APPENDIX F

Transportation and Environmental Benefits of Developing Unutilized Industrial Sites: Brownfields

Chris Hendrickson, Deborah Lange, Scott Matthews, Yeganeh Mashyesh

International Society of Industrial Ecology 2011, Berkeley, California

Agenda

- Introduction
  - Methodology
- Results
- Discussion
- Conclusion

Brownfield Developments

View of Herr’s Island in 1981 prior to its development (left) into Washington’s Landing (below)

Photo credit: Urban Redevelopment Authority of Pittsburgh

Source: http://www.pittsburghinvestment.org/images/herrispeak.jpg

Brownfield Redevelopment - Barriers

- Cost of remediation and lack of funding
- Uncertainty over cleanup standards
- Concerns over liability
- Land assembly issues
- Reluctance to invest in distressed communities

Brownfield Redevelopment - Benefits

- Use existing infrastructure
- Keep green spaces intact
- Increase cost-effectiveness of transit (depending on the development location)
- Provide greater opportunities for physical activity
- Generate of local tax revenue
- Reduce vehicle miles traveled and the consequential emissions

Transportation System’s Impact on Greenhouse Gas Emission

Transportation GHG Reduction Policy Goals

Energy Independence and Security Act 2007 – Section 1101(c)
Transportation System's Impact on Climate Change

American Association of State Highway and Transportation Officials (AASHTO) Goal
Reduce rate of growth in VMT to approximately rate of population growth (about 1% per year)

Motivating Questions

› Do Brownfield Developments reduce VMTs? What are the contributing factors for such reduction?

› Would the environmental cost savings resulted from VMT reduction offset the extra initial infrastructure development costs (i.e. remediation) of Brownfield Developments?

Vehicle Miles Traveled (VMT)

37% Increase in VMT by light duty motor vehicles (1990 – 2008)
~15,000 miles/person

Forecasted VMT growth will outpace gains from improved fuel economy and alternative fuels.

Agenda

• Introduction
  • Methodology
  • Results
  • Discussion
  • Conclusion

Methodology

Site Identification
Analyzing TAZs
AEEF Model (Air Pollutant Emission)
PM0.1 Model
Vehicle Emission Factors

HBV Trips
HBNW Trips
Distance
Demographics

Direct Cost (Time & Fuel)
External Environmental Cost

Cost Comparison between Brownfield and Greenfield Developments

Brownfield and Greenfield VMT Comparison (Estimated vs. Projected)
VMT Comparison Results
Brownfield and Greenfield Developments’ Travel Pattern Comparisons
Home-Based Work Auto Trips per Household

Cost Comparison Results
Brownfield and Greenfield Developments

Direct Costs
External Environmental Costs

Annual Reductions per Household

<table>
<thead>
<tr>
<th>Variables</th>
<th>Brownfield Developments</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Miles Traveled</td>
<td>8,800</td>
<td>52</td>
</tr>
<tr>
<td>Number of Trips</td>
<td>1,200</td>
<td>28</td>
</tr>
<tr>
<td>Direct Cost of Driving ($)</td>
<td>4,000</td>
<td>60</td>
</tr>
<tr>
<td>Environmental Cost of Driving ($)</td>
<td>680</td>
<td>66</td>
</tr>
</tbody>
</table>

Remediation Cost of Brownfield Developments: $190,000/Acre
Brownfield Unit Density: 65 Units/Acre

Initial Cost $2,900 per Household
Benefit: $2,900 per Household per Year

Uncertainty Analysis – 20 Year Period

Net Present Value – Model A Sensitivity
Remediation: $550,000/Acre, Density: 65 Units/Acre

Source: Various Literature (mostly Chicago Brownfield Initiative, R. J. Moore)
Stakeholders’ Benefits and Costs of Brownfield Redevelopment

<table>
<thead>
<tr>
<th>Who?</th>
<th>Potential Benefits</th>
<th>Potential Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Residents</td>
<td>Reduced Health Risks - Increased Home Values - Reduced Crime Rate</td>
<td>Increased Tax - Noise - Congestion</td>
</tr>
<tr>
<td>Brownfield Residents</td>
<td>Saved Time - Saved Fuel - Improved Health</td>
<td>Safety Concerns - Lower Quality of School</td>
</tr>
<tr>
<td>Developers</td>
<td>Existing Infrastructure - Zoning Differentiation - Fund and Subsidies</td>
<td>Remediation Cost - Timing Issues - Liability Concerns</td>
</tr>
<tr>
<td>Society at Large</td>
<td>Improved Health - Reduced Emission</td>
<td>Tax</td>
</tr>
<tr>
<td>The City</td>
<td>Property Tax - Employment Opportunities - Other Income</td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>Achieving Emission Reduction Goals - Traffic Fees</td>
<td>Funding - Subsidies</td>
</tr>
<tr>
<td>Transportation Authorities</td>
<td>Achieving VMT Reduction Goals - Increasing Cost Effectiveness of Transit</td>
<td></td>
</tr>
</tbody>
</table>

