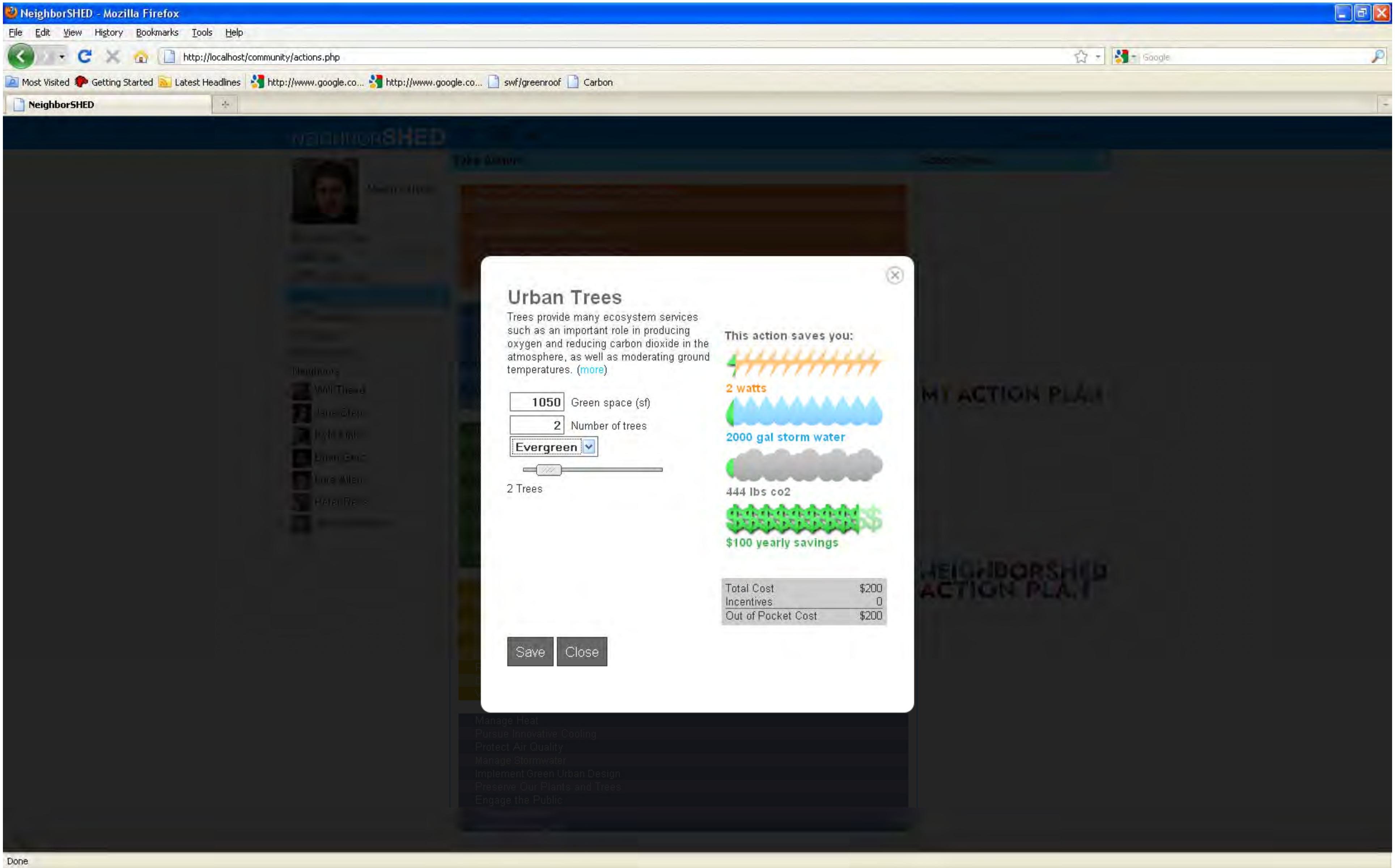
NeighborSHED
Urban Trees
Trees provide many ecosystem services such as an important role in producing oxygen and reducing carbon dioxide in the atmosphere, as well as moderating ground temperatures. They are also elements in landscaping and agriculture, both for their aesthetic appeal, their food producing ability and
Back
Close
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Done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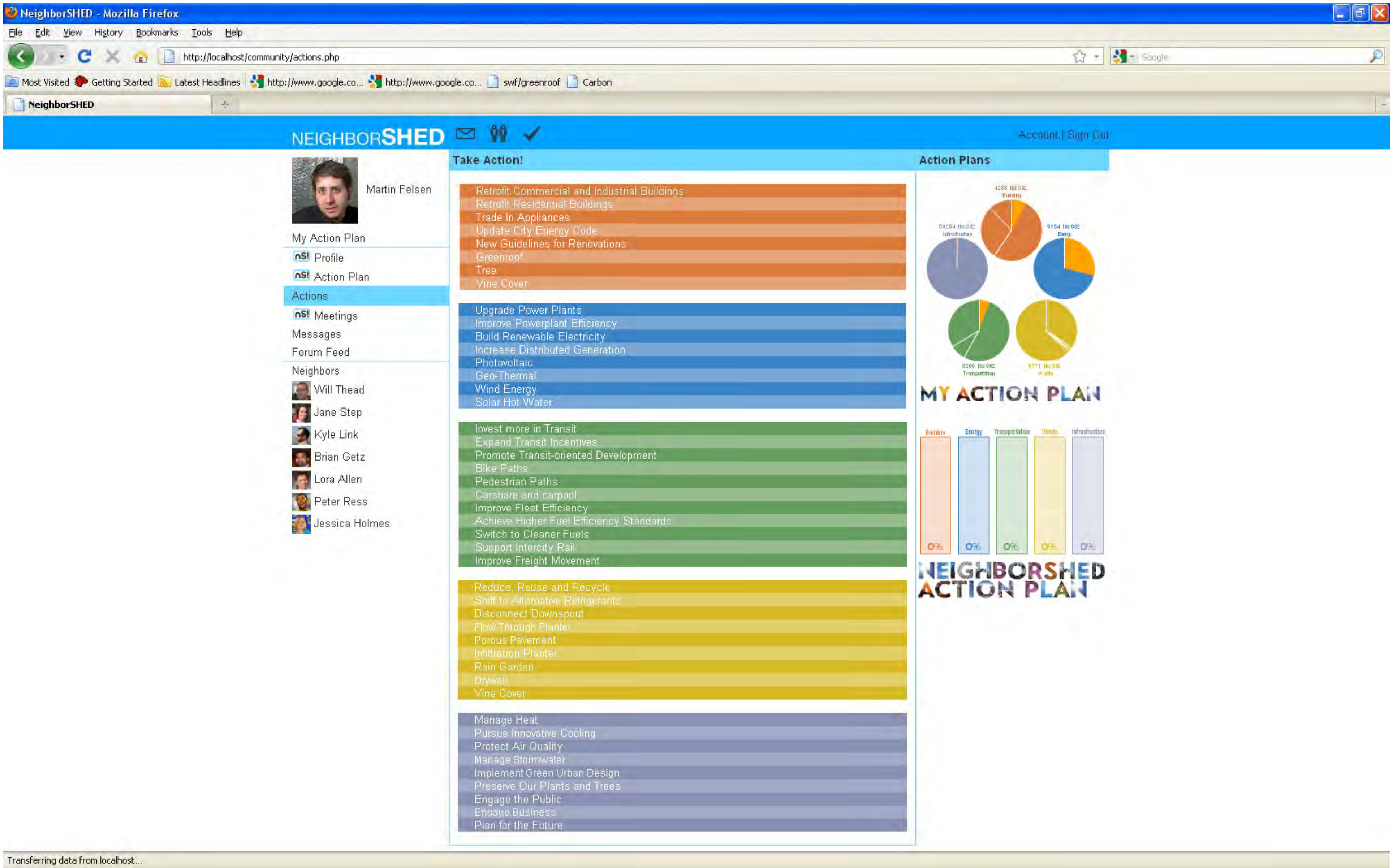
NeighborSHED
Urban Trees
Trees provide many ecosystem services such as an important role in producing oxygen and reducing carbon dioxide in the atmosphere, as well as moderating ground temperatures. (more)
1050 Green space (sf)
2 Number of trees
Evergreen
2 Trees
This action saves you:
2 watts
2000 gal storm water
444 lbs co2
$100 yearly savings
Total Cost $200
Incentives 0
Out of Pocket Cost $200
Save
Close
Done



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Engage Business
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MY ACTION PLAN
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0%
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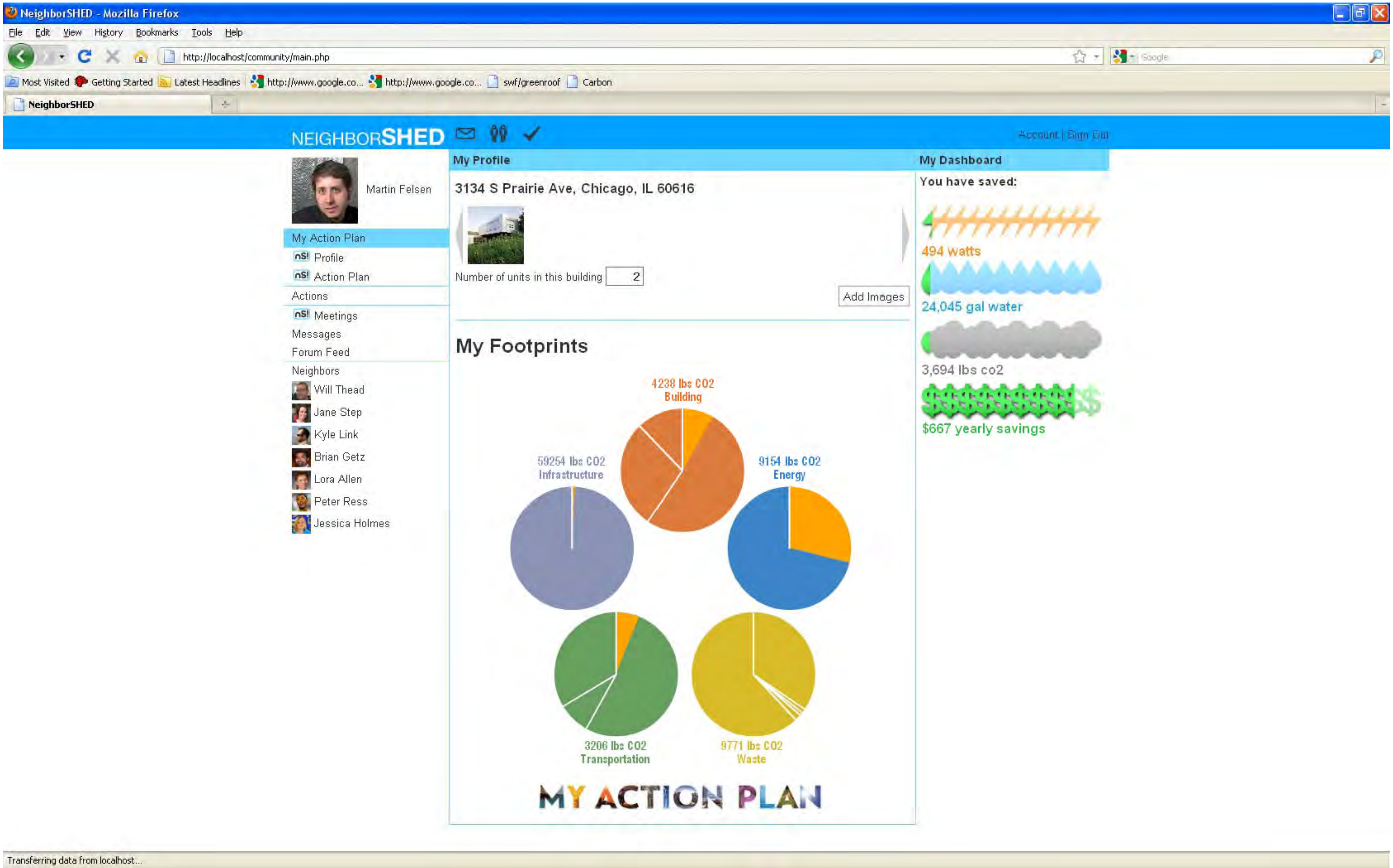
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...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Peter Ress
Jessica Holmes
My Profile
3134 S Prairie Ave, Chicago, IL 60616
Number of units in this building 2
Add Images
My Footprints
4238 lbs CO2 Building
59254 lbs CO2 Infrastructure
9154 lbs CO2 Energy
3206 lbs CO2 Transportation
9771 lbs CO2 Waste
MY ACTION PLAN
My Dashboard
You have saved:
494 watts
24,045 gal water
3,694 lbs co2
$667 yearly savings
Transferring data from localhost...


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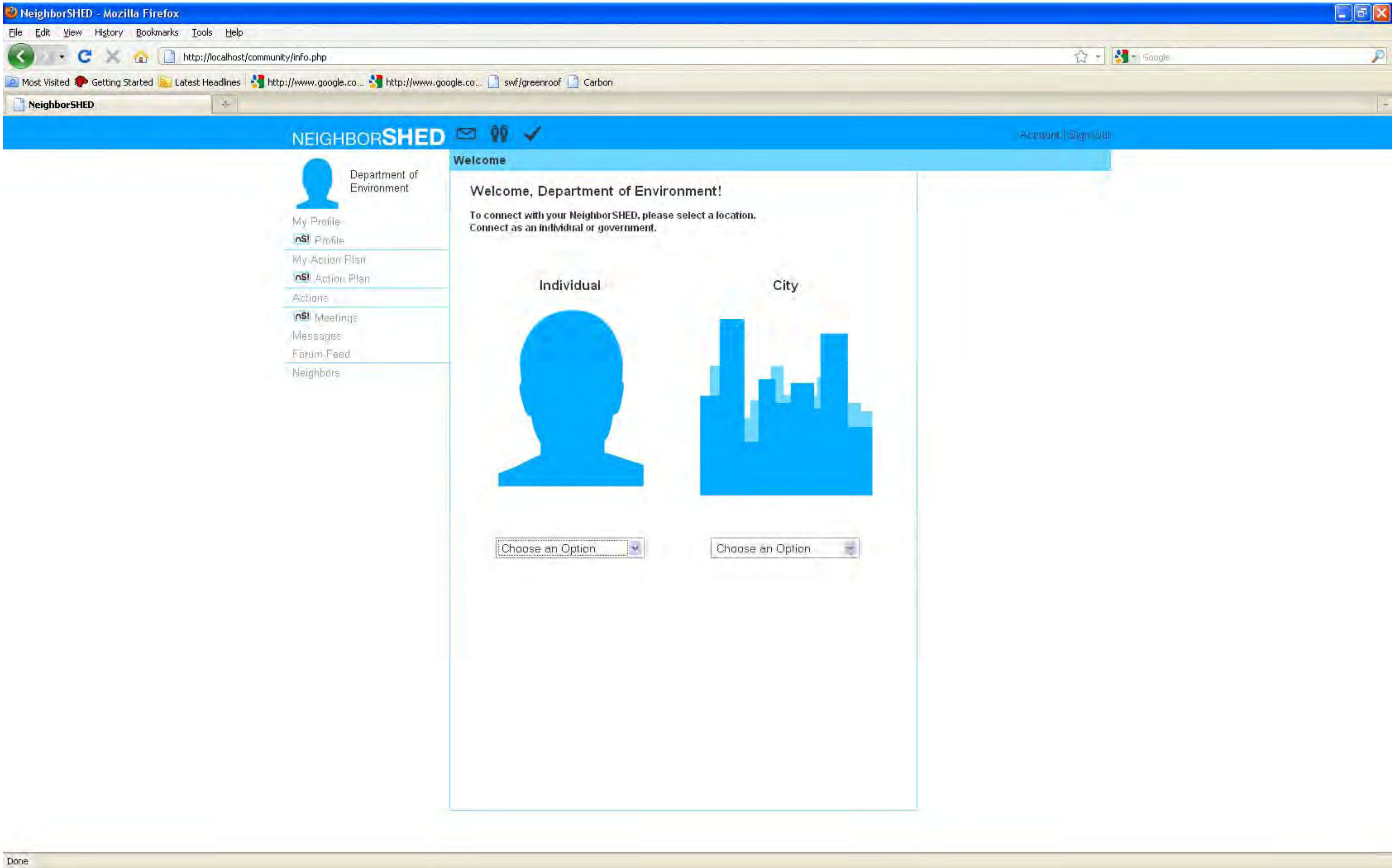
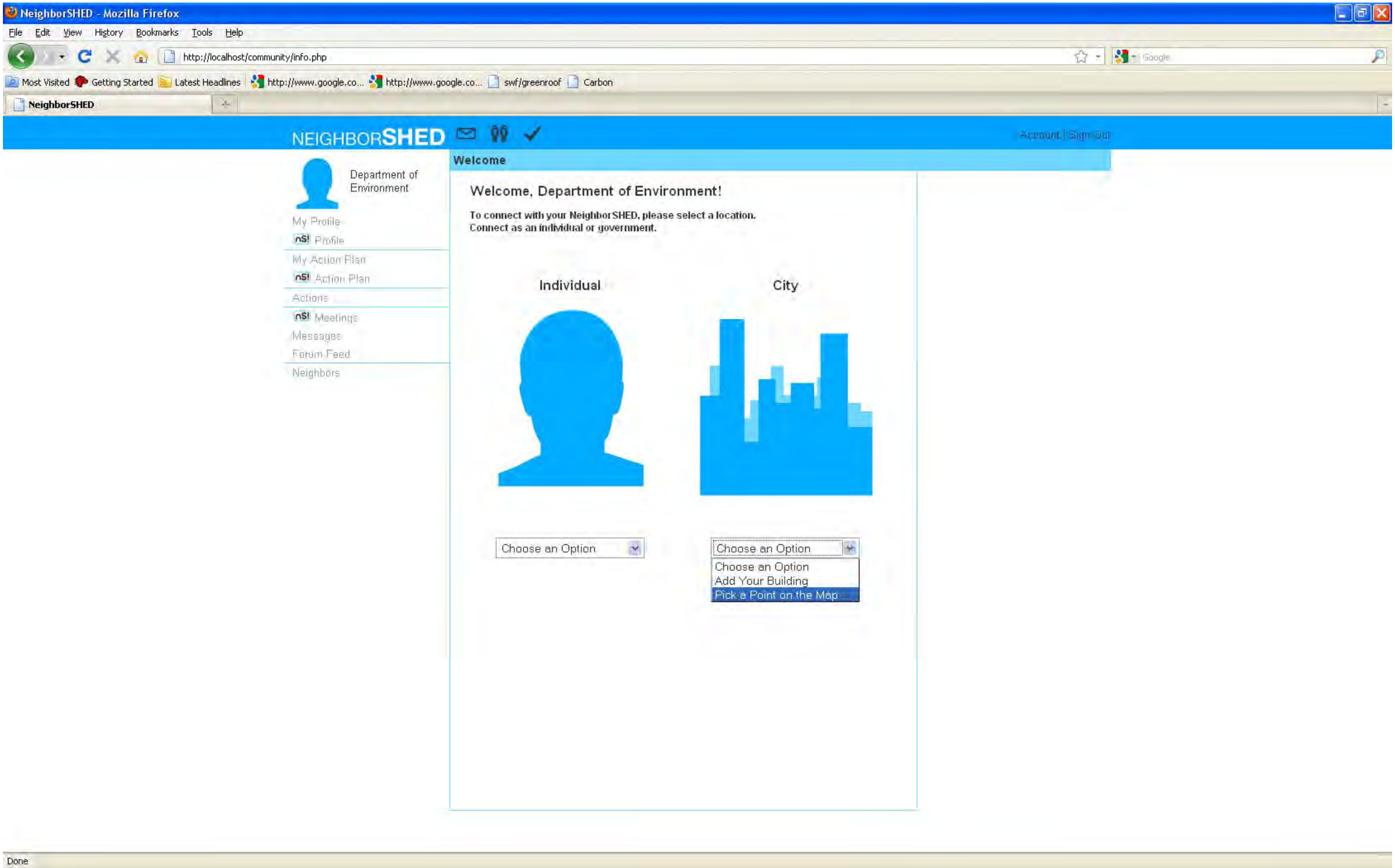
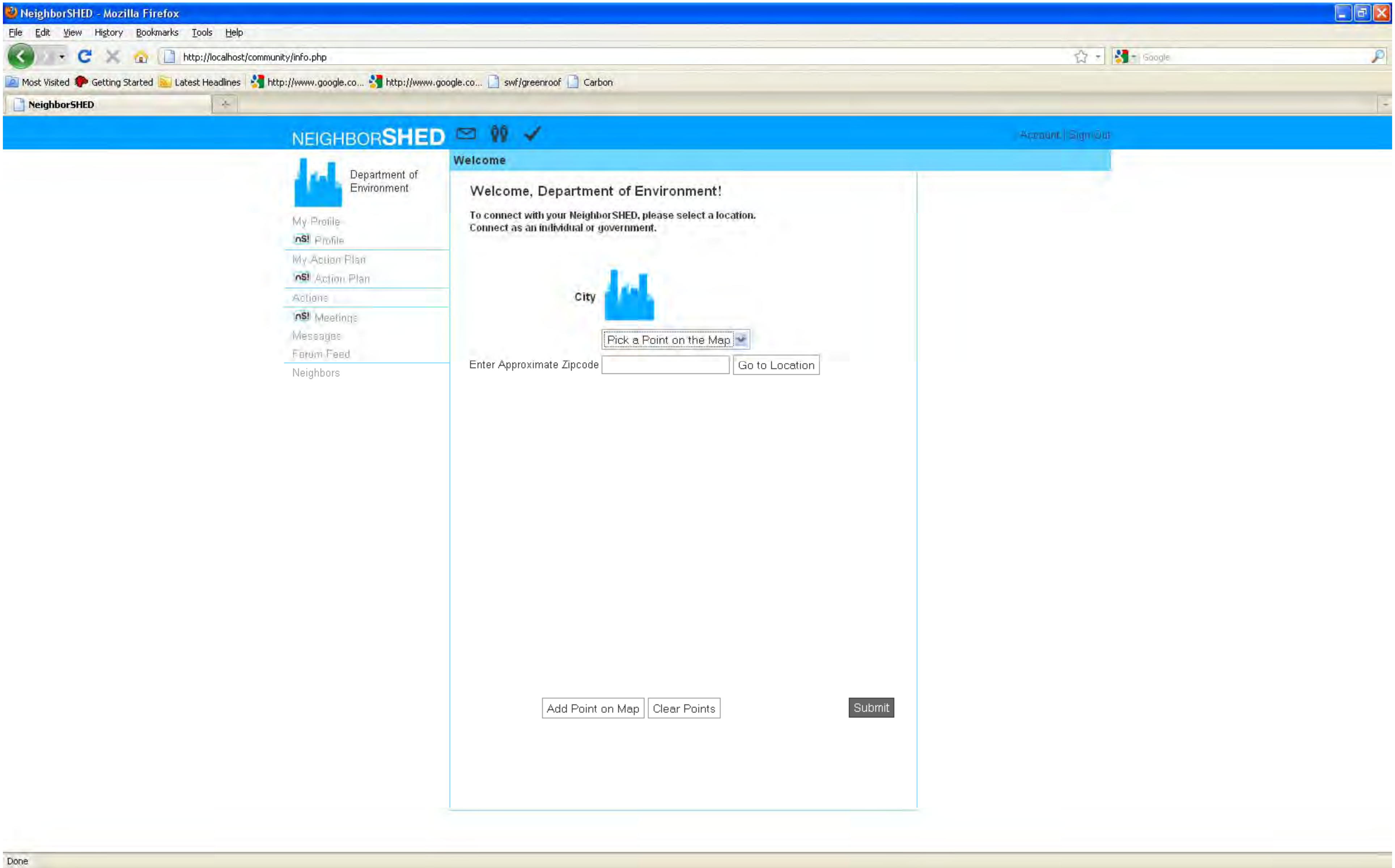
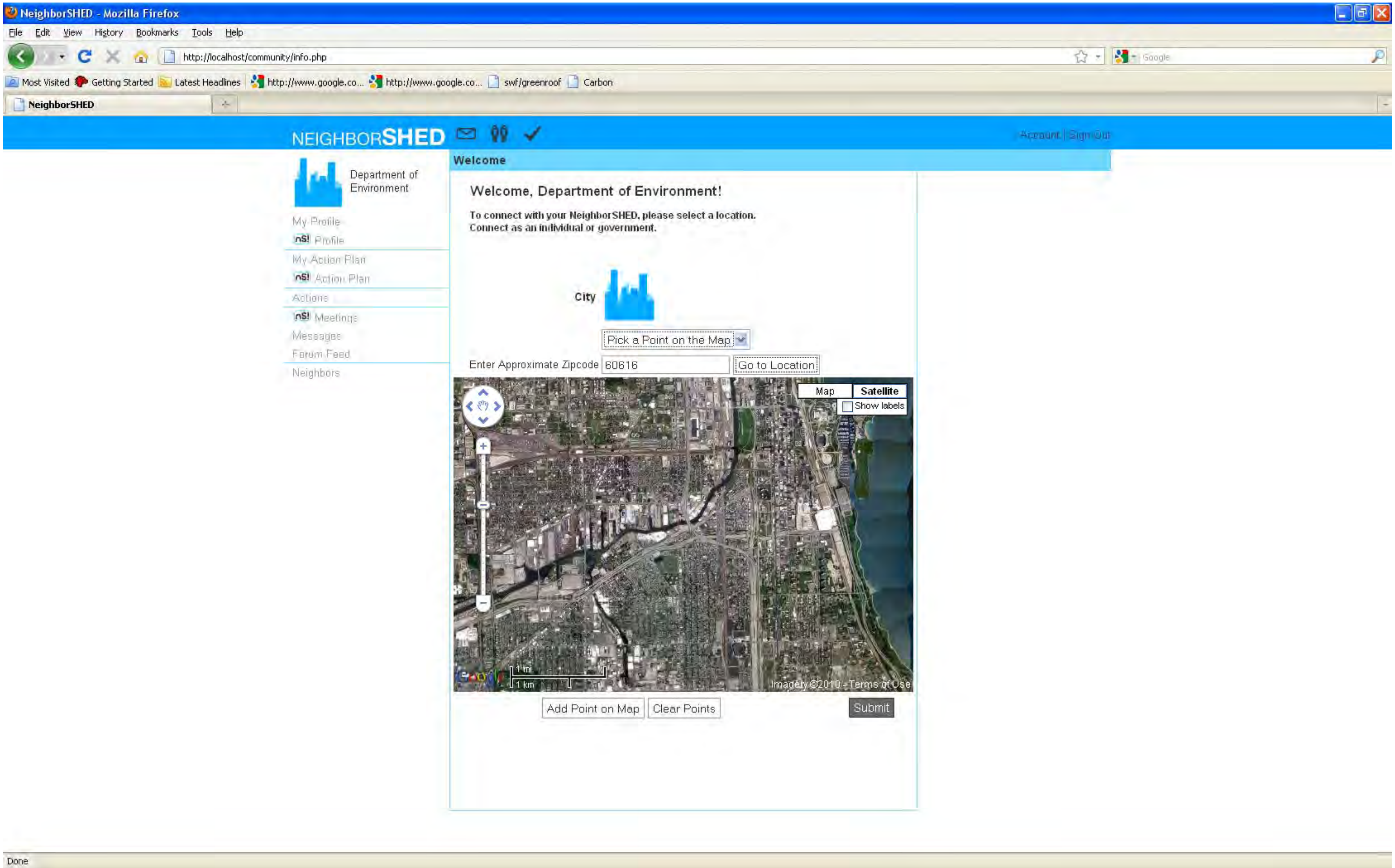
Welcome to NeighborSHED!
neighbor SHED
Email
Password
Sign In
NeighborSHED helps you take environmental action and connect with people in your area.
nS!
Get Started!
First Name
Last Name
Your Email
Create Password
Re-enter Password
Get Started!
Done

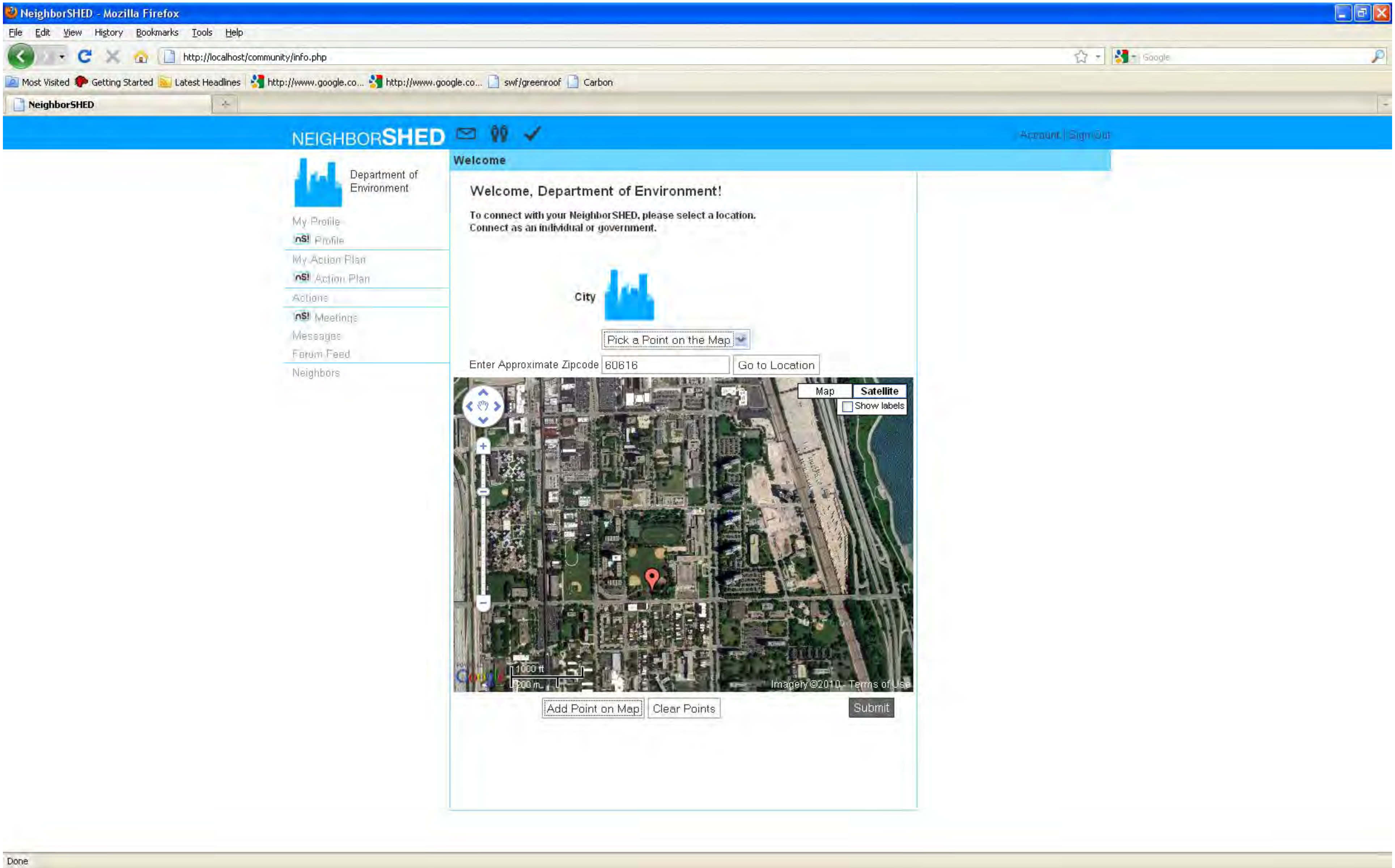
Welcome to NeighborSHED! - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/index.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
Welcome to NeighborSHED!
neighbor SHED
Email
Password
Sign In
NeighborSHED helps you take environmental action and connect with people in your area.
nS!
Get Started!
First Name Department of
Last Name Environment
Your Email doe@cityofchicago.gov
Create Password
Re-enter Password
Get Started!
Done

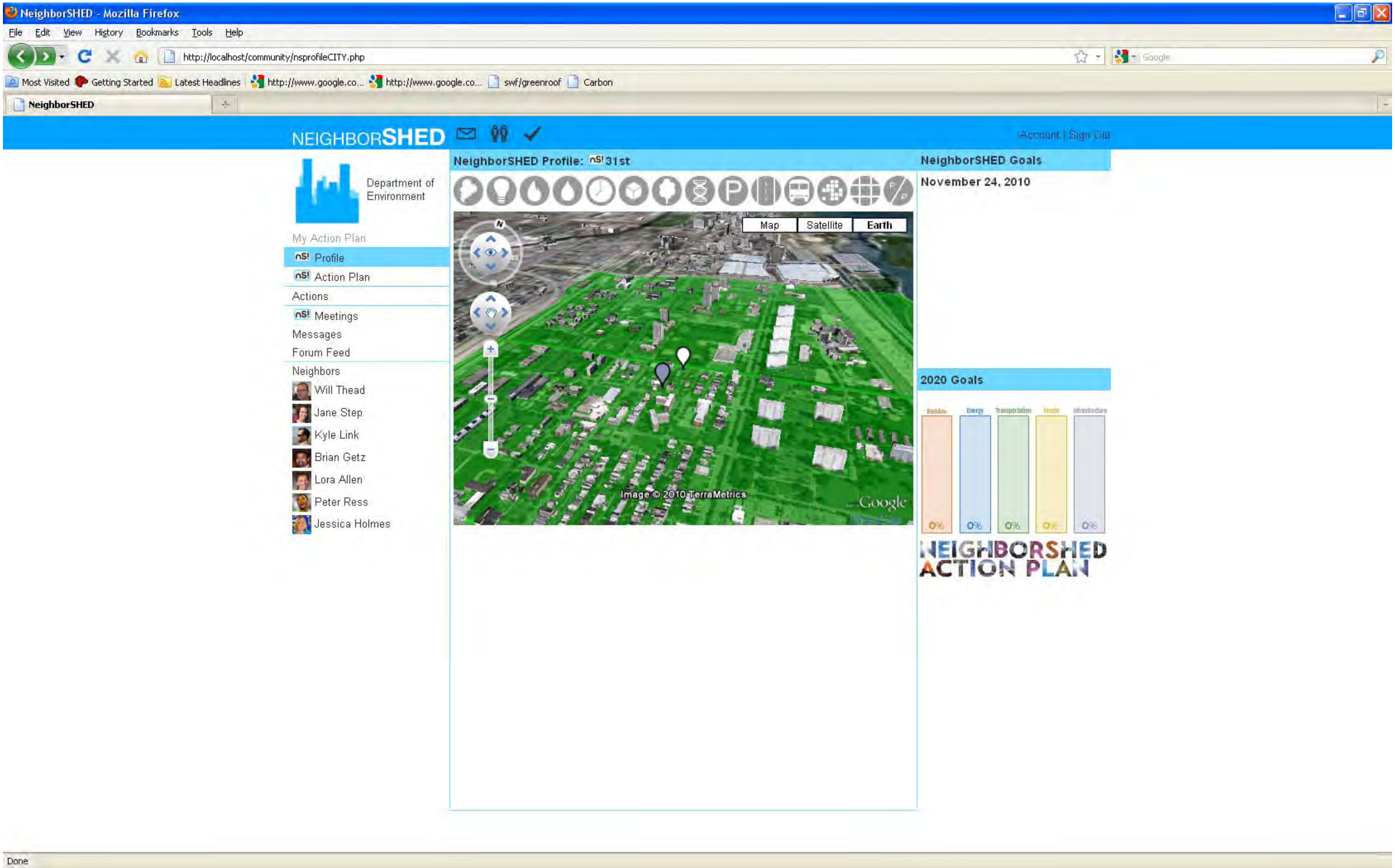

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/info.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | SignOut
Welcome
Department of Environment
My Profile
nS! Profile
My Action Plan
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Welcome, Department of Environment!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
Individual
City
Choose an Option
Choose an Option
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/info.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | SignOut
Department of Environment
My Profile
nS! Profile
My Action Plan
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Welcome
Welcome, Department of Environment!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
Individual
City
Choose an Option
Choose an Option
Choose an Option
Add Your Building
Pick a Point on the Map
Done

