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THE ENVIRONMENTAL AND ECONOMIC IMPACTS OF BROWNFIELDS REDEVELOPMENT

EVANS PAULL

Northeast-Midwest Institute
www.nemw.org

Purpose and Use of this Report

This paper is termed a "Working Draft for Distribution." That term is meant to convey that the report is being widely distributed for review and comment, and that the findings are subject to revision. Readers/reviewers are free to cite the data and findings, but NEMW advises that citations should also refer to the document as a "working draft."

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The review panel included:

- Jared Creason, EPA National Center for Environmental Economics
- Lee Ilan, New York City Mayor's Office
- Joe Cronyn, Lipman-Frizzell and Mitchell, real estate consultants
- Chis De Sousa, University of Wisconsin at Milwaukee
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Another resource provided to NEMW was an unpublished master's thesis by Greg Lewis, a fellow NEMW staffer. The thesis covered two Baltimore case studies and their impacts on Baltimore neighborhoods.

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EXECUTIVE SUMMARY

This paper seeks to summarize established quantifiable impacts of brownfields redevelopment in the areas of environmental, economic, community, and fiscal effects. Brownfields redevelopment, supporters claim, can represent gains on many fronts. On the economic development side, there are employment gains, leveraged investment, and revitalized neighborhoods. Fiscal impacts include generating new sources of local revenue derived from previously unproductive land and lowering requirements for investment in infrastructure to accommodate growth. On the environmental side, brownfields redevelopment, when compared to greenfields development, saves land from the negative externalities associated sprawl, reduces air emissions and greenhouse gases, improves water quality through reduced runoff, and generally accommodates growth in an environmentally responsible fashion.

This paper reviews the evidence related to each of these purported benefits and attempts to quantify the impacts. The approach is primarily a literature review. The author has relied on existing research, which has been assembled, compared, and analyzed in order to highlight the most relevant data and reconcile different findings. Then, using this refined impact data, the report applies the findings to two hypothetical public investment scenario which seek to estimate the impacts of additional federal spending on brownfields.

Environmental Benefits of Brownfields Redevelopment

- ***Cleanup/Reduced Threat to Public Health.*** Almost 50,000 sites have completed state Voluntary Cleanup Programs (VCP) programs since the inception of VCP programs in the mid-1990s. This pace, estimated at 6,000 to 7,000 sites annually, reflects vast progress, although it still represents a small portion of the need – the current pace is addressing, at best, 1.4 % of the inventory, annually.

- ***Responsible Growth and Saving Land from Destructive Sprawl Development.*** One acre of redeveloped brownfields has been estimated to conserve 4.5 acres of greenfields sprawl development. With brownfields increasingly being used for dense residential and mixed residential redevelopment, brownfield sites collectively represent a particular opportunity for environmentally responsible accommodation of population growth. According to the U.S. Conference of Mayors 2007 report, 82 responding cities estimated that redeveloping brownfields could accommodate 2.8 million households.

- ***Air Quality Improvements.*** The findings from three case studies indicate that brownfields projects, in comparison to alternative greenfields projects, save between 20 percent and 40 percent of vehicle miles traveled. This translates directly to air emissions reductions or savings of a similar magnitude.

- ***Saving Energy and Reducing Greenhouse Gases (GHG).*** "Urban Compact Development" reduces transportation-related greenhouse gas (GHG) emissions by 20 percent to 40 percent in comparison to sprawling/spread development patterns. Brownfields case studies indicate similar reductions. This 20 to 40 percent reduction may understate the GHG benefits of urban compact development and brownfields

- ***Water Quality Impacts/Reduced Runoff***. An EPA study concluded that there are very significant water quality benefits of dense development due to lowered run-off per dwelling unit. Brownfields redevelopment, because it tends to be higher density, also tends to improve water quality.

Economic and Community Impacts

Studies of brownfields redevelopment indicate that the majority (between 55 and 80 percent) of brownfields projects involve public subsidy. The following discussion relates only to those projects that require this public investment.

- ***Employment and Investment Impacts.*** Although there is no comprehensive national data that represent the full breadth of brownfields redevelopment activity, two sources give an indication of the impacts:
  - The EPA Brownfields Program has leveraged 48,238 jobs and $11.3 billion in new investment as of March, 2008.
  - The 2007 U.S. Conference of Mayors survey indicates that 150 cities have successfully redeveloped 1,578 brownfields sites. Eighty of the reporting cities also listed permanent job impacts which totaled 115,600 jobs.

- ***Leveraging Investment.*** Interpreting the results of eight studies with widely varying results, NEMW concludes that public investments in brownfields leverage total investments at a ratio of approximately $1/public investment to $8/total investment. Brownfields-related subsidies for site assessment, cleanup, and site preparation leverage total investment at a higher ratio of 1 to 20, consistent with Milwaukee studies. The 1 to 20 ratio is the average public cost to make the land "development ready." Brownfield sites in severely distressed areas require higher subsidy levels, as much as double the ratios indicated here.

- ***Leveraging Employment.*** Interpreting results from six studies with widely varying results, NEMW concludes that it takes between $10,000 and $13,000 in public investment to leverage one job. Isolating public costs for brownfields-related site preparation, NEMW concludes that an average $5,700 in public costs leverage one job. For reference, the standard for judging investments by the U.S. Department of Housing and Urban Development and the U.S. Small Business Administration is $35,000 per job.

- ***Neighborhood Revitalization as Measured by Property Value Increase***. Cleanup and redevelopment lead to property value increases on the order of five percent to 15 percent for properties that are up to 3/4 mile from the site. However, there are documented cases where "impact" projects, usually involving change in use from

industrial to parks or mixed use, have had much higher impacts, even exceeding 100 percent.

Fiscal Impacts

- ***Direct Generation of Local Tax Revenue.*** From the micro/project-specific perspective, public investments in brownfields are generally recouped from local taxes generated by the project within about five years, although tax credits may extend this period. From the macro perspective, the U.S. Conference of Mayors survey found that redeveloped brownfields in 62 surveyed cities could lead to $408 million in annual local tax revenue. Further, the survey found that redeveloping remaining brownfields could generate between $1.3 and $3.8 billion in local taxes.

- ***Lower Investment in Infrastructure.*** Brownfields and greyfields usually have infrastructure in place so there is a cost savings in building and maintaining infrastructure relative to alternative new/sprawl development. The magnitude of this cost savings is uncertain. One analysis pegged the savings at as much as $1/brownfields vs. $10/greenfields. The literature in the area of sprawl vs. new "compact development" suggests smaller increments, where the differential is 10 to 35 percent. Future research may reconcile these findings in that there is likely a significantly greater infrastructure savings attributable to brownfields/greyfields relative to new compact development.

Linchpin Effect

- In some instances, brownfields redevelopment is the catalyst or the linchpin that creates a positive environment for new investment and leads to transformation of entire neighborhoods and districts.

Impact Projections for Additional Public Investments in Brownfields

NEMW has used the findings above and in the body of this report to estimate the impacts of additional investments in brownfields.

NEMW is not advocating for any particular policy or budget. Never-the-less, if policy-makers are considering additional public investments in brownfields, NEMW is in a position, as a result of this report, to estimate the impacts of those additional investments. Therefore NEMW created two federal funding scenarios and estimated impacts, as follows:

- Reauthorize the EPA Brownfields Program with double the current appropriations level of $165 million annually;
- Authorize a new brownfields tax credit with a $1 billion cap (consistent with HR 3080)

In order to calculate impacts NEMW made an assumption that the new federal funds would provide one-third of needed public investments – that state and local government would provide two-thirds. This federal share is somewhat higher than the current finding that the

federal government is providing 20 to 25 percent of public funds for brownfields, and it reflects a concept that many in brownfields spheres share – that the federal government should be a more equal partner.

Then using the leverage ratios and benefit data from the report, NEMW calculated the impacts of the additional investments. The calculations are detailed in Appendix 2. NEMW advises that these are "order of magnitude" estimates and projections, not precise predictions.

Table 1. Estimating the Incremental Impacts of Additional Federal Investments in Brownfields Funding

Impact area	***Ratio/factor***	***Double the EPA Brownfields Budget – add $165 million***		***Adopt a federal brownfields tax credit w/ $1 billion cap***	
		Assume that federal dollars provide 33% of public investments – state and local provide remainder			
		Annual impact	***20-year cumulative impact***	***Annual impact***	***20-year cumulative impact***
Total investment leveraged	$1 public investment leverages $8 total investment	$4 billion	$79 billion	$24 billion	$480 billion
Jobs accommodated	$11,500 public investment leverages one job, and 70% of brownfields will be job-producing	30,100 jobs	603,000 jobs	183,000 jobs	3.65 million jobs
Population accommodated in existing developed area	40 percent of brownfields sites will be residential or mixed residential, and densities will be 15 DUs per acre	4,500 households	89,300 households	27,100 households	541,000 households
Land conservation	1 acre brownfields redeveloped corresponds to 4.5 acres conserved	3,300 acres	67,000 acres	20,300 acres	406,000 acres

The Environmental and Economic Impacts of Brownfields Redevelopment

INTRODUCTION

As defined by the US Environmental Protection Agency, "brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."

This paper seeks to summarize established and quantifiable impacts of brownfields redevelopment in the areas of environmental, economic, community, and fiscal effects. Brownfields redevelopment, according to supporters, can represent gains on many fronts. On the economic development side, there are employment gains, leveraged investment, and revitalized neighborhoods. Fiscal impacts include generating new sources of local revenue derived from previously unproductive land and lowering requirements for investment in infrastructure to accommodate growth. On the environmental side, brownfields redevelopment, when compared to greenfields development, saves land from destructive sprawl, and reduces air emissions and greenhouse gases, largely because of fewer and shorter auto-based work and shopping trips.

The paper analyzes the evidence in relation to each of these factors and seeks to quantify the impacts. The effort here is primarily a literature search - the author has relied on existing research, which has been assembled, compared, and analyzed in order to highlight the most relevant data. Then, using this refined impact data, the report applies the findings to hypothetical public investment scenarios: what benefits would be derived from additional public investments in brownfields?

CHARACTERISTICS OF BROWNFIELDS SITES

Before this report turns to impact analysis, the studies reviewed in preparing this report contain volumes of valuable information that help frame the obstacles and issues involved in redeveloping brownfields. The following are particularly noted:

Number of Sites

The U.S. General Accounting Office found in a 2004 report that there are between 450,000 and one million brownfields sites nationally.[1] Some of the particular efforts of cities and states to inventory brownfields sites include:

- In the U.S. Conference of Mayors 2007 survey, 188 cities reported 24,896 sites representing 89,673 acres of land.[2]
- The State of Iowa identified 4,000 sites, which is one indication that brownfields impact less urbanized states.[3]

[1] U.S. General Accounting Office, 2004 (NOTE: All footnotes are abbreviated references to publications that are fully identified in the Bibliography section)
[2] U.S. Conference of Mayors, January, 2008.

- The State of New Jersey has identified 14,000 "Known contaminated sites."[4]
- Brownfields sites in the City of Milwaukee have been estimated at between 1,000 and 3,000 sites depending on what is being counted.[5] The County of Milwaukee identified at 8,004 sites in 2002.[6]
- The State of Wisconsin estimated its brownfields inventory at 10,000 sites in 2006.[7]

Primary Barriers to Reuse: Cleanup and Site Preparation Costs

Cleanup Costs. The 1999 Council for Urban Economic Development (CUED) study found that remediation constituted 20 percent of public funds used on brownfields sites and seven percent of total funds invested.[8] As discussed in the "Leveraging Investment" section, 83% of the sites in the CUED study involved public ownership at some point in the process and the sites tended to involve higher levels of public subsidy relative to other studies. This may mean that the 20 percent number is on the low side, because the CUED sites tended to have high non-cleanup subsidy needs.

NEMW reviewed data provided by EPA relative to cleanups on 271 sites funded through the brownfields program; the average cleanup cost was $602,000. The 1999 CUED study found the average remediation cost to be about $780,000. Adjusting for inflation, this finding would be that an average cleanup cost is $983,000 in 2007 dollars. However, the CUED study does not include gas station/petroleum cleanup sites, and neither study includes a representative number of sites where land contamination is "perceived only" and cleanup costs are the in-building remediation expenditures, which are typically of lower magnitude. With these data limitations noted, NEMW estimates that cleanup costs *for non-petroleum sites with land contamination* are typically in the range of $600,000 to $1,000,000.

