Progress Report 2: October 1, 2009 – March 31, 2010
Accessing Brownfield Sustainability: Lifecycle Assessment and Carbon Footprinting
The Western Pennsylvania Brownfields Center at Carnegie Mellon, in collaboration with the Pennsylvania Downtown Center
US Environmental Protection Agency Brownfield Training Research and Technical Assistance Grant
Award: TR – 83417301 – 0
April 30, 2010

A. Background

The primary purpose of this project is to develop the methodology and subsequent tools that stakeholders can use to assess the sustainability of Brownfield development as measured through carbon footprinting, pollutant emissions and energy impacts. The research is intended to apply innovative analytical techniques (such as economic input-output life cycle analysis) to estimate the carbon emissions, pollutant emissions and energy impacts associated with Brownfield development; while documenting the drivers of these impacts given alternative Brownfield development scenarios.

Training and technical assistance efforts complement the primary research purpose. Through training, we intend to educate and disseminate information that will allow the members of the community to better understand the public health risks of unattended Brownfields and the benefits of alternative remediation strategies. Through technical assistance, we intend to provide targeted communities with a prioritization tool that will allow for fair, transparent and equitable Brownfield development decisions.

Our work has been divided into 3 primary Activities:

- *Activity 1: Training – Empowerment Through Knowledge*. Enhance Pennsylvania Downtown Center's (PDC) webpage for Brownfield relevant information, participate in annual PDC events to provide Brownfield related content, and conduct topic specific seminars. As the

project proceeds, the target group for training will be expanded beyond PDC's current membership.

- *Activity 2: Research – Quantifying the Sustainable Brownfield*. Develop a life cycle assessment model, including footprinting, for comparison of Brownfield development relative to greenfield development, beta test the tool on sites (preferably) selected in cooperation with PDC members, finalize and validate the model, develop a computer based tool, train PDC members to use the tool, and coordinate with US Environmental Protection Agency to develop strategy for transferring tool to other Brownfield stakeholders.

- *Activity 3: Technical Assistance – Site Selection Through Prioritization*. Assist PDC members in developing inventories of sites, beta test the Site Prioritization tool with select PDC members, finalize Site Prioritization tool, distribute Tool to remainder of PDC members, and coordinate with the Pennsylvania Department of Environmental Protections and the USEPA to develop strategy for transferring both tools to other Brownfield stakeholders.

B. Overall Progress

The official date of the award was March 12, 2009. Pre-award approval from the USEPA Project Officer allowed our work to commence in October 2008 and our first Progress Report was submitted on October 1, 2009. Progress Report 2 addresses the time period between October 2009 and March 2010.

Carnegie Mellon personnel working on technical aspects of the project include Professor Chris Hendrickson, Dr. Deborah Lange, Amy Nagengast and Michael Blackhurst (graduate students), and Kevin Williams and Ronell Auld (undergraduate students). PDC personnel working on the project include Bill Fontana and Eddy Kaplaniak.

Overall progress with respect to each Activity is summarized as follows:
Activity 1: Training – Empowerment Through Knowledge – we continue to participate in PDC meetings and have shared information with the equivalent of more that 50 communities in Pennsylvania. PDC's brownfield webpage should be online before the end of May.

Activity 2: Research – Quantifying the Sustainable Brownfield – We have identified a set of 12 brownfield/greenfield developments (24 sites in total) across the country for sustainability analysis. Our first step was to assess commuting behavior of the residents living in and around brownfield developments compared to greenfield developments. We found differences in modal shares, energy requirements and greenhouse gas emissions for the two types of developments. For two of these developments, we are near completion on detailed case studies on residential developments (one brownfield and one greenfield) to assess the environmental emissions associated with both the construction phase and the residential use phase. Both of these efforts had presentations accepted for the April 19-21, 2010 Business of Brownfield Conference, sponsored by the Engineers' Society of Western Pennsylvania. Templates created through the preparation of the detailed case studies will be used by our group of undergraduate summer interns. One paper has been submitted to the American Society of Civil Engineers for publications in one of their peer reviewed journals.