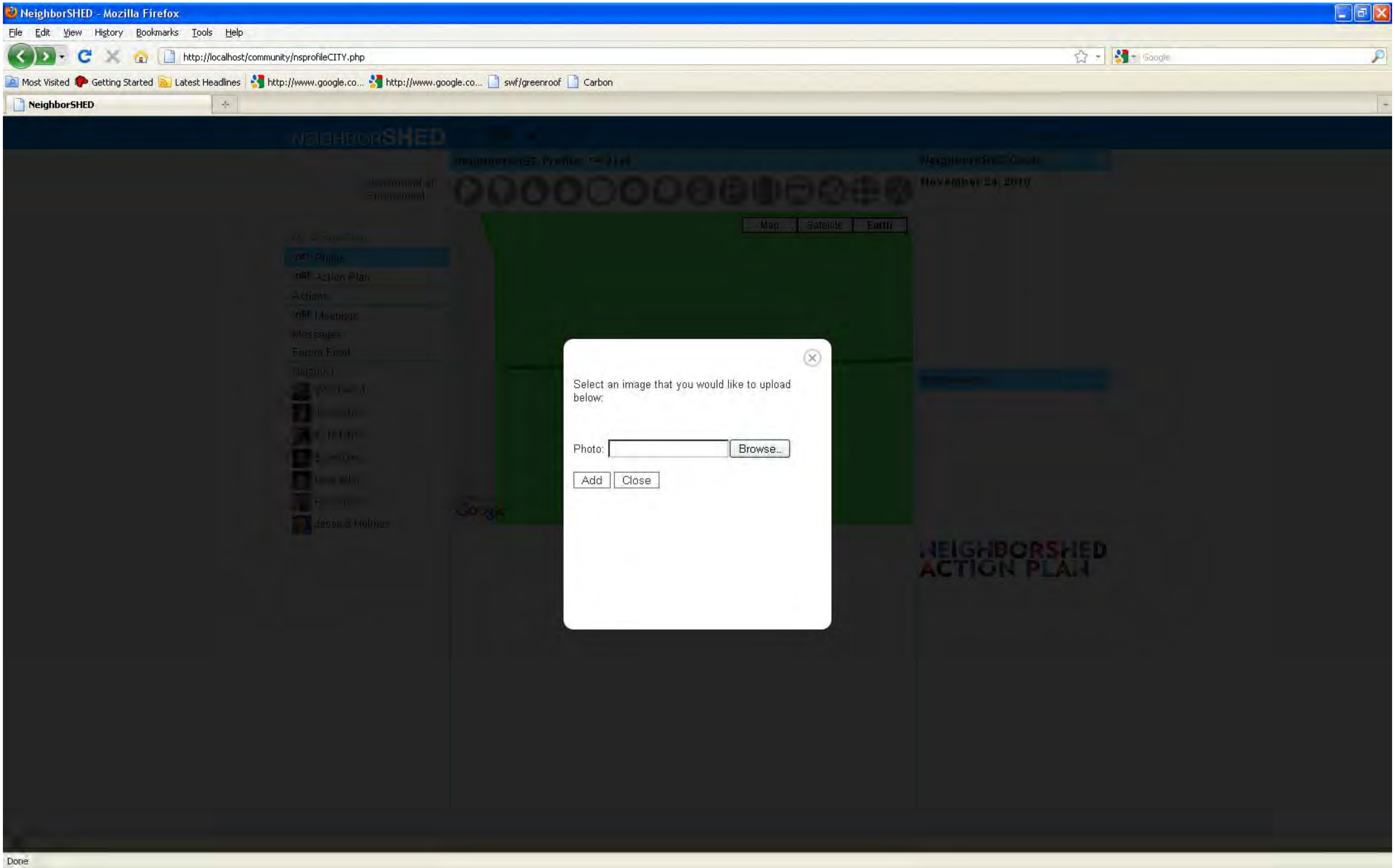

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/info.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | SignOut
Department of Environment
My Profile
nS! Profile
My Action Plan
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Welcome
Welcome, Department of Environment!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
City
Pick a Point on the Map
Enter Approximate Zipcode
Go to Location
Add Point on Map
Clear Points
Submit
Done

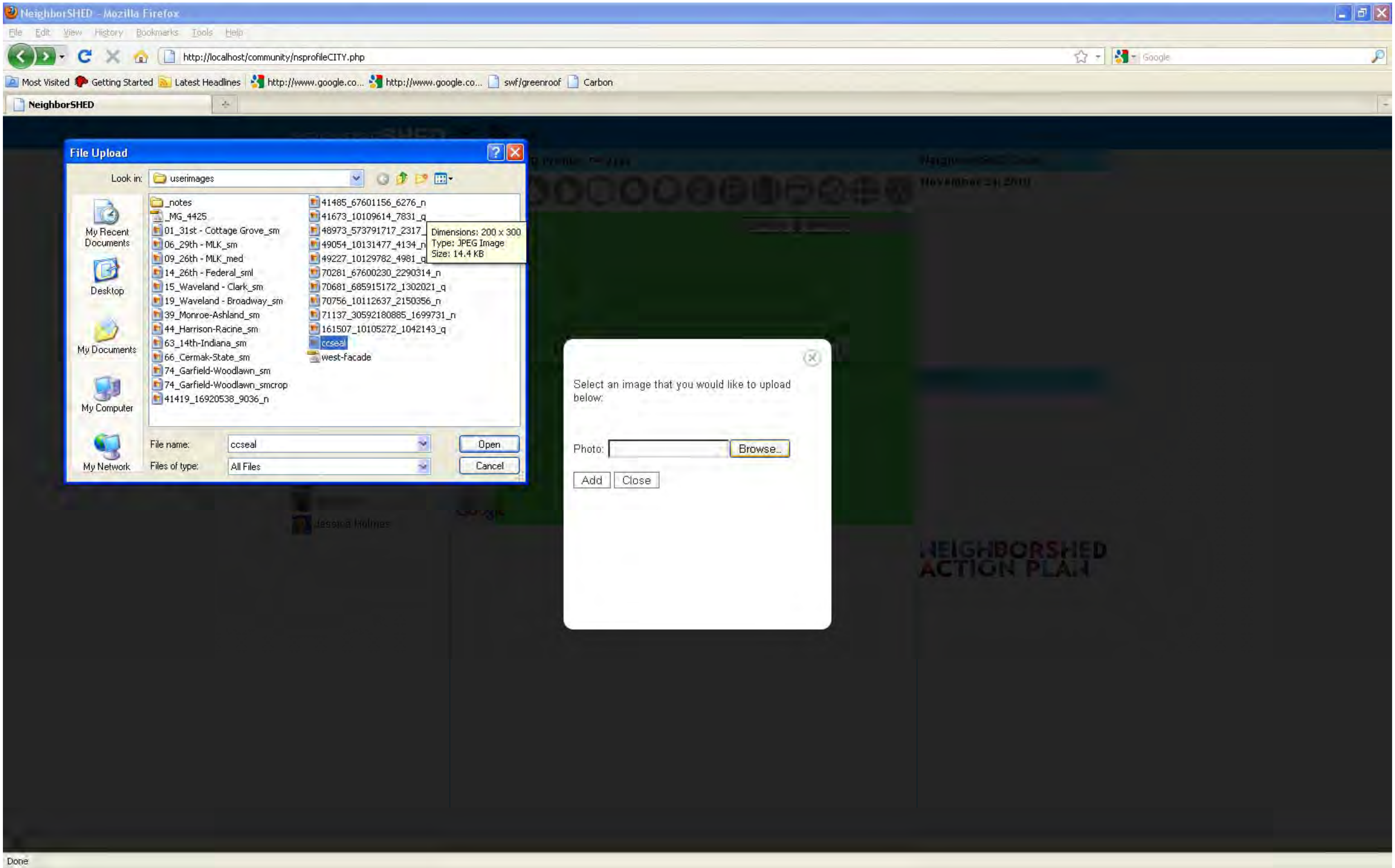

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/info.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Signout
Department of Environment
My Profile
nS! Profile
My Action Plan
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Welcome
Welcome, Department of Environment!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
City
Pick a Point on the Map
Enter Approximate Zipcode 60616
Go to Location
Map
Satellite
Show labels
1 mi
1 km
Imagery ©2010 - Terms of Use
Add Point on Map
Clear Points
Submit
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/info.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Signout
Welcome
Department of Environment
My Profile
Profile
My Action Plan
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Welcome, Department of Environment!
To connect with your NeighborSHED, please select a location.
Connect as an individual or government.
City
Pick a Point on the Map
Enter Approximate Zipcode
60616
Go to Location
Map
Satellite
Show labels
1000 ft
200 m
Imagery ©2010 , Terms of Use
Add Point on Map
Clear Points
Submit
Done

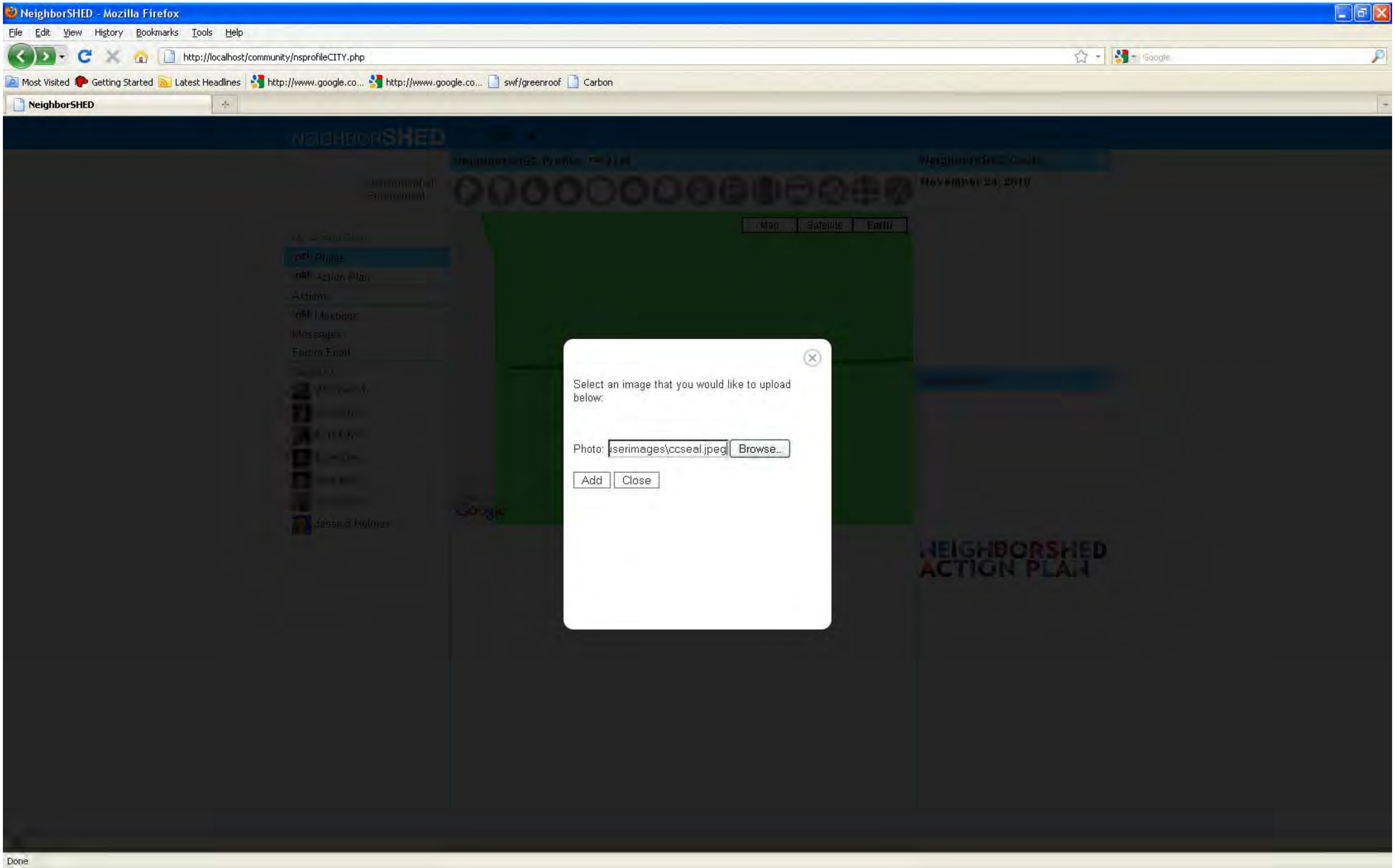


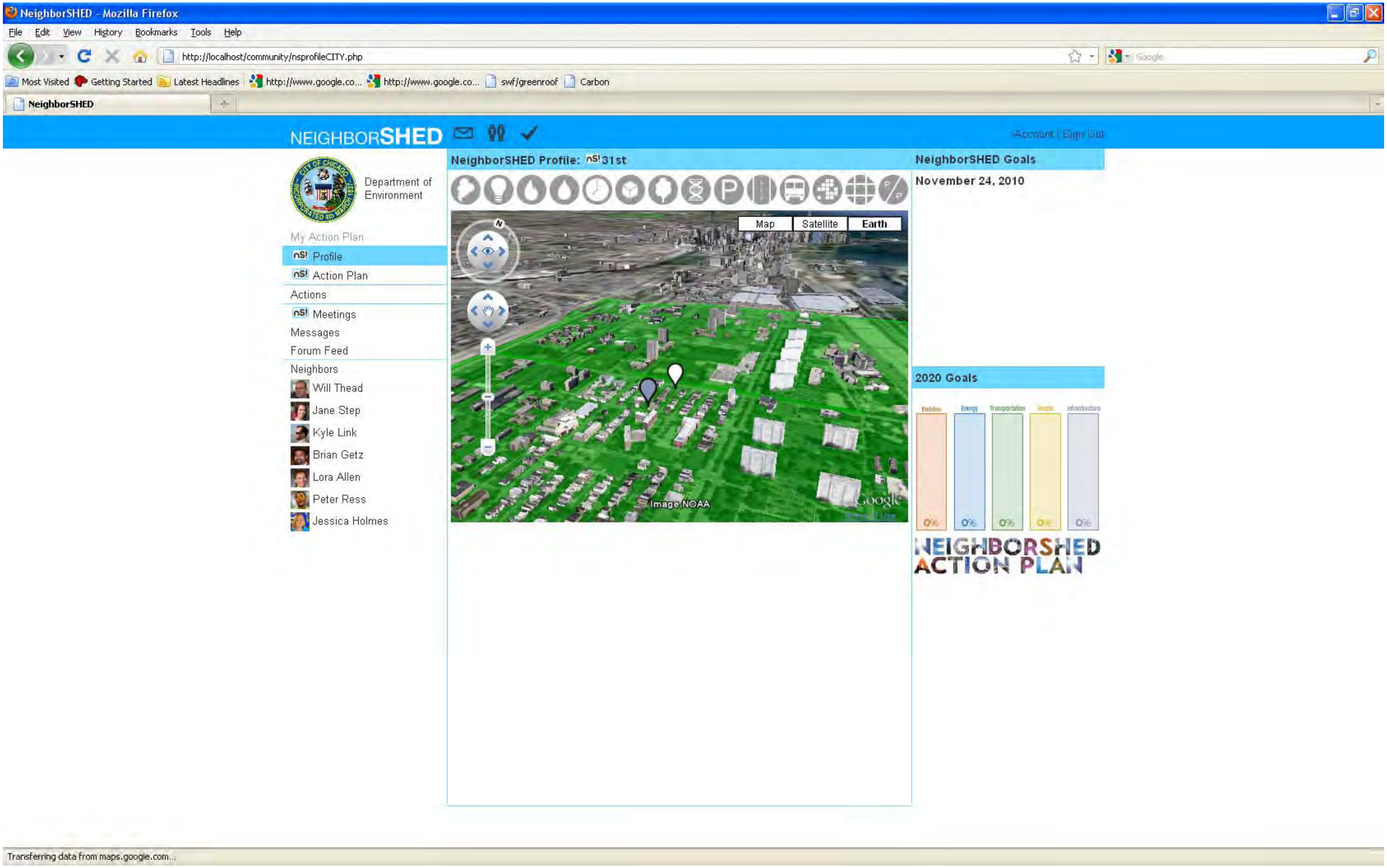
NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofileCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Department of Environment
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Google
NeighborSHED Goals
November 24, 2010
2020 Goals
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Done

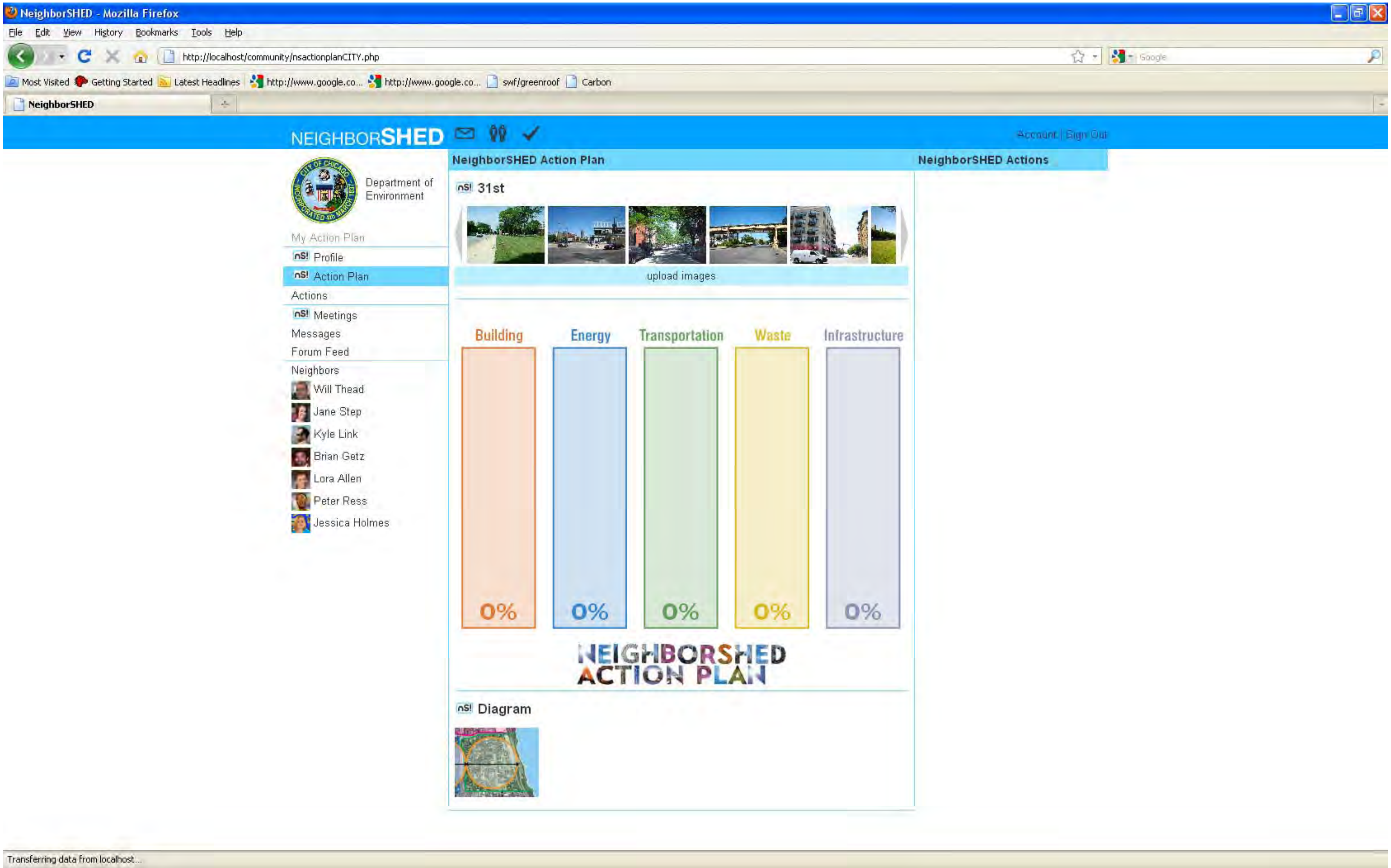

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofileCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
NeighborSHED Profile
NeighborSHED Goals
November 24, 2010
Map Satellite Earth
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Jessica Holmes
Select an image that you would like to upload below:
Photo:
Browse...
Add Close
NEIGHBORSHED ACTION PLAN
Done

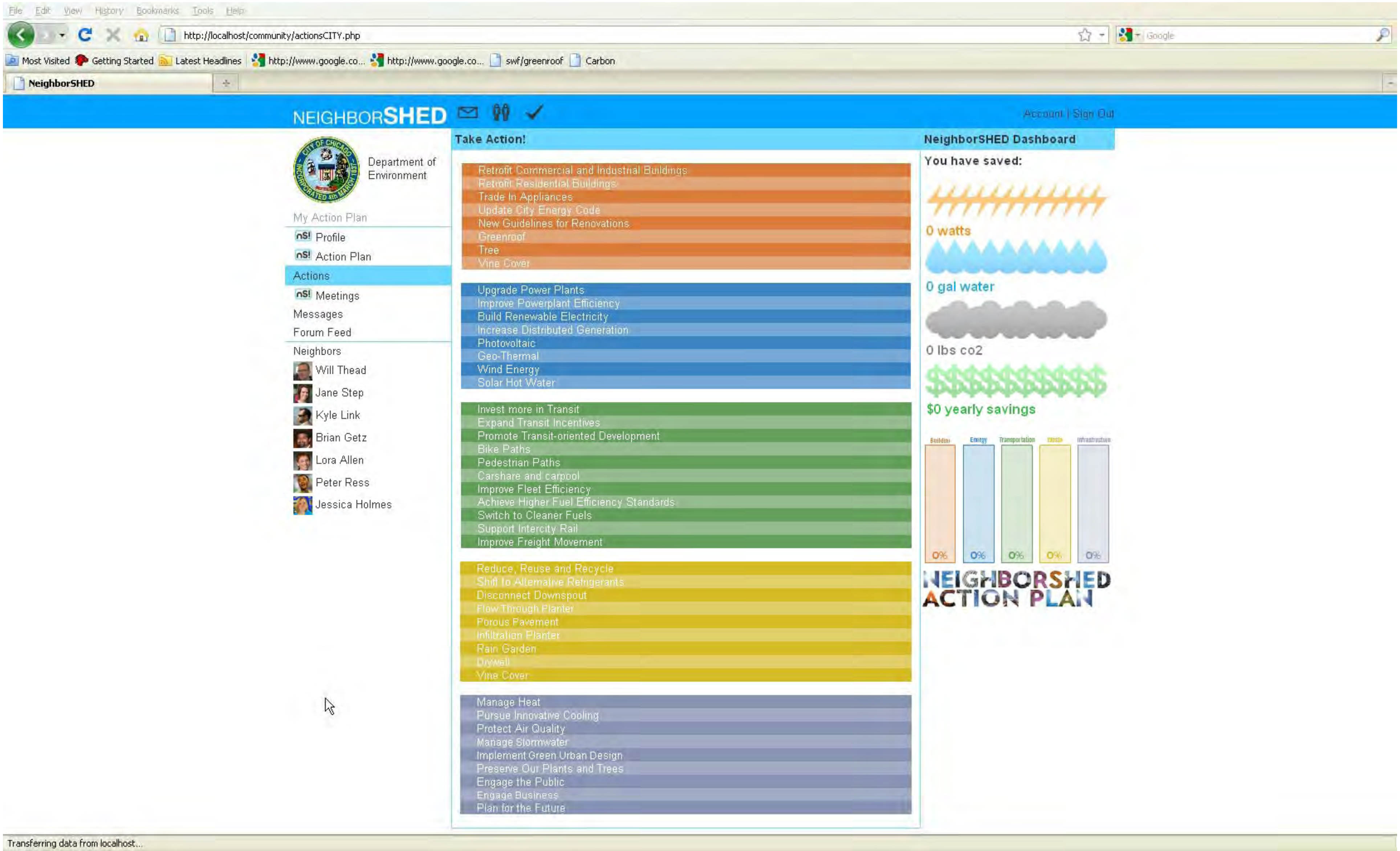


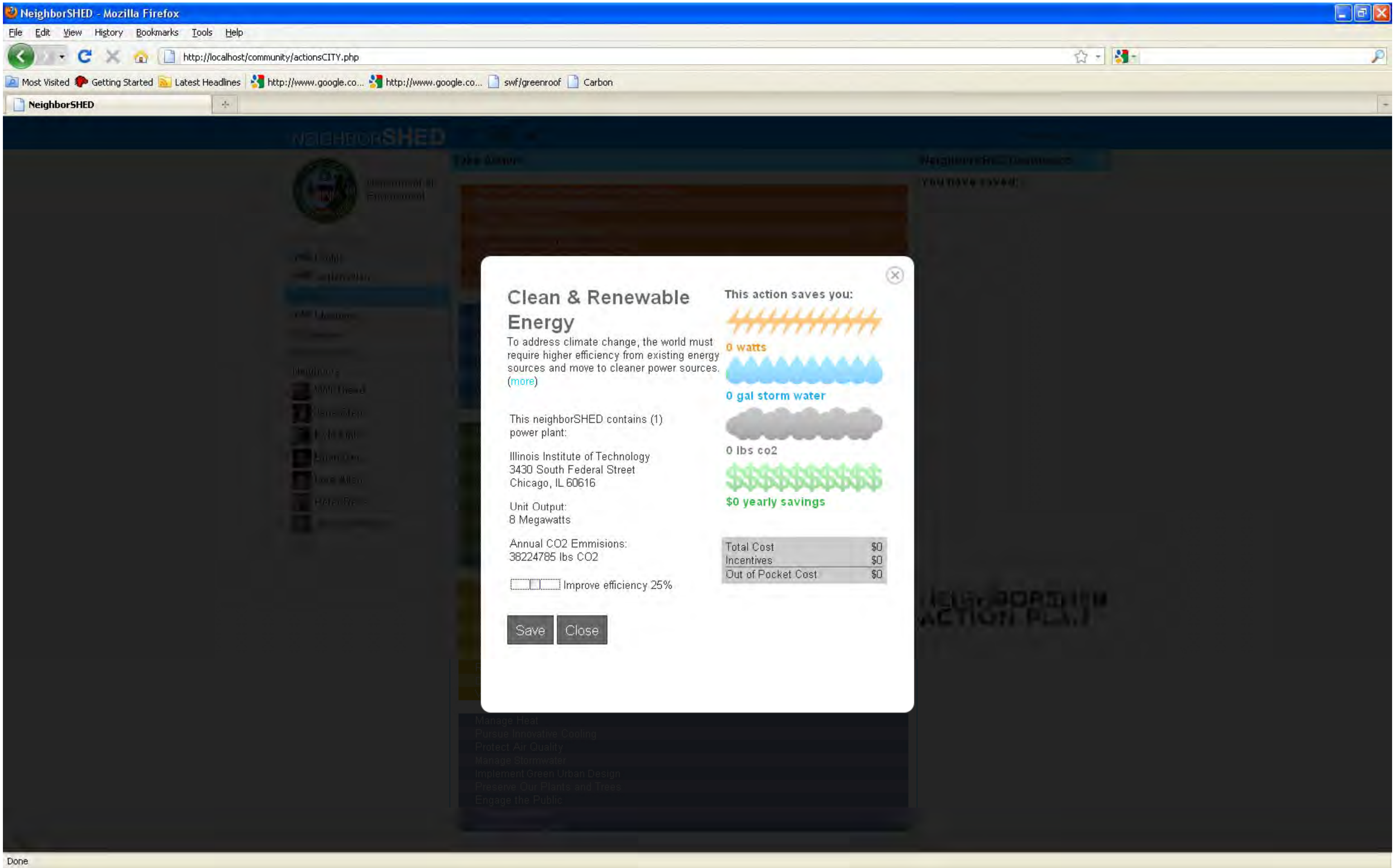
NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofileCITY.php
Google
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
File Upload
Look in:
userimages
My Recent Documents
Desktop
My Documents
My Computer
My Network
_notes
_MG_4425
01_31st - Cottage Grove_sm
06_29th - MLK_sm
09_26th - MLK_med
14_26th - Federal_sml
15_Waveland - Clark_sm
19_Waveland - Broadway_sm
39_Monroe-Ashland_sm
44_Harrison-Racine_sm
63_14th-Indiana_sm
66_Cermak-State_sm
74_Garfield-Woodlawn_sm
74_Garfield-Woodlawn_smcrop
41419_16920538_9036_n
41485_67601156_6276_n
41673_10109614_7831_q
48973_573791717_2317_
49054_10131477_4134_n
49227_10129782_4981_q
70281_67600230_2290314_n
70681_685915172_1302021_q
70756_10112637_2150356_n
71137_30592180885_1699731_n
161507_10105272_1042143_q
ccseal
west-facade
Dimensions: 200 x 300
Type: JPEG Image
Size: 14.4 KB
File name:
ccseal
Files of type:
All Files
Open
Cancel
Select an image that you would like to upload below:
Photo:
Browse...
Add
Close
NEIGHBORSHED
ACTION PLAN
Done

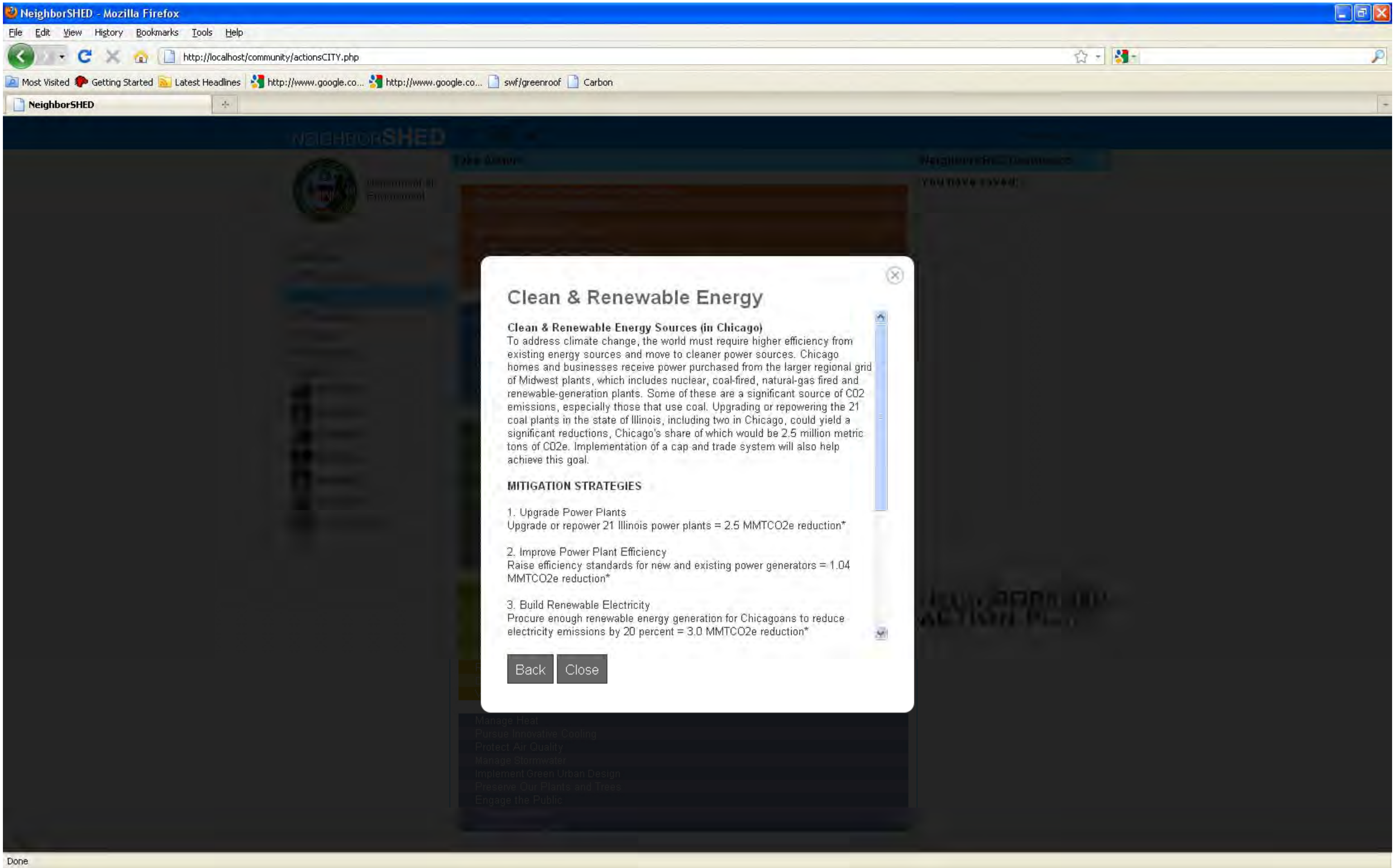

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofileCITY.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
Map
Satellite
Earth
Select an image that you would like to upload below:
Photo:
serimages\ccseal.jpeg
Browse...
Add
Close
Jessica Holmes
NEIGHBORSHED ACTION PLAN
Done

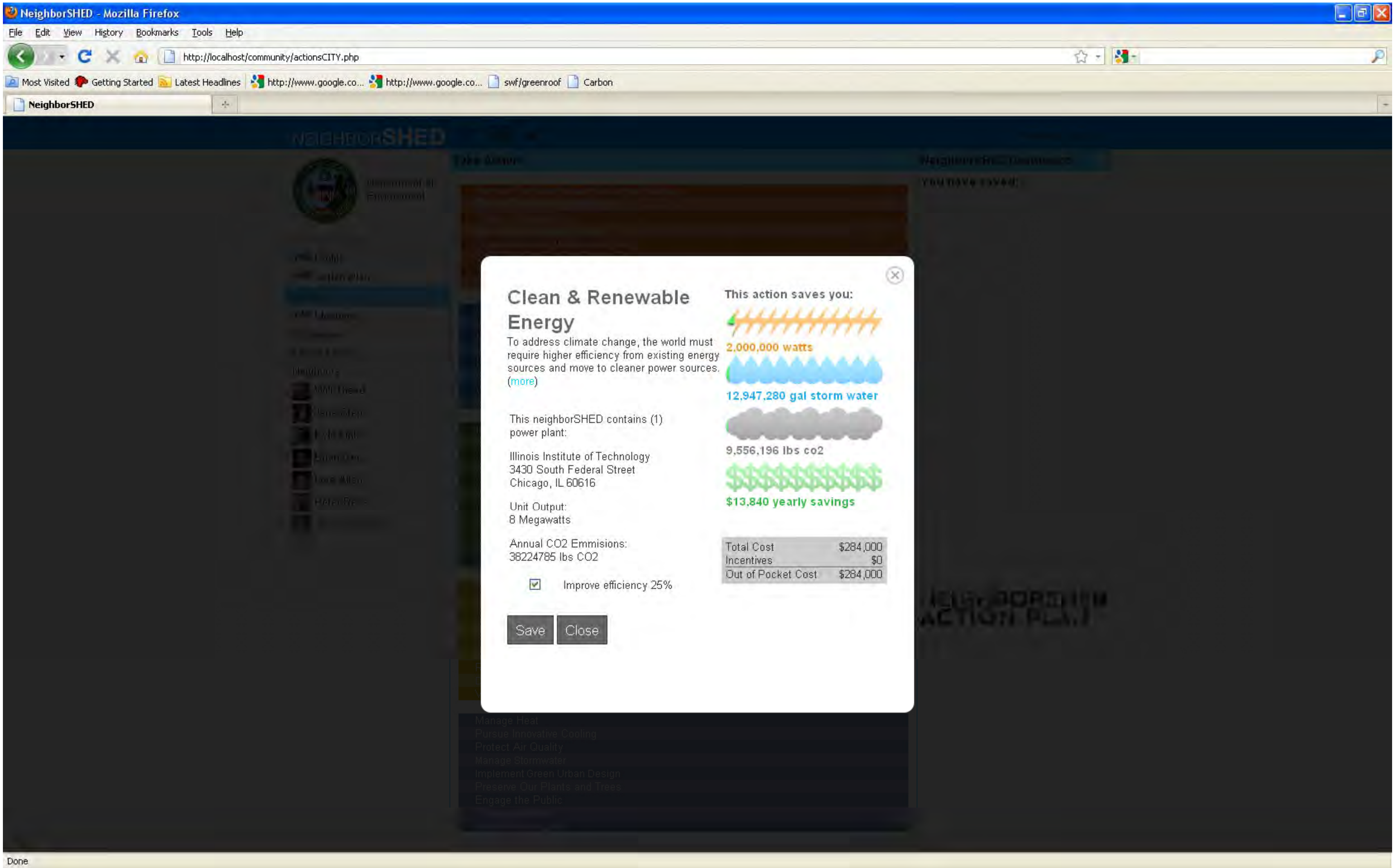

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsprofileCITY.php
Google
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Department of Environment
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image NOAA
Google
NeighborSHED Goals
November 24, 2010
2020 Goals
Energy
Transportation
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from maps.google.com...

