UBC Social Ecological Economic Development Studies (SEEDS) Student Report

Revealing Carbon in Hampton Place

Laiyi Chow

Barry Jonat

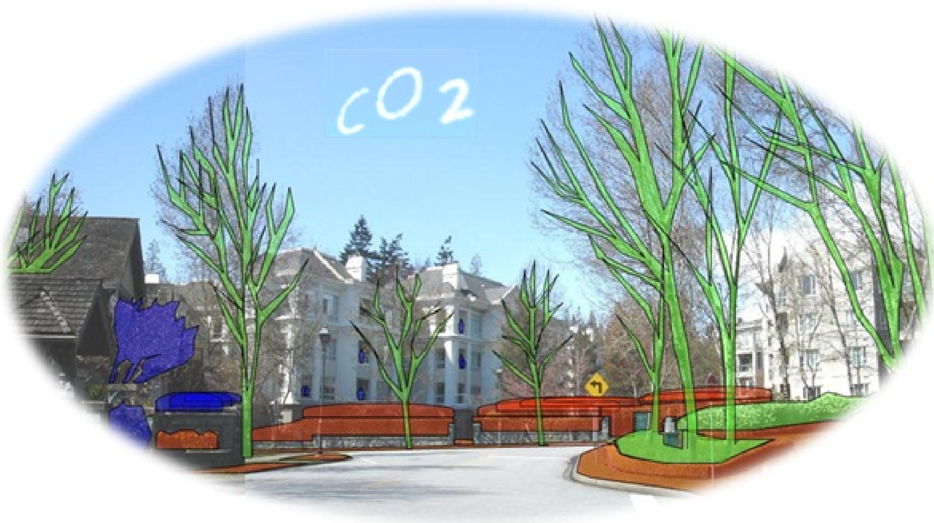
Martin Lewynsky

University of British Columbia

FRST 490/521C

April, 2011

Revealing Carbon in Hampton Place



Laiyi Chow, Barry Jonat, Martin Lewynsky

FRST 490/521C Landscape Planning for Sustainability

April 2011

Table of Contents

List of Figures

List of Tables

Introduction

As people become increasingly aware of climate change and its consequences they have began to examine the sustainability of their own communities and neighbourhoods. This report is intended to serve as a visual assessment of sustainability in the Hampton Place neighbourhood, a member of UBC's UNA. The result is an initial understanding of the community's carbon footprint, identification of key visual indicators, and recommendations for further study.

Objectives

The goal of the project is to reveal carbon in Hampton Place. This project seeks to answer the following questions.

1) What is the area's carbon footprint?
2) Can you or residents see their carbon footprint?
3) How could the carbon footprint be made more visible?
4) Provide a base and recommendations for UNA to continue with the study.

To answer the questions for the residential area the research and tasks were divided into the following items.

1) Identify resource/carbon sources, sinks and pools within the landscape and assess sustainability
2) Examine social behaviour and perceptions within the context of sustainability
3) Identify and examine visual sustainability indicators
4) Estimate carbon footprint
5) Develop visuals to convey findings to stakeholders
6) Determine potential focus of future studies

Methods

To accomplish these tasks we collected both quantitative and qualitative data from various sources. Qualitative data was collected through visual observations and recorded using photographs and notes. Quantitative data was collected through research and readily available information on the UNA neighbourhoods, as well as comparable neighbourhoods. We used MS Excel to produce numerical figures to support visual data.

To visually display carbon in the landscape we developed a series of graphics for each different type of carbon sources in the neighbourhood. One type of graphic that we produced is a colour coded cross section showing a range of carbon intensity. Starting with a photo from Hampton Place we placed polygons over features that were known to either be low or high carbon sources. We also supplemented these cross sections with related photos to highlight details that are not easily distinguished.

Site Assessment

SPATIAL CHARACTERISTICS

Table 1: Impervious and green surface areas in Hampton Place

Total Area	108675 m^2	
Buildings	Area	
St. James House	4390	
The Chatham	823	
The Bristol	4092	
Wyndham Hall	1560	
The Stratford	625	
The Regency	644	
The Balmoral	750	
The Pemberley	1936	
The Sandringham	6350	
West Hampstead	4930	
Thames Court	6431	
Total Building Area	32531 m^2	
Public Road	Area	
Hampton Place Street	7762	
Total Public Road Area	7762 m^2	
Driveways	Area	
St. James House	318	
The Chatham	500	
The Bristol	252	
Wyndham Hall & The Stratford	632	
The Regency	101	
The Balmoral	498	
The Pemberley	364	
The Sandringham	1629	
West Hampstead	1754	
Thames Court	1156	
Total Driveway Area	7204 m^2	
Public Sidewalk	Area	
Hampton Place Street	2172	
Total Public Sidewalk Area	2172 m^2	
Private Sidewalk	Area	
Estimated 18% of each strata	6506	
Total Private Sidewalk Area	6506 m^2	
Total Impervious Space	**56174 m^2**	**52%**
Total Green Space	**52501 m^2**	**48%**
Impervious/Green Space	**1.07**	

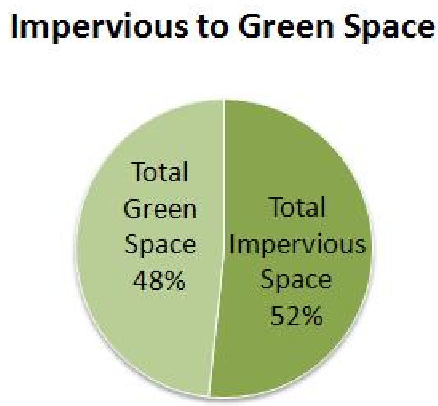


Figure 1: Comparison of total impervious space to total green space

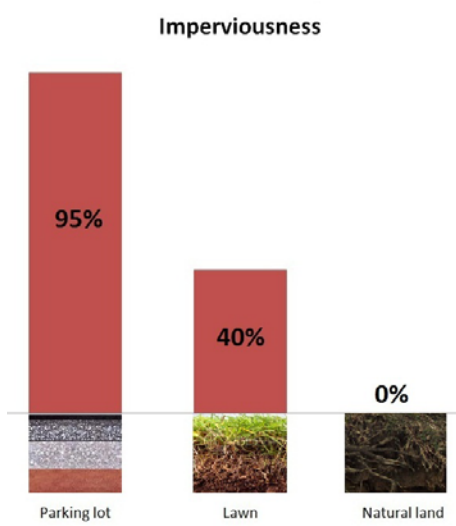


Figure 3: Imperviousness of parking lot, lawn grass, and natural land in most cases