Policy Implications
Quantitative results should encourage MPOs, DOTs and transportation policy makers to consider Brownfield redevelopments as a VMT reduction strategy:

- Provide incentives and funding to other stakeholders
- Cooperate with other agencies such as EPA to select sites that would result in more VMT reduction (i.e. proximity to transit)
- Guide and provide incentives to developers and planners to implement smart growth principles (i.e. diversity and interconnectedness)
- Facilitate and encourage cooperation between agencies on a federal, state and local levels to work at cross purposes
Acknowledgments

> Dr. Chris Hendrickson, Dr. Scott Matthews, Dr. Deborah Large
> Green Design Reading Group
> Steinbrener Institute
> NSF Grant No. 0755672
> U.S. EPA Brownfield Training and Technical Assistance Grant
> The Southwestern Pennsylvania Commission
> Chicago Metropolitan Agency for Planning
> Baltimore Metropolitan Council
> Minneapolis Metropolitan Council

Outstanding Issue – Future Work

> Expansion of the analysis to include more sites and especially those that will help with the combination of VMT reduction strategies
> Expansion of the analysis to include other aspects of Brownfield Developments including commercial and retail facilities
> Including congestion and transit environmental costs

Liability Issues

> Ohio and Illinois

The Paradox of Intensification

*Ceteris paribus*, urban intensification which increases population density will reduce per capita car use, with benefits to the global environment, but will also increase concentrations of motor traffic, worsening the local environment in those locations where it occurs.

Remediation Cost Based on Various Documentations

<table>
<thead>
<tr>
<th>Study</th>
<th>Remediation Cost ($) (2010)</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago 2003</td>
<td>2,100,000-320,000</td>
<td>Various Projects</td>
</tr>
<tr>
<td>Akron 2004</td>
<td>586,000</td>
<td>Pittsburgh</td>
</tr>
<tr>
<td>L.A. 2004</td>
<td>250,000-300,000</td>
<td>Capping</td>
</tr>
<tr>
<td>1982 1990</td>
<td>5.550</td>
<td></td>
</tr>
<tr>
<td>U.S. Mean 2010</td>
<td>45,000</td>
<td></td>
</tr>
<tr>
<td>Texas 1999</td>
<td>22,000</td>
<td>Phytoremediation</td>
</tr>
<tr>
<td>Texas 1999</td>
<td>56,000</td>
<td>Soil Capping</td>
</tr>
<tr>
<td>Texas 1999</td>
<td>56,000</td>
<td>Asphalt Capping</td>
</tr>
</tbody>
</table>

Source: http://en.wikipedia.org/wiki/Compass_City
Brownfield and Greenfield Developments’ Travel Pattern Comparisons

<table>
<thead>
<tr>
<th>Type</th>
<th>Average VMT (miles/HH)</th>
<th>Average Distance (miles/trip)</th>
<th>Average # of Trips/HH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfield (BF)</td>
<td>14.0</td>
<td>6.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Greenfield (GF)</td>
<td>19.0</td>
<td>6.3</td>
<td>3.0</td>
</tr>
<tr>
<td>National</td>
<td>24.0</td>
<td>9.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Reduction (GF to BF)</td>
<td>42%</td>
<td>33%</td>
<td>17%</td>
</tr>
</tbody>
</table>

HBW Auto Trips – BF & GF Comparison

![Number of Trips vs. Distance/Trip](image)

HBNW Auto Trips – BF & GF Comparison

![Number of Trips vs. Distance/Trip](image)

DVMT/HH Range Comparison – BF & GF – HBNW Auto Trips

![DVMT/HH Range Comparison](image)

Comparison of Direct & Indirect Average Daily Costs/HH between Brownfield & Greenfield Sites

<table>
<thead>
<tr>
<th>Area</th>
<th>Average Direct Costs ($/Day)</th>
<th>Average Indirect External Environmental Costs ($/Day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfield</td>
<td>8.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Greenfield</td>
<td>10.6</td>
<td>4.1</td>
</tr>
<tr>
<td>National</td>
<td>20.0</td>
<td>7.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area</th>
<th>Average Direct Costs ($/Day)</th>
<th>Average Indirect External Environmental Costs ($/Day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownfield</td>
<td>8.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Greenfield</td>
<td>10.6</td>
<td>4.1</td>
</tr>
<tr>
<td>National</td>
<td>20.0</td>
<td>7.4</td>
</tr>
</tbody>
</table>
Sources of Ammonia Emissions:

**Agriculture** is by far the biggest source of ammonia emissions. Livestock farming and animal waste account for the biggest percentage of total ammonia emissions which are due to the decomposition of urea from large animal wastes and uric acid from poultry wastes.