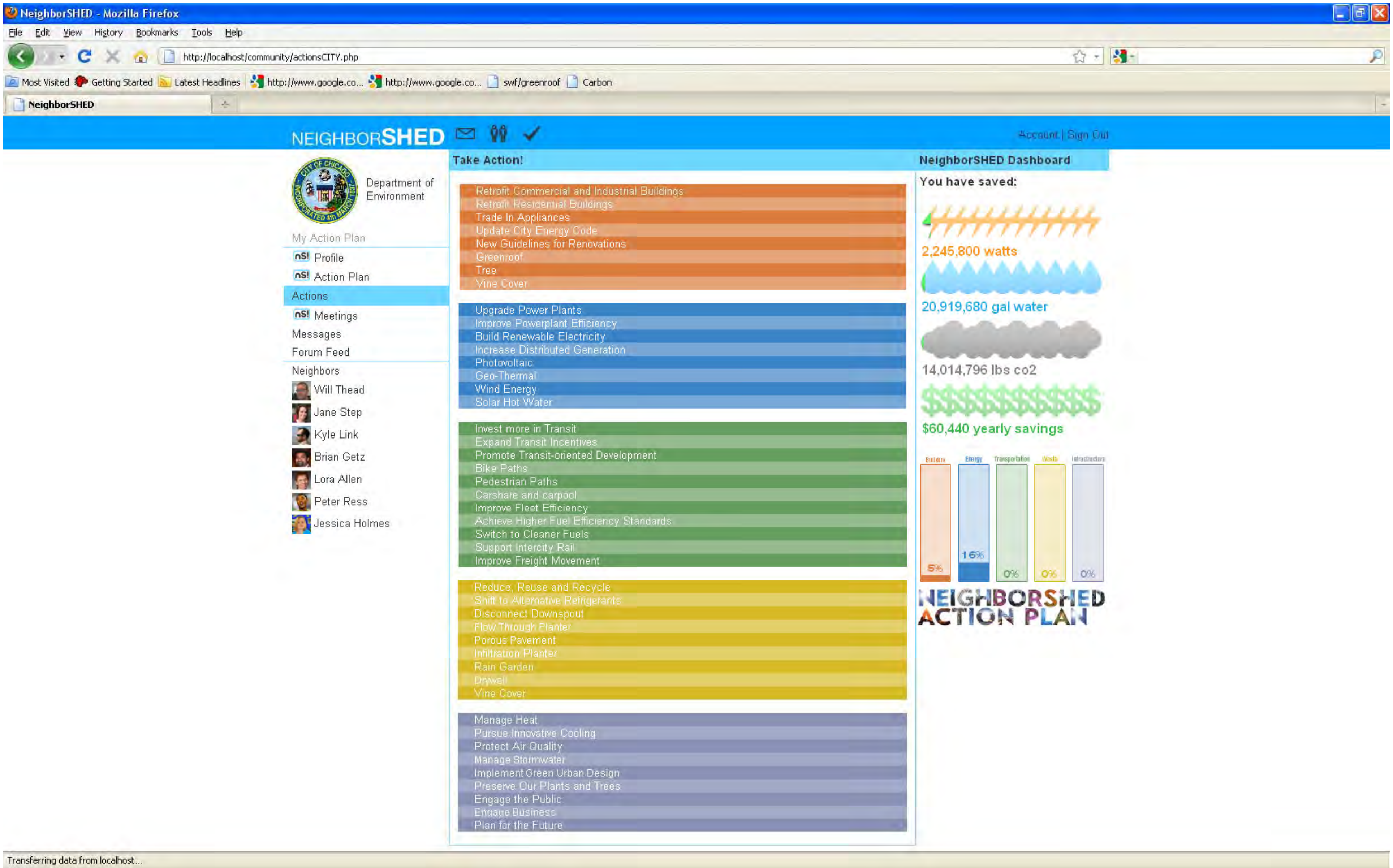

NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/nsactionplanCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Department of Environment
NeighborSHED Action Plan
NeighborSHED Actions
31st
upload images
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
Building
Energy
Transportation
Waste
Infrastructure
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Diagram
Transferring data from localhost...


File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited
Getting Started
Latest Headlines
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Department of Environment
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
Take Action!
Retrofit Commercial and Industrial Buildings
Retrofit Residential Buildings
Trade In Appliances
Update City Energy Code
New Guidelines for Renovations
Greenroof
Tree
Vine Cover
Upgrade Power Plants
Improve Powerplant Efficiency
Build Renewable Electricity
Increase Distributed Generation
Photovoltaic
Geo-Thermal
Wind Energy
Solar Hot Water
Invest more in Transit
Expand Transit Incentives
Promote Transit-oriented Development
Bike Paths
Pedestrian Paths
Carshare and carpool
Improve Fleet Efficiency
Achieve Higher Fuel Efficiency Standards
Switch to Cleaner Fuels
Support Intercity Rail
Improve Freight Movement
Reduce, Reuse and Recycle
Shift to Alternative Refrigerants
Disconnect Downspout
Flow Through Planter
Porous Pavement
Infiltration Planter
Rain Garden
Drywell
Vine Cover
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
NeighborSHED Dashboard
You have saved:
0 watts
0 gal water
0 lbs co2
$0 yearly savings
0%
0%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Clean & Renewable Energy
To address climate change, the world must require higher efficiency from existing energy sources and move to cleaner power sources. (more)
This neighborSHED contains (1) power plant:
Illinois Institute of Technology
3430 South Federal Street
Chicago, IL 60616
Unit Output:
8 Megawatts
Annual CO2 Emmisions:
38224785 lbs CO2
Improve efficiency 25%
Save
Close
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives $0
Out of Pocket Cost $0
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Clean & Renewable Energy
Clean & Renewable Energy Sources (in Chicago)
To address climate change, the world must require higher efficiency from existing energy sources and move to cleaner power sources. Chicago homes and businesses receive power purchased from the larger regional grid of Midwest plants, which includes nuclear, coal-fired, natural-gas fired and renewable-generation plants. Some of these are a significant source of C02 emissions, especially those that use coal. Upgrading or repowering the 21 coal plants in the state of Illinois, including two in Chicago, could yield a significant reductions, Chicago's share of which would be 2.5 million metric tons of C02e. Implementation of a cap and trade system will also help achieve this goal.
MITIGATION STRATEGIES
1. Upgrade Power Plants
Upgrade or repower 21 Illinois power plants = 2.5 MMTCO2e reduction*
2. Improve Power Plant Efficiency
Raise efficiency standards for new and existing power generators = 1.04 MMTCO2e reduction*
3. Build Renewable Electricity
Procure enough renewable energy generation for Chicagoans to reduce electricity emissions by 20 percent = 3.0 MMTCO2e reduction*
Back
Close
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Clean & Renewable Energy
To address climate change, the world must require higher efficiency from existing energy sources and move to cleaner power sources. (more)
This neighborSHED contains (1) power plant:
Illinois Institute of Technology
3430 South Federal Street
Chicago, IL 60616
Unit Output:
8 Megawatts
Annual CO2 Emmisions:
38224785 lbs CO2
Improve efficiency 25%
Save
Close
This action saves you:
2,000,000 watts
12,947,280 gal storm water
9,556,196 lbs co2
$13,840 yearly savings
Total Cost $284,000
Incentives $0
Out of Pocket Cost $284,000
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
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Department of Environment
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Action Plan
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Neighbors
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Take Action!
Retrofit Commercial and Industrial Buildings
Retrofit Residential Buildings
Trade In Appliances
Update City Energy Code
New Guidelines for Renovations
Greenroof
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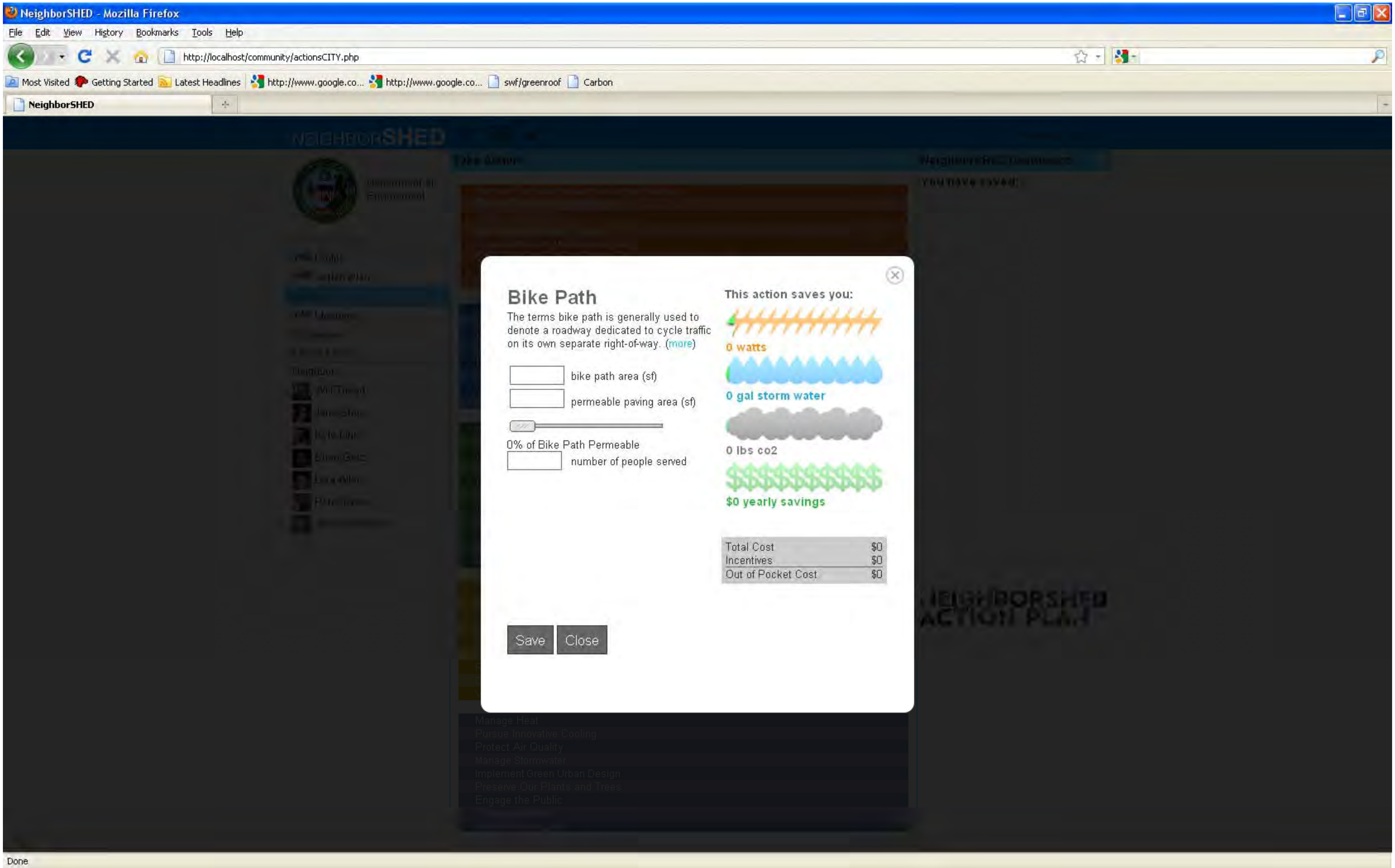
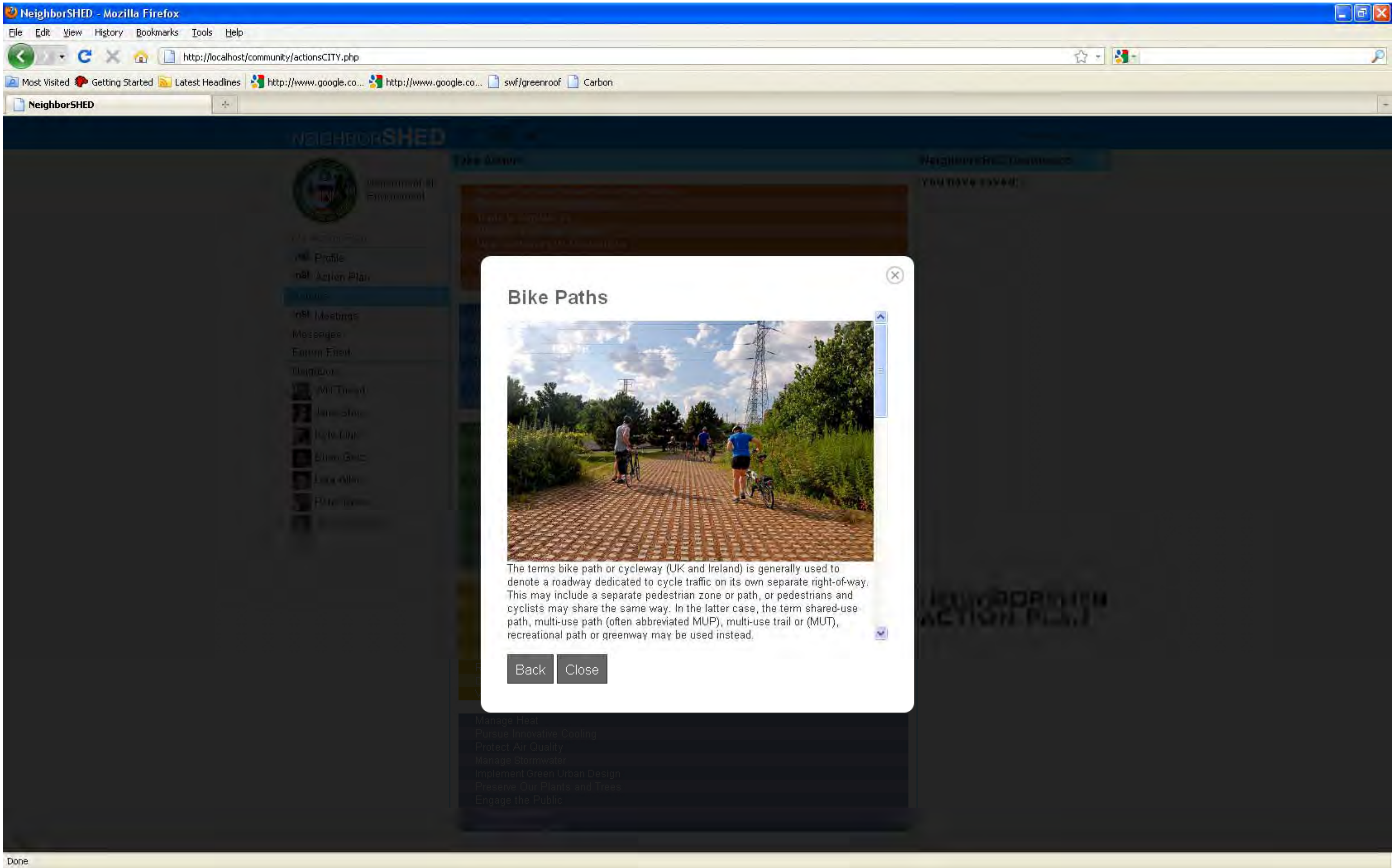
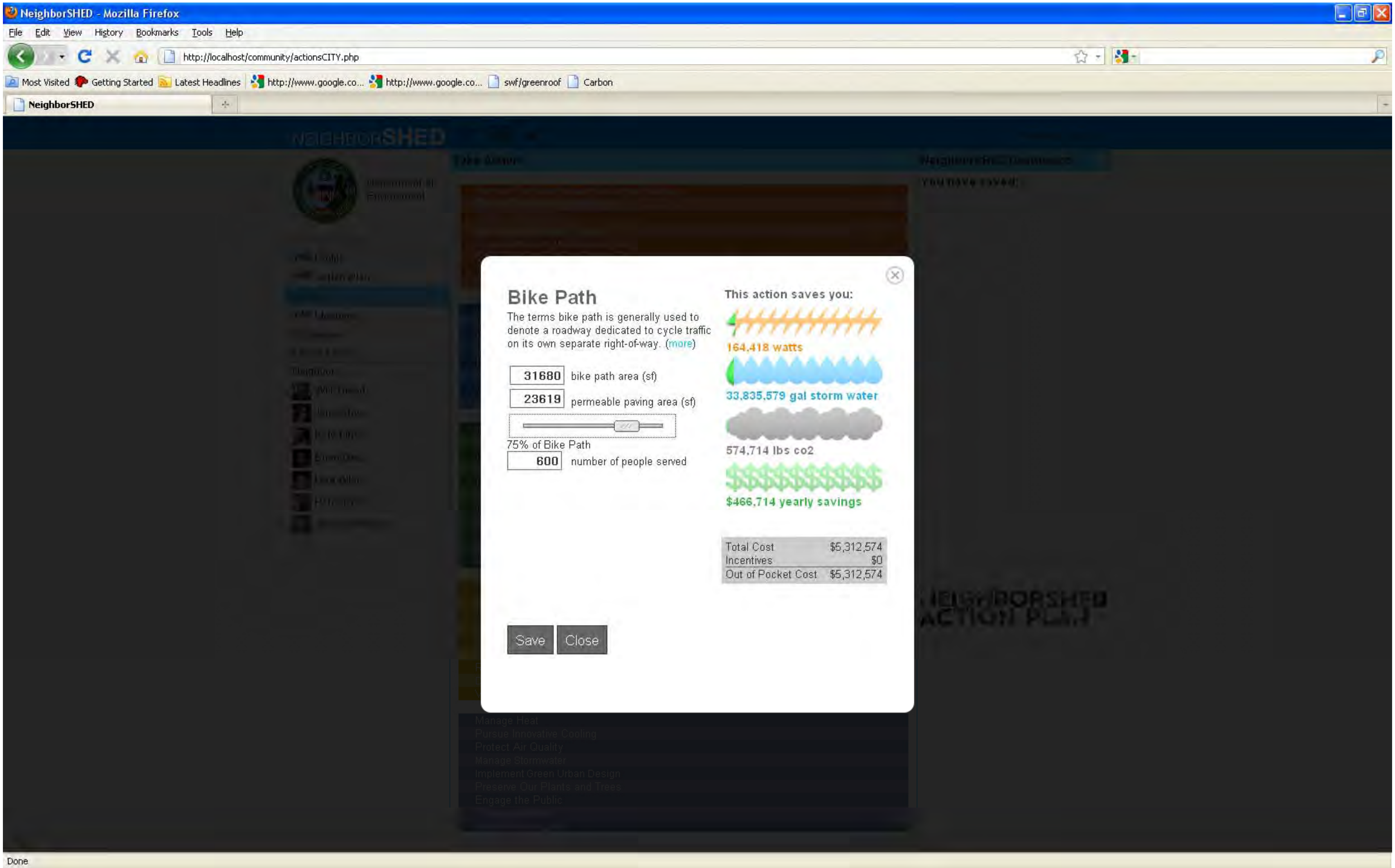
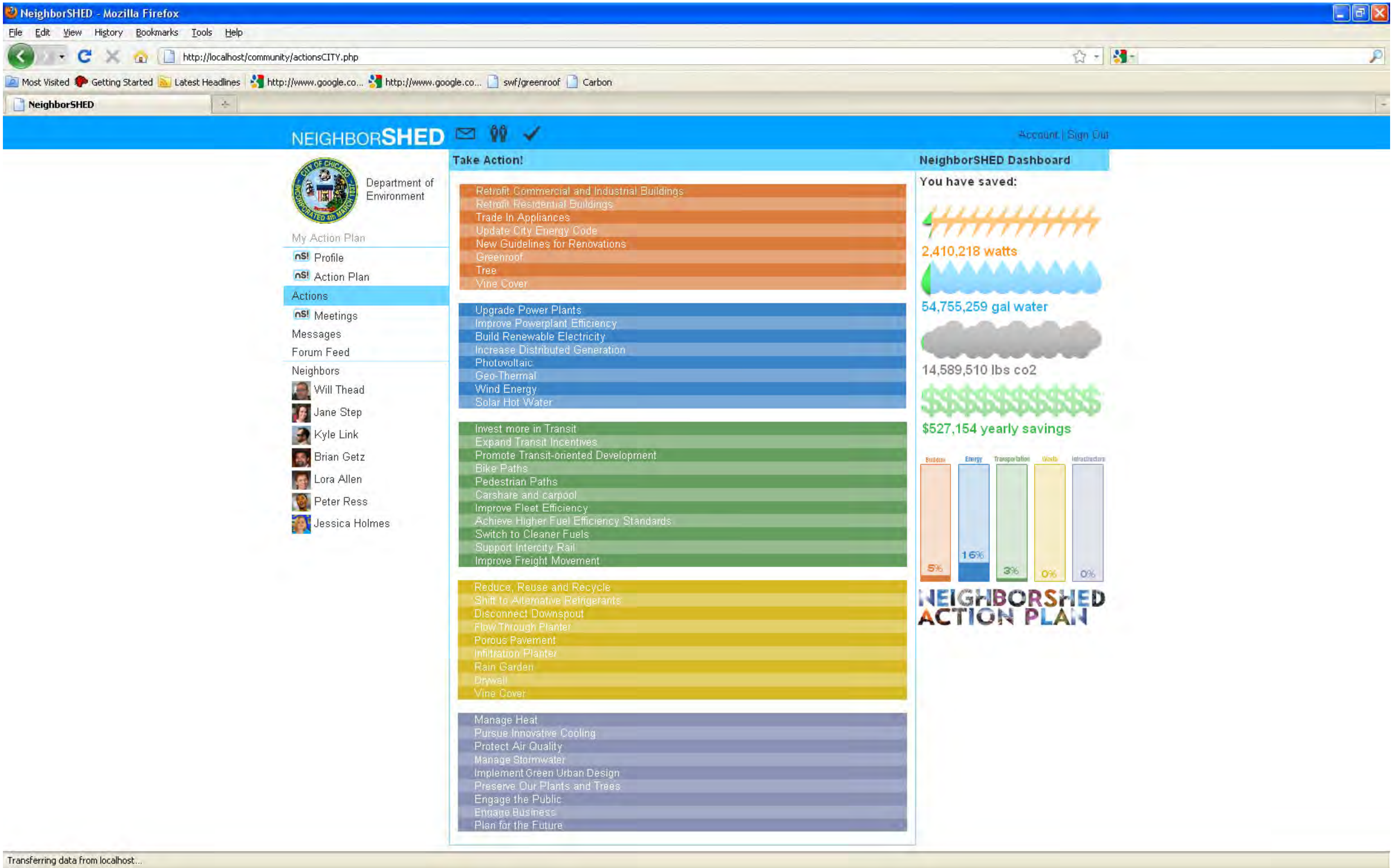
Upgrade Power Plants
Improve Powerplant Efficiency
Build Renewable Electricity
Increase Distributed Generation
Photovoltaic
Geo-Thermal
Wind Energy
Solar Hot Water
Invest more in Transit
Expand Transit Incentives
Promote Transit-oriented Development
Bike Paths
Pedestrian Paths
Carshare and carpool
Improve Fleet Efficiency
Achieve Higher Fuel Efficiency Standards
Switch to Cleaner Fuels
Support Intercity Rail
Improve Freight Movement
Reduce, Reuse and Recycle
Shift to Alternative Refrigerants
Disconnect Downspout
Flow Through Planter
Porous Pavement
Infiltration Planter
Rain Garden
Drywell
Vine Cover
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
NeighborSHED Dashboard
You have saved:
2,245,800 watts
20,919,680 gal water
14,014,796 lbs co2
$60,440 yearly savings
Energy
Transportation
5%
16%
0%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Bike Path
The terms bike path is generally used to denote a roadway dedicated to cycle traffic on its own separate right-of-way. (more)
bike path area (sf)
permeable paving area (sf)
0% of Bike Path Permeable
number of people served
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives $0
Out of Pocket Cost $0
Save
Close
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Bike Paths
The terms bike path or cycleway (UK and Ireland) is generally used to denote a roadway dedicated to cycle traffic on its own separate right-of-way. This may include a separate pedestrian zone or path, or pedestrians and cyclists may share the same way. In the latter case, the term shared-use path, multi-use path (often abbreviated MUP), multi-use trail or (MUT), recreational path or greenway may be used instead.
Back
Close
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Done
Bike Path
The terms bike path is generally used to denote a roadway dedicated to cycle traffic on its own separate right-of-way. (more)
31680 bike path area (sf)
23619 permeable paving area (sf)
75% of Bike Path
600 number of people served
This action saves you:
164,418 watts
33,835,579 gal storm water
574,714 lbs co2
$466,714 yearly savings
Total Cost $5,312,574
Incentives $0
Out of Pocket Cost $5,312,574
Save
Close
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
NEIGHBORSHED
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Department of Environment
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Action Plan
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Meetings
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Neighbors
Will Thead
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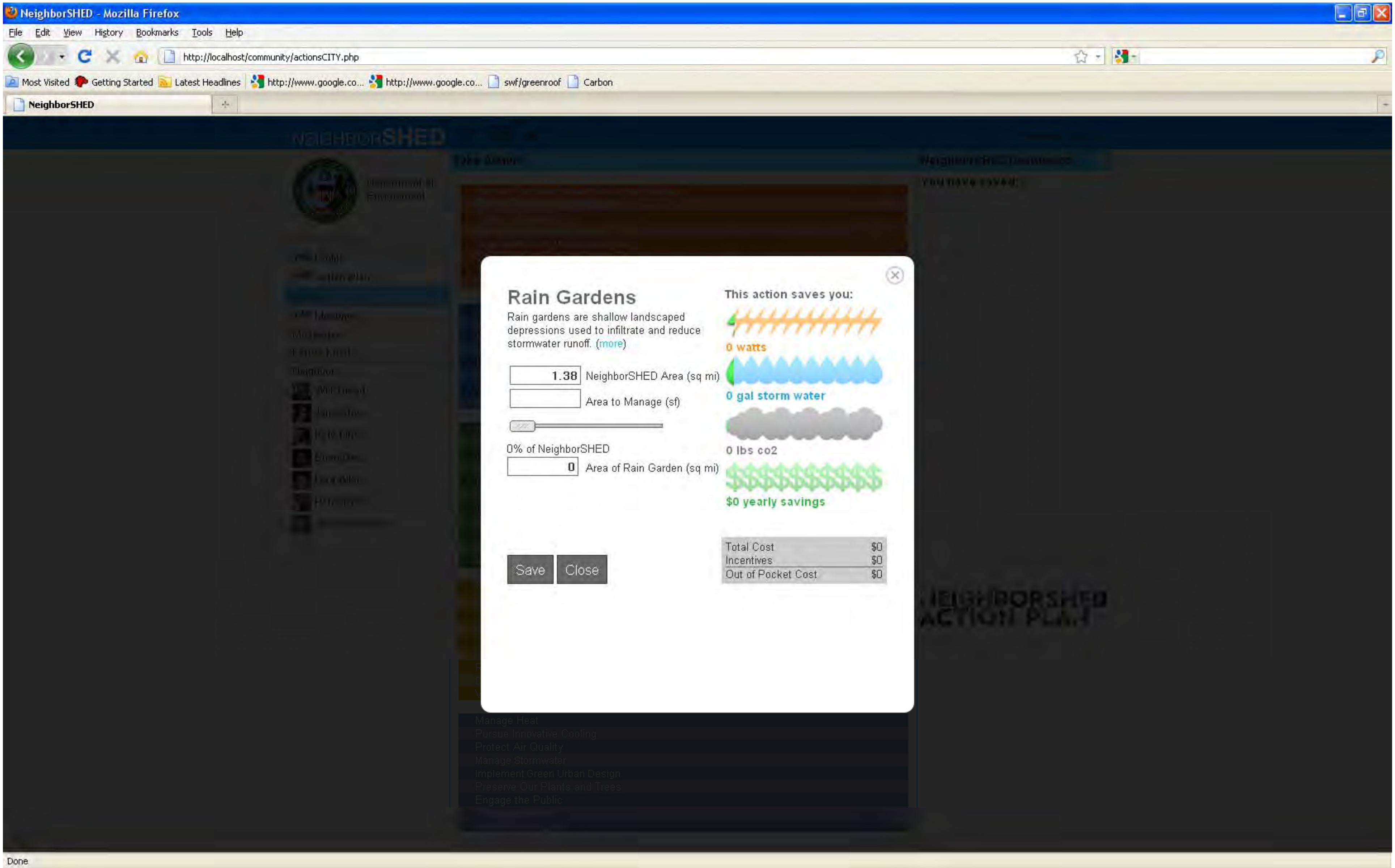
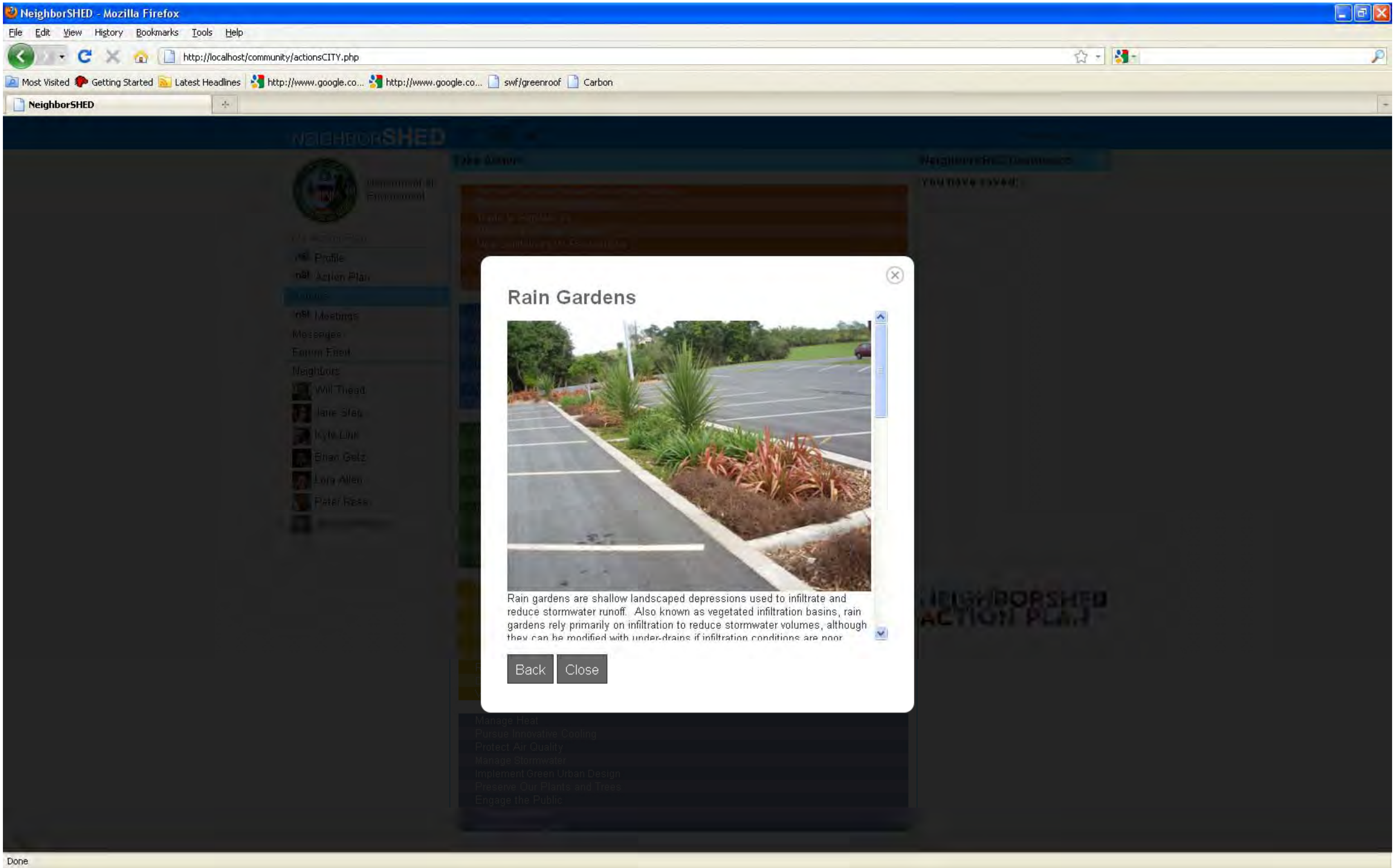
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
Take Action!
Retrofit Commercial and Industrial Buildings
Retrofit Residential Buildings
Trade In Appliances
Update City Energy Code
New Guidelines for Renovations
Greenroof
Tree
Vine Cover
Upgrade Power Plants
Improve Powerplant Efficiency
Build Renewable Electricity
Increase Distributed Generation
Photovoltaic
Geo-Thermal
Wind Energy
Solar Hot Water
Invest more in Transit
Expand Transit Incentives
Promote Transit-oriented Development
Bike Paths
Pedestrian Paths
Carshare and carpool
Improve Fleet Efficiency
Achieve Higher Fuel Efficiency Standards
Switch to Cleaner Fuels
Support Intercity Rail
Improve Freight Movement
Reduce, Reuse and Recycle
Shift to Alternative Refrigerants
Disconnect Downspout
Flow Through Planter
Porous Pavement
Infiltration Planter
Rain Garden
Drywell
Vine Cover
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
NeighborSHED Dashboard
You have saved:
2,410,218 watts
54,755,259 gal water
14,589,510 lbs co2
$527,154 yearly savings
5%
16%
3%
0%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Rain Gardens
Rain gardens are shallow landscaped depressions used to infiltrate and reduce stormwater runoff. (more)
1.38 NeighborSHED Area (sq mi)
Area to Manage (sf)
0% of NeighborSHED
0 Area of Rain Garden (sq mi)
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives $0
Out of Pocket Cost $0
Save
Close
Done


