May 2020

Environmental Benefits of Brownfields Redevelopment—
A Nationwide Assessment

Prepared for:
U.S. Environmental Protection Agency
Office of Brownfields and Land Revitalization

Prepared by:
ICF and Renaissance Planning

EPA 560-R-20-001

Table of Contents

APPENDICES

List of Figures

List of Tables

ACRONYMS

ACRES	Assessment, Cleanup and Redevelopment Exchange System
ACS	American Community Survey
BFR	Brownfields Redevelopment (Scenario)
CBG	Census Block Group
CBSA	Core-Based Statistical Area
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FY	Fiscal Year
GSA	U.S. General Services Administration
ISGM	Impervious Surface Growth Model
LEHD	Longitudinal Employer–Household Dynamics
NLCD	National Land Cover Database
OBLR	Office of Brownfields and Land Revitalization
OMB	Office of Management and Budget
PAD-US	Protected Areas Database of the United States
SLC	Smart Location Calculator
SLD	Smart Location Database
TG	Trend Growth (Scenario)
VMT	Vehicle-Miles Traveled

EXECUTIVE SUMMARY

Brownfields cleanup and redevelopment is an important aspect of most communities' future planning and economic development goals. A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Environmental liability often is seen as a barrier to redevelopment, particularly at sites that were previously used for manufacturing or other industrial uses.

A growing body of research indicates that brownfields redevelopment can offer significant economic and environmental benefits compared with the development of land outside of the urban core or on previously undeveloped properties. Environmental benefits of brownfields development include reduced stormwater runoff leading to improved water quality, and reduced greenhouse gas emissions leading to improved air quality.

Environmental Benefits of Brownfields Redevelopment – A Nationwide Assessment provides insight into the role that brownfields redevelopment can play in mitigating the environmental impacts of economic growth across the country.

METHODOLOGY

This study evaluates the environmental impacts of development patterns under two hypothetical growth scenarios – the **Brownfields Redevelopment (BFR)** scenario, which assumes that future redevelopment will occur at all available brownfield sites, capturing a substantial portion of new jobs and housing units; and the **Trend Growth (TG)** scenario, which assumes that new jobs and housing units will be distributed across a metropolitan area in a similar pattern as recent growth trends (i.e., greenfield development and without an emphasis on brownfields redevelopment). In this study, the same level of future growth and development activities (new jobs and housing units) are assumed for each scenario; however, the increase in jobs and housing units associated with growth are allocated to properties differently, based on a land use allocation model. The model estimated the environmental impacts resulting from new growth under each scenario (the BFR and TG scenarios) for the period of time between 2013 and 2030 in 50 metro areas across the United States.

Model Framework

The scenario analysis required a four-step process:

Step 1 – Prepare Data and Model Inputs

Property data for the BFR scenario was obtained from the U.S. Environmental Protection Agency's (EPA's) Assessment, Cleanup, and Redevelopment Exchange System (ACRES), an online database that allows EPA's Brownfields Program grantees to electronically submit their site-specific data directly to EPA. The study used information from the ACRES database on brownfields properties not yet redeveloped. Brownfield sites that previously were redeveloped were excluded from the study's scenario analysis because these properties are unlikely to accommodate additional jobs and housing units beyond the level of growth associated with the previous development. After all ACRES data points were reviewed, the universe of brownfield properties available to formulate the BFR scenario totaled 5,023 unique brownfields properties across the United States.

The TG scenario uses Census block groups (CBGs) as the unit of analysis, and new jobs and housing units are allocated primarily to Census block groups with strong recent growth trends based on U.S. Census data. CBG features and attribute data for the entire country were obtained from EPA's Smart Location Database.

Step 2 – Develop Scenario Parameters

The BFR and TG scenarios were developed using a standardized land use allocation model. The model distributes future growth in jobs and housing units across a metro area. The distribution of this growth is guided by the following questions:

- How many new jobs and housing units will be added to a given metro area by 2030?
- How much new development can a given location accommodate?
- What locations are most likely to be (re)developed first?
- What types of activities (jobs and housing) are likely to be added as a given location is developed?

Step 3 – Allocate Growth

The model relies on control totals to determine how much growth to allocate to each metro area under each scenario. Control totals are the number of new jobs and housing units to allocate for a given metro area over the 2013 to 2030 time period and were obtained from Woods & Poole county-level demographic and economic forecasts. Woods & Poole includes a comprehensive database that contains economic and demographic data and future estimates for the United States and all states, regions, counties, and core-based statistical areas for every year from 1970 through 2050.

The allocation model proceeded in two major phases:

- The first, or "**primary**," phase of the BFR scenario allocates as much growth as possible to brownfield sites, based on the development capacity and activity mix estimates for each site. During the primary phase of the TG scenario, the same increments of jobs and housing units allocated to brownfields are re-allocated to non-brownfield areas. This analysis phase provides a direct comparison of the environmental impacts between localized growth at brownfield sites and growth in non-brownfield areas (e.g., outside of the urban core or on undeveloped properties).
- In the "**secondary**" phase of both scenarios, the remaining increment of growth is allocated according to the data and parameters guiding the TG scenario. The secondary phase of analysis occurs when capacity for new growth at brownfield sites is exhausted, and all remaining growth is allocated to trending block groups. The differences in environmental impacts between the BFR and TG scenarios for this analysis phase are often small and always smaller than the differences observed in the primary phase. Secondary environmental benefits may arise from preserving development capacity in growing location-efficient neighborhoods.
- Finally, the "**cumulative**" assessment of each growth scenario compares the environmental impacts of total growth across a broader metro area, regardless of phase. While the primary phase focuses on localized environmental impacts from brownfields redevelopment (relative to growth in non-brownfield areas), the cumulative assessment quantifies the environmental impacts based on areawide growth patterns.

This modeling structure gives priority to brownfield sites in the BFR scenario and assumes that once all known brownfield capacity is developed, the remaining growth will follow recent trends.

The model was applied to 50 metro areas of varying population size, geographic location, growth dynamics, development history, and density of brownfield sites. The metro areas were grouped into six growth profile categories using population and growth rate statistics to ensure that metro areas were analyzed against other metro areas of analogous size and growth.

Step 4 – Estimate Environmental Impacts

The environmental analysis module developed for this study estimates stormwater impacts and air quality impacts. Stormwater impacts are estimated by calculating the expected growth in impervious surface area associated with each growth scenario. Impervious surface coverage is a proxy for a range of stormwater impacts, where higher impervious surface coverage (or an increase in the acreage of impervious surfaces) is generally correlated with higher runoff volumes and increased concentrations of non-point source pollutants in runoff.

Air quality impacts associated with residential and employment transportation decisions related to new development are estimated by calculating changes in vehicle-miles travelled (VMT). VMT is a measure of total vehicular travel within a metro area and is a proxy for transportation-related air emissions.

MODEL RESULTS

Allocation Results

Brownfield sites across the 50 analyzed metro areas could potentially accommodate as many as 640,000 new housing units and 1.39 million new jobs under the aggressive development scenario. These totals represent almost 13 percent and 11 percent, respectively, of total growth expected for the analyzed metro areas between 2013 and 2030.

The number of housing units and jobs potentially accommodated by brownfield sites varies substantially by growth profile. For example, metro areas designated as having an *Industrial Legacy* growth profile (e.g., small cities with slow growth) often have relatively large numbers of brownfields and thus can absorb a large portion of new growth (housing, in particular). In contrast, brownfield sites in metro areas characterized as *Growth Hubs* (e.g., moderate to large cities with rapid growth) only have sufficient capacity to accommodate a small proportion of new housing units and a moderate share of new jobs.

> *Brownfield sites in the 50 analyzed metro areas could potentially accommodate between 200,000 to 640,000 new housing units and 415,000 to 1,389,000 new jobs.*

A temporal analysis performed as part of this study found that, across all growth profiles, growth associated with available brownfield site capacity was reflected as an increase in new jobs typically within 4 to 9 years of the start of the BFR growth scenario and by the addition of new housing units within 6 to 12 years of the start of the BFR scenario. Brownfield site growth or development capacity is filled in the relatively near-term (4 to 9 years) in the case of jobs-oriented redevelopment, reflecting the tendency for many brownfield sites to be located in employment-rich areas.

Impervious Surface Growth Results

Growth and development modify existing land covers, replacing previously pervious surfaces, such as fields and forests, with pavement and rooftops (i.e., impervious surfaces). Development patterns that limit the expansion of impervious surfaces benefit the environment by mitigating the runoff of pollutants to waterbodies.

In the primary analysis phase, the total impervious surface acreage added under the BFR scenario is significantly lower than that added under the TG scenario development for all metro areas analyzed. For every brownfield acre redeveloped, approximately 1.28 to 4.60 acres of impervious surface would be expected to be saved compared to having the same development occur at TG sites. This range represents the average reduction in impervious surface by brownfields redevelopment across all analyzed metro areas. Thus, if a given metro area had 1,000 acres of developable brownfield sites, it would be reasonable to assume that redevelopment of brownfields sites would save approximately 1,280 to 4,600 acres of impervious surface. On a percentage basis, brownfields redevelopment results in average impervious surface reductions of approximately 73 percent to 80 percent compared to trend growth.

When considering the cumulative impacts of brownfields redevelopment across the broader metro area, a similar picture emerges, though the magnitude of the benefits of the BFR scenario is lower than in the primary analysis phase, as expected. For every brownfield acre redeveloped, approximately 0.65 to 3.16 acres of impervious surface is saved relative to the TG scenario after all regional growth (beyond what the brownfield sites can accommodate) is accounted for. On a percentage basis, the cumulative BFR scenario yields impervious surface reductions of approximately 1.3 percent to 6.6 percent compared to the TG scenario.

For every brownfield acre redeveloped, approximately 0.65 to 4.60 acres of impervious surface would be expected to be saved if the same development had occurred in trend growth (non-brownfield) areas.

While the degree of reduction varies by growth profile, impervious surface area reductions from brownfields redevelopment are seen in metro areas across all growth profiles under both the base and aggressive growth scenarios.

Transportation and Vehicle Miles Traveled (VMT) Results

Development in central areas (e.g., central business districts, transportation hubs) typically result in residents and workers taking shorter trips and reduced automobile usage compared with development that occurs in fringe areas or areas outside the urban center. Brownfields tend to be located in densely developed, centralized areas where development typically results in fewer VMT per capita each day than development that occurs in fringe areas. Therefore, brownfields development results in fewer transportation-related air emissions.

Based on this study, residential VMT is expected to be substantially lower in the BFR scenario versus the TG scenario in all growth profiles in both the primary and cumulative analyses. Based on the primary phase results across all metro areas analyzed, new residents at brownfield sites are expected to generate, on average, 7.3 to 9.7 fewer VMT per capita per day than if they moved to TG locations. On a percentage basis, brownfields redevelopment results in residential VMT reductions of approximately 25 percent to 33 percent compared to trend growth across all analyzed metro areas. The cumulative results suggest that brownfields redevelopment can result in VMT per capita reductions of 0.5 to 1.8 miles per day, on average, for *all* new residents after all regional growth (beyond what the brownfield sites could hold) is accounted for. These findings suggest that each brownfield acre redeveloped can reduce a metro area’s residential VMT generation by hundreds of miles per day.

Travel patterns also are affected by job location. Commuting to and from work is a substantial portion of daily VMT for many people. For all analyzed metro areas, new jobs at brownfield sites (primary phase) are expected to generate 2.1 to 2.5 fewer VMT per worker per day than new jobs in trending areas. On a percentage basis, this is equivalent to employment VMT reductions of approximately 8.8 percent to 10 percent compared with trend growth across all analyzed metro areas. The cumulative results

Brownfields redevelopment reduces per capita residential VMT by an average of 0.5 to 9.7 miles per day and job-related VMT by 0.2 to 2.5 miles per day.

indicate brownfields redevelopment could result in per job VMT reductions of 0.2 to 0.5 miles per day, on average, for *all* new jobs after all regional growth (beyond what the brownfield sites could hold) is accounted for. In all analysis phases, each redeveloped brownfield acre generates substantially lower workplace-related VMT (30 to 190 miles) across all analyzed metro areas.

KEY FINDINGS

Brownfields redevelopment is more location-efficient than trend growth across key environmental metrics.

Location-efficient communities are dense and vibrant, with walkable streets, access to transit, proximity to jobs, mixed land uses, and concentrations of retail and services. Location efficiency promotes development patterns that limit the strain on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads.

The reallocation of new jobs and housing to brownfield sites within a metro area will produce environmental benefits by reducing impervious surfaces and VMT. On a per acre basis, brownfields redevelopment leads to less impervious surface area being consumed or developed than trend growth development. Brownfields redevelopment also alters travel to and from the home and the workplace, mitigating growth in VMT due to the fact that housing and jobs are more efficiently located and the potential increased use of public transportation. The location efficiency advantages of brownfields are most clearly seen in the primary phase analysis results, which provide a direct comparison of the environmental impacts between localized growth at brownfield sites and growth in non-brownfield areas. Based on the temporal analysis performed as part of this study, these primary phase environmental benefits are expected to occur typically in the near term (e.g., within the first decade of brownfields redevelopment).

Growth profiles demonstrate the importance of metro area growth contexts.

Although it is true that brownfields redevelopment is more location-efficient than trend growth across all metro area growth profiles, the growth profiles demonstrate how the total magnitude of environmental benefits can differ dramatically. If the metro area's brownfield sites are less centrally located, then the environmental benefits are not as great as the benefits associated with brownfields sites in more central locations. Also, if there is a limited number of brownfields or modest brownfield acreage available for redevelopment, the impact of brownfields on development patterns – and, in turn, the environment – is less significant when considering all new growth (cumulative analysis results). Environmental benefits are maximized when brownfield properties are aggressively redeveloped and growth outside urban centers is minimized.

Brownfields development will sometimes produce additional benefits for growth beyond brownfield sites.

Brownfields redevelopment often results in additional environmental benefits by re-shaping longer term growth patterns. Redeveloping brownfields can maximize infill development capacity, making subsequent non-brownfield growth patterns more efficient for the metro area as well. A metro area brownfields redevelopment strategy can affect more than just the residents and employees of that development, as demonstrated by the secondary and cumulative analysis phases of this study. A brownfields redevelopment strategy can also influence the behavior of neighbors and nearby employers. Not only do the residents and employees of the new development impose lower environmental impacts, those who live or work nearby also may benefit through closer services, employment, and access to other community goods.

Brownfields redevelopment can often shift metro area development patterns to mitigate environmental impacts.

The effectiveness of brownfields redevelopment depends largely on the amount of growth that can be reallocated to more efficient locations relative to trend growth patterns. The cumulative findings in this study, which focus on total growth across a broader metro area and not just the brownfields portion, suggest that having robust development capacity at brownfield sites in high growth areas that have development momentum will maximize the environmental benefits of redevelopment. Brownfields redevelopment reorganizes significant amounts of new jobs and housing into smarter locations, such that the resulting development pattern substantially limits the environmental impacts of new growth.

1. INTRODUCTION

1.1 Background

In the majority of urban areas in the United States, real estate development is driving the demand for infill properties and brownfields located in the urban core. However, uncertainty related to environmental liability for potential contamination at infill properties and brownfields can pose a barrier to redevelopment, particularly at properties previously used for manufacturing or other industrial uses. In some cases, the risk of investing in a potentially contaminated property is compounded by restrictive zoning rules or the need to upgrade or replace existing infrastructure to accommodate redevelopment options. In many cases, the U.S. Environmental Protection Agency's (EPA) Brownfields Program grants may help reduce some of the risks associated with the redevelopment of potentially contaminated properties.

A growing body of research and case studies conducted by EPA indicate that brownfields redevelopment (and urban redevelopment in general) can offer significant environmental benefits compared with the development of land outside of the urban core or on previously undeveloped properties. The benefits of redeveloping brownfields and infill properties include reduced stormwater runoff and subsequently improved water quality, as well as reduced greenhouse gas emissions and impacts on air quality from reductions in vehicular travel. These benefits are described in a handful of previous studies which suggest that brownfields redevelopment may result in a reduction of 25 percent to 80 percent in impervious surfaces, and stormwater runoff reductions of 43 percent to 60 percent. In addition, vehicle-miles traveled (VMT) may be reduced 7 percent to 89 percent (with most benefits in the range of 20 percent to 55 percent).[1,2,3] These expected benefits derive for two main reasons:

- In general, brownfield sites are typically located in the urban core, or in older neighborhoods, and previous uses of brownfield properties included the establishment of impervious surfaces and stormwater management infrastructure. The cleanup and redevelopment of brownfield properties most likely will not result in significant increases in the amount of impervious surfaces or channeled stormwater management infrastructure. In contrast, when new development occurs in greenfield areas that are characterized by open spaces and pervious surfaces, the new development transforms these areas by adding additional impervious pavements and rooftops that require stormwater runoff management solutions. These differences in development contexts and impacts result in meaningful expected differences between the stormwater and water quality impacts of brownfields redevelopment compared with development on previously undeveloped property.
- From a transportation point of view, brownfield sites tend to be located closer to transportation hubs and are more accessible to commercial and recreational destinations than greenfield sites. These two factors influence travel behaviors, particularly a reduced use of personal automobiles and an increase in pedestrian traffic, bike riding, and use of public transportation. The result is reduced emissions due to reductions in VMT in areas where brownfields and infill sites are redeveloped, compared with growth or development in greenfield locations, which tend to be located outside of urban areas. In addition, many

[1] U.S. Environmental Protection Agency. "Comparing Methodologies to Assess Transportation and Air Quality Impacts of Brownfields and Infill Development." EPA 231-R-01-001. August 2001.

[2] U.S. Environmental Protection Agency. "Air and Water Quality Impacts of Brownfields Redevelopment: A Study of Five Communities." EPA 560-F-10-232. April 2011.

[3] "Ten Years of Technical Assistance: Successes, Lessons Learned and a Look Forward." 2013. Unpublished.

brownfield sites with high levels of accessibility also will make it more viable to develop higher density mixed-use development that further reduces travel by increasing the chances that employees and residents will make more trips on site or nearby, rather than traveling significant distances between residential areas and commercial or recreational areas.

1.2 Project Purpose and Overall Approach

This study provides insight into the role that brownfields redevelopment can play in mitigating the air and water environmental impacts of growth across the country. It offers a standard, consistent methodology for answering the following questions at the metropolitan and national levels:

- ***What are the estimated environmental benefits – in terms of stormwater runoff and transportation emissions – associated with redeveloping brownfields compared with greenfield development or "trend development"?***
- ***What are the environmental benefits of reallocating jobs and housing to infill locations and brownfields in a given metropolitan area?***

This study evaluates the environmental impacts of development patterns under two hypothetical growth scenarios: one in which brownfield sites are redeveloped and metro growth patterns are reshaped, and another where recent metro growth trends (i.e., greenfield development) persist over time. The approach developed for this study employs scenario analysis techniques described in detail in later sections of this report.

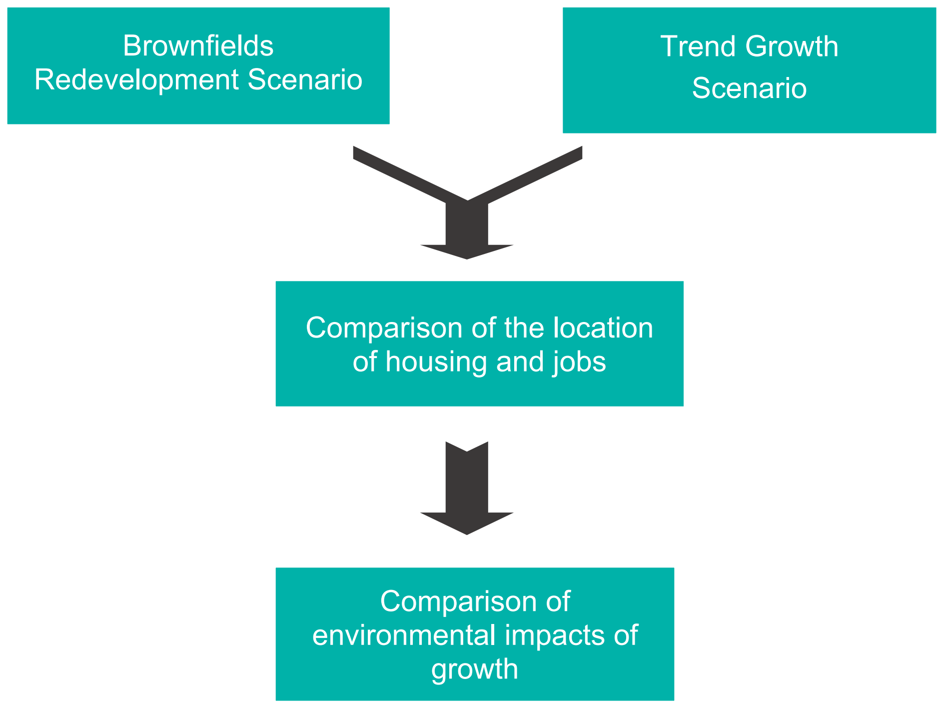
The general framework for analyzing each growth scenario and assessing the potential benefits of brownfields redevelopment is shown in Figure 1. This general approach was applied to 50 metro areas (or core-based statistical areas [CBSAs])[4] across the United States containing 5,023 known brownfield sites. The results at the metro level were then aggregated according to EPA region, metro area type, and nationally to develop typical ranges of stormwater and transportation emissions benefits associated with brownfields redevelopment.

For all 50 metro areas included in the study, the following two scenarios were constructed and analyzed to forecast the growth of new jobs and housing units for each respective metro area from 2013 to 2030. Then the predicted jobs and housing growth numbers were allocated to potential growth areas within the metro area boundaries:

- **Brownfields Redevelopment (BFR) Scenario** assumes that redevelopment will occur at all available brownfield sites, capturing as many of the metro area's allocated new jobs and/or housing units as possible within the assumed development capacity for these properties. If all brownfields are redeveloped, any remaining forecasted growth in jobs and housing will be allocated in accordance with recent growth trends (i.e., allocated to non-brownfield properties). In this way, all metro area growth will be allocated, and the use of brownfield properties will be maximized to provide a model of future development that is concentrated around the redevelopment of brownfields.
- **Trend Growth (TG) Scenario** allocates the same level of development activities (new jobs and housing units) assumed for the BFR scenario but allocates the growth in jobs and housing to properties in accordance with recent historical development trends. This provides a model of future development in which recent trends toward greenfield and outer rim development persist over time and available brownfields are not redeveloped.

[4] Core-based statistical areas (CBSAs) as defined by the Office of Management and Budget (OMB) for 2016.

Figure 1. Scenario Analysis Approach



Each of these two scenarios models alternative visions for metro area growth. The context in which growth occurs can significantly influence the magnitude of the environmental impacts posed by new development, a concept referred to as "location efficiency" in urban planning and analysis.[5] Location efficient communities are dense and vibrant, with walkable streets, access to transit, proximity to jobs, mixed land uses, and concentrations of retail and services.[6] Location efficiency promotes development patterns that limit the strain on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads. Location efficiency dynamics were used to estimate two measures of the environmental impacts of new growth for each scenario:

- **Change in impervious surface area (urban footprint):** This measure serves as a proxy for stormwater runoff and non-point source pollutants impacts.
- **Change in vehicle-miles traveled (VMT):** This measure serves as a proxy for mobile source emissions and air quality.

Based on the comparisons of the two environmental impact measures under the two growth scenarios for the 50 metro areas analyzed in this study, brownfields redevelopment generally leads to limited expansion of impervious surfaces and lower VMT than trend growth development. This holds true across a variety of metro area contexts, as demonstrated through the variety of metro areas represented in the study.

[5] EPA Smart Location Mapping, https://www.epa.gov/smartgrowth/smart-location-mapping
[6] Center for Neighborhood Technology, https://www.cnt.org/projects/location-efficiency-hub

1.3 Report Structure

This report covers the methodology for modeling the BFR and TG scenarios and discusses the environmental modeling results for each scenario for groups of similar metro areas. It also generalizes metro model results to a national level to provide typical ranges of benefits associated with brownfields redevelopment opportunities. Finally, it communicates several key findings as high-level guides for understanding the role that brownfields redevelopment can play at localized and regional/metro scales in minimizing environmental impacts.

The remainder of this report is organized into the following sections, supported by a glossary and several detailed technical appendices:

- **Section 2 – Model Framework and Mechanics:** Explains the scenario analysis process, data sources used, growth and environmental modeling procedures, and assumptions for developing alternative growth scenarios for any given metro area.
- **Section 3 – Model Results:** Reports and interprets the environmental modeling results, comparing the BFR scenario to the TG scenario to summarize environmental benefits across the 50 analyzed metro areas.
- **Section 4 – Key Findings:** Offers important takeaways from the scenario analysis results, focusing on implications for future investigation and EPA's mission of environmental protection.

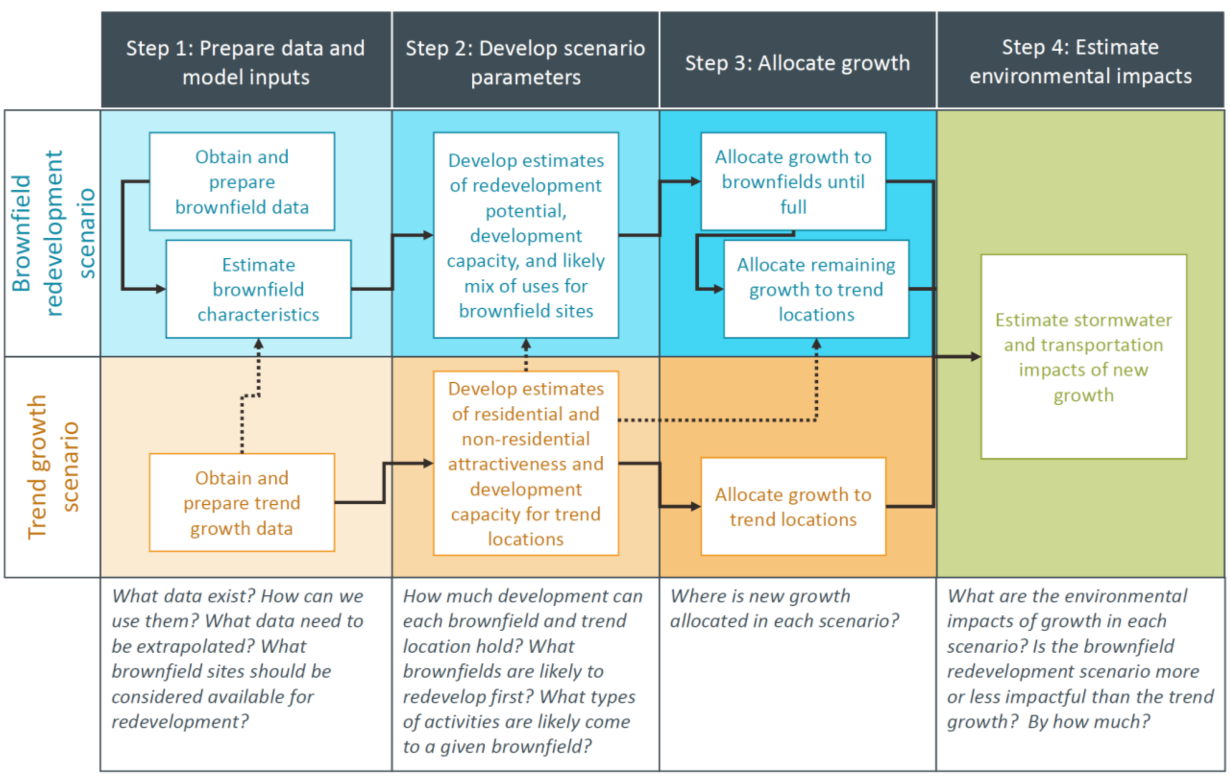
2. MODEL FRAMEWORK AND MECHANICS

The scenario analysis process is complex. It requires using readily available, nationally consistent data to model growth and development in any given metro area in the United States and prepare estimates of the environmental impacts of new growth for alternative development scenarios. This section covers the key details of the modeling framework and mechanics in four major steps:

- **Step 1 (Prepare data and model inputs)** involves obtaining, vetting, and processing the brownfields, historical growth, and related datasets required to develop the two alternative scenarios (brownfields redevelopment and trend growth).
- **Step 2 (Develop scenario parameters)** focuses on adapting the data processed in Step 1 to a generalized form expected by the land use allocation model used to develop alternative growth scenarios in Step 3.
- **Step 3 (Allocate growth)** allocates metro area growth using a land use allocation model to generate each alternative development scenario.
- **Step 4 (Estimate environmental impacts)** estimates the environmental impacts resulting from new growth as modeled in each alternative scenario.

Figure 2 outlines the step-by-step creation of each alternative scenario, the main components of each step, and interactions among the datasets and processes utilized in each scenario. It also lists the key analytical questions answered within each step. The dotted lines in the figure highlight how portions of the TG scenario development inform portions of the brownfields redevelopment scenario. For example, development capacity at brownfield sites is estimated based, in part, on the density of development in block groups near the brownfield, which is calculated as part of the TG scenario development.

Figure 2. Overall Model Framework and Process Steps with Key Questions



The following sections describe each of the scenario development process steps in detail.

2.1 Scenario Analysis Process Step 1 – Prepare Data and Model Inputs

Step 1 involved obtaining and vetting the necessary datasets and preparing the model inputs to develop the BFR and TG alternative growth scenarios.

2.1.1 Brownfields Redevelopment Scenario Data Inputs

ACRES data for brownfields redevelopment scenario

Data for the BFR scenario was obtained from the EPA's Assessment, Cleanup and Redevelopment Exchange System (ACRES). ACRES is an online database for EPA's Brownfields Program grantees to electronically submit their site-specific brownfields data directly to EPA. The data in ACRES is a subset of the universe of brownfield sites in the United States. Only sites that have received and used funds from the Brownfields Program are included. There are significantly more brownfield properties across the United States than what is represented in ACRES.

The data used in this study were pulled from ACRES in early March 2017 and reflect a time period from fiscal year (FY) 1995 through FY 2016. Because the data entry requirements for grantees changed over this time period, not every brownfield property in ACRES had all the necessary information available to be included in the BFR scenario. Therefore, additional data correction efforts were needed to ensure that the data used in modeling the BFR scenario would be as accurate as possible and fairly reflect the inventory of available brownfield sites in the studied metro areas. With help from EPA staff, issues of disparities in reported geographic locations, invalid or missing latitude/longitude coordinates, and questionable property size attributes were corrected using recommended review protocols. Figure 3 illustrates a summary of the results of the ACRES review and applied protocols for developing the final set of brownfield properties for consideration in this study. Figure 3 also provides descriptive statistics for the brownfield properties. Appendix A identifies the key fields from ACRES that were used in the model analysis and provides a detailed presentation of the ACRES review and applied protocols.

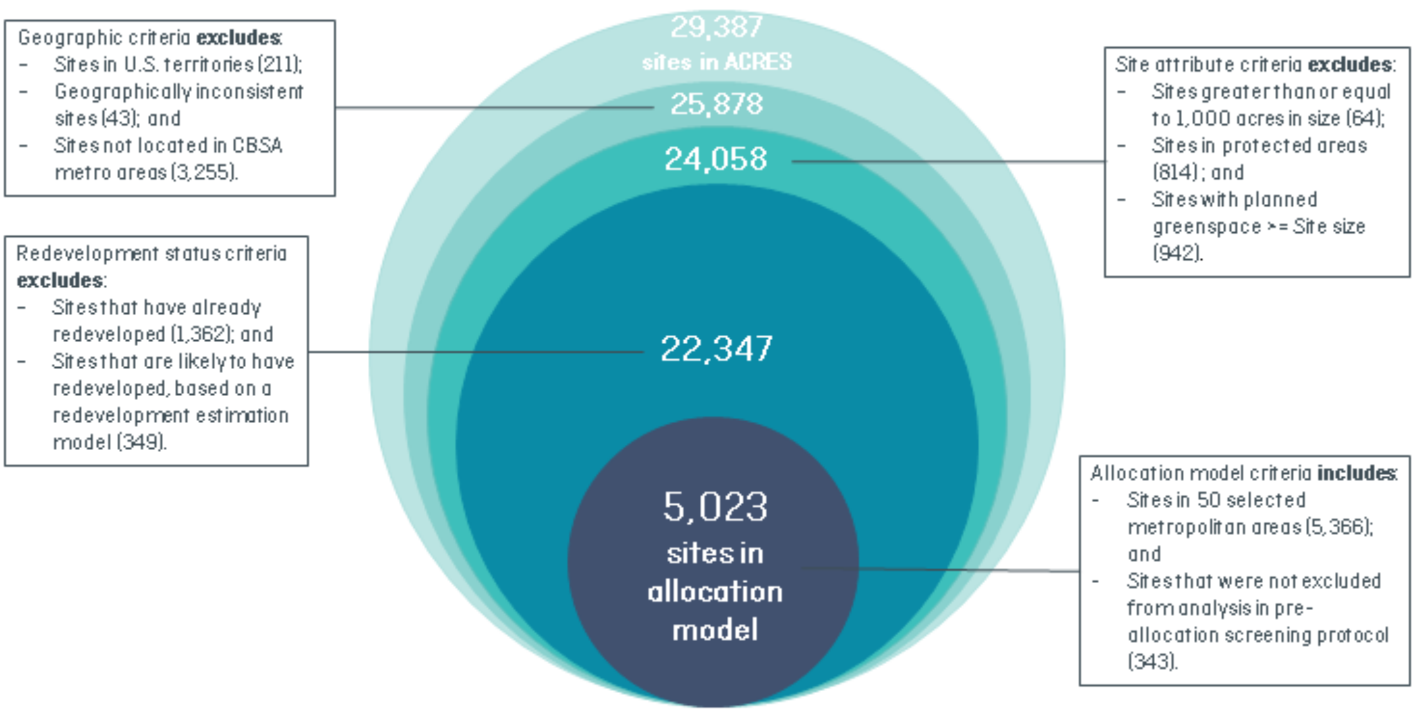
After all ACRES data points were reviewed and the appropriate correction protocols applied, the universe of brownfield properties available to formulate the BFR scenarios totaled 5,023 unique sites. Each site must have met all of the following criteria to be included in the study:

1. **Geographic criteria:**
    a. ACRES geographic coordinates place the site inside a metro area[7] in the 50 states (sites in U.S. territories were excluded).
    b. ACRES geographic coordinates and address information are consistent with one another (see Appendix A for details on geographic consistency).

[7] Core-based statistical area (CBSA) based on Office of Management and Budget (OMB) definitions as reflected in U.S. Census geographic data.