The CUED study found median cleanup costs per acre of $57,000.

The U.S. Conference of Mayors produces an annual survey of cities involved in brownfields redevelopment. Every year, "funding for cleanup" ranks as the top impediment to redevelopment of brownfields.[9]

Site Preparation. Most brownfields sites have site preparation costs over-and-above site assessment and cleanup. Leveraging studies in Milwaukee isolate public investment in brownfields-related site preparation, including cleanup costs, as a percent of total investment. This is a valuable way to look at brownfields public investments because it isolates the cost of making land "development ready." These studies indicate ratios as follows:

- Milwaukee City: $1/public site prep to $34/total investment;
- Milwaukee County: $1/public site prep to $20/total investment;[10]

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[3] Personal communication, Iowa Department of Economic Development, 2007.
[4] New Jersey Department of Environmental Protection, http://www.state.nj.us/dep/srp/kcs-nj/kcs-nj.htm
[5] McCarthy, 2006; and Halfen, A and De Sousa, C, 2008.
[6] De Sousa, C. 2005
[7] Wisconsin Department of Natural Resources, 2006
8 Council for Urban Economic Development (CUED),. 1999.
[9] U.S. Conference of Mayors, 2005, 2006, 2008
[10] De Sousa, 2005

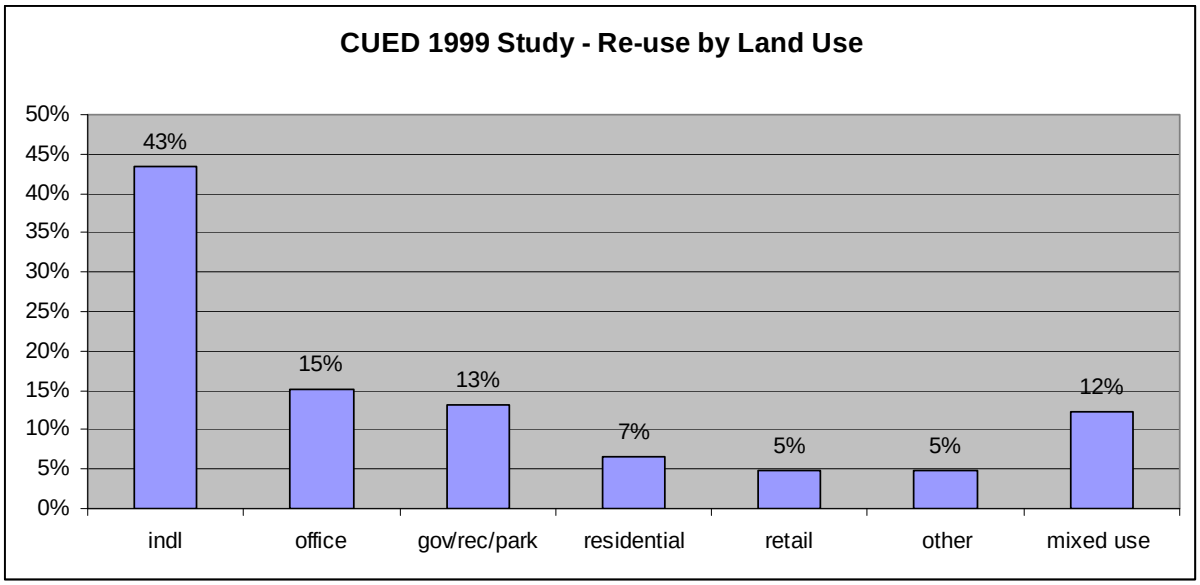
- Milwaukee residential: $1/public site prep to $63/total investment.[11]

Until more studies focus on this site preparation factor, NEMW recommends using the most conservative of the three studies, $1/public site prep to $20/total investment, to represent the average public cost to make brownfield sites development-ready.

Reuse Trends Favor Non-Industrial, Mixed Use, and Residential

In the 1999 CUED study, industrial and mixed industrial projects comprised about 50 percent of all 107 projects in the survey. Only 12 percent of the CUED sites were listed as mixed use, and most of those included industrial reuse.[12] See Figure 1.

Figure 1. CUED Study of Brownfields Sites, 1999, Sites by Land Use

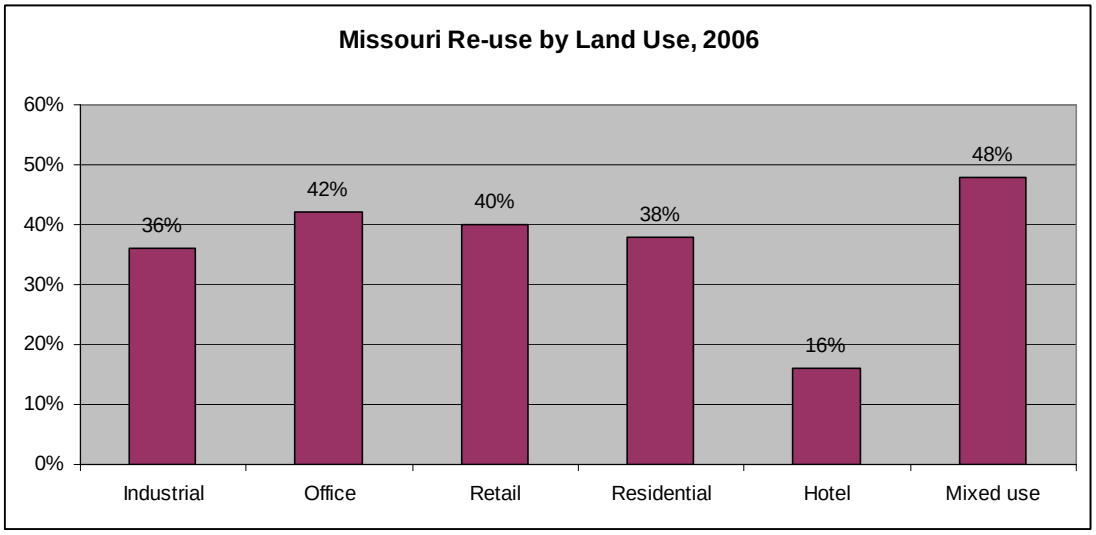


In a 2003 survey of brownfields developers, researchers found a more balanced re-use mix with industry still leading (32 percent), but mixed use (26 percent), commercial (22 percent, and residential (11 percent) all gaining relative to the 1999 CUED survey.[13]

In the 2006 Missouri study of 50 sites, mixed use was predominant (48 percent of the sites listed more than one land use), and office, residential, and retail reuse were all more frequently cited than industrial.[14] See Figure 2.

[11] De Sousa, "Residential…," 2006
[12] Council for Urban Economic Development (CUED), 1999.
[13] Wernstedt, Mayer, and Yount, 2003
[14] Missouri Department of Natural Resources, 2006

Figure 2. Missouri Brownfields Sites by Land Use[15]



While methodological differences could explain some of the variations, the progression from 1999 to 2003 and then to 2006 likely represents the changing nature of the brownfields marketplace, which now favors non-industrial reuse and far greater mixing of uses.

The dramatic growth of residential reuse (from 7 percent in CUED/1999 to 38 percent in Missouri/2006) is partly a marketplace phenomenon but may be also influenced by two other factors: remediation technologies lowering cleanup costs; and greater acceptance of institutional controls as a means of minimizing risk without removing all contaminants. Studies in Chicago and Milwaukee indicate that the majority of residential units constructed on brownfields sites are market rate, but substantial numbers of affordable units are also being created – 13 percent of units in Milwaukee were affordable, compared to 36 percent of units in Chicago.[16]

The trends toward greater mixed use and residential use mean that brownfields redevelopment is now in greater alignment with smart growth objectives of accommodating population growth, as well as employment growth, within existing developed areas.

Relatively High Density

In the discussion of environmental and economic impacts, below, there are repeated references to the benefits of density. Density factors into virtually every impact factor, from economic (more jobs per acre) to water quality impacts (reduced runoff). Four studies have given an indication of the relationship between brownfields and density:

[15] Missouri Department of Natural Resources, 2006. Note the percentages add to more than 100%. A site that is, for example, mixed residential and retail appears in three categories: residential, retail and mixed use.
[16] De Sousa, "Residential…" 2006

- A 2001 George Washington University (GWU) study[17] examined 142 brownfield sites and documented the relationship between brownfields and intensity of use. Researchers estimated that, on average, brownfields projects use one acre of land to every 4.5 acres used in comparable greenfields development. There are two cautions in using this data: one is that urban-suburban differences in zoning and land use regulations, rather than actual building floor area ratios or jobs per acre, were the determining factors in projecting the brownfields-greenfields land trade-off; and second that the study found significantly differing ranges within each land use.
- A study of residential brownfields projects in Milwaukee and Chicago found densities of 29 and 59 units per acre, respectively.[18] This is at least five times typical suburban densities.
- Looking at job intensity, NEMW calculated that 50 brownfields sites in the State of Missouri averaged 16.1 jobs created/retained per acre [19] Considering that this calculation includes projects that were partly or fully residential (38 percent of the Missouri projects included residential space), as well as some projects that were incomplete, this level of job intensity is consistent with densities that are greater than spread/suburban business and industrial parks.
- NEMW analyzed data on certified green buildings provided the U.S. Green Buildings Council and found that projects receiving brownfields points were more than twice as likely to also get density points relative to all certified green buildings.

Because the GWU study was the most comprehensive of these studies, later calculations in this report will use the one acre/brownfields to 4.5 acres/greenfields ratio as the best measurement of the land trade-off. "Density," as measured by floor area ratios, dwelling units per acre, and jobs per acre, may differ from this figure, but there is little current data to indicate whether it may be higher or lower.

Investments by Level of Government - State Investments Outweigh Local and Federal Investment

Several studies have tracked governmental investments by level of government. Table 2 gives the results of these studies. NEMW points out that the CUED study probably understates federal contributions because it preceded the statutory EPA Brownfields Program. The CUED report may overstate local funding because 84 percent of the sites involved local government public ownership. The Illinois study may also overstate local contributions relative to other states because of the heavy use of tax increment financing (TIF) in Illinois. NEMW has therefore altered these findings and estimated the funding sources as follows:

- State: 45 percent
- Local: 30 to 35 percent
- Federal: 20 to 25 percent[20]

[17] George Washington University, 2001
[18] De Sousa, "Residential…," 2006
[19] NEMW from data in Missouri Department of Natural Resources, 2006
[20] NEMW attempted to make sure that federal funds that are "pass-throughs" to local government (e.g CDBG)were classified as federal funds, but the federal contribution may be under-reported because of the pass-through problem.

Table 2. Public Investment by Level of Government

	Totals		Federal		State		Local	
	No. proj.	Total subsidy	Federal amount	% fed	State amount	% state	Local amount	% local
Missouri[21]	50	$294,230,575	$ 56,807,337	19.3	$171,250,238	58	$ 65,325,000	22
Illinois[22]	27	$ 10,308,870	$ 3,916,836	38.0	$ 1,065,636	10	$ 5,326,398	52
CUED report[23]	107	$517,096,520	$ 57,618,497	11	$195,090,651	38	$265,387,372	51
Total	**184**	**$821,635,965**	**$118,342,670**	**14.4**	**$367,406,525**	**45**	**$336,038,770**	**41**

Private Versus Publicly-Owned and Publicly-Assisted Sites

A 2002 survey of 400 brownfields projects[24] indicated that private developers were the lead entity for two-thirds of brownfields sites. The remaining one-third were developed "in conjunction with local government and redevelopment authorities." Presumably most sites in the latter group involved public ownership at some point in the process. This finding reinforces the need for public agencies to have at their disposal the full spectrum of economic development tools, including eminent domain, in order to address the complexity of brownfield sites. The same survey found that only 20 percent of the projects reporting funding information were classified as 100 percent privately financed.