NeighborSHED - Mozilla Firefox
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Most Visited
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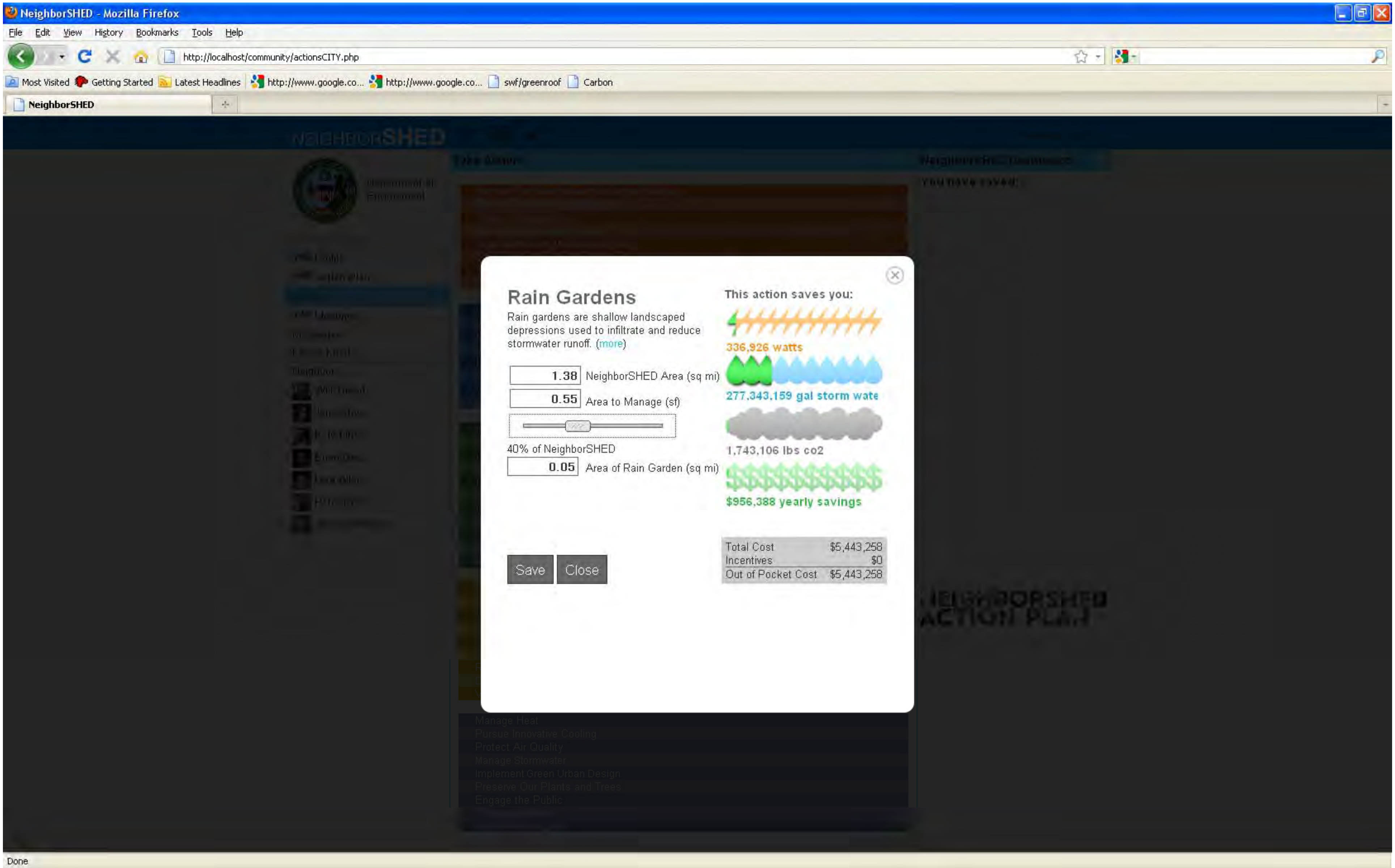
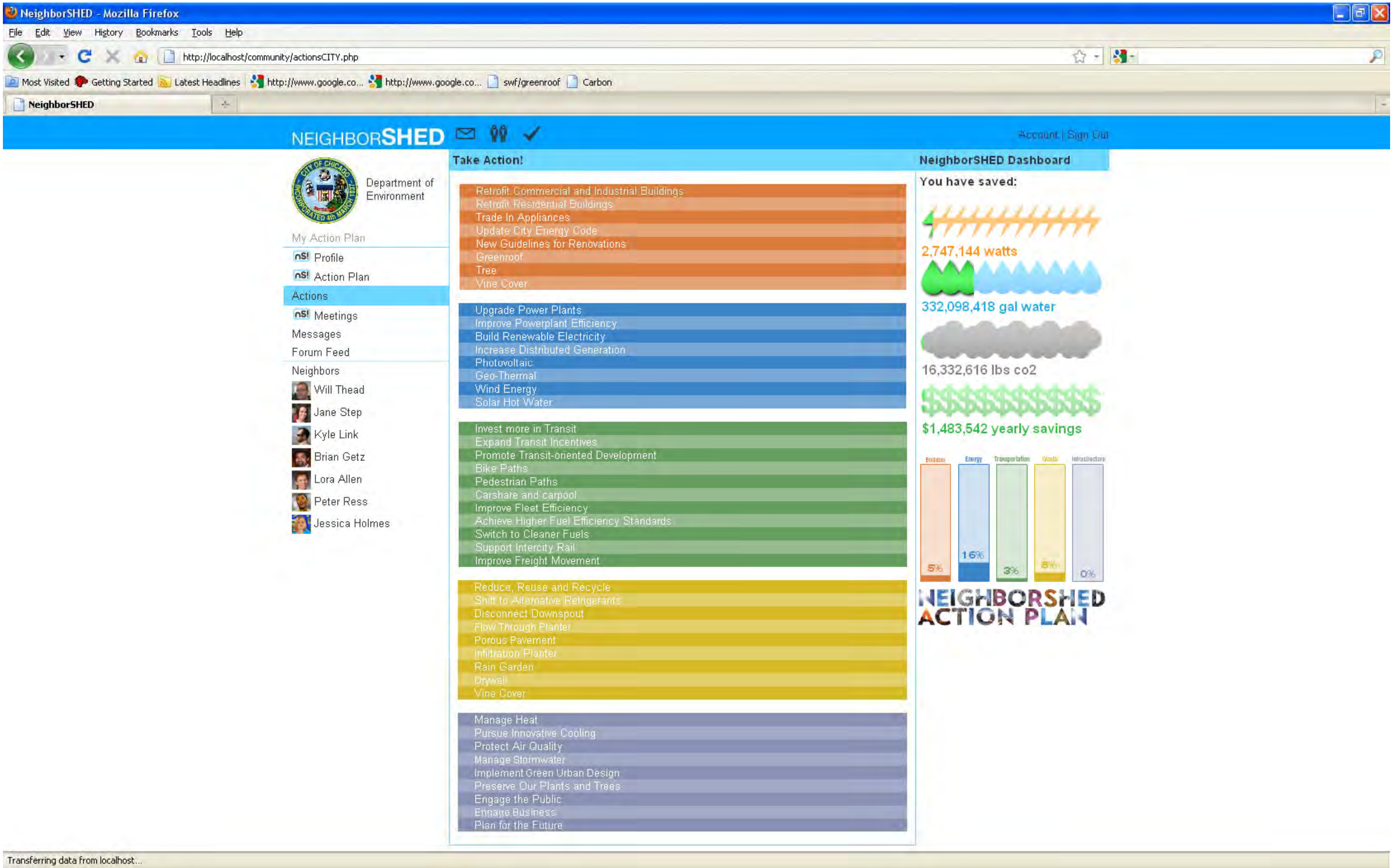
http://www.google.co...
http://www.google.co...
swf/greenroof
Carbon
NeighborSHED
Rain Gardens
Rain gardens are shallow landscaped depressions used to infiltrate and reduce stormwater runoff. Also known as vegetated infiltration basins, rain gardens rely primarily on infiltration to reduce stormwater volumes, although
Back
Close
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Rain Gardens
Rain gardens are shallow landscaped depressions used to infiltrate and reduce stormwater runoff. (more)
1.38 NeighborSHED Area (sq mi)
0.55 Area to Manage (sf)
40% of NeighborSHED
0.05 Area of Rain Garden (sq mi)
This action saves you:
336,926 watts
277,343,159 gal storm wate
1,743,106 lbs co2
$956,388 yearly savings
Total Cost $5,443,258
Incentives $0
Out of Pocket Cost $5,443,258
Save
Close
Done



NeighborSHED - Mozilla Firefox
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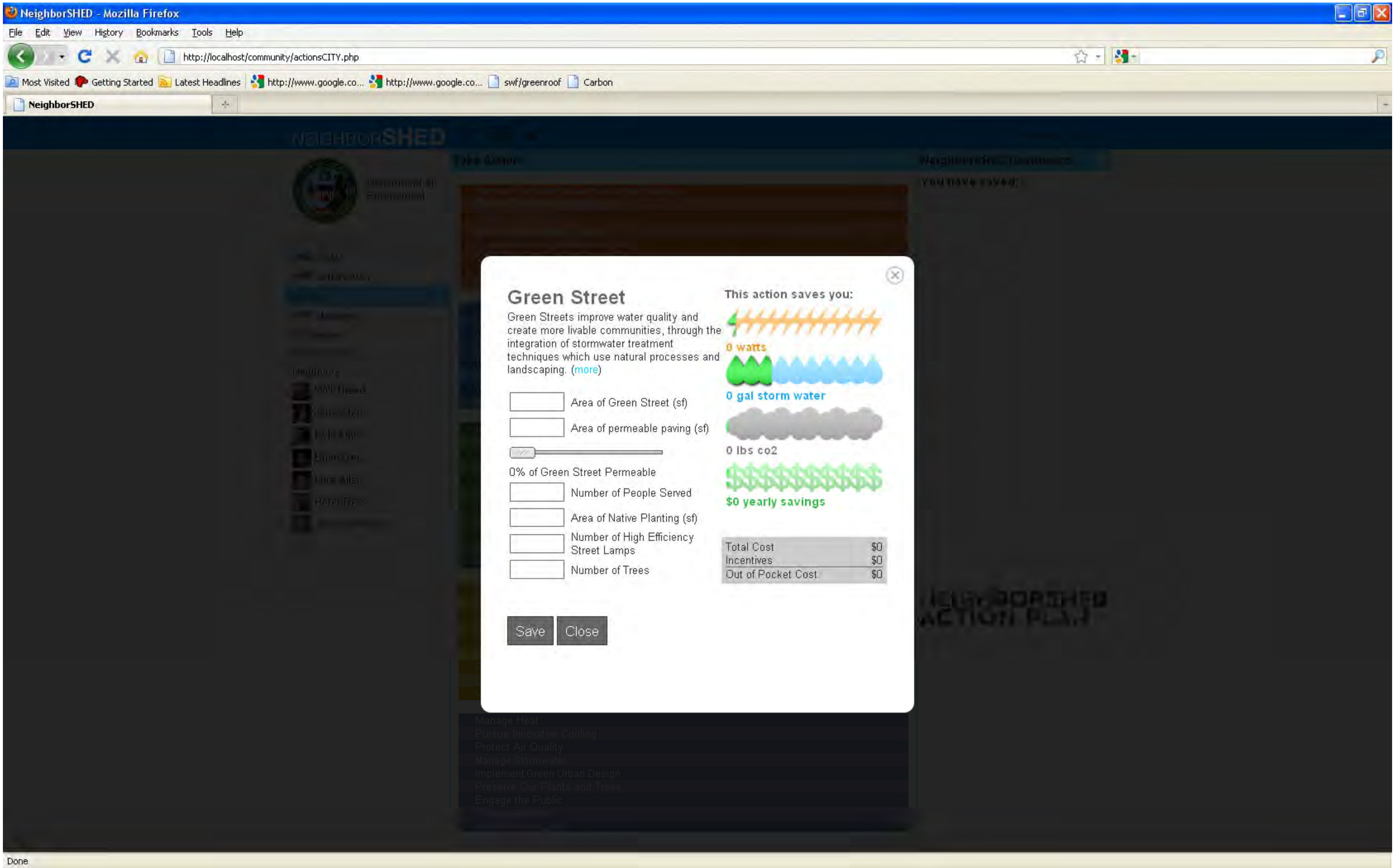
NeighborSHED
NEIGHBORSHED
Account | Sign Out
Department of Environment
My Action Plan
Profile
Action Plan
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
Take Action!
Retrofit Commercial and Industrial Buildings
Retrofit Residential Buildings
Trade In Appliances
Update City Energy Code
New Guidelines for Renovations
Greenroof
Tree
Vine Cover
Upgrade Power Plants
Improve Powerplant Efficiency
Build Renewable Electricity
Increase Distributed Generation
Photovoltaic
Geo-Thermal
Wind Energy
Solar Hot Water
Invest more in Transit
Expand Transit Incentives
Promote Transit-oriented Development
Bike Paths
Pedestrian Paths
Carshare and carpool
Improve Fleet Efficiency
Achieve Higher Fuel Efficiency Standards
Switch to Cleaner Fuels
Support Intercity Rail
Improve Freight Movement
Reduce, Reuse and Recycle
Shift to Alternative Refrigerants
Disconnect Downspout
Flow Through Planter
Porous Pavement
Infiltration Planter
Rain Garden
Drywall
Vine Cover
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
NeighborSHED Dashboard
You have saved:
2,747,144 watts
332,098,418 gal water
16,332,616 lbs co2
$1,483,542 yearly savings
Energy
Transportation
5%
16%
3%
8%
0%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...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http://localhost/community/actionsCITY.php
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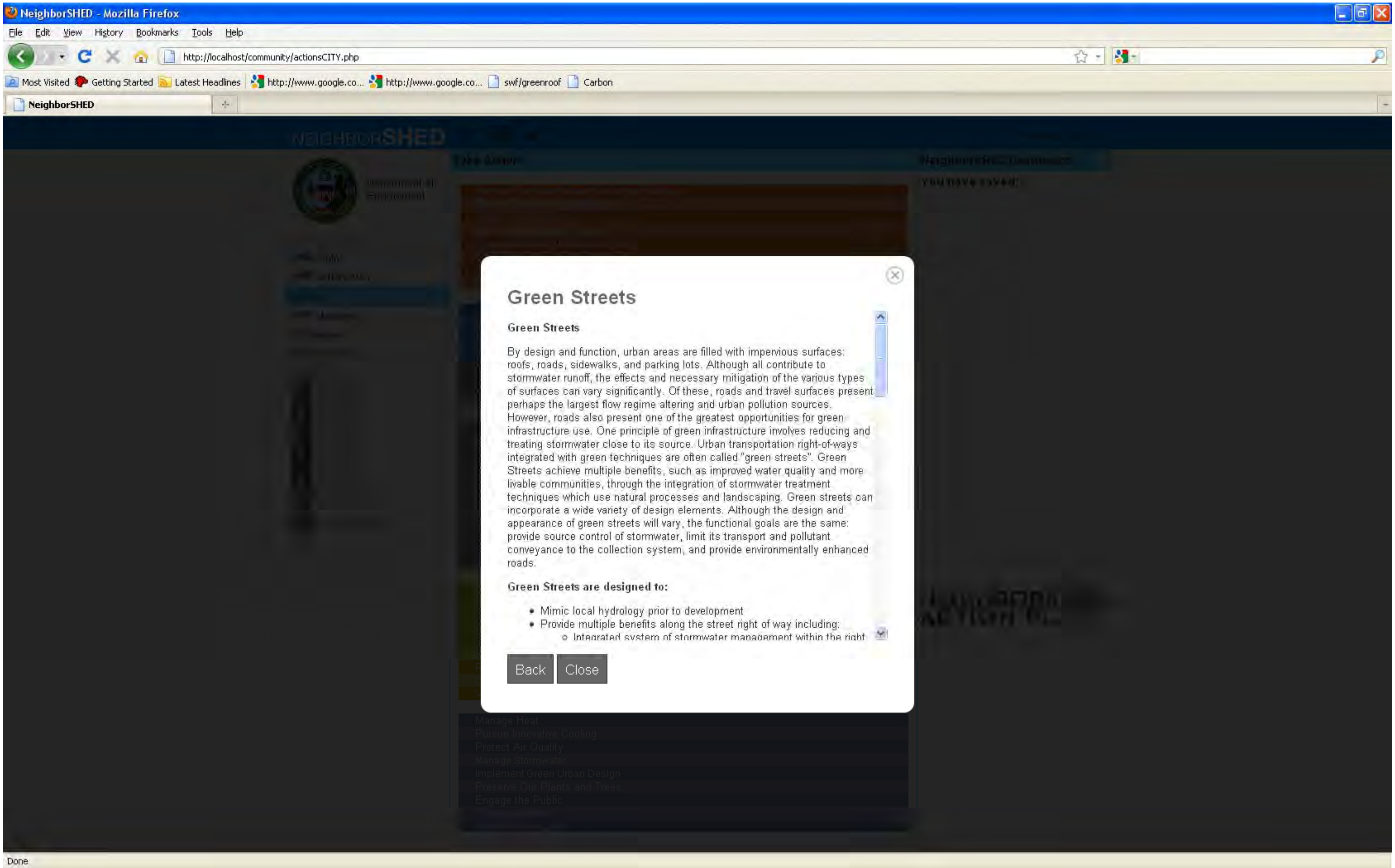
NeighborSHED
Green Street
Green Streets improve water quality and create more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping. (more)
Area of Green Street (sf)
Area of permeable paving (sf)
0% of Green Street Permeable
Number of People Served
Area of Native Planting (sf)
Number of High Efficiency Street Lamps
Number of Trees
Save
Close
This action saves you:
0 watts
0 gal storm water
0 lbs co2
$0 yearly savings
Total Cost $0
Incentives $0
Out of Pocket Cost $0
Done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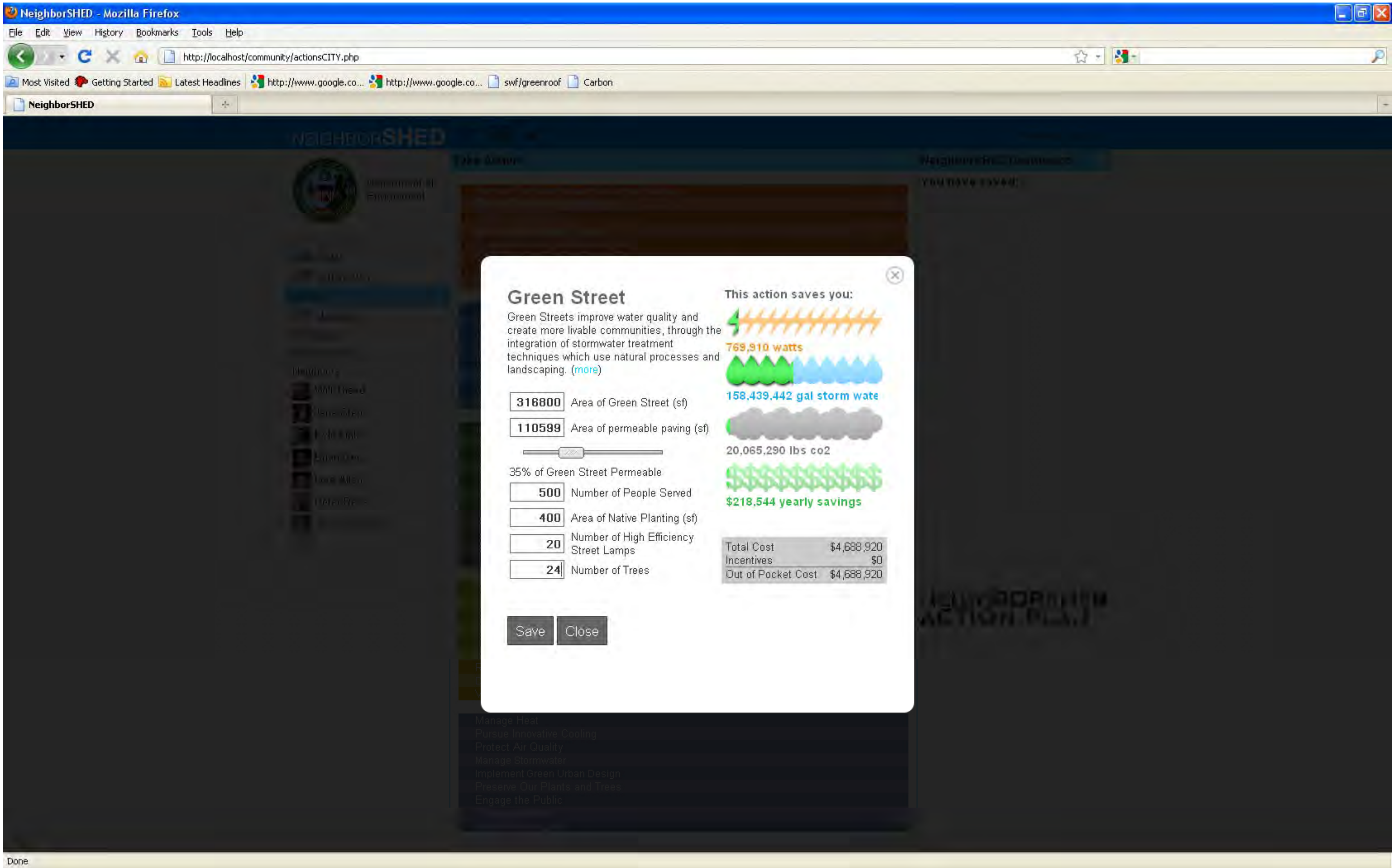
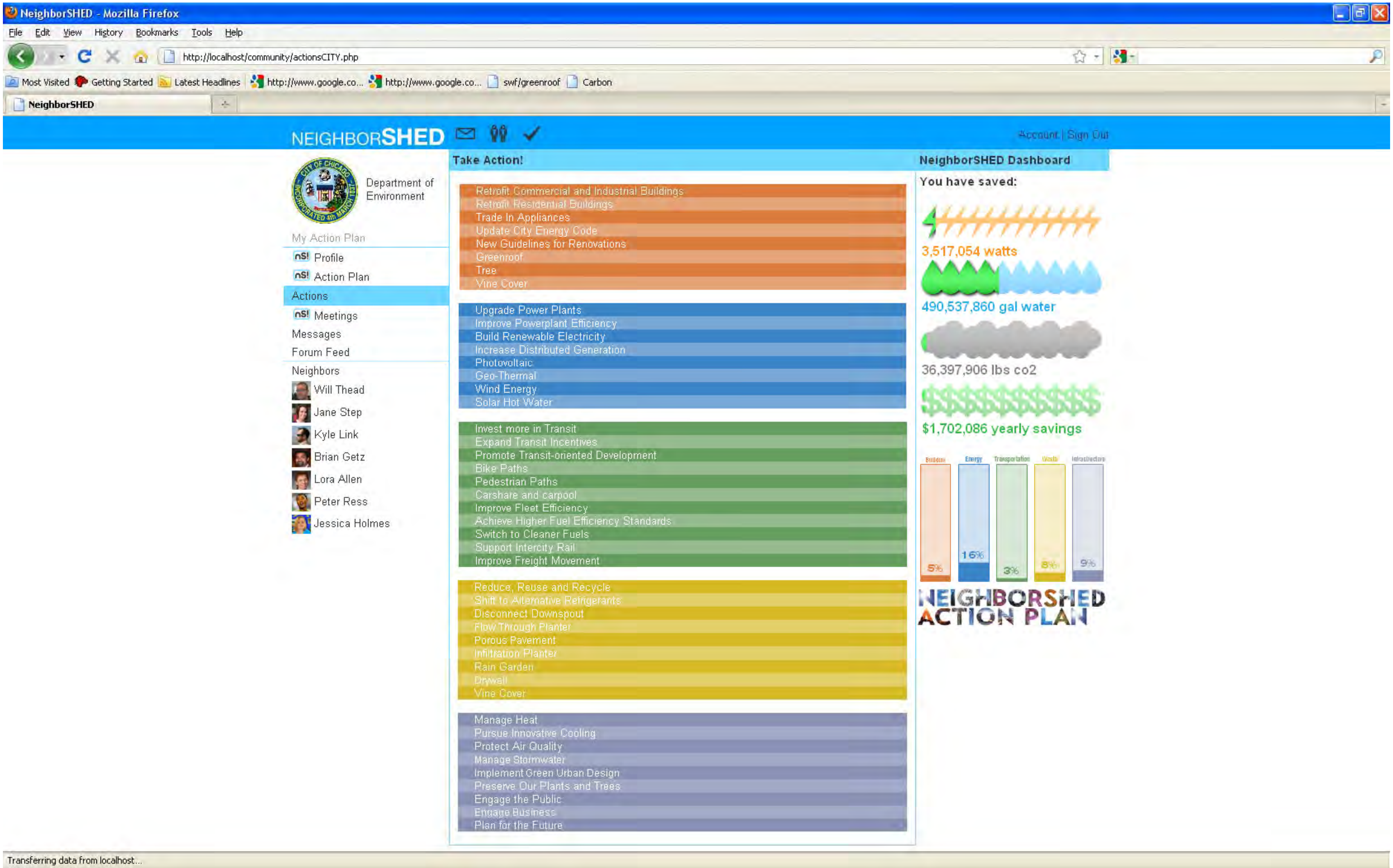
NeighborSHED
Green Streets
Green Streets
By design and function, urban areas are filled with impervious surfaces: roofs, roads, sidewalks, and parking lots. Although all contribute to stormwater runoff, the effects and necessary mitigation of the various types of surfaces can vary significantly. Of these, roads and travel surfaces present perhaps the largest flow regime altering and urban pollution sources. However, roads also present one of the greatest opportunities for green infrastructure use. One principle of green infrastructure involves reducing and treating stormwater close to its source. Urban transportation right-of-ways integrated with green techniques are often called "green streets". Green Streets achieve multiple benefits, such as improved water quality and more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping. Green streets can incorporate a wide variety of design elements. Although the design and appearance of green streets will vary, the functional goals are the same: provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, and provide environmentally enhanced roads.
Green Streets are designed to:
• Mimic local hydrology prior to development
• Provide multiple benefits along the street right of way including:
Back
Close
Done


NeighborSHED - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/community/actionsCITY.php
Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
NeighborSHED
Green Street
Green Streets improve water quality and create more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping. (more)
316800 Area of Green Street (sf)
110599 Area of permeable paving (sf)
35% of Green Street Permeable
500 Number of People Served
400 Area of Native Planting (sf)
20 Number of High Efficiency Street Lamps
24 Number of Trees
This action saves you:
769,910 watts
158,439,442 gal storm wate
20,065,290 lbs co2
$218,544 yearly savings
Total Cost $4,688,920
Incentives $0
Out of Pocket Cost $4,688,920
Save
Close
Done


NeighborSHED - Mozilla Firefox
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Most Visited Getting Started Latest Headlines http://www.google.co... http://www.google.co... swf/greenroof Carbon
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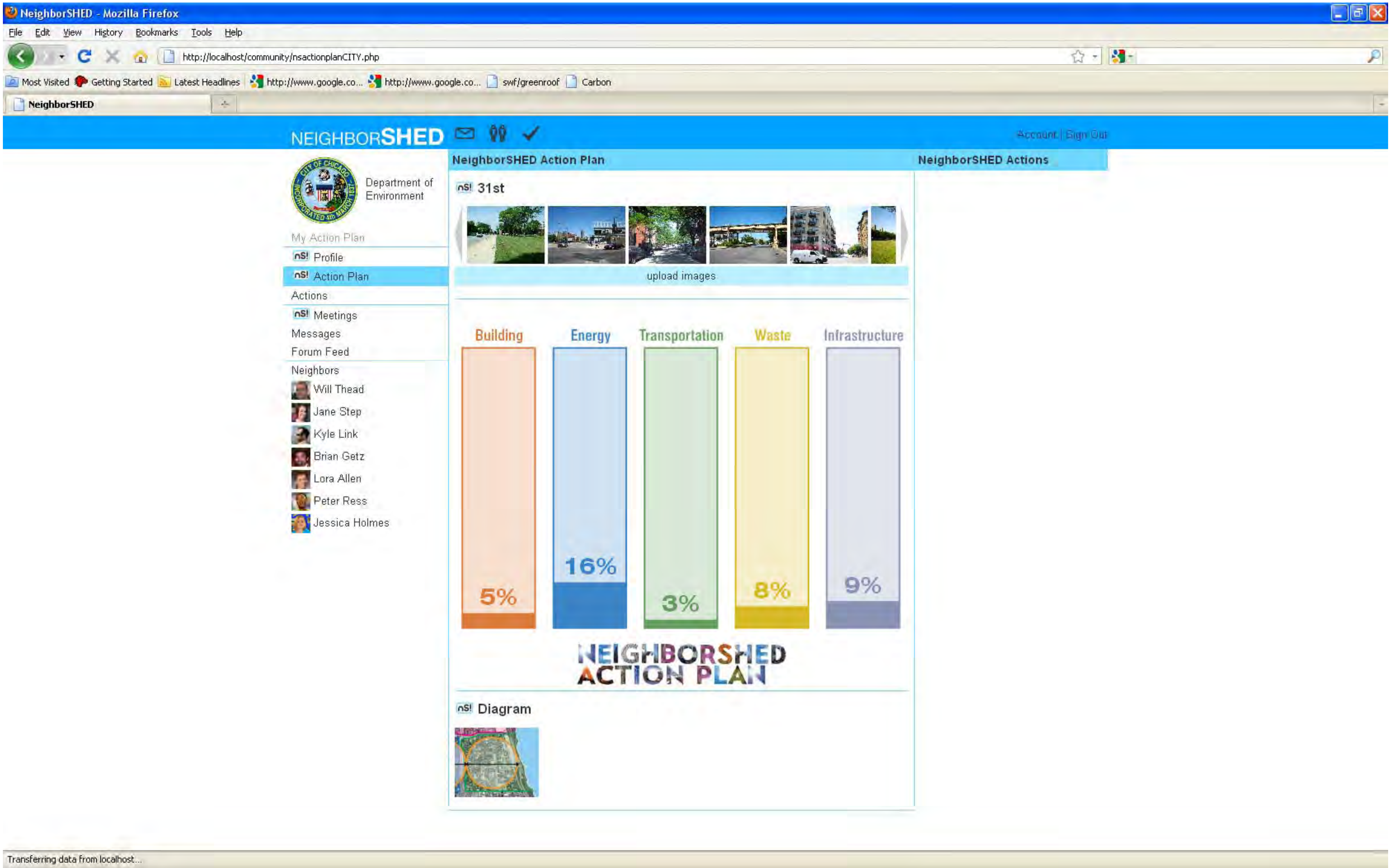
Take Action!
Retrofit Commercial and Industrial Buildings
Retrofit Residential Buildings
Trade In Appliances
Update City Energy Code
New Guidelines for Renovations
Greenroof
Tree
Vine Cover
Upgrade Power Plants
Improve Powerplant Efficiency
Build Renewable Electricity
Increase Distributed Generation
Photovoltaic
Geo-Thermal
Wind Energy
Solar Hot Water
Invest more in Transit
Expand Transit Incentives
Promote Transit-oriented Development
Bike Paths
Pedestrian Paths
Carshare and carpool
Improve Fleet Efficiency
Achieve Higher Fuel Efficiency Standards
Switch to Cleaner Fuels
Support Intercity Rail
Improve Freight Movement
Reduce, Reuse and Recycle
Shift to Alternative Refrigerants
Disconnect Downspout
Flow Through Planter
Porous Pavement
Infiltration Planter
Rain Garden
Drywall
Vine Cover
Manage Heat
Pursue Innovative Cooling
Protect Air Quality
Manage Stormwater
Implement Green Urban Design
Preserve Our Plants and Trees
Engage the Public
Engage Business
Plan for the Future
NeighborSHED Dashboard
You have saved:
3,517,054 watts
490,537,860 gal water
36,397,906 lbs co2
$1,702,086 yearly savings
Energy
Transportation
5%
16%
3%
8%
9%
NEIGHBORSHED ACTION PLAN
Transferring data from localhost...