2. **Site attribute criteria:**
   a. ACRES geographic coordinates place the site outside of a protected area (e.g., parkland, nature preserve, and managed lands) as identified via the Protected Areas Database of the United States (PAD-US).[8]
   b. ACRES redevelopment data do not indicate that the entire site acreage will be devoted to future green space.
   c. ACRES site size data is less than 1,000 acres (very large sites are atypical; allocating to these sites could skew growth and/or environmental analysis results).
3. **Redevelopment status criteria:**
   a. The site is not assumed to have already been redeveloped (based on the "Determining brownfields redevelopment status" analysis [see next section]).
4. **Allocation model criteria:**
   a. The site is located within the 50 metro areas selected for modeling.
   b. The site was not excluded based on a pre-allocation protocol described in further detail in Section 2.3.3, Specific Application to 50 Metropolitan Areas.

Figure 3. Reducing the "Universe" of Brownfields



[8] United States Geological Survey, National Gap Analysis Project (GAP) | Protected Areas Data Portal, https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/protected-areas

Descriptive Statistics for the Universe of Brownfields Sites included in the Study

<table>
<tr><th colspan="3">Descriptive statistic</th><th colspan="3">Site Size (after application of protocols)</th><th colspan="3">Planned Greenspace</th><th colspan="3">Number of grants</th></tr>
<tr><td colspan="3">Minimum</td><td colspan="3">0.03 acres</td><td colspan="3">0.0 acres</td><td colspan="3">1</td></tr>
<tr><td colspan="3">Maximum</td><td colspan="3">1,200 acres</td><td colspan="3">180 acres</td><td colspan="3">8</td></tr>
<tr><td colspan="3">Mean</td><td colspan="3">5.93 acres</td><td colspan="3">0.14 acres</td><td colspan="3">1.13</td></tr>
<tr><td colspan="3">Median</td><td colspan="3">1.0 acres</td><td colspan="3">0.0 acres[9]</td><td colspan="3">1</td></tr>
<tr><td colspan="12">Sites by Number of Grants:</td></tr>
<tr><td colspan="4">1 grant: 3663 (72.9%)
2 grants: 818 (16.3%)
3 grants: 294 (5.9%)
4 grants: 124 (2.5%)</td><td colspan="4">5 grants: 56 (1.1%)
6 grants: 26 (0.5%)
7 grants: 19 (0.4%)
8 grants: 9 (0.1%)</td><td colspan="4">9 grants: 7 (0.1%)
10 grants: 5 (<0.1%)
More than 10 grants: 2 (<0.1%)</td></tr>
<tr><td colspan="12">Number of Grants by Type:</td></tr>
<tr><td colspan="6">Assessment Grants: 4,452 (76.7%)
Cleanup Grants: 234 (4.0%)
BCLRF: 241 (4.2%)</td><td colspan="6">Multi-purpose: 5 (<1%)
Section 128(a) State/Tribal: 620 (10.7%)
TBA: 254 (4.4%)</td></tr>
</table>

Determining brownfields redevelopment status

The BFR scenario assumes that all undeveloped brownfield sites will be redeveloped to accommodate metro area growth between 2013 and 2030. However, some of the brownfield sites identified in ACRES were redeveloped prior to the model base year of 2013. These sites were removed from the scenario allocation model because they had already been redeveloped prior to 2013. They are identified in the ACRES database based on the REDEV_START_DATE and REDEV_COMPLETION_DATE fields. Specifically, any site having a redevelopment completion date prior to January 1, 2013, was removed from the scenario allocation model. Likewise, any site having a redevelopment start date prior to January 1, 2012, and having no recorded redevelopment completion date was assumed to have been redeveloped already[10]; these sites were also removed from the model.

On the other hand, sites that have a redevelopment completion date after January 1, 2013, have been redeveloped, but any jobs or housing added to the site would not be reflected in year 2013 datasets. As such, these sites were always included in the scenario allocation model. Future growth was allocated to these sites based on the model assumptions documented below – the specifics of each site's actual redevelopment program are unknown for the purposes of this study. In addition, if a site has not been confirmed as "ready for reuse" in the ACRES database, it was assumed to not be redeveloped as of 2013 and was included in the scenario allocation model.[11]

[9] The vast majority of sites in ACRES have 0 acres of planned greenspace recorded. The median value (50th percentile) of this skewed distribution is actually zero.

[10] An analysis of sites with valid redevelopment start and completion dates suggested that the average redevelopment period is about a year in length, although this may be due to simplified bookkeeping and not a reflection of true typical redevelopment timelines.

[11] It is theoretically possible for a site to have a redevelopment completion date before 2013 and not be confirmed as "ready for reuse" in ACRES. In these cases, the redevelopment data were deemed authoritative. These sites were removed from the scenario allocation model based on redevelopment information regardless of their "ready for reuse" status.

These criteria applied only to a selection of sites in ACRES. Most sites in ACRES have no recorded information regarding redevelopment start or completion dates. For these records, the site's redevelopment status is unclear – it is ready for redevelopment, but the actual redevelopment status is unknown. In some cases, these sites may have been redeveloped prior to the model base year, even though no redevelopment activity is recorded in ACRES. This is common among sites that received EPA assistance for assessment and/or cleanup, but the redevelopment was subsequently funded through non-EPA sources. It would be inappropriate to include brownfield sites that have already been redeveloped in the scenario allocation model because they are unlikely to accommodate additional jobs and/or housing beyond the current level of development. To address this issue, a statistical approach was taken to model the redevelopment status for any property that was "ready for reuse,"[12] but was missing redevelopment date information.

A binary choice model calculating the probability of brownfields redevelopment was estimated utilizing a database of sites assumed to have already been redeveloped (based on the redevelopment start and completion date criteria described above) and a selection of ACRES records for sites known to not yet be redeveloped. Site and neighborhood characteristics are provided as independent variables in the model, which calculates the likelihood that a given ACRES site had already been redeveloped by the start of 2013. This model was used to designate sites with no redevelopment data in ACRES as being "likely already developed" (redevelopment model results ≥ 0.5) or "likely undeveloped." Sites that were likely already developed were removed from the scenario allocation model. The factors found to reliably estimate brownfield development status are described below. The relative influence of each factor on redevelopment probability varies based on its U.S. Census region location (Northeast, Midwest, South, or West) and metro population (small or large [less than or greater than 1M population]). An illustration of redevelopment status assumptions and model outputs are shown for the Milwaukee, Wisc. area in Figure 4.

- **Ready for reuse status:** Sites indicated as "ready for reuse" in ACRES are more likely to be redeveloped than other sites.
- **Site size (in acres):** Larger site size values from ACRES are correlated with a higher probability of redevelopment.
- **Number of grants for the site:** If a site received funding through multiple grants, it suggests an institutional commitment to cleanup and reuse of the site. Sites with more grants are correlated with a higher probability of redevelopment.
- **Proximity to fixed guideway transit (share of block group area):** Sites near transit station areas have a higher probability of redevelopment, based on the statistical analysis. Transit station area proximity is determined by the proportion of the Census block group (CBG) in which the site is located that is within a half mile of a fixed guideway transit station (data available from EPA's Smart Location Database [SLD]).[13]
- **Regional centrality:** Sites near the center of a metro area are correlated with a higher probability of redevelopment. Regional centrality is measured based on auto accessibility. First, auto accessibility scores are calculated for each CBG in a metro area, defining how many jobs are reachable from each. Then these values are normalized for the region, such that the block group with the highest auto accessibility score receives a score of 1.00 and all other block groups' scores are expressed as their respective auto accessibility

[12] In ACRES, the READY_FOR_REUSE field contains a value of "Y."
[13] EPA Smart Location Mapping, https://www.epa.gov/smartgrowth/smart-location-mapping

values with respect to the maximum score (i.e., a value between zero and 1.00). Regional centrality data are available from the SLD (see SLD User Guide for additional information on the calculation of auto accessibility and regional centrality metrics).[14]

The general formula for the brownfields redevelopment probability model is provided below:

$$\frac{1}{1+\ e^{b\ +m_1*Rfr+\ m_2*SS+\ m_3*NG+\ m_4*D4b050+\ m_5*D5cri}}$$

Where:

m_1, m_2, m_3, m_4, m_5 = Coefficients related to “ready for reuse,” “site size,” “number of grants,” “proximity to fixed guideway transit,” and “regional centrality,” respectively. The coefficients vary by the Census region in which the site is located and the size of the metro area in which it is located (see Table 1 below).

b = Model constant, which varies by the Census region in which the site is located and the size of the metro area in which it is located (see Table 1)

Rfr = Ready for reuse dummy variable (sites that are ready for reuse have a value of 1, all others have a value of zero)

SS = Estimated site size (in acres) from the ACRES database (or based on assumptions consistent with the protocols described in Appendix A)

NG = Number of grants administered for site assessment or cleanup

D4b050 = D4b050 value (share of block group within a half mile of a fixed guideway transit station) from the SLD for the block group in which the site is located

D5cri = D5cri value (regional centrality index) from the SLD for the block group in which the site is located

Combined with other quality assurance protocols (mentioned in the previous section and described in detail in Appendix A), the exclusion of sites that were assumed to have already been redeveloped left 22,347 brownfield sites in the universe for potential BFR scenario development (5,363 sites in the 50 analyzed metro areas).

[14] EPA Smart Location Database Technical Documentation and User Guide, https://www.epa.gov/smartgrowth/smart-location-database-technical-documentation-and-user-guide

Figure 4. Brownfields Redevelopment Status in Milwaukee, Wisc.

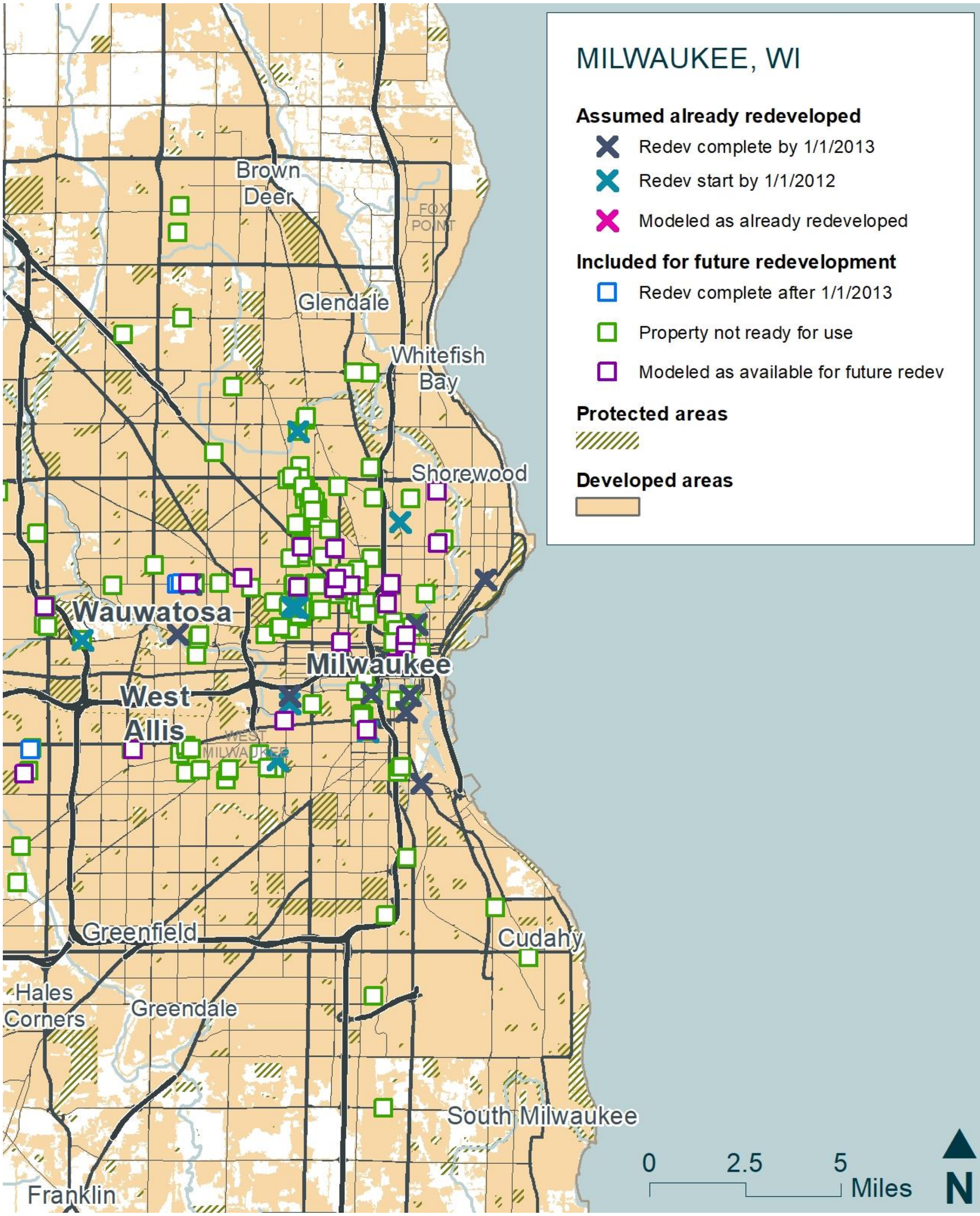


Table 1. Brownfields Redevelopment Status Model Coefficients by Census Region and Metropolitan Area Size

Census Region	Metro Size	Constant	Ready for Reuse	Site Size	Number of Grants	D4b050 (fixed guideway transit)	D5cri (regional centrality)
NORTHEAST	Small	-2.8883	2.2466	0.0073	0.1736	2.2664	1.7424
	Large	-1.7022	2.0448	0.0198	0.1902	0.7399	-0.8548
MIDWEST	Small	-2.3834	2.2371	-0.0047	0.3254	NA	0.6844
	Large	-3.1296	2.3841	0.0185	0.2662	3.3115	0.9350
SOUTH	Small	-2.5029	2.2760	0.0044	0.4666	1.6341	-0.0914
	Large	-2.1597	2.0346	0.0108	0.2506	1.0031	0.4199
WEST	Small	-2.8310	2.1019	0.0067	0.3630	6.0962	0.6057
	Large	-2.5423	2.9833	0.0128	0.2588	-0.5946	0.0696

2.1.2 Trend Growth Scenario Data Inputs

Unlike the BFR scenario, where future growth is allocated to brownfield properties (at the site/property level), the TG scenario utilizes CBGs as the unit of analysis, and new jobs and housing are allocated primarily to block groups with strong recent growth trends. Typically, these are greenfield areas and outer rim locations. CBG features and attribute data were obtained for the entire country from EPA's Smart Location Database (SLD). To account for the difference in geographic scale between the two scenarios, the BFR allocation results are summarized from the site level to the block group level, and all environmental modeling (see Section 2.4) occurs at the block group scale.

To prepare the data for the TG scenario, it was essential to determine:

- Which block groups experienced housing growth.
- Which block groups experienced employment growth.
- What areas within each block group were undeveloped.
- What areas within each block group are protected from future development (e.g., parks, preserves, managed lands).

Any growing CBG was considered a potential location for new development in the TG scenario. A block group was deemed to be "growing" if:

- New housing units were built within the block group between 2000 and 2013, according to the American Community Survey (ACS)[15], and
- A positive average annual change in jobs located within the block group was estimated from 2003 (or the earliest available year of Longitudinal Employer–Household Dynamics [LEHD] data[16]) to 2013. The average annual change in jobs was calculated as the mean

[15] ACS Table B25034 – Year Structure Built (Housing Units)
[16] Most states' LEHD jobs estimates are available from 2002, but others joined the program later, meaning that the earliest available LEHD data may be from 2005, for example. Massachusetts was the last state to participate in LEHD, starting in 2011. With so few

year-over-year change in total employment for the available years' data. See Appendix B for details on the estimation of average annual change in jobs.

Block groups with higher growth rates for a given activity were considered to be more attractive for that type of growth. A block group that was experiencing only housing growth was not considered to be eligible for growth in employment and vice versa. Block groups experiencing growth in both housing and jobs were eligible for either type of growth.

Finally, existing activities were assumed to be primarily located on the "developed" portions of each block group. The National Land Cover Database (NLCD) differentiates developed land cover types from undeveloped land cover types. Meanwhile, the Protected Areas Database of the United States (PAD-US) defines acreage protected from significant future development activity. Any areas of a block group outside the PAD-US features was considered "unprotected area." The undeveloped land cover area for each block group was overlaid on its unprotected acreage to determine its greenfield area – that is, the undeveloped portions of the block group where no development prohibitions apply. The greenfield area is used later in the scenario analysis model to estimate how much new growth can occur in a given location.

2.2 Scenario Analysis Process Step 2 – Develop Scenario Parameters

Step 2 involved developing key parameters for the BFR and TG growth scenarios, including determining how much new development a location can accommodate, which locations are likely to be redeveloped first, and how many new jobs and housing are likely to be added.

The BFR and TG scenarios are generated using a standardized land use allocation model. The model distributes future growth in jobs and housing units across a metro area, and it requires several key pieces of information (parameters) that guide the allocation process. The model parameters address the following questions:

- How many new jobs and housing units will be added to a given metro area by 2030? (*Control Totals*)
- How much new development can a given location accommodate? (*Capacity*)
- What locations are most likely to be (re)developed first? (*Attractiveness*)
- What types of activities (jobs and housing) are likely to be added as a given location is developed? (*Activity Mix*)

This section outlines the logic behind each of these allocation questions and describes parameter development based on available data sources for each growth scenario (see Section 2.1 above). It first discusses the BFR scenario, detailing the assumptions and processes that provide the required allocation parameters to the land use model based on ACRES brownfield site data and neighborhood characteristics (i.e., data from nearby block groups). The TG scenario is then addressed with a focus on the assumptions and processes used to estimate values for these parameters based on recent growth trends.

years of data available there, estimates of employment growth trends may be unreliable. In addition, Washington, D.C., only began participating in 2010 and may pose similar challenges. As such, the Washington, D.C., metro area and any metro area with territory in Massachusetts are not well suited for analysis in this study.

Table 2 summarizes the key differences in the parameter development assumptions for the BFR and TG scenarios. Note that for both scenarios, control totals are developed in the same way, meaning that the same numbers of new jobs and new housing units are allocated in the BFR and TG scenarios. Control totals are derived from Woods & Poole economic forecasts based on estimated 2013 activity and forecasted 2030 activity for each metro area analyzed. For example, the control total for new jobs to be allocated in a given metro area is the 2030 jobs total forecasted in Woods & Poole for all counties in the metro area minus the 2013 jobs total estimated in Woods & Poole for all counties in the metro area. The increment of "new jobs" is the jobs control total, which is then allocated to brownfield sites and trending block groups.

Table 2. Summary of the Differences in the BFR and TG Scenarios

Scenario Development Question	Brownfields Redevelopment Scenario	Trend Growth Scenario
How many new jobs and housing units will be added to a given metropolitan area by 2030? (Control Total)	For both scenarios, control totals of new jobs and new housing units are based on Woods & Poole economic forecasts, aggregated to the metro level (no difference).	
How much new development can a given location accommodate? (Capacity)	Based on site size from ACRES with reductions for greenspace	Based on undeveloped and unprotected acreage in each growing CBG
What locations are most likely to be (re)developed first? (Attractiveness)	Based on redevelopment probability estimates	Based on the magnitude of recent growth trends by type (residential vs. employment)
What types of activities (jobs and housing) are likely to be added as a given location is developed? (Activity Mix)	Likely mix of new activities based on recent growth trends	Based on the magnitude of recent growth trends by type (residential vs. employment)

2.2.1 Brownfields Redevelopment Scenario Parameters

The framing questions listed above guided the development of allocation model parameters for the universe of brownfield sites to simulate brownfields redevelopment through 2030 as described below.

How much development can a given location accommodate?

The magnitude of environmental benefits that brownfields redevelopment might confer to a metro area depends largely on the extent to which brownfields redevelopment can reshape area-wide growth patterns. This, in turn, depends on the amount of growth that can be accommodated by each available brownfield site in the metro area.

The ACRES database does not provide detailed information about redevelopment capacity, local policies, or market forces governing potential redevelopment options at any given brownfield site. For this reason, the redevelopment capacity of each brownfield site was estimated for the scenario analysis model as follows.

1. The expected density of development at the site was estimated based on the characteristics of the surrounding area (see details below).
2. The size of each brownfield site was obtained using information in ACRES or based on the assumptions outlined in Appendix A.
3. The expected development density was then multiplied by the site size to determine the total number of jobs and housing units that could be developed at the site.

Estimating the expected density of development at a brownfield site

The expected density of development at a given brownfield site was estimated from the characteristics of the surrounding neighborhood, based on block group data. The "prevailing" density of development in the area around a brownfield site was assumed to provide a reasonable benchmark for the potential density of development at the brownfield site. Two separate prevailing density estimates were developed to model two different BFR scenarios – a "**base**" configuration in which a lower expected development density was estimated for each brownfield site and an "**aggressive**" configuration in which a higher expected development density was estimated. These alternative configurations of the BFR scenario allowed the scenario allocation model and subsequent environmental analysis to model a range of potential brownfields redevelopment benefits.

In either the base or the aggressive configuration, the expected density of development at the brownfield site was estimated based on the prevailing density of development in the area.

For the base configuration, *the density of development at a brownfield site is expected to match the most densely developed block group in its vicinity*. The prevailing density is estimated based on the highest net activity density observed at a block group within a half-mile radius around the brownfield site[17] (see the notes on exceptional cases below). Net activity density was calculated as jobs plus housing units per developed acre.[18] For this report, this prevailing density estimate is methodologically identical to the "greenfield" density estimation process for block groups (see Section 2.2.2 below). It represents a reasonable limit on development intensity in greenfield areas based on development intensity in the surrounding area, and this estimate is used to cap development density at brownfield sites in the base configuration.

For the aggressive configuration, *the density of development at a brownfield site is expected to reflect the potential for development intensification and exceed the density at the most densely developed block group in its vicinity.* Thus, the prevailing density of development in the vicinity of a brownfield site could be higher than the greenfield density estimate, especially for sites located in built-out urban settings. For each site, a separate estimate of prevailing density was developed, referred to as the infill density estimate.[19] The infill density estimate reflects the possibility that new growth may be added in locations that are already built-out, through redevelopment and infill projects. It is derived based on a regression analysis that estimated the increase in net activity density at the block group level from 2000 to 2010. Net activity density in 2000 was estimated based on year 2000 Census housing data, the 2001 NLCD (see Section 2.1), and 2002 LEHD jobs data.[20] Net activity density in 2010 was estimated based on year 2010 Census housing data,

---

[17] That is, around the site's latitude/longitude coordinates after making any location adjustments according to the protocols outlined in Appendix A.

[18] Activity unit density is frequently used in urban planning forecasting applications to express the total intensity of development in a given area.

[19] In some cases, the infill density estimate for a brownfield site may be null because no qualifying block groups are within a half-mile of the site. The next paragraph defines the criteria that qualify a neighboring block group's data to support infill density estimation.

[20] 2002 is the earliest year for which LEHD data are available.

the 2011 NLCD, and 2010 LEHD jobs data. The change in net activity density was found to be a function of:

- Existing activity density within each block group
- Percentage of the block group's existing activities that are jobs
- Age of housing stock within the block group
- Metro area population size
- Proportion of the block group's area that is currently undeveloped
- Regional centrality (SLD)
- Proximity to transit (SLD)

The change in net activity density was calculated as the estimated infill density for all block groups having more than half of their unprotected acreage (i.e., areas outside of parks or other protected lands) already developed. For other block groups, the infill density estimate was not applicable because a large portion of the block group remains open to greenfield development. If one or more block groups having an infill density estimate were located within a half-mile radius of a brownfield site, the prevailing density estimated for that site was based on the highest infill density estimate. Thus, the prevailing activity density estimate for a given brownfield site in the aggressive configuration was sometimes the greenfield density estimate, just like in the base configuration. For cases where the brownfield site was located in a built-out urban area, the prevailing activity density estimate for the site was the infill density estimate, reflecting the potential for more intense development to occur at the site based on its contexts.

In all cases, for the aggressive configuration of the BFR scenario, the prevailing density estimate (whether it reflects the greenfield density or infill density) for a given brownfield site was doubled[21] to estimate the expected density of development at the site. The combination of the potential use of the infill density estimate and the doubling of the prevailing density estimate allows brownfield sites to take on a higher percentage of metro area growth in the aggressive configuration.

The decision to double prevailing density in modeling the aggressive BFR configuration was vetted through a review of available literature addressing brownfields redevelopment and urban infill development.[22] The reviewed studies focused largely on comparisons with greenfield and suburban locations rather than on comparable developments in the immediate vicinity of each site. There was little in the literature that provided comparison of brownfields development densities relative to nearby/adjacent infill site densities or what might constitute an aggressive or compact development density. However, while there are many site- and location-specific variables that go into development decisions (such as zoning, entitlements, and other land use planning principals), the literature does support the notion that brownfields typically are developed at higher densities than greenfield developments (sometimes significantly so), and that redevelopment density is an important determinant of expected environmental benefits justifying a remediation effort. The literature also suggests that generally all developers seek higher development densities for their projects to drive their financial viability, including brownfields

[21] In 2010, the Urban Land Institute (ULI) completed a review of three studies on land use and driving, and the role that compact development can play in reducing greenhouse gas emissions. One of the studies used a doubling of density as the basis for a compact development scenario and was used here. http://uli.org/wp-content/uploads/ULI-Documents/Land-Use-and-Driving-Low-Res.pdf

[22] In addition to the ULI studies cited above, other articles and studies were reviewed, including: Hendrickson, C. et. al., 2013. *Estimation of Comparative Life Cycle Costs and Greenhouse Gas Emissions of Residential Brownfield and Greenfield Developments*, https://www.cmu.edu/steinbrenner/brownfields/Current%20Projects/files/bf_gf-life-cycle-comparison-paper-final-submittal.pdf; Mashayekh, Y. et. al., 2012. *Role of Brownfield Developments in Reducing Household Vehicle Travel*, https://www.cmu.edu/steinbrenner/brownfields/epa-lca-project/ym-role-of-brownfield-developments-in-reducing-household-vehicle-travel-asce-up-1943-5444-0000113.pdf; and Paul, E., 2008. *The Environmental and Economic Impacts of Brownfields Redevelopment,* http://www.nemw.org/wp-content/uploads/2015/06/2008-Environ-Econ-Impacts-Brownfield-Redev.pdf.

developers who are often faced with additional costs associated with properly managing and mitigating contamination.

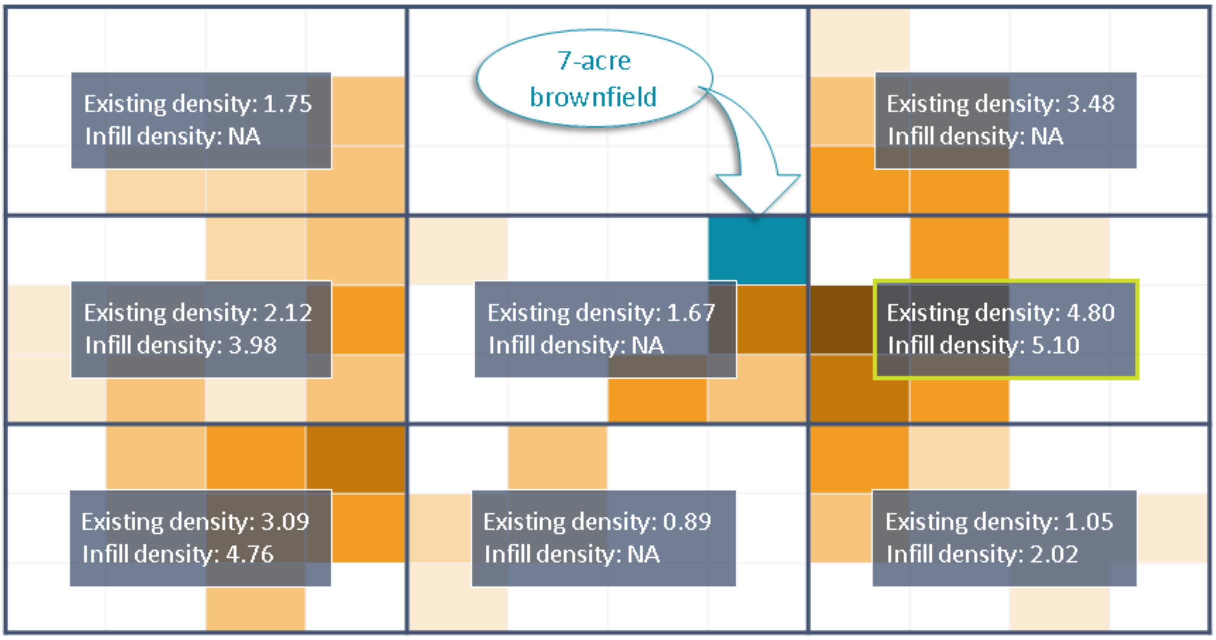
In the allocation model, the BFR scenario assumes that each brownfield redevelopment will be at least as dense as nearby developments. The growth model implicitly accounts for local growth policies and economics by estimating brownfield development capacity based on the prevailing development densities in nearby block groups. However, the literature suggests that development might be denser still in many locations. Therefore, for the aggressive BFR configuration, a density factor of two times prevailing density is the assumed increase. Examples from the literature suggest that brownfields can develop at substantially higher densities on a site-by-site basis, but the best available example of a generalized, regional “compact development” paradigm (the 2010 ULI study cited above) uses the doubling assumption to answer similar questions to those posed by this study. In short, the approach taken for this study brackets an optimistic forecast of future development by basing brownfields development densities on current prevailing densities (the base configuration) and on an assumed doubling of that density (aggressive configuration).

Figure 5 provides a conceptual illustration of the capacity calculation process for brownfield sites, showing differences between the base and aggressive configurations. The blue area in the center represents a 7-acre brownfield site. The brownfield sits in a block group (demarcated by bold lines) in which the existing density is 1.67 activities per acre, as shown in the orange area below the site. In neighboring block groups, the highest observed existing density is 4.8 activities per acre, which represents the greenfield density estimate. Therefore, in the base configuration, the brownfield site will be assumed to develop to 4.8 activities (jobs plus housing units) per acre. The highest infill density estimate among block groups near the brownfield site is 5.1 activities per acre (note that some neighboring blocks have no infill density estimate since more than half of their areas remain undeveloped). Therefore, for the aggressive configuration, this higher potential density becomes the assumed prevailing density; that figure is doubled to provide an upper limit on allowable total activity density at the brownfield site (10.2 activities per acre). Since the brownfield site is 7 acres in size, its capacity is set at 71 activities (10.2 activities per acre * 7 acres = 71.4 activities, rounded down to 71 activities). For the base configuration, the greenfield density estimate of 4.8 activities per acre would be applied to the 7-acre site, yielding a capacity of 33 activities.

For both the base and aggressive BFR scenario configurations, two caveats apply to the above descriptions of how expected development density was estimated for brownfield sites:

- If the brownfield site was located in a rural setting, the net activity density of the block group in which the site was located was used to establish the baseline development density rather than the highest density in the vicinity. Any block group larger than 2,500 acres was considered a “rural setting.”
- If no prevailing net density information was available, or if prevailing density values were less than 2 activities per acre (i.e., the brownfield site is located in a very sparsely developed area), then a minimum development density of 2 activities per acre was assumed.

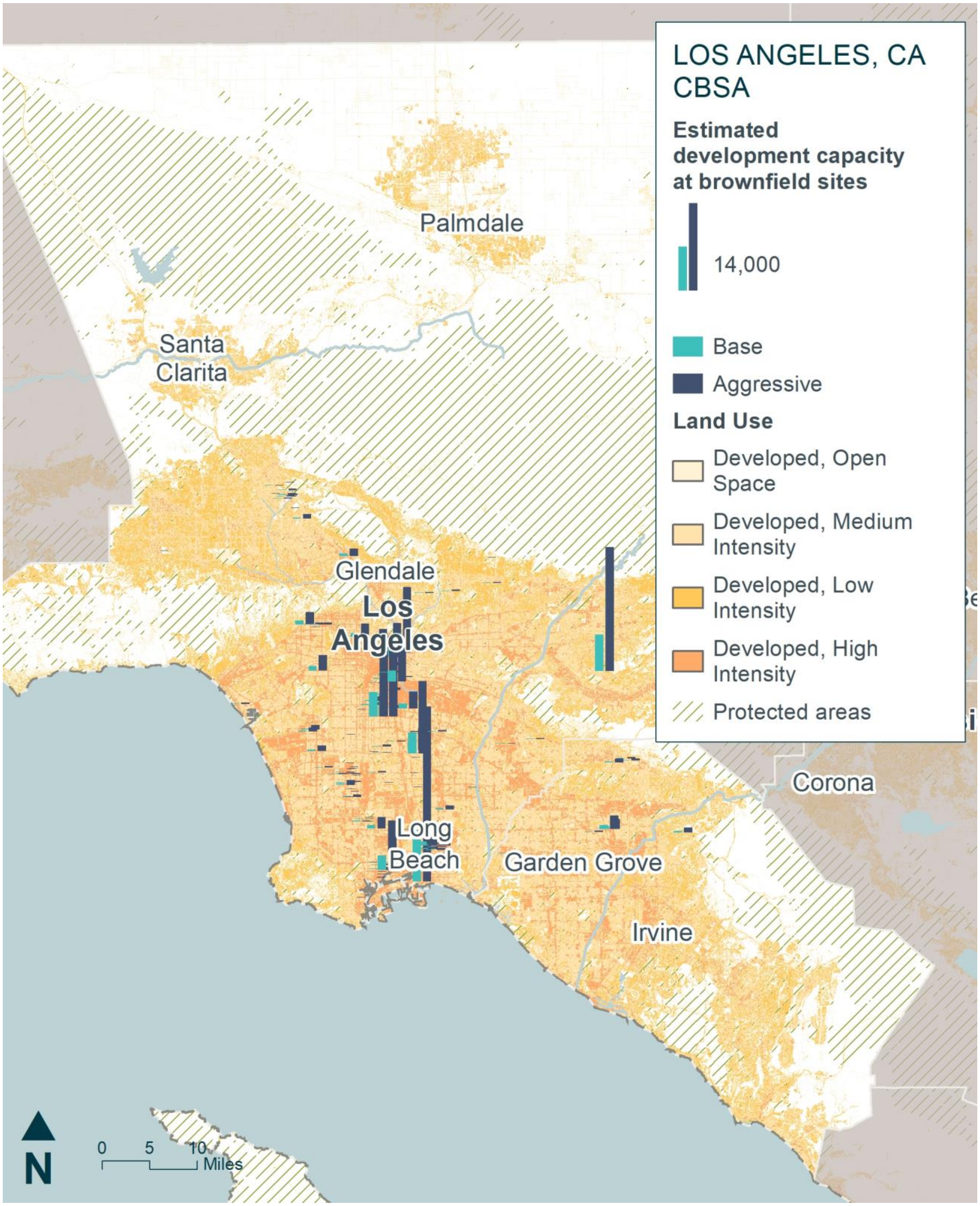
Figure 5. Capacity Estimation for New Activities at Brownfield Sites



Estimating expected density of development at a brownfield site		
	Base Configuration	**Aggressive Configuration**
Greenfield density estimate *(maximum existing density in vicinity)*	4.80 activities per acre	4.80 activities per acre
Infill density estimate *(maximum modeled infill density in vicinity)*	NA	5.10 activities per acre
Prevailing development density	4.80 activities per acre	5.10 activities per acre * 2 = 10.20 activities per acre
Calculating site capacity		
Site size	7 acres	7 acres
Capacity (site size * prevailing development density)	7 acres * 4.80 activities per acre = 33 activities	7 acres * 10.2 activities per acre = 71 activities

Figure 6 provides an example of the capacity estimation results for available brownfield sites in the Los Angeles metro area.