Livestock – contributes more than 50% of all emissions
Fertilizer application
Oceans
Vegetation
Biomass burning

Non-Climate Damages via Air Pollution Emissions Experiments and Policy Analysis Model (APEEP)

VMT Reduction – Other Strategies

Per Capita Annual Vehicle Travel Per Country

Correlation does not prove causation!
## Typical Steps in the Redevelopment Process

<table>
<thead>
<tr>
<th>Pre-Development</th>
<th>Redevelopment Phase</th>
<th>Reducing the Risk</th>
<th>Redevelopment Process Phase</th>
<th>Property Assessment Appraisal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify and File a Redevelopment Area</td>
<td>Contract Negotiation</td>
<td>Source Funding</td>
<td>Redevelopment Team</td>
<td>Redevelopment Project Management and Financial Counseling</td>
</tr>
<tr>
<td>Confirm Usability</td>
<td>Redevelopment Action Team</td>
<td>Source Funding</td>
<td>Redevelopment Team</td>
<td>Redevelopment Project Management and Financial Counseling</td>
</tr>
<tr>
<td>Phase I: The Inception of Redevelopment</td>
<td>Redevelopment Development Phase</td>
<td>Source Funding</td>
<td>Redevelopment Team</td>
<td>Redevelopment Project Management and Financial Counseling</td>
</tr>
<tr>
<td>Complete and Conform to Appropriate Standards</td>
<td>Redevelopment Project Management and Financial Counseling</td>
<td>Source Funding</td>
<td>Redevelopment Team</td>
<td>Redevelopment Project Management and Financial Counseling</td>
</tr>
</tbody>
</table>


## Mode Share Depending on Distance from Public Transit Stop

<table>
<thead>
<tr>
<th>Distance from Public Transit Stop</th>
<th>Walk</th>
<th>Bus</th>
<th>Train</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mile (1 km)</td>
<td>24%</td>
<td>45%</td>
<td>27%</td>
</tr>
<tr>
<td>0.5 mile (0.5 km)</td>
<td>17%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>0.25 mile (0.25 km)</td>
<td>9%</td>
<td>7%</td>
<td>9%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>


## Sample Calculations

\[
FU_{(0)} = (FE_i \times DVMT_{(0)} + (FE_j \times DVMT_{(j)}) \\
FC_{(0)} = (FU_{(0)} + P \times C)
\]

- \(FU_{(0)}\) = Fuel use for site \(a\) (MJ/day);
- \(FE\) = Fuel energy (MJ/Mile);
- \(FC\) = Fuel cost for site \(a\) ($/day);
- \(P\) = Price of gas ($2.8/gallon);
- \(C\) = Cost factor for pollutant i ($/1000gram);
- \(DVMT\) = Daily vehicle miles traveled (mile/day);
- \(i\) and \(j\) represent freeway and arterial respectively.

## Direct Cost

\[
FU_{(0)} = (FE_i \times DVMT_{(0)} + (FE_j \times DVMT_{(j)}) \\
FC_{(0)} = FU_{(0)} + P \times C
\]

- \(FU_{(0)}\) = Fuel use for site \(a\) (MJ/day);
- \(FE\) = Fuel energy (MJ/Mile);
- \(FC\) = Fuel cost for site \(a\) ($/day);
- \(P\) = Price of gas ($2.8/gallon);
- \(DVMT\) = Daily vehicle miles traveled for site \(a\) (mile/day);
- \(i\) and \(j\) represent freeway and arterial respectively.

## External Environmental Cost

\[
C_{(a)} = DVMT_{(a)} \times EF_i \times C_i
\]

- \(C_{(a)}\) = Cost of pollutant \(i\) for development \(a\) ($/day);
- \(DVMT\) = Daily vehicle miles traveled for development \(a\) (mile/day);
- \(EF\) = Emission factor for pollutant \(i\) (grams/mile); and
- \(C\) = Cost factor for pollutant \(i\) ($/1000gram).