Activity 3: Technical Assistance – Site Selection Through Prioritization – we have created a 'Brownfield Taskforce,' within the PDC, to work with Main Street and Elm Street managers to simplify the process to inventory brownfields as a precursor to understanding and employing the prioritization tool. Summer students will be assisting in this effort.

C. Efforts and Accomplishments by Activity

Activity 1: Training – Empowerment Through Knowledge. Note that this effort is the primary focus of the PDC. With support from the Pennsylvania Department of Community and Economic Development, the PDC represents more than 150 communities across Pennsylvania, therefore, they represent the opportunity to educate a wide audience.

General Education

- Two managers meetings were held: one in Butler, PA (December 3, 2009, 34 attendees) and one in Reading, PA (December 9, 2009 – 37 attendees). At both meetings, there was a discussion regarding the completion of the brownfield inventory and the CMU-PDC brownfield project. As a direct result of questions raised at the managers meeting, PDC created a Brownfield Taskforce (BT). This BT, comprised of managers that have volunteered to participate, will provide advice on the conflicts and concerns that are limiting the interest and participation of Main Street and Elm Street managers across the state.

- The first monthly meeting of the Brownfield Taskforce was held in January 2010. The Taskforce has seven community members and meetings are generally an hour in duration. The taskforce will provide feedback and direction on PDC's brownfields project.

- The Community Revitalization Academy was held on February 24, 2010 in Harrisburg, PA; 28 managers were in attendance. Deborah Lange presented "Brownfields 101" but noted that a number of managers have relevant information and experience to share with their peers. A good discussion ensued the result of which was a request for actual brownfield projects from the communities so that step-by-step site management processes can be formulated and used as templates for other similar sites. The intent is to prepare these case studies for discussion at the PDC annual meeting to be held in June 2010 in Lancaster, PA.

Website

- PDC upgraded website due to launch at the end of May. A brownfield information and resource section is part of the upgraded website.

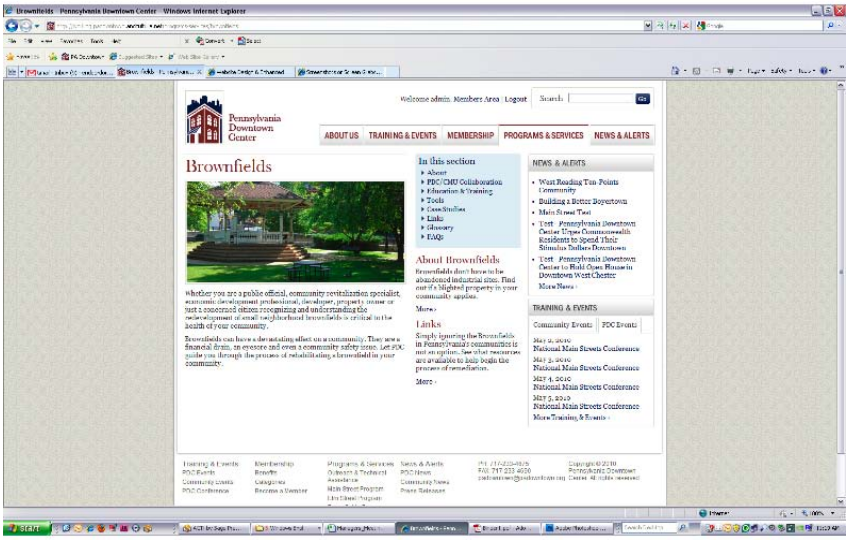

Figure 1: Mock-up of the Proposed PDC 'Brownfield' Webpage

Activity 2: Research – Quantifying the Sustainable Brownfield

We are pursuing two sub-activities within Activity 2. In Activity 2A, we are making site specific comparisons between a local brownfield and greenfield development. In Activity 2B, we are looking at census data gathered in year 2000 to evaluate the commuting behavior of people living in census tracts that contain brownfield development as compared to census tracks that contain greenfield developments. Both activities are in a pilot stage and will be expanded to include more communities as our work proceeds.