Figure 6. Brownfield Capacity Estimation Results for the Los Angeles Metro Area



What locations are most likely to be redeveloped first?

The land use allocation model used to generate the 2030 BFR scenario requires some mechanism to identify the probable order of redevelopment at brownfield sites over the 2013 to 2030 period. This is typically provided in the form of a development "attractiveness" score. For brownfield sites, the attractiveness score was estimated as the "redevelopment probability" value generated by applying the Brownfields Redevelopment Status Model described in the "Determining brownfields redevelopment status" section above. For attractiveness scoring purposes, the model was applied to all sites that were in the allocation set (i.e., those assumed to be available for redevelopment), yielding a redevelopment probability score that ranks some sites as more likely to be redeveloped (more attractive) than others. The most attractive sites will "fill up" with redevelopment (new jobs and/or housing units up to full capacity) first.[23]

Figure 7 shows the results of the brownfield attractiveness scoring process for the Los Angeles metro area.

What types of activities (jobs and housing) are likely to be added as a given location is developed?

The estimated mix of future (allocated) growth activities (jobs and housing) at a given brownfield site was estimated based on several factors:

1. For areas of increasing growth, the mix of activities allocated to each site is guided by the jobs-to-housing ratio corresponding to recent growth patterns in the block group in which the site is located. (ACS and LEHD – see Section 2.1.2, Trend Growth Scenario Data Inputs, above).
2. If the area has not experienced growth recently, then the mix of activities allocated is based on the existing total jobs-to-housing ratios in the block group in which the site is located (ACS and LEHD).
3. If the jobs-to-housing ratio of growth in the block group, or for existing activity in the block group, is unavailable due to a lack of activities, then the mix of allocated activities is based on the jobs-to-housing ratio for recent growth in the Census tract in which the site is located. This circumstance is very rare and applies to a very small set of sites (ACS and LEHD).

Figure 8 shows the brownfield activity mix estimates for sites in the Los Angeles metro area.

---

[23] In the BFR allocation, ultimately all sites will fill up, making the differentiation of brownfield sites by redevelopment attractiveness scores largely unnecessary. This is because the universe of available brownfield sites is limited to a subset of sites in the ACRES database, and there are not enough sites listed to accommodate all incoming growth for any given metro area. The attractiveness scoring process described here does, however, establish a standard approach for translating the ACRES database (with appropriate screening protocols applied) into a set of usable inputs for the land use allocation model, anticipating the potential for expansion of the universe of brownfield sites through expansions of, or supplements for, the ACRES database. With a large enough number of sites and sufficient development capacity, it may be possible to generate a scenario in which brownfields capture all metro area growth, leaving some sites undeveloped over the allocation horizon. In such a case, it is necessary to provide attractiveness scores to order the allocation and focus development at the sites with the highest redevelopment probabilities.

Figure 7. Brownfield Attractiveness Estimation Results for the Los Angeles Metro Area

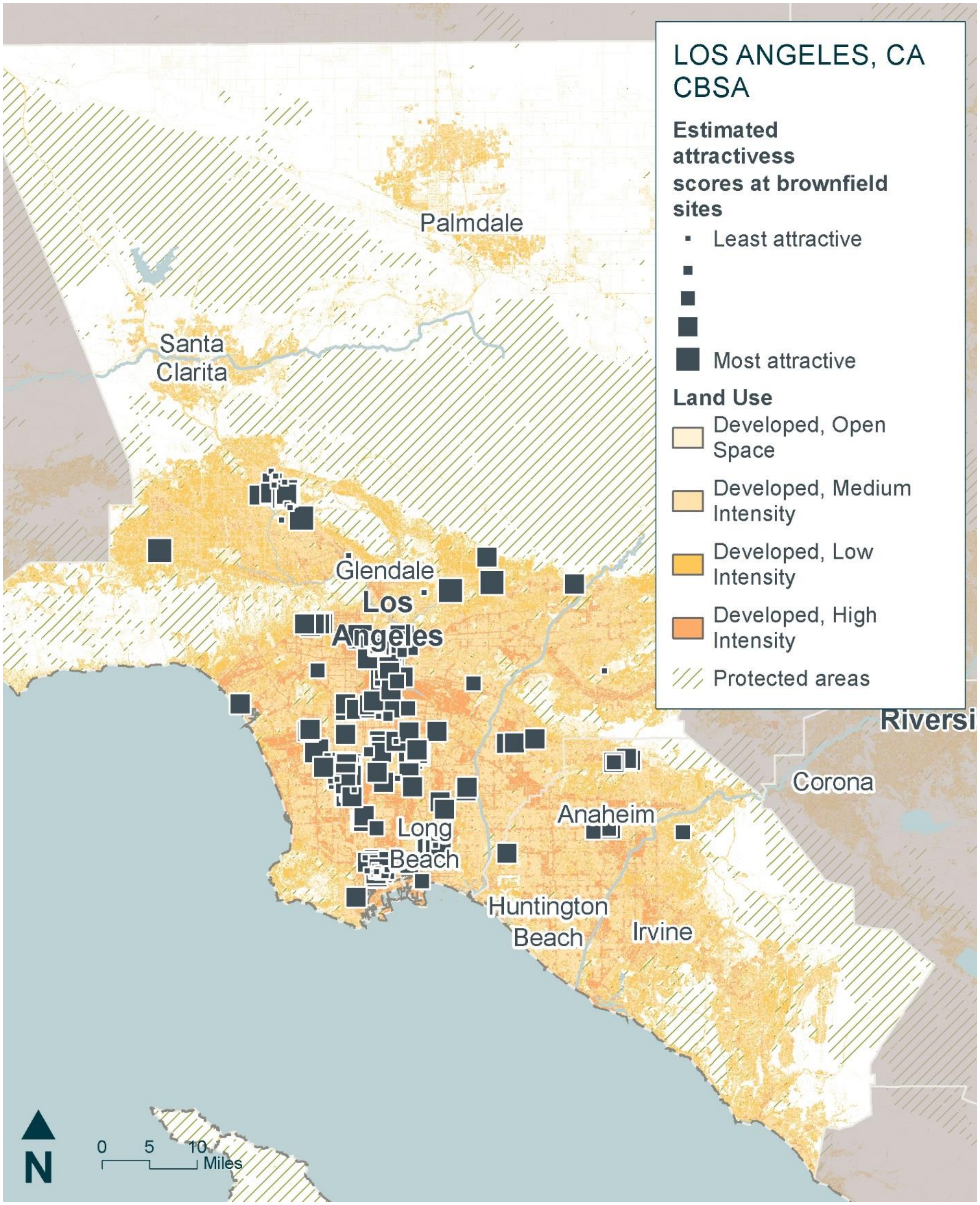
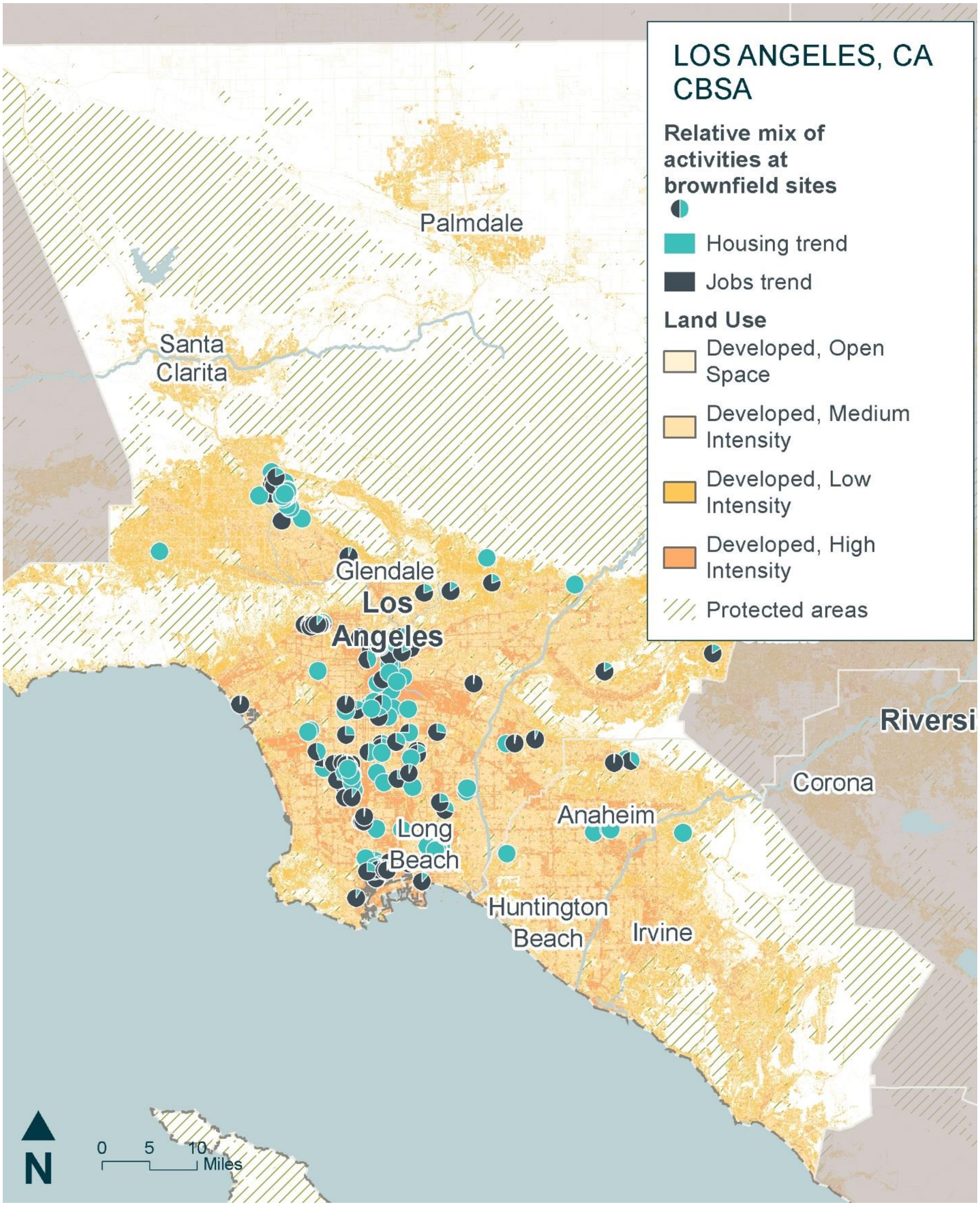


Figure 8. Brownfield Activity Mix Estimation Results for the Los Angeles Metro Area



2.2.2 Trend Growth Scenario Parameters

Guided by the same framing questions, the land use model parameters for the TG scenario are based on recent growth trends. While the BFR parameter estimates referenced brownfield sites as the unit of analysis for the primary allocation phase and then shifts to block groups for the secondary phase, the TG parameter estimates are summarized at the CBG level for both allocation phases.

How much development can a given location accommodate?

As with the BFR scenario, the growth capacity for each block group was estimated for the TG scenario by estimating the developable area within the block group and applying an expected density of development to that acreage. However, the TG capacity estimate blends the greenfield and infill capacity estimates described in Section 2.2.1, above, to yield total estimated development capacity.

Greenfield capacity estimate: As noted in Section 2.1.2, Trend Growth Scenario Data Inputs, above, the undeveloped, unprotected portion of a block group (i.e., undeveloped area outside of parklands and other areas protected from significant development) was taken as its greenfield area. The expected density of development in TG greenfield areas was estimated in the same way as the base configuration's prevailing density estimate described in the BFR scenario. The net activity density (jobs plus housing per developed acre) in all block groups was estimated. For each block group, the highest prevailing net density among itself and its neighbors (any adjacent block groups) was taken as its greenfield density estimate. The product of the greenfield area and the greenfield density estimate is the estimated development capacity in the greenfield portions of each block group.

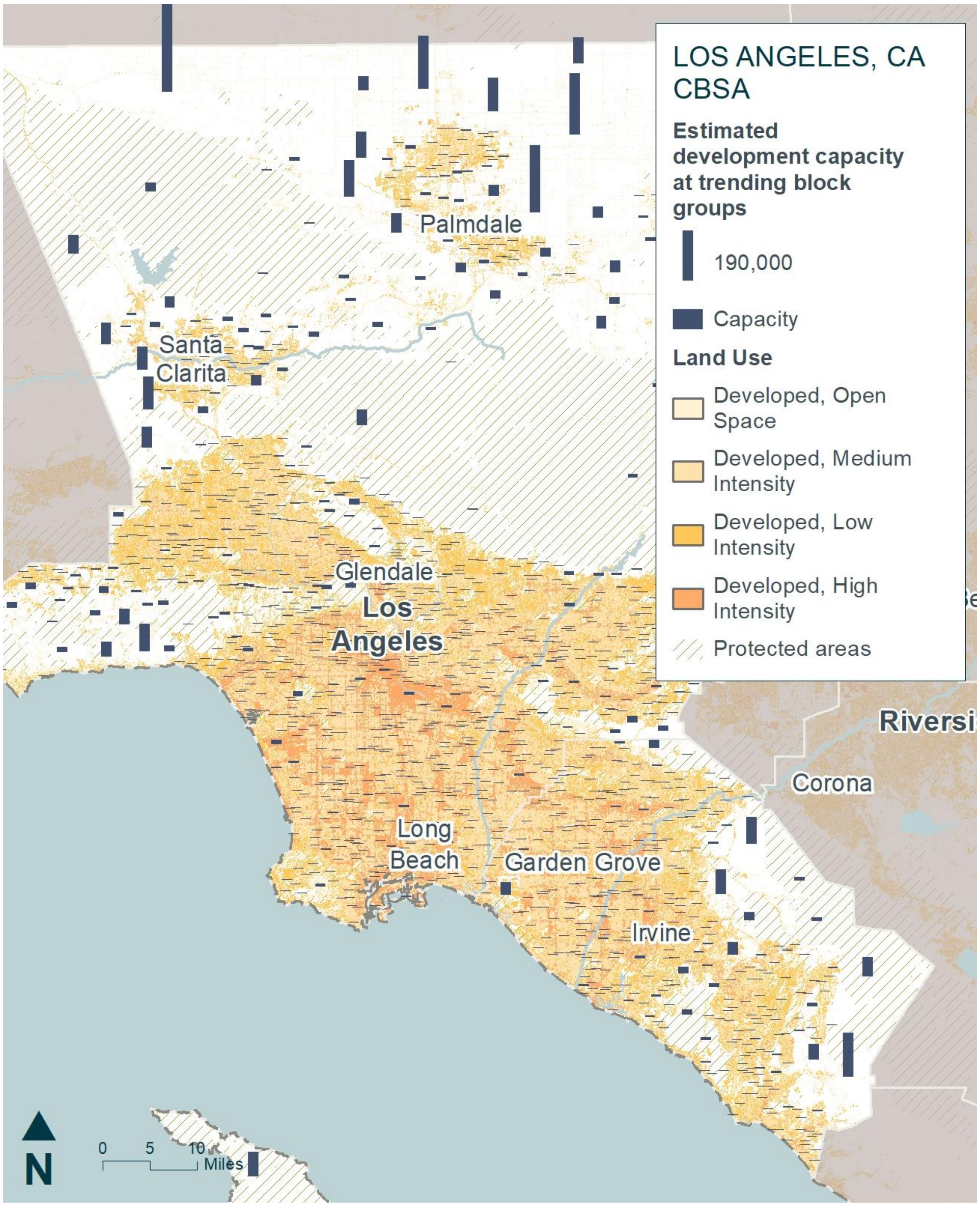
Infill capacity estimate: The developed, unprotected portion of a block group (i.e., developed area outside of parklands and other areas protected from significant development) was used as its infill area. The expected increase in density within the infill area was determined based on a regression analysis as described in Section 2.2.1 above. In brief, the change in net activity density was found to be a function of:

- Existing activity density within the block group
- Percentage of the block group's existing activities that are jobs
- Age of housing stock within the block group
- Metro population size
- Proportion of the block group's area that is currently undeveloped
- Regional centrality (SLD)
- Proximity to transit (SLD)

These factors were used to estimate the infill density estimate – the potential change in density in portions of a block group that are already developed. The infill density estimate accounts for the potential for built-out (portions of) block groups to continue to grow. It was only calculated for block groups that have more than half of their existing unprotected acreage already developed. For other block groups, the infill density estimate is not applicable because the majority of the block group remains open for greenfield development. The product of the infill area and the infill density estimate is the estimated development capacity in the infill portions of each block group.

The greenfield and infill capacity estimates were summed to produce the total development capacity estimate for each TG block group. There is no "base" or "aggressive" configuration of the TG scenario because it is the "business as usual" baseline. The TG scenario is intended to model growth trends as a frame of reference against which the BFR scenario may be compared. To assume the TG scenario follows different growth dynamics (i.e., different allowable development densities) simply because brownfields are assumed to develop to higher densities in its aggressive configuration undermines the central premise of this study. Thus, only one capacity value is calculated and provided to the land use model for trending block groups. Figure 9 shows the capacity estimation results for the Los Angeles metro area.

Figure 9. Trend Growth Capacity Estimation Results for the Los Angeles Metro Area



What locations are most likely to be developed first?

The attractiveness score of each block group, which determines the order in which block groups are developed for trend growth, is estimated based on each block group's share of total metro growth in housing or jobs. For example, if a given block group "A" added 100 housing units from 2000 to 2013 and was located in a metro area that added 20,000 housing units over the same period, that block group represents one-half of 1 percent of the total growth in housing in the metro area. Block groups that experienced the highest proportion of recent metro growth are allocated additional growth prior to allocating growth to block groups that represent smaller proportions of recent growth. Continuing the example above, if block group A added 100 housing units and block group B added 1,000 housing units, block group B is clearly growing more rapidly and, therefore, the model allocates additional growth to block group B before allocating growth to block group A, assuming that block group B has the capacity to accommodate the additional growth. The attractiveness scores were calculated independently for the housing allocation and for the employment allocation.[24]

Figure 10 displays trend growth attractiveness scores for the Los Angeles metro area. The scores are indexed such that the block group with the highest attractiveness value is given a value of 100 and all other block groups are scored relative to that maximum score. Keeping with the example presented above, block group B has the highest housing attractiveness and would receive an index score of 100; block group A has an attractiveness value that is one-tenth of block group B and would receive an index score of 10.

What types of activities (jobs and housing) are likely to be added as a given location is developed?

For the TG scenario, an activity type (i.e., a job or a household) is allocated to a particular block group based on the attractiveness score of the block group. If the growth activity is an increase in households, the housing attractiveness scores determine which block group the new unit is allocated to. Alternatively, if the activity to be allocated is a job, the employment attractiveness scores determine which block group the new job is allocated to. New jobs and housing units are effectively allocated simultaneously, and one activity type does not take precedence over the other in block groups that are growing both in residential and non-residential activity.

2.3 Scenario Analysis Process Step 3 – Allocate Growth

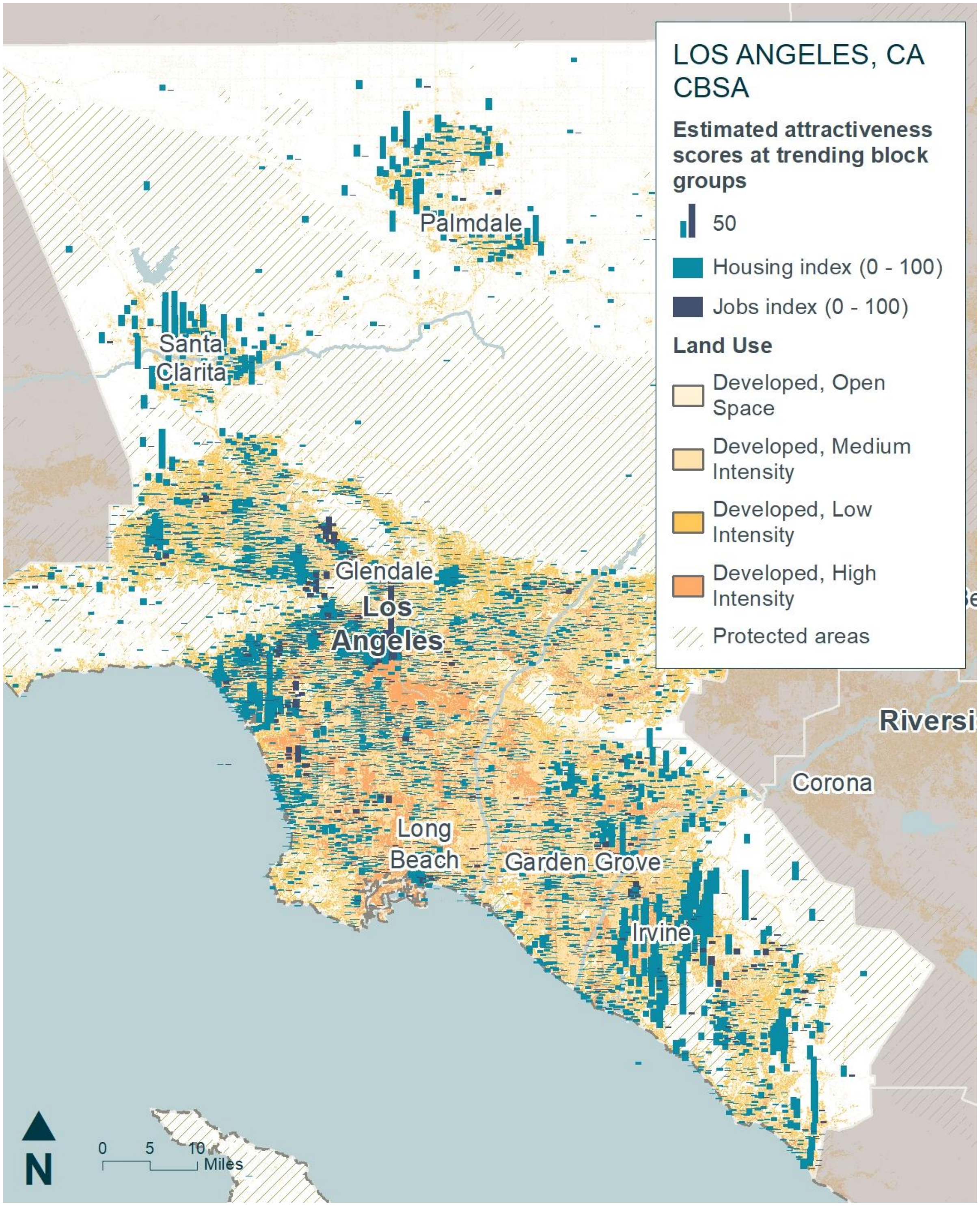
Step 3 involved running the model to allocate growth in jobs and housing under the BFR and TG scenarios for 50 metro areas of different population size, geographic location, growth dynamics, development history, and density of brownfield sites.

2.3.1 Overview of Allocation Model Steps

Once the parameters guiding the allocation of new jobs and housing units within each metro area were prepared for brownfield sites and trend growth block groups, the allocation model was run.

[24] Ideally, separate housing and employment attractiveness scores would be calculated for the brownfields scenario as well. However, limited data on the details of brownfields redevelopment projects make it difficult to achieve these independent estimates. As such, the brownfields scenario uses an estimate of generalized redevelopment attractiveness and bases the mix of activities (jobs versus housing units) on prevailing growth trends or existing activities in the vicinity.

Figure 10. Trend Growth Housing Attractiveness Estimation Results for the Los Angeles Metro Area



The model relies on metro area control totals to determine how much growth to allocate to each metro area. As explained in Section 2.2, control totals are simply the number of new jobs and housing units to allocate for a given metro area. One metro area might have forecasted growth of 10,000 new jobs, while another may be expecting more than a million. For this study, the control total quantities of new jobs and new housing units for each metro area analyzed were derived from Woods & Poole county-level demographic and economic forecasts, which cover all U.S. jurisdictions.

The control total amount of each activity type is distributed across the metro area on an iterative one-by-one basis. For example, starting with a control total of 100 new jobs, the model would select a brownfield site or block group location (depending on the scenario being analyzed) within the metro area to allocate a single job to, leaving 99 jobs remaining to be allocated. This process would be repeated until there are no jobs remaining to be allocated. The selection of which location to allocate each job to varies with each iteration and is guided by the other model parameters (capacity, attractiveness, and activity mix as defined in Section 2.2). The steps of the location selection process are outlined below.

Determining what activity to allocate in each iteration

For most regions, there are both new jobs and new housing units to allocate. Since jobs and housing units may be co-located, and since the allocation of activity to a given location reduces its capacity for additional growth in subsequent iterations, allocating one activity type prior to the other would give undue precedence to that activity type. For example, if the allocation model distributed job growth first, the allocated jobs may consume all of the available capacity at a given location before the housing allocation begins. Even if that location is attractive for housing growth, no housing units can be allocated there because there is no remaining development capacity. The same problem could occur if housing units were allocated first. There is no compelling reason to prioritize jobs over housing (or vice versa) in this way. As such, at the start of each iteration, the allocation model randomly chooses to allocate a job or housing unit. As the model works through numerous iterations, jobs and housing units are effectively allocated simultaneously.

Determining where to allocate an activity

Once the activity to be allocated has been determined, the location where the activity will be allocated is selected based on the attractiveness and capacity values of all of the potential locations in the metro area. In the BFR scenario, these potential locations include the available brownfield sites; in the TG scenario, they are block groups.

- **The influence of attractiveness scores.** The selection of a location where an activity will be allocated is made by a random choice, but the probability of picking a given location is weighted by its attractiveness score. A helpful illustration of this process is to consider a dice roll. With a normal six-sided die, the probability of rolling a five is about 17 percent, the same as for any other number on the die. However, if the die has three faces showing the number five, the probability of rolling a five is 50 percent. The attractiveness scores calculated for potential allocation locations work in the same way, increasing the probability that a highly attractive location is selected and diminishing the probability that a modestly attractive location is selected. Thus, the attractiveness scores described in Section 2.2 guide the allocation model to put more activity in the most attractive locations while distributing growth throughout the metro area.
- **The influence of capacity scores.** When a location is selected, the activity to be allocated is added to that location, and the location's capacity for additional growth is diminished. Over the course of numerous iterations, a single location may be selected many times, and eventually, its capacity may be exhausted. When this happens, the location is "de-

activated," and it cannot be selected again in subsequent iterations. Additional growth will be allocated to other locations that have remaining capacity. Thus, the development capacity estimates described in Section 2.2 limit the amount of activity that can be allocated to a single location.

- **The influence of activity mix scores (BFR scenario only).** The attractiveness scores that inform the selection of a brownfield site for allocation are activity-neutral. That is, each brownfield has a single attractiveness score that is used regardless of whether a job or a housing unit is being allocated. When a brownfield site is selected for allocation, the activity mix score for the site determines whether that activity can be allocated there. For example, if there has been no recent job growth near a brownfield site, it will have a jobs activity mix score of zero and will not be available for job growth during allocation, even if it has a high redevelopment probability (attractiveness score). Thus, the activity mix values described in Section 2.2 guide the model to allocate different activity types to brownfield sites, such that their modeled development mix (when allocation is complete) resembles the recent growth momentum observed in the area around each site. The activity mix for block groups in the trend growth location is not analyzed because each block group has a separate attractiveness score for housing and jobs growth.

The details about how the allocation steps described above are implemented differ slightly between the BFR and TG scenarios.

For the BFR scenario, only brownfield sites are considered as potential growth locations when the allocation process begins. That is, the model is focused on allocating metro growth to the brownfield sites exclusively until all of their development capacity has been exhausted, or until all growth in the metro area has been allocated.[25] If brownfield capacity is exhausted and any portion of the metro area control totals remains to be allocated, the block group locations used by the TG scenario are introduced as potential growth locations to accommodate the remaining growth.

For the TG scenario, the brownfield sites are never included as potential recipient features. All of a metro area's forecasted growth is allocated to trending block groups.

2.3.2 Phases of Allocation

The process described above yields two alternative growth scenarios, modeling all forecasted growth for a given metro area. It also provides a basis for estimating the potential environmental impacts of brownfields redevelopment by focusing on the "phases" of the allocation in the BFR scenario. As noted, the BFR scenario attempts to allocate as many activities as possible to brownfield sites until their capacity for development is exhausted. The remaining metro area growth is then allocated following the trend growth process. These two distinct allocation phases can be mirrored in the TG scenario through a simple accounting system:

- The BFR scenario is modeled in its entirety prior to the TG scenario.
- The first, or "**primary**," phase of the BFR scenario allocates as much growth as possible to brownfield sites, based on the development capacity and activity mix estimates for each site.

> The "**primary**" phase of the BFR scenario allocates as much growth as possible to brownfield sites. During the primary phase of the TG scenario, the same increments of jobs and housing units allocated to brownfields are re-allocated to non-brownfield areas.

[25] For the 50 metro areas analyzed, there are no cases in which the brownfield sites accommodate all of a CBSA's growth in jobs and housing.

- For the TG scenario allocation, the total number of jobs and housing units allocated to brownfield sites in the first "phase" of the BFR scenario is known. Thus, a corresponding first phase of the TG scenario can be run, utilizing these amounts as control totals. This "re-allocates" the same portion of growth that went to brownfields into trending areas, earmarking the locations to which growth would be expected to occur in the TG scenario if brownfields redevelopment does not occur.
- In the BFR scenario, the "**secondary"** phase of analysis occurs when capacity for new growth at brownfield sites is exhausted, and all remaining growth is allocated to trending block groups.
- For the TG scenario, the allocation process simply continues until all forecasted metro area growth is allocated, but the secondary phase results are stored in a separate table from the primary phase results.

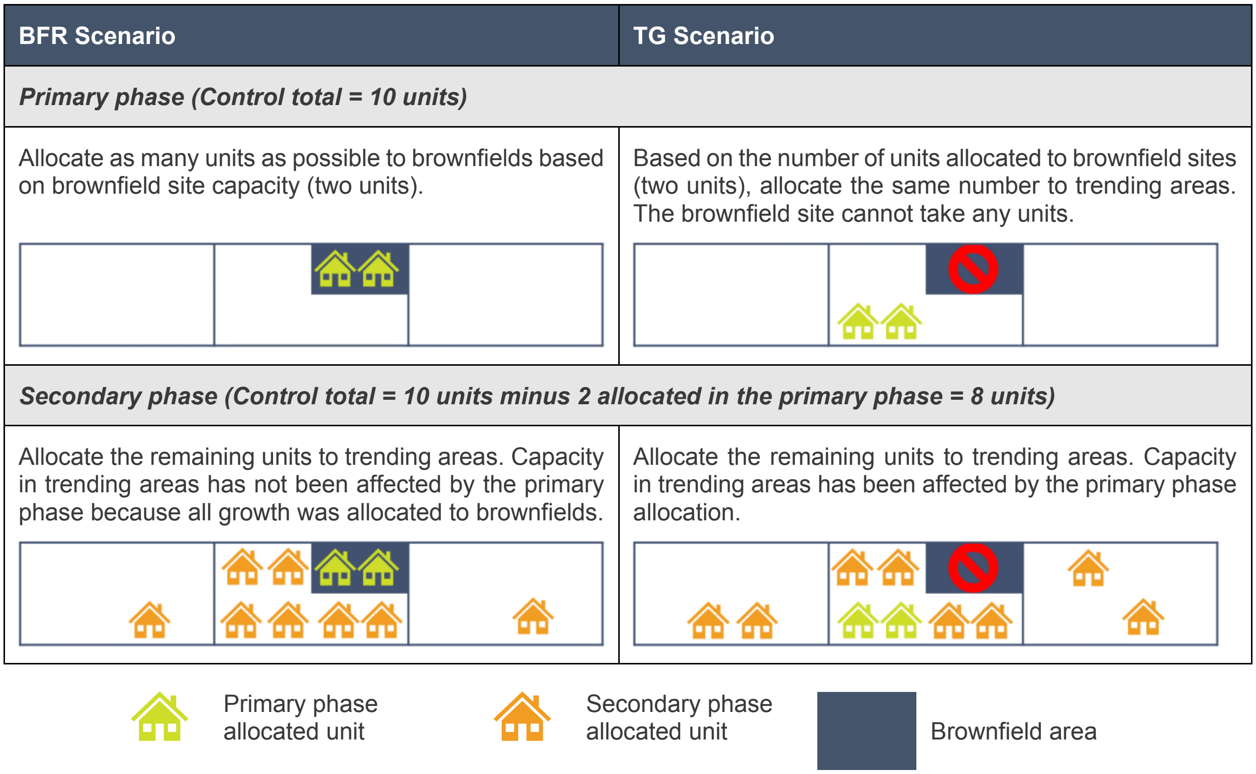
The "**secondary**" phase of analysis occurs when capacity for new growth at brownfield sites is exhausted, and all remaining growth is allocated according to the data and parameters guiding the TG scenario.

Figure 11 provides a simple illustration of this process and the implications for each phase of growth. The first phase of allocation is referred to as the "primary" phase and the second as the "secondary" phase. In the example, 10 housing units are allocated. In the study area, there is only one known brownfield site with a capacity for two housing units, and it sits in an attractive centrally located block group. In the primary allocation phase, two of the study area's 10 new housing units are allocated to the brownfield site. In the secondary phase, the remaining eight housing units are allocated to trending block groups because brownfield capacity has been exhausted. Six of these eight units allocated in the second phase are located in the same block group where the brownfield site is located. Thus, a total of eight out of the 10 new housing units were allocated to the central block group in the BFR scenario. The TG scenario mirrors the BFR scenario, allocating two housing units in the first phase. These two units are allocated to the central block group due to its attractiveness for housing growth. When the second phase of the TG scenario begins, there is only capacity for four additional housing units in the central block group. Therefore, only four of the eight housing units allocated in the secondary phase go to the central block group due to capacity limitations; remaining growth is distributed among the other available block groups. In total, six units are allocated to the central block group in the TG scenario, compared with eight in the BFR scenario. This example shows how available growth capacity on brownfield properties affects the spatial distribution of growth in each allocation phase, as well as in the cumulative picture of area-wide growth.