Of the site analysis studies reviewed for this report, only one included a representative sample of sites that were 100 percent privately financed. This Milwaukee-Chicago residential study found that about 45 percent of sites involved no public financing.[25]

Table 3. Publicly-assisted vs. 100% Privately Financed Projects

Study area		Public incentives	100% Private	Total	% Privately financed
Milwaukee Residential		21	11	32	34
Chicago Residential		25	27	52	52
TOTAL		46	38	84	45%

Data on this point is insufficient to draw a precise conclusion, but clearly most sites, possibly as much as 80 percent, require some level of public subsidy in order to proceed to successful redevelopment. One reason for this, aside from the obvious extra site assessment and cleanup costs, is that brownfields sites are concentrated in lower income areas – the 1999 CUED study

[21] Missouri Department of Natural Resources, 2006
[22] Walzer, Norman, and Gisele F. Hamm, Illinois Institute for Rural Affairs, 2005
[23] CUED, 1999
[24] XL Environmental and IEDC, 2002, cited in Werrnsted et al, 2004
[25] De Sousa, "Residential…," 2006

found brownfields sites were located in neighborhoods with poverty rates roughly double the national rate.[26]

Prototypical Brownfields Site

A number of studies have documented brownfields site and investment characteristics. In order to describe the typical brownfields site NEMW reviewed eight studies which included the annual US Conference of Mayors surveys and case studies in Missouri, Illinois, Milwaukee and Chicago – see Appendix 1. There are methodological difficulties in combining studies that may have used different definitions or collected data in different ways. An additional difficulty is that most of the surveys and studies under-report gas station and other small sites, which tend to have lower acreage and impact numbers.

NEMW estimates the following as prototypical of brownfields sites *other than gas stations and dry-cleaning sites* (see Appendix 1):

- Mean site size: 5 - 6 acres
- Median site size: 3 – 4 acres
- Mean site investment: $20 - $25 million
- Mean jobs created or retained (employment-producing projects only): 80 – 100 permanent full-time jobs

An explanatory comment with respect to means and medians: economists usually use medians to characterize the "typical" asset among a range of assets. Means are usually higher than medians for distribution analyses similar to that undertaken here. NEMW had rather little data that reflected medians; so the indicators above are mostly described as means.

With brownfields site characteristics explained as background, the current analysis now turns to the impacts of brownfields redevelopment.

ENVIRONMENTAL AND ENERGY IMPACTS

Site Cleanup and Reduced Risk to Public Health

Finding: *Almost 50,000 sites have completed state Voluntary Cleanup Programs (VCP) programs since the inception of VCP programs in the mid-1990s. This pace, estimated at 6,000 to 7,000 sites annually, reflects vast progress, although it still represents a small portion of the need – the current pace is addressing, at best, 1.4 % of the inventory, annually.*

Cleaning up the land and protecting public health are obvious and direct benefits of brownfields redevelopment. A 2002 study by the School of Public Health in Johns Hopkins University looked at 182 vacant sites in Southeast Baltimore and examined correlations between known or suspected contamination and public health indices. The conclusion was that "The health analysis revealed disparities across southeast Baltimore, including excess deaths from

[26] CUED, 1999

respiratory illness and cancers … and a spatial and statistical relationship between environmentally-degraded brownfields area and at-risk communities."[27] Although there are multiple causes of these health disparities, cleaning up brownfield sites, especially in known high risk areas, should be part of any strategy to reduce to public health disparities.

The best available national indicator of the volume of brownfields cleanup activity is the number of sites going through state voluntary cleanup programs, which now totals 48,950 sites.[28] It should be noted that this is an imprecise measurement because of variations in state program eligibility, variations in reporting, and other factors. Still, it does give one indication that there is a large volume of brownfields sites that are being cleaned up to the satisfaction of state regulatory agencies. If one assumed that the pace of cleanups had increased over a 10-year period, the current rate might be 6,000 to 7,000 sites annually.

Clearly much progress has been made relative to the pre-voluntary cleanup era (early 1990s and before), but it should also be pointed out that there are an estimated 450,000 to one million sites, nationally,[29] so the current pace is addressing, at best, 1.4 percent of the inventory annually. Further adding to the daunting task is the fact that an unknown number of new sites are added to the inventory each time a manufacturing plant, gas station, or dry-cleaning establishment is closed and becomes a vacant site.

Responsible Growth and Saving Land from Sprawl Development

Finding: *One acre of redeveloped brownfields has been estimated to conserve 4.5 acres of greenfields sprawl development. With brownfields increasingly being used for dense residential and mixed residential redevelopment, brownfields also represent a particular opportunity for environmentally-responsible accommodation of population growth. According to the U.S. Conference of Mayors 2007 report, 82 responding cities estimated that redeveloping brownfields could accommodate 2.8 million households.*

In many communities, the trade-off is clear. Growth will go somewhere; if it is not accommodated in the existing developed area (brownfields, infill), it will go to greenfields sites.

As discussed above ("Characteristics of Brownfields Sites," "Relatively High Density"), brownfields projects have been estimated to conserve land in a ratio of 1 acre/brownfields redeveloped to 4.5 acres/greenfields conserved.[30] Note that the relationship between brownfields and density was also confirmed by the previously referenced Milwaukee and Chicago studies that found densities of 29 and 59 units per acre, respectively.[31] Although Milwaukee and Chicago are not necessarily representative of all brownfields, it does not seem unreasonable to assume that residential brownfields projects are several multiples of suburban densities or about 15 units per acre.

[27] Litt, 2002
[28] US Environmental Protection agency, 2005.
[29] U.S. General accounting Office, 2004
[30] George Washington University, 2001
[31] De Sousa, "Residential…," 2006

The trend (outlined above in the "Characteristics of Brownfields Sites" section) is toward much greater reuse of brownfields for residential and mixed residential use (about 40 percent of brownfields sites). Putting together the trend toward residential use and the findings related to density, one begins to see the potential for brownfields sites to accommodate population growth in a land-efficient fashion.

The U.S. Conference of Mayors' 2006 survey found that among the 82 respondent cities, there is a capacity to house 2.8 million additional people at brownfield areas where infrastructure is already in place.[32] It is stressed that this survey represents only a sample.

In the Executive Summary and Appendix 2, NEMW has estimated the impact of an additional $1 billion federal investment in brownfields. If the additional federal funds provide one-third of new public investments, the projected incremental gain from that investment is:

- 541,000 households accommodated annually in existing developed areas over a 20-year period;
- 3.7 million jobs over a 20-year period, all accommodated in existing developed areas; and
- 406,000 acres conserved over a 20-year period.

Air Quality Improvements

Finding: *The findings from three case studies indicate that brownfields projects, in comparison to alternative greenfields projects, save between 20 percent and 40 percent of vehicle miles traveled. This translates directly to air emissions reductions or savings of a similar magnitude.*

This conclusion is based on the findings of three studies.

U.S. Conference of Mayors (USCM) research under the "Clean Air-Brownfields" project established a strong relationship between brownfields redevelopment and air quality benefits. The Baltimore and Dallas case studies projected lower vehicle miles traveled (VMTs), with reductions attributable to the brownfields sites, relative to greenfield sites, ranging from 23 percent to 55 percent. [33] This translated into reduced VOCs and NOX emissions, as follows:

Table 4. Reduction of Air Pollutants, Brownfields/Infill vs. Greenfields sites

	% decrease attributable to brownfields/infill site vs. greenfields site	
	VOC	NOX
Baltimore	36%	40%
Dallas	73%	87%

[32] U.S. Conference of Mayors, 2006.
[33] U.S. Conference of Mayors, 2001.

Similarly, EPA's extensive modeling analysis of Atlantic Station in Atlanta, a mixed-use redevelopment of the Atlantic Steel brownfields site, found VMT savings relative to three alternative suburban sites similar in magnitude to the USCM study (14 percent to 52 percent).[34] Atlantic Station, which is now about 50 percent built out, conducts annual surveys of residents and the employees of their business/tenants. The surveys have found that residents and employees average eight and twelve vehicle miles traveled per day, respectively, compared to an Atlanta regional average of 30 vehicle miles traveled per person per day – reductions of 73 percent and 60 percent, respectively, relative to regional norms, roughly double the VMT savings expected by the pre-development model.

A cautionary note: three case studies is less than ideal in order to draw conclusions about brownfields, generally. For example, the three projects were all located in large central cities where there is a clear urban-suburban dichotomy. These findings may not apply to rural or small town brownfields sites.

Energy and Greenhouse Gases

Finding: *"Urban Compact Development" reduces transportation-related greenhouse gas (GHG) emissions by 20 percent to 40 percent in comparison to sprawling/spread development patterns. Brownfields case studies (cited above) indicate similar reductions. This 20 to 40 percent reduction likely understates the GHG benefits of urban compact development and brownfields redevelopment because it does not include several land use related energy benefits, such as lower "line-loss" in distributing electricity to dense urban areas relative to spread suburban areas, and the lower energy requirements for building and maintaining infrastructure.*

A recent report released by Urban Land Institute (ULI) documents that compact urban redevelopment, as an alternative to sprawl, reduces VMTs by 20 percent to 40 percent, or 30 percent as an average.[35] This translates into reducing driving-related GHGs by 7 percent to 12 percent by the year 2050. Other studies have come to similar conclusions.[36] Factors that determine the greater and lesser VMT savings attributable to urban compact redevelopment are:

- Location near city center
- Density
- Mixing of uses/internal design
- Degree of connectedness to the existing grid
- Access to transit

Above under "Characteristics of Brownfields Sites," NEMW concluded that brownfields sites tend to be dense and are increasingly mixed use. Good data is lacking related to the other three VMT factors above, but a fair assumption would be that most brownfields sites meet those criteria as well.

[34] U.S. Environmental Protection Agency, June, 2006.
[35] Urban Land Institute, et al, 2008.
[36] Some of the studies include: Pew Center on Global Climate Change, 2005; Wernstedt, Kris, 2004; Environmental and Energy Study Institute and the Funders Network, 2004; Goldberg, David et al, King. Larry, 2002. (see bibliography)

The three previously referenced case studies (see "Air Quality Improvements" section above) also quantify the relationship between brownfields redevelopment and air quality, based on the transportation impacts of brownfields versus greenfields sites. It can be assumed that the impact of these three brownfields projects on VMT-related energy use and greenhouse gases is of a similar magnitude as that calculated for other air pollutants cited. This would mean an approximate 20 to 40 percent VMT-related GHG savings, the same as that calculated for urban compact redevelopment above.[37]

However, there are also six non-travel GHG benefits of urban compact development and brownfields redevelopment:

1. Lower energy demands due to economies of energy use in higher density development with more vertical structures.
2. Lower energy use to the degree that there is a correlation between brownfields and green/energy-efficient buildings.
3. Lower energy requirements related to building and maintaining infrastructure.
4. Greater efficiency (lower line-loss rate) of transmitting energy to sites that are more dense, closer to transmitting/generating stations, and within existing service areas.
5. The "carbon sink" value of conserving land that would otherwise be developed.
6. GHG reductions due to urban/brownfields projects that are served by waste-to-energy plants or district heating systems that also reduce GHGs.
7. Lower energy required due to the more frequent rehabilitation of existing buildings in urban/brownfields projects – it takes less energy to rehabilitate existing structures, relative the energy required for new construction.

Currently available information does not permit a quantification of these factors, although NEMW reported some suggestive findings in the Institute's working paper on the "Energy Benefits of Urban Infill, Brownfields, and Sustainable Urban Redevelopment." Once these issues have been fully quantified, the 20 to 40 percent transportation-related GHG reduction referenced above may prove to be an understatement of the climate benefits of compact urban development and brownfields redevelopment.

A disclaimer for this discussion is the same as for the "air quality" section, above: that three case studies are less than ideal in order to draw firm conclusions and that the findings may not apply to rural and small town brownfield sites.

Brownfields and Sustainable Development

Finding: *Brownfields redevelopment is sometimes classified as "sustainable" simply because it involves accommodating growth in the existing developed area. However, there is also evidence of a growing marketplace phenomenon of brownfields projects reaching the higher*

[37] The cautionary note in the air quality section also applies here, that three case studies is less than desirable in order to characterize brownfields generally, and that the three case studies are all urban central cities, not necessarily applicable to all brownfields sites.

sustainability standards of green buildings. The degree and strength of this marketplace phenomenon is unclear from current research.