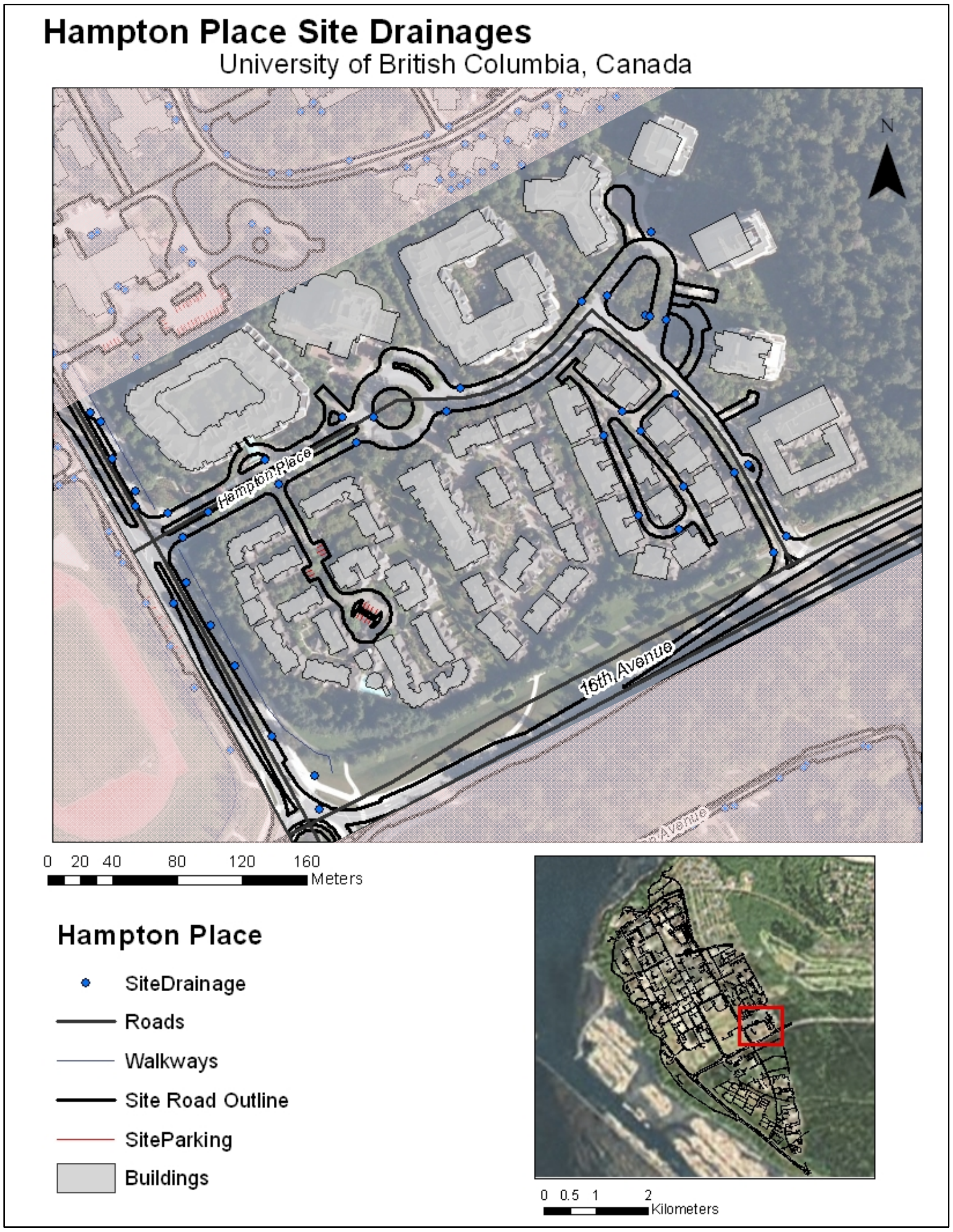


Figure 2: Distribution of storm drainages in Hampton Place (ArcGIS Map created by Thea Sellmann and modified by Laiyi Chow)

The land coverage types in Hampton Place are considered for examining the general land uses of the area. Impervious and green spaces are the two broad land coverage classes used. The impervious surfaces were broken down into areas of buildings (or rooftops), public roads, driveways, public sidewalk and private sidewalk, as shown in Table 1 of area calculations and Figure 1 of impervious to green space comparison. Based on the area estimations, the total area of rooftops are the largest impervious space and the total area of public roads is the second largest impervious space. Also, the total area of driveways is approximately the same as the total area of public roads. These findings suggest that accessibility and mobility are of primary importance for Hampton Place residents.

Based on the Carrall Greenway B street example from the Elements db program, a low to moderate capacity road (or collector road) with stormwater mitigation can have zero net imperviousness (Kellett & Girling, 2010). This is probably because rainwater and used municipal water flow down via storm drainages. Based on the ArcGIS map of storm drainages in Hampton Place (see Figure 2), there are many storm drainages in the neighbourhood. At the watershed scale, water from Hampton Place is redirected down storm drainages and may reach the local creek, called Booming Ground Creek (UBC Campus and Community Planning, 2011).

In contrast, a street without stormwater mitigation is nearly 100% impervious based on examples in the Elements db program. Since paved streets alone are highly impervious, the pavement limits urban tree roots to rainwater and air. This causes a need to intensively manage the urban trees and other plants for appearance and optimal growing conditions, in particularly, optimal aeration and soil moisture content. Unlike natural lands, the grass allows some water to infiltrate the soil because grass (or lawn) is generally 40% impervious as shown in Figure 3 (Bowles, 2002). In this case, green space, which includes grass, shrubs, and urban trees, make up approximately of Hampton Place.