Activity 2A: Site Specific Comparisons

We continue to assess the environmental emissions (particularly greenhouse gas emissions) from both the construction and use phases of one brownfield and one greenfield development in the Pittsburgh area.

The greenfield is located in Cranberry Township, approximately 28 miles north of downtown Pittsburgh. Cranberry Township is comprised of several residential neighborhoods. Cranberry Heights was chosen as the principal neighborhood for this investigation: largely due to the readily available data from its original bond contracts. "Cranberry Heights is a single family

home community located in North-West Cranberry Township in close proximity to the Cranberry Highlands Golf Course, Interstate 79 and State Route 19" (CHHOA, 2009).

Figure 2: Map and Satellite Image of Cranberry Heights (Google Maps, 2009)

Cranberry Heights is approximately 270 acres with a total road length of roughly 3.6 miles. There are 244 housing units in Cranberry Heights.

The brownfield, Phase 1 of Summerset at Frick Park, is located about 6 miles east of downtown Pittsburgh. Summerset was constructed along the Nine Mile Run creek. The site was originally used as a slag (i.e. the dross or scoria of a metal) dump for Duquesne Slag Co. in the early 1900's.

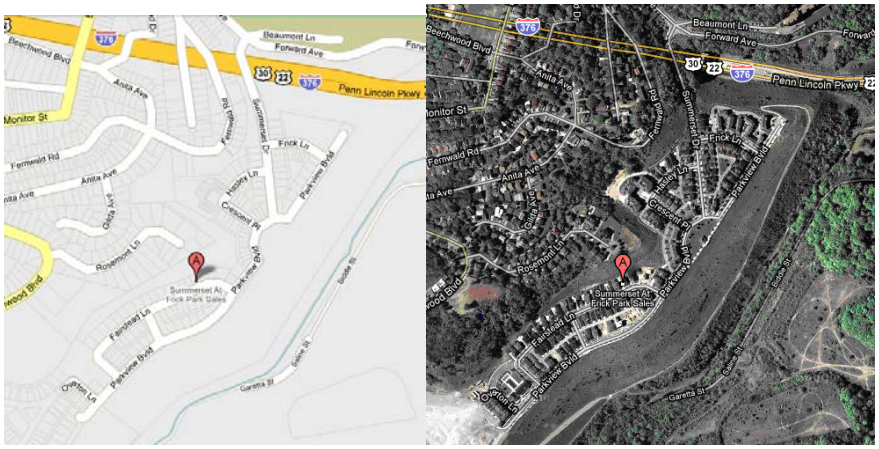

Figure 3: Map and Satellite Image of Summerset at Frick Park (Phase 1) (Google Maps, 2009)

The analysis of both case studies is broken into two phases: construction and use. The construction phase considers the initial and one time procedures used to develop the site; and measure the GHG emissions contributed by the production of materials and services used in the

remediation, site construction and pre-development work. The data for the construction phase were provided by the respective planner and developer for each residential development.

The use phase reflects the on-going operations of the development; and measures the annual GHG emissions from residential utility consumption and vehicle usage. Data for the use phase was thus acquired using a residential survey. The Cranberry Heights survey was made available via an online service; there were a total of 75 responses out of a possible 244. The Summerset survey was distributed to each household via postal mail; there were a total of 40 responses out of a possible 199.

Analyses for both the construction and use phases were performed using the Economic Input Output – Life Cycle Assessment model (developed at Carnegie Mellon) as well as process calculations using data from the US Environmental Protection Agency and the Bureau of Economic Analysis.

The total CO_2 E. emissions for both the construction and use phases are summarized in Table 1 (Cranberry - greenfield) and Table 2 (Summerset – brownfield).