These analysis phases provide the means of comparing the "primary" and "secondary" effects of redeveloping brownfields relative to the TG scenario. For each scenario and each allocation phase, the environmental impacts of new growth are estimated.

In the BFR scenario, new development at brownfield sites will result in some increases in impervious surface and VMT generation. However, when that same increment of growth is allocated according to the TG scenario, the environmental impacts of new growth typically are much greater (see Section 3, Model Results, for detailed comparisons). Comparing the portion of growth allocated to brownfields versus where growth may occur in the TG scenario reveals the *location efficiency* of brownfield sites relative to trending locations. The primary environmental benefits of redeveloping brownfields are accomplished through this location efficiency; by diverting growth into smarter locations (e.g., infill areas and areas where brownfields are typically located), the environmental impacts of new growth are reduced.

Figure 11. Illustration of the Allocation Phases



In addition, sometimes there are secondary benefits of brownfields redevelopment. These benefits arise from the fact that brownfield sites offer additional development capacity in typically efficient locations that would not be available in the TG scenario. In Figure 11 above, six housing units are allocated to the central block group in the secondary phase of the BFR scenario, while two go to peripheral locations. In the TG scenario, four units are allocated centrally and four go to peripheral locations. If the environmental impacts of growth at the central location are lower on a per unit basis than those at peripheral locations, the BFR scenario's secondary allocation phase will have a lower impact than the TG scenario's secondary allocation phase.

Consider a hypothetical example: A given block group near the central business district of a city experiences substantial recent job growth and has a 20-acre brownfield site within its borders. In the BFR scenario, the brownfield will redevelop to its maximum capacity in the first phase of allocation. In the second phase, the non-brownfield portions of the block group will be in play, following the logic of the TG scenario. In the TG scenario, the brownfield is assumed to have not been redeveloped. Therefore, during the first phase of allocation, a large portion of the block group's development capacity is used up. During the second phase of the TG allocation, the remaining capacity may be developed before all jobs are allocated, forcing remaining jobs to go to other, less efficient locations around the metro area. When comparing the environmental impacts of each scenario's second phase of application, the BFR scenario will show a large number of jobs in a central city location, while the TG scenario will show a few jobs in the central city location and others in less efficient locations. The redevelopment of brownfields can confer benefits in shaping growth patterns beyond the redevelopment of the sites themselves by *preserving capacity at smart locations*.

When the scope of analysis is expanded from a single block group to the entire metro area, it is harder to anticipate the extent to which secondary benefits will accrue. In all cases, the secondary benefits are modest compared with the primary benefits. The presence and magnitude of secondary benefits depend on the specific brownfield locations and the nature of growth trends in each metro area. For example, if a region's brownfields are concentrated in central locations and the block groups in which they are located have experienced substantial recent growth, the BFR secondary allocation results will likely show a strong trend toward the center of the region, while the TG secondary allocation results will be more dispersed due to capacity limitations in those block groups. On the other hand, if the region's brownfields are more dispersed, they offer no or limited additional capacity in central locations. Similarly, if the central locations in which a region's brownfield sites are found show limited trend growth, the capacity preserved by brownfields redevelopment may not be in demand during the secondary allocation phase. In either of these cases, the secondary benefits of brownfields redevelopment are likely to be modest. The inclusion of secondary benefits in this study provides additional insight into the potential for brownfields redevelopment to shape future growth and promote development patterns that mitigate the environmental impacts of growth.

Finally, the combined allocation for each scenario (combining the first and second phases) is evaluated to assess the "**cumulative**" benefits of brownfields redevelopment. This grouping provides the means to assess the extent to which brownfields redevelopment can shift the entire metro area's growth patterns to reduce the environmental impacts of development. Since the environmental models rely, in many cases, on multivariate analyses and/or non-linear formulas, the cumulative impacts are not equivalent to the sum of the primary and secondary impacts.

> The "**cumulative**" assessment of each growth scenario compares the environmental impacts of total growth across a broader metro area, regardless of phase.

Maps illustrating the primary, secondary, and cumulative allocation results for both BFR and TG scenarios are presented in Section 3 of this report.

2.3.3 Specific Application to 50 Metropolitan Areas

The allocation approach described above was applied to 50 CBSAs (also referred to in this report as "metropolitan areas" or "metro areas") to cover metro areas of different population size, geographic location, growth dynamics, development history, and density of brownfield sites. The method for selecting the 50 metro areas involved the following three steps:

1. **Reduce the universe of metro areas:** To arrive at a robust group of metro areas from which to select the final 50 for analysis, any CBSAs that had limited or problematic data were eliminated from consideration. Of the 955 CBSAs in the United States, 308 lacked ACRES brownfield sites recorded in the ACRES database or had inadequate data. Another 367 were eliminated for having low brownfield density (less than 50 total brownfield sites in the CBSA and fewer than 20 brownfield sites per 1,000 square miles of CBSA area), which is an important indicator of the impact that brownfield development could have on growth dynamics. As a result of this first step, 280 CBSAs (or 29 percent) were left for consideration.
2. **Group metro areas by growth dynamics:** Six growth profile categories were created using population and growth rate statistics to ensure that metro areas were analyzed against other metro areas of analogous size and growth. Future development patterns are strongly influenced by the size (population) of a metro area, and how slowly or quickly the metro area is growing. It is likely that the environmental impacts of brownfields redevelopment for large metro areas experiencing marginal growth will look very different from the environmental benefits for small, swiftly growing metro areas. Table 3 outlines the characteristics of the six

growth profiles that were developed. A detailed explanation of the criteria ranges is available in Appendix C.

Table 3. Characteristics of Growth Profiles for Metropolitan Areas[26]

Growth Profile Name	Metro Area Size	Growth Rate	Population Density	Capacity of Redevelop-ment Activity	Brownfield Density	No. Eligible for Analysis	No. Chosen for Analysis	Example Cities
Growth Hub	Medium and Large	Moderate to Rapid	Moderate to High	High	High	19	6	Austin, TX Seattle, WA
Industrial Legacy	Small and Tiny	Slow	Low to Moderate	Low to Moderate	Moderate to High	171	18	Sturgis, MI Albany, NY
Stable Metropolis	Huge	Slow	High	High	High	4	2	Los Angeles, CA Philadelphia, PA
Slow and Steady	Medium and Large	Slow	Moderate to High	High	Moderate to High	16	6	Baltimore, MD New Orleans, LA
Big and Growing	Huge	Moderate to Rapid	High	High	High	4	2	Atlanta, GA Dallas, TX
Up and Coming	Small and Tiny	Moderate to Rapid	All Densities	All Capacities	All	66	16	Durham, NC Boulder, CO
					Total	**280**	**50**	

3. **Select metro areas:** The last step involved choosing metro areas from each growth profile. To understand whether metro areas within each growth profile have anything in common beyond population size and growth rate, each group was assessed according to three key indicators: population density, brownfield density, and capacity for growth. These indicators provide deeper insight into the development and industrial history of a metro area, as well as the potential for growth in the future. Of the 280 CBSAs eligible for analysis, 50 were selected to provide broad geographic coverage across the county. The number of modeled CBSAs by profile group loosely reflects the total number in each group. For example, there are 171 CBSAs characterized as *Industrial Legacy* metro areas, more than any other category. The number of *Industrial Legacy* metro areas selected for analysis is 18, more than any other category. Likewise, there are a small number of *Stable Metropolis* and *Big and Growing* metro areas nationwide (four each), and just two are included from each profile in the analysis (at least two examples from each growth profile were included among the 50 CBSAs).

   The 50 CBSAs analyzed offer broad coverage of the nation, geographically, such that representatives of each growth profile are found in differing regional contexts. Moreover, the selected CBSAs cover a substantial share of brownfields sites in ACRES and of the national population. Their 5,366 brownfield sites comprise 29 percent of brownfields recorded in ACRES within the 280 eligible CBSAs. In 2010, roughly 73 million people lived in one of the 50 selected CBSAs, or 24 percent of the national population at the time. The results of the analysis undertaken in this study should therefore offer a strong representative sample of the contexts in which brownfields redevelopment can occur across the country, and the typical benefits of brownfields redevelopment described should reflect average conditions for

[26] The definition and numerical ranges for each characteristic (metro area size, growth rate, population density, capacity of redevelopment activity, and brownfield density) are described in Appendix C.

different metro area types and areas within the country (see the results summarized by EPA region). Figure 12 shows the 50 CBSAs by growth category geographically and Table 4 lists them. Appendix C provides additional details regarding the characterization of CBSAs and the distribution of selected CBSAs by growth profile, EPA region, and Census Region.

4. **Quality review of brownfield sites in selected metro areas:** Growth allocation modeling was validated using 12 CBSAs (those with asterisks in Table 4), which were selected to span a range of geographic locations, population size, development history, and growth capacity, and to optimize validation test results. During model testing, it was discovered that several brownfield sites appeared as outliers in terms of their development capacity, even after the protocols applied to the ACRES data were in place. These outlier sites overstated brownfield capacity and skewed the results of the BFR scenario. To ensure reasonable results for all CBSAs, a final screening protocol was introduced prior to running the full allocation model. The screening focused on an analysis of the top 10 percent of all brownfield sites in each CBSA (in terms of estimated development capacity). Brownfields were screened based on the reasonableness of each site's capacity estimate. The screening identified 115 high-capacity sites that had incorrect site size estimates or location information. It also revealed 161 duplicate sites that would have overstated the brownfields capacity for certain CBSAs. The screening required 276 sites (5.14 percent) to be dropped from the analysis.

   The manual screening results of the top 10 percent of sites in each CBSA suggested that site duplication/co-location may be an issue throughout the ACRES dataset. To address this, an additional set of screening protocols was developed to search the ACRES database for potential duplicate sites based on site location (proximity), property name and address similarity, and site size attributes. This screening protocol was applied only to those brownfield sites in the 50 selected CBSAs and not among the 10 percent of sites subjected to the manual screening process described above. This process flagged 893 additional sites as potential duplicates in 215 sets, where a set is a group of proximate sites with similar attribute details. Each set was then manually reviewed to assess whether the flagged sites in the set were genuine duplicates. This process found a further 67 duplicate sites, which were dropped from the analysis as well as 52 sites for which location data needed to be updated. This resulted in a final total of 5,023 sites included in the allocation process.

Figure 12. Map of the 50 Selected CBSAs by Growth Profile

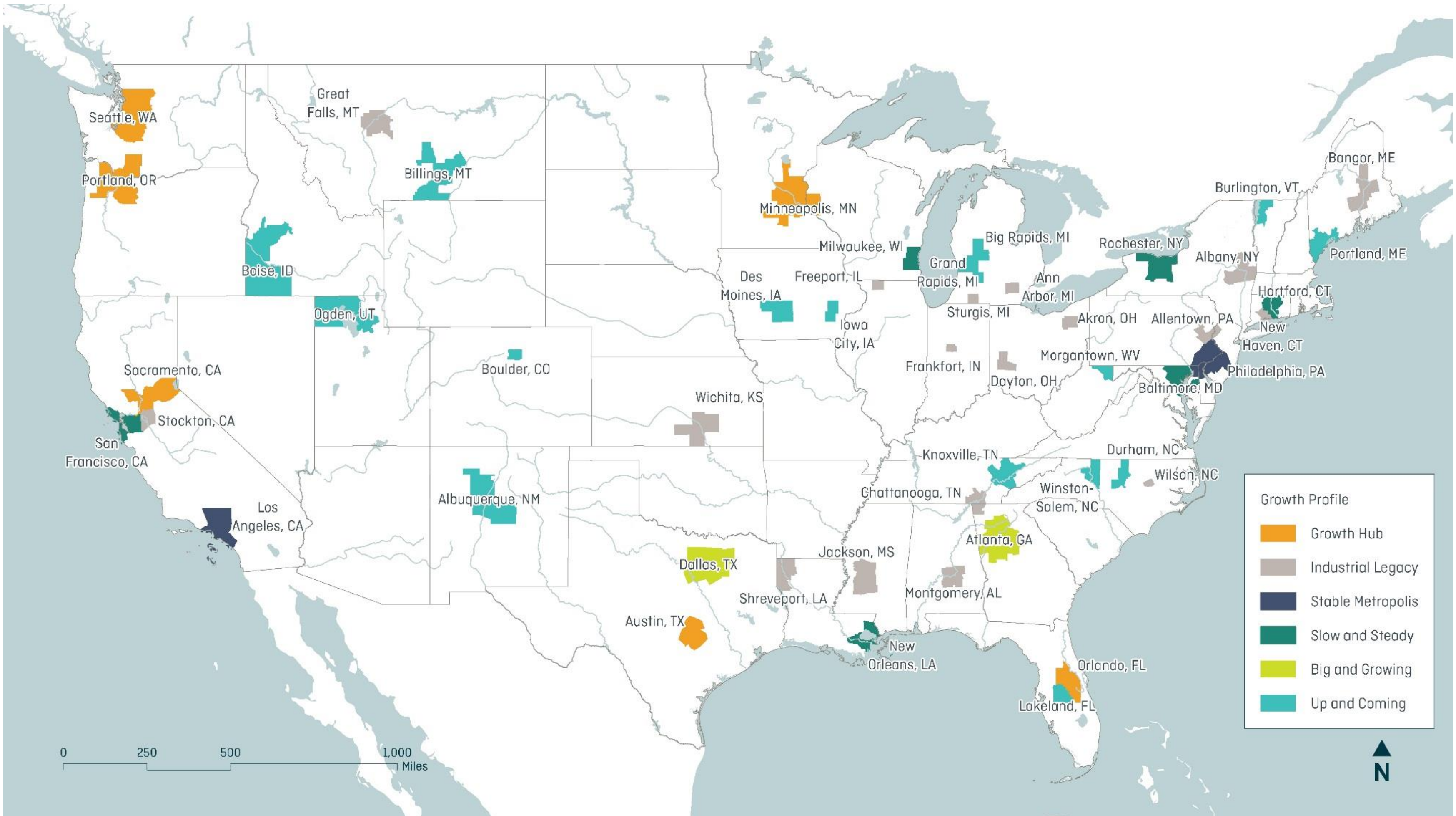


Table 4. Categorization of 50 Selected CBSAs by Growth Profile

CBSA Name	Census Region	EPA Region
Growth Hubs		
Austin-Round Rock, Texas	South	6
Minneapolis-St. Paul–Bloomington, Minn.-Wisc.*	Midwest	5
Orlando-Kissimmee-Sanford, Fla.	South	4
Portland-Vancouver-Hillsboro, Ore.-Wash.	West	10
Sacramento–Roseville–Arden-Arcade, Calif.	West	9
Seattle-Tacoma-Bellevue, Wash.*	West	10
Industrial Legacy		
Akron, Ohio	Midwest	5
Albany-Schenectady-Troy, N.Y.	Northeast	2
Allentown-Bethlehem-Easton, Pa.-N.J.	Northeast	3
Ann Arbor, Mich.	Midwest	5
Bangor, Maine	Northeast	1
Chattanooga, Tenn.-Ga.	South	4
Dayton, Ohio	Midwest	5
Frankfort, Ind.	Midwest	5
Freeport, Ill.	Midwest	5
Great Falls, Mont.	West	8
Jackson, Miss.	South	4
Montgomery, Ala.	South	4
New Haven-Milford, Conn.	Northeast	1
Shreveport-Bossier City, La.	South	6
Stockton-Lodi, Calif.	West	9
Sturgis, Mich.	Midwest	5
Wichita, Kan.	Midwest	7
Wilson, N.C.	South	4
Stable Metropolis		
Los Angeles-Long Beach-Anaheim, Calif.*	West	9
Philadelphia-Camden-Wilmington, Pa.-N.J.-Del.-Md.	Northeast	2
Slow and Steady		
Baltimore-Columbia-Towson, Md.*	South	3
Hartford-West Hartford-East Hartford, Conn.*	Northeast	1
Milwaukee-Waukesha-West Allis, Wisc.*	Midwest	5
New Orleans-Metairie, La.*	South	6
Rochester, N.Y.*	Northeast	2
San Francisco-Oakland-Hayward, Calif.*	West	9

CBSA Name	Census Region	EPA Region
Big and Growing		
Atlanta-Sandy Springs-Roswell, Ga.*	South	4
Dallas-Fort Worth-Arlington, Texas*	South	6
Up and Coming		
Albuquerque, N.M.*	West	6
Big Rapids, Mich.	Midwest	5
Billings, Mont.	West	8
Boise City, Idaho	West	10
Boulder, Colo.	West	8
Burlington-South Burlington, Vt.	Northeast	1
Des Moines-West Des Moines, Iowa	Midwest	7
Durham-Chapel Hill, N.C.	South	4
Grand Rapids-Wyoming, Mich.	Midwest	5
Iowa City, Iowa	Midwest	7
Knoxville, Tenn.	South	4
Lakeland-Winter Haven, Fla.	South	4
Morgantown, W.Va.	South	3
Ogden-Clearfield, Utah	West	8
Portland-South Portland, Maine	Northeast	1
Winston-Salem, N.C.	South	4

** CBSAs used in validating the growth allocation model.*

2.4 Scenario Analysis Process Step 4 – Estimate Environmental Impacts

Step 4 involved estimating the stormwater and air quality impacts of each development scenario within each metro area.

Once the allocation of future activities for the Brownfield Redevelopment (BFR) and Trend Growth (TG) scenarios was determined for all 50 CBSAs, the environmental impacts of each development scenario within each metro area were assessed. The environmental analysis module developed for this study estimates stormwater impacts and air quality impacts. Stormwater impacts are estimated by calculating the expected growth in impervious surface area associated with each growth scenario (urban footprint expansion). Air quality impacts associated with transportation decisions related to new development are estimated by calculating changes in VMT.

2.4.1 Stormwater Impacts

Impervious surface coverage is a proxy for a range of stormwater impacts, where higher impervious surface coverage is generally correlated with higher runoff volumes and increased concentrations of non-point source pollutants in runoff. Impervious surface growth refers to the total area of hard surfaces added to a location because of new development. Changes in the total area of impervious surfaces may result from construction of new buildings or from infrastructure added to support new development, such as parking lots. Increases in impervious surface are typically higher when development occurs in areas that are characterized by greenfield land covers, such as open space or agricultural uses. When new development or growth occurs in already-developed areas, the increase or expansion of impervious surfaces is usually modest.

EPA's Impervious Surface Growth Model (ISGM)[27] was used to estimate the total amount of impervious surface added in each metro area under each development scenario. The model incorporates housing density, jobs density, and metro area centrality to estimate the proportion of total land area covered by impervious materials at the CBG scale. The ISGM is applied to existing conditions based on block group data obtained from EPA's Smart Location Database (SLD). These data are updated post-allocation, and the model is reapplied. The difference between each block group's future and existing impervious area estimates reflects the expected change in impervious surface area under each alternative growth scenario.

The model equation for the ISGM is provided below:

$$\%\,imp = \frac{100}{1 + \left(\frac{1}{0.008 + 0.1227 * D1b + 0.093 * D1c + 7.39E - 07 * D5ar}\right)}$$

Where

- ***% imp*** = Percentage of a block group's total area that is covered by impervious surfaces
- ***D1b*** = Block group's housing density in units per unprotected acre from the SLD (variable heading "D1b") for existing conditions or after allocation for future conditions
- ***D1c*** = Block group's employment density in jobs per unprotected acre value from the SLD (variable heading "D1c") for existing conditions or after allocation for future conditions
- ***D5ar*** = Number of jobs reachable by driving within 45 minutes from the block group from the SLD (variable heading "D5ar") for existing conditions or after allocation for future conditions

For a given block group, as new jobs and residents are allocated, the impervious surface coverage will be modeled to increase, as all of the variables named above will increase. The increases will be more pronounced in areas that are currently sparsely developed, which receive substantial growth. The increase in total impervious surface area will be least pronounced in areas that are currently heavily developed. Typically, brownfield sites are found in currently developed areas, and growth in these areas is likely to only modestly increase impervious surface area. The trend growth areas often include greenfield areas and peripheral locations where new growth will substantially increase impervious surface area.

2.4.2 Transportation Impacts

Each scenario's impacts on transportation behaviors were modeled by estimating VMT generated by new growth. VMT is a measure of total vehicular travel within a metro area and is a proxy for transportation-related air emissions. Both the BFR and TG scenarios were evaluated using two independent VMT assessments: residential and employment. Residential VMT describes the amount of driving undertaken to and from new households, and employment VMT describes the amount of driving undertaken to and from new jobs. In either case, the expectation is that new activities located in centralized, well connected, multi-modal areas will generate fewer VMT than

[27] EPA Impervious Surface Growth Model, https://www.epa.gov/smartgrowth/impervious-surface-growth-model

new activities in auto-oriented, fringe development areas. Analyzing both VMT measures offers a complete understanding of the impacts of new development on travel patterns under the BFR and TG scenarios.

Residential VMT

Household travel behavior has been shown to be responsive to various attributes of the built environment, often referred to as “D variables.” As shown in Table 5, these include several common measures, such as density of development, diversity of land uses, design of neighborhood streets, distance to transit, and access to destinations. Built environment attribute data from the SLD were used to model CBG-to-CBG variances in average per capita VMT. The SLD variables referenced are indicators of each of the five D variables commonly referenced in the transportation and land use literature (Table 5).

Table 5. D Variables and SLD Indicators

D Variables	SLD	Indicator	Primary Impact on Travel Behavior
Density	D1a	Residential Density	More destinations nearby increase walking and biking.
Diversity	D2	Land Use Entropy	A greater range of destinations nearby also increased the likelihood of walking and biking.
Design	D3	Intersection Density, weighted by three-legged, four-legged, or more intersections	More direct pedestrian pathways and more distributed vehicle traffic support better walking and biking conditions.
Distance	D4	Distance of Transit	Convenient access increases the likelihood of using transit.
Destinations	D5ar	Accessibility to Jobs by Auto, gravity weighted	Greater access to destinations generates shorter average vehicle trips.

For each scenario and phase of analysis, residential VMT is estimated using these variables. The details of this procedure are documented in Appendix D. In general, when housing units are allocated to densely developed block groups with diverse land uses, well-connected local street networks, and nearby fixed-guideway transit, and are located in central areas, the residential VMT generation rate will be relatively low. Brownfield sites are often found in these contexts. On the other hand, when the growth pattern is more dispersed and the growth scenario results in additional housing being developed in existing greenfield areas, residential VMT generation will be relatively high. In many CBSAs, substantial portions of recent growth have gone into such areas, although it varies from one metro area to the next.

Employment VMT

Whereas many studies have been conducted relating the D variables to household travel behaviors, there are comparably few studies covering the attributes of workplace location that influence how workers travel to their jobs. When EPA updated the SLD in 2013, it partnered with the U.S. General Services Administration (GSA) to develop the Smart Location Calculator (SLC).[28] The SLC estimates workplace-related VMT based on the D variables, as well as several socio-economic and demographic variables. It consists of two primary components, each having

[28] U.S. EPA-GSA Smart Location Calculator, https://www.slc.gsa.gov/slc/

three steps. The first component addresses home-to-work VMT and the second estimates work-based VMT (meetings, deliveries, lunch/errands, etc.). The three steps for each component are similar.

- Step 1 uses a logistic model to estimate the probability that vehicle trips are generated;
- Step 2 uses a linear model to estimate the average trip length for each trip type; and
- Step 3 multiplies the results of Steps 1 and 2 to yield an estimate of vehicle miles generate per job.

The results for each component can be added together for a total VMT per job estimate, which in turn can be applied to total jobs to get total employment-related VMT. The SLC is the best available resource for estimating workplace VMT generation in a consistent manner across the country and was used during this study to assess employment VMT created under each development scenario.

3. MODEL RESULTS

This section presents the results of the allocation and environmental benefits models, summarized by metro area profile. These results offer rule-of-thumb values indicating the potential environmental benefits of brownfields redevelopment in varying contexts.

Differences between the BFR and TG scenarios are reported on a per brownfield acre basis to relativize the impacts of brownfield redevelopment. As noted later in Section 3.4 (Model Uncertainties), this study does not attempt to assess the viability of redeveloping any particular brownfield site; rather it assumes redevelopment will occur at *all* brownfield sites in the BFR scenario to quantify the typical differences in environmental impacts associated with growth at brownfields sites relative to growing areas in land outside of the urban core or on previously undeveloped and greenfield properties. The per brownfield acre results reported here provide a simple mechanism for quantifying the potential benefits of redeveloping an arbitrary number of brownfield sites, both in terms of direct comparisons to where activities at the brownfield site might otherwise have gone and in the context of holistic regional growth expectations.

Detailed results of the allocation and environmental benefits models for each of the 50 selected metro areas are presented in Appendix E.

3.1 Allocation Model Results

As discussed in Section 2.3.2, the allocation model proceeds in two major phases:

- The first, or "**primary,**" phase of the BFR scenario allocates as much growth as possible to brownfield sites, based on the development capacity and activity mix estimates for each brownfield. During the primary phase of the TG scenario, the same increments of jobs and housing allocated to brownfields are re-allocated to trending (i.e., non-brownfield) areas. This analysis phase provides a direct comparison of the environmental impacts between localized growth at brownfield sites and growth in non-brownfield areas.
- In the "**secondary**" phase of both scenarios, the remaining increment of growth is allocated according to the data and parameters guiding the TG scenario. In the BFR scenario, block groups have their full capacity for development available for this secondary phase because all growth in the primary phase was allocated to brownfield sites. In the TG scenario, many block groups begin the secondary phase with diminished capacity for additional development, having been assigned new jobs and/or housing units in the primary phase. The differences in environmental impacts between the BFR and TG scenarios for this secondary analysis phase are often small and always smaller than the differences observed in the primary phase. Secondary environmental benefits may arise from preserving development capacity in growing location-efficient neighborhoods.

This modeling structure gives priority to brownfield sites in the BFR scenario and assumes that once all known brownfield capacity is developed, the remaining growth will follow recent trends. Table 6 outlines the key concepts to keep in mind when viewing allocation results and interpreting the environmental impact estimates described later in this section.

The combination of the primary and secondary allocation phases provides a picture of "**cumulative**" growth and development from 2013 to 2030 within a metro area under the BFR and TG scenarios. While the primary phase focuses on localized environmental impacts from brownfields redevelopment (relative to growth in non-brownfield areas), the cumulative assessment quantifies the environmental impacts based on areawide growth patterns. The cumulative assessment quantifies the extent to which brownfields redevelopment could reshape broader metropolitan growth patterns and accompanying areawide environmental impacts.

Table 6. "Primary" and "Secondary" Allocation Concepts

	Brownfields Redevelopment Scenario	Trend Growth Scenario
Primary Allocation Phase		
Objective	Allocate as many jobs and housing units to brownfield sites as possible based on estimated development capacity.	Re-allocate the jobs and housing units from brownfield sites to trending locations throughout the metro area.
Where does growth occur?	At brownfield sites	In neighborhoods (block groups) that have experienced substantial growth in the past decade
What are the implications?	Development patterns and travel behaviors of new workers and residents will reflect the contexts in which the brownfield sites are located.	Development patterns and travel behaviors of new workers and residents will reflect those typical in the fastest growing parts of the metro area.
How is development capacity utilized?	Only capacity at brownfield sites is absorbed.	Non-brownfield capacity at trending locations is absorbed.
What are the implications?	Non-brownfield capacity remains untouched, preserving capacity in the neighborhoods in which the brownfields are located.	Non-brownfield capacity is reduced at trending locations, according to the amount of activity allocated there.
Secondary Allocation Phase		
Objective	Allocate the remaining increment of jobs and housing units to trending areas.	Continue allocation of jobs and housing units to trending locations.
Where does growth occur?	In neighborhoods (block groups) that have experienced substantial growth in the past decade	In neighborhoods (block groups) that have experienced substantial growth in the past decade. If a trending area's development capacity is fully absorbed, any remaining growth will go to other trending areas.
What are the implications?	Development patterns and travel behaviors of new workers and residents will reflect those typical in the fastest growing parts of the metro area.	Development patterns and travel behaviors of new workers and residents will reflect those typical in the fastest growing parts of the metro area, with sufficient development capacity to accommodate the remaining growth.

Figures 13 through 15 illustrate the primary, secondary, and cumulative allocation results, respectively, of both BFR and TG scenarios in the Los Angeles metro area.

Figure 13. Primary Allocation in BFR and TG Scenarios for the Los Angeles Metro Area

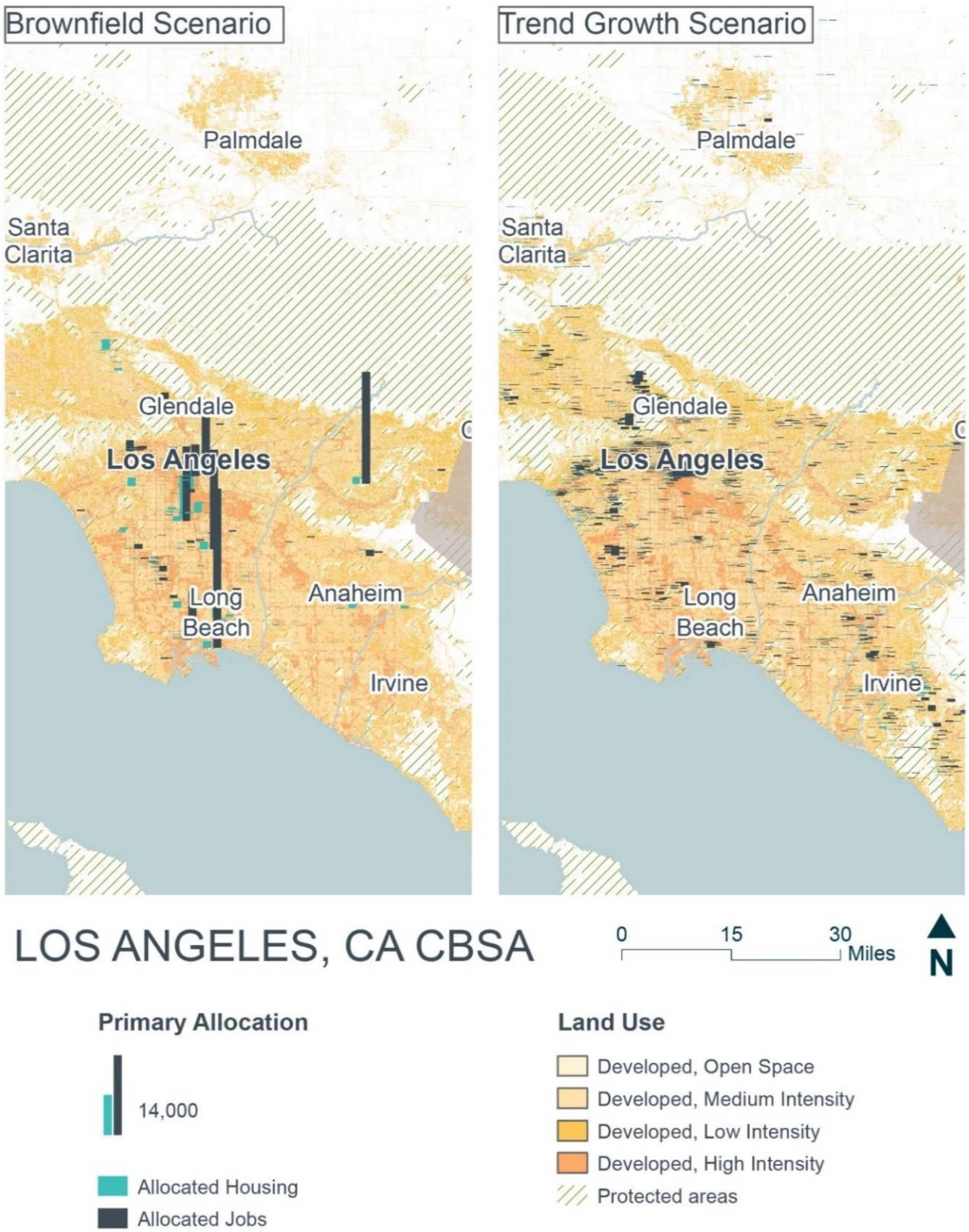


Figure 14. Secondary Allocation in BFR and TG Scenarios for the Los Angeles Metro Area