LANDSCAPING

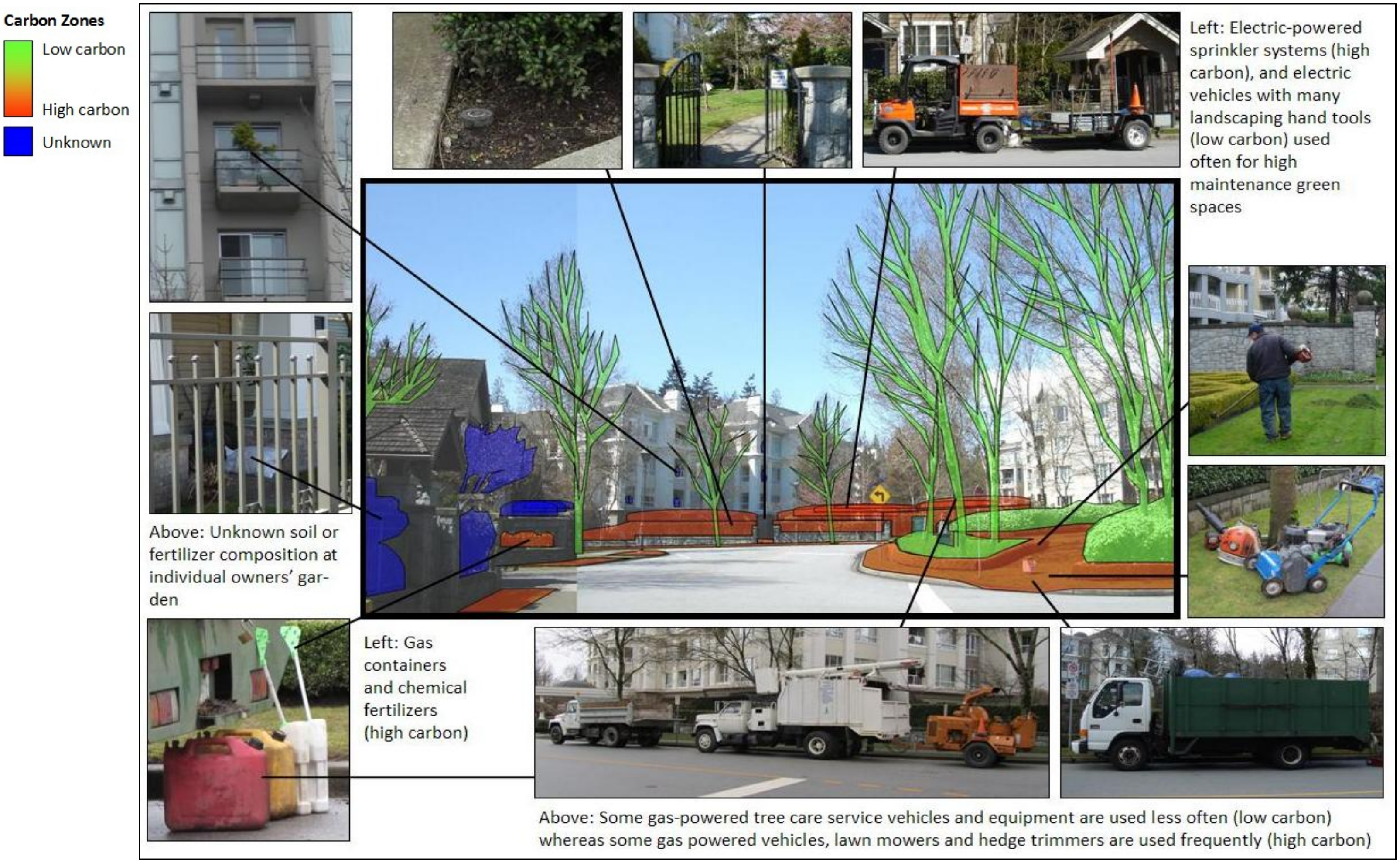


Figure 4: Landscaping cross section of The Sandringham (on the left), The Bristol (in the centre) and park-like island (on the right) with carbon associations

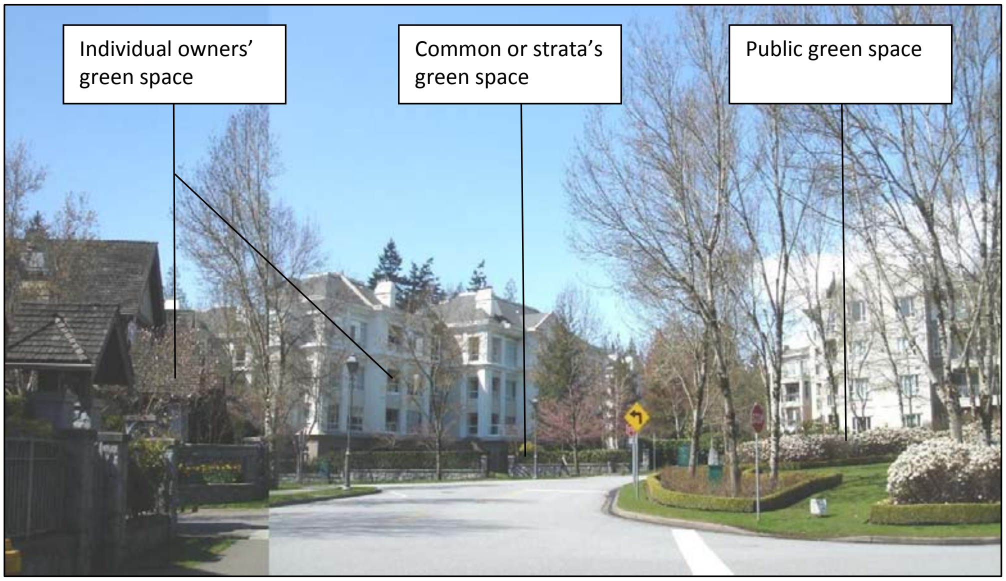


Figure 5: The main types of green space in Hampton Place with The Sandringham (on the left), The Bristol (in the centre) and park-like island (on the right)

Landscaping and irrigation services are significant UNAs expenses. According to UNA financial information, landscaping expenses have been increasing since 2005 (UNA, 2010). In Hawthorn Place these costs were spent primarily on maintenance of grass and fall leaf clean-up (Colter, 2010). In comparing the types of landscape space in Hampton Place to Hawthorn, it is estimated that the former has higher pruning costs and lower grass maintenance costs. Despite this difference, resource allocations are likely very similar between the two communities.