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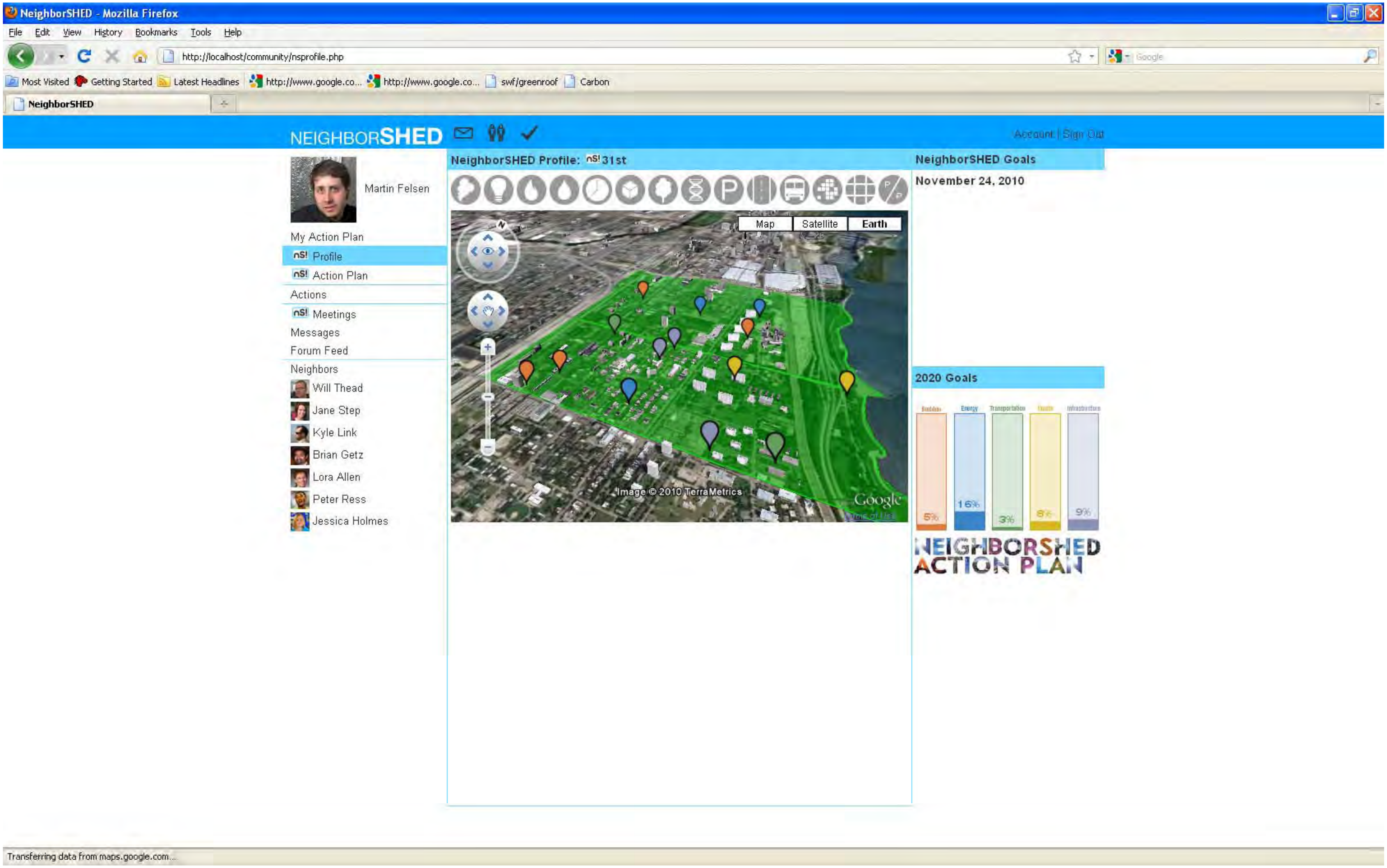
Actions
Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Action Plan
31st
upload images
Building
Energy
Transportation
Waste
Infrastructure
5%
16%
3%
8%
9%
NEIGHBORSHED ACTION PLAN
Diagram
NeighborSHED Actions
Transferring data from localhost...


NeighborSHED - Mozilla Firefox
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http://localhost/community/nsprofile.php
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NeighborSHED
NEIGHBORSHED
Account | Sign Out
Martin Felsen
My Action Plan
nS! Profile
nS! Action Plan
Actions
nS! Meetings
Messages
Forum Feed
Neighbors
Will Thead
Jane Step
Kyle Link
Brian Getz
Lora Allen
Peter Ress
Jessica Holmes
NeighborSHED Profile: nS! 31st
Map
Satellite
Earth
Image © 2010 TerraMetrics
Google
NeighborSHED Goals
November 24, 2010
2020 Goals
Energy
Transportation
5%
16%
3%
8%
9%
NEIGHBORSHED
ACTION PLAN
Transferring data from maps.google.com...

neighborSHED

# post research...

| | |
|---|---|
| 2010: | complete neighborSHED research / model |
| 2011: | apply model (as template) to City of Chicago |
| 2012: | apply model to next City, State, University |
| beyond: | more models... |

ARCHITECTURE + URBAN DESIGN
3209 S Morgan St, CHICAGO IL 60608
312.638.9100 / fax 312.604.7819
URBANLAB.COM
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## SECTION 06: **NeighborSHED Methodology: Metrics Powering Actions**

The dual and interdependent needs to (1) improve water quality and generate (and mitigate use of) energy, and (2) prioritize cost-effective infrastructure investments have brought Blue/Green Infrastructure practices to the fore. Our objective has been to compile each of these benefits into the NeighborSHED blue/green infrastructure calculator. Our research began by defining benefits that accrue with a set of common blue/green infrastructure practices: tree planting, renewable energy strategies, urban heat island effect, infiltration practices, permeable pavement, water harvesting, geothermal energy mitigation practices, green roofs, etc. Each practice suggested input units as the basis for benefit calculations, and each practice explored variables that affect the accumulation of benefits, and scales at which the benefit occurs. We explored the relationship between input units of blue/green infrastructure practice with resource units representing the value of individual benefits. Finally, we began to document how calculation of NeighborSHED benefits could be aggregated at both smaller and larger scales and between practices. The methodology for this compilation is detailed below in text format and Excel database forms that power the NeighborSHED blue/green infrastructure calculator.

# NeighborSHED Methodology

URBANLAB

# Actions

## Building

- Retrofit Residential Buildings
- Retrofit Commercial and Industrial Buildings
- Trade In Appliances
- Tree
- Greenroof
- Update City Energy Code
- New Guidelines for Renovations

## Energy

- Photovoltaic
- Geo-Thermal
- Wind Energy
- Solar Hot Water
- Upgrade Power Plants
- Improve Powerplant Efficiency
- Build Renewable Electricity
- Increase Distributed Generation

## Transportation

- Carshare and carpool
- Bike More / Walk More
- Switch to Fuel Efficient Vehicle
- Invest more in Transit
- Expand Transit Incentives
- Promote Transit-oriented Development
- Bike Paths
- Pedestrian Paths
- Improve Fleet Efficiency
- Achieve Higher Fuel Efficiency Standards
- Switch to Cleaner Fuels
- Support Intercity Rail
- Improve Freight Movement

## Waste

- Recycle
- Disconnect Downspout
- Flow Through Planter
- Porous Pavement
- Infiltration Planter
- Rain Garden
- Drywell
- Shift to Alternative Refrigerants

**Infrastructure**

- Manage Heat ✶ ✶ ✶ ✶
- Implement Green Urban Design ✶ ✶ ✶ ✶

## Retrofit Residential Buildings

Investments in building efficiency retrofits can simultaneously address the challenges of economic recovery, energy insecurity, and global warming by laying the foundation for sustained economic growth, driving demand in the construction and manufacturing sectors, and creating hundreds of thousands of good jobs across the country. Retrofitting our homes and businesses will also slash consumer energy expenditures, increase real estate values, and provide low-cost, near-term reductions in global warming pollution.[2]

### Applicability

Today, buildings account for 70 percent of all U.S. electricity consumption and 40 percent of total U.S. greenhouse gas emissions. Yet much of our housing and building stock is old, inefficient, and unnecessarily wasteful. While building codes and green building standards offer a tool for achieving deep improvements in energy use for new buildings, half of the buildings that will be standing in 30 years already dot our landscape. Any strategy to capture the benefits of energy efficiency in our "built environment" must include a program to retrofit our existing stock of residential, commercial and industrial structures.[2]

### Benefits

Deep building retrofits can cut energy use by 20 to 40 percent with proven techniques and off-the-shelf technologies. Best of all, they can pay for themselves from the energy they save. "Rebuilding America," a national program to cut energy waste in buildings, could reduce energy bills economy-wide by hundreds of billions of dollars annually. Energy efficiency retrofits also create good local construction jobs across the country at a time when well over a million construction workers sit idle in a sagging housing market. Demand for the manufactured products needed to retrofit buildings will also result in jobs by revitalizing the manufacturing sector and contributing to sustainable, long-term economic growth.[2]

### Maintenance Considerations

If building retrofits can be profitable and offer so many additional social and economic benefits, why has a large-scale market not yet materialized? The short answer is that the market for energy efficiency faces many information failures and real market barriers. Without specific public policies to encourage widespread private investments in energy efficiency, the great value of this market will be left unclaimed. The U.S. economy will be worse off for this failure to act. So too will our planet.[2]

### Cost Considerations

The failures evident in the lack of a thriving nationwide marketplace for energy efficiency products and services include:

- Poor availability of information for consumers about their energy consumption.
- Split incentives between building owners and tenants to invest in energy efficiency retrofits.
- Lack of capital or access to capital to support investments in energy efficiency.
- Limited tenancy or ownership structures that encourage short-term decision making and do not take into account the benefits of energy efficiency.
- Perceived costs of retrofits, and a lack of knowledge about available solutions.
- General risk aversion by consumers, especially when loans are tied to their personal credit instead of conveying with property.

- Disaggregated energy efficiency markets where many small decisions about purchasing, materials, operations, and maintenance are required in order to realize savings.
- High up-front borrowing costs for retrofits.
- The risk of creditor default in a real estate finance market that today is severely constrained.[2]

$$n\ (\text{Houses}) \times \frac{300\ (\$)}{1\ (\text{House})} = \text{Cost of Weatherization}$$

$$n\ (\text{R value})n \times \frac{20\ (\$)}{1\ (\text{R Value})} \times \quad (\text{Houses}) = \text{Cost of Insulation}$$

$$n\ (\text{Heating systems}) \times \frac{350\ (\$)}{1\ (\text{Heating systems})} = \text{Cost of Upgrading Heating System}$$

$$n\ (\text{Cooling systems}) \times \frac{225\ (\$)}{1\ (\text{Cooling systems})} = \text{Cost of Upgrading Cooling System}$$

$$n\ (\text{Faucets}) \times \frac{45\ (\$)}{1\ (\text{Faucets})} = \text{Cost of Water Efficient Faucets}$$

$$n\ (\text{Bulbs}) \times \frac{3\ (\$)}{1\ (\text{Bulbs})} = \text{Cost of Energy Efficient Bulbs}$$

Cost of Weatherization + Cost of Insulation + Cost of Upgraded Heating System
+ Cost of Upgraded Cooling System + Cost of Water Efficient Faucets + Cost of Energy Efficient Bulbs = Cost of Retrofit

$$n\ (\text{Faucets}) \times \frac{19931\ (\text{gal})}{1\ (\text{Faucets})} = \text{Gallons of Water Saved}$$

$$n\ (\text{Houses}) \times \frac{502\ (\text{watts})}{1\ (\text{House})} = \text{Watts Saved from Weatherization}$$

$$n\ (\text{Houses}) \times \frac{502\ (\text{watts})}{1\ (\text{House})} = \text{Watts Saved from Insulation}$$

$$n\ (\text{Heating systems}) \times \frac{160\ (\text{watts})}{1\ (\text{Heating systems})} = \text{Watts Saved from Heating System Upgrade}$$

$$n\ (\text{Cooling systems}) \times \frac{68\ (\text{watts})}{1\ (\text{Cooling systems})} = \text{Watts Saved from Cooling System Upgrade}$$

$$n\ (\text{Bulbs}) \times \frac{43\ (\text{watts})}{1\ (\text{Bulbs})} = \text{Watts Saved from Energy Efficient Bulbs}$$

Watts from Weatherization + Watts from Insulation + Watts from Upgraded Heating System
+ Watts from Upgraded Cooling System + Watts from Energy Efficient Bulbs = Watts Saved from Retrofit

$$n\ (\text{Houses}) \times \frac{1795\ (\text{lbs})}{1\ (\text{House})} = \text{lbs of CO2 saved from Weatherization}$$

$$n\ (\text{R value})n \times \frac{20\ (\text{lbs})}{1\ (\text{R Value})} \times (\text{Houses}) = \text{lbs of CO2 saved from Insulation}$$

$$n\ (\text{Heating systems}) \times \frac{574\ (\text{lbs})}{1\ (\text{Heating systems})} = \text{lbs of CO2 Saved from Upgraded Heating System}$$

$$n\ (\text{Cooling systems}) \times \frac{698\ (\text{lbs})}{1\ (\text{Cooling systems})} = \text{lbs of CO2 Saved from Upgraded Cooling System}$$

$$n\ (\text{Faucets}) \times \frac{20\ (\text{lbs})}{1\ (\text{Faucets})} = \text{lbs of CO2 Saved from Efficient Faucets}$$

$$n\ (\text{Bulbs}) \times \frac{323\ (\text{lbs})}{1\ (\text{Bulbs})} = \text{lbs of CO2 Saved from Efficient Bulbs}$$

CO2 from Weatherization + CO2 from Insulation + CO2 from Upgraded Heating System + CO2 from Upgraded Cooling System + CO2 from Energy Efficient Bulbs + CO2 from Water Efficient Faucets = CO2 Saved from Retrofit

$$n\ (\text{Houses}) \times \frac{12.50\ (\$)}{1\ (\text{Month})} \times \frac{12\ (\text{Month})}{1\ (\text{Year})} = \text{Money Saved from Weatherization}$$

$$n\ (\text{R value})n \times \frac{0.50\ (\$)}{1\ (\text{Month})} \times \frac{12\ (\text{Month})}{1\ (\text{Year})} \times (\text{Houses}) = \text{Moeny saved from Insulation}$$

$$n\ (\text{Heating systems}) \times \frac{32\ (\$)}{1\ (\text{Heating systems})} = \text{Money Saved from Upgraded Heating System}$$

$$n\ (\text{Cooling systems}) \times \frac{95\ (\$)}{1\ (\text{Cooling systems})} = \text{Money Saved from Upgraded Cooling System}$$

Money Saved from Weatherization + Money Saved from Insulation + Money Saved from Upgraded Heating System + Money Saved from Upgraded Cooling System = Money Saved from Retrofit

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## Retrofit Commercial and Industrial Buildings

Energy retrofits in commercial and industrial buildings could result in savings of 1.3 MMT CO2e in 2020. Commercial and industrial energy efficiency programs are proven to be cost effective. These programs can achieve an average of 30 percent savings by retrofitting buildings using existing technologies. The retrofits address building envelopes, heating, cooling, hot water, lighting systems, and plug load. Technologies and strategies used include lighting retrofits, passive day-lighting, re-commissioning of buildings, super insulation, energy efficient windows, high efficiency boilers and furnaces, heat recovery systems, energy management systems, solar or tankless hot water systems, and high efficiency equipment to reduce plug load. Effective programs combine technical and financial assistance to help property owners make the best choices to achieve the highest savings and return on their investments. Large commercial and industrial customers may have energy managers on staff who are able to manage consumption and electricity and gas purchase contracts.[5]

### Applicability

Chicago's large and economically important commercial sector resides in more than 22,000 buildings varying in size from skyscrapers to corner grocery stores. The sector includes service businesses (e.g., retail stores, hotels, and restaurants), hospitals and health care providers, public and private schools, correctional institutions, museums, and religious organizations. Municipal buildings are also included in the commercial sector. The industrial and manufacturing sector, housed in more than 700 buildings, includes a variety of businesses including metal working, electronics manufacturing, construction and food processing. When looking at the combined energy consumption of the commercial and industrial sectors, commercial buildings account for 90 percent of electricity and 50 percent of natural gas consumption. This is, in part, because the commercial sector is so large and because many downtown office buildings are heated using electricity. Industrial users have a higher proportion of natural gas consumption related to industrial processes. The number of commercial buildings and the amount of commercial square footage in Chicago increased from 1979 to 1992, while total energy consumption remained flat, reflecting increased efficiency of newly constructed buildings. The number and energy consumption of industrial buildings has decreased as this sector has declined over the same period.[5]

### Benefits

Energy consumption and emissions can realistically be reduced by 30 percent on average in existing commercial buildings if comprehensive energy retrofits are implemented and equipment is maintained. According to the 2000 tax assessor database, there are 22,448 commercial buildings and 734 industrial buildings currently in Chicago. Of these, 80 percent—assuming the same rate of demolition and substantial renovation that has been observed in the residential sector—or 18,000 will be standing in 2020. The industrial sector is shrinking at an annual rate of 3 percent according to the U.S. Census, therefore it is assumed that the rate of decrease in industrial buildings will also be 3 percent, resulting in 425 industrial buildings in 2020.[5]

Energy efficiency programs reduce operating costs by as much as 30 percent, providing substantial benefits for the owners of commercial buildings. Energy efficiency programs also have a positive impact on individual buildings. The Building Owners and Managers Association (BOMA) states that commercial office managers in Chicago compete for long-term lease agreements by offering competitive rents and cite the importance of reducing operating costs through energy efficiency improvements. Additionally, tenants are often seeking "greener office space" to improve employee comfort and meet company goals.[5]

## Cost Considerations

The typical cost of retrofits for commercial and industrial buildings varies greatly depending on the building type and use. Costs for individual energy conservation measures are discussed below under the Program Elements section. The average cost ranges from $25 to $75 per square foot. The return on investment (ROI) for energy retrofits in this sector ranges from 25% to 40%.[5]

Energy efficiency retrofits in the commercial and industrial sectors are typically funded through energy performance contracts. Energy performance contracts use venture capital to fund the initial capital costs associated with energy retrofits and are repaid through the energy savings. There are also programs for specific building types including an Illinois Department of Commerce and Economic Opportunity (ILDCEO) program for small business and grant funding for non-profits.[5]

The financial costs may be high for performing comprehensive energy retrofits in the commercial and industrial building stock, but the savings opportunities are large and examples from other states show that payback is possible.[5]

Energy consumption in existing commercial and industrial buildings can be reduced significantly by providing incentives to large customers and technical and financial assistance to small customers. The Clinton Climate Initiative has announced a landmark program to reduce energy consumption in buildings using the energy performance contracting model. Chicago could make great strides by implementing this program on a large scale with the private building sector.[5]

## Initiatives and Models

One of the current programs available to the commercial and industrial sector in Chicago is the Small Business $mart Energy (SB$E) program which provides energy efficiency technical services for small to medium-sized for-profit businesses. Financial assistance is not provided as part of this program. Another voluntary effort to improve energy efficiency among Chicago businesses is the Midwest Energy Efficiency Association's Building Operator Certification (BOC) training program, a competency-based training and certification program for operations and maintenance staff working in institutional, commercial and industrial buildings. BOC achieves measurable energy savings by training individuals who are directly responsible for day-to-day building operations.[5]

## Trade In Appliances

Modern energy-efficient appliances, such as refrigerators, freezers, ovens, stoves, dishwashers, and clothes washers and dryers, use significantly less energy than older appliances. Current energy efficient refrigerators, for example, use 40 percent less energy than conventional models did in 2001.[3]

### Applicability

According to a 2009 study from McKinsey & Company the replacement of old appliances is one of the most efficient global measures to reduce emissions of greenhouse gases. Modern power management systems also reduce energy usage by idle appliances by turning them off or putting them into a low-energy mode after a certain time. Many countries identify energy-efficient appliances using energy input labeling.[3]

### Benefits

If all households in Europe changed their more than ten year old appliances into new ones, 20 billion kWh of electricity would be saved annually, hence reducing CO2 emissions by almost 18 billion kg. In the US, the corresponding figures would be 17 billion kWh of electricity and 27,000,000,000 lb (1.2×1010 kg) CO2.[3]

Energy consumption and emissions can be reduced by replacing old room air conditioners and refrigerators via an aggressive trade-in program and by replacing four million incandescent light bulbs with CFLs. 0.284MMT CO2e can be saved through the actions described in Figure 2. With approximately one million households in Chicago, the appliance programs would reach roughly 10 to 20% of households.[5]

### Timeline

Trade-in and rebate programs can be developed and implemented on a fairly short timeline: six months to a year. The earlier programs start, the earlier consumers will start seeing the financial savings coming from these energy efficiency measures.[5]

### Cost Considerations

Funding is necessary to support trade-in programs. As the State of Illinois determines the structure and level of funding for future energy efficiency programs, the City of Chicago could actively advocate for the creation of robust programs to make energy efficiency a part of the culture of Illinois, much as it is in states that have led on this issue. For example, SB1184 (Harmon) that is currently in the Illinois General Assembly creates a funding mechanism for energy efficiency programs and specifically sets aside 10 percent of funding for programs run by municipalities.[5]

Effective appliance trade-in programs cost, including program administration and recycling, in the range of \$100 to \$200 for each refrigerator and just over \$100 for each room air conditioner. A new Energy Star rated refrigerator can cost \$400 or more today depending on the size. An Energy Star rated room air conditioner can cost \$150 or more today. Replacing a 10 year old refrigerator can save \$40 annually and each room air conditioner \$25 annually.[5]

**Technical Considerations**

Appliance and light bulb replacement programs are the bread and butter of energy efficiency programs throughout the nation and have a long track record of success. Key partners include utilities, appliance manufacturers, retailers and local energy efficiency organizations; these groups work together to make such strategies very feasible.[5]

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| Room Air Conditioner | AC | # of Units Traded |
| Refrigerator | ref | # of Units Traded |
| Light Bulb | lbulb | # of Units Traded |

$$\text{Appliances (AC)} \times \frac{150\ (\$)}{1\ (\text{AC})} = \text{Cost of Trade In}$$

$$\text{Appliances (AC)} \times \frac{221\ (\text{kWh})}{1\ (\text{AC})} \times \frac{1000\ (\text{W})}{1\ (\text{kWh})} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\times \frac{221\ (\text{kWh})}{1\ (\text{AC})} \times \frac{0.158\ (\$)}{1\ (\text{kWh})} = \text{Money Saved}$$

$$\text{Appliances (AC)} \times \frac{298\ (\text{lbs})}{1\ (\text{AC})} = \text{lbs CO2 Saved}$$

$$\text{Appliances (ref)} \times \frac{400\ (\$)}{1\ (\text{ref})} = \text{Cost of Trade In}$$

$$\text{Appliances (ref)} \times \frac{500\ (\text{kWh})}{1\ (\text{ref})} \times \frac{1000\ (\text{W})}{1\ (\text{kWh})} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{Appliances (ref)} \times \frac{500\ (\text{kWh})}{1\ (\text{ref})} \times \frac{0.158\ (\$)}{1\ (\text{kWh})} = \text{Money Saved}$$

$$\text{Appliances (ref)} \times \frac{670\ (\text{lbs})}{1\ (\text{ref})} = \text{lbs CO2 Saved}$$

$$\text{Appliances (lbulb)} \times \frac{2\ (\$)}{1\ (\text{ref})} = \text{Cost of Trade In}$$

$$\text{Appliances (lbulb)} \times \frac{93\ (\text{kWh})}{1\ (\text{lbulb})} \times \frac{1000\ (\text{W})}{1\ (\text{kWh})} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{Appliances (lbulb)} \times \frac{93\ (\text{kWh})}{1\ (\text{lbulb})} \times \frac{0.158\ (\$)}{1\ (\text{kWh})} = \text{Money Saved}$$

$$\text{Appliances (lbulb)} \times \frac{126\ (\text{lbs})}{1\ (\text{lbulb})} = \text{lbs CO2 Saved}$$

Cost (AC) + Cost (ref) + Cost (lbulb) = Total Cost of Trade In

Watts Saved (AC) + Watts Saved (ref) + Watts Saved (lbulb) = Total Watts Saved

lbs CO2 Saved (AC) + lbs CO2 Saved (ref) + lbs CO2 Saved (lbulb) = Total lbs CO2 Saved

Money Saved (AC) + Money Saved (ref) + Money Saved (lbulb) = Money Saved

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## Tree

Trees provide many ecosystem services such as an important role in producing oxygen and reducing carbon dioxide in the atmosphere, as well as moderating ground temperatures. They are also elements in landscaping and agriculture, both for their aesthetic appeal, their food producing ability and habitat structure.[9]

### Applicability

Through the direct interception of rainfall and by increasing the ability of soil to store water, trees provide significant stormwater retention benefits. Many studies attempt to begin measuring these benefits by considering the gallons of rainfall intercepted, and assuming a reduction in conventional treatment costs. As the volume of water intercepted is clearly a function of the size of the tree, or the area of canopy cover, both per tree measures based on tree size and percent canopy cover methods have been utilized. On a per tree basis, estimates range from 292 gallons intercepted annually (40-year average) by a small tree (21 ft. spread) to 2,162 gallons intercepted annually by a large tree (37 ft. spread).[9]

### Benefits

Through the cooling impacts provided by evapotranspiration and shade, trees reduce the need for air conditioning in buildings, thus reducing building energy consumption. By reducing wind speeds and the infiltration of outside air into buildings and homes, as well as reducing heat transfer, trees can also have a significant impact on energy needs for heating. Reduced energy consumption leads to direct costs savings for building owners as well as in reduced emissions from power plants and from burning natural gas.[9]

Through reduced energy consumption and through direct sequestration, trees contribute to an overall reduction in atmospheric carbon dioxide levels. To estimate the value of reductions in atmospheric CO2, it is necessary to calculate both the pounds sequestered as well as the pounds avoided from reduced energy consumption per tree. Studies estimate annual net reductions (40-year average) in CO2 to range from 226 pounds avoided and sequestered to 911 pounds from a large tree opposite a west-facing residential wall. Trees also increase recreational opportunities and local property values. These benefits are discussed in further detail below, in the section on the economic valuation of the benefits of green infrastructure.[9]

### Permits

Most trees require a City permit. Check with your City for specific permit requirements.

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Number of Trees | tree | Tree |
| Cost of Tree | cost | Dollar |
| Stormwater Sequestered | stWater | Gallon |

$$\text{tree (tree)} \times \frac{\text{cost (\$)}}{\text{(tree)}} = \text{Total Cost of Trees}$$

$$\text{tree (tree)} \times \frac{\text{savings (\$)}}{\text{(tree)}} = \text{Money Saved}$$

$$\text{tree (tree)} \times \frac{\text{carbon (lbs)}}{\text{(tree)}} = \text{CO2 Saved}$$

$$\text{tree (tree)} \times \frac{\text{stWater (gal)}}{\text{(tree)}} = \text{Stormwater Sequestered}$$

$$\text{stWater (tree)} \times \frac{\text{0.0012 (kWh)}}{\text{(tree)}} \times \frac{\text{12 (mon)}}{\text{1 (yr)}} \times \frac{\text{1000 watts}}{\text{1 (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

## Greenroof

A greenroof is a lightweight layer of vegetation and soil installed on building rooftops. The shallow growing medium of greenroof intercepts rainwater and evapotranspirates a portion of it, particularly in the summer months. Rainwater not evapotranspirated is slowed, filtered, and cooled through its movement through the soil layer. In addition to reducing the amount of stormwater generated from a roof, greenroof also reduce urban heat island, provide habitat and amenity value, improve roof longevity and reduced heating and cooling costs. Simple greenroof consist of a waterproof membrane, drainage material, a lightweight layer of soil and a cover of plants. They can be two to six inches deep. A variety of plants are available for greenroof plantings, such as sedums, succulents and hardy perennials. The rooftop growing environment requires plant species to be drought-tolerant and able to grow in shallow soils.[8]

### Applicability

Greenroofs are appropriate for all building types - residential, commercial, industrial and institutional - and are applicable both to new and existing buildings depending of roof type and load-bearing capacity of the building. Some considerations for implementing Greenroofs include the growing medium, plant selection, waterproofing and drainage systems.[8]

### Benefits

Greenroofs produce both stormwater quantity and quality benefits by reducing stormwater flows and filtering pollutants. They also filter air pollutants and reduce outdoor air temperatures that contribute to the urban heat island effect. They provide habitat and biodiversity and provide an attractive amenity for the building and for buildings with views to the greenroof.  In insulation provided by greenroofs also lowers building heating and cooling costs.  Greenroofs are more durable than conventional roofs delaying the need to costly roof replacement by twenty years or longer.[8]

### Maintenance Considerations

Once a greenroof is well established, maintenance requirements are usually minimal. This may include some summer watering, weeding and mulching. During the first few years when the vegetation systems are establishing, some additional watering may be required. Inspection of the roof membrane and drainage flow paths should be performed on a regular basis. If grasses or other annual plants are included, then cutting and removing dry vegetation is recommended to avoid the accumulation of combustible material.[8]

### Cost Considerations

A greenroof initially costs more than a conventional roof but typically lasts twice as long (about 40 years). The construction costs for a new greenroof tend to range from $10 to $15 per square foot. Re-roofing costs are higher, ranging from $15- $25 per square foot. A vegetated roof, on average, can be expected to prolong the life of a conventional roof by at least 20 years because the vegetation prevents the roof from being exposed to ultraviolet radiation and cold winds. The building owner can also realize cost savings from lower heating and cooling costs.  Since the greenroof industry is relatively new to the United States, greenroof construction costs may decrease as the industry develops.[8]

### Safety and Siting Requirements

- Consult a professional for designing and building a greenroof
- Greenroofs can be on flat roofs or pitched structures up to a slope of 25%
- Roof strength must be adequate to hold the additional weight of the greenroof
- Overflow structures – such as drains or downspouts - must also be incorporated into an greenroof[8]

### Permits

Local building codes may require a permit to construct an greenroof. Please contact your local building department for requirements. Also, proper greenroof design may require a structural engineer and landscape designer.[8]

### Variables for Calculation

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Greenroof Area | grArea | Square Feet |
| Greenroof Depth | grDepth | Inch |
| Cost per Area | costsf | Dollar |
| Particulate Matter Removed | lbspm | Pound |
| Runoff Coefficient | runco | Numerical Value |
| Stormwater Saved | stWater | Gallon |

$$\text{grArea (sf)} \times \text{grDepth (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} = \text{volume of Green Roof}$$

$$\text{grArea (sf)} \times \text{annualRain (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} = \text{volume of water landing on Green Roof}$$

$$\text{grArea (sf)} \times \text{annualRain (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} \times (1 - \text{runco } (.5)) \times \frac{7.4805\text{ (gal)}}{\text{(ft3)}} = \text{volume of water Sequestered}$$

$$\text{grArea (sf)} \times \text{costsf (\$)} = \text{cost of Greenroof}$$

$$\text{grArea (sf)} \times \frac{.359339\text{ lbs}}{\text{(sf)}} = \text{lbs of CO2 saved}$$

$$\text{grArea (sf)} \times \frac{.189853076216712\text{ kWh}}{\text{(sf)}} \times \frac{1000\text{ watts}}{1\text{ kWh}} \times \frac{300}{2592000} = \text{watts saved}$$

$$\text{kWhsaved} \times \frac{.0.158\text{ (\$)}}{\text{(kWh)}} + \text{stWater (gal)} \times \frac{.0.00021\text{ (\$)}}{\text{(gal)}} = \text{moneysaved}$$

## Update City Energy Code

Updating the City of Chicago's energy code to include more stringent conservation guidelines and requiring compliance at the point of sale of property could result in CO2e savings of 1.13 MMT CO2e in 2020.[6]

Building codes develop minimum standards for the structural and mechanical safety of buildings and their systems, developed to protect public health and sanitation. Energy codes have been added to basic building guidelines to make buildings more energy efficient. The implementation of energy codes can reduce energy use from 15% to 30%. In a local study assessing the impacts of adopting the International Energy Conservation Code (IECC), it was found that residential buildings in compliance with IECC have annual savings of 25%. Chicago adopted its own energy code—the Chicago Energy Conservation Code, modeled after the International Code Council's (ICC) 2001 IECC—in 2003. Full enforcement of the current energy code, and any subsequent revisions, is important for realizing the full GHG reduction potential of this mitigation strategy.[6]

### Applicability

One of the new opportunities identified in this mitigation strategy is taking advantage of the typical cycle of a building turnover by requiring energy code compliance at the "sale" stage. Donald Shoup (AICP) found in a 1996 study that about half of all owner-occupied housing units in the U.S. were sold at least once within ten years. This presents a dependable cycle of turnover at 5 percent per year on which to structure enforcement, regulation and/or incentives, such as energy code compliance.[6]

### Benefits

The most significant benefit of this mitigation strategy is lowered household energy costs. Additionally, there are economic benefits to the local economy associated with on-going investment in the housing stock, including job creation among the building trades.[6]

The GHG reduction potential assumes that energy code compliance is required at the point of sale for residential housing in the City of Chicago, estimating conservatively that 5 percent of housing units are sold annually for a total of 421,000 units between 2010 and 2020. These units would be retrofitted as needed to meet energy code requirements. A 25% energy savings, and corresponding GHG reduction, is anticipated from these retrofits.[6]

### Cost Considerations

Assuming that funds can be identified to assist low to moderate income home owners, this program is financially feasible. Property owners often invest in buildings prior to sale in order to increase the sale price, so this mitigation property harnesses an existing trend. This program would ensure that investment is targeted to energy saving improvements in addition to cosmetic improvements that are typically made. Any higher purchase price that results from this provision should be mitigated by reduced energy costs.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Number of Units per Year | newUnits | Units/Year |
| Percent of Non-Compliance | nonComp | Percent |
| Cost per Area | costsf | Dollar |

$$6500\ \text{(Units/Year)} \times \text{nonComp}\ (\%) \times \frac{0.00225\ \text{(MMTCO2)}}{1\ (\%)} = \text{MMTCO2 Reduction Loss}$$

1.13 MMTCO2 Estimated CO2 Reduction - MMTCO2 Reduction Loss = Total MMTCO2 Reduction

## New Guidelines for Renovations

A growing number of local governments are adopting Leadership in Energy and Environmental Design (LEED) standards as a way to achieve high performance buildings. LEED is a voluntary rating system issued by the U.S. Green Building Council (USGBC)1. LEED works best in new construction and major renovation projects where integrated building design provides ample opportunities to gain the credits necessary for achieving a LEED rating.[7]

### Applicability

According to building permit data, there are an average of 6,000 residential renovations and 100 commercial building renovations each year in Chicago. In order to maximize the energy savings of existing buildings, the City of Chicago could mandate green building standards for all substantial renovations of residential and commercial buildings in Chicago. The residential sector could adhere to the newly established guidelines of the Chicago Green Homes Program, while the commercial sector could benefit from a similarly structured green building rating program. The green building program should include a significant training component for involved parties, including industry and trades people and homeowners.[5]

### Benefits

It is possible to reduce emissions by 0.31 MMT CO2e by implementing energy retrofits that adhere to green building standards. The emissions reductions are 0.19 MMT CO2e in residential buildings and 0.12 MMTCO2e for commercial buildings.[5]

- Rooted vegetation — trees, shrubs and groundcover — creates a cooler, better drained site, with greater protection from wind than a site covered in turf grass. Light colored and porous surfaces further reduce the site's heat absorption compared with impervious asphalt.
- A cool site contributes to a cool city and a cool building.
- Lower energy use reduces emissions of CO2, NOx, SOx.
- Use materials with recycled content and divert construction / demolition waste. These actions preserve virgin materials and reduce the size of landfills.
- Containing and treating rainwater on site reduces water pollution associated with stormwater runoff and wastewater treatment effluent.
- Vegetation sequesters CO2 and reduces Global Warming.[7]

### Safety and Siting Requirements

During Schematic Design, a building and its site can be designed for advantageous acceptance of solar gain (more in winter than in summer) and for daylight penetration. Management of stormwater via detention, infiltration or irrigation, on-site waste water treatment, and the installation of separate greywater and blackwater waste lines are all best considered starting with the Schematic Design stage, in conjunction with site issues.