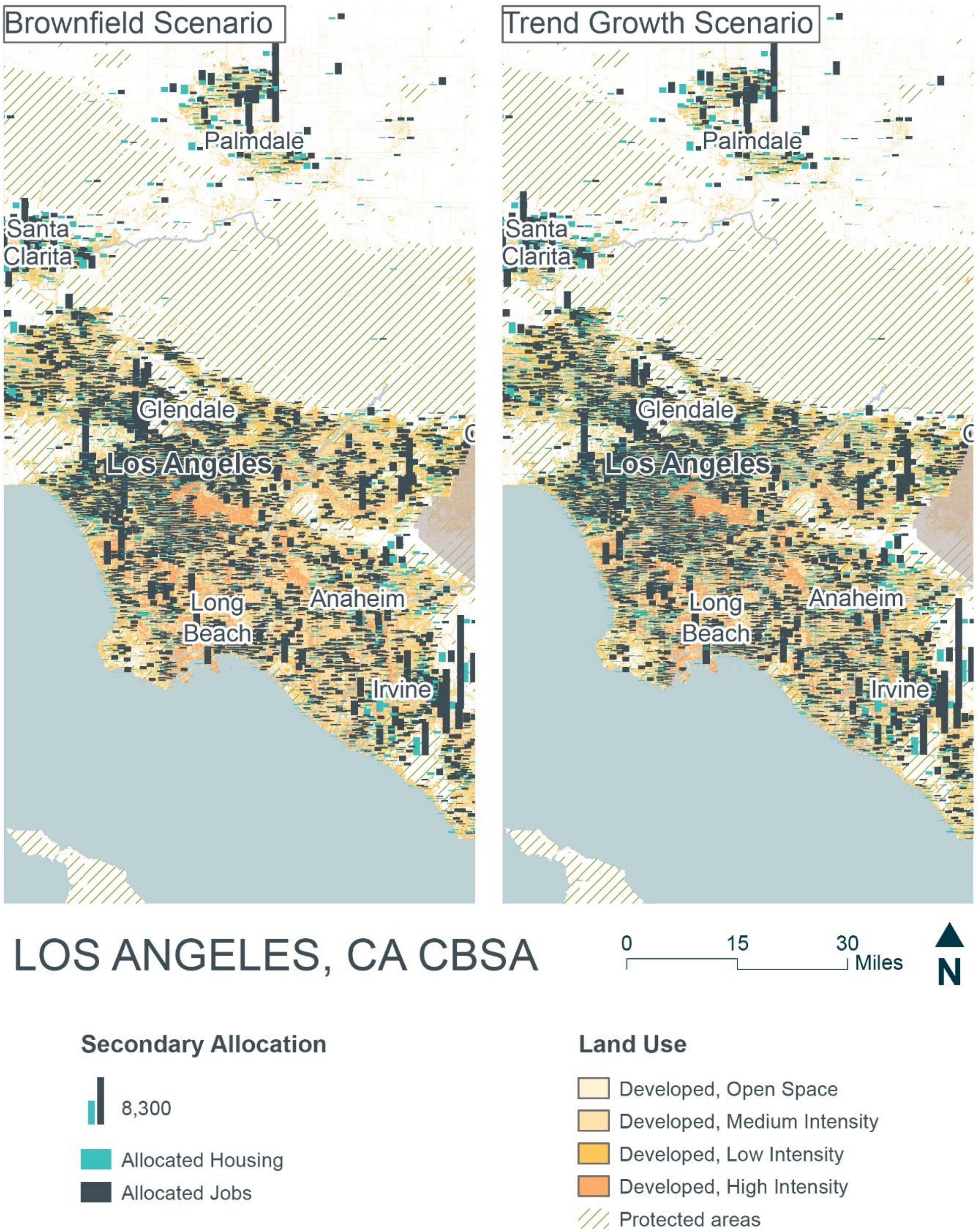


Figure 15. Cumulative Allocation in BFR and TG Scenarios for the Los Angeles Metro Area

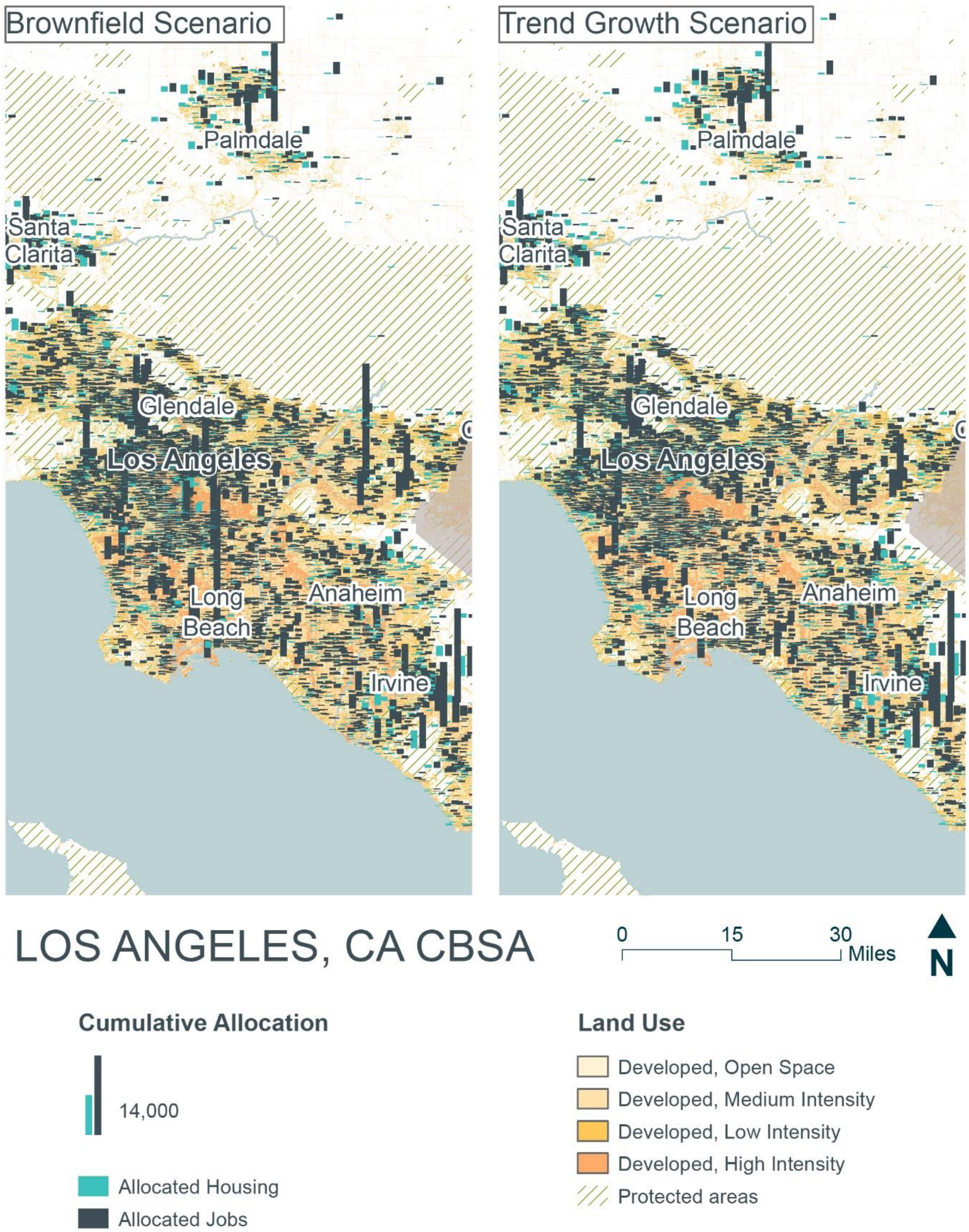


Table 7 displays the total number of new jobs and housing units allocated to brownfield sites in the primary allocation phase by growth profile (see Table 3 in Section 2.3.3 for explanations of growth profiles). The share of growth captured at brownfields, represented as a percentage of total added jobs or housing, is also reported. Ranges are reported in the table, reflecting the "base" and "aggressive" formulations for estimating the brownfield development capacity described in Section 2.2 (Scenario Analysis Process Step 2 – Develop Scenario Parameters) above. As a reminder, the base estimate assumes that brownfields will develop at densities matching the highest observed densities in nearby block groups; the aggressive estimate assumes more intense development of brownfields (roughly twice the base density estimate, generally).

Table 7. Activities Allocated to Brownfield Sites in the "Primary" Allocation Phase

	Housing		Jobs	
GROWTH PROFILE	**Newly Allocated Housing Units**	**Percentage of Housing Control Total**	**Newly Allocated Jobs**	**Percentage of Jobs Control Total**
Growth Hub	42,993 to 142,484	2.8% to 9.2%	159,979 to 542,059	5.0% to 17.0%
Industrial Legacy	40,473 to 117,037	13.6% to 39.2%	28,197 to 96,239	2.9% to 10.0%
Stable Metropolis	35,637 to 118,883	5.5% to 18.5%	97,564 to 316,045	3.7% to 11.8%
Slow and Steady	31,083 to 103,394	6.8% to 22.6%	62,487 to 211,536	4.0% to 13.7%
Big and Growing	19,514 to 66,664	1.4% to 4.8%	29,618 to 100,346	1.1% to 3.6%
Up and Coming	29,888 to 91,153	4.1% to 12.6%	37,124 to 123,115	2.6% to 8.6%
All	***199,588 to 639,615***	***3.9% to 12.6%***	***414,969 to 1,389,340***	***3.3% to 11.0%***

Brownfield sites in the 50 analyzed metro areas could potentially accommodate as many as 640,000 new housing units and 1.39 million new jobs under the aggressive development scenario. These totals represent almost 13 percent and 11 percent, respectively, of total growth expected for the analyzed metro areas between 2013 and 2030. However, the shares of housing units and jobs potentially accommodated by brownfield sites vary substantially by growth profile. This reflects the variability in the total number of brownfields in each metro area, the density of development around those brownfields (brownfield capacity), the types of growth observed in the vicinity of brownfields in recent years (activity mix), and overall growth rates.

Metro areas designated as having an *Industrial Legacy* growth profile, for example, tend to be slow-growing areas and often have relatively large numbers of brownfields (as demonstrated by the number of property-specific entries in the ACRES database). As such, the allocation model shows that brownfields can absorb a large portion of new growth in these areas. Brownfield sites in *Industrial Legacy* metro areas are expected to take on an especially high share of housing growth (13.6% to 39.2%), reflective of modest housing growth throughout the metro area and an overall trend of higher housing growth in the areas in which brownfield sites are located. For example, residential redevelopments of former warehouse districts are common in these metro areas and provide just one example of how surrounding redevelopment positively influences housing growth in brownfield locations.

In contrast, metro areas characterized as *Growth Hubs* are marked by rapid growth. Brownfield sites in these metro areas only have sufficient capacity to accommodate a small proportion of new housing units (2.8% to 9.2%) and a moderate share of new jobs (5.0% to 17.0%) as the rate of growth in the metro area, overall, is high. Since brownfield locations in these metro areas can accommodate a larger share of jobs than housing units, this suggests that many brownfield sites in *Growth Hub* metro areas are located in areas that have recently experienced relatively strong job growth.

A temporal analysis of the allocation results for the BFR scenario was performed to determine the expected year of brownfield redevelopment completion (i.e., when available brownfield site capacity was filled) (see Appendix F). Across all growth profiles, available brownfield site capacity was typically filled by new jobs within 4 to 9 years of the start of the BFR scenario and by new housing units within 6 to 12 years of the start of the BFR scenario. The brownfield redevelopment completion timeframes depend largely on the base and aggressive configurations of the BFR scenario and represent a mean condition; there are cases where the timeframe is shorter and cases where it is longer. The expected years before brownfield site capacity is filled tends to be relatively near-term (4 to 9 years) in the case of jobs-oriented redevelopment and mid- to long-term (6 to 12 years) for housing-oriented redevelopment. These results generally reflect the tendency for brownfield sites to be located in employment-rich areas.

Detailed results of the allocation model for each of the 50 selected metro areas are in Appendix E.

3.2 Translating Development Patterns to Environmental Outcomes

As noted above, the allocation results provide distinct pictures of growth patterns, distributing new jobs and housing units to brownfield sites and trending areas in the BFR scenario and to trending areas only in the TG scenario. These growth patterns drive the assessment of the expected environmental impacts associated with new growth.

The centerpiece of the environmental models is the concept of location efficiency, which posits that the effects of urban development are different in different parts of a metro area. Location efficient communities are dense and vibrant, with walkable streets, access to transit, proximity to jobs, mixed land uses, and concentrations of retail and services.[29] Location efficiency promotes development patterns that limit the strain on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads. The location efficiency concept is applied to estimate the expansion of impervious surface due to new growth and the change in VMT resulting from new growth. Illustrations of how location efficiency affects the environmental outcomes of two hypothetical scenarios are provided below:

> **Location efficiency** promotes development patterns that limit the strain on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads.

- An out-of-town company is expanding and will bring 250 new jobs to a metro area. The company is considering two sites: one in a redeveloping industrial district adjacent to the metro area's central business district and one in a suburban research park campus. The

[29] Center for Neighborhood Technology, https://www.cnt.org/projects/location-efficiency-hub

increase in impervious surface at the first site will likely be much lower than at the second site because the industrial district is located adjacent to an existing developed area, rather than the new office contributing to sprawling development outside of the urban core area.

- A family has re-located to a new town. They are considering two houses: one in an in-town neighborhood with frequent bus service and one near a suburban office park with a nearby park-and-ride lot. At the in-town location, the family will likely generate fewer and shorter vehicle trips for commuting and discretionary travel than at the suburban location because the family will be located closer to existing amenities in town.

While individual circumstances vary, the illustrations above reflect typical expected outcomes associated with new activities locating in different parts of a metro area. If larger numbers of new jobs and housing units come to more "efficient" areas, the resulting metro development patterns will have less significant environmental impacts.

The concept of location efficiency is important to keep in mind when examining the estimated environmental impacts of the BFR and TG scenarios presented in this study. Depending on the location efficiency of brownfield sites and trend growth locations, the development patterns modeled under the BFR scenario will have greater or lesser impacts on the environment compared with the TG scenario. Summarization by allocation phase (primary, secondary, or cumulative) provides insight into how location efficiency dynamics interact with brownfield site characteristics and metro area growth trends. The magnitudes of the differences between the BFR and TG scenarios vary by metro area and are sensitive to the number, locations, and capacity of brownfield sites, as well as the character of metro area growth trends. Table 8 provides an outline of considerations that are useful for interpreting the environmental results by each allocation phase.

Table 8. Understanding Environmental Results by Allocation Phase

	Primary Phase	Secondary Phase	Cumulative
Key question(s)	Are brownfield sites more "location-efficient" than trending areas? What is the magnitude of the difference?	Do brownfield sites preserve capacity in "location-efficient" trending areas? What is the magnitude of the difference?	Does the growth diverted to brownfield sites result in a metro area growth pattern that utilizes "location-efficient" places more heavily than the trend? What is the magnitude of the difference?
Comparison	BFR vs. TG environmental impacts for the "primary" phase of allocation	BFR vs. TG environmental impacts for the "secondary" phase of allocation	BFR vs. TG environmental impacts for the cumulative allocations
Factors affecting results	Where are brownfield sites located vs. where are trending areas located?	Are brownfield sites located in "location-efficient" trending areas? How much growth was allocated to brownfield sites?	How much growth was allocated to brownfield sites? Were the brownfield sites more "location-efficient" than trending areas?

The environmental impacts of the primary allocation phase provide insight into the location efficiency of a metro area's brownfield sites relative to its trending areas. Consider the two illustration examples noted above, as applied to thousands of new jobs and housing units. If brownfields are situated in location-efficient areas, many incoming businesses and residents will settle in areas within or nearby downtown, resulting in relatively light impacts on impervious surface and VMT generation. However, it is possible that the brownfield sites are in inefficient locations for some metro areas. Moreover, some metro areas may be experiencing growth trends that emphasize urban infill development and promote efficient development patterns. In these instances, the brownfield location may not produce less environmental impacts than traditional growth in trending areas. Thus, the primary environmental results reported in the following sections describe the relative efficiency of brownfield sites compared with the growth trend.

For the secondary phase of allocation, the principal difference between the BFR and TG scenarios is the available development capacity at trending locations (see Table 6). In the BFR scenario, only brownfield capacity is utilized, so the block group in which a brownfield is located retains its development capacity as allocated activities are accommodated by brownfield sites during the primary phase. If this neighborhood is a TG location as well, some of its capacity will likely have been utilized during the primary allocation phase for the TG scenario, leaving only a fraction of that capacity available for the secondary allocation.

Again, the illustration of a new company entering the marketplace and considering locating in a redeveloping industrial district is a useful aid. In the BFR scenario, the company might fill space in a brownfields redevelopment, preserving non-brownfield portions of the old industrial district for additional development by future incoming jobs or residents. In the TG scenario, however, the brownfields redevelopment is not an option, so the company consumes non-brownfield development capacity in the old industrial district. Whereas in the BFR scenario, the old industrial district could host new jobs in the brownfield location, as well as in non-brownfield portions of the area; in the TG scenario, it can only host jobs in the non-brownfield portions. Additional new jobs or residents will have to search for space in other parts of the metro area that may be less efficient. Therefore, the BFR scenario may offer environmental benefits over the TG scenario if brownfield sites are in location-efficient areas *and* those areas have experienced substantial growth in recent years (i.e., they are attractive locations for trend growth). Moreover, the amount of growth allocated to brownfield sites in the primary allocation phase impacts the amount of non-brownfield capacity preserved in the secondary phase, making the potential for secondary benefits reflective of the total brownfield capacity at sites in trending, location-efficient areas.

The cumulative summarization of the primary and secondary allocation phases and accompanying environmental impacts represent the overall patterns of development under the BFR and TG scenarios. If the cumulative BFR scenario has less impact than the cumulative TG scenario, it indicates that the redevelopment of brownfields is expected to divert enough growth to location-efficient areas to alter metro area development patterns and reduce the environmental impacts of new growth. If brownfield sites are in areas that are not location-efficient relative to the trend growth, the cumulative results will show little difference between the BFR and TG scenarios, indicating that brownfields redevelopment would produce minimal impacts on the environmental outcomes of new growth in the metro area. In addition, there may be cases where the brownfield sites are more location-efficient than the trend growth, but the development capacity of brownfields is insufficient to meaningfully alter growth trends, allowing the impacts from growth in the secondary allocation to dominate the benefits of brownfields redevelopment, as modeled in the primary allocation.

Each metro area is different. The results for the environmental impacts of new growth for all phases are described in detail in the sections that follow, grouped by growth profile, to provide a broad understanding of trends affecting the potential benefits of brownfields redevelopment across the country.

Figure 13 shows the primary allocation results of both the BFR and TG scenarios in the Los Angeles metro area.

3.3 Environmental Impact Model Results

The location efficiency of a site influences the environmental impacts of new growth, as modeled by the increase in impervious surface and VMT. Increases in impervious surface from new development typically brings about increased stormwater runoff volumes and greater levels of non-point source pollutants in runoff. Transportation impacts of new development are measured in terms of additional VMT generated. VMT impacts are sensitive to the location efficiency of new housing growth, as well as that of new employment growth. As such, two separate VMT estimates are provided – one focused on residential VMT and the other focused on employment VMT. The two estimates cannot be combined into a single estimate of total VMT as each includes unknown portions of trips between home and work, and a sum of the numbers would double-count VMT resulting from commuting trips. However, both VMT estimates provide insight into how development patterns mitigate vehicular travel demand and associated emissions.

The models used to estimate the environmental impacts of new growth yield estimates of total changes in impervious surface and VMT. Since the metro areas evaluated each have different past and future growth trends and brownfield locations, these figures make comparisons among metro areas difficult. For the purposes of reporting and meaningful comparison across growth profiles, the model results are translated to the same unit of measure – change per redeveloped brownfield acre. This normalized measure is calculated by dividing the absolute changes yielded from the environmental models by the acreage of brownfields to which activities were allocated in the allocation model. In addition, VMT generation on a per capita or per worker basis is reported.

Environmental results are presented for the primary, secondary, and cumulative allocations. The emphasis of this report is on the primary phase because it provides a direct comparison of brownfields redevelopment and trend growth. Superior location efficiency, as reflected in the primary phase results, would suggest that the redevelopment of brownfields offers environmental benefits beyond site remediation by promoting development patterns that limit the strains on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads. The secondary phase results reveal the potential for brownfields redevelopment to allow better utilization of non-brownfield capacity in location-efficient areas to further mitigate the environmental impacts of new development. The cumulative results describe the extent to which brownfields redevelopment can be expected to shift broader metro area growth patterns to mitigate the environmental impacts of new development.

The results presented below focus on the *differences* between the BFR and TG scenarios. The numbers and percentages reported in the tables reflect the BFR scenario results minus the TG scenario results. Negative numbers and percentages indicate that the BFR scenario confers an environmental benefit by mitigating the impacts of new development on impervious surface expansion or VMT generation.

Detailed results from the environmental modeling for each of the 50 selected metro areas are in Appendix E.

3.3.1 Impervious Surface Growth

Growth and development modify existing land covers, replacing previously pervious surfaces, such as fields and forests, with pavement and rooftops. Development patterns that limit the expansion of impervious surfaces benefit the environment by mitigating the runoff of pollutants to waterbodies and benefit the jurisdictions and developers responsible for providing stormwater management infrastructure. Table 9 displays the potential benefits of brownfields redevelopment in limiting impervious surface expansion.

Table 9. Change in Impervious Surface Acres, Primary Phase

GROWTH PROFILE	Change in Impervious Surface Acres per Redeveloped Brownfield Acre (acres)	Percent Change in Impervious Surface Acres (%)
Growth Hub	-3.42 to -11.8	-85.8 to -89.7
Industrial Legacy	-0.57 to -2.08	-56.3 to -66.1
Stable Metropolis	-0.91 to -3.44	-65.1 to -77.2
Slow and Steady	-1.09 to -4.36	-65.4 to -74.4
Big and Growing	-0.84 to -3.26	-63.0 to -71.9
Up and Coming	-0.76 to -2.71	-64.9 to -72.2
***All*[30]**	***-1.28 to -4.60***	***-72.3 to -79.7***

The total impervious surface acreage added by brownfields redevelopment was significantly lower than that added by TG development for all metro areas analyzed. For every brownfield acre redeveloped, approximately 1.28 to 4.60 acres of impervious surface would be expected to be saved if the same development had occurred at TG sites (see "All" row in Table 9). This range represents the average reduction in impervious surface by brownfields redevelopment based on the location efficiency of these sites. Thus, if a given metro had 1,000 acres of developable brownfield sites, it would be reasonable to assume that their redevelopment would save approximately 1,280 to 4,600 acres of impervious surface. On a percentage basis, brownfields redevelopment results in impervious surface reductions of approximately 73 percent to 80 percent compared to trend growth.

However, the ranges vary depending on the metro area. Brownfield sites are much more location-efficient than TG sites in *Growth Hub* metro areas, which show the most dramatic difference between the BFR and TG scenarios. This indicates that brownfield sites are typically in centralized areas in *Growth Hubs* and that recent growth trends in these metro areas have emphasized fringe expansion. In contrast, *Industrial Legacy* metro areas represent the smallest reductions in impervious surface acres of all the growth profiles. These results suggest that brownfield sites in *Industrial Legacy* metro areas are in decentralized areas, the growth trend in these areas is relatively compact, or a mix of both.

As described in detail above, secondary benefits are created when primary activities are allocated to brownfields in location-efficient areas, preserving non-brownfield capacity in the area surrounding the brownfield. Table 10 shows the general potential to minimize impervious surface expansion in these areas, although the sensitivity to the amount of growth allocated to the brownfield sites is easily discernible.

[30] Here and throughout this section, the "All" row is not the average of the rows above. It is calculated by combining the model results for all 50 metro areas analyzed and generating a range of nationwide average values.

Table 10. Change in Impervious Surface Acres, Secondary Phase

GROWTH PROFILE	Change in Impervious Surface per Redeveloped Brownfield Acre
Growth Hub	-0.17 to -1.26
Industrial Legacy	0.05 to -0.13
Stable Metropolis	-0.36 to -0.91
Slow and Steady	-0.35 to -1.72
Big and Growing	0.91 to -0.40
Up and Coming	0.04 to -0.18
All	***-0.04 to -0.71***

When brownfields are redeveloped "aggressively," all metro areas are expected to see additional impervious surface benefits in the BFR scenario versus the TG scenario. The results indicate that an aggressive redevelopment approach is required to optimize the potential secondary benefits of brownfields redevelopment. The results for all metro areas combined suggest that each acre of brownfields redevelopment, when developed aggressively, will prevent up to nearly three-quarters of an acre of impervious surface from being added. However, when brownfields are developed "conservatively" under the base configuration, the secondary impervious surface benefits are minimal relative to trend growth.

The cumulative benefit measure (see Table 11) combines the primary and secondary impacts to consider the full metro area implications of brownfields redevelopment on impervious surface acres. Since unequal proportions of cumulative growth occur during the primary and secondary phases, the cumulative results are not simply the sums of the primary and secondary results.

Table 11. Change in Impervious Surface Acres, Cumulative

GROWTH PROFILE	Change in Impervious Surface per Redeveloped Brownfield Acre
Growth Hub	-1.56 to -6.35
Industrial Legacy	-0.33 to -1.80
Stable Metropolis	-0.82 to -2.95
Slow and Steady	-0.92 to -4.27
Big and Growing	0.52 to -2.07
Up and Coming	-0.37 to -1.75
All	***-0.65 to -3.16***

This is clearly visible in the *Growth Hub* metro areas, which have dramatic differences between the BFR and TG scenarios in the primary results (Table 9). The primary allocation represents a fairly small proportion of cumulative growth (see Section 3.1, Allocation Model Results), and so the cumulative results shown in Table 11 are tempered heavily by the secondary phase results (Table 10). *Industrial Legacy*, *Big and Growing*, and *Up and Coming* metro areas can only gain significant cumulative environmental benefits if brownfields are redeveloped aggressively. With base assumptions applied, the cumulative impact of brownfields redevelopment on impervious growth in these metro areas is negligible when cumulative regional growth is considered.

3.3.2 Transportation and Vehicle-Miles Traveled

Travel behaviors often depend on local and metro area contexts. Development in central areas (e.g., central business districts, transportation hubs) typically result in shorter trips and reduced automobile usage compared with developments in fringe areas or areas outside the urban center. Travel to and from home differs from travel to and from work. Since the locations of both homes and jobs influence overall travel behaviors, residential-end and workplace-end transportation analyses are presented below.

For ease of comparison with other model results, the changes in both residential and workplace VMT reported below are presented in normalized ranges, from base to aggressive, on a per redeveloped brownfield acre and a per capita basis. The per capita rates provide the most meaningful comparison across different growth profiles. They express how the BFR scenario affects daily VMT generated on a per person or per job basis, normalizing the impact so that the results are not influenced by the varying volume of growth in brownfield sites across growth profiles. The per redeveloped brownfield acre numbers are based on the expected differences in total daily VMT generated, divided by the total brownfield acreage in each metro area. The total VMT estimate used in this calculation is related to the per capita/ per job rate estimate, but also depends on the volume and density of residential/employment growth at brownfield sites. For example, if a 1-acre site has a low estimated per capita VMT generation rate, but only 10 new households are allocated there, the per redeveloped brownfield acre VMT benefit will be modest compared with a scenario in which the same site receives 100 new households. Thus, the two measures provide different insights into how brownfields redevelopment can alter travel behavior.

For both residential and workplace VMT measures, the per redeveloped brownfield acre results are reported only for the primary phase of analysis to focus on the location efficiency and quantity of growth at brownfield sites. For the secondary and cumulative phases, the spatial scope of the growth and accompanying VMT modeled shift to numerous trend growth block groups in the metro area. Normalization of the VMT estimate for these region-wide growth patterns on a per brownfield acre basis provides little insight, and the VMT per capita numbers are more helpful for understanding the secondary and cumulative impacts of brownfields redevelopment on VMT generation.

Residential VMT

One way that brownfields redevelopment can influence the VMT associated with new growth is to divert new housing units to location-efficient areas. Brownfield locations tend to be in densely developed, centralized areas where development typically results in fewer VMT per capita each day than development that occurs in fringe development areas. This results in lower levels of total VMT (and less transportation-related air emissions) generated from new housing development when compared with trend growth locations.

As shown in Table 12, residential VMT is expected to be substantially lower in the BFR scenario versus the TG scenario in all growth profiles. The per brownfield acre results suggest that a single acre of brownfields redevelopment can reduce residential VMT generation by hundreds of miles per day. This is accomplished by bringing more residents to areas that produce fewer VMT per capita per day. Indeed, the BFR scenario reduces VMT per capita generated each day by 7.3 to 9.7 miles, on average, across all analyzed metro areas. On a percentage basis, brownfields redevelopment results in residential VMT reductions of approximately 25 percent to 33 percent compared to trend growth across all analyzed metro areas.

Growth Hub metro areas could see a reduction of 13.0 to 15.2 VMT per capita from primary activity allocation at brownfield sites, the largest relative reduction of residential VMT among all growth profiles. *Up and Coming* metro areas could also see a large reduction in estimated VMT per capita (-10.9 to -13.2) from new residents in the BFR versus TG scenarios. Both of these growth profiles are characterized by high growth rates. In many fast-growing metro areas, a substantial portion of new development occurs along the suburban periphery due to the volume of growth and cost of land. In these decentralized low-density environments, VMT generation is generally expected to be high. Thus, when housing units are diverted to location-efficient brownfield sites, residential VMT could be reduced substantially.

Table 12. Change in Residential-Based VMT, Primary Phase

GROWTH PROFILE	Change in Residential VMT per Redeveloped Brownfield Acre	Change in Residential VMT per Capita	Percent Change in Residential VMT (%)
Growth Hub	-270 to -1,047	-13.0 to -15.2	-43.9 to -51.0
Industrial Legacy	-66.3 to -337	-3.9 to -6.8	-13.4 to -23.2
Stable Metropolis	-67.4 to -347	-4.4 to -6.8	-19.6 to -30.1
Slow and Steady	-87.6 to -429	-3.9 to -5.7	-16.6 to -24.3
Big and Growing	-130 to -565	-7.3 to -9.3	-17.7 to -22.5
Up and Coming	-142 to -525	-10.9 to -13.2	-32.1 to -38.6
All	***-127 to -536***	***-7.3 to -9.7***	***-25.2 to -33.1***

The secondary results for residential VMT presented in Table 13 suggest that only two growth profiles will typically see reductions in per capita VMT for growth outside of brownfield sites: *Stable Metropolis* and *Big and Growing*. In all other growth profiles, residential VMT is estimated to be marginally higher in the BFR scenario versus the TG scenario for the secondary analysis phase.

Table 13. Change in Residential-Based VMT, Secondary Phase

GROWTH PROFILE	Change in Residential VMT per Capita
Growth Hub	0.04 to 0.08
Industrial Legacy	0.39 to 0.16
Stable Metropolis	-0.39 to -0.05
Slow and Steady	0.08 to 0.24
Big and Growing	-0.04 to -0.04
Up and Coming	0.22 to 0.10
All	***0.01 to 0.05***

One potential explanation for the higher VMT in the BFR scenario is that although the trending areas are generally less location-efficient than brownfield areas (as seen in the primary results and in the results for other measures), they may evolve into more efficient places over time. Consider the following example: From a current suburban housing development, a family may drive many miles each day for commuting, dropping children off at school, and for shopping and personal business trips. Over time, additional housing developments may come to the area, prompting retailers to build new stores closer to the family. Moreover, a new school may be built to serve the children of the burgeoning community. As the area matures, these land use changes will reduce VMT for the family as many of their daily activities are nearer.

The residential VMT model is especially sensitive to these kinds of changes, particularly in metro areas that currently have relatively low area-wide average housing density. This is because the model relies on the elasticities of VMT with respect to density and access to destinations. Increases in density across numerous suburban areas could potentially push local densities above the prevailing average for the metro area, while the introduction of new jobs in these areas also would provide a slight boost to accessibility. This explanation of the findings is supported by the fact that *Stable Metropolis* and *Big and Growing* growth profiles are characterized by relatively high area-wide densities, and these areas are the only ones for which a secondary benefit is expected from the model.

The cumulative results in Table 14 suggest that the lower VMT levels from the primary allocation outweigh the modest increases modeled from the secondary allocation. Overall, brownfields redevelopment can be expected to reshape metro area growth and focus it in location-efficient areas that reduce the VMT added from new households. The *Industrial Legacy* growth profile has the greatest cumulative reduction in VMT per capita among all growth profiles, largely driven by the relatively high portion of total housing that can be allocated to brownfields.

Table 14. Change in Residential-Based VMT, Cumulative

GROWTH PROFILE	Change in Residential VMT per Capita
Growth Hub	-0.4 to -1.7
Industrial Legacy	-0.7 to -4.4
Stable Metropolis	-0.7 to -1.8
Slow and Steady	-0.5 to -2.1
Big and Growing	-0.3 to -1.1
Up and Coming	-0.5 to -2.3
All	***-0.5 to -1.8***

Employment VMT

Travel patterns also are affected by job location. Commuting to and from work is a substantial portion of daily VMT for many people. Thus, job growth in efficient locations often results in shorter commutes and the use of multiple modes of travel, such as available public transportation. In addition, work-related travel for meetings or work-based personal business trips (lunch, dry cleaning, or other errands) tends to generate fewer VMT in location-efficient areas. If this study only included the residential VMT estimate, the extent to which brownfields redevelopment could divert job growth to efficient locations would not be understood. For this reason, a separate estimate of employment-related VMT is included.

Table 15 displays the differences in employment-based VMT between the BFR and TG scenarios for the primary phase of analysis. As with residential VMT, the employment-based VMT is reported in terms of per brownfield acre redeveloped and on a per job basis for the primary phase; the per job figures only are used for the secondary and cumulative phases. As shown, brownfield sites are consistently found in more location-efficient areas for jobs development than trending areas, regardless of the growth profile. For all analyzed metro areas, new jobs at brownfield sites are expected to generate 2.1 to 2.5 fewer VMT per worker per day than new jobs in trending areas. This difference results in substantially fewer total workplace VMT generated, such that each acre of brownfield redeveloped can be expected to reduce workplace-based VMT by 29.2 to 116 miles per day, on average. On a percentage basis, brownfields redevelopment results in employment VMT reductions of approximately 8.8 percent to 10 percent, compared with trend growth across all analyzed metro areas.

Table 15. Change in Employment-Based VMT, Primary Phase

GROWTH PROFILE	Change in Employment VMT per Redeveloped Brownfield Acre	Change in Employment VMT per Job	Percent Change in Employment VMT (%)
Growth Hub	-97.9 to -382	-3.3 to -3.8	-13.2 to -15.0
Industrial Legacy	-8.9 to -33.5	-1.9 to -2.1	-8.0 to -8.7
Stable Metropolis	-18.3 to -73.7	-1.1 to -1.4	-5.0 to -6.2
Slow and Steady	-16.9 to -90.9	-1.0 to -1.5	-4.6 to -7.1
Big and Growing	-15.2 to -51.2	-1.5 to -1.5	-5.4 to -5.4
Up and Coming	-13.6 to -50.2	-2.2 to -2.4	-8.5 to -9.4
All	***-29.2 to -116***	***-2.1 to -2.5***	***-8.8 to -10.3***

Once again, the location efficiency of brownfield sites is most evident in *Growth Hub* metro areas – the per worker VMT generation rates are 3.3 to 3.8 miles lower in the BFR scenario than in the TG scenario, and the volume of jobs allocated per brownfield acre means that this advantage can substantially reduce daily total workplace VMT generated. *Industrial Legacy* areas again provide an intriguing contrast. While the per worker VMT reduction is not as great as in *Growth Hubs*, it is still substantial at 1.9 to 2.1 VMT per job. However, the volume of jobs allocated per brownfield acre is relatively low (recall from Section 3.1, Allocation Model Results, that brownfields in *Industrial Legacy* areas were often in areas with heavily residential growth trends), meaning that the total reduction in workplace VMT per brownfield acre redeveloped is modest compared with other growth profiles.

Slow and Steady metro areas have the smallest difference between the BFR and TG scenarios in terms of per worker VMT generation, suggesting that brownfield locations are only modestly more location-efficient than trending job growth areas. However, these metro areas also allocated some of the highest numbers of jobs to brownfield sites. As a result, they have the second highest total estimated VMT reduction per redeveloped brownfield acre among all growth profiles.