While approximately half of the land in Hampton Place is classified as 'green space', these areas may not necessary be very "green" in terms of sustainability or climate change mitigation, as shown in Figure 4. These green spaces can be found in public green space (i.e. park-like island or roundabout), common or strata's green space, and individual owners' green space (i.e. gardens on ground floor or in pots. Landscaping service that occurs in the public and common green spaces could be assessed, whereas individual owners' green space remains uncertain due to respect for privacy. Visual assessments of the former indicate that there are both low and high carbon landscaping activities.

Public and Common Green Space

In assuming that UNA invests only on landscaping the public and strata's green space (see Table 2), the visual analysis of carbon usage focuses on these areas.

Table 2: Comparison of green spaces by professional landscaping service and do-it-yourself landscaping

Type of green space	**Hired landscaping service**	**Do-it-yourself landscaping**
Individual owner's green space	?	✓
Common or strata's green space	✓	?
Public green space	✓	none*

* Hampton Place currently does not have a community garden (UNA, 2010).

Grass, Flowers, and Shrubs

A large portion of the public and strata's green space is made up of grass lawns, flowers, and manicured shrubs, all appearing to be high maintenance. Based on a conversation with a landscaper, the lawn is cut weekly using gas-powered lawn mowers (personal communication, unknown, March 23, 2011). According to Environment Canada, running a "gas powered lawnmower for 1 hour is equal to driving a new car between 320 and 480 kilometres" (Environment Canada, 2007). This would be similar to driving the distance from UBC Vancouver to Kamloops. Gas powered lawn mowers and hedge trimmers have extremely inefficient motors, with a significant proportion of fuel being emitted without being fully combusted (U.S. Environmental Protection Agency, 2011). Despite having small motors, these tools emit more soot and GHG's per unit of energy production than car engines. Therefore, the amount of greenhouse gasses emitted per year from managing grass lawns and manicured shrubs alone could be very high (see Recommendations for more information).

In addition, gas-powered vehicles are used to transport the heavy equipment to site, contributing to the greenhouse gases emissions in Hampton Place. By contrast, smaller electric vehicles were seen being used to carry hand tools for managing the hedges, shrubs and plants. . However, in visiting Hampton Place at different times of the week, gas-powered large vehicles appear to be used more often than not.

Water is another resource that is heavily relied on for maintenance of grass lawns and shrubs. At first glance the green coloured electric boxes and black sprinkler heads blend in well with the green shrubs and dark brown soil, as they are designed to do. However, this may prevent people from realizing their impact. While these sprinkler systems have an automatic schedule, which has the potential to allow the UNA to manage and conserve water (Statistics Canada, 2008), it is fairly common for these schedules to run whether watering is required or not. Having found excess water flow from a public green space (see Figure X), pollutants that accumulate on the impervious surfaces, and chemical fertilizers that may not have penetrated deep in the soil, run-off into storm drainages (Capital Regional District, 2011; Statistics Canada, 2008). These pollutants and chemicals most likely reach the local creek and may influence the aquatic ecosystem downstream because higher concentrations of contaminants were found in the South catchment than an undisturbed catchment based on a water quality assessment in 2005 (Macdonald, 2005).

In accounting for the emissions from municipality-treatment of water, fertilizer production and transportation, and regular care, maintaining grass lawns are not only costly, but also a high carbon aesthetic. This is also applicable to the non-native flowers and shrubs planted in the area as these plants are often not able to survive without significant maintenance.

Figure 6: Electrically controlled and powered sprinkler system

Figure 7: Excess water usage

Urban Trees

Impervious surfaces can cause unintended consequence related to the heat island effect (NOAA Coastal Services Center, 2011). Impervious surfaces like roofs, parking lots and roads absorb and emit heat, increasing temperatures in Hampton Place (NOAA Coastal Services Center, 2011). The increase in temperature likely encourages residents to use air conditioning, contributing to greenhouse gases in the atmosphere. Based on observations, urban trees may be mitigating the heat island effect by supplying shade and reducing the amount of heat absorbing surface area. This also reduces energy demand by regulating temperatures (NOAA Coastal Services Center, 2011). Estimates of urban forest carbon sequestration were limited by available data.

For estimating annual carbon sequestration of urban tree or reduction of carbon emissions in a local area, i-Tree is a software produced by USDA Forest Service that allows one to model carbon effects based on one's local field data (USDA Forest Service, 2011). Unlike many forest carbon calculators, this software also allows one to focus on municipality's street trees (USDA Forest Service, 2006).

Individual Owners' Green Space

In walking along the public sidewalk, a watering can and package of soil or fertilizer were found near one Hampton Place resident's doorstep, and a garden hose and hand tools were found at another resident's outdoor space. These observations suggest that some residents are interested in gardening and landscaping themselves. At most individual owners' green space, there were mainly non-native flowers and shrubs planted. This composition of green space probably requires more maintenance than a composition of native species that would be more adapted to Vancouver climate (U.S. Environmental Protection Agency, 2008). Also, based on the spatial arrangement of flower pots and rooted plants, vegetables and herbs are not likely grown in the area. However, sights and signs of edible landscape can be difficult to find in March and in the small sample of green spaces from the public sidewalk. Since the use of fertilizers, pesticides, and water is largely uncertain, the carbon effects are also uncertain in the individual owners' green space.