Brownfields redevelopment is often classified as "sustainable," or at least more sustainable than the greenfields development alternative, because brownfields projects are using already-developed land and infrastructure, and avoiding the negative externalities associated with more spread development patterns. However, there is also evidence that brownfields redevelopment is strongly correlated with the higher environmental standards of green buildings. The evidence is largely anecdotal, but includes:

- U.S. Green Buildings Council data indicate that 25 percent of applicants to the Leadership in Energy and Environmental Design for Neighborhood Developments (LEED-ND) pilot are applying for points under the brownfields criteria.[38]
- Cherokee Investment Partners, the nation's largest brownfields developer, announced the adoption of a corporate objective of seeking LEED certification for all its projects, whenever feasible.
- NEMW found that all four "Mega-Brownfields Projects" highlighted in a recent tax increment financing report were seeking LEED certification.
- Many experts, practitioners, and real estate consultants indicate a strong trend of brownfields and urban redevelopment projects, generally, going green.

NEMW tracks brownfields projects that have exceptional green/sustainability elements (see http://www.nemw.org/brownfields.htm#sustain).

Water Quality Impacts/Less Runoff

Finding: *An EPA study concluded that there are very significant water quality benefits of dense development due to lowered run-off per dwelling unit. Brownfields redevelopment, because it tends to be higher density, also tends to improve water quality.*

An EPA report compared the runoff attributable to various densities, but accommodating the same amount of development, and found that "the higher density scenarios generated less stormwater runoff per house at all scales and time periods." The report states,

"We found that:

- With more dense development of eight houses per acre, runoff rates per house decrease by about 74 percent from one house per acre.
- For the same number of houses, denser development produces less runoff and less impervious cover than low-density development.
- For a given amount of growth, lower density development covers more of the watershed."[39]

As noted above, brownfields sites tend to be redeveloped with the urban densities, which are associated with lower run-off.

[38] U.S. Green Buildings Council data provided to NEMW, October, 2007.
[39] Richards, Lynn, June, 2006.

ECONOMIC AND COMMUNITY IMPACTS

Employment and Investment Impacts

Finding: *Although there is no comprehensive national data that represent the full breadth of brownfields redevelopment activity, two sources give an indication of the impacts:*

- *$1.3 billion invested through the EPA Brownfields Program has leveraged 48,238 permanent jobs and $11.3 billion in new investment, as of March, 2008.*
- *The 2007 U.S. Conference of Mayors survey indicates that 150 cities have successfully redeveloped 1,578 brownfields sites. Eighty of the reporting cities also listed permanent job impacts which totaled 115,600 jobs-- a rate of approximately 137 jobs per site.*

Indicators of Economic Impact. Brownfields programs generally have four objectives: cleanup, smart growth, neighborhood revitalization, and economic development. Of the four objectives the easiest to measure is economic development – jobs and investment; so those are the numbers that are often used to represent program success. NEMW acknowledges that these two numbers are crude indicators of economic activity. The number of jobs reported here are permanent jobs accommodated (created or retained) in brownfields projects, but there is no distinction between the type of job (for example does it pay a living wage with health benefits?), whether neighborhood or low-income people are filling the jobs, or whether the job is 'new," "retained," or "relocated." Nor is there any indication of secondary off-site jobs that might be induced by the primary on-site jobs. (For more discussion of issues in reporting job impacts, see Howland, 2007.)

Accepting these short-comings in the data, NEMW also points out that the job and investment numbers are worth reporting partly because brownfields redevelopment is serving three other objectives aside from economic development. Thus, the above cited EPA impact data can be viewed as *48,000 jobs and $11 billion investment in sites that helped re-direct growth to neighborhoods that had been suffering the ill-effects of vacant contaminated properties.*

Samples vs. Full Impact. NEMW stresses that these two sources -- EPA-funded projects and USCM surveys -- are fairly small samples of brownfields sites. To illustrate the point, NEMW has made two hypothetical calculations based partly on hard data and partly on assumptions. We know that 48,950 sites have completed state voluntary cleanup programs (VCP). Other data reported above suggest that the average brownfields site (if job-producing) creates about 90 jobs. In order to estimate the full job impact of brownfields redevelopment, two assumptions are made:

1. That 60 percent of sites that have completed a state VCP program have been "substantially redeveloped." The 40 percent that are removed from this calculation are meant to account for three problems:1) that some sites remain vacant after going through VCPs; 2) smaller gas station and dry cleaning sites are unlikely to have the job intensity of the sites that were in the surveys that resulted in the 90 jobs per site calculation; and 3) that some sites are listed multiple times in VCP records.
2. That 70 percent of the brownfields that have been redeveloped have been for employment-producing uses (based on the CUED study and studies of sites in Missouri and Milwaukee).

With these two assumptions, NEMW calculates that completed VCP sites may have already accommodated *1.9 million jobs* on brownfields sites (see Appendix 3).

Similarly, if one assumed that these redeveloped VCP sites (60 percent of 48,950) created investment at the same rate as sites found in surveys in this report (approximately $24 million per site), *the total investment in completed brownfields sites would be approximately $703 billion.*[40]

Note that these two calculations are presented only to make the point that the size and impact of the brownfields industry is much larger than might be indicated by the USCM and EPA job and investment numbers. If these calculations are cited, care should be taken to also cite the assumptions.

Impacts of Increased Public Investment. Another way to look at the larger job and investment picture is to quantify the impacts of possible increases in public investments. In the Executive Summary and Appendix 2, NEMW estimates the job and investment impacts of an increased federal commitment of $1 billion annually. If the additional federal funds provide one-third of new public investments, the projected incremental gain from that investment is:

- 3.7 million jobs over a 20-year period, all accommodated in existing developed areas; and
- $480 billion in new investment over a 20-year period.

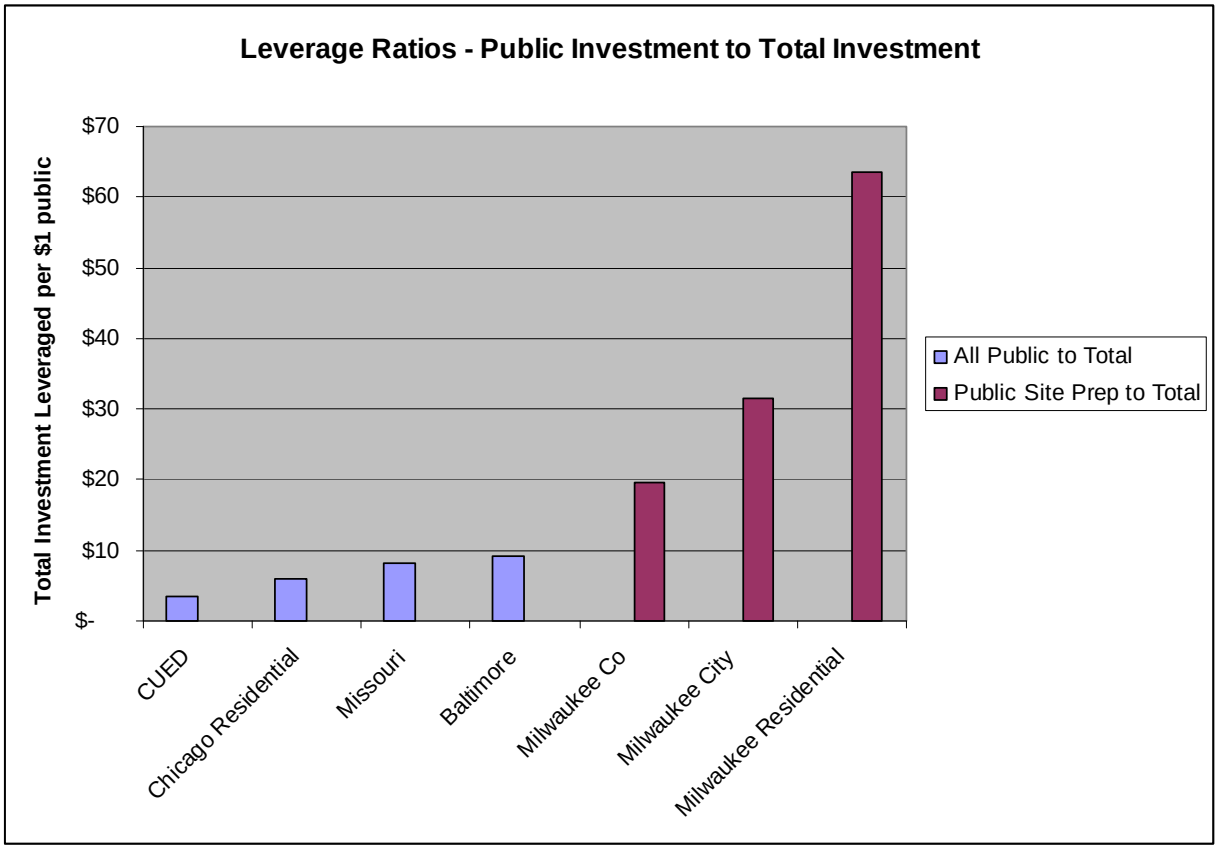
Leveraging Investment

Finding: *Interpreting the results of eight studies with widely varying results, NEMW concludes that public investments in brownfields leverage total investments at a ratio of approximately $1/public investment to $8/total investment. Brownfields-related subsidies for site assessment, cleanup, and site preparation leverage total investment at a higher ratio of 1 to 20, consistent with Milwaukee studies. The 1 to 20 ratio is the average public cost to make the land "development ready." Brownfield sites in severely distressed areas require higher subsidy levels, as much as double the ratios indicated here.*

Above cited data indicates that the majority (possibly as much as 80 percent) of brownfields sites require a public subsidy in order to stimulate private investment. Naturally, the level of subsidy necessary to leverage private dollars can be large or small depending on the project economics. However, it is surprising that surveys of *multiple* sites find widely varying leverage ratios. Median leveraging numbers from the studies below vary widely from a low of $1/public-to-$3.41/total investment to a high of $1/public-to$63/total investment.

[40] NEMW advises that these estimates are based on data and assumptions that are not well established. The estimates should not be cited without a full explanation of the data sources and assumptions – see Appendix 3.

Figure 3. Leverage Ratios of Public Investment to Total Investment



NEMW has concluded that, as an industry average, public investment in brownfields leverage total investment in a ratio of approximately $1/public to $8/total investment. The following is summary of the results from each study, with NEMW analysis aimed toward reconciling the numbers.[41]

Missouri.[42] Missouri tracked 50 brownfields sites and documented all sources of public investment and private investment.[43] The 50 projects involved a total private investment of $2.18 billion and leveraged by $310.1 million in public funds, producing a total investment of $2.51 billion. The ratio of public funds to *total* funds was 1 to 8.06. The ratio of public funds to *private* funds was 1 to 7.1. State funds represented 65 percent of total public funds, outweighing local (25 percent) and federal (10 percent). More details of the Missouri study are reported in Appendix 4.

> ***NEMW Comment.*** Missouri's analysis is the most recent available (2006) and has advantages over older studies in that it captures the trend toward non-industrial reuse of

[41] NEMW reviewed one additional study not cited in the text: Walzer, Norman and Gisele Hamm, 2005. The study of thirty-seven Illinois sites lacked documentation to allow comparison to other reports and review of methodology. The report included of some sites that had no private investment, and the authors acknowledged that impacts are significantly understated as a result of incomplete projects.
[42] Missouri Department of Natural Resources, 2006

brownfields. Non-industrial reuse is associated with greater intensity in use of land and therefore greater private investment leveraged per public dollar.

Missouri has a brownfields tax credit program that pays up to 100 percent of site assessment and remediation expenses. This, along with an aggressive state historic preservation tax credit program, accounted for $110 million, or more than one-third of all public investments. It can be assumed that these resources allow Missouri to more heavily subsidize brownfields sites than most states which lack comparable vehicles, which would tend to indicate that the Missouri leveraging ratios are lower than might be typical nationally.

CUED.[44] A 1999 analysis of 107 brownfields projects found that $1 of public funds leveraged $3.59 in *total* investment, or $2.48 in *private* investment. The authors calculated the ratios two ways with respect to "publicly-supported debt;" the above figures count debt on the public investment side of the ledger. If publicly-supported debt is reclassified as private, the ratio increases to $1/public to $3.59/private. Local public funds provided the majority (51 percent) of all public funds, contrasting sharply with the Missouri study, which found state funding providing the majority of the assistance. Remediation constituted eight percent of total costs and 20 percent of public costs. Because the CUED study has been used as the standard since it was published in 1999, NEMW is reviewing the data and methodology in considerable detail.