- Evergreen trees planted in front of west and possibly east glazing can block glare during winter months when the sun is low.
- Deciduous trees block 80-90% of sunlight in summer while only 20-40% in winter, after they have lost their leaves This makes deciduous trees particularly appropriate for south-facing fenestration.

- A trellis with creeping vines can be an effective shading device.
- For sites with winter winds and summer breezes from consistent directions, trees can create a buffer against the former, without impeding the latter.[7]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Residential Units | resUnits | Units |
| Commercial Units | comUnits | Units |

$$\text{resUnits (Units)} \times \frac{3.2\ \text{(MT)}}{1\ \text{(Unit)}} + \text{comUnits (Units)} \times \frac{123\ \text{(MT)}}{1\ \text{(Unit)}} = \text{MTCO2 Reduced}$$

$$254\ \text{(gWh)} \times \frac{1\ \text{(W)}}{1000000\ \text{(gWh)}} \times \frac{300}{2592000} = \text{Watts Saved from Electricity Use}$$

$$30000000\ \text{(gWh)} \times \frac{100067\ \text{(kWh)}}{1\ \text{(Therm)}} \times \frac{1000\ \text{(W)}}{1\ \text{( kWh)}} \times \frac{300}{2592000} = \text{Watts Saved from Natural Gas Use}$$

$$\text{Watts Saved from Electricity Use} + \text{Watts Saved from Natural Gas Use} = \text{Total Watts Saved}$$

## Photovoltaic

Photovoltaics, or PV, is a technology that converts light directly into electricity.[18]

Solar panels are becoming the technology of choice for off grid commercial and residential applications. Solar collectors, to date, use two fundamental approaches, using the sun's energy to collect electricity or using the sun's energy to collect heat. PV or photovoltaic panels use the sun's energy to generate electricity.[18]

### Applicability

Photovoltaics are appropriate for all building types - residential, commercial, industrial and institutional - and are applicable both to new and existing buildings depending of roof type and load-bearing capacity of the building.

### Benefits

PV panels generate electricity without emitting green house gases, CO2. They can be cost effective thru the use of local fiscal incentives through your local, state and federal rebate/incentive programs.[18]

### Maintenance Considerations

Photovoltaic installations can operate for many years with little maintenance or intervention after their initial set-up, so after the initial capital cost of building any solar power plant, operating costs are extremely low compared to existing power technologies.[19]

### Cost Considerations

PV panels are becoming cost effective thru the use of the incentive programs available from federal, state, city and private industry. The panel cost, itself, is forecasted to continue to decline as new lower cost manufacturing processes and higher volumes come into play. Current panel costs are ~$4-$5/W with forecasts of $1/W in the next 5-10 years as high volume, low cost manufacturing processes are defined and come on line.[18]

### Safety and Siting Requirements

- Photovoltaics can be on flat roofs or pitched structures up to a slope of 25%
- Roof strength must be adequate to hold the additional weight of the Photovoltaics

### Permits

City and county permits are available through your approved solar installation specialist. A solar PV permit (electrical permit) is required.[18]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Average Hours of Sunlight | sunhour | Hour |
| Peak Wattage Requirement | peakWatt | DC |
| Cost per Peak Watt | peakCost | Dollar |
| Electricity Cost | elecCost | Dollar |
| System Lifetime | lifetime | Year |

$$\text{kWhmon (kWh)} \times \frac{44.44}{\text{sunhour (hr)}} \times \frac{6\ (\$)}{\text{peakwatt}} = \$\text{ of System}$$

$$\text{kWhmon (kWh)} \times \frac{0.158\ (\$)}{1\ \text{(kWh)}} \times \frac{12\ \text{(mon)}}{1\ \text{(yr)}} \times \text{lifetime (yr)} = \$\text{ Saved}$$

$$\text{kWhmon (kWh)} \times \frac{12\ \text{(mon)}}{1\ \text{(yr)}} \times \frac{0.000528\ \text{(ton)}}{1\ \text{(kWh)}} \times \frac{2204.62262\ \text{(lbs)}}{1\ \text{(ton)}} = \text{lbs CO2}$$

$$\text{kWhmon (kWh)} \times \frac{12\ \text{(mon)}}{1\ \text{(yr)}} \times \frac{1000\ \text{watts}}{1\ \text{(kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

## Geo-Thermal

Geothermal heating is the direct use of geothermal power for heating applications. Humans have taken advantage of geothermal heat this way since the Paleolithic era. Approximately seventy countries made direct use of a total of 270 PJ of geothermal heating in 2004. As of 2007, 28 GW of geothermal heating capacity is installed around the world, satisfying 0.07% of global primary energy consumption. Thermal efficiency is high since no energy conversion is needed, but capacity factors tend to be low (around 20%) since the heat is mostly needed in the winter.

Geothermal energy originates from the heat retained within the earth since the original formation of the planet, from radioactive decay of minerals, and from solar energy absorbed at the surface. Most high temperature geothermal heat is harvested in regions close to tectonic plate boundaries where volcanic activity rises close to the surface of the Earth. In these areas, ground and groundwater can be found with temperatures higher than the target temperature of the application. However, even cold ground contains heat, below 10’ or 3 Meters, the ground is consistently 12.8°C (55°F), and it may be extracted with a geothermal heat pump. Due to recent advances in heat pump performance, this is now a rapidly growing market in the US.[15]

### Applicability

There are a wide variety of applications for cheap geothermal heat. In 2004 more than half of direct geothermal heat was used for space heating, and a third was used for spas. The remainder was used for a variety of industrial processes, desalination, domestic hot water, and agricultural applications. The cities of Reykjavík and Akureyri pipe hot water from geothermal plants under roads and pavements to melt snow. Geothermal desalination has been demonstrated.

Geothermal systems tend to benefit from economies of scale, so space heating power is often distributed to multiple buildings, sometimes whole communities. This technique, long practiced throughout the world in locations such as Reykjavik, Iceland, Boise, Idaho, and Klamath Falls, Oregon is known as district heating.[15]

### Benefits

Geothermal energy is a type of renewable energy that encourages conservation of natural resources. According to the U.S. Environmental Protection Agency, geo-exchange systems save homeowners 30-70 percent in heating costs, and 20-50 percent in cooling costs, compared to conventional systems. Geo-exchange systems also save money because they require much less maintenance. In addition to being highly reliable they are built to last for decades. Some utilities, such as Kansas City Power and Light, offer special, lower winter rates for geothermal customers, offering even more savings.[15]

### Maintenance Considerations

A properly installed closed-loop heat pump requires very little maintenance aside from regularly maintaining the air filter and air blower assembly. Water coil maintenance is recommended on open-loop installations as water quality can greatly affect the heat exchanger efficiency.[16]

**Cost Considerations**

A geothermal system will vary greatly depending on individual circumstances, but on average a typical home of 2000 square feet will cost between $14,000 - $18,000. This represents somewhere around double the costs of a conventional heating, cooling and hot water system. A geothermal system often sees a 3 – 5 year payback of these additional costs.[16]

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| Annual BTUs Used | btuUsed | BTU |
| Coefficient of Performance | cop | Numerical Value |

$$\text{btuUse (gal)} \times \frac{1\ (\$)}{72{,}082\ (\text{btu})} = \text{Cost of Heating/Cooling}$$

$$\text{btuUse (gal)} \times \frac{1}{\text{cop}} \times \frac{1\ (\$)}{72{,}082\ (\text{btu})} = \text{Cost of Heating/Cooling with Geothermal}$$

$$\text{Cost of Heating/Cooling} - \text{Cost of Heating/Cooling w/ Geothermal} = \text{Money Saved}$$

$$\text{btuUse (gal)} - \left( \text{btuUse (gal)} \times \frac{1}{\text{cop}} \right) = \text{Btus Saved}$$

$$\text{btu Saved (btu)} \times \frac{0.0000327\ (\text{lbs})}{(\text{btu})} = CO_2\ \text{Saved}$$

$$\text{btu Saved (btu)} \times \frac{1\ (\text{kWh})}{3412.3\ (\text{btu})} \times \frac{1000\ (\text{watts})}{1\ (\text{kW})} \times \frac{1000\ (\text{watts})}{1\ (\text{kW})} \times \frac{300}{2592000} = \text{Watts Saved}$$

## Wind Energy

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity, wind mills for mechanical power, wind pumps for pumping water or drainage, or sails to propel ships.
Large-scale wind farms are connected to the electric power transmission network; smaller facilities are used to provide electricity to isolated locations. Utility companies increasingly buy back surplus electricity produced by small domestic turbines. Wind energy, as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, and produces no greenhouse gas emissions during operation. However, the construction of wind farms is not universally welcomed because of their visual impact but any effects on the environment are generally among the least problematic of any power source.

Wind power is non-dispatchable, meaning that for economic operation, all of the available output must be taken when it is available. Other resources, such as hydropower, and load management techniques must be used to match supply with demand. The intermittency of wind seldom creates problems when using wind power to supply a low proportion of total demand, but as the proportion rises, increased costs, a need to upgrade the grid, and a lowered ability to supplant conventional production may occur. Power management techniques such as exporting and importing power to neighboring areas or reducing demand when wind production is low, can mitigate these problems.

### Applicability

Wind power systems can be used for both commercial and residential energy applications.

### Benefits

Unlike conventional fossil fuels, wind energy is renewable, abundant energy that will be available for future generations. Wind displaces electricity that would otherwise be produced by burning natural gas, thus helping to reduce gas demand and limit gas price hikes. According to the American Wind Energy Association, the current U.S. gas shortage amounts to approximately 3 to 4 billion cubic feet (Bcf) per day. By the end of 2004, wind plants were generating about 17 billion kilowatt-hours (kWh) annually, or the equivalent of nearly 0.5 Bcf/day of natural gas. In most areas of the country, every kilowatt-hour of electricity produced by wind power helps reduce the demand for natural gas used to generate electricity. Lower demand for natural gas helps mitigate rising costs of consumer heating and electricity, industrial processes, and chemical and agricultural feedstocks.

### Maintenance Considerations

Operation and maintenance (O&M) costs constitute a sizeable share of the total annual costs of a wind turbine. For a new turbine, O&M costs may easily make up 20-25 per cent of the total legalized cost per kWh produced over the lifetime of the turbine. If the turbine is fairly new, the share may only be 10-15 per cent, but this may increase to at least 20-35 per cent by the end of the turbine's lifetime. As a result, O&M costs are attracting greater attention, as manufacturers attempt to lower these costs significantly by developing new turbine designs that require fewer regular service visits and less turbine downtime.

**Cost Considerations**

Wind power has no fuel costs and low or negligible costs for maintenance. However, there is a relatively high initial investment cost. Wind farm producing the same amount of electricity as a mid-sized coal-fired power plant will cost more to build, but substantially less to operate over a 20 year-plus time frame. It is in this higher initial investment that makes the cost per KWh higher.

**Siting Requirements**

Good selection of a wind turbine site is critical to economic development of wind power. Aside from the availability of wind itself, other factors include the availability of transmission lines, value of energy to be produced, cost of land acquisition, land use considerations, and environmental impact of construction and operations. Off-shore locations may offset their higher construction cost with higher annual load factors, thereby reducing cost of energy produced. Wind farm designers use specialized wind energy software applications to evaluate the impact of these issues on a given wind farm design.

**Permits**

Please contact a licensed, certified installation expert.

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| kW Load | kWLoad | kW |
| Electricity Cost | elecCost | Dollar |
| System Lifetime | lifetime | Year |
| Electricty Displaced | kwhSaved | kWh |

$$\text{kWLoad (kW)} \times \frac{5{,}000\ (\$)}{(\text{kW})} = \$\text{ of System}$$

$$\text{kWhmon (kWh)} \times \frac{0.158\ (\$)}{1\ (\text{kWh})} \times \frac{12\ (\text{mon})}{1\ (\text{yr})} \times \text{lifetime (yr)} = \$\text{ Saved}$$

$$\text{kWhmon (kWh)} \times \frac{12\ (\text{mon})}{1\ (\text{yr})} \times \frac{0.000528\ (\text{ton})}{1\ (\text{kWh})} \times \frac{2204.62262\ (\text{lbs})}{1\ (\text{ton})} = \text{lbs CO2}$$

$$\text{kWhmon (kWh)} \times \frac{12\ (\text{mon})}{1\ (\text{yr})} \times \frac{1000\text{ watts}}{1\ (\text{kWh})} \times \frac{300}{2592000} = \text{Watts Saved}$$

## Solar Hot Water

Solar Hot Water refers to water heated by solar energy. Solar heating systems are generally composed of solar thermal collectors, a fluid system to move the heat from the collector to its point of usage, and a reservoir or tank for heat storage and subsequent use. The systems may be used to heat water for home or business use, for swimming pools, or as an energy input for space heating and cooling and industrial applications.[20]

In many climates, a solar hot water system can provide a very high percentage (50% – 75) of domestic hot water energy. In many northern climates, combined hot water and space heating systems are used to provide 15 – 25% of home heating energy.[20]

Residential solar thermal installations can be subdivided into two kinds of systems: compact and pumped systems. Both systems typically include an auxiliary energy source (electric heating element or connection to a gas or fuel oil central heating system) that is activated when the water in the tank falls below a minimum temperature setting such as 50 °C. Hence, hot water is always available. Alternately, a wood stove chimney can be used as an auxiliary energy source in northern climates.[20]

### Applicability

Solar hot water systems can be used for both commercial and residential hot water applications.[20]

### Benefits

A 2kW 120-gallon solar hot water system can save approximately 18-20% in energy usage per year or $200 depending on your local utility.[20]

### Maintenance Considerations

Today's solar water heating systems are very reliable, designed for protection from freezing, low-maintenance and have a life expectancy of more than 20 years. The system should be installed by professional, licensed installers.[20]

### Cost Considerations

The installed cost for a 2kW 120-gallon solar hot water system is approximately $8000.[20]

A federal incentive of 30% is currently available with no maximum cap. A state incentive will be available in summer 2010. Check here for up to date rebates and incentives information: http://www.dsireusa.org[20]

### Siting Requirements

Solar panels must be oriented in a south or west facing direction with little or no shade.[20]

### Permits

Mechanical, electrical and plumbing permits may be required. Please contact a licensed, certified installation expert.[20]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Water Tank Capacity | capacity | Gallon |
| Inlet Water Temperature | inTemp | Degree Fahrenheit |
| Hot Water Temperature | hotTemp | Degree Fahrenheit |
| Hot Water Usage | hotUse | Gallon |
| BTU per Hour | btuHour | BTU/hr |
| Electricty Displaced | kwhSaved | kWh |

$$(\text{inTemp (d)} - \text{hotTemp (d)}) \times \text{hotUse (gal)} \times \frac{\text{btuHour (BTU/hr)}}{\text{(gal)}} \times \frac{\text{(kWh)}}{\text{13649.2 (BTU/hr)}} \times \text{(cont'd on next line)}$$

$$\frac{\text{1000 (watts)}}{\text{1 (kW)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{kWhSaved (Kwh)} \times \frac{\text{0.158 (\$)}}{\text{1 (kWh)}} = \text{Money Saved}$$

$$\text{kWhSaved (Kwh)} \times \frac{\text{0.545445 (lbs)}}{\text{1 (kWh)}} = \text{CO2 Saved}$$

$$\text{capacity (gal)} \times \frac{\text{67.50 (\$)}}{\text{(gal)}} = \text{Cost of System}$$

## Upgrade Power Plants

Today, more than half of the electricity generated in the United States comes from coal. For the foreseeable future, coal will continue to be the dominant fuel used for electric power production. The low cost and abundance of coal is one of the primary reasons why consumers in the United States benefit from some of the lowest electricity rates of any free-market economy.[12]

The Department's Office of Fossil Energy is working on ways to keep coal in America's electricity future. The key challenge is to remove the environmental objections to the use of coal in tomorrow's power plants. New technologies being developed in the Fossil Energy program could virtually eliminate the sulfur, nitrogen, and mercury pollutants released when coal is burned. It may also be possible to capture greenhouse gases emitted from coal-fired power plants and prevent them from contributing to global warming concerns.[12]

### Applicability

In the year 2000, the 21 coal fired plants located in Illinois generated 78,863 GWh of electricity or 27% of all the electricity generated in the MAIN electric region used in this analysis.[6]

### Benefits

With the awarding of $1 billion in Recovery Act funding to the FutureGen Alliance, Ameren Energy Resources, Babcock & Wilcox, and Air Liquide Process & Construction, Inc., the partner recipients will repower Ameren's 200 megawatt Unit 4 in Meredosia, Illinois with advanced oxy-combustion technology. The plant's new boiler, air separation unit, CO2 purification and compression unit will deliver 90 percent CO2 capture and eliminate most SOx, NOx, mercury, and particulate emissions. Ameren Energy Resources estimates that the retrofitting of the plant is expected to create approximately 500 construction jobs and allow Ameren to recall 50 permanent workers who were laid off last year.[13]

This project will also provide performance and emissions data for future commercial guarantees, and establish operating and maintenance experience for future large-scale commercial projects. The FutureGen Alliance will help design the test program for the new facility to incorporate a broad range of coals and operating conditions to expand the market for this repowering approach.[13]

In addition, the project partners, working with the State of Illinois, will establish a regional CO2 storage site in Mattoon, Illinois and a CO2 pipeline network from Meredosia to Mattoon that will transport and store more than 1 million tons of captured CO2 per year. The project partners estimate the new pipeline network is expected to create 275 contruction jobs and 75 permanent jobs. The pipeline network, along with the repository in Mattoon, helps to lay the foundation for a regional CO2 network. The Mattoon site will be used to conduct research on site characterization, injection and storage, and monitoring and measurement.[13]

Oxy-combustion burns coal with a mixture of oxygen and CO2 instead of air to produce a concentrated CO2 stream for safe, permanent, storage. In addition, oxy-combustion technology creates a near-zero emissions plant by eliminating almost all of the mercury, SOx, NOx, and particulate pollutants from plant emissions. The Department of Energy's National Energy Technology Laboratory studies have identified oxy-combustion as potentially the least cost approach to clean-up existing coal-fired facilities and capture CO2 for geologic storage.[13]

An upgrade or repowering of 21 Illinois power plants would eqaute to 2.5 MMTCO2e reduction.[17]

## Improve Power Plant Efficiency

Increasing the thermal efficiency of the existing U.S. fleet of coal-fired power plants by 10 percent within five years would save 150 million metric tons of carbon equivalent emissions per year and reduce the amount of coal required to produce the current level of electric power generation from these plants. A 10 percent increase in the thermal efficiency would raise the overall efficiency of the coal-fired power plant fleet from 32.5% to 35.8% – about three percentage points of efficiency gain – and likely reduce other environmental emissions.[14]

### Applicability

The U.S. energy infrastructure encompasses an enormous investment in capital assets and systems to produce fuels and electric power for businesses, transportation, and homes. While the long-term opportunity to reshape this infrastructure to have a low-carbon profile is promising, near-term opportunities to reduce carbon emissions are very limited. Because coal-fired power plants account for over 80 percent of carbon emissions from the power sector, improving the efficiency of the existing coal-fired power plant fleet presents one of the most promising, low-cost options for reducing near-term carbon emissions.[14]

### Methods

There are a number of specific improvements in power plants that can be investigated relatively quickly. These include:

- Cleaning tubes and boilers
- Maintaining instrumentation
- Restoring seals
- Removing deposits on turbine blades
- Condenser maintenance programs
- Decreasing excess oxygen to the boiler
- Installing variable speed drives for motors
- Pursuing opportunities for waste heat utilization for coal drying and using solar energy for feed water heating[14]

### Benefits

Research is also underway to increase the fuel efficiency of coal-fueled power plants. Today's plants convert only a third of coal's energy potential to electricity. New technologies in Energy's Fossil Energy program could nearly double efficiency levels in the next 10-15 years. Higher efficiencies mean even more affordable electricity and fewer greenhouse gases.[14]

Raising efficiency standards for new and existing power generators would equate to a 1.04 MMTCO2e reduction.[17]

## Build Renewable Electricity

Photovoltaic (PV) technology and wind power are two proven alternative clean energy sources for utilityscale production of electricity. This strategy analyzes renewable electricity generation using these sources. Using renewable generation sources instead of fossil fuel plants will result in greenhouse gas (GHG) savings and many other benefits that include reducing air pollutants that damage public health, increasing opportunities for innovation, and new job creation.[6]

To address climate change, the world must require higher efficiency from existing energy sources and move to cleaner power sources. Chicago homes and businesses receive power purchased from the larger regional grid of Midwest plants, which includes nuclear, coal-fired, natural-gas fired and renewable-generation plants. Some of these are a significant source of C02 emissions, especially those that use coal. Upgrading or repowering the 21 coal plants in the state of Illinois, including two in Chicago, could yield a significant reductions, Chicago's share of which would be 2.5 million metric tons of C02e. Implementation of a cap and trade system will also help achieve this goal.[17]

**Mitigation Strategies**

Build Renewable Electricity
Procure enough renewable energy generation for Chicagoans to reduce electricity emissions by 20 percent = 3.0 MMTCO2e reduction*

*MMTCO2e (million metric tons carbon dioxide equivalent) is the term for the quantity of any greenhouse gas, including carbon dioxide, methane and others, translated CO2 by weighing it by its relative global warming potential. A reduction of 1 MMTCO2e is equivalent to removing nearly 185,000 cars from the road.[17]

In order to reduce 3 MMT CO2e, 82 million MWH of generation would have to be replaced assuming the average emission rates for the electricity pool. The example of replacing the four largest coal-fired plants would require 46 million MWH of coal-fired generation to be replaced.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| mWh Converted to Renewable | renewmwh | mWh |
| Cost of Convert to Wind Energy | costWind | Dollar |
| Cost of Convert to Photovoltaic Energy | costPV | Dollar |

$$\text{renewmwh (mWh)} \times \frac{1.1\ \text{(MT)}}{1\ \text{(mWh)}} = \text{MTCO2 Reduced}$$

$$\text{renewmwh (mWh)} \times \frac{1000\ \text{(kWh)}}{1\ \text{(mWh)}} \times \frac{5.42\ (¢)}{1\ \text{(kWh)}} \times \frac{1\ (\$)}{100\ (¢)} = \text{Cost to Convert to Wind Energy}$$

$$\text{renewmwh (mWh)} \times \frac{1000\ \text{(kWh)}}{1\ \text{(mWh)}} \times \frac{48.4\ (¢)}{1\ \text{(kWh)}} \times \frac{1\ (\$)}{100\ (¢)} = \text{Cost to Convert to Photovolaic Energy}$$

## Increase Distributed Generation

Chicago can reduce its reliance on central station power plants and increase the use of clean, efficient power generated onsite at local facilities by creating rules and incentives that promote increased use of distributed generation (DG) and combined heat and power (CHP) projects. This mitigation strategy focuses on the use of DG and CHP to reduce CO2e from electricity generation.[6]

**Applicability**

DG is typically used in situations where a customer wants to manage peak load for economic, reliability or other reasons. CHP is an extension of DG where on-site generation balances the electric generating capacity with the recovery of heat from the system for uses such as industrial processes, heating and running cooling systems. It has additional value in terms of both energy efficiency and emissions reductions. CHP is wellsuited to use in the food industry (both manufacturing and retail), hospitals, and institutional campuses such as universities. DG and CHP are also being considered for new commercial, industrial, and large residential developments.[6]

**Benefits**

By adopting goals set by the City in its 2001 Energy Plan, there is a potential to reduce emissions by 0.685 MMT CO2e from cleaner electric generation and 0.430 MMT C02e from reduced natural gas use for creating heat.[6]

The main benefits of DG and CHP will be more efficient generation of power. If low emissions generation technologies are used, emissions will be lower than that of the regional emissions profile. Additional benefits will come from reducing line losses and capturing waste heat for other uses. As newly planned facilities are identified that could benefit from the use of either DG or CHP in their design, the potential for Chicago could be significant.[6]

**Cost Considerations**

DG and CHP face a number of significant financial hurdles including installation costs, which could involve regulatory fees and equipment costs, as well as the cost of natural gas. This mitigation strategy will be more feasible for developers and building owners if new buildings can incorporate these costs into their financing and operations budgets.[6]

The least expensive technology is large gas combined cycle turbines, which cost approximately $600/KW to install. The most expensive technology is fuel cells, which could run $5,000/KW to install. There are a range of more conventional but less efficient smaller gas generators with costs from $1,000 to $1,800 KW. In addition, customers must pay a substantial one-time cost for an interconnection study to satisfy utility requirements. These studies are reported to range from $3,000 to $250,000 depending on the size and complexity of the system.[6]

### Initiatives and Models

The State of Illinois Small Business $mart Energy Program administered by the Department of Commerce and Economic Opportunity, and the Smart Energy Design Assistance Center at the University of Illinois Urbana-Champaign, help businesses with the upfront costs of energy efficiency projects such as DG or CHP. The Midwest CHP Application Center, the Midwest CHP Initiative, and the Midwest Cogeneration Association also provide resources and technical support for DG and CHP. The Environmental Law and Policy Center is currently leading efforts to create good interconnection standards, in which the City could participate.[6]

## Carshare and carpool

Car sharing and carpooling and vanpooling are two alternatives to daily and weekly travel in a single occupancy vehicle that can reduce greenhouse gas (GHG) emissions. The CO2e savings potential ranges from 0.300 to 0.511 MMT CO2e depending on how aggressive the policy implementation is for each program.[6]

### Applicability

Car sharing has the potential to save 20-46 million gallons of gasoline in 2020. Carpooling and vanpooling can potentially save 16 million and 265,600 gallons of gasoline respectively.[6]

### Benefits

Car sharing provides cost savings over owning and operating a private vehicle. In Chicago, the average car sharing member could save as much as $4,000-$6,000 per year in transportation costs. Municipalities can realize savings by transitioning their fleets to car sharing. The City of Philadelphia has confirmed a cost savings of $5,385,000 over the next 5 years, by removing 75 cars from its fleet and replacing them with 3 Philly CarShare vehicles.[6]

Numerous studies have shown the benefits of car sharing in both car ownership patterns and travel behavior. According to the I-GO car sharing program, every car sharing vehicle in their fleet replaces 17 privately owned vehicles. Vehicle replacement numbers vary from 5 to 20 depending on the car sharing company—how many cars they operate, where they are located in relation to members, how dense an area is and how accessible to alternative modes of transportation, and members' behavior in terms of selling cars and/or delaying the purchase of new cars. Car sharing also alters member behavior. Members drive less; they chain trips together when driving and use other modes of transportation, especially public transportation, more often. These behavior changes result in reduced vehicle miles traveled (VMT) and travel distances—as people are more likely to use services closer in proximity, which in turn benefits the community.[6]

### Cost Considerations

Growth of car sharing involves considerable investment on the part of the car sharing operator; however, over time car sharing user fees can support increased growth in fleets. If car sharing is to be a strategy widely available throughout the city, investment will be necessary to grow car sharing, particularly in less dense communities.[6]

There is no cost on the part of the municipality, although the City could choose to provide parking spaces for car sharing vehicles.[6]

### Initiatives and Models

A recent of carpooling is GoLoco—a part carpooling, part social networking website provides access to real-time carpooling information, while adding a fun social element that may make carpooling more attractive to some. Illinois Lt. Governor Pat Quinn hosts a carpooling site21 that similarly works to connect people to car sharing opportunities in Illinois.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Miles Shared | shareMile | Mile |
| Number of People Sharing | sharePeople | People |

$$\text{shareMile (mile)} \times \frac{9.3156\ \text{(watt)}}{\text{(mile)}} = \text{Total Watts from Driving}$$

$$\text{shareMile (mile)} \times \frac{9.3156\ \text{(watt)}}{\text{(mile)}} \times \frac{1}{\text{sharePeople}} = \text{Personal Watts from Sharing}$$

$$\text{Total Watts from Driving} - \text{Personal Watts from Sharing} = \text{Watts Saved}$$

$$\text{shareMile (mile)} \times \frac{0.983\ \text{(lbs)}}{\text{(mile)}} = \text{Total CO2 from Driving}$$

$$\text{shareMile (mile)} \times \frac{0.983\ \text{(lbs)}}{\text{(mile)}} \times \frac{1}{\text{sharePeople}} = \text{Personal CO2 from Sharing}$$

$$\text{Total CO2 from Driving} - \text{Personal CO2 from Sharing} = \text{CO2 Emissions Saved}$$

$$\text{shareMile (mile)} \times \frac{21.5\ \text{(gal)}}{\text{(mile)}} \times \frac{3\ (\$)}{\text{(gal)}} \times \frac{52\ \text{(week)}}{\text{(yr)}} = \text{Total Yearly Cost}$$

$$\text{shareMile (mile)} \times \frac{21.5\ \text{(gal)}}{\text{(mile)}} \times \frac{3\ (\$)}{\text{(gal)}} \times \frac{52\ \text{(week)}}{\text{(yr)}} \times \frac{1}{\text{sharePeople}} = \text{Personal Yearly Cost from Sharing}$$

$$\text{Total Yearly Cost} - \text{Personal Yearly Cost from Sharing} = \text{Money Saved}$$

## Bike More / Walk More

Walking and biking trips reduce greenhouse gas (GHG) emissions by decreasing the number of trips taken in motor vehicles. The graph above shows that for City of Chicago almost one third of all trips are one mile or less, and nearly half are shorter than two miles. These short trips provide a distinct opportunity to increase bicycle and pedestrian mode share, an opportunity that has not been sufficiently exploited. While it might not seem that these short trips equate to large GHG emissions reductions, it is important to remember that a short pedestrian or cycle trip often replaces a longer automobile trip, e.g. a pedestrian might choose a local store for shopping over driving to a major shopping center.[6]

### Applicability

The U.S. Census' 2000 "Journey to Work" data shows that 73,512 people (5,956 bikers, 67,556 walkers) aged 16 or above walk or ride their bicycles to and from work in Chicago.[6]

### Benefits

Walking offers great health benefits as the most accessible form of exercise, and is considered to be one of the key strategies to confronting the looming obesity epidemic. According to Lilah Besser and Andrew Dannenberg, in an article for American Journal of Preventive Medicine, "Americans who use transit spend a median of 19 minutes daily walking to and from transit; 29 percent achieve more than 30 minutes of physical activity a day solely by walking to and from transit." Additionally, a walkable, bikeable city relieves its residents of the financial burden of owning and operating a car (see Financial Savings section below). Other benefits include increased public safety through more "eyes on the street," and the economic benefits to local business through increased foot traffic.[6]

### Cost Considerations

Basic adult bicycles can be purchased for as low as \$100-\$300, and even less if purchased used.[6]

### Initiatives and Models

There are several successful programs and pilot projects that the City of Chicago can build off of to help increase bicycle and pedestrian mode share. These programs include:

- The City of Chicago has increased the focus on bicycling with bike facilities—parking and showers—at Millennium Park. All new City facilities could include bike parking, lockers, showers and other facilities that make biking to work and other destinations possible.
- The Chicago Department of Transportation (CDOT) pedestrian program is responsible for both the Bicycle Ambassador program, which teaches bicycling skills, and the Walking School Bus Programs. A walking school bus is a group of children walking to school with one or more adults. It can be as informal as two families taking turns walking their children to school to a structured route with meeting points, a timetable and a regularly rotated schedule of trained volunteers.
- The Chicagoland Bicycle Federation's individualized mode shift marketing program—Go Healthy!—encourages residents to include active travel in their lives. The program works by identifying people within a target population who aspire to change their travel behavior. The program's goal is then to shift two trips a week per person in any one household to biking, walking, transit, or some combination of the three. It

adapts and builds on the successful TravelSmart program from Australia and Portland, Oregon.