TRANSPORTATION

Figure 8: Transportation cross section of Hampton Place entrance along Wesbrook Mall with carbon associations

Snapshots of different modes of transportation are observed and shown above (Figure 8). Some residents are using more sustainable transportation while others are driving up Hampton Place's carbon footprint, literally. Vehicles have been given priority in the community, a fact that is visually apparent in the expanse of driveways, parking locations, and wide one-way traffic lanes of 6 to 7 metres curb to curb. In comparison, there is no space solely dedicated to bike riders, despite ample road width. Furthermore, public sidewalks are 1.2 metres wide, providing 5 times less space for those choosing to travel without the use of a motor vehicle. Results from 'car and pedestrian counts' indicate that driving gas-powered personal vehicles is the dominant choice of travel, despite many professionals, students, and other residents choosing to walk. Of the vehicles counted, approximately 40% were SUVs, vans, and trucks.
Furthermore, show that traffic rates during rush hour on weekdays can average up to two cars per minute entering or exiting Hampton Place through the Wesbrook Mall main entrance. If both 16th Avenue and Wesbrook Mall main entrances were taken into account, this rate could potentially double to four cars per minute on average entering or exiting Hampton Place.

Table 3: Summary of the transportation survey results at Hampton Place entrance along Wesbrook Mall

Date	AM/ PM	Duration (min)	Large car	Small car	Service or Other Vehicle	Total	Average vehicles per min	Cyclists	Average cyclists per min	Walker	Average Walkers per min
Wed., March 30, 2011	AM	60	35	66	16	117	2.0	6	0.1	71	1.2
Wed., March 30, 2011	AM	35	31	31	7	69	2.0	5	0.1	42	1.2
Thurs., March 31, 2011	PM	50	46	42	2	90	1.8	-	-	10	0.2

The car counts give only a small sample of Hampton Place residents' choices in travel and a glimpse of some residents' lifestyle. For instance, a wheelchair taxi drove through Hampton Place and probably picked up a resident with special needs whereas a typical yellow taxi arrived to pick up a professional individual. During one morning, a student, and a mother and son were seen riding the Community Shuttle bus, which passes Hampton Place almost every 30 minutes (UBC Transportation Planning, 2011). The Community Shuttle bus appears to be rarely full of passengers during most time of the day except from 12 to 1pm and 5 to 7pm on weekdays and weekends (UBC Transportation Planning, 2011). In addition, a Dairyland Home Service vehicle entered Hampton Place to deliver milk to some residents despite the fact that Hampton Place is located very close to a Save-On-Foods store, which sells Dairyland milk. The milk home delivery service may indicate that some residents reminisce about their childhood memories of milk delivered to their doorstep (New Hampshire Historical Society, 2008).

Other observations give clues to carbon usage of transportation in Hampton Place. For instance, most personal vehicles had no passengers besides the driver, indicating a lack of car pooling. Also, a small portion of the vehicles exited and returned within 5, 15 or 30 minutes. Even though there can be human errors in recognizing the same vehicles or drivers during rush hour, there were enough distinct vehicles observed to suggest that some residents' destination points can be approximately less than 2 to 15 km away in order to have exited and returned within a short period of time. According to BC TransLink Travel Calculator beta version, the "average driver travelling alone in a car (15km/day) emits 5.21 tonnes of Greenhouse gas emissions per year" (TransLink, 2009). This is consistent with U.S. Environmental Protection Agency's estimation of an average passenger vehicle emitting 5.20 metric tonnes CO_2e (U.S. Environmental Protection Agency, 2011). Based on the observations of parked and moving vehicles in Hampton Place, some drivers are most likely emitting above the annual average greenhouse gas emissions of an average car because of the type of car used. For example, a hemi-engine vehicle (or high carbon vehicle) was found entering an underground parking lot. On the other hand, a particular Smart Car (or low carbon vehicle) was often found parked on the street.

According to BC TransLink, “over 1/3 Vancouver work trips are under 5 km - easily replaceable by cycling or walking” (TransLink, 2011). Currently, information of how most residents travel to work, school and/or other locations is not available. If this kind of information was available, UNA can estimate and evaluate their transportation carbon footprint per year. Also, UNA may be interested in how many people switched to sustainable modes of transportation from year to year.
Currently, Hampton Place appears to lack outdoor bicycle-friendly features to encourage residents to cycle to work or school. Based on observations, many bikes are parked and locked in underground parking lots. Some of the bikes were stacked and locked in a way that suggests they would not be easily taken out or used daily. For instance, a set of family bikes that were locked together is probably used on some weekends or evenings for leisure. In contrast, some bikes were organized in rows or columns, and located near the exit/entrance of the underground parking lot. This arrangement is more convenient for frequent bicycle-users. At the few small outdoor bike racks in Hampton Place there were rarely any parked bikes. Even though Hampton Place has some bicycle storage space, the main road (Hampton Place Street) could be discouraging residents to cycle to work or school because the road lacks bicycle lanes, forcing cyclist and drivers to share the main road. This could be also applicable to skateboarders in the neighbourhood.