In general, all modeled metro areas present a potential reduction in employment VMT per job from secondary activity allocation (Table 16). Of all the growth profiles, *Slow and Steady* metro areas could experience the greatest secondary reduction in employment VMT. The non-brownfield capacity preserved at these locations is utilized in the secondary allocation phase, compounding the brownfields redevelopment benefits by allowing more jobs to be added in efficient areas.

Table 16. Change in Employment-Based VMT, Secondary Phase

GROWTH PROFILE	Change in Employment VMT per Job
Growth Hub	-0.12 to -0.29
Industrial Legacy	-0.06 to -0.11
Stable Metropolis	-0.18 to -0.26
Slow and Steady	-0.16 to -0.37
Big and Growing	-0.06 to -0.06
Up and Coming	-0.06 to -0.10
All	***-0.11 to -0.20***

In the primary results, *Big and Growing* metro areas showed moderate changes in VMT per job, and only modest reductions in total VMT (see Table 15 above). This suggests that *Big and Growing* metro areas were unable to accommodate a sufficient number of new jobs at brownfield sites to capitalize on the available VMT per job reductions. The allocation results showed that *Big and Growing* metro areas had a jobs-heavy allocation at brownfields. Taking all of this into consideration, it appears that the brownfields in *Big and Growing* metro areas may not be concentrated in the densest areas of those metro areas. Otherwise, the change per redeveloped brownfield acre would likely be higher. In addition, the secondary results for employment VMT suggest that, while the redevelopment of these brownfields preserves capacity in location-efficient areas of the metro area, the additional growth that can be allocated in those areas is modest. Since *Big and Growing* metro areas have very high expected growth rates, it is perhaps not surprising that only a very small proportion of total job growth (1.1 percent to 3.6 percent) was allocated to brownfields (see Section 3.1, Allocation Model Results). This also helps explain the relatively small secondary benefits for these metro areas, as well as the narrow range in the base and aggressive configurations.

The cumulative results for employment VMT in Table 17 indicate that brownfields redevelopment can substantially redistribute metro area growth to reduce the VMT added by incoming jobs. The impact varies by growth profile. In *Growth Hubs*, 100,000 incoming jobs could result in 28,000 to 88,000 fewer daily VMT if allocated to brownfield sites rather than to trending areas. For *Big and*

Growing metro areas, the same number of jobs would have a more modest impact, but still mitigate workplace daily VMT generation by 7,000 to 11,000. By aggressively developing brownfield sites and identifying additional, similar development opportunities (e.g., brownfields not identified in ACRES, greyfield redevelopment opportunities), these transportation benefits could be augmented, helping to preserve transportation infrastructure capacity and maintain air quality.

Table 17. Change in Employment-Based VMT, Cumulative

GROWTH PROFILE	Change in Employment VMT per Job
Growth Hub	-0.28 to -0.88
Industrial Legacy	-0.12 to -0.31
Stable Metropolis	-0.22 to -0.39
Slow and Steady	-0.19 to -0.53
Big and Growing	-0.07 to -0.11
Up and Coming	-0.12 to -0.30
All	***-0.18 to -0.45***

3.4 Model Uncertainties

In reviewing and interpreting the allocation and environmental impact results presented above, it is important to keep in mind the uncertainties inherent in the models used to develop the growth scenarios and metrics. A brief synopsis of sources of uncertainty is provided below.

- **ACRES data** – The ACRES brownfield site locations and attributes that drive the allocation model are sometimes imprecise, missing, or otherwise questionable. The protocols described in Appendix A and the screening steps discussed in Section 2.3.3. address many of the ACRES data quality concerns, however a comprehensive detailed review of ACRES site data was not feasible as a component of the current study.

  Moreover, ACRES does not record every brownfield site in the country; only sites that have received and used funds from the Brownfields Program are included in ACRES. Thus, the estimated environmental benefits of brownfields redevelopment presented in this study are based on an incomplete nationwide brownfields inventory. It is likely that most metro areas contain many more brownfields than are currently being evaluated. Therefore, it is reasonable to expect that a more complete inventory of brownfield sites would further enhance the benefits of brownfields redevelopment.

- **Brownfields redevelopment status** – As noted in Section 2.1.1, it is difficult to determine the actual redevelopment status of each brownfield site. Redevelopment accomplishments are recorded for some sites in ACRES, but comprehensive redevelopment details are unavailable. This study developed a simple model of redevelopment status to remove some sites that may have already been redeveloped from the universe of sites used in the BFR scenario. The number, location, and attributes of sites where redevelopment activity could occur is a key factor influencing the environmental impacts of the BFR scenario and how they compare with those of the TG scenario.

- **Number of brownfield sites likely to be redeveloped by 2030** – This study does not attempt to assess the viability of redeveloping any particular brownfield site based on market, policy, environmental, physical, or any other set of characteristics. Rather it assumes redevelopment will occur at *all* brownfield sites in the BFR scenario to quantify the typical differences in environmental impacts associated with growth at brownfields sites relative to growing areas in land outside of the urban core or on previously undeveloped and greenfield properties. It is, however, unlikely that all sites in the ACRES database would be fully redeveloped by 2030, meaning the cumulative results presented above could be diluted by slower or partial redevelopment progress.
- **Brownfield development capacity** – There is no reliable, uniform method for determining how many new jobs and/or housing units a brownfield site could accommodate in a redevelopment scenario. Each brownfield site is situated within distinctive market, policy, and environmental contexts that are difficult to describe with detail or precision for a national dataset. The approach used in this study is to assume redevelopment at brownfields will be as dense as the densest development among surrounding block groups. It is, of course, possible that many redevelopment projects would fall short of this density estimate, while others might exceed it. Moreover, the density multiplier used to factor up potential brownfield redevelopment densities in the aggressive configuration (double the prevailing density) is a coarse attempt to account for densification opportunities at brownfields. While the literature suggests that brownfields are frequently redeveloped to densities much higher than greenfield densities (sometimes as much as 10 times greenfield densities), it is less revealing when comparing brownfields densities to other potential infill locations.

4. KEY FINDINGS

The environmental benefits model results from this study are summarized by growth profiles. The results require careful consideration of metro area characteristics, brownfield location and development capacity, the different allocation phases, and in some cases, the intricacies of the environmental models themselves to understand the story of how brownfields redevelopment can promote more efficient development patterns for different metro area growth profiles.

This section summarizes the following key findings from the analysis of the model results:

- Brownfields redevelopment is more location-efficient than trend growth across the two key environmental metrics considered in this study.
- Growth profiles demonstrate the importance of metro area growth contexts.
- Brownfields development will sometimes produce additional benefits for growth not allocated to brownfield sites.
- Brownfields redevelopment can often shift metro area development patterns to mitigate environmental impacts.

4.1 Brownfields redevelopment is more location-efficient than trend growth.

Across key environmental metrics, brownfields redevelopment is more location-efficient than the trend growth. The location efficiency of brownfield sites is demonstrated by the primary results from all of the models (Table 18). The primary phase provides a direct comparison of environmental impacts between localized growth at brownfield sites and the same increment of growth in trending (i.e., non-brownfield) areas. In rare cases, aggressive development of brownfield sites is necessary to attain the location efficiency benefits, while in all cases, the aggressive development maximizes the benefits.

Table 18. Summary of Primary Environmental Benefits of Brownfields Redevelopment versus Trend Growth Development

Environmental Metric	Range of Benefits
Change in Impervious Surface Acres (per redeveloped brownfield acre)	-1.28 to -4.60 acres
Change in Residential VMT (per redeveloped brownfield acre)	-127 to -536 miles
Change in Residential VMT (per capita)	-7.3 to -9.7 miles
Change in Employment VMT (per redeveloped brownfield acre)	-29.2 to -116 miles
Change in Employment VMT (per job)	-2.1 to -2.5 miles

Table 18 summarizes these findings:

- **Impervious surface** – The aggregate results for analyzed metro areas demonstrate that on a per acre basis, brownfields redevelopment leads to less impervious surface area being consumed or developed than trend growth development. Across all growth profiles, the benefit can be from 1.28 to 4.60 fewer acres of impervious surface per acre of redeveloped brownfield.

- **Residential VMT** – Similar reductions hold true for residential VMT on both a per brownfield acre and per capita basis in that the brownfield scenario outperforms trend growth across different profiles. Based on this study, redevelopment of brownfield locations generates 7.3 to 9.7 fewer VMT per person per day than trend development. For the metro areas analyzed and under current assumptions about brownfield development capacity, this amounts to approximately 127 to 536 fewer daily VMT from new growth for each brownfield acre redeveloped.
- **Employment VMT** – As with residential VMT, brownfields redevelopment alters travel to and from the workplace, mitigating growth in VMT due to the fact that jobs are more efficiently located and the potential increased use of public transportation. The ranges of benefits for workplace VMT are narrower on a per acre and per job basis than the residential trends, although they are more consistent across all growth profiles. Redevelopment of brownfield locations generate 2.1 to 2.5 fewer VMT per job per day than trend development, and approximately 25.2 to 116 fewer daily employment VMT for each brownfield acre redeveloped.

These findings do not imply an overall decrease in impervious surface area or VMT as a result of brownfields redevelopment directly, but rather a reduction in the growth of these measures by bringing new jobs and housing units to more efficient locations. The primary analysis results suggest that this trend of brownfield locations performing better than trend growth locations will likely be true on a project-by-project basis (for specific redevelopment opportunities at brownfields). Moreover, the benefits of brownfields redevelopment appear to be meaningful in all growth profiles considered. The primary results indicate a positive answer to the question posed at the outset of the study: The reallocation of new jobs and housing to brownfield sites within a metro area will produce environmental benefits in terms of reductions in impervious surfaces and VMT when compared with trend growth. Based on the temporal analysis performed as part of this study, these primary phase environmental benefits are expected to occur typically in the near term (e.g., within the first decade of brownfields redevelopment).

In addition, this study uses only those brownfield sites inventoried in EPA's ACRES database. It is likely that most metro areas contain many more brownfields than are currently being evaluated. Therefore, it is reasonable to expect that a more complete inventory of brownfield sites would further enhance the benefits of brownfields redevelopment.

4.2 Growth profiles demonstrate the importance of metropolitan area growth contexts.

Although it is true that brownfields redevelopment is more location-efficient than trend growth across all metro area growth profiles, the profiles demonstrate how the total magnitude of environmental benefits can differ dramatically:

- **Allocation results** – The profiles demonstrate the variability in how much future growth can be reallocated to brownfield sites. In the case of housing activities, this can span from a low of 1.4 percent in *Big and Growing* metro areas diverted to brownfield locations to a high of 39.2 percent in *Industrial Legacy* metro areas. With jobs, the percentages are not as wide ranging, but still vary from a low of 1.1 percent in *Big and Growing* metro areas to 17 percent in *Growth Hubs*. The share of growth that can be accommodated at brownfields depends on the growth rates of each metro area and the number and locations of brownfield sites in the ACRES database.

- **Impervious surface** – For all metro areas, brownfields redevelopment can limit the expansion of impervious surface. The magnitude of the benefit depends on the location efficiency of brownfield sites relative to prevailing growth trends. Benefit ranges varied from a maximum impervious surface reduction of 11.8 acres per brownfield acre redeveloped in the *Growth Hubs* to a minimum of 0.57 acres per brownfield acre redeveloped in *Industrial Legacy* metro areas.
- **Residential VMT** – Similar reductions hold true for residential VMT on both a per redeveloped brownfield acre and per capita basis. Residential VMT reductions are most sensitive to the density and centrality of development in growing areas, so the profiles with brownfield sites in the densest and most accessible parts of the metro area can significantly alter travel behaviors, especially if recent housing growth has been dispersed in low-density areas outside of the urban core. On a per acre basis, residential VMT under brownfields redevelopment can be 66 to 1,047 daily VMT less than trend development. In per capita terms, brownfields redevelopment could reduce daily VMT generated by each incoming resident by 15.2 miles in *Growth Hubs* or just 3.9 miles in *Industrial Legacy* and *Slow and Steady* metro areas.
- **Employment VMT** – Employment VMT reductions are less dramatic than potential residential VMT reductions but are broadly consistent across different growth profiles on a per job basis. At the high end of the spectrum, each incoming job in *Growth Hub* metro areas is expected to generate 3.8 fewer VMT at a brownfield site versus a trend growth location. At the low end, that figure is 1.0 fewer VMT in *Slow and Steady* metro areas. Brownfield sites in *Growth Hubs* are dense areas and can accommodate many new jobs, such that each redeveloped brownfield acre in these metro areas could reduce total employment VMT by 382 miles each day. *Industrial Legacy* metro areas put fewer jobs in high-density brownfield sites, resulting in a base VMT reduction estimate of just 8.9 daily VMT per redeveloped brownfield acre.

Benefits associated with redeveloping brownfields depend on the location efficiency of those brownfield sites and the percentage of metro area growth that can be accommodated by such sites. For example, if the metro area's brownfields are less centrally located, then the environmental benefits are not as great as the benefits associated with brownfields sites in more central locations. Also, if there is a limited number of brownfields or modest brownfield acreage available for redevelopment, their impact on development patterns – and, in turn, the environment – is less significant.

The growth profiles demonstrate that the strategies used to maximize the benefits of brownfields redevelopment vary greatly, depending on the metro area context. Therefore, it is essential to understand the magnitude of the location efficiency of brownfield sites relative to trending areas. As the ranges in environmental benefits for each growth profile illustrate, the benefits are maximized when these brownfield properties are aggressively redeveloped and growth outside urban centers is minimized.

4.3 Brownfields development will sometimes have additional benefits for growth not allocated to brownfields.

This study finds a difference in the environmental impacts between the BFR and TG scenarios during the secondary phase of growth. Prior studies focused exclusively on the increment of growth in brownfields versus the same increment of growth following recent trends (e.g., the primary phase of analysis in this study).[31, 32] While those dynamics remain the focus of this effort, it is important to recognize that brownfields redevelopment may result in additional environmental benefits by re-shaping longer term growth patterns. The secondary phase of allocation models development patterns when capacity for new growth at brownfield sites is exhausted, and all remaining growth is allocated throughout the metro area to trending (i.e., non-brownfield) areas. The secondary phase results demonstrate that redeveloping brownfields can maximize infill development capacity, making subsequent non-brownfield growth patterns more efficient for the metro area as well. Thus, secondary benefits may arise from preserving development capacity in growing location-efficient neighborhoods.

Although these secondary benefits are usually modest, it is still important to acknowledge that a metro area brownfields redevelopment strategy can impact more than just the residents and employees of that development. A brownfields redevelopment strategy can also influence the behavior of neighbors and nearby employers. Not only do the residents and employees of the new development impose lower environmental impacts, those who live or work nearby also may benefit through closer services, employment, and access to other community goods.

4.4 Brownfields development often can shift metropolitan area development patterns to mitigate environmental impacts.

The effectiveness of brownfields redevelopment across a broader geographic scale depends on the amount of growth that can be reallocated to more efficient locations relative to the trend. The cumulative findings in this study, which focus on total areawide growth patterns and not just the brownfields portion, depend on the entire set of factors influencing the allocations for the BFR and TG scenarios. The cumulative assessment quantifies the extent to which brownfields redevelopment could reshape broader metropolitan growth patterns and accompanying areawide environmental impacts. Having robust development capacity at brownfield sites in high growth areas that have development momentum will make the greatest use of development potential at location-efficient sites and maximize the environmental benefits of redevelopment.

In some metro area growth profiles, the cumulative benefits are dampened by the small share of growth that can be accommodated at brownfields. In other cases, brownfield location efficiency is not dramatically greater than trending areas. In all cases, however, brownfields redevelopment reorganizes significant amounts of new jobs and housing into smarter locations, such that the resulting development pattern substantially mitigates the environmental impacts of new growth. Table 19 provides a snapshot of the cumulative benefits of brownfields redevelopment, summarized for all 50 analyzed CBSAs.

---

[31] U.S. Environmental Protection Agency. “Comparing Methodologies to Assess Transportation and Air Quality Impacts of Brownfields and Infill Development.” EPA 231-R-01-001. August 2001.

[32] U.S. Environmental Protection Agency. “Air and Water Quality Impacts of Brownfields Redevelopment: A Study of Five Communities.” 2011. https://www.epa.gov/sites/production/files/2015-09/documents/bfenvironimpacts042811.pdf

Table 19. Summary of Cumulative Environmental Benefits of Brownfields Redevelopment versus Trend Growth Development

Metric	Range of Benefits
Change in Impervious Surface Acres (per redeveloped brownfield acre)	-0.65 to -3.16 acres
Change in Residential VMT (per capita)	-0.5 to -1.8 miles
Change in Employment VMT (per job)	-0.18 to -0.45 miles

GLOSSARY

ACRES: The U.S. Environmental Protection Agency's (EPA) Assessment, Cleanup and Redevelopment Exchange System (ACRES). ACRES is an online database for EPA's Brownfields Program grantees to electronically submit their site-specific brownfields data directly to EPA. The data in ACRES is a subset of the universe of brownfield sites in the United States. Only sites that have received and used funds from the Brownfields Program are included in ACRES. Property data for the Brownfields Redevelopment (BFR) growth scenario were obtained from ACRES.

Brownfield: A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Brownfields Redevelopment (BFR) scenario: A hypothetical growth scenario which assumes that future development will occur at all available brownfield sites across the 50 metropolitan areas considered in this study. Both "base" and "aggressive" growth configurations are modeled under the BFR scenario. For the **base configuration**, the density of development at a brownfield site is expected to match the most densely developed block group in its vicinity. For the **aggressive configuration**, the density of development at a brownfield site is expected to reflect the potential for development intensification and exceed the density at the most densely developed block group in its vicinity.

Built-out: Having little or no remaining buildable land available for development.

Census block group (CBG): A geographical unit used by the U.S. Census Bureau that is between the Census Tract and the Census Block. It is the smallest geographical unit for which the bureau tabulates and publishes sample data (i.e., data that is only collected from a fraction of all households).

Control totals: The number of new jobs and housing units to allocate for a given metropolitan area over a given time period. In this study, job and housing unit control totals are obtained from Woods & Poole county-level demographic and economic forecasts.

Core-based statistical area: A U.S. geographic area defined by the Office of Management and Budget that consists of one or more counties (or equivalents) anchored by an urban center of at least 10,000 people plus adjacent counties that are socioeconomically tied to the urban center by commuting.

D variables: Various attributes of the built environment, including the following five common measures: **D**ensity of development, **D**iversity of land use, **D**esign of neighborhood streets, **D**istance to transit, and access to **D**estinations.

Development activities: Refers to the specific types of uses for a property or site that is being developed or redeveloped. In this study, development activities include residential housing units and commercial/industrial jobs. Development activity mix refers to a combination of housing units and jobs at a given property or site.

Development attractiveness: A measure of which locations are the most likely to be redeveloped first. The land use allocation model used in this study identifies the probable order of redevelopment at properties over the 2013 to 2030 study period. The most attractive sites will "fill up" with redevelopment (new jobs and/or housing units) first.

Development capacity: A measure of how much redevelopment (i.e., new jobs and/or housing) a given location can accommodate.

Fixed-guideway transit: Any transportation system or facility that uses and occupies a designated right-of-way or rails, including, but not limited to, rapid rail, light rail, commuter rail, busways, automated guideway transit, trolley coaches, ferryboats, and people movers.

Greenfield/Greenfield development: Vacant or undeveloped tracts of land that are available for business or industrial use. They are referred to as "greenfields" because often their former usage (or in some cases, their current usage) is agricultural production, forest land, or some other undeveloped function. Greenfield sites are most often located in the urban fringe of the path of development or in rural areas where undeveloped land is more likely to be present. Greenfield development refers to the real estate development of land not previously used for residential, commercial, or industrial purposes.

Growth profile: Groupings of common metropolitan areas based on size (population) and growth rate statistics (how slowly or quickly the metropolitan area is growing). In this study, six different growth profiles were developed in order to compare the environmental benefits among peer metropolitan areas, including *Big and Growing*, *Stable Metropolis*, *Growth Hubs*, *Slow and Steady*, *Up and Coming*, and *Industrial Legacy*. See Appendix C (Metropolitan Area Growth Profiles) for a detailed discussion on how growth profiles were developed for this study and examples of each profile.

Impervious surface: A land surface that is covered by impenetrable materials that repel rainwater and do not permit it to infiltrate the ground. Common impervious surfaces found in urban and suburban landscapes include pavement, roads, sidewalks, driveways, parking lots, and roofs. Adding these surfaces to a landscape can alter the flow of rainwater and streams.

Infill/Infill development: An urban planning term for the rededication of land in an urban environment, usually open space, to new construction. Infill development refers to the development of vacant or under-utilized parcels within existing urban areas that are already largely developed. Many communities have significant vacant land within city limits that, for various reasons, has been passed over in the normal course of urbanization.

Land use allocation model: A model that distributes (or allocates) future growth in jobs and housing units across a given area. The distribution of this growth is guided by how many new jobs and housing units will be added over a given time period, how much new development a given location can accommodate, which locations are most likely to be (re)developed, and what types of activities (jobs and housing) are likely to be added as a given location is developed.

Location-efficient/Location efficiency: Location efficiency refers to polices and approaches that promote development patterns which limit the strain on existing stormwater and transportation infrastructure, and the associated environmental impacts of increased stormwater and traffic loads. Location-efficient communities are dense and vibrant, with walkable streets, access to transit, proximity to jobs, mixed land uses, and concentrations of retail and services.

Non-point source pollution: Pollution resulting from many diffuse sources, in direct contrast to point source pollution, which results from a single source. Non-point source pollution generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage, or hydrological modification (rainfall and snowmelt) where tracing pollution back to a single source is difficult. Non-point source pollution can include excess fertilizers, herbicides, and insecticides from agricultural lands and residential areas; oil, grease, and toxic chemicals from urban runoff and energy production; and sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks.

Smart locations: A planning term that refers to dwellings and workplaces that are centrally located in walkable neighborhoods with great transit service and a variety of nearby destinations, enabling people to rely less on their personal vehicles for commuting and daytime trips. This can result in lower congestion and pollution impacts, in addition to reduced cost burdens on local infrastructure.

Trend Growth (TG) scenario: A hypothetical growth scenario which assumes that recent metropolitan growth trends persist over time.

Vehicle-miles traveled (VMT): Used in transportation planning, VMT is a measure of the amount of travel for all vehicles in a geographic region over a given time period. VMT is used as a proxy for transportation-related air emissions. In this study, air quality impacts associated with residential and job-related transportation decisions due to new development are estimated by calculating changes in VMT.

Woods & Poole: A comprehensive database that contains more than 900 variables of economic data and demographic data and future estimates for the United States and all states, regions, counties, and core-based statistical areas for every year from 1970 through 2050.

APPENDICES

APPENDIX A: ACRES DATA AND LOCATION VALIDATION PROCESS

ACRES Data Inputs Used in the Study[33]

Variable/Factor	ACRES Abbreviation
Grant ID number	GRANT_ID
Property ID number	PROPERTY_ID
Location information (address, city, state, zip; latitude and longitude) = site	ADDRESS, CITY, STATE_CODE, ZIP_CODE, LATITUDE_MEASURE, LONGITUDE_MEASURE
Property size	PROPERTY_SIZE
Ready for reuse	READY_FOR_REUSE
Redevelopment details	REDEV_START_DATE, REDEV_COMPLETION_DATE
No. of grants received at unique site	(count of each PROPERTY_ID grants)
Planned for greenspace	FUTURE_GREENSPACE_ACRES

ACRES Site Location Validation Process and Decision Protocol

Variable/ Factor	ACRES Abbreviation	Inventory and Results	Decision Protocol
Grant ID number	GRANT_ID	40,748 total grants	None needed; all sites retained for analysis. Multiple grants will be connected to the individual unique property ID through a relational database.
Property ID number	PROPERTY_ID	29,387 unique brownfield properties	None needed; all sites retained for analysis.
Location information (address, city, state, zip; latitude and longitude) = site	ADDRESS, CITY, STATE_CODE, ZIP_CODE, LATITUDE_MEASURE, LONGITUDE_MEASURE	• Geographically consistent sites [27,199 sites (93%)] • Located outside 50 states and Washington, D.C. (i.e., sites in territories) [210 sites, (< 1%)] • Remaining sites with inconsistent geographic data (address and lat/long data do not appear to correspond) [1,978 sites (7%)][34]	• If all geographic variables are internally consistent (when the address and latitude and longitude information correspond), then they will be used. • Excluded those sites outside 50 states and Washington, D.C. (i.e., sites in territories). • Included geographically inconsistent sites for which location data have been validated or where

[33] Other factors in the ACRES dataset were either incomplete or it was preferred to use an alternative dataset to ensure consistency. For example, although other land uses (as planned or identified for after redevelopment) would appear to be useful, it has been excluded because land uses do not necessarily indicate the amount of jobs or housing without other contextual information. See Step 2: Develop Scenario Parameters on how this contextual information is gathered and applied to forecast potential development outcomes.

[34] Invalid or missing latitude or longitude, or significant distance between the latitude and longitude information and the address

Variable/ Factor	ACRES Abbreviation	Inventory and Results	Decision Protocol
		○ Data validated or corrected for 181 sites (< 1%) ○ Assume lat/long correct for sites where internal consistency could not be verified [1,340 sites (4.5%)] ○ Assume address is correct for sites where internal consistency could not be verified [414 sites (1.4%)] ○ Unresolved location issues [43 sites (< 1%)]	lat/long or address information is assumed to be accurate. • Excluded those sites with unresolved geographic inconsistencies.
Property size	PROPERTY_SIZE	• Missing property size [2,356 sites (8%)] • "0 acres" property size [468 sites (1.6%)] • Greater than 100,000 acres [263 sites (1%)]	• If a property size (PROPERTY_SIZE) is available and ranges from 0.1 acres to < 1,000 acres, it will be used. • Those sites with missing property sizes or "0 acres" property sizes will be assumed to be 1.0 acre, which is roughly the median of all accurate sites in the current dataset.[35] • Excluded all sites greater than 1,000 acres.
Ready for reuse	READY_FOR_REUSE	• "Y" [6,216 sites (21%)] • "N" [23,159 sites (79%)] • Blank [12 sites (< 1%)]	• Those with "Y" and not assumed to be already redeveloped (based on redevelopment start or completion dates) will be put through the brownfields redevelopment estimation procedure. • Those with "N" and blank sites and not assumed to be already redeveloped (based on redevelopment start or completion dates) will be assumed to be available for redevelopment.
Redevelop-ment details	REDEV_START_DATE, REDEV_COMPLETION_DATE	• Redevelopment completion date before 2013 [709 sites (2.4%)] • Redevelopment start date before 2012 and completion date missing [1,156 sites (3.9%)]	• If the site has a valid redevelopment completion date (REDEV_COMPLETION_DATE) in ACRES prior to 2013, it will be considered already redeveloped and excluded from the analysis. • If the site has a valid redevelopment start date (REDEV_START_DATE) in ACRES prior to 2012, it will be

[35] The median PROPERTY_SIZE value was used instead of the mean to avoid the problem of outlier values skewing the result (the mean size for all accurate sites in the current dataset is about 45 acres.

Variable/ Factor	ACRES Abbreviation	Inventory and Results	Decision Protocol
			considered already redeveloped and excluded from the analysis.[36] • See “Determining brownfields redevelopment status” section of report to see how sites not fitting the first two bullets will be used in the analysis.
No. of grants received at unique site	(count of each PROPERTY_ID grants)	Multiple grants associated with a specific site [2,715 sites (9%)]	None needed; all sites retained for analysis.
Planned for greenspace	FUTURE_GREENSPACE_ACRES	Include greenspace information [1,910 sites (7%)]	• If ACRES indicates that a property is to be redeveloped partially as greenspace, the site size will be reduced by the greenspace redevelopment area.

[36] An analysis of sites with valid redevelopment start and completion dates suggests that the average redevelopment period is about 1 year, although this may be due to simplified bookkeeping and not a reflection of the actual typical redevelopment timeline.

APPENDIX B: ESTIMATION OF AVERAGE ANNUAL CHANGE IN JOBS

Since Longitudinal Employer–Household Dynamics (LEHD) data are synthesized from unemployment insurance records, there are sometimes notable discrepancies in local jobs estimates from one year to the next. To smooth the data, 3-year averages were taken to represent employment at each block group in a given year. For example, a block group with employment figures of 134, 48, 75, and 60 for the years 2002, 2003, 2004, and 2005, respectively, would have a 2003 employment estimate of 87 (average of 134, 48, and 75) and a 2004 employment estimate of 61 (average of 48, 75, and 60).

These estimates of employment in each year were then compared over time. The average year-over-year change in jobs in each block group was calculated to reflect the overall employment growth trend in the block group. Block groups that have higher average annual growth rates will be considered more attractive for future metro area employment growth. Block groups with negative average annual growth rates will be considered as “declining” areas, and no new metro area jobs will be allocated to these block groups.

A quality assurance check on average growth rates was conducted to ensure that the temporal smoothing was effective. Comparing year-to-year volatility (i.e., the absolute change in reported employment from one year to the next) of temporally smoothed estimates and un-smoothed estimates showed a drastic reduction in volatility. Nearly 30 times fewer block groups were flagged as having high volatility (measured as total volatility / average annual change > 20) after temporal smoothing. In addition, the remaining high-volatility block groups seemed to be randomly distributed geographically, suggesting that no bias exists in the LEHD data that would require additional data modifications.

LEHD data varies by state. Most states’ LEHD jobs estimates are available from 2002, but others joined the program later, meaning that the earliest available LEHD data may be from 2005, for example. Massachusetts was the last state to participate in LEHD, starting in 2011. With so few years of data available there, estimates of employment growth trends may be unreliable. In addition, Washington, D.C., only began participating in 2010 and may pose similar challenges. As such, the Washington, D.C., metro area and any metro area with territory in Massachusetts are not well suited for analysis in this study.

APPENDIX C: METROPOLITAN AREA GROWTH PROFILES AND SELECTION OF 50 CBSAS TO INCLUDE IN THE STUDY

C.1 Growth Profile Development

Growth profiles were developed using 2010 core-based statistical area (CBSA) definitions because the analysis is built with 2010 population data. The final brownfields analysis is reported using 2016 CBSA definitions.

This study developed profiles to present and compare the benefits among peer metro areas. Profiles were developed based on population and growth rate to ensure that metro areas were analyzed against other metro areas of analogous size and growth.

Size

Metro area size was measured using 2010 U.S. Census population data. Each of the 280 CBSAs eligible for analysis were categorized and organized into the following classes:

Size Class	Definition
Tiny	Less than 250,000
Small	250,000 to 1,500,000
Medium	1,500,000 to 3,000,000
Large	3,000,000 to 5,000,000
Huge	More than 5,000,000

Growth Rate

Growth rate was measured by the percent change in population from 2015 to 2030. This was calculated using the number of households added between 2010 and 2030 (according to Woods & Poole) multiplied by the average household size in 2016 (2.3 persons). Growth rates were calculated for each of the 280 CBSAs eligible for analysis. Each of the 280 CBSAs eligible for analysis were categorized and organized into the following classes:

Growth Rate Class	Definition
Slow	Less than 0.15
Moderate	0.15 to 0.30
Rapid	Greater than 0.30

Size and growth rate were combined to define eight distinct growth dynamics. Each CBSA of the 280 eligible for analysis was assigned a growth profile and tabulated below.

Growth Dynamic	Number of CBSAs
Huge CBSAs with moderate to rapid growth	4
Huge CBSAs with slow growth	4
Medium to Large CBSAs with moderate to rapid growth	19
Medium to Large CBSAs with slow growth	16
Small CBSAs with moderate to rapid growth	39
Small CBSAs with slow growth	39
Tiny CBSAs with moderate to rapid growth	27
Tiny CBSAs with slow growth	132
Total	***280***

The following characteristics were identified and combined with the growth dynamics above to develop growth profiles:

Characteristic	Definition
Number of brownfield properties	Derived from the 22,347 properties in ACRES selected for analysis
Population density	Population per square mile
Brownfield density	Brownfields per square mile
Brownfield capacity	Number of housing units
Geographic commonality	U.S. Census region and EPA region

Population Density (persons per square mile)

Class	Definition
Low	Less than 200
Medium	200 to 500
High	More than 500

Brownfield Density (brownfields per square mile)

Class	Definition
High density	25th percentile
Moderate density	Inter-quartile range
Low density	75th percentile

Brownfield Capacity (number of housing units)

Class	Definition
High	Less than 500
Moderate	500 to 3,000
Low	More than 3,000

Based on the CBSA characteristics and growth dynamics described above, the following growth profiles were identified:

Growth Profile Name	Characteristics	No. of CBSAs for Consideration
Big and Growing	• Huge CBSAs with moderate to rapid growth • All in the South • High brownfield and population density • High capacity	4
Stable Metropolis	• Huge CBSAs with slow growth • The usual suspects (Los Angeles, New York, Chicago, Philadelphia) • High brownfield and population density • High capacity	4
Growth Hubs	• Medium and large CBSAs with moderate to rapid growth • Distributed across the country • Moderate to high population density • High capacity • Mostly high brownfield density	19
Slow and Steady	• Medium and large CBSAs with slow growth • Distributed across the country • Moderate to high population and brownfield density • High capacity	16
Up and Coming	• Small and tiny CBSAs experiencing moderate to rapid growth, excluding two rapidly growing CBSAs: Jacksonville, Fla., and Durham, N.C. • Southern trend – More than 50% located in the sunbelt • Mix of brownfield and population density • Mix of capacity • Generally low and moderate brownfield density, although two CBSAs have high brownfield density: Fayetteville, N.C., and Ann Arbor, Mich.	66
Industrial Legacy	• Small and tiny CBSAs with slow growth • Majority in the Midwest • Moderate and high brownfield density • Low to moderate population density • Low to moderate capacity	171

C.2 Selection of 50 CBSAs to Include in the Study

Of the 280 CBSAs eligible for analysis, 50 were selected to provide broad geographic coverage across the county. The number of modeled CBSAs by profile group loosely reflects the total number in each group. For example, there are 171 CBSAs characterized as *Industrial Legacy* metro areas, more than any other category. The number of *Industrial Legacy* metro areas selected for analysis is 18, more than any other category. Likewise, there are a small number of *Stable Metropolis* and *Big and Growing* metro areas nationwide (four each), and just two are included from each profile in the analysis (at least two examples from each growth profile were included among the 50 CBSAs).

As shown below, the 50 CBSAs analyzed offer broad coverage of the nation, geographically, such that representatives of each growth profile are found in differing regional contexts.