NEMW Comment. The CUED report was an accurate reflection of the brownfields marketplace in the late 1990s, but data in more recent studies indicate considerably higher leveraging ratios. There are two primary reasons that the CUED study is no longer the best data to indicate leverage ratios.

First, the CUED survey contained a very high percentage of sites that were in public ownership; 81 percent were owned by public agencies at some point in the process. This was presumably a reflection of the marketplace at the time. Because the study was focused on completed sites, the sites in the survey were likely planned in the mid-90s or earlier, before there was widespread private sector acceptance of state voluntary cleanup programs. Sites that involve public ownership are likely to involve greater subsidy, because they are, by definition, sites that have been passed over by the private sector. Surveys that have been carried out more recently reflect the more prevalent current practice of sites that remain in private ownership, but involve public subsidies to close gaps.

Second, the CUED study, with pre-1999 data, reflects the prevalence of industrial reuse of brownfields. This was also accurate for the time, but the marketplace has changed substantially in 10 years. The most frequent reuse in the CUED study was industrial (approximately 50%); whereas office and mixed office is the most frequent reuse in the Missouri study (44%). Office uses constituted only 22 percent of the CUED sites.[45] Further, only seven percent of the CUED projects were residential, compared to 38 percent of Missouri study projects that were residential or mixed residential. This trend toward

[44] Council for Urban Economic Development (CUED), 1999.

[45] In order to make the CUED number comparable to the Missouri number, NEMW assumed that 60 percent of the CUED "mixed-use" projects included office uses.

non-industrial development should be expected to have a favorable impact on investment ratios because residential, mixed-use, and office development all involve both more intense use of land and greater investment per square foot of building space. Further, industrial development sometimes involves subsidy of the business itself, irrespective of site issues.

Thus, for several reasons, more recent findings should be given greater weight than the older CUED study. However, the CUED study does provide an indication of the extent of subsidy needed for relatively more difficult sites.

Chicago/Residential Projects:[46] Data for 18 publicly-assisted residential projects indicated that $164 million in public support (all public funds/all levels of government, not just brownfields funding) leveraged $991 million in total investment for a ratio of 1:6. The ratio of public dollars to private dollars was 1:5. Other findings:

- There were 52 residential projects constructed and planned from 1995 to 2004 that reused 133 acres of brownfields. Forty-nine of those projects generated over $2.17 billion in redevelopment, with publicly-assisted projects leveraging $1.04 billion in investment versus private projects at $1.14 billion.
- The largest public source, by far, was tax increment financing (TIF) at $104 million or 63 percent of all public funding. The TIF-funded projects, which typically targeted the most distressed sites, generated over $913 million with $1 TIF generating $8.76 in total investment. Chicago may be the most aggressive city in the country in using TIF to address brownfields

NEMW Comment. This study produces results that are roughly between the CUED study and the Missouri study. In trying to compare the results, NEMW points out that local tax increment financing (TIF) funds comprised 63 percent of all subsidies. Chicago's aggressive use of TIF allows the city to address sites with large gaps, which presumably allows Chicago to more heavily subsidize projects relative to other cities and states nationally. Another issue that lowers the Chicago leverage numbers is that all of the housing projects involve affordable housing or mixed income. The subsidies were partly used to make units affordable; and affordable units require subsidy irrespective of site issues.

Baltimore. An analysis of eight of Baltimore's larger brownfields projects revealed that public investments of $5.4 million in cleanup funds and $49 million in total development subsidies leveraged $405 million in total investment. The cleanup funds to total investment ratio was $1 to $60, and the ratio for total development subsidies to total investment was $1 to $9.25. The ratio of public dollars to private dollars was one to eight. (See Appendix 5.)

NEMW Comment. The Baltimore analysis has too few sites to generalize from, but it does tend to indicate higher leverage numbers, relative to, especially, the CUED study.

[46] De Sousa, "Residential…,"2006.

Milwaukee/Brownfields.[47] There are two Milwaukee studies. First, a study of 64 brownfield projects supported with City of Milwaukee funds between 1995 and 2000 found that $5.7 million invested in *brownfields-related/site preparation* subsidies (not necessarily *all* subsidies) leveraged over $325 million in investment, leading to a ratio of total investment to public investment of 32 to 1 (the ratio was 57 to 1 for city costs). Milwaukee County brownfields investments produced a somewhat lower 20 to 1 ratio.

Milwaukee/Residential Projects:[48] The second Milwaukee analysis (by the same author) examined 32 residential brownfield projects that were developed from 1990 to 2004, reusing 95 acres of brownfield land and leveraging $500 million in redevelopment. Twenty-one of those projects received $5.2 million in public brownfields-related subsidy (site assessment, remediation, and/or site preparation activities) and leveraged $329 million in private investment, leading to a ratio of $1 of public brownfields funds leveraging $64 in total investment. In contrast to the Chicago residential study by the same author, the Milwaukee analysis excluded infrastructure and subsidies needed to make the housing affordable.

> ***NEMW Comment.*** The two Milwaukee studies produced much higher leveraging ratios than any other studies. This is largely explained by the concentration on "brownfields-related site preparation" costs, which exclude infrastructure and subsidies that are specific to the use, such as housing subsidies to produce affordable units or business subsidies to attract an industrial user. This methodology has validity because it tends to isolate the financing gaps that are specific making land "development-ready."
>
> The Milwaukee studies also tend to support the higher leveraging ratios in the Missouri study rather than the lower leveraging ratio in the CUED study. If one assumed that the excluded costs meant that the Milwaukee subsidies are understated by one-half, the leveraging ratios would still be higher than Missouri and several multiples of CUED.
>
> The exceptionally high leveraging ratio for the Milwaukee residential projects ($1/public to $64/total) also reflects the previous point that residential development involves more intense use of land and more dollar improvement per square foot.

Taking into account the differences in methodology, timing, and the characteristics of the sites studied, NEMW concludes that brownfields public investments leverage total investment in a ratio of approximately $1/public to $8/total investment. The Milwaukee studies, which count a smaller universe of brownfields-related site preparation subsidies, give the best indication of how brownfields-specific public investments (cleanup and site preparation) leverage total investment: $1/public leverages $20/total.[49] This site preparation leveraging number is one way to measure the productivity of brownfields investments because it focuses on the site-related subsidies needed to make land "development ready."

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[47] De Sousa, 2005

[48] De Sousa, "Residential…,"2006.

[49] NEMW used the lowest public to total investment ratio of the three Milwaukee analyses. Given limited data (all by the same author), NEMW preferred to err on the conservative side.

Lastly, the CUED study, with a ratio of $1/public to $3.59/total investment, gives a continuing benchmark for the extent of subsidy needed to address more difficult sites – roughly double the subsidy of typical sites. If a state or locality were to structure an incentive with an objective of encouraging redevelopment in severely distressed areas, the CUED results would tend to indicate a need for subsidies to cover more than 20 percent of total development costs.

All of these studies are a snapshot in time and all results probably understate total investment to some degree because some investment occurs after the study data collection point.

Leveraging Employment

Finding: *Interpreting results from six studies with widely varying results, NEMW concludes that it takes between $10,000 and $13,000 in public investment to leverage one job. Isolating public costs for brownfields-related site preparation, NEMW concludes that an average $5,700 in public costs leverage one job. For reference, the standard for judging investments by the U.S. Department of Housing and Urban Development and the U.S. Small Business Administration is $35,000 per job.*

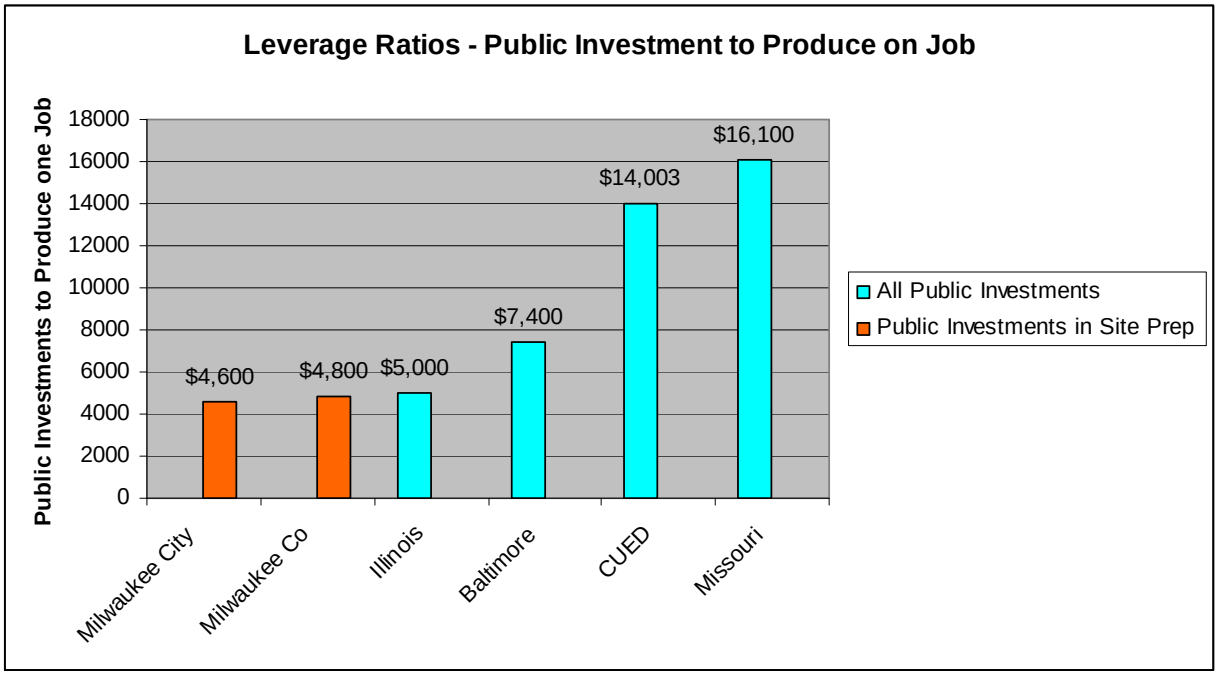
In the discussion below, NEMW is counting permanent jobs accommodated (created or retained) in brownfields redevelopment projects. (See the discussion of jobs as an indicator in the section above, "Employment and Investment Impacts, Indicators of Economic Impacts").

Job leveraging ratios have been reported in six different studies, varying from a low of $4,500 per job to a high of $16,100 per job See Figure 4). Below, NEMW summarizes the results and attempts to reconcile the data.

- **CUED.** [50] The CUED 1999 study found that, on average, it took a public investment of $14,003 to leverage one job, with "publicly-supported debt" counting on the public investment side. If "publicly-supported debt" is reclassified as private investment, the ratio drops to $10,900/public investment to produce one job. The CUED analysis counted 37,000 jobs created in 90 job-producing projects with $517 million in public investment. As noted above, the CUED data were derived from a survey that primarily reflected publicly owned sites. This may mean the public investment needed is high, relative to studies that are more representative of private and public sites.

[50] CUED, 1999

Figure 4. Leveraging Ratios – Public Investment to Produce One Job



- **Missouri.**[51] Missouri counted $33,600 in public investment to produce one job. However, this ratio counts all projects assisted, including residential projects and other projects where no jobs were created, which would be inconsistent with other methodologies. NEMW removed the residential and "no-job" projects from the Missouri spreadsheet and calculated the public investment per job to be $16,100. Missouri's aggressive brownfields and historic tax credit incentives may mean that they more heavily subsidize job-producing projects relative to other states.

- **Baltimore.** The previously referenced analysis of eight Baltimore projects involved a total subsidy of $49 million which reaped a total of 6,600 permanent jobs, a ratio of $7,400/subsidy to create one job. Isolating brownfields subsidies for site testing and cleanup results in a ratio of $1,100/subsidy to produce one job. (See Appendix 5.)

- **Milwaukee.**[52] A study of 64 brownfield projects supported with City of Milwaukee funds between 1995 and 2000 found that they created or retained over 2,200 full- and part-time jobs. The amount of subsidy for brownfields-related site preparation, and not all public subsidies, was $4,600 to produce one job. The corresponding number for 63 projects in Milwaukee County was $4,800.