BUILDINGS AND INFRASTRUCTURE

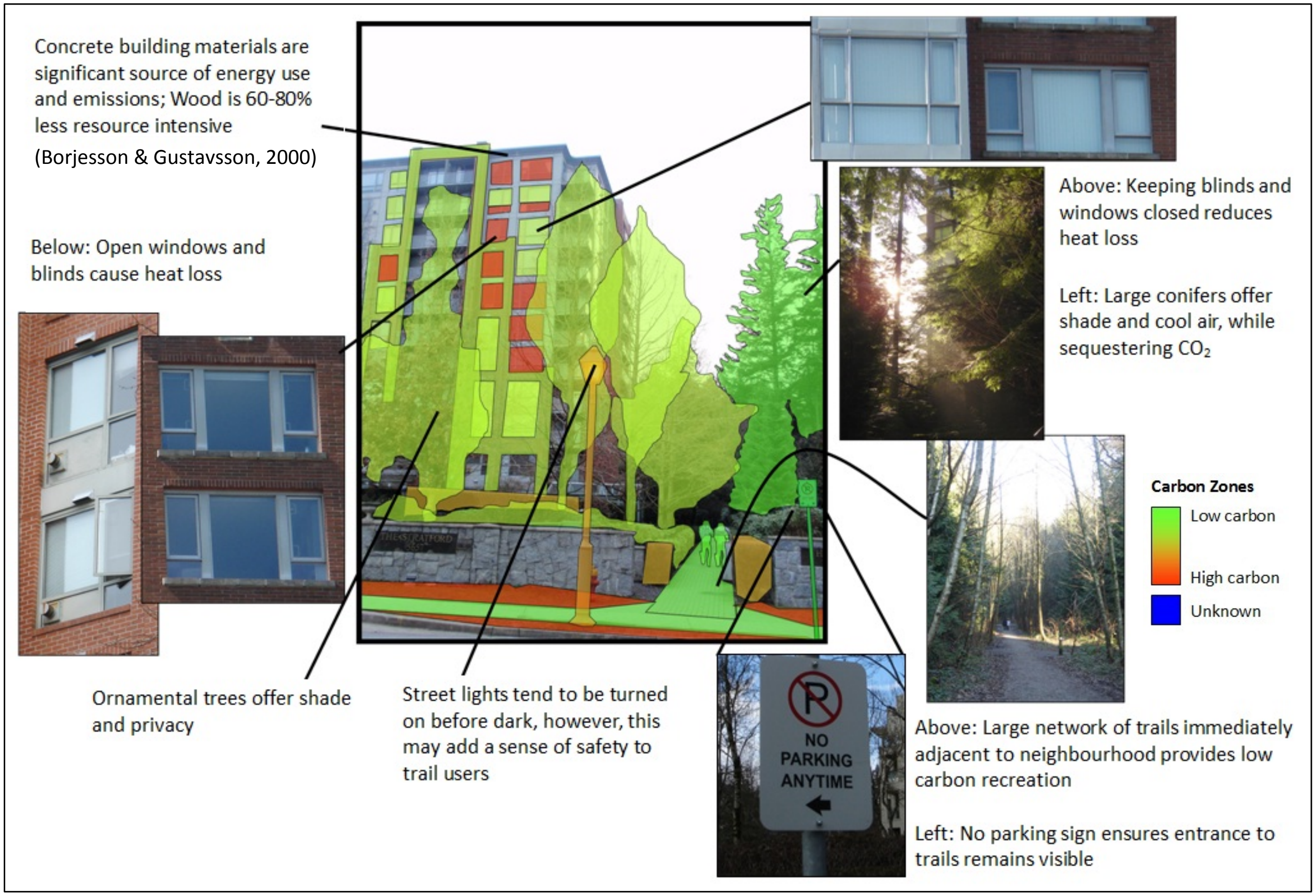


Figure 9: Building and infrastructure cross section of Hampton Place with carbon associations

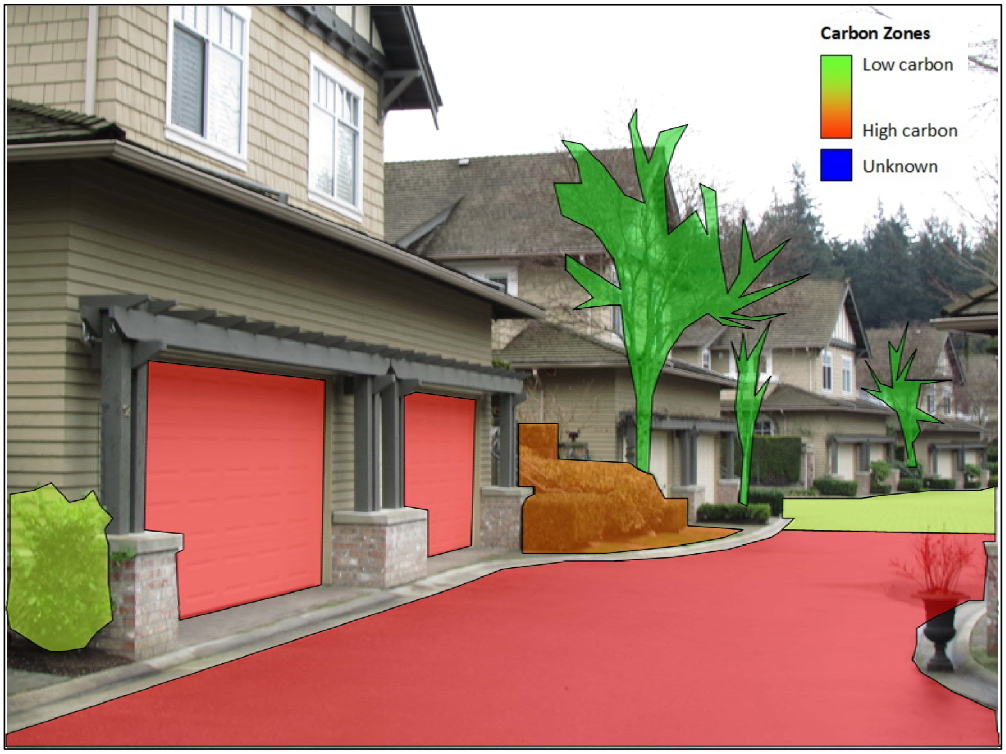


Figure 10: Semi-detached neighbourhood cross section with carbon associations

In the semi-detached neighbourhoods there were notable signs of high and low carbon. The fully paved section of the road is marked red, highlighting its conduciveness to vehicle use and failure to offer any visual cues which would invite alternative transportation choices. This road substrate also creates an impermeable layer, preventing rain water from draining into the soil. Garage doors were also marked with red as they encourage personal vehicle use. The yellow section in the background marks the section of road made of paving stones. This alternative allows for water infiltration, making it a greener alternative to standard paving, yet it continues to encourage vehicle usage. The small shrubs highlighted yellow to orange correspond to a range of sustainability levels depending on water and pruning maintenance requirements. At one end, naturally shaped shrubs, as well as larger trees, require little maintenance to support their carbon sequestering growth. At the opposite end, manicured shrubs with well defined edges require significant carbon emitting maintenance.

Hampton place GHG emissions

To get an idea of Hampton Place's carbon footprint we estimated carbon emissions from housing, personal transportation, and solid waste. This was done by compiling readily available information, adopting data collection methods used in related studies, and integrating findings in similar neighbourhoods and buildings. Total emissions from landscaping were not estimated due to time and data constraints, however a partial estimate is provided.