- The successful five-month "Bike Chicago" program from the Mayor's Office of Special Events could be replicated in a "Walk Chicago" encouragement program. This type of program would foster a culture of walking similar to the pronounced bike culture that has been created in Chicago.[6]

The TravelSmart program identifies individuals who want to change the way they travel and provides them with the information, incentives, encouragement and tools they need to shift from driving to transit, bicycling, walking, car sharing or carpooling. Participants are identified by targeted outreach to those geographies with the greatest mode shift potential. In Portland, the program resulted in nine percent less car travel in the targeted geography with a corresponding eight percent increase in walking, cycling, and public transit. These figures represent a 12 percent reduction in Vehicle Miles Traveled (VMT). Changes in travel behavior were shown to sustain one year after the initial marketing efforts. Furthermore, the data indicated that these results did not affect participants' overall mobility in terms of their activities outside the home, travel time and number of trips per day. The results support the use of individualized marketing as an effective strategy to increase environmentally friendly modes of travel and reduce car travel.[6]

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| Miles Biked or Walked | bwMile | Mile |

$$\frac{\text{bwmile (mile)}}{\text{1 (month)}} \times \frac{\text{12 (month)}}{\text{1 (year)}} \times \frac{\text{1 (gal)}}{\text{22 (mile)}} = \text{Gallons Gas Saved}$$

$$\text{Saved Gallons of Gas} \times \frac{\text{19.4 (lbs)}}{\text{1 (gal)}} = \text{lbs of C02 Saved}$$

$$\text{Saved Gallons of Gas} \times \frac{\text{125000 (Btu)}}{\text{1 (gal)}} \times \frac{\text{1 (kWh)}}{\text{3413 (Btu)}} \times \frac{\text{1000 (W)}}{\text{1 (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

## Switch to Fuel Efficient Vehicles

Increasing gas mileage in vehicles can lead to dramatic improvements in greenhouse gas (GHG) emissions. Fuel economy standards currently are, as they have been since its creation in 1975, set through the Corporate Average Fuel Economy (CAFE), administered by the National Highway Traffic Safety Administration (NHSTA). Until 1997, recent CAFE standards required new passenger vehicles to average 27.5 miles per gallon (MPG) of fuel, and new light trucks 22 MPG for an overall average of 24.7 MPG. With the passage of the Energy Independence and Security Act of 2007, fuel economy standards are required to be raised to an average to an average of 35 mpg by 2020—the first time the CAFE average has been raised since the 1970's. The bill calls for increasing CAFE standards every year, starting in 2011, and raising it to a "maximum feasible rate" between 2021 and 2030. The City of Chicago could be at the forefront of the efforts to advocate for rapid implementation of the new CAFE standards.[6]

### Applicability

By increasing fuel efficiency by four percent annually beginning in 2010, Chicago could save 858,000 metric tons of CO2e in 2020. A less aggressive goal of three percent annual improvements would yield savings of 512,000 metric tons of CO2e.[6]

### Benefits

There is very little downside for Chicago in increasing the fuel economy of vehicles. If the estimates from the CBO are accurate, the increased costs of new vehicles should not bring an undue burden upon the public. With the fierce competition among auto manufacturers, increased costs would need to be kept to a minimum rather than risk decreasing market share. If the costs associated with increasing CAFE standards are closer to General Motors' estimates, consumers would pay higher prices for vehicles.[6]

### Cost Considerations

The costs of implementing an increase in CAFE standards are debatable. The Congressional Budget Office (CBO) estimated in 2004 that a rise in CAFE standards of 3.8 MPG—enough to reduce the amount of gasoline used by 10 percent—would cost $3.6 billion per year nationally, or approximately $230 per new vehicle.[6]

The auto manufacturers paint a different picture. General Motors estimates the cost of raising CAFE standards from 25 to 35 MPG by 2020 at $5-7 thousand per vehicle in current dollars. Officials from General Motors also claim that every new car made by 2020 would need to be a hybrid or diesel-powered to meet the new standard.[6]

### Initiatives and Models

In July 2002, California passed AB 1493, which required the California Air Regulations Board to develop and adopt measures that achieve the most feasible and cost-effective reduction of GHG emissions from passenger cars and light trucks sold in California. After a series of public workshops and hearings, standards were adopted that would apply to 2009 and later model years and would require approximately 30 percent reductions in GHG emissions by 2016. California was the first state to pass such standards and has been followed by eleven other states. This bill has been delayed due to pending lawsuits and Congress is currently debating whether or not to grant a waiver to California so it can implement the law in time to apply it to the 2009 model year of vehicles.[6]

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| Miles Driven | mile | Mile |
| Standard Gas Consumtpion | smpg | MPG |
| Efficient Gas Consumption | empg | MPG |

$$\frac{n\ (\text{mile})}{1\ (\text{month})} \times \frac{12\ (\text{month})}{1\ (\text{year})} \times \frac{1\ (\text{gal})}{22\ (\text{mile})} = \text{Annual Standard Gas Consumption}$$

$$\frac{n\ (\text{mile})}{1\ (\text{month})} \times \frac{12\ (\text{month})}{1\ (\text{year})} \times \frac{1\ (\text{gal})}{35\ (\text{mile})} = \text{Annual Fuel Efficient Gas Consumption}$$

Annual Standard Gas Consumption - Annual Fuel Efficient Gas Consumption = Annual Saved Gallons of Gas

$$\text{Gas Saved (gal)} \times \frac{19.4\ (\text{lbs})}{1\ (\text{gal})} = \text{CO2 Saved Annually}$$

$$\text{Gas Saved (gal)} \times \frac{125000\ (\text{Btu})}{1\ (\text{gal})} \times \frac{1\ (\text{kWh})}{3413\ (\text{Btu})} \times \frac{1000\ (\text{W})}{1\ (\text{kWh})} \times \frac{300}{2592000} = \text{Watts Saved Annually}$$

$$\text{Gas Saved (gal)} \times \frac{3.50\ (\$)}{1\ (\text{gal})} = \text{Money Saved Annually}$$

## Invest more in Transit

A comprehensive and accessible transit system is the linchpin to a wide network of strategies to reduce carbon emissions in the transportation sector. The key to reducing reliance on carbon-intensive vehicle travel is to provide a wide choice of transportation modes—walking, biking, car-sharing, car pooling, and transit. The potential success of other transportation sector mitigation strategies, such as parking cash-out programs and congestion pricing, are also reliant on the availability of convenient public transit.[6]

### Applicability

Only 18% of trips are work-related, while the remainder are for personal, family, social, school, and faith-related trips. Different types of transit—train, bus, express bus, streetcar and paratransit—are appropriate for different lengths and types of trips. Transit use is also correlated with frequency of service and hours of operation. The recent rise in CTA ridership parallels other travel innovations, such as the ability to bring bicycles on buses.[6]

### Benefits

Benefits of increased transit, and associated decreased VMT, include improved air quality, reduction in road construction and maintenance costs, reduced congestion, improved access to jobs, access for young, old and people with mobility limitations, fewer vehicle-related fatalities and serious injuries, and increased routine physical activity, i.e., walking to stations or bus stops.[6]

### Cost Considerations

Three large-scale route extensions within city limits have received consideration by transit authorities in recent years: the Red Line extension to 130th St., the Circle Line, and the Mid-City Transitway. As of 1997, the proposed Red Line expansion was expected to cost $282 million and the Mid-City Transitway to cost $1 billion. The Circle Line was proposed in a later plan, without a financial estimate. According to press reports, the plan is estimated at $1 billion.

Express bus service has proven to be a popular service enhancement, expanding from one line in the 1990s to 10 lines in 2007. The changeover to express bus service costs approximately $1 million per route. Minimal costs are associated with dedicated bus and bike lanes, which speed service, allow adherence to transit schedules without bus bunching, and give transit the advantage over congested private vehicle travel. This would require only modest planning, signage and re-striping expenses.

Priority signal technology for buses would reduce idling at lights and increase transit attractiveness by reducing travel time. The RTA has committed $13 million in Congestion Mitigation and Air Quality (CMAQ) funds to regional transit signal priority. The amount required to implement priority signalization in the city is unknown.[6]

### Initiatives and Models

The City's "Take 5" pledge asks citizens to replace one car trip a month with a transit trip; which would account for an additional 18,500,000 transit trips per year, or about half the number of trips proposed.

There are currently several transit expansion plans under consideration. The Mid-City Transitway is a proposed 21-mile circumferential corridor extending from the Jefferson Park station on the CTA Blue Line south to Midway Airport then southeast to the 87th Street station on the CTA Red Line. (An alternative plan to develop a limited access truck route for this right-of-way is also under consideration.)[6]

## Expand Transit Incentives

There is great potential to create new or expanded revenue streams for the transit system. The City could promote the equivalent of a U-Pass for its employees, public school employees and major businesses. A potential model is the city of Boulder's (CO) EcoPass, where employers purchase bulk transit passes at a discount. The costs are primarily for marketing the pass, and the revenue from bulk pass purchases would provide a net increase to the CTA system.[6]

**Initiatives and Models**

Chicago has begun to investigate market based parking policies, including the new Transportation Enhancement Districts (TEDS) which build on research by Donald Shoup. The use of market based policies could be expanded as quickly as possible, since they have been shown to generate significant amounts of revenue and simultaneously return benefits to those seeking parking, as well as easing bus navigation by reducing cruising for parking.[6]

The City could consider a special property tax on parking spaces in public and private lots to equalize the field between transit and private vehicle trips and provide revenue for the CTA. The actual costs of parking are extensively researched in Donald Shoup's The High Cost of Free Parking, including a chapter entitled "The Ideal Source of Local Public Revenue."[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
| --- | --- | --- |
| Percent Ridership Increase | ridership | Percent |

$$n\%\ (\text{ridership}) \times \frac{14000\ (\text{MTCO2})}{1\%\ (\text{ridership})} = \text{MTCO2 Emissions Saved from Vehicle Miles Traveled}$$

## Promote Transit-oriented Development

The nature and form of the built environment contribute to the greenhouse gas (GHG) producing activities that occur in a community, particularly in the energy and transportation sectors. Residents of disperse, sprawling communities may travel long distances to reach work, school and shopping destinations, often in automobiles. In comparison, those who live in compact, dense, transit-rich communities make shorter commutes to destinations and amenities that are close by. The dense building forms of compact communities—condos, townhouses, and attached housing—utilize less exterior walls and are inherently more energy efficient than stand alone buildings.[6]

### Applicability

The nature and form of the built environment contribute to the greenhouse gas (GHG) producing activities that occur in a community, particularly in the energy and transportation sectors. Residents of disperse, sprawling communities may travel long distances to reach work, school and shopping destinations, often in automobiles. In comparison, those who live in compact, dense, transit-rich communities make shorter commutes to destinations and amenities that are close by. The dense building forms of compact communities—condos, townhouses, and attached housing—utilize less exterior walls and are inherently more energy efficient than stand alone buildings.[6]

### Benefits

2.4 metric tons CO2e of transportation emissions will be reduced per household per year for every household that moves into a smart growth area versus the region at large.[6]

Benefits include increased quality of life for residents who can walk and use transit to travel to work, retail and other amenities. Residents also realize significant cost of living savings associated with reduced auto travel and building energy use. A 2006 study concluded that households living close to transit spend 15% on transportation costs as opposed to those without access to transit spending 23%.[6]

Other benefits include reduced road congestion; increased air quality; preservation of open space, park land, and farmland; and less need for sprawling infrastructure investment and maintenance. There is also less electricity line loss that occurs when energy is delivered to distant locations.[6]

### Initiatives

The City of Chicago has incorporated some smart growth principles into its planning and development. Chicago currently has density bonus zoning which provides incentives for increased density in exchange for other development concessions. This zoning option could be amended to provide additional focus on areas close to transit. The Planned Development District Ordinance could also be enhanced to specifically incorporate transit-oriented design, including reduced parking ratio requirements and deeded transit passes.[6]

### Cost Considerations

Financial incentives may be offered to attract developers to employ smart growth principles, and could include low interest loans, tax deferrals and infrastructure improvements. However, these initial public investments will realize a return on investment due to increased tax revenue from rising property values and increased sales.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Households in Smart Growth Area | household | Household |

$$n\ (\text{Household}) \times \frac{2.4\ (\text{MTCO2})}{1\ (\text{Household})} = \text{MTCO2 Transportation Emissions Saved per Household}$$

$$\frac{2.4\ (\text{MTCO2})}{1\ (\text{Household})} \times \frac{5291\ (\text{lbs})}{1\ (\text{MTCO2})} \times \frac{1\ (\text{gal})}{19.4\ (\text{lbs})} \times \frac{3.50\ (\$)}{1\ (\text{gal})} = \text{Money Saved per Household}$$

## Bike Paths

The terms bike path or cycleway (UK and Ireland) is generally used to denote a roadway dedicated to cycle traffic on its own separate right-of-way. This may include a separate pedestrian zone or path, or pedestrians and cyclists may share the same way. In the latter case, the term shared-use path, multi-use path (often abbreviated MUP), multi-use trail or (MUT), recreational path or greenway may be used instead.

### Applicability

In the U.S., the term sidepath commonly denotes a path or sidewalk that has been designated for use by cyclists and is within the right of way of a public road, but is not immediately adjacent to the portion of the way for vehicular traffic (i.e., the traveled way). This definition of sidepath excludes designated bicycle lanes, as they are immediately adjacent to the traveled way.

### Benefits

Cycling is an extremely efficient mode of transportation optimal for short to moderate distances. Bicycles provide numerous benefits compared to motor vehicles, including exercise, an alternative to the use of fossil fuels, no air or noise pollution, much reduced traffic congestion and likelihood of causing a fatality, easier parking, greater maneuverability, and access to both roads and paths. The advantages are at less financial cost to the user as well as society (negligible damage to roads, and less pavement required). Criticisms and disadvantages of cycling include reduced protection in crashes, particularly with motor vehicles, longer travel time (except in densely populated areas), vulnerability to weather conditions, difficulty in transporting passengers, and the skill and fitness required.

### Maintenance Considerations

Moving motor vehicles generate a “sweeping” effect that pushes road debris such as grit and broken glass to the edge of the roadway. By excluding motor traffic, cycle lanes and cycle tracks become parts of the road that are no longer routinely “swept”, thus collecting more broken glass and gravel. In addition, some off-road designs are not accessible to standard road sweeping equipment. One UK study estimated that cycle path users are seven times more likely to get punctures than are road cyclists.

### Safety Concerns

The source of the direct safety problem lies in the nature of the predominant car/bicycle collision types. The majority of collisions on urban roads occur at junctions and involve turning vehicles. Rear-end type collisions are only a major factor on arterial or interurban roads. More width for cyclists to use on rural/arterial roads with few junctions might lower the net number of collisions, but the data does not help answer the question of whether separating cyclist from other users would make a significant difference one way or the other.

### Cost Considerations

Between the late 1980s and early 1990s the Netherlands spent 1.5 billion guilders (US$945 million) on cycling infrastructure, yet cycling levels stayed practically the same. When the flagship Delft Bicycle Route project was evaluated, the results were “not very positive: bicycle use had not increased, neither had the road safety. A route network of bicycle facilities has, apparently, no added value for bicycle use or road safety”.

## Pedestrian Paths

A pedestrian path (also footpath, walking trail, nature trail) is a thoroughfare intended for by pedestrians but not by motorized vehicles. The term is often for paths within an urban area that offer shorter quieter routes for pedestrians, they may also provide access to the surrounding countryside or parks. In some parts of the world the term ‘footpath’ is also used for longer Trails in more remote places.

### Applicability

Footpaths can be located in many settings for varied uses and experiences. As a few examples, these can include:

- Parks: for means of convenient, recreational, and aesthetic, movement in and through public spaces, urban parks, neighborhood parks, linear parks, botanic gardens, and regional [[open space] park]]s.
- in Gardens and Designed Landscapes: in private gardens, at school-university and business park campuses; and at park visitors centers as natural history interpretive nature trails in designed wildlife gardens.
- in Sculpture gardens and Open air museums, as Sculpture trails and historic interpretive trails.
- in a wilderness setting, such as a day-Trail or long-distance trail within a protected nature reserve, such as a national park, from a trailhead.
- as Jogging paths, horse trails, and mountain biking routes; and
- as disability handicapped and wheelchair accessible paths meeting ADA specifications in sensory gardens and all the above settings.

### Benefits

Increased walkability has proven to have many other individual and community health benefits, such as opportunities for increased social interaction, an increase in the average number of friends and associates where people live, reduced crime (with more people walking and watching over neighborhoods, open space and main streets), increased sense of pride, and increased volunteerism. One of most important benefits of walkability is the decrease of the automobile footprint in the community. Carbon emissions can be reduced if more people choose to walk rather than drive. Walkability has also been found to have many economic benefits, including accessibility, cost savings both to individuals and to the public, increased efficiency of land use, increased livability, economic benefits from improved public health, and economic development, among others.

### Maintenance Considerations

Footpaths may be constructed from low maintanenence materials including “masonry, brick, poured or modular unit concrete, cut stone or wood boardwalk.  Other loose materials can be used such as crushed rock, decomposed granite, fine wood chips. These loose materials may need minimal maintanance to maintain.

## Improve Fleet Efficiency

There are many vehicle fleets operating in the city of Chicago: commercial, personal, City-owned and operated, Chicago Transit Authority, and car sharing. These fleets account for a large portion of vehicle miles traveled (VMT) within the City and corresponding greenhouse gas (GHG) emissions. The City has total control over its own fleet of vehicles—the size, composition, and fuels used—and limited control over a number of others such as CTA buses, taxis, and school buses. This section will explore strategies that require greater fuel efficiency or the use of alternative fuels to reduce emissions from the fleets that the City controls and/or plays some role in operations, including taxis, school buses, CTA buses, and garbage trucks.[6]

### Applicability

By switching 100 percent of the taxi fleet to hybrid electric vehicles with better fuel efficiency, there is the potential to save 129,000 tons CO2e annually. This savings assumes that the current fleet—comprised of 6,300 Crown Victorias, or their equivalent, which average 14 miles per gallon (MPG) and are driven an average of 60,000 miles per year—are replaced with Ford Escape Hybrids, or their equivalent, which average 34 MPG. Each taxi would save more than 20 tons CO2e per year, approximately one ton for every 3,000 miles they drive. Approximately 15.9 million gallons of gasoline would be saved annually.[6]

Assuming each of the 2,600 school buses in the City averages 13,000 mile per year while operating at seven miles per gallon of diesel fuel, replacing current fuel with B20 gasoline could reduce emissions by up to 9,800 metric tons CO2e annually.[6]

CTA Buses traveled 66.2 million miles in 2000 while getting 3.1 miles per gallon, using diesel fuel. Switching to diesel hybrids would save 30 percent of the gallons of gas consumed and nearly 70,000 tons CO2e annually.[6]

### Benefits

Fuel savings can amount to approximately $6,000 per year per taxi, with variation due to mileage and the cost of fuel. Pilot programs have shown that cab drivers in Ford Escape Hybrids save $30 per 150- to 300-mile shift as compared to the same distance with the traditional, full-sized sedan cabs. As fuel prices continue to rise, these financial benefits will only increase. The CTA could save approximately $56,000 per year on fuel, using the Energy Information Administration (EIA) average price for diesel gas in May 2007, by switching to hybrid buses. Hybrid buses cost 15% less to operate than diesels due to fuel savings and decreased maintenance fees.[6]

### Maintenance Considerations

There have been concerns regarding the durability of hybrid vehicle engines. Prior to pilot programs in San Francisco and New York, there were concerns about whether the Hybrid taxis could endure the long shifts on San Francisco hills or in New York congestion, along with skepticism that their engines would last until the 100,000 mile warranty. However, test programs in both cities have had cabs hit 100,000 miles without reporting any major problems in terms of wear and tear.[6]

**Cost Considerations**

The City currently has a list of approved makes and model year vehicles that are approved for taxi use. The list of approved vehicles could be amended to allow only hybrid vehicles such as the Ford Escape Hybrid (over time) as part of this strategy. A new Ford Escape Hybrid, which is being used in this strategy for illustrative purposes, costs approximately $26,000. This is slightly more than a new Ford Crown Victoria (used for illustrative purposes in this strategy as the typical current taxi) which costs approximately $25,000 and is more expensive than some other cab options. As in New York City and other cities, cab companies are required to purchase their own vehicles[6]

The financial feasibility of this strategy varies by fleet, technology, and use rates. The largest barriers are the upfront capital costs for biodiesel fueling stations and hybrid vehicles. However, it is feasible to significantly increase the number of hybrid buses in the fleet with sufficient capital funds. Between 1996 and 2005, New York City purchased 450 Compressed Natural Gas buses and 325 hybrid buses. The Energy Policy Act of 2005 provides several tax credits to help offset the capital costs of purchasing hybrid or natural gas trucks. Once these upfront costs are overcome, there are operating savings to be found in fleet efficiency.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Hybrid Taxi | hyTaxi | Gallons |
| Biodeisel School Bus | bioBus | School Bus |
| Biodeisel CTA Bus | bioCTA | CTA Bus |

$$n\ (\text{Hybrid Taxi}) \times \frac{20\ (\text{Tons})}{1\ (\text{Hyrbid Taxi})} = \text{Annual MTCO2 Emissions Reduced per Year from using Hybrid Taxis}$$

$$n\ (\text{Hybrid Taxi}) \times \frac{1000\ (\$)}{1\ (\text{Hybrid Taxi})} = \text{Cost to Switch to Hybrid Taxis}$$

$$\frac{0.05\ (\text{gal})}{1\ (\text{mile})} \times \frac{3.50\ (\$)}{1\ (\text{gal})} \times \frac{60000\ (\text{mile})}{1\ (\text{Hybrid Taxi})} = \text{Annual Money Saved from Using Hybrid Taxis}$$

$$n\ (\text{School Bus}) \times \frac{3.77\ (\text{MTCO2})}{1\ (\text{School Bus})} = \text{Annual MTCO2 Emissions Reduced per Year from using Biodeisel School Buses}$$

## Achieve Higher Fuel Efficiency Standards

Increasing gas mileage in vehicles can lead to dramatic improvements in greenhouse gas (GHG) emissions. Fuel economy standards currently are, as they have been since its creation in 1975, set through the Corporate Average Fuel Economy (CAFE), administered by the National Highway Traffic Safety Administration (NHSTA). Until 1997, recent CAFE standards required new passenger vehicles to average 27.5 miles per gallon (MPG) of fuel, and new light trucks 22 MPG for an overall average of 24.7 MPG.1 With the passage of the Energy Independence and Security Act of 2007, fuel economy standards are required to be raised to an average to an average of 35 mpg by 2020—the first time the CAFE average has been raised since the 1970's. The bill calls for increasing CAFE standards every year, starting in 2011, and raising it to a "maximum feasible rate" between 2021 and 2030. The City of Chicago could be at the forefront of the efforts to advocate for rapid implementation of the new CAFE standards.[6]

### Benefits

By increasing fuel efficiency by four percent annually beginning in 2010, Chicago could save 858,000 metric tons of CO2e in 2020. A less aggressive goal of three percent annual improvements would yield savings of 512,000 metric tons of CO2e.[6]

The six-county region around Chicago would save approximately 5.1 MMT CO2e in 2020 under the more aggressive target and approximately 3.1 MMT CO2e in 2020 under the less aggressive target.[6]

Chicago recently hit a record high of $4.25 per gallon of gasoline. Assuming a constant price of $4.00 per gallon of fuel, Chicago consumers would save $400 million annually with increased fuel economy standards. These savings would only increase as the price of gasoline increases.[6]

### Implementation

The City of Chicago could encourage increased fuel economy in a number of ways; four specific implementation mechanisms are described below. While CAFE standards are implemented at the national level, the Supreme Court's recent decision signifies a local role in pressing for increased standards.

- User fees for vehicle ownership. User fees could be applied to vehicle purchases to incentivize the purchase of more fuel efficient vehicles. For example, the difference in the City residential vehicle sticker is only $15 between regular passenger vehicles and large passenger vehicles (including SUVs) which is not nearly enough of a deterrent to purchase a smaller, more efficient vehicle. User fees would need to increase dramatically if long-term behavior and purchasing patterns are to be altered. With investments in new vehicles costing anywhere from $20-40,000, user fees would need to be significant for any local long-term changes to fuel efficiency.
- Feebate. Like a user fee for vehicle ownership, a feebate system, "a tax on vehicle purchases or a rebate given to buyers of new vehicles based on fuel economy," could be implemented in the city on vehicles purchased within the City limits. The tax and rebate are intended to offset each other, with the tax providing the money for the incentive to purchase more efficient vehicles. The Center for Clean Air Policy identifies the CO2e savings potential from a feebate introduced on a state level, or for 100,000 cars, as 1,321 metric tons. A feebate system that encourages even a .01 increase in MPG can significantly reduce CO2e. Like the user fee described above, a feebate would also have to be priced to encourage behavior change—on the order of $1800 for a 20 mpg shift in fuel efficiency.

- Increased gas taxes. Chicago currently has a gas tax rate of five cents per gallon. This is on top of six cents per gallon for Cook County taxes and 21.6 cents per gallon for Illinois (22.6 cents per gallon for diesel). A recent report by the CBO cites a 10 year old study by the U.S. Department of Energy that states a 15 cent hike in the gas tax would reduce VMT by 3.8 percent. Given today's gas prices, it is likely that a higher level of additional taxes would be necessary to achieve the same result. With record high gas prices, it is challenging for a local government to consider substantial increases in gas taxes.
- Expand Vehicle Idling Management Policy. The City currently has a Vehicle Idling Management Policy which limits idling for City vehicles to no more than five minutes per hour while not in traffic. (This policy does not apply to emergency vehicles.) This policy could be expanded by ordinance to apply to private vehicles, including trucks and buses to reduce wasted fuel.[6]

**Cost Considerations**

The costs of implementing an increase in CAFE standards are debatable. The Congressional Budget Office (CBO) estimated in 2004 that a rise in CAFE standards of 3.8 MPG—enough to reduce the amount of gasoline used by 10 percent—would cost $3.6 billion per year nationally, or approximately $230 per new vehicle.[6]

The auto manufacturers paint a different picture. General Motors estimates the cost of raising CAFE standards from 25 to 35 MPG by 2020 at $5-7 thousand per vehicle in current dollars.5 Officials from General Motors also claim that every new car made by 2020 would need to be a hybrid or diesel-powered to meet the new standard.[6]

## Switch to Cleaner Fuels

Replacing a portion of gasoline with cleaner, alternative fuels can generate moderate savings in Chicago's greenhouse gas (GHG) emissions. There are more than 19 pounds of carbon dioxide emitted per gallon of gasoline combusted. Most alternative fuels produce less CO2e per gallon, largely because the CO2 emitted from biofuels during combustion is treated as biogenic carbon and accounted for in agricultural, forestry, and other land use emissions profiles. These biofuel emissions are considered in the lifecycle GHG impacts discussion in this strategy.[6]

### Applicability

Current technology permits the use of ethanol, primarily from corn, biodiesel, and compressed natural gas-powered vehicles. In the near future, the possibility of even lower lifecycle GHG forms of ethanol, such as cellulosic ethanol, and greater use of hydrogen and plug-in electric cars could have an even greater potential for emission reductions. Advanced technologies and alternative fuels are being researched by national laboratories and universities and it is expected that they will become more financially and technically feasible in the near future.[6]

### Benefits

Switching to a greater share of alternative fuels has the potential to save approximately 675,000 metric tons of CO2e annually by 2020. A less aggressive policy would save nearly 440,000 metric tons of CO2e annually by 2020.[6]

Increasing the use of alternative fuels reduces our reliance on fossil fuels, and, therefore, oil imports. Policies that support alternative fuel development, distribution, and use ensure greater energy independence. Other benefits include the potential to increase jobs in the United States directly tied to all aspects of alternative fuel production and use. Alternative fuels, with low tailpipe emissions, can also serve to reduce criterion pollutants which are direct causes/irritants of asthma.[6]

### Implementation

While the long term success of alternative fuels will largely depend on circumstances out of the control of a city government, there a number of options the City can consider in fostering such opportunities. The City can play a role in the rate of deployment for alternative fuel options. Here are some action items that could be considered to help achieve the goals laid out:

- Require the City fleet to use alternative fuels which would help set a local market to both add a supply of alternative fuels for the region, and help add enough volume for economies of scale to work to reduce costs.
- Reduce or waive local sales taxes for alternative fuels while their price remains higher than gasoline. This would remove some price disparity as a barrier to deployment.
- Set benchmarks for annual alternative fuel purchases. If these are not met, the City, with the help of the State, could begin to require fuel stations to sell alternative fuels. This would allow the market to work its course and would only require intervention if it was unable to meet realistic targets that would ensure a reduction in emissions by 2020.[6]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
| --- | --- | --- |
| Gallons of Deisel switched to Biodeisel | biodeisel | Gallons |

$$\text{Deisel (gal)} \times \frac{22.2\text{ (lbs)}}{1\text{ (gal)}} = \text{lbs CO2 Emissions from Deisel}$$

$$\text{Biodeisel (gal)} \times \frac{5.84\text{ (lbs)}}{1\text{ (gal)}} = \text{lbs CO2 Emissions from Biodeisel}$$

lbs CO2 Emissions from Deisel - lbs CO2 Emissions from Biodeisel = CO2 lbs Emissions Saved

## Support Intercity Rail

High speed rail can serve to make intercity passenger travel more efficient—reducing high-emitting passenger vehicle and air trips less than 500 miles in length. High speed rail is a piece of an interconnected transportation system that provides choice, brings economic benefit and stands to reduce CO2e. Introducing high speed rail that will serve Chicago and its residents is at the center of this mitigation strategy.[6]

### Applicability

Intercity travel in the U.S. is currently accomplished primarily using automobiles, airplanes, and buses. Amtrak and commuter rail serve only one percent of all intercity trips. Automobile trips dominate the intercity market accounting for 90 percent of all trips, followed by air with seven percent and bus with only two percent. The idea of intercity rail travel, in particular high speed intercity rail, is gaining in popularity in the U.S. and there are now 11 federally designated high speed rail corridors. Chicago serves as the hub for one of those corridors.[6]

### Benefits

The potential GHG reductions from intercity rail improvements could yield an estimated 1.61 MMTCO2e per year.[6]

The Midwest Regional Rail System would provide a competitive travel option and alternative, especially for smaller cities currently under served by air service. The MWRRS "A Transportation Network for the 21st Century" cites other advantages, such as being attractive to both business and leisure travelers, providing an opportunity to expand the workforce across cities, developing intercity connectivity, and serving as an alternative for those who cannot drive or chose not to own a vehicle.[6]

### Cost Considerations

The Midwest Regional Rail System total costs are estimated at $7.7 billion (2002 dollars). The new fleet of high efficient trainsets will cost approximately $1.1 billion and the necessary infrastructure improvements are estimated to cost $6.6 billion. The $6.6 billion public investment is estimated to spark an additional $2.6 billion in public and private sector investments for improving and building amenities at or near stations.[6]

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## Improve Freight Movement

Freight movement contributes to greenhouse gas emissions—emissions that will continue to grow along with the projected increases in freight for this region. Greenhouse gas (GHG) emissions reductions in the City of Chicago and the region from freight could be realized by implementing one or more of the following suggestions: 1) moving as much freight by rail and waterborne modes as possible; 2) allowing for swift movement of goods—avoiding as much congestion as possible—where mode shift cannot be accomplished; 3) implementing land use and planning practices that allow the region to lower its GHG impact from freight—encouraging development around this historically valuable regional asset; and 4) making rail more efficient.[6]

### Applicability

The freight industry is a major economic force for Chicago and the region. On rail alone, $350 million worth of goods move to, from or through the region annually. There are over 20 railroads that directly employ 37,000 workers with an annual payroll of $1.7 billion operating in the region. The economic force is even greater when considering trucking and related jobs in manufacturing, warehousing, shipping, and firms that cluster near rail access points. Trucks carry $572 million worth of goods, to, from or through the region every year. The Chicago region has 2,800 miles of rail line. There are 78 terminals along these rail lines and they are used by 1,200 trains per day (500 freight and 700 passengers). The freight industry is expected to increase from 37,500 railcars moving through Chicago per day in 2004 to 64,000 railcars moving through Chicago per day in 2030. Assuming linear growth, there will be approximately 53,800 railcars in 2020.[6]

### Benefits

For every percent of ton-miles of freight moved from truck to rail, there will be a national savings of 5.0 MMT $CO_2e$; Chicago's proportion is 0.047 MMT $CO_2e$. For every percent of freight moved by waterborne mode rather than by truck, there will be a national savings of 4.7 MMT $CO_2e$. Chicago's proportion is 0.043 MMT $CO_2e$.[6]

The Chicago Region Environmental and Transportation Efficiency Program (CREATE) estimates that the railroads' diesel consumption will be reduced by 7 million gallons in 2007 with fuel savings expected to increase to 18 million gallons in 2042. Assuming linear growth, there would be a savings of 11 million gallons in 2020. Given that this amount of fuel is expected to be saved in the Chicago region it is estimated that Chicago would save one-third of this amount based population trends, which would amount to a savings of 21,600 million tons $CO_2$ or 0.022 MMT $CO_2e$.[6]

### Cost Considerations

The CREATE Program will take six years to complete and cost an estimated $1.5 billion. The participating railroads will pool their resources together to contribute $232 million toward the $1.5 billion.[6]

The CREATE Program estimates that the Chicago region will generate $595 million for improved efficiencies for rail passengers and motorists. The CREATE Program also estimates air quality improvements valued at $1.1 billion and construction related benefits valued at $2.2 billion.[6]

## Actions

Increase freight by rail and waterborne modes; allow for swift movement of goods where mode shift cannot be accomplished; implement land use and planning practices to lower GHG impact from freight; make rail more efficient.[4]

## Variables for Calculation

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Percent of Truck to Rail | rail | % Ton-Mile |
| Percent of Truck to Waterborne | water | % Ton-Mile |

$$n\ (\%\ \text{Ton-Miles}) \times \frac{0.047\ (\text{MMT CO2})}{1\ (\%\ \text{Ton-Miles})} = \text{MMTCO2 Saved by Switching Freight from Truck to Rail}$$

$$n\ (\%\ \text{Ton-Miles}) \times \frac{0.047\ (\text{MMT CO2})}{1\ (\%\ \text{Ton-Miles})} = \text{MMTCO2 Saved by Switching Freight from Truck to Rail}$$

## Household Recycle

Recycling is processing used materials (waste) into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, reduce air pollution (from incineration) and water pollution (from landfilling) by reducing the need for "conventional" waste disposal, and lower greenhouse gas emissions as compared to virgin production. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse, Recycle" waste hierarchy.