- **Illinois.**[53] An analysis of 37 brownfields projects in Illinois found that the median total federal, state, and local subsidy per job created was $2,168, $2,989 and $598,

[51] Missouri, 2006
[52] De Sousa, 2005
[53] Walzer, Norman and Gisele Hamm, 2005.

respectively. The study did not report total public investment per job. Because the denominators are different for each calculation, adding the three together is not mathematically correct, but a rough estimate would be that it takes about $5,000 in total public subsidies to produce one job.

As noted above in the "Leveraging Investment" section, some of the results here may overstate the public investment side of the equation because of a disproportionately high number of publicly-owned sites, as in the CUED report, and the likely incomplete reporting of jobs generated. Note the Milwaukee studies did not count all public costs – only brownfields-related site preparation. As noted in "Leveraging Investment," NEMW agrees with the Milwaukee approach, i.e., that it is important to isolate site preparation as a leverage measure.

NEMW concludes that the average amount of public investment to produce one job is between $10,000 and $13,000. The Milwaukee studies suggest that about one-half that amount ($5,700) invested in overcoming *brownfields-related site preparation* will generate one job. Over time, these leveraging numbers will likely turn out to be too small, because significant job-generation occurred after data collection.

Neighborhood Revitalization and Property Value Increase

Finding: *Cleanup and redevelopment often leads to property value increases on the order of five percent to 15 percent for properties that are up to 3/4 mile from the site. There are documented cases where "impact" projects, usually involving change in use from industrial to parks or mixed use, have had much higher impacts, even exceeding 100 percent.*

The data suggest that cleanup and redevelopment of brownfields sites lead to property value increases among adjoining and/or nearby neighborhood properties. The evidence comes first from two studies that document the negative impact of vacant, unused brownfields sites:

- An analysis of the value of commercial and industrial properties surrounding brownfields within a 1.5-mile radius found values were 10 percent lower on average after controlling for other location factors. [54]
- A study of the impact of industrial and commercial brownfields on surrounding properties in Baltimore found that proximity to an industrial brownfield property that was either listed or de-listed from a brownfields registry had no relationship on the value of surrounding industrial property, while proximity to a listed or delisted commercial brownfield did cause a negative externality on the value of commercial property. Specifically, the price of property increases in value as one moves from 500 meters to one kilometer away from a listed commercial brownfield by 6.98 percent and from a de-listed commercial brownfield by 4.36 percent.[55]

Second, a number of studies measure the upside property value benefit of cleanup and redevelopment:

[54] Ihlanfeldt and Taylor, 2002
[55] Longo and Alberini (2005)

- Research measuring and comparing the impact of different forms of publicly-assisted brownfields redevelopment (greenspace, industrial, commercial, and residential) on the value of single-family homes (pre- and post-redevelopment) in Milwaukee projects analyzed and 58 Minneapolis projects analyzed revealed the following:[56]

  Table 6. Property Value Increases Due to Brownfields Redevelopment

Type project	**Milwaukee** **Geog. Scope** = 4,000 ft	**Minneapolis** **Geog. Scope** = 2,500 ft
Residential projects	8.6%	3.1%
Commercial projects	15.8%	4.6%
Parks projects	11.7%	4.4%
Industrial projects	4.7%	3.2%
All sample (net)	**11.4%**	**2.7%**

- A report prepared by the International Economic Development Council (IEDC) found that seven completed brownfields-to-greenspace projects reported mean off-site property value increases of 126 percent, compared to a control group that averaged 25 percent increases.[57]
- An analysis of the economic and fiscal impact of the American Can project in Baltimore found that neighborhood property values rose 17.6 percent in the four-year period following completion of the project. This compared to citywide property values rising 4.4 percent.[58]
- A study of the Lincoln Neighborhood in Kenosha, Wisconsin, found that the remediation of a brownfield would raise property values for a representative house in the area by 1.7 percent to 6.2 percent, while both remediation and conversion to greenspace would raise values by 3.4 percent to 10 percent.[59]
- An estimate from Canadian experience was that property values increase as much as 10 percent within an approximate radius of 1.5 miles when a brownfield property is redeveloped. Alternately, on average, commercial and industrial properties near brownfields are 10 percent lower in property values after other factors had been considered.[60]

A literature review which covered this subject cited some studies that indicate little or no positive effects of a cleanup. The author speculated that these cases were ones where the surrounding neighborhood was so dilapidated and unattractive to new investment that cleanup of an isolated site made no difference.[61]

[56] De Sousa, Wu, and Westphal in progress
[57] International Economic Development Council (IEDC), 2002.
[58] Lipman-Frizzell, 2002
[59] Kaufman and Cloutier, 2006
[60] Hara, Dan. 2003.
[61] Howland, 2007

See also the "Linchpin Effect" section, below, for a discussion of higher impact projects that rejuvenate larger corridors and districts.

FISCAL IMPACTS

The fiscal benefits of brownfields redevelopment fall into four categories:

- Directly generating local and state tax revenue by putting unproductive land back to tax generating use;
- Indirectly generating local tax revenue by boosting the property values/property taxes of adjoining or nearby properties (as addressed above);
- Requiring lower investment in infrastructure to accommodate growth, relative to greenfields development; and
- Other indirect impacts of brownfields versus greenfields development.

Direct Generation of Local Tax Revenue

Finding: *From the micro/project-specific perspective, public investments in brownfields are generally recouped from local taxes generated by the project within about five years, although tax credits may extend this period. From the macro perspective, the U.S. Conference of Mayors survey found that redeveloped brownfields in 62 surveyed cities could lead to $408 million in annual local tax revenue. Further, the survey found that redeveloping remaining brownfields could generate between $1.3 and $3.8 billion in local taxes.*

A review of available information suggests that public investments on brownfields tend to reap positive fiscal benefits in five years or less.

- **Baltimore.** The Baltimore analysis of eight large brownfields projects found that $49.1 million in one-time total development subsidies would lead to the city gaining $9.4 million in annual property taxes, once all tax credits expired (see Appendix 5). At this rate, it would take 5.2 years to recoup public investment in brownfields from increased real property taxes.[62]
- **Milwaukee.** Based on the 2005 tax rate for Milwaukee County, the 32 brownfields-to-housing projects developed and planned in Milwaukee between 1990 and 2004 will generate approximately $13.5 million annually in gross taxes, with $4.6 million of that going to the city. Brownfields-related subsidies ($5.7 million) get paid back in less than three years.[63]

The above calculation includes only direct taxes from the project, without taking into account any indirect neighborhood effect or multiplier effect. It should also be noted that the numbers do not take into account any tax credits. These are probably offsetting factors, but caution should be used in drawing conclusions from this limited data.

[62] This calculation is theoretical – it assumes no property tax credits and immediate upward revision of assessments based on 100 percent of improvement values.
[63] De Sousa, 2005

National USCM Data. From a more macro point of view, the 2007 USCM survey of 62 responding cities indicated that redeveloped brownfields are producing $408 million in local tax revenue annually. NEMW has calculated a mean local tax generation of $626,000 per site. The survey also found that redeveloping remaining brownfields sites could generate local taxes at nine times the current yield; 105 respondents indicated that redeveloping brownfields would lead to between $1.3 billion and $3.8 billion in local tax revenue annually.

Lower Investment in Infrastructure

Finding: *Brownfields and greyfields usually have infrastructure in place so there is a cost savings in building and maintaining infrastructure relative to alternative new/sprawl development. The magnitude of this cost savings is uncertain. One analysis pegged the savings at as much as $1/brownfields vs. $10/greenfields. The literature in the area of sprawl vs. new "compact development" suggests smaller increments, where the differential is 10 to 35 percent. Future research may reconcile these findings in that there is likely a significantly greater infrastructure savings attributable to brownfields/greyfields relative to new compact development.*

Brownfields projects make use of the infrastructure that was put in place for the original, usually industrial, use of the brownfields area. From a fiscal efficiency point of view, advocates maintain, it simply makes sense to utilize this infrastructure rather than build new infrastructure to support or subsidize increasingly inefficient land use patterns. However, the quantitative evidence supporting this point of view is a little thin.

There are two kinds of studies that look at the infrastructure cost differentials.

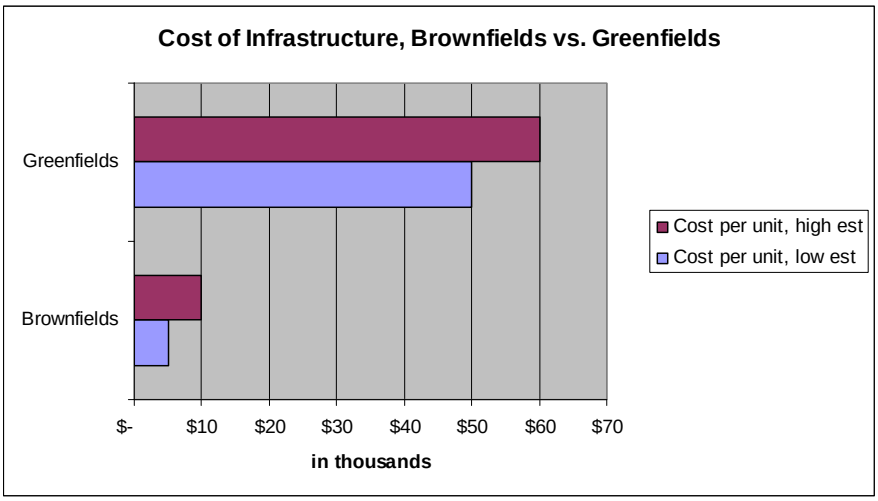
First, there are a series of reports that look at the relative costs of building and maintaining infrastructure for spread/sprawl development patterns vs. "compact development." A comprehensive analysis of the costs of sprawl by the Transportation Research Board concluded that the differential in cost to build infrastructure for sprawl development relative to "compact development" is only ten percent.[64] However, a review of the research and literature for the State of Delaware found a more significant savings of 25 to 35 percent (compact vs. spread) just on the capital side, and the authors speculated that there were more significant savings on the operating cost side.[65] Although it is not explicit in these studies, it appears that "compact development" is a sub-set of *new* development, not *re*development.

Another kind of study compares the costs of infrastructure: new/sprawl vs. brownfields and greyfields, (*re*development in areas where infrastructure is in place). Unfortunately, NEMW found only one study that had this focus, and only the results, not the methodology, were reported. According to research by the Center for Neighborhood Technology, infrastructure costs per unit are between five and 10 times higher at greenfields sites compared to brownfields and that infrastructure differential between one dwelling unit per acre and seven dwelling units per acre is $50,000 per unit.[66] See Figure 5.

[64] Transportation Research Board, 2000
[65] Mix, Troy D., 2003
[66] Center for Neighborhood Technology, 2004

The 1999 IEDC study found that 45 percent of the brownfields projects studied had *no* substantial infrastructure costs, which would tend to support the Center for Neighborhood Technology findings.

Figure 5. Cost of Infrastructure, Brownfields vs. Greenfields



NEMW cannot come to a definitive/quantitative conclusion on this point. However, it makes common sense that the infrastructure costs for brownfields/greyfields should be less than any *new* development (compact or spread). Future research may reconcile these findings in that there is likely a significantly greater infrastructure savings attributable to brownfields/greyfields relative to new compact development.

Other Indirect Costs – Brownfields Versus Greenfields

Finding: *The transportation-related "externalities" (indirect costs) of greenfields development are about 3.5 times the indirect costs of brownfields redevelopment.*

Research by De Sousa carried out in Toronto, Canada, comparing brownfields redevelopment in the city versus greenfield development in the periphery found the external costs associated with transportation (i.e., parking, accident, pollution, and health costs) imposed by those living and working on urban brownfield sites to be significantly lower than by those living on greenfields: $26,960/acre/year less for residents and $7,760/acre/year less for industrial employees.

The results of a similar earlier analysis, which attempted to quantify the social costs and benefits of brownfields versus greenfields development, is included as Appendix 7. The results are consistent with the above conclusion.

LINCHPIN EFFECT

Finding: *In some instances, brownfields redevelopment is the catalyst or the linchpin that creates a positive environment for new investment and leads to transformation of entire neighborhoods and districts.*

This "linchpin" concept is difficult to quantify or to establish a direct cause and effect relationship through a scientifically-defensible methodology. There is academic literature that reflects skepticism toward claims of extraordinary secondary benefits of even in small number of projects. A 1999 review of brownfield projects in Michigan produced a finding that "no case was found where an initial brownfield investment led plausibly to significant secondary development."[67]

Granted that evidence is largely anecdotal, with some corroborating data; the author's experience includes two Baltimore projects that are regarded as linchpins by the local Baltimore real estate community. One of these, Tide Pont, is the subject of an unpublished master's thesis which generated some supportive data.