For transportation estimates we performed three car counts at different over the course of 2 days. This, along with observations gathered on other site visits, gave us a rough idea of the numbers of people driving, as well as a good representation of the types of vehicles driven through the neighbourhood. A number of averages were acquired from a study done by the city of Vancouver on its carbon emissions. This included percentage of people who drive to work, carbon from solid waste as well as average CO_2 emissions from different types of vehicles. Total number of vehicles was calculated using the number of housing units in Hampton place and Vancouver averages. The total number of vehicles was divided into small car, large car and SUV/light trucks. These numbers were then multiplied by their associated annual CO_2 averages and the results were summed up for a total. Calculated values can be seen below in table 4.

Table 4: Calculations of GHG emissions from personal transportation

	Small car	Large car	SUV
Average TCO_2/vehicle/year	3.057229	4.036751	4.535429
Percentage of vehicles	30%	27%	43%
CO_2 tonnes/year	542.68	632.25	1,136.57
		Total CO_2	**2,311.49**

To calculate the emissions of the housing at Hampton place all of the buildings were divided into three different categories which were high rise, low rise and semi-detached. Thames Court, The Pemberley, West Hampstead and The Sandringham were classified as semi-detached. The Balmoral, The Chatham, The Regency and The Stratford were classified as high rise. St. James House, The Bristol and Wyndham Hall were classified as low rise. From this point it was determined that the low rise and high rise buildings were similar enough to lump them together in the calculations. As we did not have access to the insides of these buildings this could not be fully confirmed. Average housing unit emissions values were attained from study by Firth and Lomas (2009) on investigating CO_2 emissions in urban housing. Average and calculated values can be found in table 5 below.

Table 5: Calculations of GHG emissions from housing

	Semi-detached	High rise	Low rise
Number of units	264	364	329
Average TCO_2/unit/year	5.6	3.6	3.6
Tonnes CO_2 / year	1478.4	1310.4	1184.4
		Total CO_2	**3973.2**

It appears as though Hampton Place has a similar waste management system as the rest of Vancouver, with the blue-box recycling program and garbage available, while composting is not supported on a community scale. Solid waste calculations were therefore based on averages from the same study on the city of Vancouver mentioned earlier. The total annual emissions from solid waste in Hampton Place were determined to be 308.6 tonnes.

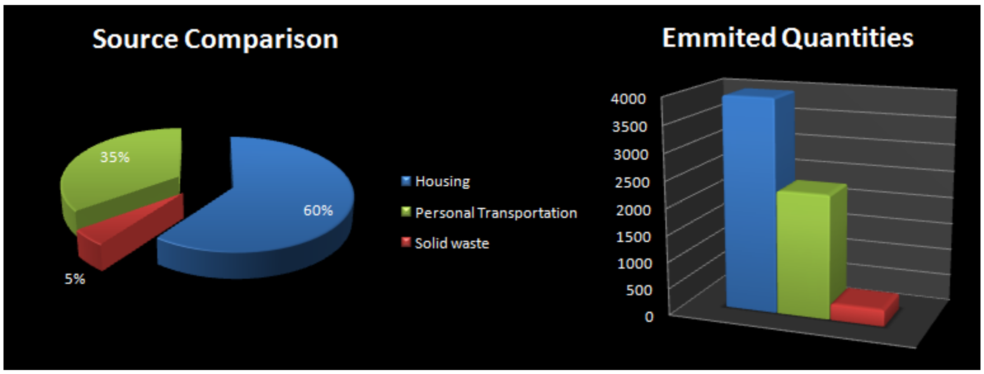


Figure 11: GHG emission estimations from housing, personal transportation and solid waste

Figure 11 above contains a pie chart comparing the three sources that were calculated, as well as a graph displaying total annual tonnes of CO_2. Comparing the various sources shows which ones are the largest and therefore has the greatest room for improvement. Based on housing, personal transportation and solid waste Hampton Place has a carbon footprint of 6593.3 tonnes/year.

Indicators

Category	**Quantitative Data**	**Qualitative Data**
Transportation	-Total number of commuters -Average travel distance and frequency to work or school -# cars per resident or group (i.e. student, professional, retiree, strata, etc.) -Distance traveled by different transportation methods per year - % surface area dedicated to high carbon vs. low carbon transportation	-Traffic by different modes of transportation -Road space relative to sidewalk space -Bike storage space or racks -Public transit vehicle & route -Parking space -Estimate of passengers in vehicles or level of carpooling
Buildings and Infrastructure	-Floor area ratio (FAR) -Energy use per dwelling/per occupant/per building -Total population per building	-Noise from gas utilities & other energy generators -Window usage (i.e. opened/closed windows & blinds) -Street lights and light fixtures -Signage (i.e. One Way arrow sign, No Parking sign) -Types of building materials
Landscaping	-Cubic metres or gallons of total water usage -Mass of fertilizer (kg) -Composition of fertilizer -Area of grass coverage -Area of tree canopy coverage -% native or non-native species -% contaminants from stormwater and water quality assessment	-Densely spaced sprinkler heads -Gas and chemical fertilizer containers -Water-demanding vegetation -Noise from gas-powered tools -Excess water flowing down storm drainages

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted: Don't add space between paragraphs of the same style, Line spacing: single

Formatted Table

Recommendations

Future studies of sustainability in Hampton Place are recommended in order to further define and estimate key indicators. While the visual assessments provided in this report serve as a first step towards revealing the community's carbon footprint, additional data would be invaluable for both measuring and monitoring sustainability, as well as supporting improvement initiatives. This data can be collected from resident surveys and questionnaires, ongoing monitoring and auditing of resource usage, urban tree counts, financial records, and visual assessments. Information about the demographics of Hampton Place would also be useful in estimating and evaluating the community's carbon footprint. There are numerous carbon and GHG accounting tools available to aid in estimating carbon footprints, for example, 'GHGProof' is a MS Excel program that requires few inputs and allows the user to change assumptions to match their specific application.