The Cranberry Heights results suggest that the emissions from the initial construction phase are quickly dwarfed by the yearly emissions from either the utility consumption or vehicle usage. Furthermore, residential utility consumption produces roughly twice the emissions from residential vehicle travel each year.

Table 1 – Cranberry Heights Construction & Use Phase Emissions (lbs. CO_2 Equivalents): 244 housing units on 270 acres

	Total	Per Acre of Development	Per Household	Per Capita
Construction Phase – Earthwork and infrastructure improvements, excluding home construction	4×10^6	14,800	16,400	4,400
Use Phase – Utility Consumption per Year	18.9×10^6	70,000	77,400	21,000
Use Phase – Vehicle Usage per Year	9.7×10^6	35,600	40,000	10,800

The Phase 1 of Summerset results suggest that the yearly operational (use phase) emissions will surpass the initial construction phase emissions in approximately two years. Furthermore, utility usage produces roughly three times the travel related emissions each year.

Table 2 – Phase 1 of Summerset Construction & Use Phase Emissions (lbs. CO_2 Equivalents): 199 housing units on 32 acres

	Total	Per Acre of Development	Per Household	Per Capita
Construction Phase – Earthwork and infrastructure improvements, excluding home construction	24×10^6	750,00	120,600	60,300
Use Phase – Utility Consumption per Year	9.4×10^6	290,00	47,200	23,600
Use Phase – Vehicle Usage per Year	3.3×10^6	103,00	16,600	8,300

We are working to find the normalizing unit for comparing the brownfield and greenfield studied in this analysis. On a per household basis the greenfield, Cranberry Heights, appears to emit more green house gases (GHG) than the brownfield, Phase 1 of Summerset. However, on a per capita or per acre basis the results are reverse; a result of the higher household occupancy, and lower housing density in Cranberry.

The initial construction phase (i.e. Earthwork and infrastructure improvements) is an exception to this inspection. The high degree of grading and remediation undergone in the brownfield, Phase 1 of Summerset, has elevated its construction phase emissions well beyond that of the greenfield, Cranberry Heights.

We are working to collect more case studies. A recent visit to Peters Township (approximately 20 miles south of Pittsburgh) has revealed two residential developments: *Hiddenbrook*, a brownfield, and *Woodland*, a greenfield. Both developments are within Peters Township, and are comparable with regards to the number and types of housing units (same developer) and location. A comparison between this brownfield-greenfield pair (as well as others to be collected) may shed light on what units of measurement are suitable for evaluation.

Activity 2B – Commuting Behavior of Residents

1. Efforts and Accomplishments

The commuting behavior of residents in brownfield and greenfield neighborhoods within six cities[1] was accomplished using the 2000 US Decennial Census and supplemental external data. The travel patterns of residents were initially analyzed separately for individual and public transportation. Significant advancement from the October progress report can be attributed to calculating the:

- Average speed of vehicles in the studied metropolitan areas
- Upstream (supply chain) energy and greenhouse gas impacts from electricity and fuel production
- Public transit authorities annual energy type consumption distribution and corresponding energy and greenhouse gas impact

The final analysis combines all modes of transportation in order to better define the energy and greenhouse gas estimate per commuter. The research and technical documentation is 95% complete which includes supplemental information on the brownfield and greenfield census tracts and Google map locations. The work has been submitted to the *American Society of Civil Engineers (ASCE)-Journal of Urban Planning and Development*.

A selection of the results corresponding to modes of transportation and energy per commuter per year can be seen in Figure 4 & 5 below. Figure 4 displays the various travel modes averaged among the 12 brownfield and greenfield developments. The three largest differences between the two types of developments are individual automobile, public transportation and walking.