CBSAs were selected to ensure that the analysis included CBSAs in all EPA and Census regions.

EPA Region	Number of CBSAs Eligible for Consideration	Number of CBSAs Selected for Analysis
1	18	5
2	10	3
3	21	3
4	65	10
5	85	10
6	21	5
7	29	3
8	8	4
9	15	4
10	8	3
Total	***280***	***50***

Census Region	Number of CBSAs Selected for Consideration	Number of CBSAs Selected for Analysis
Midwest	115	13
Northeast	37	9
South	96	16
West	32	12
Total	***280***	***50***

C.3 Summary of 50 Selected CBSAs

Overall Selection Summary

Development Profile	Number of Potential CBSAs	Number of CBSAs in Pilot Study	Number of CBSAs Selected for Further Study	Total CBSAs for Analysis	Total CBSAs as a Percentage of Potential CBSAs for Analysis
Big and Growing	4	2	0	2	50%
Stable Metropolis	4	1	1	2	50%
Growth Hubs	19	2	4	6	32%
Slow and Steady	16	6	0	6	38%
Up and Coming	66	1	15	16	24%
Industrial Legacy	171	0	18	18	11%
Total	**280**	***12***	***38***	***50***	***18%***

Big and Growing (2)

CBSA Name	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Atlanta-Sandy Springs-Marietta, Ga.	Huge	Moderate	High	Moderate	High	South	6
Dallas-Fort Worth-Arlington, Texas	Huge	Moderate	High	Moderate	High	South	6

Stable Metropolis (2)

CBSA Name	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Los Angeles-Long Beach-Anaheim, Calif.	Huge	Slow	High	High	High	West	9
Philadelphia-Camden-Wilmington, Pa.-N.J.-Del.-Md.	Huge	Slow	High	High	High	Northeast	2

Growth Hubs (6)

CBSA Name	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Austin-Round Rock-San Marcos, Texas	Medium	Rapid	Moderate	Moderate	High	South	6
Minneapolis-St. Paul-Bloomington, Minn.-Wisc.	Large	Moderate	High	High	High	Midwest	5
Orlando-Kissimmee-Sanford, Fla.	Medium	Moderate	High	Low	High	South	4
Portland-Vancouver-Hillsboro, Ore.-Wash.	Medium	Moderate	Moderate	Moderate	High	West	10
Sacramento–Arden-Arcade–Roseville, Calif.	Medium	Moderate	Moderate	High	High	West	9
Seattle-Tacoma-Bellevue, Wash.	Large	Moderate	High	Moderate	High	West	10

Slow and Steady (6)

CBSA	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Baltimore-Towson, Md.	Medium	Slow	High	High	High	South	3
Hartford-West Hartford-East Hartford, Conn.	Medium	Slow	High	High	High	Northeast	1
Milwaukee-Waukesha-West Allis, Wisc.	Medium	Slow	Moderate	High	High	Midwest	5
New Orleans-Metairie-Kenner, La.	Medium	Slow	Low	Low	High	South	6
Rochester, N.Y.	Medium	Slow	Moderate	Moderate	High	Northeast	2
San Francisco-Oakland-Fremont, Calif.	Large	Slow	High	High	High	West	9

Up and Coming (16)

CBSA	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Albuquerque, N.M.	Small	Moderate	Low	Low	Low	West	3
Big Rapids, Mich.	Tiny	Moderate	Low	High	Low	Midwest	5
Billings, Mont.	Tiny	Moderate	Low	Low	Moderate	West	8
Boise City, Idaho	Small	Moderate	Low	Low	Moderate	West	10
Boulder, Colo.	Small	Rapid	Moderate	Moderate	Low	West	8
Burlington-South Burlington, Vt.	Tiny	Moderate	Low	Moderate	High	Northeast	1
Des Moines-West Des Moines, Iowa	Small	Moderate	Low	Moderate	High	Midwest	7
Durham-Chapel Hill, N.C.	Small	Rapid	Moderate	Moderate	High	South	4
Grand Rapids-Wyoming, Mich.	Small	Moderate	Moderate	High	High	Midwest	5
Iowa City, Iowa	Tiny	Moderate	Low	High	Moderate	Midwest	7
Knoxville, Tenn.	Small	Moderate	Moderate	Moderate	High	South	4
Lakeland-Winter Haven, Fla.	Small	Moderate	Moderate	Moderate	Moderate	South	4
Morgantown, W.Va.	Tiny	Moderate	Moderate	Low	Moderate	South	3
Ogden-Clearfield, Utah	Small	Moderate	Moderate	Moderate	Moderate	West	8
Portland-South Portland-Biddeford, Maine	Small	Moderate	Low	High	High	Northeast	1
Winston-Salem, N.C.	Small	Moderate	Low	Moderate	Moderate	South	4

Industrial Legacy (18)

CBSA	Size	Growth Rate	Population Density	Brownfield Density	Brownfield Capacity	Census Region	EPA Region
Akron, Ohio	Small	Slow	High	High	High	Midwest	5
Albany-Schenectady-Troy, N.Y.	Small	Slow	Moderate	Moderate	High	Northeast	2
Allentown-Bethlehem-Easton, Pa.-N.J.	Small	Slow	High	High	High	Northeast	5
Ann Arbor, Mich.	Small	Slow	Moderate	High	High	Midwest	4
Bangor, Maine	Tiny	Slow	Low	Low	Moderate	Northeast	1
Chattanooga, Tenn.-Ga.	Small	Slow	Moderate	Moderate	Moderate	South	4
Dayton, Ohio	Small	Slow	Moderate	Moderate	Moderate	Midwest	5
Frankfort, Ind.	Tiny	Slow	Low	Moderate	Moderate	Midwest	5
Freeport, Ill.	Tiny	Slow	Low	High	Moderate	Midwest	5
Great Falls, Mont.	Tiny	Slow	Low	Low	Moderate	West	8
Jackson, Miss.	Small	Slow	Low	Moderate	Moderate	South	4
Montgomery, Ala.	Small	Slow	Low	Moderate	Moderate	South	4
New Haven-Milford, Conn.	Small	Slow	High	High	High	Northeast	1
Shreveport-Bossier City, La.	Small	Slow	Low	Moderate	High	South	6
Stockton, Calif.	Small	Slow	Moderate	Moderate	Moderate	West	9
Sturgis, Mich.	Tiny	Slow	Low	High	Moderate	Midwest	5
Wichita, Kan.	Small	Slow	Moderate	Low	High	Midwest	7
Wilson, N.C.	Tiny	Slow	Moderate	Moderate	Low	South	4

APPENDIX D: ESTIMATING RESIDENTIAL VMT BASED ON THE BUILT ENVIRONMENT

Household travel behavior has shown to be responsive to various attributes of the built environment, often referred to as "D variables." These include several common measures, such as the density of development, diversity of land use, design of neighborhood streets, distance to transit, and access to destinations. Built environment attribute data from the Smart Location Database (SLD) was used to model CBG-to-CBG variances in average per capita VMT. The SLD variables referenced are indicators of each of the five Ds commonly referenced in the transportation and land use literature, as shown in Table D-1.

Table D-1. D Variables and SLD Indicators

D Variables	SLD	Indicator	Primary Impact on Travel Behavior
Density	D1a	Residential Density	More destinations nearby increase walking and biking.
Diversity	D2	Land Use Entropy	A greater range of destinations nearby also increases the likelihood of walking and biking.
Design	D3	Intersection Density, weighted by three-legged and four-legged or more intersections	More direct pedestrian pathways and more distributed vehicle traffic support better walking and biking conditions.
Distance	D4	Distance of Transit	Convenient access increases the likelihood of using transit.
Destinations	D5ar	Regional Accessibility to jobs by auto, gravity weighted	Greater access to destinations generates shorter average vehicle trips.

Each D variable is tabulated for every CBG in the CBSA being analyzed. The value of each D variable is tabulated for existing conditions from the SLD. For each scenario and phase of the allocation process, two of the D variables are updated to reflect the changes brought about by new development – density (D1) and destinations (D5) are both updated. There is insufficient data from the allocations to update the other D variables, so the existing values are retained after allocation. The average value of each D is calculated for the entire metro area and new block group level attributes are calculated that describe the extent to which each block group's built environment characteristics deviate from the regional average. An example calculation for the D1 variable in block group *i* is shown below:

$$D1_i - \overline{D1}/\overline{D1}$$

In numerous studies, various formulations of the D variables at household locations have been shown to influence travel behaviors, such as mode choice, trip generation, trip length, and VMT generation. A meta-analysis of these studies yielded a set of elasticities for estimating total residential VMT based on the D variables.[37] These elasticities, listed by D variable in Table D-2, are the best available resource for estimating household VMT in a consistent manner across the country.

[37] Ewing, Reid, and Cervero, Robert. "Travel and the Built Environment – A Meta-Analysis." *Journal of the American Planning Association, 76*, May 2010.

Table D-2. Elasticities of VMT with Respect to D Variables[38]

D Variables	Elasticity
Density	-0.10
Diversity	-0.09
Design	-0.20
Distance	0.05
Destinations	-0.35

Each elasticity value is multiplied by each block group's corresponding D deviation value. The resulting products are summed to obtain a VMT generation rate factor. This factor represents the extent to which a block group is expected to produce more (values above 1) or less (values between zero and 1) VMT on a per capita basis than is typical for the metro area, considering its built environment characteristics. The VMT generation rate factor is then multiplied by the average daily VMT per capita rate assumed for the CBSA being analyzed. The rate is unique to each metro area, and each metro area's rate was determined from Federal Highway Administration (FHWA) Table HM-71. However, FHWA does not generate an estimated VMT per capita for all CBSAs selected for this study. Alternate estimates of VMT per capita were identified or calculated for those CBSAs, as detailed in Table D-3.

Table D-3. Estimated VMT for Select CBSAs

CBSA Name	VMT per capita	Source
Albany-Schenectady-Troy, N.Y.	30.09	Brookings Institute
Big Rapids, Mich.	26.7	Equal to neighboring CBSA – Grand Rapids, Mich. – estimated VMT per capita
Frankfort, Ind.	23.18	Equal to neighboring CBSA – Lafayette, Ind. – estimated VMT per capita
Freeport, Ill.	24.81	Equal to neighboring CBSA – Rockford, Ill. – estimated VMT per capita
Sturgis, Mich.	29.72	Average of neighboring CBSAs – Kalamazoo, Mich. (30.49) and Battle Creek, Mich. (28.95) – estimated VMT per capita
Wilson, N.C.	34.33	Average of neighboring CBSAs – Greenville, N.C. (43), Rocky Mount, N.C. (28), and Goldsboro, N.C. (31) – estimated VMT per capita

Having estimated the VMT per capita for each block group in the CBSA being analyzed, the daily VMT generated by each block group's new households is derived by multiplying the VMT per

[38] Ewing, Reid, and Cervero, Robert. "Travel and the Built Environment – A Meta-Analysis." *Journal of the American Planning Association, 76*, May 2010.

capita value by the estimated incoming population. Since the land use allocation model focuses on housing units rather than population, an assumed persons-per-household ratio of 2.54 (national average in 2015) was used to derive new population figures for each block group.

APPENDIX E: DETAILED ALLOCATION AND ENVIRONMENTAL BENEFITS RESULTS

its	Jobs allocated	Jobs
/Secondary/Cumulative	Change in impervious surface area	Acres
ary/Secondary/Cumulative	VMT generated by new (allocated) households	Daily vehicle miles of travel
ulative	Change in VMT per capita	Daily vehicle miles of travel per person
	Change in VMT generated by existing households	Daily vehicle miles of travel
nary/Secondary/Cumulative	Total VMT generated by new (allocated) jobs	Daily vehicle miles of travel
	Total VMT per job generated by new (allocated) jobs	Daily vehicle miles of travel per employee

CHARACTERISTICS						
e Name	Size	Growth Rate	Geographic Distribution	Population Density	Capacity for Redevelopment Activity	Brownfiel
	Medium and Large	Moderate to Rapid	Well-distributed	Moderate to High	High	Hi
acy	Small and Tiny	Slow	Majority in Midwest	Low to Moderate	Low to Moderate	Moderate
olis	Huge	Slow	Uneven	High	High	Hi
dy	Medium and Large	Slow	Well-distributed	Moderate to High	High	Moderate
ng	Huge	Moderate to Rapid	All in Southern US	High	High	Hi
g	Small and Tiny	Moderate to Rapid	Southern focused	All	All	A

414,969	**3.3%**	**32%**	**68%**	**29,734**	**6.71**	**13.96**	**20.67**	**639,615**	**12.6**

Difference		Percent Difference		Difference per BF acre	
(ac)	Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
8,196.2)	(62,768.0)	-85.83%	-89.72%	(3.42)	(11.79)
(3,477.1)	(12,684.4)	-56.32%	-66.06%	(0.57)	(2.08)
(5,483.1)	(20,660.3)	-65.07%	-77.19%	(0.91)	(3.44)
(3,888.6)	(15,505.8)	-65.36%	-74.39%	(1.09)	(4.36)
(2,370.3)	(9,247.9)	-63.00%	-71.88%	(0.84)	(3.26)
(4,498.9)	(16,039.8)	-64.85%	-72.16%	(0.76)	(2.71)
37,914.3)	**(136,906.0)**	**-72.29%**	**-79.66%**	**(1.28)**	**(4.60)**

Difference		Percent Difference		Difference per BF acre	
(ac)	Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
(892.4)	(6,718.3)	-0.22%	-1.81%	(0.17)	(1.26)
322.0	(811.3)	0.29%	-0.83%	0.05	(0.13)
(2,147.5)	(5,437.2)	-1.22%	-3.45%	(0.36)	(0.91)
(1,258.3)	(6,106.6)	-0.86%	-4.62%	(0.35)	(1.72)
2,589.7	(1,136.9)	0.79%	-0.36%	0.91	(0.40)
259.1	(1,041.1)	0.12%	-0.51%	0.04	(0.18)
(1,127.4)	**(21,251.3)**	**-0.08%**	**-1.66%**	**(0.038)**	**(0.71)**

Difference		Percent Difference		Difference per BF acre	
(ac)	Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
(8,283.8)	(33,801.1)	-1.95%	-7.98%	(1.56)	(6.35)
(2,015.5)	(10,964.1)	-1.72%	-9.33%	(0.33)	(1.80)
(4,953.7)	(17,696.2)	-2.70%	-9.79%	(0.82)	(2.95)
(3,277.3)	(15,203.1)	-2.17%	-10.11%	(0.92)	(4.27)
1,478.7	(5,879.5)	0.45%	-1.78%	0.52	(2.07)
(2,213.1)	(10,367.6)	-0.99%	-4.65%	(0.37)	(1.75)
19,264.7)	**(93,911.7)**	**-1.35%**	**-6.59%**	**(0.65)**	**(3.16)**

Difference		Percent Difference		Difference per BF acre	
(mi)	Aggr. (mi)	Base	Aggr.	Base (mi/ac)	Aggr. (mi/ac)
437,176)	(5,572,375)	-43.93%	-50.97%	(270.0)	(1,046.9)
404,280)	(2,054,686)	-13.37%	-23.21%	(66.3)	(337.2)
405,069)	(2,085,384)	-19.56%	-30.05%	(67.4)	(347.1)
311,728)	(1,528,478)	-16.61%	-24.28%	(87.6)	(429.4)

Difference		Percent Difference		Difference per BF acre	
/capita)	Aggr. (mi/capita)	Base	Aggr.	Base (mi/capita/ac)	Aggr. (mi/capita/ac)
(13.0)	(15.2)	-43.93%	-50.97%	(0.002)	(0.003)
(3.9)	(6.8)	-13.37%	-23.21%	(0.001)	(0.001)
(4.4)	(6.8)	-19.56%	-30.05%	(0.001)	(0.001)
(3.9)	(5.7)	-16.61%	-24.28%	(0.001)	(0.002)
(7.3)	(9.3)	-17.74%	-22.53%	(0.003)	(0.003)
(10.9)	(13.2)	-32.07%	-38.64%	(0.002)	(0.002)
(7.3)	**(9.7)**	**-25.21%**	**-33.11%**	**(0.00)**	**(0.00)**

Difference		Percent Difference		Difference per BF acre	
/capita)	Aggr. (mi/capita)	Base	Aggr.	Base (mi/capita/ac)	Aggr. (mi/capita/ac)
0.04	0.08	0.12%	0.26%	0.000	0.000
0.39	0.16	1.16%	0.46%	0.000	0.000
(0.39)	(0.05)	-1.63%	-0.22%	(0.000)	(0.000)
0.08	0.24	0.34%	0.97%	0.000	0.000
(0.04)	(0.04)	-0.11%	-0.10%	(0.000)	(0.000)
0.22	0.10	0.72%	0.34%	0.000	0.000
0.01	**0.05**	**0.03%**	**0.15%**	**0.00**	**0.00**

Difference		Percent Difference		Difference per BF acre	
/capita)	Aggr. (mi/capita)	Base	Aggr.	Base (mi/capita/ac)	Aggr. (mi/capita/ac)
(0.4)	(1.7)	-1.36%	-5.60%	(0.000)	(0.000)
(0.7)	(4.4)	-2.16%	-13.26%	(0.000)	(0.001)
(0.7)	(1.8)	-3.08%	-7.59%	(0.000)	(0.000)
(0.5)	(2.1)	-1.94%	-8.81%	(0.000)	(0.001)
(0.3)	(1.1)	-0.84%	-3.01%	(0.000)	(0.000)
(0.5)	(2.3)	-1.70%	-7.68%	(0.000)	(0.000)
(0.5)	**(1.8)**	**-1.49%**	**-5.91%**	**(0.00)**	**(0.00)**

Difference		Percent Difference		Difference per BF acre	
(mi)	Aggr. (mi)	Base	Aggr.	Base (mi/ac)	Aggr. (mi/ac)
521,150)	(2,033,110)	-13.25%	-14.97%	(97.9)	(382.0)
(54,471)	(203,981)	-7.96%	-8.68%	(8.9)	(33.5)
109,930)	(442,728)	-5.01%	-6.18%	(18.3)	(73.7)
(60,239)	(323,469)	-4.58%	-7.08%	(16.9)	(90.9)
(43,243)	(145,327)	-5.44%	-5.40%	(15.2)	(51.2)
(80,359)	(296,915)	-8.51%	-9.44%	(13.6)	(50.2)
59,392.2)	**(3,445,530.7)**	**-8.81%**	**-10.29%**	**(29.24)**	**(115.88)**

Difference		Percent Difference		Difference per BF acre	
mi/job)	Aggr. (mi/job)	Base	Aggr.	Base (mi/job/ac)	Aggr. (mi//job/ac)
(3.3)	(3.8)	-13.25%	-14.97%	(0.001)	(0.001)
(1.9)	(2.1)	-7.96%	-8.68%	(0.000)	(0.000)
(1.1)	(1.4)	-5.01%	-6.18%	(0.000)	(0.000)
(1.0)	(1.5)	-4.58%	-7.08%	(0.000)	(0.000)
(1.46)	(1.45)	-5.44%	-5.40%	(0.001)	(0.001)
(2.2)	(2.4)	-8.51%	-9.44%	(0.000)	(0.000)
(2.1)	**(2.5)**	**-8.81%**	**-10.29%**	**(0.00)**	**(0.00)**

Difference		Percent Difference		Difference per BF acre	
mi/job)	Aggr. (mi/job)	Base	Aggr.	Base (mi/job/ac)	Aggr. (mi//job/ac)
(0.12)	(0.29)	-0.49%	-1.13%	(0.000)	(0.000)
(0.06)	(0.11)	-0.25%	-0.44%	(0.000)	(0.000)
(0.18)	(0.26)	-0.78%	-1.10%	(0.000)	(0.000)
(0.16)	(0.37)	-0.66%	-1.57%	(0.000)	(0.000)
(0.057)	(0.059)	-0.21%	-0.21%	(0.000)	(0.000)
(0.06)	(0.10)	-0.24%	-0.39%	(0.000)	(0.000)
(0.11)	**(0.20)**	**-0.45%**	**-0.79%**	**(0.00)**	**(0.00)**

Difference		Percent Difference		Difference per BF acre	
mi/job)	Aggr. (mi/job)	Base	Aggr.	Base (mi/job/ac)	Aggr. (mi//job/ac)
(0.28)	(0.88)	-1.11%	-3.46%	(0.000)	(0.000)
(0.12)	(0.31)	-0.47%	-1.25%	(0.000)	(0.000)
(0.22)	(0.39)	-0.93%	-1.68%	(0.000)	(0.000)
(0.19)	(0.53)	-0.80%	-2.27%	(0.000)	(0.000)
(0.07)	(0.11)	-0.26%	-0.39%	(0.000)	(0.000)
(0.12)	(0.30)	-0.45%	-1.16%	(0.000)	(0.000)
(0.18)	**(0.45)**	**-0.71%**	**-1.79%**	**(0.00)**	**(0.00)**

ce	Percent Difference		Difference per BF acre	
Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
(6,356)	-57.93%	-66.63%	(0.78)	(2.97)
(18,713)	-64.35%	-75.97%	(1.03)	(3.80)
(4,517)	-63.39%	-72.24%	(0.76)	(2.78)
(13,946)	-79.33%	-78.84%	(1.45)	(3.65)
(20,197)	-67.37%	-75.12%	(1.17)	(4.20)
(16,822)	-65.29%	-75.18%	(0.86)	(3.38)
(3,330)	-71.15%	-76.11%	(0.86)	(2.74)
(2,109)	-61.11%	-70.11%	(1.04)	(4.01)
(32,530)	-83.73%	-89.89%	(2.16)	(8.48)
(18,385)	-82.45%	-87.91%	(2.52)	(9.99)
(136,906)	**-72.29%**	**-79.66%**	**(1.28)**	**(4.60)**

ce	Percent Difference		Difference per BF acre	
Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
(716)	-0.60%	-1.81%	(0.13)	(0.33)
(2,408)	-0.05%	-3.20%	(0.01)	(0.49)
(877)	0.53%	-1.38%	0.22	(0.54)
362	2.10%	0.22%	0.93	0.09
(3,494)	-0.62%	-2.71%	(0.19)	(0.73)
(2,001)	0.52%	-0.49%	0.44	(0.40)
(248)	-0.52%	-0.93%	(0.13)	(0.20)
215	-0.41%	0.57%	(0.32)	0.41
(10,137)	-2.56%	-5.79%	(1.35)	(2.64)
(1,947)	-0.29%	-1.20%	(0.27)	(1.06)
(21,251)	**-0.08%**	**-1.66%**	**(0.04)**	**(0.71)**

ce	Percent Difference		Difference per BF acre	
Aggr. (ac)	Base	Aggr.	Base (ac)	Aggr. (ac)
(5,115)	-2.64%	-10.51%	(0.60)	(2.39)
(14,263)	-2.91%	-14.64%	(0.58)	(2.89)
(3,198)	-0.31%	-4.64%	(0.13)	(1.97)
(8,027)	0.11%	-4.49%	0.05	(2.10)
(16,567)	-2.63%	-10.72%	(0.85)	(3.44)
(10,833)	0.04%	-2.54%	0.03	(2.17)
(2,906)	-3.15%	-9.46%	(0.80)	(2.39)
(289)	-0.57%	-0.71%	(0.45)	(0.55)
(25,087)	-3.90%	-12.13%	(2.14)	(6.54)
(7,627)	-1.02%	-4.43%	(0.96)	(4.14)
(93,912)	**-1.35%**	**-6.59%**	**(0.65)**	**(3.16)**

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
(2,917,441)	-4.13%	-21.57%	(114)	(592)
(568,749)	-0.12%	-3.04%	(13)	(350)
(2,657,932)	-0.35%	-4.52%	(54)	(695)
(2,406,751)	-1.73%	-7.02%	(124)	(500)
(6,778,514)	-1.01%	-4.04%	(342)	(1,360)
(2,177,931)	-10.27%	-36.66%	(501)	(1,790)
(88,625)	-0.85%	-1.20%	(120)	(169)
(2,273,684)	-1.99%	-4.38%	(275)	(592)
(3,199,896)	-2.59%	-7.89%	(578)	(1,739)
(24,075,413)	**-1.49%**	**-5.91%**	**(205)**	**(810)**

ce	Percent Difference		Difference per BF acre	
ggr. (mi/capita)	Base	Aggr.	Base (mi/capita/ac)	Aggr. (mi/capita/ac)
(5.5)	-14.09%	-19.72%	(0.002)	(0.003)
(6.7)	-18.11%	-28.81%	(0.001)	(0.001)
(8.7)	-20.44%	-30.74%	(0.004)	(0.005)
(12.2)	-22.03%	-30.71%	(0.002)	(0.003)
(5.4)	-13.11%	-19.23%	(0.001)	(0.001)
(10.8)	-22.36%	-28.70%	(0.002)	(0.002)
(18.2)	-48.43%	-60.47%	(0.012)	(0.015)
(4.1)	-9.78%	-17.39%	(0.004)	(0.008)
(6.7)	-18.60%	-28.50%	(0.001)	(0.002)
(19.3)	-73.94%	-76.24%	(0.010)	(0.010)
(9.7)	**-25.21%**	**-33.11%**	**0.000**	**0.000**

ce	Percent Difference		Difference per BF acre	
ggr. (mi/capita)	Base	Aggr.	Base (mi/capita/ac)	Aggr. (mi/capita/ac)
0.1	0.48%	0.41%	0.000	0.000
0.1	0.53%	0.45%	0.000	0.000
0.1	0.74%	0.50%	0.000	0.000
0.3	1.05%	0.66%	0.000	0.000
0.2	0.37%	0.65%	0.000	0.000
(0.0)	-0.06%	-0.11%	(0.000)	(0.000)
(0.1)	0.84%	-0.32%	0.000	(0.000)
(0.1)	-0.70%	-0.44%	(0.000)	(0.000)
0.1	-1.00%	0.40%	(0.000)	0.000
(0.1)	-0.47%	-0.23%	(0.000)	(0.000)
0.0	**0.03%**	**0.15%**	**0.000**	**0.000**

ce	Percent Difference		Difference per BF acre	

Aggr. (mi)	Base	Aggr.	Base (mi/ac)	Aggr. (mi/ac)
(63,681)	-0.23%	-0.76%	(10.35)	(29.73)
(260,524)	-0.55%	-1.38%	(24.81)	(52.86)
(68,390)	-0.20%	-0.50%	(18.11)	(42.06)
(79,084)	-0.13%	-0.26%	(10.30)	(20.69)
(322,959)	-0.46%	-1.18%	(29.57)	(67.12)
(243,328)	-0.20%	-0.26%	(39.14)	(48.83)
(19,855)	-0.25%	-0.34%	(12.69)	(16.31)
(17,479)	-0.55%	-0.35%	(56.23)	(33.27)
(946,554)	-1.11%	-1.72%	(183.28)	(246.63)
(236,015)	-0.30%	-0.84%	(47.88)	(128.26)
(2,257,869)	**-0.45%**	**-0.79%**	**(46.65)**	**(75.93)**

ce	Percent Difference		Difference per BF acre	
Aggr. (mi)	Base	Aggr.	Base (mi/ac)	Aggr. (mi/ac)
(204,356)	-0.58%	-2.04%	(26.96)	(95.41)
(650,234)	-0.91%	-2.73%	(43.99)	(131.94)
(219,571)	-0.47%	-1.45%	(43.82)	(135.04)
(253,031)	-0.27%	-0.79%	(22.76)	(66.19)
(787,780)	-0.81%	-2.42%	(54.84)	(163.73)
(489,696)	-0.28%	-0.51%	(53.69)	(98.26)
(29,389)	-0.28%	-0.48%	(14.29)	(24.15)
(32,598)	-0.61%	-0.60%	(63.81)	(62.05)
(2,698,406)	-1.70%	-4.07%	(294.26)	(703.09)
(338,337)	-0.37%	-1.11%	(60.79)	(183.87)
(5,703,400)	**-0.71%**	**-1.79%**	**(75.89)**	**(191.81)**

ce	Percent Difference		Difference per BF acre	
Aggr. (mi/job)	Base	Aggr.	Base (mi/job/ac)	Aggr. (mi//job/ac)
(2.1)	-7.24%	-8.57%	(0.00)	(0.00)
(1.8)	-6.12%	-7.85%	(0.00)	(0.00)
(2.5)	-9.51%	-10.36%	(0.00)	(0.00)
(2.3)	-8.63%	-9.43%	(0.00)	(0.00)
(2.3)	-8.11%	-8.99%	(0.00)	(0.00)
(1.6)	-5.92%	-5.94%	(0.00)	(0.00)
(1.1)	-3.05%	-4.32%	(0.00)	(0.00)
(0.8)	-2.86%	-3.19%	(0.00)	(0.00)
(3.6)	-13.26%	-15.63%	(0.00)	(0.00)
(1.0)	-3.42%	-4.33%	(0.00)	(0.00)
(2.5)	**-8.81%**	**-10.29%**	**(0.00)**	**(0.00)**

3	713.9	144,427	15,490	10.73%	5,237	3.63%	442,734	38,775	8.76%
1	583.1	4,258	4,167	97.86%	1,286	30.20%	23,860	2,900	12.15%
5	66.4	3,387	452	13.35%	140	4.13%	4,369	157	3.59%
8	80.9	12,118	1,676	13.83%	517	4.27%	26,007	12,040	46.30%
10	142.8	66,015	1,269	1.92%	405	0.61%	122,727	8,180	6.67%
8	28.7	44,903	76	0.17%	22	0.05%	97,662	821	0.84%
1	171.0	19,283	2,137	11.08%	633	3.28%	48,884	9,171	18.76%
4	228.6	23,958	3,419	14.27%	1,032	4.31%	62,125	5,761	9.27%
6	1,254.7	809,401	18,815	2.32%	5,490	0.68%	1,723,128	56,202	3.26%
5	123.0	3,947	3,947	100.00%	1,923	48.72%	62,451	421	0.67%
7	278.5	42,502	19,517	45.92%	7,625	17.94%	124,643	81	0.06%
4	68.2	70,451	7,118	10.10%	2,078	2.95%	144,506	17,438	12.07%
5	50.2	181	181	100.00%	175	96.69%	1,790	186	10.39%
5	51.0	1	1	100.00%	1	100.00%	2,747	2,658	96.76%
5	801.6	69,571	14,918	21.44%	4,567	6.56%	156,851	16,727	10.66%
8	71.4	1,796	1,080	60.13%	322	17.93%	5,409	1,929	35.66%
1	419.7	42,612	7,267	17.05%	2,159	5.07%	160,973	30,113	18.71%
7	94.4	13,145	738	5.61%	210	1.60%	33,946	7,906	23.29%
4	335.6	32,730	209	0.64%	79	0.24%	99,728	8,751	8.77%
4	1,016.9	66,852	24,236	36.25%	7,584	11.34%	139,970	4,384	3.13%
4	1,146.4	42,569	2,780	6.53%	850	2.00%	76,989	5,645	7.33%
9	1,643.3	483,286	34,954	7.23%	10,324	2.14%	1,932,010	125,228	6.48%
5	755.3	53,915	19,328	35.85%	5,701	10.57%	192,358	27,290	14.19%
5	1,133.5	286,841	31,942	11.14%	9,695	3.38%	660,284	131,305	19.89%
4	340.5	21,494	3,899	18.14%	1,239	5.76%	53,108	346	0.65%
3	613.8	10,478	1,645	15.70%	540	5.15%	20,886	814	3.90%
1	295.0	17,227	16,626	96.51%	4,923	28.58%	92,590	11,307	12.21%
6	513.5	44,462	11,293	25.40%	3,371	7.58%	147,547	5,606	3.80%
8	344.3	59,099	927	1.57%	383	0.65%	102,399	4,407	4.30%
4	363.0	250,338	5,711	2.28%	1,729	0.69%	523,892	25,725	4.91%
2	4,364.5	160,374	83,929	52.33%	25,313	15.78%	739,301	190,817	25.81%
1	673.1	40,159	8,292	20.65%	2,698	6.72%	78,072	14,304	18.32%
10	1,037.6	235,500	7,777	3.30%	2,289	0.97%	427,473	32,435	7.59%
2	241.1	25,688	13,600	52.94%	3,999	15.57%	118,711	4,453	3.75%
9	1,220.4	168,008	16,711	9.95%	5,625	3.35%	359,291	252,912	70.39%
9	916.3	147,021	36,416	24.77%	10,616	7.22%	486,721	105,299	21.63%
10	659.7	322,812	53,595	16.60%	15,741	4.88%	679,339	60,839	8.96%
6	724.6	23,521	8,602	36.57%	2,523	10.73%	56,196	13,298	23.66%
9	58.0	35,394	7,603	21.48%	2,249	6.35%	66,617	206	0.31%
5	249.3	405	405	100.00%	405	100.00%	2,260	1,578	69.82%
7	844.1	25,381	21,642	85.27%	6,572	25.89%	70,779	612	0.86%
4	6.9	4,773	136	2.85%	41	0.86%	8,266	0	0.00%
4	87.9	56,843	2,929	5.15%	864	1.52%	105,168	102	0.10%