Baltimore/Tide Point. Tide Point is the redevelopment of the former Procter and Gamble soap plant on Baltimore's waterfront, just south of the downtown/Inner Harbor. Tide Point consists of 400,000 square feet of modernized office and technology space, accommodating 1,600 jobs, and representing $72 million investment. It is viewed by local real estate observers as spurring interest in the entire Locust Point neighborhood. The project, completed in 2000, is regarded as paving the way for at least three subsequent conversions of underutilized industrial land to new residential, mixed use, and commercial redevelopment projects, totaling several multiples of the Tide Point investment:

- Silo Point ($70 million investment, 228 dwelling units and 130,000 square feet of commercial space);
- Foundry on Fort (70,000 square feet of commercial space); and
- McHenry Row (planned mixed use with 250 apartments, $70 million investment).

More importantly, Tide Point attracted a young workforce to the neighborhood, and their home renovation projects appeared to set a trend that attracted yet more renovation and reinvestment by middle- and upper-middle income families. Although this is difficult to capture in a quantifiable fashion, a draft Master's thesis [68] made available to NEMW provides some excellent indicators:

- Property taxes for the Tide Point parcels grew dramatically, as the valuation increased from $3.8 million in 2001 to $50.1 million in 2007;
- Average commercial and residential property sales prices rose approximately fivefold from 1995 (pre-Tide Point, $58,800) to 2007 ($276,600); and
- Construction permits grew dramatically, about fivefold from 1995 to 2007. When the construction permits are compared to citywide permits, which also grew, the Locust Point growth rate still exceeds the citywide rate by a factor of 3.52. See table 5.

[67] Hula, 1999 cited in Howland, 2007
[68] Lewis, Gregory William, 2008.

Table 5. Tide Point Impacts: Locust Point Construction Permits Compared To Citywide Permits, 1995 – 2007.

	Locust Point permits	***Location Quotient analysis, Locust Point relative to citywide permits***[69]
1995	146	1.06
2001	468	4.28
2007	722	3.52

Baltimore/American Can. The American Can redevelopment in Baltimore ($27 million investment, 300,000 square feet of office, technology, and retail space) was the first site to complete Maryland's Voluntary Cleanup Program after it was adopted by the legislature in 1997. In turning a prominent neighborhood eyesore into an exciting mix of retail and office space, the Can Company is regarded as the starting point of the Canton neighborhood revitalization, which now includes surging residential property values, a revitalized O'Donnell Square commercial strip, the $100 million mixed-use Brewer's Hill redevelopment, and the $1 billion mixed-use Canton Crossing redevelopment. An analysis of the economic and fiscal impact of the American Can project in Baltimore found that neighborhood property values rose 17.6 percent in the four-year period following completion of the project. This compared to citywide property values rising 4.4 percent.[70] This property value analysis was carried out before the Brewer's Hill and Canton Crossing development projects.

Minneapolis/Central Riverfront. The Minneapolis Park and Recreation Board maintains that recent public investments within the Minneapolis Central Riverfront ($55 million in parks and $150 million in public improvements), much of it on brownfields land, has leveraged over $1.2 billion in private investment in residential (3,000 dwelling units), as well as commercial, entertainment, and other uses.[71]

Some other projects that have been reported as sparking larger scale reinvestment are described in the EPA document, "For EPA's Brownfields Program, 'Green' Refers to More than the Environment:" http://www.epa.gov/swerosps/bf/success/Green_Money.pdf

The disclaimer is, again, many factors may have contributed to the new investment and neighborhood resurgence reported in the above examples, but the perception in local real estate communities is that the initial investment in a brownfields site was an important catalyst.

[69] The Location Quotient analysis is as follows: ratio of Locust Point tax parcels to citywide tax parcels divided by ratio of Locust Point permits to citywide permits. The 1995 rate (1.06) means that the Locust Point permitting rate was approximately proportionate to the Locust Point share of citywide tax parcels. The 2007 rate (3.52) shows that the permitting rate for Locust Point exceeded the citywide rate by a factor of 3.52.

[70] Lipman-Frizzell, 2002

[71] De Sousa, Chris, "Issues Briefing: Brownfields, Greenfields, Redevelopment and Protection Linkages," Coastal Connections 2006 Land Use Roundtable http://www.glc.org/landuse/inroundtable/pdf/de_sousa.pdf

Table 6. Brownfields Impacts, By the Numbers[72]	
Total sites: Estimated number of vacant/contaminated sites, nationally[73]	450,000 to 1,000,000 sites
Environmental Benefits:	
• Sites cleaned up under state programs, cumulative[74]	48,850 sites
• VMT-related air emissions and greenhouse gases saved from compact urban redevelopment, including brownfields (vs. greenfields) [75]	20% - 40%
• Acres of greenfields saved per one acre brownfields redeveloped [76]	4.5 acres
• Reduced runoff due to density (8 DU/acre vs. 1 DU/acre) [77]	74%
Economic Impacts:	
• EPA Program (as of March, 2008):	
o Total job impacts	48,238
o Total investment impacts	$11.3 billion
• USCM survey of 200 cities	
o Total job impacts, redeveloped sires, USCM survey (80 respondent cities)[78]	116,000
• Total development funding leveraged by $1 public funding of brownfields-related site preparation	$20
• Total development funding leveraged by $1 public funding (all purposes, including infrastructure)	$8.00
• Public funding for brownfields-related site preparation to produce one job	$4,700
• All public subsidies to produce one job	$10,000 – $13,000
• Increase in area property values following cleanup and redevelopment of a brownfields site	5% to 15%
Fiscal Benefits	
• USCM survey – local tax revenue from redeveloped brownfields (62 respondent cities)[79]	$408 million
• USCM survey – potential local tax revenues from redeveloping remaining brownfields (100 respondent cities)[80]	$1.3 billion to $3.8 billion
• Average amount of time to recoup brownfields subsidies through property taxes (not including tax credits)	5 years

[72] If source not noted, see text
[73] US General Accounting Office, 2004
[74] US Environmental Protection Agency, 2005
[75] Urban Land Institute, 2008
[76] George Washington University, 2001
[77] Richards, Lynn, June, 2006
[78] US Conference of Mayors, 2007
[79] US Conference of Mayors, 2007
[80] US Conference of Mayors, 2007

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APPENDICES

Appendix 1. Mean Brownfields Site Characteristics

Appendix 2. Impacts of an Additional $1 Billion Annual Federal Investment

Appendix 3. Impact of Past/Current Brownfields Redevelopment Activity

Appendix 4. Missouri - Economic Impact of Brownfields, "Hidden Treasures Report," 2006

Appendix 5. Baltimore Brownfields Projects

Appendix 6. Community Quality of Life Improvements Attributable to Three Brownfields to Park Projects

Appendix 7. Indirect Societal Benefits and Costs - Brownfields Versus Greenfields Development

Appendix 1. Mean Brownfields Site Characteristics

A. Calculation of average site acreage for Brownfields

Study	sites	acres	Mean acres per site	Median ac per site
USCM Site inventory				
- USCM acres per site - 2001 survey	19,000	178,000	9.4	
- USCM acres per site - 2006 survey	21,872	96,039	4.4	
- USCM acres per site - 2007 survey	23,307	83,949	3.6	
USCM Sites developed:				
- USCM acres per site - 2003 survey	922	10,594	11.5	5.0
- USCM acres per site - 2006 survey	1409	10,905	7.7	
- USCM acres per site - 2007 survey	1,578	16,947	10.7	
Missouri - sites assisted by incentives	50	636	12.7	
CUED	107	1391	13.0	4.0
Wisconsin - sites assisted through state programs	259	900	3.5	
Chicago residential study - sites developed	52	133	2.6	0.5
Milwaukee co brfds	129	779	6.0	
Milwaukee city brfds	74	318	4.3	
Milwaukee other area jurisdictions	53	468	8.8	
Milwaukee residential study - sites developed	32	91	2.8	0.9
XL Environmental Developer survey				8.5
Milwaukee site inventory	879	2171	2.5	
Total and weighted average	**69,723**	**403,321**	**5.8**	
Unweighted average			**6.5**	**3.78**

Note: NEMW calculated the acreages for CUED, Milwaukee, and Chicago studies from mean site size X the number of sites

NEMW concludes that the mean site size is 5 - 7 acres; the median is 3 - 4 acres

B. Calculation of jobs per site

	Sites	Job impacts	Jobs per site
Study			
EPA	178	12,574	70.6
USCM	657	61,194	93.1
Missouri	50	11,053	221.1
Milwaukee	70	1,900	27.1
TOTAL	955	86,721	**90.8**

C. Calculation of investment per site

	Sites	Investment	Investment per site	Investment in 2008 dollars	Investment per site
Study					
CUED	117	$1,857,097,000	$15,872,624	$2,451,368,040	$20,951,864
Missouri	50	$2,200,000,000	$44,000,000	$2,354,000,000	$47,080,000
Milwaukee	70	$ 350,000,000	$ 5,000,000	$ 437,500,000	$ 6,250,000
Milwaukee residential	21	$ 329,589,000	$15,694,714	$ 362,547,900	$17,264,186
Chicago residential	24	$1,043,048,000	$43,460,333	$1,147,352,800	$47,806,367
TOTAL	282	$5,779,734,000	**$20,495,511**	$6,752,768,740	$23,945,988

Appendix 2. Impacts of an Additional Federal Investment

Scenarios:

1. **New Federal Investment is $165 million, doubling the current appropriations level for the EPA brownfields program**
2. **New Federal Investment is $1 million, corresponding to proposals to establish a Brownfields Tax Credit**

Scenario and site factors used in calculations below:	
Consider impacts over number of years	20
Total investment leveraged by one dollar of public investment	$ 8.00
Public investment required to create one job	$ 11,500
Mean brownfields site investment	$ 23,945,988
Percent of total investment represented by public subsidy (mean ratio of total subsidy to total investment is 1:8)	12.5%
Mean public subsidy per site (of subsidized sites)	$ 2,993,249
Acres greenfields conserved by one acre of brownfields redeveloped	4.5
Mean site size of brownfields sites	5.0
Percent of brownfields projects that are residential or mixed residential	40%
Residential densities – DU per acre	15
Federal share of public costs is	33%

Investment and jobs	**Scenario 1 – New Federal Investment is $165 million**		**Scenario 2 – New Federal Investment is $1 million**	
	Annual	**20 years**	**Annual**	**20 years**
Federal investment leverages total investment	$ 4 billion	$79 billion	$24 billion	$480 billion
Jobs, assuming 70 percent of brownfields projects are job-producing	30,130	602,609	182,609	3,652,174

Land conserved	Scenario 1 – New Federal Investment is $165 million		Scenario 2 – New Federal Investment is $1 million	
	Annual	20 years	Annual	20 years
Number of redeveloped brownfields sites per $1 billion investment[81]	165	3,307	1,.002	20,045
Acres redeveloped per $1 billion investment	744	14,883	4510	90,203
Acres saved per $1 billion investment	3,349	66,976	20,296	405,914

Population growth accommodated	Scenario 1 – New Federal Investment is $165 million		Scenario 2 – New Federal Investment is $1 million	
	Annual	20 years	Annual	20 years
Acres redeveloped as residential or mixed use	298	5,953	1,804	36,081
DU accommodated per the density and acreage above	4,465	89,301	27,061	541,218

[81] $1 billion divided by subsidy per site

Appendix 3. Impact of Past/Current Brownfields Redevelopment Activity

As noted in the text, there is no national estimate of current and past brownfields redevelopment activity and the impact thereof. NEMW has attempted to create this data by making certain assumptions and using proxies of known data for unknown data. The best proxy for current brownfields redevelopment activity is the number of sites that have completed state voluntary cleanup and response programs, which is 48,950 sites, according to the 2005 U.S. EPA (SRA International) report, "State Brownfields and Voluntary Response Programs." Using this data as a proxy for total brownfields activity involves many data difficulties, chiefly that states vary widely in the sites that get reported. For example, some states count petroleum sites, and others do not. Some states address "perceived" contamination sites, and others do not. Nevertheless, this is the only source for comprehensive national data, and using the 48,950 site figure would not *overstate* brownfields activity -- no states are reporting sites that do not fall within the federal definition of a brownfield.