## Strategies to Reduce Greenhouse Gas Emissions of Transportation Sector

- **Type of Fuel (Low-Carbon)**
- **Fuel Economy (Increase)**
- **Improving Transportation Efficiency (Management and Operations)**
- **Reducing Travel Activity (Vehicle Miles Traveled)**
Components

- Site Selection Criteria:
  - Metropolitan Areas
  - Relatively Large Developments
  - Developed in the Past 20 Years
  - At Least 100 Housing Units
- Residential Developments Only
- 2010 TDM Models
- Only Automobile Trips
- Arterial vs. Freeway Miles: TTI Urban Mobility Report (2009)
- Speed: Freeways (65mph); Arterials (35mph)
- Distances are based on shortest paths.

Travel Demand Models

1. Trip Generation
2. Trip Distribution
3. Mode Choice
4. Assignment

Travel Time Comparisons with National Averages – Auto Only

<table>
<thead>
<tr>
<th></th>
<th>TAZ Based</th>
<th>Census Based</th>
<th>Survey Based</th>
<th>NHTS 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BP</td>
<td>Gf</td>
<td>BP</td>
<td>Gf</td>
</tr>
<tr>
<td>HWW Travel Time (min)</td>
<td>12.0</td>
<td>16.0</td>
<td>20.0</td>
<td>24.0</td>
</tr>
<tr>
<td>HBNW Travel Time (min)</td>
<td>19.0</td>
<td>26.0</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Comparison of VMT and GHG Reductions with Various Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Geographic Area</th>
<th>Type of Land Use</th>
<th>Average Reduction in VMT</th>
<th>Range of Reductions in VMT</th>
<th>Range of Reduction in GHG Per Household</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Study</td>
<td>Baltimore, Washington, Houston, Phoenix</td>
<td>Brownfield</td>
<td>52%</td>
<td>38% - 63%</td>
<td>25% - 75%</td>
</tr>
<tr>
<td>EPA 2016</td>
<td>Seattle, Portland, Los Angeles</td>
<td>Brownfield</td>
<td>47%</td>
<td>23% - 57%</td>
<td>23% - 57%</td>
</tr>
<tr>
<td>EPA 2015</td>
<td>13 cities: Atlanta, Boston, Chicago, Cleveland, D.C., Denver, Houston, Seattle, St. Louis, Los Angeles</td>
<td>Brownfield</td>
<td>61%</td>
<td>39% - 83%</td>
<td>-</td>
</tr>
<tr>
<td>US Conference of Mayors (2014)</td>
<td>Baltimore and Dallas</td>
<td>Brownfield</td>
<td>23%</td>
<td>5% - 50%</td>
<td>27% - 87%</td>
</tr>
<tr>
<td>EPA 2014</td>
<td>Atlantic Station, Atlanta</td>
<td>Brownfield</td>
<td>73%</td>
<td>45% - 52%</td>
<td>-</td>
</tr>
<tr>
<td>CII 2010</td>
<td>U.S.</td>
<td>Compact</td>
<td>45%</td>
<td>30% - 65%</td>
<td>32% - 60%</td>
</tr>
<tr>
<td>HCR 2010</td>
<td>U.S.</td>
<td>Compact</td>
<td>-</td>
<td>3% - 15%</td>
<td>5% - 25%</td>
</tr>
<tr>
<td>Feng 2008</td>
<td>U.S.</td>
<td>Compact</td>
<td>23%</td>
<td>20% - 40%</td>
<td>10% - 36%</td>
</tr>
</tbody>
</table>

Brownfield Sites - Facts

- 450,000 Brownfield sites in the U.S.
- Abandoned or underutilized
- Desirable real estate resources from social perspective:
  - Increase jobs
  - Improve tax base
  - Impact land value positively
  - Improve health
Contributing Factors to VMT Reductions

- **Distance to City Center:**
  - Shorter Distances per Trip
  - Fewer Trips

- **Design:**
  - Walkability
  - Access to Transit

- **Diversity:**
  - Mixed-use Development

- **Density:**
  - High vs. Low
APPENDIX G

PDC’S PROPERTY PROFILE

Complete on per property - fill in as much information as possible.

GENERAL INFORMATION

Date: ______________________
Name and title of person completing the profile: ______________________
Name of organization: ____________________________________________
Address: ______________________ Phone number: ______________________
E-mail: ______________________

PROPERTY OWNER

Name of site (if applicable): _______________________________________
Address: Street: ________________________________________________
City: ______________________ Zip: ______________________
County: ______________________ E-mail: ______________________
Is the owner open to redevelopment options? Yes ___ No ___ Not sure ___

SITE INFORMATION

Name of site (if applicable): _______________________________________
Address: Street: ________________________________________________
City: ______________________ Zip: ______________________
County: _______________________________________________________
Municipality: _________________________________________________
Tax parcel ID# ___________________ Tax millage rate: ______________
Are there any tax liens currently on the property? Yes ___ No ___ Not sure ___