In regards to the visual and aesthetic characteristics of sustainability, it is important to define the how Hampton Place residents see their neighbourhood and determine the values that guide their opinions. With this understanding, sustainable options can be designed to match stakeholder desires. For instance, if wide traffic lanes are considered aesthetically pleasing a simple bike lane could be established to increase the use of sustainable modes of travel. Other aesthetic considerations may require more complex sustainable options, such as changes to landscaping. Perhaps highly manicured shrubs are desirable, in which case, lower maintenance native shrubs such as cedars could be used in place of high maintenance non-native boxwoods.

References

Borjesson, P., & Gustavsson, L. (2000). Greenhouse gas balances in building construction: wood versus concrete from life-cycle and forest land use perspectives. *Energy Policy* , 575-588.

Bowles, G. (2002). *Impervious Surface - an Environmental Indicator*. Retrieved March 27, 2011, from The Land Use Tracker: http://www.uwsp.edu/cnr/landcenter/tracker/Summer2002/envirindic.html

Capital Regional District. (2011). *Reducing Impervious Surfaces*. Retrieved March 27, 2011, from Capital Regional District: http://www.crd.bc.ca/watersheds/protection/howtohelp/reduceimpervious.htm

Colter, R. (2010). *UNA Hawthorn Park Project Definition Report.*

Dauncey, G. (2005). *Tranport*. Retrieved April 8, 2011, from BC Sustainable Energy Association: http://www.bcsea.org/learn/get-the-facts/energy-use/transport

Environment Canada. (2007, June 29). *About the Air Quality Health Index: Did you know*. Retrieved April 7, 2011, from Environment Canada: http://www.ec.gc.ca/cas-aqhi/default.asp?lang=En&xml=BD834AFE-250E-4D6A-B0CE-DCF4D4F8B4C6

Firth, S. & K. Lomas. (2009). *Investigating CO_2 Emission Reductions in Existing Urban Housing Using a Community Domestic Energy Model*. Department of Civil and Building Engineering, Loughborough University, UK: Glasgow Scotland.

Government of British Columbia. (2010). *Vancouver City Updated 2007 Community Energy and Emissions Inventory*. Government of British Columbia: Vancouver.

Kellett, R., & Girling, C. (2010). *Case View: Carrall Greenway B*. Retrieved March 31, 2011, from Elements db : http://elementsdb.sala.ubc.ca/

Lam, C. (2009). *Vancouver - City in the Metro-Vancouver Regional District*. Retrieved April 8, 2011, from BCEmissions.ca: http://bcemissions.ca/go/city/Vancouver/#commute_mode

Macdonald, R. (2005). *Estimated Character and Contaminant Loadings in Stormwater Runoff from UBC Drainage Catchments.* Vancouver: The Sheltair Group.

New Hampshire Historical Society. (2008). *Museum - From Dairy to Doorstep: Milk Delivery in New England, 1860-1960*. Retrieved 27 2011, March, from New Hampshire Historical Society: http://www.nhhistory.org/museumexhibits/dairy/dairy_to_doorstep.htm

NOAA Coastal Services Center. (2011). *Alternatives for Coastal Development: One Site, Three Scenarios*. Retrieved March 27, 2011, from NOAA Coastal Services Center: http://www.csc.noaa.gov/alternatives/impervious.html

Statistics Canada. (2008, November 21). *Canadians lawns and gardens: Where are they the "greenest"?* Retrieved March 27, 2011, from Statistics Canada: http://www.statcan.gc.ca/pub/16-002-x/2007002/10336-eng.htm

TransLink. (2009, December 4). *My Travel Calculator*. Retrieved April 9, 2011, from TransLink: http://mytravel.mypassionforaction.net/mytravel/TransLink%20Travel%20Calculator.html

TransLink. (2011). *TravelSmart*. Retrieved April 8, 2011, from Translink: http://www.travelsmart.ca/en/Work/Businesses.aspx

U.S. Environmental Protection Agency. (2011, March 22). *Emission Facts: Greenhouse Gas Emissions from a Typical Passenger Vehicle*. Retrieved April 8, 2011, from U.S. Environmental Protection Agency: http://www.epa.gov/otaq/climate/420f05004.htm

U.S. Environmental Protection Agency. (2008, November 10). *Landscaping with Native Plants*. Retrieved April 8, 2011, from U.S. Environmental Protection Agency: http://www.epa.gov/greenacres/nativeplants/factsht.html

UBC Campus and Community Planning. (2011). *Project Purpose: UBC Vancouver Campus Integrated Stormwater Management Review*. Retrieved March 27, 2011, from UBC Campus and Community Planning: www.planning.ubc.ca/smallbox4/file.php?sb4ab9222917a95

UBC Transportation Planning. (2011, March 14). *Community Shuttles*. Retrieved March 27, 2011, from UBC Transportation Planning: http://trek.ubc.ca/transportation-options/transit/community-shuttles/

UNA. (2010, April 26). *Community Garden*. Retrieved April 9, 2011, from University Neighbourhoods Association: http://www.myuna.ca/about-us/neighbourhoods/community-garden/

UNA Community Garden Committee. (2010). *Organic Gardening*. Retrieved April 9, 2011, from UNA Community Gardens: http://unagardens.wordpress.com/garden-manual/organic-gardening/

UNA. (2010). *Publications*. Retrieved March 27, 2011, from University Neighbourhoods Association: http://www.myuna.ca/about-us/publications/

University Neighbourhoods Association. (2010). *Publications*. Retrieved March 27, 2011, from University Neighbourhoods Association: http://www.myuna.ca/about-us/publications/

USDA Forest Service. (2006). *i-Tree: About*. Retrieved April 9, 2011, from i-Tree Tools for Assessing and Managing Community Forests: http://www.itreetools.org/about.php

USDA Forest Service. (2011, March 24). *i-Tree: Identify, Understand, and Manage Urban Tree Populations*. Retrieved April 9, 2011, from USDA Forest Service - Carbon: http://www.nrs.fs.fed.us/carbon/local-resources/downloads/Itree%20carbon_handout.pdf