Accepting the starting point data limitations, NEMW then made one key assumption in order to reflect impacts of these sites. NEMW assumed that 60 percent of the VCP sites have been or are being "substantially redeveloped," i.e., redeveloped to a degree that the "mean brownfields site" estimates in Appendix 1 are applicable. The 40 percent taken out of the calculations is meant to account for: sites that remain vacant; smaller (gas station and dry-cleaning) sites which do not generate significant impact numbers; and sites where the VCP count may be reporting the same site multiple times under different addresses.

There are obvious weaknesses in this assumption – for example, if gas station sites turned out to be the majority of the 48,000-plus sites, then the projections would be too high.

Acknowledging these significant weaknesses, NEMW offers the following as a very crude estimate of the impact of past and current brownfields redevelopment activity:

- Total investment represented by VCP sites: $703 billion.
- Jobs accommodated at VCP sites: 1.9 million.
- Households accommodated at VCP sites: 661,000.
- Greenfield sites conserved: 198,000 acres.

These estimates should not be taken out of the context of the crude assumptions that were made to derive the data. The calculations are on the next page.

Appendix 3. Impact of Past/Current Brownfields Redevelopment Activity

Factors and findings to create estimated impacts

VCP sites completed , 10 years	48,950
Average annual VCP sites per year, 10 years	4,895
Assumed annual VCP sites, 2006-07, adjusted upward to reflect presumed growth over the 10-year timeframe	6,000
Years required to address inventory, if no new brownfields added and rate of redevelopment remains the same	121
Assumed redevelopment rate of VCP sites - sites that have been "substantially redeveloped"	60%
Estimated number of brownfields sites "substantially redeveloped" annually	3,600
VCP sites substantially redeveloped, cumulative	29,370
Mean brownfields site investment	$23,945,988
Mean jobs per site for job-producing sites	91
Percentage of all sites redeveloped for job-producing uses	70%
Percentage of all sites redeveloped for residential and mixed residential use	30%
Mean acreage per site	5.0
Acreage greenfields conserved per one acre brownfields redeveloped	4.5

Total investment represented by VCP sites

Mean investment per site	$23,945,988
Total investment represented by VCP sites	$703,293,680,474

Jobs represented by VCP sites

Mean jobs per site	91
VCP and state response sites	1,866,908

Population accommodated

VCP sites substantially redeveloped for residential or mixed residential	8,811
Acreage redeveloped as residential or mixed residential	44,055
Units per acre	15
DUs or households accommodated	660,825

Land conserved

Mean acreage	5.0
Acreage substantially redeveloped	44,055
Acreage greenfields conserved	198,248

Appendix 4. Missouri - Economic Impact of Brownfields, "Hidden Treasures Report," 2006[82]

Sites	50
Investment	$2,200,000,000
Jobs	11,053
Acres	636
Average site size	12.72
Jobs/acre	17
Investment/acre	$3,459,119
Total investment/job	$199,041
Investment per site	$44,000,000
Jobs per site	221.06
$1 public investment leverages total investment of…	$8.10
$1 public investment leverages private investment of…	$7.10
Public investment to produce one job (non-residential projects)	$16,200

Public investment by level of government	***Amount***	***Percentage***
Total state	$171,250,238	64.8%
Total federal[83]	$26,821,252	10.2%
Total local	$65,325,000	24.7%

[82] Missouri supplied NEMW with a comprehensive spreadsheet of the individual projects, their impacts, and funding sources. Some of the data reported here were calculated by NEMW, using the spreadsheets.
[83] Missouri classified CGBG and Empowerment Zone funding as "local." NEMW reclassified those as federal.

Missouri – Sources of Funding for 50 Brownfield Projects

State of Missouri Assistance	**217,108,198**		**40**	**1,359,801,900**	**6.3**		**6,073**	**35,750**
*** BF state tax credits**	**57,423,749**		**37**	**1,319,801,900**	**23.0**		**5,970**	**9,619**
*** SHPO state tax credits**	**102,108,521**		**22**	**1,040,397,000**	**10.2**		**2,665**	
* State TIF	54,000,000		1	400,000,000	7.4		2,500	21,600
* BF state infrastructure grant	1,000,000		1	25,000,000	25.0		0	
* DED development tax credit	950,000		2	40,000,000	42.1		80	11,875
* MDFB infrastructure tax credits	890,000		1	25,000,000	28.1		0	
* Rebuilding Communities tax credits	344,928		1	2,000,000	5.8		29	11,894
* Due diligence grant	255,000		3	81,500,000	319.6		805	317
* Rural Bus. Enterprise grant	136,000		1				23	5,913
Federal Assistance	**18,304,252**		**8**	**214,490,900**	**11.7**		**688**	**26,605**
*** Federal BF tax deductions**	**12,200,000**		**1**	**47,000,000**	**3.9**		**75**	
* HUD EDI grant	2,150,000		2	42,450,000	19.7		62	34,677
* US Dept. of Commerce EDA grant	1,900,000		1	12,000,000	6.3		350	5,429
*** EPA assessment grant**	**1,050,000**		**4**	**147,720,900**	**140.7**		**148**	**7,095**
* Historic Preservation Tax Credits	1,004,252	**XXXX**	1	5,320,000	5.3		53	
Local Government Assistance	**73,842,000**		**17**	**539,435,000**	**7.3**		**3,072**	**24,037**
* TIF	62,050,000		12	475,000,000	7.7		2,400	25,854
* Empowerment zone	8,350,000		3	49,950,000	6.0		487	17,146
* KC Econ. Devel. Grant	3,000,000		1	3,450,000	1.2		80	37,500
* Gap funding	275,000		1	10,600,000	38.5		105	2,619
* CDBG	167,000		1	2,450,000	14.7		62	2,694
Other Assistance								
* Edward Jones Funding	848,000		1	2,450,000	2.9		62	
No Assistance			**6**	**182,014,100**			**1,830**	

XXXX Federal Historic Tax Credits could be as high as $80 million.

Appendix 5. Baltimore Brownfields Projects[84]

			Public funds						
Project	**Reuse**	**Land/ bdg space**	**Site assessment and cleanup amount**	**Source/ type**	**Other development subsidy**	**Source/ type**	**Tax credits**	**Source**	**Total**
Montgomery Park	Office	27 acre/ 1.3 mil sq ft	$ 2,000,000	BRIP loan	$13,000,000	HUD 108, EBDI Loans	$25,000,000	Historic tax credit	$ 40,000,000
Highland Marine Terminal	Port/ Industry	30 acre/ 850,000 sq ft	$ 1,000,000	DBED loan/grant					$ 1,000,000
Port Liberty	Port/ Industry	30 acre	$ 500,000	BRIP/EBMC loan/grant					$ 500,000
Whitman Requardt Engineering	Office	3 acre	$ 150,000	City/EPA site assessment					$ 150,000
Mid-Atlantic Bakery/X-Esskay	Bakery	11 acre/ 300,000 sq ft	$ 400,000	City/DBED	$1,600,000	DBED			$ 2,000,000
Brewer's Hill Phase I	Office/ mixed use	27 acre/ 300,000 sq ft	$ 350,000	DBED BRIP; EPA site asst			$2,000,000	Hist tax credit	$ 2,350,000
Canton Crossing Phase I	Office/ mixed use	50 acre total	$ 3,000,000	DBED BRIP Grant/cwlrf loan					$ 3,000,000
Guilford Pharmaceuticals	Office/ lab	4 acre/ 80,000 sq ft	$ 100,000	City grant					$ 100,000
TOTALS			**$ 7,500,000**		**$ 14,600,000**		**$ 27,000,000**		**$ 49,100,000**

[84] Source: the author's files from when he directed the brownfields program for the City of Baltimore.

Baltimore Brownfields Projects, continued

Project	Economic benefit		
	Jobs	Private Investment	Real property taxes, annual after credits expire
Montgomery Park	2,500	$ 150,000,000	$ 3,492,000
Highland Marine Terminal	220	$ 14,000,000	$ 325,920
Port Liberty	200	$ 11,000,000	$ 256,080
Whitman Requardt Engineering	350	$ 17,000,000	$ 395,760
Mid-Atlantic Bakery/X-Esskay	240	$ 10,100,000	$ 235,128
Brewer's Hill Phase I	1,000	$ 60,000,000	$ 1,396,800
Canton Crossing Phase I	2,000	$ 125,000,000	$ 2,910,000
Guilford Pharmaceuticals	100	$ 18,000,000	$ 419,040
TOTALS	**6,610**	**$ 405,100,000**	**$ 9,430,728**

Leveraging Ratios			
Public funds for cleanup to produce one job	$ 1,135	Total private investment leveraged by $1 total development subsidy	$ 8.25
Total development subsidy to produce one job	$ 7,428	Total investment leveraged by $1 total development subsidy	$ 9.25
Total private investment leveraged by $1 cleanup funding	$ 54.01	10-year value of real property taxes leveraged by $1 cleanup funding	$ 12.57
Total investment leveraged by $1 cleanup funding	$ 60.56	Years to recover all public subsidies from increased real property tax revenues	$ 5.21

Notes:
Cleanup amount represents amount paid by public funds only. Brewer's Hill total cleanup investment was $1.1 million; Canton Crossing - $3 million.
Real property taxes generated are after all tax credits expire, usually after 10 years.

Appendix 6. Community Quality of Life Improvements Attributable to Three Brownfields to Park Projects

When over 475 site users and neighborhood residents were asked to rate the community impacts of three brownfields-to-park projects in the Midwest (Ping Tom Memorial Park and Senka Park in Chicago and Mill Ruins Park/Stone Arch Bridge in Minneapolis), the following scores emerged. Mean scores were calculated based on a five point scale where 1 = major negative impact, 2 = minor negative impact, 3 = no impact, 4 = minor positive impact, 5 = major positive impact.[85]

Community Quality of Life Impacts	Mean Score
Scenic beauty	4.74
Trails for walking, hiking and biking	4.66
Neighborhood appeal	4.66
Having natural areas present	4.63
Access to recreational areas	4.61
Community pride	4.59
Blight removal	4.51
Personal fitness	4.49
Property values	4.46
Access to quiet area	4.46
Social interaction among residents	4.46
Personal health	4.44
Access to children's playgrounds	4.31
Planned activities for children	4.30
Having wildlife present	4.30
Access to picnicking areas	4.29
Access to educational displays/programs	4.22
Economic/business activity	4.09
Public facilities (restroom, water fountain)	3.93
Crime levels	3.78
Drug problems	3.65

[85] De Sousa, "Unearthing…," 2006

Appendix 7. Indirect Societal Benefits and Costs - Brownfields Versus Greenfields Development

From: Persky and Wiewel, "Summary of Social, Public, and Private Benefits of Brownfield versus Greenfield Industrial Locations in Chicago," (1996)

Persky and Wiewel carried out an early study comparing the costs and benefits associated with brownfield-versus-greenfield development scenarios for Chicago's Brownfields Forum, which at the time, was one of the first citywide efforts to map out an urban brownfields strategy. Their main results are as follows:

SOCIAL AND PUBLIC BENEFITS OF BROWNFIELD LOCATION VS. GREENFIELD (1,000 EMPLOYEE FACILITY)(US$)			PRIVATE BENEFITS OF GREENFIELD LOCATION VS. BROWNFIELD (1,000 EMPLOYEE FACILITY)		
AREA	NET BENEFITS (EMPLOYEE/YEAR)		AREA	NET BENEFITS (EMPLOYEE/YEAR)	
	Low Estimate	High Estimate		Low Estimate	High Estimate
Savings from reduced automotive congestion	$150	$500	Increase in greenfield property values	$10	$250
Savings in social costs related to reduced auto accidents	$30	$650	Lower industrial wage costs	$2,300	$2,900
Savings in costs associated with reduced air pollution from automobiles	$10	$650	Lower land costs	10%	15%
Savings from access to open space	$2	$70	Lower taxes	$2,750	$3,700
Savings from lower rates of housing abandonment	$25	$300			
Savings from reduced subsidies to infrastructure operation	$250	$1,350			