### Applicability

Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics. Although similar in effect, the composting or other reuse of biodegradable waste – such as food or garden waste – is not typically considered recycling.

### Benefits

- Recycling and composting diverted nearly 70 million tons of material away from landfills and incinerators in 2000, up from 34 million tons in 1990-doubling in just 10 years.
- Every ton of paper that is recycled saves 17 trees.
- The energy we save when we recycle one glass bottle is enough to light a light bulb for four hours.
- In the U.S., processing minerals contributes almost half of all reported toxic emissions from industry, sending 1.5 million tons of pollution into the air and water each year. Recycling can significantly reduce these emissions.
- It takes 95% less energy to recycle aluminum than it does to make it from raw materials. Making recycled steel saves 60%, recycled newspaper 40%, recycled plastics 70%, and recycled glass 40%.
- In 2000, recycling resulted in an annual energy savings equal to the amount of energy used in 6 million homes (over 660 trillion BTUs). In 2005, recycling is conservatively projected to save the amount of energy used in 9 million homes (900 trillion BTUs).
- A national recycling rate of 30% reduces greenhouse gas emissions as much as removing nearly 25 million cars from the road.
- Recycled paper supplies more than 37% of the raw materials used to make new paper products in the U.S. Without recycling, this material would come from trees. Every ton of newsprint or mixed paper recycled is the equivalent of 12 trees. Every ton of office paper recycled is the equivalent of 24 trees.
- When one ton of steel is recycled, 2,500 pounds of iron ore, 1,400 pounds of coal and 120 pounds of limestone are conserved.
- Recycling prevents habitat destruction, loss of biodiversity, and soil erosion associated with logging and mining.[28]

### Cost Considerations

Recycling is economical in several ways related to manufacturing processes. Recycling cuts down on waste produced by processing raw materials into usable forms. For example, recycling aluminum reduces mining wastes, processing wastes, and emissions produced by extracting the aluminum from the ore.

Recycling usually requires less refining than raw materials. For example, it takes much less energy to melt down an aluminum can to make another aluminum can than to process the raw materials to make a can. This cuts down on chances for environmental damage and conserves our natural resources.[29]

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## Disconnect Downspout

Traditionally, roof runoff flows through gutters and downspouts into a stormwater system or combined sewer. During a storm event, a large volume of rainwater may overload the sewer system and overflows into rivers and streams. Disconnecting downspouts can reduce stormwater volumes by directing runoff into vegetated areas, which also helps to clean the runoff. Downspouts can also be directed into a rain barrel or cistern for storage.[22]

### Applicability

Effective downspout disconnection requires that there be adequate landscaping or vegetation available to accept water. Rain barrels may be used where vegetation is limited, provided that the collected water can overflow to open green space areas. Diversion and/or storage of roof runoff with rain barrels or cisterns are applicable to most residential, commercial and institutional properties.[22]

### Benefits

Downspout disconnection is simple, inexpensive, effective, and easily integrated into landscape design. It reduces the amount of stormwater entering into the stormwater system and has the potential to remove billions of gallons of residential roof water annually from the combined sewer system. Storing roof runoff for irrigation or gray water systems conserves potable water and can reduce water bills. It is a simple and low cost action that residents can take to improve the health and quality of the water bodies in their cities.[22]

### Maintenance Considerations

Disconnected downspouts require minimal maintenance. The discharge location has to be periodically checked to ensure proper erosion control and drainage. Accumulated leaves or debris should be routinely removed from gutters, and materials' leaks or debris should be checked.[22]

### Cost Considerations

Downspout disconnection is inexpensive. Some cities provide small financial incentives to residents who disconnect themselves or will offer the disconnection at no cost. Materials such as elbows and extensions are readily available at hardware, building supply, and home improvement stores.[22]

### Safety and Siting Requirements

- A common method of residential disconnection is to cut the downspout above the sewer standpipe, plug the standpipe and attach an elbow and extension piece that directs runoff to the discharge point. In many cases, a splash block at the end of the extension conveys water away from foundations and prevents erosion.
- Roof runoff must be discharged at least five feet away from any property lines.
- The discharge from the pipe should not flow toward the building or neighboring property.
- For systems that free-fall to the air away from the building, the collection area below the concentrated discharge must have a minimum of two inches of gravel per story of free-fall or other protective material rated to withstand flows and be spaced away from the building foundation according to the standards above.

Downspouts can also be replaced with other structures that convey roof runoff to the discharge point, such as:

- Drip chains, usually made of steel, with a minimum three-inch diameter
- Scuppers, which collect and concentrate the runoff and allow it to free-fall
- Decorative gargoyles that concentrate the runoff and allow it to free-fall[22]

**Permits**

Some cities require a permit for disconnecting downspouts. Permits are also required if the downspouts are directed to onsite storm water management facilities such as cisterns.[22]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area of Roof | roofArea | Square Feet |
| Annual Rain Fall | annualrain | Inch |

$$\text{roofArea (sf)} \times \text{annualRain (in)} \times \frac{1\ \text{(ft)}}{12\ \text{(in)}} \times \frac{7.4805\ \text{(gal)}}{\text{(ft3)}} = \text{Gallons Water Sequestered}$$

$$\text{stWater (gal)} \times \frac{0.0012\ \text{(kWh)}}{\text{(gal)}} \times \frac{1000\ \text{(watts)}}{1\ \text{(kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{0.00021\ (\$)}{\text{(gal)}} = \text{Money Saved}$$

$$\text{stWater (gal)} \times \frac{0.0012\ \text{(kWh)}}{\text{(gal)}} \times \frac{0.545445\ \text{(lbs)}}{1\ \text{(kWh)}} = \text{CO2 Saved}$$

## Flow Through Planter

Flow-through planters are planter boxes that temporarily store stormwater before it is filtered through vegetation and soil and drained to a disposal point. They are often used on sites where space is limited or where soils are poorly drained or contaminated. Flow-through planters are designed with a layer of gravel, soil, and vegetation. The planters themselves can be created with a variety of materials, such as stone, concrete, brick, plastic, lumber or wood. A variety of small trees, shrubs and other plants can be used in flow-through planters, as long as they are tolerable of seasonally moist and dry soil conditions.[23]

### Applicability

Flow-through planters can be used on most sites, but are especially useful for sites with space constraints because of their smaller footprint. They are good for sites with poorly drained soils, steep slopes, areas with high groundwater, or areas with contamination.[23]

### Benefits

Because flow-through planters temporarily store stormwater, they reduce stormwater runoff flow rates. The filtering of the plants and soil removes pollutants, reduces temperature and improves water quality. Flow-through planters can be attractive, and are easily integrated into the overall landscape design. If sited adjacent to a building, flow-through planters can provide energy benefits to the building.[23]

### Maintenance Considerations

The plants and structural components of flow-through planters require periodical inspection. Remove sediment and clear debris from inlet pipes and curb cuts to maintain proper drainage.[23]

### Cost Considerations

Costs vary depending on size and materials. Flow-through planters are generally more expensive to construct than simpler stormwater infiltration facilities, but they occupy less space on the site. However, for new construction, their cost is comparable or less expensive than conventional stormwater systems.[23]

### Safety and Siting Requirements

- Flow-through planters can be located adjacent to a building foundation because they do not infiltrate the stormwater
- Incorporate an overflow to drain to a proper destination or disposal point[23]

### Permits

Infiltrating stormwater facilities may require a number of permits and inspections based on their location and design. Consult the Stormwater Management Manual and Stormwater Retrofits Permits and Inspections Brochure for specific guidance.[23]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area to Manage | manArea | Square Feet |
| Area of Flow-through Planter | plantArea | Square Feet |
| Cost of System | cost | Dollar |
| Infiltration Rate | infilrate | Numerical Value |
| Storm Water Sequestered | stWater | Gallon |

$$\text{manArea (sf)} \times 6\% = \text{Infiltration Area}$$

$$\text{manArea (sf)} \times \text{annualRain (in)} \times \frac{1\ \text{(ft)}}{12\ \text{(in)}} \times \frac{7.4805\ \text{(gal)}}{\text{(ft3)}} \times \text{infilrate} = \text{Gallons Water Sequestered}$$

$$\text{manArea (sf)} \times \frac{\text{cost (\$)}}{\text{(sf)}} = \text{Cost of infiltration Area}$$

$$\text{stWater (gal)} \times \frac{0.0012\ \text{(kWh)}}{\text{(gal)}} \times \frac{1000\ \text{(watts)}}{1\ \text{(kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{0.00021\ \text{(\$)}}{\text{(gal)}} = \text{Money Saved}$$

$$\text{stWater (gal)} \times \frac{0.0012\ \text{(kWh)}}{\text{(gal)}} \times \frac{0.545445\ \text{(lbs)}}{1\ \text{(kWh)}} = \text{CO2 Saved}$$

## Porous Pavement

Pervious pavement refers to paving materials - typically pervious concrete, stone or plastic - that promote infiltration of rain and snowmelt. These materials are similar to the conventional ones, but have more air space that allow water to pass through the pavement into a reservoir base of crushed aggregate, then infiltrate into the ground. Pervious pavement is designed to accept precipitation only and is typically thicker than traditional contrete to support the same loads.[24]

### Applicability

Pervious pavement is particularly appropriate for the following applications: overflow and special event parking, driveways, utility and access roads, emergency access lanes, fire lanes and alleys.[24]

### Benefits

Pervious pavement reduces stormwater runoff flow rate and volume, recharges groundwater and maintains stream base flows. The subgrade also filters pollutants. Pervious pavement is less prone to cracking or buckling from freezing and thawing. Studies indicate it requires less frequent repair and patching than conventional paving. In some cases, pervious pavement may reduce or eliminate the need for an underground storm drain system or a curb and gutter system. Pervious pavement is an effective method of managing stormwater runoff without limiting use of the space.[24]

### Maintenance Considerations

It is important to control site erosion and sedimentation of the pavement surface to prevent clogging and maintain permeability. Cleaning or vacuuming the surface once or twice a year maintains porosity. Vegetated paving blocks may require occasional mowing. Properly installed pervious paving systems last more than 20 years.[24]

### Cost Considerations

Pervious concrete pavements range in cost depending on the size of the installation. Costs can be as much as two to three times greater than conventional concrete or asphalt. However, there are indications that pervious pavement requires less frequent replacement.[24]

### Safety and Siting Requirements

- Follow manufacturer’s installation instructions.
- Weather conditions during installation can affect the performance and longevity of pervious pavement. Check with manufacturers for guidelines.
- Slope must be less than 10% over the paved area.
- Use pervious pavement over soils that drain well, like gravelly or loamy sand.
- Do not use pervious pavements in areas with high sediment loads.
- Pervious pavement is not allowed in areas where hazardous material is stored or transported.
- Most systems include an under layer of at least 12 inches of clean gravel over a layer of geotextile fabric. The under layer serves as an underground detention basin and should include an overflow outlet to prevent water from rising through the pavement.[24]

**Permits**

Pervious pavement systems used to replace public parking or walkway areas may require a building permit from your City. Stormwater systems on non-residential sites need commercial building permits.[24]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area to Manage | manArea | Square Feet |
| Area of Porous Pavement | pavArea | Square Feet |
| Cost of System | cost | Dollar |
| Infiltration Rate | infilrate | Numerical Value |
| Storm Water Sequestered | stWater | Gallon |

$$\text{manArea (sf)} \times 4\% = \text{Paved Area}$$

$$\text{manArea (sf)} \times \text{annualRain (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} \times \frac{7.4805\text{ (gal)}}{\text{(ft3)}} \times \text{infilrate} = \text{Gallons Water Sequestered}$$

$$\text{pavarea (sf)} \times \frac{\text{cost (\$)}}{\text{(sf)}} = \text{Cost of Paved Area}$$

$$\text{stWater (gal)} \times \frac{0.0012\text{ (kWh)}}{\text{(gal)}} \times \frac{1000\text{ (watts)}}{1\text{ (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{0.00021\text{ (\$)}}{\text{(gal)}} = \text{Money Saved}$$

$$\text{stWater (gal)} \times \frac{0.0012\text{ (kWh)}}{\text{(gal)}} \times \frac{0.545445\text{ (lbs)}}{1\text{ (kWh)}} = \text{CO2 Saved}$$

## Infiltration Planter

Infiltration planters are structures or containers with open bottoms that allow stormwater to infiltrate into the ground. They are often used on sites where space is limited. Infiltration planters are designed with a layer of gravel, soil, and vegetation. The planters themselves can be created with a variety of materials, such as stone, concrete, brick, plastic, lumber or wood. A variety of small trees, shrubs and other plants can be used in infiltration planters, as long as they are tolerable of seasonally moist and dry soil conditions. Infiltration planters are likely to need watering and weeding in the first one to three years.[25]

### Applicability

Infiltration planters can be used on most sites. They are especially useful for sites with space constraints, because of their smaller footprint, and work best on sites with good drainage.[25]

### Benefits

Infiltration planters reduce stormwater runoff flow rate, volume, temperature and pollutants, and recharge groundwater. Infiltration planters can be attractive, and are easily integrated into the overall landscape design. If sited adjacent to a building, infiltration planters can provide energy benefits to the building.[25]

### Maintenance Considerations

The plants and structural components of infiltration planters require periodic inspection. Remove sediment and clear debris from inlet pipes and curb cuts to maintain proper drainage.[25]

### Cost Considerations

Costs vary depending on size and materials. Infiltration planters are generally more expensive to construct than simpler stormwater infiltration facilities, but they occupy less space on the site.[25]

### Safety and Siting Requirements

- Infiltration planters should be located at least five feet from any property line
- Variances or adjustments may be required to locate an infiltration planter closer than ten feet from the building foundation
- Infiltration planters are located flush to the ground or above ground.
- Incorporate an overflow to drain to a proper destination or disposal point.[25]

### Permits

Infiltrating stormwater facilities may require a number of permits and inspections based on their location and design. Consult the Stormwater Management Manual and Stormwater Retrofits Permits and Inspections Brochure for specific guidance.[25]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area to Manage | manArea | Square Feet |
| Area of Infiltration Planter | plantArea | Square Feet |
| Cost of System | cost | Dollar |
| Infiltration Rate | infilrate | Numerical Value |
| Storm Water Sequestered | stWater | Gallon |

$$\text{manArea (sf)} \times 6\% = \text{Infiltration Area}$$

$$\text{manArea (sf)} \times \text{annualRain (in)} \times \frac{\text{1 (ft)}}{\text{12 (in)}} \times \frac{\text{7.4805 (gal)}}{\text{(ft3)}} \times \text{infilrate} = \text{Gallons Water Sequestered}$$

$$\text{manArea (sf)} \times \frac{\text{cost (\$)}}{\text{(sf)}} = \text{Cost of infiltration Area}$$

$$\text{stWater (gal)} \times \frac{\text{0.0012 (kWh)}}{\text{(gal)}} \times \frac{\text{1000 (watts)}}{\text{1 (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{\text{0.00021 (\$)}}{\text{(gal)}} = \text{Money Saved}$$

$$\text{stWater (gal)} \times \frac{\text{0.0012 (kWh)}}{\text{(gal)}} \times \frac{\text{0.545445 (lbs)}}{\text{1 (kWh)}} = \text{CO2 Saved}$$

## Rain Garden

Rain gardens are shallow landscaped depressions used to infiltrate and reduce stormwater runoff. Also known as vegetated infiltration basins, rain gardens rely primarily on infiltration to reduce stormwater volumes, although they can be modified with under-drains if infiltration conditions are poor. They can be planted with a combination of trees, shrubs, grasses and flowering perennials as part of an integrated landscape design. Rain gardens can often manage stormwater runoff from small storm events. If sized properly, they can manage stormwater from larger events; otherwise a safety overflow may be required. Rain gardens are ideally suited for people who have an interest in gardening since they can be easily integrated into a landscape design. Depending on the plants selected, they can provide food and shelter for many birds, butterflies, and beneficial insects.[26]

### Applicability

Rain gardens are suitable for all properties with soil conditions suitable for infiltration. Rain gardens can manage stormwater generated from roofs, patios, driveways, parking areas, and other impervious areas.[26]

### Benefits

Rain gardens are very effective at reducing stormwater flows and volumes through storage and infiltration and improving water quality by settling and filtering out pollutants. The vegetation also helps prevent soil erosion, provides wildlife habitat, and is visually attractive.[26]

### Maintenance Considerations

Rain garden maintenance is similar to the maintenance of a typical garden. During the first couple years, rain gardens will need watering and weeding until the plants become established. In addition to weeding, rain gardens will need periodic removal of sediment and debris. Rain gardens should be checked after large storm events to ensure proper function.[26]

### Cost Considerations

Rain garden costs will vary depending on existing conditions, design, and material selection. Planned and designed properly, a rain garden is likely to be effective for over 20 years.[26]

### Safety and Siting Requirements

- Rain gardens infiltrate stormwater and are often required by building codes to be a minimum distance from property lines and building foundations (typically 5-ft from property lines and 10-ft from buildings).
- Like other infiltration facilities, rain gardens are usually not appropriate in areas with high water tables
- Rain gardens are not designed as ponds; they should drain within 30 hours of storm event
- Consider pre-treatment facilities (such as swales) to remove sediment before it enters the rain garden
- Rain gardens work best in areas that drain relatively shallow slopes of usually less than 5%. Runoff from steeper slopes can be piped into the basin with proper erosion control measures in place.
- Overflow or disposal systems may be required, depending on the sizing of the rain garden.[26]

**Permits**

Local building department codes may require a permit to construct a flow-through planter. Please contact your local building department.[26]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area to Manage | manArea | Square Feet |
| Rain Garden Area | gardenArea | Square Feet |
| Cost of System | cost | Dollar |
| Infiltration Rate | infilrate | Numerical Value |
| Stormwater Sequestered | stWater | Gallon |

$$\text{manArea (sf)} \times 6\% = \text{Rain Garden Area}$$

$$\text{manArea (sf)} \times \text{annualRain (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} \times \frac{7.4805\text{ (gal)}}{\text{(ft3)}} \times \text{infilrate} = \text{Gallons Water Sequestered}$$

$$\text{manArea (sf)} \times \frac{\text{cost (\$)}}{\text{(sf)}} = \text{Cost of Rain Garden}$$

$$\text{stWater (gal)} \times \frac{0.0012\text{ (kWh)}}{\text{(gal)}} \times \frac{1000\text{ (watts)}}{1\text{ (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{0.00021\text{ (\$)}}{\text{(gal)}} = \text{Watts Saved}$$

$$\text{stWater (gal)} \times \frac{0.0012\text{ (kWh)}}{\text{(gal)}} \times \frac{0.545445\text{ (lbs)}}{1\text{ (kWh)}} = \text{Watts Saved}$$

## Drywell

A drywell is an underground perforated pipe surrounded with gravel that collects stormwater runoff and infiltrates it into the ground. Stormwater from roofs, parking lots, and other impervious surfaces flows through an inlet pipe that empties into the drywell. Drywells are made from concrete or plastic in a variety of widths and depths. A catch basin may be required for drainage areas other than residential roofs.[27]

### Applicability

Drywells can be installed under any surface with adequate drainage. They are not allowed for wastewater drainage or in wellhead protection areas. Plants can be established on top of the facility, however there is a need for occasional access for maintenance and inspection.[27]

### Benefits

Drywells reduce runoff flow rate, volume, and temperature, and help recharge groundwater. They are disposal only systems and are usually paired with a water quality or pretreatment facility.[27]

### Maintenance Considerations

Periodically inspect drywell systems to ensure proper operation and structural stability. Maintenance needs include controlling erosion, removing excessive debris, and cleaning and repairing inlet and outlet pipes. Clogged drywells must be refurbished or replaced. A drywell can last up to 30 years with proper construction and maintenance.[27]

### Cost Considerations

Drywells are commonly available from construction supply companies, and are relatively inexpensive to install and maintain. Depending on their size, drywell systems cost from $1,200 to $1,500 including installation.[27]

### Safety and Siting Requirements

- Drywells are prohibited where there is permanent or seasonal groundwater within 10 feet of the bottom of the drywell.
- Use drywells in soils that drain well and in areas with low water tables.
- Place drywells at least 10 feet from the building foundation or basement, 20 feet from any cesspool, and five feet from any property lines.
- Pits for drywells must be at least four feet in diameter and five feet deep. Minimum drywell diameter is 28 inches.
- Drywells must be at least 500 feet from private drinking water wells.
- Refer to your City's Stormwater Management Manual for details on sizing, placement, and design.[27]

### Permits

Most drywells require a City permit. Check with your City for specific permit requirements.[27]

**Variables for Calculation**

| Name | Abbreviation | Units of Measure |
|---|---|---|
| Area to Manage | manArea | Square Feet |
| Annual Rain Fall | AnnualRain | Inch |
| Drywell Circumference | dwCirc | Inch |
| Drywell Depth | dwDepth | Feet |
| Drywell Cost | Cost | Dollar |
| Stormwater Saved | stWater | Gallon |

$$\text{manArea (sf)} \times \text{annualRain (in)} \times \frac{1\text{ (ft)}}{12\text{ (in)}} \times \frac{7.48051948}{1\text{ (ft3)}} = \text{gallons of Water Sequestered}$$

$$\text{stWater (gal)} \times \frac{0.0012\text{ (kWh)}}{1\text{ (gal)}} \times \frac{12\text{ (mon)}}{1\text{ (yr)}} \times \frac{1000\text{ watts}}{1\text{ (kWh)}} \times \frac{300}{2592000} = \text{Watts Saved}$$

$$\text{manArea (sf)} \times \frac{0.54\text{ (\$)}}{1\text{ (sf)}} = \text{\$ Cost}$$

$$\text{stWater (gal)} \times \frac{0.00021\text{ (\$)}}{1\text{ (gal)}} = \text{\$ Saved}$$

$$2\text{ (ft)} + \text{manArea (sf)} \times \frac{1\text{ (ft)}}{200\text{ (sf)}} = \text{Drywell Depth (ft)}$$

## Shift to Alternative Refrigerants

This strategy proposes the use of alternative refrigerants to replace greenhouse gas producing HydroFluoroCarbons (HFCs), used primarily in air conditioners, refrigerators and freezers.[6]

### Applicability

The most popular replacement for HCFC (Freon was one of the most common HCFCs used) became HFC-134a, developed by DuPont. HFC-134a met the standards set by the Montreal Protocol by producing no harmful ozone gases. However, HFC-134a has a global warming potential (GWP) of 1,300—meaning that one ton of HFC-134a is the equivalent to 1,300 tons of CO2 in terms of climate change impact. Since the Montreal Protocol was designed only to reduce ozone depleting gases, it placed no restrictions on HFCs. These HFCs do not produce greenhouse gases during normal use but they can be released through leakage or when service is incorrectly performed on the refrigeration or air-conditioning system.[6]

### Benefits

A reduction of 50 percent of the business as usual forecast in ozone depleting substitutes in Chicago would result in savings of 1.159 MMT CO2e—greenhouse gases (GHG)—in 2020.[6]

Assuming a suitable replacement is found, the benefit would be greatly reduced production of greenhouse gases. This should not alter the types of refrigeration that currently serve the market. The average consumer will be unaware of the transformation, just as when HCFCs were phased out in favor of HFCs.[6]

### Life Cycle Considerations

HFCs have large life cycle GHG impacts as they require large investments of energy for the development of facilities and manufacturing. This is in addition to the large amount of toxic waste produced in the manufacturing process, which must be disposed of in some way. Reducing, and eventually replacing HFCs, will have wide-scale GHG savings potential.[6]

### Cost Considerations

Manufacturers will pass along research and production costs to the consumer, however, the cost is not expected to change to a large degree, which makes these replacements feasible from a financial perspective. These burdens can be greatly reduced if replacements can be found that would not require systems to be redesigned.[6]

### Safety and Siting Requirements

HFCs are potent greenhouse gases with a very high global warming potential (GWP). According to the Intergovernmental Panel on Climate Change (IPCC), the GWP of one kilogram of F-Gases is several thousand times that of one kilogram of CO2 (using a 100-yr GWP estimate). The most commonly used HFC is HFC 134a. This chemical has a GWP of 1,430 (meaning a ton of HFC 134a in the atmosphere has the same effect as 1,430 tonnes of carbon dioxide). Some of the other HFCs have GWPs that are even worse: HFC-23 has a GWP of 14,760, HFC-143a a GWP of 4,470 and HFC-125 a GWP of 3,500. The GWP potential of CO2 is 1.[21]

| | Lifetime (years) | | 20 Years | | 100 Years | | 500 Years | |
|---|---|---|---|---|---|---|---|---|
| HFC-23 | 270 | (260) | 12,000 | (9400) | 14,800 | (12,000) | 12,200 | (10,000) |
| HFC-134a | 14 | (13.8) | 3,830 | (3,300) | 1,430 | (1,300) | 435 | (400) [21] |

**Variables for Calculation**

| **Name** | **Abbreviation** | **Units of Measure** |
|---|---|---|
| Quantity of AC Units | AC | Numerical Value |
| lbs of HFCs per AC Unit | hfclbs | Pound |
| lbs of Alt. Refrigerant per AC Unit | arlbs | Pound |
| GWP of HFC | hfcgwp | GWP |
| GWP of Alternative Refrigerant | argwp | GWP |

$$\text{AC (units)} \times \frac{6\text{ (lbs HFC)}}{1\text{ (AC)}} \times \frac{1300\text{ (GWP)}}{1\text{ (lbs HFC)}} = \text{Current GWP}$$

$$\text{AC (units)} \times \frac{6\text{ (lbs AR)}}{1\text{ (AC)}} \times \frac{40\text{ (GWP)}}{1\text{ (lbs AR)}} = \text{GWP Reduce by Using Alternative Refrigerants}$$

Current GWP - GWP Reduce by Using Alternative Refrigerants = GWP Saved

## Manage Heat

The term “heat island” describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with 1 million people or more can be 1.8–5.4°F (1–3°C) warmer than its surroundings. In the evening, the difference can be as high as 22°F (12°C). Heat islands can affect communities by increasing summertime peak energy demand, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and mortality, and water quality.[30]

### Applicability

Many communities are taking action to reduce urban heat islands using four main strategies:
1) increasing tree and vegetative cover
2) installing green roofs (also called “rooftop gardens” or “eco-roofs”)
3) installing cool—mainly reflective—roofs
4) using cool pavements[31]

### Benefits

The extent to which urban areas can benefit from heat island reduction strategies depends on a number of factors—some within and some outside of a community’s control. Although prevailing weather patterns, climate, geography, and topography are beyond the influence of local policy, decision makers can select a range of energy-saving strategies that will generate multiple benefits, including vegetation, landscaping, and land use design projects, and improvements to building and road materials.

- Trees, vegetation, and green roofs can reduce heating and cooling energy use and associated air pollution and greenhouse gas emissions, remove air pollutants, sequester and store carbon, help lower the risk of heat-related illnesses and deaths, improve stormwater control and water quality, reduce noise levels, create habitats, improve aesthetic qualities, and increase property values.
- Cool roofs can lower cooling energy use, peak electricity demand, air pollution and greenhouse gas emissions, heat-related incidents, and solid waste generation due to less frequent re-roofing.
- Cool pavements can indirectly help reduce energy consumption, air pollution, and greenhouse gas emissions. Depending on the technology used, cool pavements can improve stormwater management and water quality, increase surface durability, enhance nighttime illumination, and reduce noise.[31]

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## Implement Green Urban Design

By design and function, urban areas are filled with impervious surfaces: roofs, roads, sidewalks, and parking lots. Although all contribute to stormwater runoff, the effects and necessary mitigation of the various types of surfaces can vary significantly. Of these, roads and travel surfaces present perhaps the largest flow regime altering and urban pollution sources. However, roads also present one of the greatest opportunities for green infrastructure use. One principle of green infrastructure involves reducing and treating stormwater close to its source. Urban transportation right-of-ways integrated with green techniques are often called "green streets". Green Streets achieve multiple benefits, such as improved water quality and more livable communities, through the integration of stormwater treatment techniques which use natural processes and landscaping. Green streets can incorporate a wide variety of design elements. Although the design and appearance of green streets will vary, the functional goals are the same: provide source control of stormwater, limit its transport and pollutant conveyance to the collection system, and provide environmentally enhanced roads.[32]

**Green Streets are designed to:**

- Mimic local hydrology prior to development
- Provide multiple benefits along the street right of way including:
  - Integrated system of stormwater management within the right of way
  - Volume reductions in stormwater which reduce the volume of water discharged via pipe into receiving streams, rivers and larger bodies of water
  - Key linking component in community efforts to develop local green infrastructure networks
  - Aesthetic enhancement of the transit right of way
  - Improves local air quality by providing interception of airborne particulates and shade for cooling
  - Enhanced economic development along the transit corridor
  - Improved pedestrian experience along the street right of way."[32]

**Numerous approaches are available for creating Green Streets including:**

- Alternative Street Designs (Narrower Street Widths): A green street design begins before any BMPs are considered. If building a new street or streets, the layout and street network must be planned to respect the existing hydrologic functions of the land (preserve wetlands, buffers, high-permeability soils, etc.) and minimizing the impervious area. If retrofitting or redeveloping a street, opportunities to eliminate unnecessary impervious area should be explored.

- Swales: Swales are vegetated open channels designed to accept sheet flow runoff and convey it in broad shallow flow. The intent of swales is to reduce stormwater volume through infiltration, improve water quality through vegetative and soil filtration, and reduce flow velocity by increasing channel roughness. In the simple roadside grassed form, they have been a common historical component of road design. Additional benefit can be attained through more complex forms of swales, such as those with amended soils, bioretention soils, gravel storage areas, underdrains, weirs, and thick diverse vegetation.

- Bioretention Curb Extensions and Sidewalk Planters: Bioretention is a versatile green street strategy. Bioretention features can be tree boxes taking runoff from the street, indistinguishable from conventional tree boxes. Bioretention features can also be attractive attention grabbing planter boxes or curb extensions. Many natural processes occur within bioretention cells: infiltration and storage reduces runoff volumes and attenuates peak flows; biological and chemical reactions occur in the mulch, soil matrix, and root zone;

and stormwater is filtered through vegetation and soil.

- Permeable Pavement: Permeable pavement comes in four forms: permeable concrete, permeable asphalt, permeable interlocking concrete pavers, and grid pavers. Permeable concrete and asphalt are similar to their impervious counterparts but are open graded or have reduced fines and typically have a special binder added. Methods for pouring, setting, and curing these permeable pavements also differ from the impervious versions. The concrete and grid pavers are modular systems. Concrete pavers are installed with gaps between them that allow water to pass through to the base. Grid pavers are typically a durable plastic matrix that can be filled with gravel or vegetation. All of the permeable pavement systems have an aggregate base in common which provides structural support, runoff storage, and pollutant removal through filtering and adsorption.

- Sidewalk Trees and Tree Boxes: From reducing the urban heat island effect and reducing stormwater runoff to improving the urban aesthetic and improving air quality, much is expected of street trees. However, most often street trees are given very little space to grow in often inhospitable environments. The soil around street trees often becomes compacted during the construction of paved surfaces and minimized as underground utilities encroach on root space. By providing adequate soil volume and a good soil mixture, the benefits obtained from a street tree multiply. To obtain a healthy soil volume, trees can simply be provided larger tree boxes, or structural soils, root paths, or "silva cells" can be used under sidewalks or other paved areas to expand root zones. These allow tree roots the space they need to grow to full size.
- Climate scientists estimate that a 50-85 percent reduction below 2000 global GHG emissions by 2050 is required to achieve an atmospheric concentration of GHGs at 445-490 ppm and stabilize the climate at 2.0
- 2.4 degrees Celsius above pre-industrial temperatures.[32]

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