[1] Baltimore, Chicago, Milwaukee, Minneapolis, Pittsburgh, and St. Louis

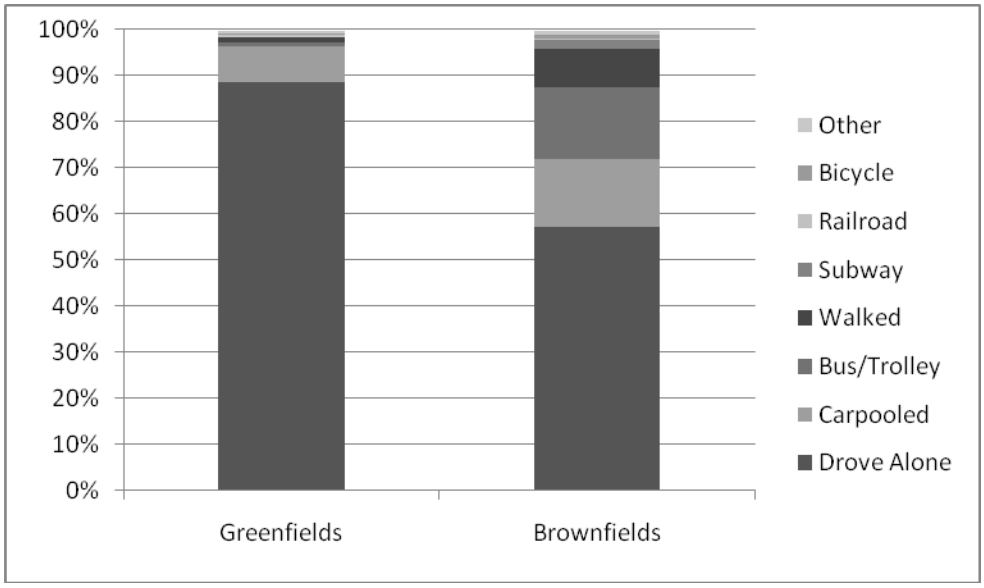

Figure 4: Greenfield and Brownfield Disaggregated Commuting Modal Shares

The research concludes by combining the various travel modes and travel times into energy consumption per commuter annually. On average for commuting patterns, the greenfield developments consume 75,000 MJ/commuter/yr (71 MBTU/commuter /yr versus 47,000 MJ/commuter/yr (45 MBTU/commuter/yr) for brownfields. Therefore, the brownfield developments consume approximately 37% less commuting energy per resident annually than the studied greenfields (Figure 5).

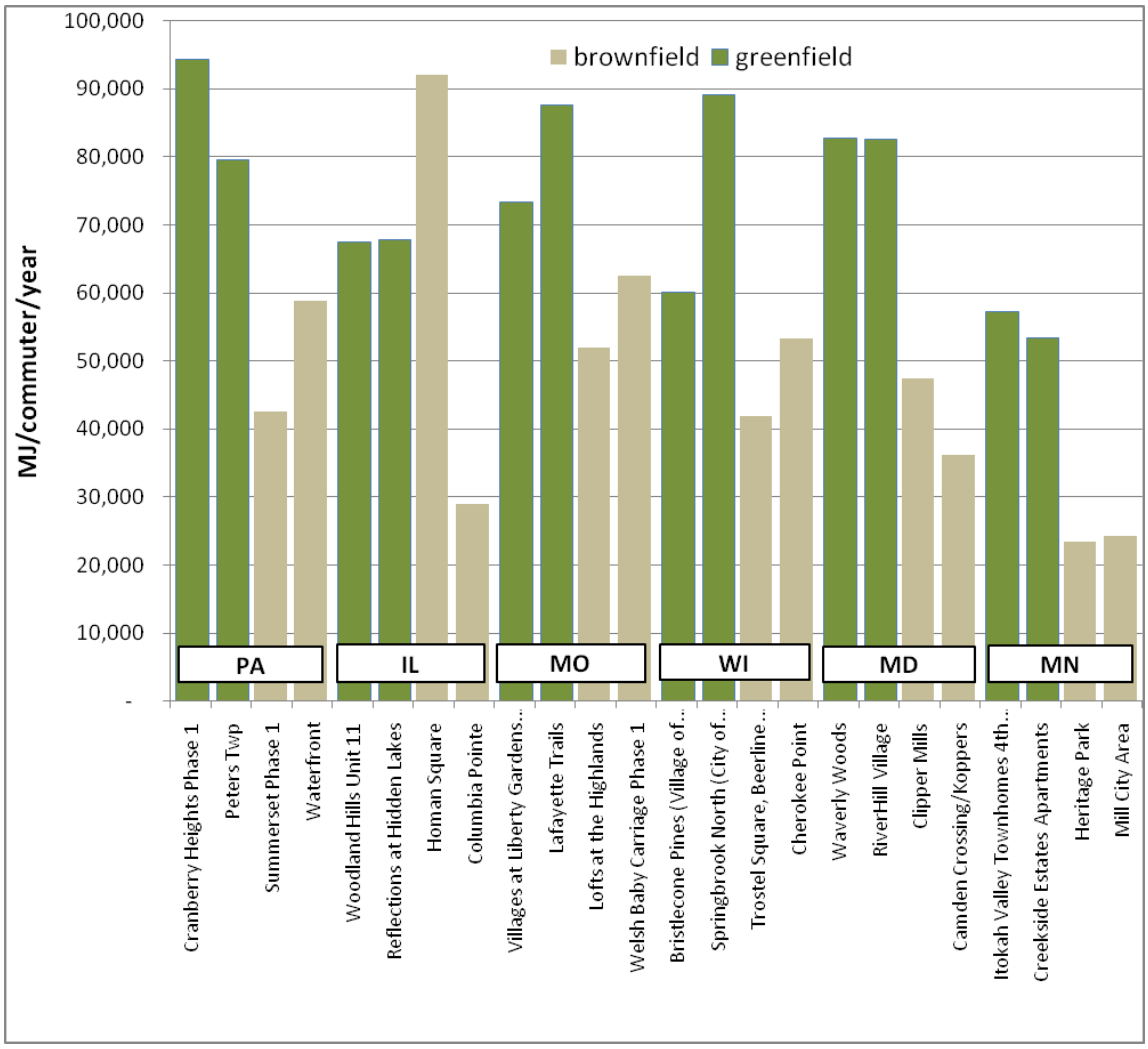

Figure 5: Total Greenfield and Brownfield Development Energy Impacts from Commuting

Activity 3: Technical Assistance – Site Selection Through Prioritization

Approximately 8 Main Street and Elm Street communities have completed the inventories for a total of about 30 sites. Through the Brownfield Taskforce, we are hoping to learn more about the Managers' level of understanding with regard to the opportunities and challenges associated with brownfield development, then work to improve that understanding before we can convince the Managers that there is a 'value added' preparing such an inventory.

In the meantime, we are reaching out to other communities that may be good candidates for both creating inventories and testing the multi-attribute decision making tool. We have spoken with Lawrenceville Development Corporation (Allegheny County, PA), East Liberty Development

Corporation (Allegheny County, PA), City of Pittsburgh, PA and the Centre County (PA) Office of Community Planning and Development.

Further, and with the support of the Pennsylvania Department of Environmental Protection, we are working with Baker Corporation to develop a web-based version of the inventory as well as the MADM tool. We need more community participation, however, to assure that the tool is appropriate for their needs.

D. Progress vs Proposed Milestones

The proposed milestones for Years 1 and 2 are presented in our application package are summarized as follows:

Completion YEAR	Activity 1: Training – Empowerment through Knowledge	Activity 2: Research – Quantifying a Sustainable Brownfield	Activity 3: Technical Assistance – Site Selection through Prioritization
1	.Participate in PDC regional events .Update PDC webpage with Brownfield related content .Nat'l Brownfields Conference (Fall 2009)	Develop framework and scope for life cycle assessment and carbon footprinting tool	Complete inventories in all select Main Street/ Elm Street Communities
2	As above with webpage updates including additional case studies	Finalize transportation, building, electricity and water analysis modules	Initiate ranking process in select Main Street/Elm Street communities

Our progress to date (based on the assumption that we are 50% through Year 2) can be summarized as follows:

Activity 1: We are on track and will attend the Business of Brownfields Conference (with two presentations) in Pittsburgh on April 19-21, 2010. PDC webpage will be updated by the end of May and case studies are to be gathered by the PDC annual conference in June.

Activity 2: Frameworks for case study comparisons as well as a method for evaluating brownfield/greenfield pairs from across the country have been developed and will be used by summer students to collect and analyze data from additional sites.

Activity 3: We have been challenged in finding the best way to engage PDC's Main Street managers so we are delayed in the completion of inventories. PDC and Carnegie Mellon are

developing a new strategy, including the development of the Brownfields Taskforce, to engage the Main Street Managers. We will revisit our progress at the June 2010 annual conference of the PDC members. In the meantime, we continue to look for other communities to engage in this exercise.

E. Actual vs, Proposed Expenditures

Actual expenditures lag proposed expenditures due to both delays in getting the award finalized as well as delays in getting students on board. We will have at least 4 interns this summer therefore, in the next reporting period, our actual expenditures will begin to approach the proposed expenditures.

F. Lessons Learned and Goals by Activity

Activity 1: Training – Empowerment Through Knowledge

Main Street and Elm Street Managers, who are funded by the Pennsylvania Department of Community and Economic Development through the PDC, have many responsibilities within the business and residential districts (respectively) that they represent. The may be responsible for marketing or community development but real estate development is not always a priority for the board of directors that they represent. More elementary education is required and the formation of the Brownfield Taskforce will provide better insight into the current level of understanding.

Activity 2: Research – Quantifying the Sustainable Brownfield

Activity 2A

The construction phase demonstrates a clear difference between the two developments. The high degree of grading and remediation undergone at Phase 1 of Summerset (brownfield), has increased its construction phase emissions well beyond that of the Cranberry Heights (greenfield). These results are consistent for a per-acre, per household, or a per capita standard of measurement.

The residential use phase does not provide an obvious difference between the two developments. On a per household basis, Phase 1 of Summerset is better at mitigating GHG. However, due to Cranberry Height's higher household occupancy, the per capita residential use phase emissions

are comparable for both developments. The challenge of selecting an appropriate normalizing unit is amplified as the residential use phase emissions surpasses the initial construction phase emissions. The evaluation of additional case studies will help to bring resolution to these questions.

Activity 2B

Our results have some significant uncertainties. First, our sample was limited to twenty-four developments. (Although, going forward, we will continue to identify and evaluate more brownfield/greenfield pairs.) Second, we used average metropolitan travel speeds and average impacts per public transportation passenger in our estimation. Third, there is considerable uncertainty in energy and greenhouse gas emission estimates. Fourth, the greenfield and brownfield developments include the surrounding neighborhoods as defined by the US census tracts. Finally, we did not consider other travel, buildings or other impacts of the developments. Nevertheless, there does appear to be substantial differences in the impacts of commuting for the two types of developments.

In terms of future goals, the 24 developments identified will be examined further to see what available data exists in terms of costs and materials for construction and housing. The developments that have access to that specific data will be analyzed similarly to the Summerset and Cranberry Heights developments discussed in Activity 2A.

Activity 3: Technical Assistance – Site Selection Through Prioritization

It is important that any tool(s) that we develop are consistent with the needs of the communities that we intend to serve. The creation of a baseline upon which to build all subsequent steps has proven to be more challenging that expected.

We note that Progress Report 3 will include efforts performed between April 1, 2010 and September 30, 2010.

Respectfully submitted,

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Reference: Cranberry Heights Home Owner Association (CHHOA). (2009)
http://www.cranberryheights.org/aboutus.htm