80.9	385	156	1,812	529	-1,427	-373	-79%	-71%	4.76
142.8	128	48	1,212	361	-1,084	-313	-89%	-87%	0.89
28.7	29	9	59	16	-30	-7	-51%	-44%	0.99
171.0	197	79	1,349	395	-1,152	-316	-85%	-80%	1.15
228.6	349	116	869	254	-520	-138	-60%	-54%	1.53
1,253.9	1879	695	5,575	1,618	-3,696	-922	-66%	-57%	1.50
123.0	97	37	343	159	-246	-122	-72%	-77%	0.79
278.5	288	100	1,616	633	-1,328	-533	-82%	-84%	1.03
68.2	156	87	1,912	563	-1,756	-476	-92%	-85%	2.29
50.2	25	17	35	23	-10	-6	-28%	-27%	0.50
51.0	43	17	250	75	-207	-58	-83%	-77%	0.85
801.5	1,025	375	3,122	949	-2,097	-574	-67%	-60%	1.28
71.4	179	57	383	112	-204	-55	-53%	-49%	2.51
419.7	945	329	2,767	795	-1,822	-467	-66%	-59%	2.25
95.4	221	94	823	235	-603	-141	-73%	-60%	2.31
336.6	454	152	910	276	-456	-124	-50%	-45%	1.35
1,016.9	1,166	474	3,047	967	-1,881	-492	-62%	-51%	1.15
1,164.4	612	232	939	290	-327	-58	-35%	-20%	0.53
1,675.8	1,067	468	5,929	1,675	-4,862	-1,207	-82%	-72%	0.64
755.5	1219	438	3,474	1,026	-2,255	-588	-65%	-57%	1.61
1,133.5	2,160	847	14,238	4,110	-12,078	-3,263	-85%	-79%	1.91
343.5	218	96	435	147	-217	-51	-50%	-35%	0.63
613.8	222	83	204	72	18	12	9%	16%	0.36
295.0	696	260	1,854	527	-1,159	-266	-62%	-51%	2.36
528.5	603	224	1,593	468	-990	-244	-62%	-52%	1.14
344.3	306	125	754	234	-448	-109	-59%	-47%	0.89
363.0	285	107	8,327	4,103	-8,041	-3,996	-97%	-97%	0.79
4,454.0	5,037	2,475	20,836	6,751	-15,799	-4,276	-76%	-63%	1.13
673.1	903	361	2,748	886	-1,845	-525	-67%	-59%	1.34
1,037.0	1527	575	2,693	790	-1,165	-215	-43%	-27%	1.47
241.1	401	144	1,733	503	-1,332	-359	-77%	-71%	1.66
1,220.4	1,445	644	22,186	6,087	-20,741	-5,443	-93%	-89%	1.18
922.3	1060	460	7,504	1,979	-6,444	-1,519	-86%	-77%	1.15
658.3	873	363	17,008	4,470	-16,135	-4,106	-95%	-92%	1.33
729.6	433	200	2,411	711	-1,978	-510	-82%	-72%	0.59
58.0	88	40	572	170	-484	-130	-85%	-76%	1.52
250.3	127	69	197	91	-70	-22	-35%	-25%	0.51
844.1	537	229	1,936	600	-1,400	-371	-72%	-62%	0.64
6.9	6	2	13	4	-7	-2	-54%	-50%	0.87
87.9	105	35	285	83	-180	-48	-63%	-58%	1.19

171.0	6,908	7,809	6,939	7,857	-31	-48	-0.45%	-0.60%	40.3
228.6	7,065	7,648	7,077	7,592	-12	56	-0.17%	0.74%	30.9
1,253.9	192,884	197,498	193,450	195,552	-566	1,946	-0.29%	1.00%	153.8
123.0	4,549	5,527	4,547	5,473	2	55	0.05%	1.00%	36.9
278.5	14,238	15,238	14,312	15,312	-74	-75	-0.51%	-0.49%	51.1
68.2	14,966	16,253	15,114	16,245	-148	8	-0.98%	0.05%	219.3
50.2	126	140	128	148	-1	-7	-1.07%	-5.06%	2.5
51.0	9	186	8	189	0	-4	3.66%	-1.94%	0.1
801.5	19,474	21,595	19,593	21,654	-119	-59	-0.61%	-0.27%	24.3
71.4	560	831	567	826	-7	6	-1.23%	0.67%	7.8
419.7	12,692	14,704	12,907	14,650	-215	54	-1.66%	0.37%	30.2
95.4	3,810	4,453	3,939	4,517	-130	-64	-3.29%	-1.41%	39.9
336.6	12,609	13,237	12,544	13,001	65	236	0.52%	1.82%	37.4
1,016.9	17,496	19,469	17,503	19,483	-7	-14	-0.04%	-0.07%	17.2
1,164.4	12,343	12,934	12,363	12,827	-19	107	-0.16%	0.84%	10.6
1,675.8	103,521	109,932	106,793	112,121	-3,271	-2,188	-3.06%	-1.95%	61.7
755.5	15,444	18,078	15,863	18,217	-419	-139	-2.64%	-0.76%	20.4
1,133.5	71,595	82,993	74,441	83,740	-2,846	-748	-3.82%	-0.89%	63.1
343.5	7,795	8,081	7,782	7,893	13	188	0.17%	2.39%	22.7
613.8	2,391	2,536	2,401	2,540	-10	-3	-0.40%	-0.13%	3.9
295.0	5,165	6,742	5,414	6,806	-249	-65	-4.60%	-0.95%	17.5
528.5	16,734	17,919	16,835	18,166	-101	-248	-0.60%	-1.36%	31.6
344.3	23,246	23,916	23,544	24,009	-298	-92	-1.26%	-0.39%	67.5
363.0	69,763	71,788	69,269	69,599	494	2,189	0.71%	3.15%	192.1
4,454.0	48,467	64,085	50,633	64,045	-2,166	41	-4.28%	0.06%	10.8
673.1	11,845	13,678	12,039	13,895	-195	-217	-1.62%	-1.56%	17.6
1,037.0	47,965	50,619	48,486	50,535	-521	83	-1.07%	0.17%	46.2
241.1	11,954	13,127	11,961	13,132	-7	-4	-0.06%	-0.03%	49.5
1,220.4	20,746	37,813	22,654	39,540	-1,908	-1,728	-8.42%	-4.37%	17.0
922.3	31,660	40,145	36,561	41,296	-4,901	-1,151	-13.41%	-2.79%	34.3
658.3	90,111	96,648	91,374	97,206	-1,263	-558	-1.38%	-0.57%	136.8
729.6	6,508	8,220	6,596	8,246	-89	-26	-1.34%	-0.32%	8.9
58.0	8,967	9,372	9,023	9,486	-56	-114	-0.62%	-1.20%	154.7
250.3	53	140	54	138	0	2	-0.19%	1.59%	0.2
844.1	8,374	9,733	8,418	9,749	-45	-17	-0.53%	-0.17%	9.9
6.9	1,273	1,279	1,220	1,126	53	153	4.31%	13.57%	184.7
87.9	15,384	15,583	15,345	14,907	39	677	0.25%	4.54%	175.0

28.7	11,156	11,212	10,615	11,263	542	-51	5.10%	-0.45%	388.18
171.0	7,324	7,954	8,191	8,219	-867	-265	-10.59%	-3.22%	42.83
228.6	7,542	7,799	7,882	7,825	-340	-27	-4.31%	-0.34%	32.99
1,253.9	196,335	198,628	197,922	196,839	-1,587	1,789	-0.80%	0.91%	156.57
123.0	4,661	5,573	5,708	5,671	-1,047	-97	-18.35%	-1.71%	37.89
278.5	14,523	15,337	15,749	15,870	-1,226	-533	-7.78%	-3.36%	52.14
68.2	15,677	16,501	16,752	16,715	-1,075	-214	-6.41%	-1.28%	229.73
50.2	161	166	185	187	-24	-21	-12.95%	-11.34%	3.20
51.0	129	227	259	263	-130	-36	-50.04%	-13.78%	2.54
801.5	21,236	22,180	22,450	22,514	-1,214	-334	-5.41%	-1.48%	26.50
71.4	859	922	944	935	-85	-12	-9.00%	-1.31%	12.04
419.7	14,394	15,245	15,455	15,372	-1,061	-128	-6.86%	-0.83%	34.30
95.4	4,354	4,634	4,703	4,732	-350	-99	-7.43%	-2.08%	45.63
336.6	13,418	13,494	13,395	13,258	23	236	0.17%	1.78%	39.87
1,016.9	18,761	19,968	20,381	20,390	-1,620	-422	-7.95%	-2.07%	18.45
1,164.4	13,054	13,194	13,237	13,095	-183	99	-1.38%	0.75%	11.21
1,675.8	105,802	110,720	111,496	113,426	-5,694	-2,706	-5.11%	-2.39%	63.14
755.5	17,097	18,635	19,052	19,144	-1,954	-508	-10.26%	-2.66%	22.63
1,133.5	77,999	85,072	87,092	87,321	-9,093	-2,249	-10.44%	-2.58%	68.81
343.5	8,018	8,180	8,189	8,030	-171	150	-2.09%	1.87%	23.34
613.8	2,621	2,623	2,593	2,607	28	16	1.07%	0.62%	4.27
295.0	6,000	7,040	7,275	7,294	-1,275	-253	-17.53%	-3.48%	20.34
528.5	17,433	18,168	18,319	18,599	-887	-431	-4.84%	-2.32%	32.98
344.3	23,789	24,111	24,224	24,219	-435	-108	-1.79%	-0.45%	69.10
363.0	70,779	72,107	74,939	72,401	-4,160	-294	-5.55%	-0.41%	194.99
4,454.0	57,304	67,568	69,306	69,815	-12,002	-2,247	-17.32%	-3.22%	12.87
673.1	13,115	14,145	14,655	14,732	-1,539	-586	-10.50%	-3.98%	19.49
1,037.0	50,170	51,371	50,730	51,183	-561	188	-1.11%	0.37%	48.38
241.1	12,470	13,304	13,597	13,610	-1,128	-306	-8.29%	-2.25%	51.73
1,220.4	32,461	41,364	43,149	44,874	-10,687	-3,510	-24.77%	-7.82%	26.60
922.3	34,397	41,065	42,629	42,850	-8,232	-1,785	-19.31%	-4.17%	37.30
658.3	91,935	97,273	98,317	99,078	-6,382	-1,805	-6.49%	-1.82%	139.66
729.6	7,754	8,646	8,903	8,917	-1,149	-271	-12.91%	-3.04%	10.63
58.0	9,064	9,415	9,538	9,636	-474	-222	-4.97%	-2.30%	156.41
250.3	195	219	262	261	-67	-42	-25.69%	-16.11%	0.78
844.1	8,938	9,967	10,269	10,310	-1,331	-343	-12.96%	-3.32%	10.59
6.9	1,279	1,280	1,233	1,129	46	151	3.74%	13.37%	185.58
87.9	15,487	15,618	15,608	15,002	-121	616	-0.78%	4.10%	176.23

66.1	22,159	7,332	35,380	10,539	-13,221	-3,207	-37.37%	-30.43%	335.24
80.9	76,549	26,744	104,408	32,324	-27,859	-5,580	-26.68%	-17.26%	945.75
142.8	58,364	20,869	88,989	28,493	-30,626	-7,624	-34.42%	-26.76%	408.74
28.7	3,101	897	3,548	1,015	-447	-117	-12.59%	-11.58%	107.91
171.0	114,446	36,315	174,015	50,935	-59,570	-14,620	-34.23%	-28.70%	669.19
228.6	275,924	84,922	330,253	98,489	-54,329	-13,567	-16.45%	-13.77%	1,206.81
1,253.9	1,173,068	364,631	1,617,171	470,657	-444,103	-106,026	-27.46%	-22.53%	935.51
123.0	217,189	102,163	267,672	129,186	-50,483	-27,023	-18.86%	-20.92%	1,765.62
278.5	462,856	213,429	1,636,080	635,967	-1,173,223	-422,538	-71.71%	-66.44%	1,661.72
68.2	389,239	170,916	691,084	201,041	-301,845	-30,125	-43.68%	-14.98%	5,703.97
50.2	10,233	9,694	10,467	10,027	-234	-332	-2.23%	-3.31%	203.97
51.0	74	84	77	67	-3	17	-3.50%	24.94%	1.45
801.5	978,637	313,278	1,179,561	361,621	-200,924	-48,343	-17.03%	-13.37%	1,221.04
71.4	39,306	11,996	48,594	14,236	-9,288	-2,240	-19.11%	-15.74%	550.59
419.7	451,818	138,821	548,138	161,007	-96,320	-22,186	-17.57%	-13.78%	1,076.60
95.4	38,842	12,152	47,388	13,756	-8,546	-1,603	-18.03%	-11.65%	407.11
336.6	30,432	11,831	29,873	11,993	558	-162	1.87%	-1.35%	90.42
1,016.9	1,612,838	561,575	2,590,496	810,670	-977,659	-249,095	-37.74%	-30.73%	1,586.06
1,164.4	263,657	83,189	244,572	75,237	19,085	7,952	7.80%	10.57%	226.43
1,675.8	1,453,307	463,510	2,071,314	610,534	-618,006	-147,024	-29.84%	-24.08%	867.25
755.5	1,048,160	313,376	1,210,736	356,943	-162,577	-43,568	-13.43%	-12.21%	1,387.35
1,133.5	1,663,885	567,988	2,447,928	740,261	-784,043	-172,272	-32.03%	-23.27%	1,467.97
343.5	299,210	113,936	487,106	149,522	-187,896	-35,586	-38.57%	-23.80%	871.19
613.8	99,883	33,858	99,008	31,792	875	2,066	0.88%	6.50%	162.74
295.0	1,057,308	320,785	1,127,479	332,123	-70,171	-11,338	-6.22%	-3.41%	3,584.70
528.5	422,050	132,952	524,195	155,325	-102,144	-22,373	-19.49%	-14.40%	798.57
344.3	69,524	29,912	71,604	29,512	-2,080	400	-2.90%	1.36%	201.95
363.0	458,631	143,432	588,745	178,645	-130,113	-35,213	-22.10%	-19.71%	1,263.48
4,454.0	3,401,583	1,201,919	4,868,961	1,459,964	-1,467,378	-258,045	-30.14%	-17.67%	763.72
673.1	424,082	155,204	591,517	189,515	-167,435	-34,311	-28.31%	-18.10%	630.09
1,037.0	486,571	147,625	458,560	133,355	28,011	14,270	6.11%	10.70%	469.20
241.1	695,955	212,680	884,301	256,255	-188,347	-43,574	-21.30%	-17.00%	2,887.06
1,220.4	978,939	350,882	1,305,005	412,496	-326,066	-61,614	-24.99%	-14.94%	802.14
922.3	1,329,122	462,378	1,972,613	560,601	-643,491	-98,223	-32.62%	-17.52%	1,441.14
658.3	427,433	143,782	3,545,191	1,036,416	-3,117,758	-892,634	-87.94%	-86.13%	649.32
729.6	573,308	185,775	784,949	227,349	-211,641	-41,574	-26.96%	-18.29%	785.76
58.0	407,825	127,007	482,072	140,943	-74,247	-13,935	-15.40%	-9.89%	7,037.53
250.3	31,318	32,072	33,552	33,572	-2,235	-1,500	-6.66%	-4.47%	125.10
844.1	787,921	354,611	1,578,626	475,241	-790,706	-120,629	-50.09%	-25.38%	933.49
6.9	6,700	2,241	8,505	2,447	-1,805	-206	-21.22%	-8.41%	972.48
87.9	241,938	72,350	297,297	87,229	-55,359	-14,880	-18.62%	-17.06%	2,753.05

142.8	4,371,605	4,413,741	4,321,151	4,343,298	50,454	70,443	1.17%	1.62%	30,615.63
28.7	2,082,508	2,086,018	2,123,220	2,146,701	-40,712	-60,683	-1.92%	-2.83%	72,460.27
171.0	1,346,600	1,454,354	1,346,734	1,440,500	-133	13,853	-0.01%	0.96%	7,873.94
228.6	1,947,391	2,166,046	1,937,708	2,141,016	9,683	25,030	0.50%	1.17%	8,517.28
1,253.9	68,460,506	69,642,878	68,494,059	70,019,593	-33,553	-376,714	-0.05%	-0.54%	54,596.32
123.0	0	134,321	0	133,150	0	1,170	#DIV/0!	0.88%	0.00
278.5	1,829,299	2,793,449	1,842,350	2,775,175	-13,051	18,274	-0.71%	0.66%	6,567.46
68.2	5,915,183	6,353,467	5,910,069	6,331,268	5,114	22,199	0.09%	0.35%	86,682.04
50.2	0	354	0	339	0	15	#DIV/0!	4.53%	0.00
51.0	0	0	0	0	0	0	#DIV/0!	#DIV/0!	0.00
801.5	4,237,242	5,022,250	4,226,808	4,981,356	10,434	40,894	0.25%	0.82%	5,286.77
71.4	31,783	65,510	31,982	64,548	-198	961	-0.62%	1.49%	445.21
419.7	2,650,342	3,031,338	2,623,799	3,017,771	26,544	13,567	1.01%	0.45%	6,315.30
95.4	780,979	810,501	777,662	808,010	3,317	2,491	0.43%	0.31%	8,185.50
336.6	4,497,606	4,501,083	4,491,943	4,518,052	5,663	-16,969	0.13%	-0.38%	13,363.46
1,016.9	4,366,093	6,063,252	4,354,399	6,057,358	11,694	5,895	0.27%	0.10%	4,293.62
1,164.4	3,489,080	3,649,189	3,449,306	3,600,996	39,774	48,193	1.15%	1.34%	2,996.46
1,675.8	27,160,017	28,666,081	27,249,099	29,299,953	-89,082	-633,872	-0.33%	-2.16%	16,207.58
755.5	2,182,930	3,043,769	2,191,084	3,048,662	-8,155	-4,893	-0.37%	-0.16%	2,889.35
1,133.5	19,597,055	21,303,391	19,423,081	21,245,993	173,974	57,398	0.90%	0.27%	17,289.59
343.5	2,134,537	2,468,064	2,112,109	2,365,689	22,429	102,375	1.06%	4.33%	6,214.99
613.8	521,247	591,404	524,429	586,641	-3,182	4,763	-0.61%	0.81%	849.25
295.0	40,587	824,014	38,902	818,834	1,686	5,180	4.33%	0.63%	137.61
528.5	1,535,337	1,900,843	1,531,658	1,895,852	3,679	4,991	0.24%	0.26%	2,905.03
344.3	4,424,642	4,463,658	4,419,241	4,460,959	5,400	2,698	0.12%	0.06%	12,852.62
363.0	24,603,402	24,975,205	24,423,496	24,714,498	179,906	260,707	0.74%	1.05%	67,779.83
4,454.0	4,443,271	7,862,192	4,423,234	7,833,903	20,038	28,290	0.45%	0.36%	997.60
673.1	2,258,793	2,643,028	2,260,621	2,636,168	-1,828	6,860	-0.08%	0.26%	3,356.06
1,037.0	13,796,601	14,128,851	13,845,422	14,264,621	-48,822	-135,770	-0.35%	-0.95%	13,304.08
241.1	768,931	1,379,814	766,694	1,367,216	2,237	12,598	0.29%	0.92%	3,189.79
1,220.4	12,012,719	12,851,193	11,878,728	12,770,914	133,991	80,279	1.13%	0.63%	9,843.18
922.3	6,148,499	7,618,713	6,010,389	7,617,476	138,109	1,237	2.30%	0.02%	6,666.70
658.3	18,588,889	21,289,723	18,675,367	21,411,884	-86,478	-122,160	-0.46%	-0.57%	28,238.57
729.6	1,345,915	1,888,200	1,338,845	1,860,865	7,069	27,335	0.53%	1.47%	1,844.68
58.0	1,725,102	2,073,437	1,720,610	2,037,332	4,492	36,105	0.26%	1.77%	29,768.81
250.3	0	0	0	0	0	0	#DIV/0!	#DIV/0!	0.00
844.1	261,096	1,325,743	260,494	1,305,411	602	20,332	0.23%	1.56%	309.33
6.9	287,895	293,298	284,861	283,047	3,034	10,251	1.07%	3.62%	41,784.47
87.9	5,375,192	5,579,972	5,310,480	5,448,730	64,712	131,242	1.22%	2.41%	61,165.14

ndustrial Legacy	5	837.8	2,309,845	2,571,161	2,628,199	2,620,183	-318,354	-49,023	-12
ndustrial Legacy	4	229.0	1,663,563	1,708,746	1,704,245	1,710,825	-40,682	-2,079	-2
ig and Growing	6	1,582.0	63,610,523	66,519,768	67,201,252	67,167,374	-3,590,729	-647,606	-5
rowth Hub	6	908.4	24,414,769	26,068,120	26,411,551	26,500,884	-1,996,782	-432,764	-7
low and Steady	3	888.9	10,163,050	10,616,047	10,666,698	10,698,358	-503,648	-82,311	-4
ndustrial Legacy	1	583.1	156,568	286,850	326,697	326,345	-170,129	-39,495	-52
p and Coming	5	66.1	242,640	255,208	259,186	251,587	-16,546	3,620	-6
p and Coming	8	80.9	701,525	742,338	735,979	745,301	-34,453	-2,963	-4
p and Coming	10	142.8	4,390,419	4,422,294	4,373,276	4,360,274	17,143	62,019	0
p and Coming	8	28.7	2,084,442	2,086,572	2,125,643	2,147,382	-41,201	-60,809	-1
p and Coming	1	171.0	1,357,011	1,459,072	1,492,747	1,481,578	-135,736	-22,505	-9
ndustrial Legacy	4	228.6	2,105,506	2,216,822	2,251,160	2,233,797	-145,654	-16,975	-6
ig and Growing	6	1,253.9	69,332,698	69,917,214	69,874,413	70,420,437	-541,716	-503,224	-0
ndustrial Legacy	5	123.0	160,053	208,563	259,888	259,344	-99,834	-50,781	-38
p and Coming	7	278.5	2,157,588	2,893,708	3,357,010	3,361,757	-1,199,422	-468,049	-35
p and Coming	4	68.2	5,927,065	6,367,852	6,502,992	6,501,155	-575,928	-133,303	-8
ndustrial Legacy	5	50.2	9,119	8,526	10,372	10,269	-1,253	-1,743	-12
ndustrial Legacy	5	51.0	63	81	77	66	-14	15	-17
p and Coming	5	801.5	5,023,936	5,274,426	5,323,103	5,313,546	-299,167	-39,121	-5
ndustrial Legacy	8	71.4	63,001	75,105	79,719	78,275	-16,718	-3,170	-20
low and Steady	1	419.7	3,020,275	3,146,498	3,145,319	3,169,372	-125,045	-22,875	-3
p and Coming	7	95.4	798,222	816,233	811,174	817,471	-12,952	-1,237	-1
ndustrial Legacy	4	336.6	4,498,555	4,503,944	4,498,130	4,522,867	425	-18,923	0
p and Coming	4	1,016.9	5,109,446	6,357,804	6,787,940	6,814,217	-1,678,495	-456,413	-24
p and Coming	4	1,164.4	3,735,989	3,727,666	3,676,585	3,670,571	59,404	57,095	1
table Metropolis	9	1,675.8	28,338,508	29,036,410	29,152,565	29,858,109	-814,057	-821,699	-2
low and Steady	5	755.5	2,824,659	3,234,476	3,364,891	3,391,935	-540,231	-157,459	-16
rowth Hub	5	1,133.5	20,707,663	21,682,732	21,659,806	21,914,084	-952,143	-231,352	-4
ndustrial Legacy	4	343.5	2,423,904	2,572,912	2,575,325	2,512,320	-151,421	60,592	-5
p and Coming	3	613.8	630,621	628,225	614,751	615,148	15,870	13,077	2
ndustrial Legacy	1	295.0	815,461	1,054,884	1,142,307	1,142,164	-326,845	-87,280	-28
low and Steady	6	528.5	1,901,098	2,018,457	2,042,153	2,046,565	-141,055	-28,108	-6
p and Coming	8	344.3	4,478,344	4,488,543	4,474,597	4,484,864	3,748	3,679	0
rowth Hub	4	363.0	24,866,768	25,064,180	24,890,790	24,855,891	-24,021	208,289	-0
table Metropolis	2	4,454.0	7,083,375	8,859,144	9,179,559	9,243,648	-2,096,184	-384,504	-22
p and Coming	1	673.1	2,575,347	2,768,132	2,823,482	2,814,760	-248,135	-46,629	-8
rowth Hub	10	1,037.0	14,168,240	14,243,129	14,218,916	14,372,124	-50,676	-128,996	-0
low and Steady	2	241.1	1,049,721	1,487,428	1,626,546	1,617,046	-576,825	-129,618	-35
rowth Hub	9	1,220.4	12,044,302	12,926,131	12,673,079	13,021,886	-628,777	-95,755	-4
low and Steady	9	922.3	7,256,523	8,004,389	7,901,530	8,149,368	-645,007	-144,980	-8
rowth Hub	10	658.3	18,796,757	21,363,203	21,963,120	22,360,298	-3,166,363	-997,095	-14
ndustrial Legacy	6	729.6	1,577,178	1,979,580	2,085,410	2,071,043	-508,232	-91,462	-24
ndustrial Legacy	9	58.0	1,997,528	2,177,176	2,183,371	2,171,865	-185,843	5,312	-8
ndustrial Legacy	5	250.3	28,830	29,532	33,483	33,390	-4,652	-3,858	-13
ndustrial Legacy	7	844.1	806,719	1,618,295	1,772,276	1,759,025	-965,557	-140,731	-54

3,137.10	3,127.53	-380.00	-58.51	-12.11%	-1.87%	-1.24	-1.18	-1.15	-1.16
7,442.12	7,470.85	-177.65	-9.08	-2.39%	-0.12%	-1.22	-1.18	-1.18	-1.18
42,478.94	42,457.52	-2269.75	-409.36	-5.34%	-0.96%	-3.05	-2.93	-2.89	-2.92
29,074.80	29,173.14	-2198.13	-476.40	-7.56%	-1.63%	-4.29	-4.14	-4.09	-4.10
11,999.35	12,034.96	-566.57	-92.59	-4.72%	-0.77%	-1.41	-1.31	-1.31	-1.32
560.26	559.65	-291.76	-67.73	-52.08%	-12.10%	-1.78	-1.61	-1.59	-1.59
3,921.12	3,806.16	-250.32	54.77	-6.38%	1.44%	-1.12	-1.10	-1.09	-1.08
9,092.89	9,208.06	-425.67	-36.61	-4.68%	-0.40%	-1.97	-1.60	-1.79	-1.55
30,627.33	30,536.27	120.06	434.34	0.39%	1.42%	-2.71	-2.66	-2.71	-2.75
73,961.13	74,717.53	-1433.59	-2115.84	-1.94%	-2.83%	-1.20	-1.20	-1.31	-1.38
8,728.50	8,663.18	-793.68	-131.59	-9.09%	-1.52%	-2.44	-2.23	-2.18	-2.22
9,845.87	9,769.93	-637.05	-74.24	-6.47%	-0.76%	-1.68	-1.63	-1.61	-1.64
55,723.89	56,159.34	-432.01	-401.31	-0.78%	-0.71%	-2.68	-2.65	-2.73	-2.78
2,112.74	2,108.32	-811.60	-412.82	-38.41%	-19.58%	-0.74	-0.65	-0.64	-0.64
12,052.16	12,069.21	-4306.10	-1680.36	-35.73%	-13.92%	-2.29	-2.26	-2.25	-2.27
95,295.90	95,268.98	-8439.74	-1953.45	-8.86%	-2.05%	-3.61	-3.29	-3.17	-3.18
206.73	204.69	-24.97	-34.74	-12.08%	-16.97%	-0.38	-0.36	-0.33	-0.33
1.50	1.30	-0.27	0.29	-17.69%	22.37%	-0.85	-0.60	-0.55	-0.54
6,641.59	6,629.67	-373.27	-48.81	-5.62%	-0.74%	-1.88	-1.76	-1.72	-1.73
1,116.67	1,096.44	-234.18	-44.40	-20.97%	-4.05%	-0.44	-0.41	-0.41	-0.41
7,494.74	7,552.06	-297.96	-54.51	-3.98%	-0.72%	-1.20	-1.10	-1.07	-1.08
8,501.98	8,567.98	-135.75	-12.97	-1.60%	-0.15%	-1.84	-1.74	-1.69	-1.67
13,365.02	13,438.52	1.26	-56.22	0.01%	-0.42%	-4.10	-4.01	-4.00	-4.02
6,675.26	6,701.10	-1650.63	-448.84	-24.73%	-6.70%	-3.20	-3.12	-3.11	-3.11
3,157.49	3,152.33	51.02	49.03	1.62%	1.56%	-1.74	-1.78	-1.81	-1.83
17,396.62	17,817.65	-485.78	-490.34	-2.79%	-2.75%	-1.30	-1.26	-1.26	-1.26
4,453.80	4,489.60	-715.05	-208.41	-16.05%	-4.64%	-0.96	-0.90	-0.88	-0.89
19,109.46	19,333.80	-840.03	-204.11	-4.40%	-1.06%	-1.63	-1.46	-1.41	-1.43
7,498.40	7,314.95	-440.88	176.42	-5.88%	2.41%	-2.57	-2.56	-2.63	-2.77
1,001.60	1,002.25	25.86	21.31	2.58%	2.13%	-1.66	-1.66	-1.68	-1.69
3,872.88	3,872.40	-1108.14	-295.91	-28.61%	-7.64%	-0.83	-0.77	-0.76	-0.76
3,863.98	3,872.33	-266.89	-53.18	-6.91%	-1.37%	-0.54	-0.52	-0.52	-0.53
12,997.73	13,027.55	10.89	10.69	0.08%	0.08%	-2.15	-2.13	-2.15	-2.21
68,571.56	68,475.42	-66.18	573.82	-0.10%	0.84%	-3.36	-3.26	-3.33	-3.46
2,060.98	2,075.37	-470.63	-86.33	-22.84%	-4.16%	-0.87	-0.80	-0.76	-0.77
4,195.06	4,182.10	-368.67	-69.28	-8.79%	-1.66%	-1.36	-1.24	-1.18	-1.17
13,711.32	13,859.06	-48.87	-124.39	-0.36%	-0.90%	-1.81	-1.81	-1.81	-1.83
6,747.47	6,708.06	-2392.87	-537.70	-35.46%	-8.02%	-0.91	-0.88	-0.88	-0.90
10,384.28	10,670.09	-515.22	-78.46	-4.96%	-0.74%	-2.76	-2.21	-1.97	-1.97
8,567.48	8,836.21	-699.37	-157.20	-8.16%	-1.78%	-0.83	-0.75	-0.72	-0.71
33,364.40	33,967.76	-4810.06	-1514.70	-14.42%	-4.46%	-1.79	-1.70	-1.68	-1.67
2,858.21	2,838.52	-696.57	-125.36	-24.37%	-4.42%	-2.04	-1.94	-1.92	-1.99
37,676.81	37,478.25	-3206.95	91.66	-8.51%	0.24%	-0.95	-0.94	-0.95	-0.99
133.75	133.39	-18.58	-15.41	-13.89%	-11.55%	-0.42	-0.37	-0.31	-0.31
2,099.70	2,084.00	-1143.94	-166.73	-54.48%	-8.00%	-1.36	-1.31	-1.30	-1.33

0.00	0.00	0.00	0.00	0.00	0.00	8.12%	1.24%	-1,064,134	-1,020,294
-0.01	-0.01	-0.01	-0.01	0.00	0.00	3.39%	0.65%	-461,218	-446,479
0.00	0.00	0.00	0.00	0.00	0.00	5.58%	0.24%	-17,092,973	-16,427,827
0.00	0.00	0.00	0.00	0.00	0.00	4.89%	1.02%	-7,813,831	-7,539,287
0.00	0.00	0.00	0.00	0.00	0.00	7.66%	-0.26%	-4,031,786	-3,777,182
0.00	0.00	0.00	0.00	0.00	0.00	12.02%	1.80%	-289,149	-307,499
-0.02	-0.02	-0.02	-0.02	0.00	0.00	3.12%	1.30%	-61,196	-59,911
-0.02	-0.02	-0.02	-0.02	0.00	0.00	10.09%	2.90%	-360,965	-292,459
-0.02	-0.02	-0.02	-0.02	0.00	0.00	-0.11%	-3.31%	-1,710,979	-1,682,959
-0.04	-0.04	-0.05	-0.05	0.00	0.01	-8.18%	-12.65%	-394,356	-393,792
-0.01	-0.01	-0.01	-0.01	0.00	0.00	11.99%	0.63%	-581,891	-532,102
-0.01	-0.01	-0.01	-0.01	0.00	0.00	4.85%	-0.91%	-1,018,781	-981,415
0.00	0.00	0.00	0.00	0.00	0.00	-1.59%	-4.52%	-17,416,603	-17,221,106
-0.01	-0.01	-0.01	-0.01	0.00	0.00	15.54%	1.95%	-327,377	-503,652
-0.01	-0.01	-0.01	-0.01	0.00	0.00	1.78%	-0.27%	-1,407,428	-1,380,923
-0.05	-0.05	-0.05	-0.05	-0.01	0.00	13.87%	3.35%	-2,074,406	-1,891,315
-0.01	-0.01	-0.01	-0.01	0.00	0.00	15.62%	8.37%	-9,345	-10,125
-0.02	-0.01	-0.01	-0.01	-0.01	0.00	55.02%	11.46%	-19,816	-16,467
0.00	0.00	0.00	0.00	0.00	0.00	9.67%	1.71%	-1,947,552	-1,828,274
-0.01	-0.01	-0.01	-0.01	0.00	0.00	8.52%	0.00%	-40,499	-38,670
0.00	0.00	0.00	0.00	0.00	0.00	12.40%	1.60%	-1,547,991	-1,419,440
-0.02	-0.02	-0.02	-0.02	0.00	0.00	9.44%	3.65%	-311,704	-293,187
-0.01	-0.01	-0.01	-0.01	0.00	0.00	2.44%	-0.35%	-2,454,476	-2,407,523
0.00	0.00	0.00	0.00	0.00	0.00	3.08%	0.34%	-3,155,037	-3,075,752
0.00	0.00	0.00	0.00	0.00	0.00	-3.72%	-3.14%	-1,251,864	-1,274,598
0.00	0.00	0.00	0.00	0.00	0.00	3.03%	0.10%	-14,747,287	-14,336,525
0.00	0.00	0.00	0.00	0.00	0.00	8.81%	1.26%	-1,588,477	-1,495,733
0.00	0.00	0.00	0.00	0.00	0.00	15.63%	2.21%	-5,670,091	-5,078,372
-0.01	-0.01	-0.01	-0.01	0.00	0.00	-2.42%	-7.48%	-1,056,362	-1,057,477
0.00	0.00	0.00	0.00	0.00	0.00	-1.45%	-1.32%	-249,866	-250,293
0.00	0.00	0.00	0.00	0.00	0.00	8.57%	0.68%	-620,134	-699,074
0.00	0.00	0.00	0.00	0.00	0.00	4.56%	-1.87%	-752,968	-719,825
-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.08%	-3.50%	-1,130,397	-1,123,245
-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.83%	-5.92%	-8,191,541	-7,940,900
0.00	0.00	0.00	0.00	0.00	0.00	14.16%	3.90%	-5,192,102	-4,826,080
0.00	0.00	0.00	0.00	0.00	0.00	14.94%	5.15%	-916,750	-834,402
0.00	0.00	0.00	0.00	0.00	0.00	-0.06%	-1.32%	-4,314,148	-4,299,756
0.00	0.00	0.00	0.00	0.00	0.00	3.23%	-1.30%	-1,035,188	-1,019,282
0.00	0.00	0.00	0.00	0.00	0.00	40.46%	11.81%	-6,157,793	-4,930,778
0.00	0.00	0.00	0.00	0.00	0.00	15.90%	4.43%	-3,666,506	-3,297,628
0.00	0.00	0.00	0.00	0.00	0.00	6.87%	1.95%	-6,689,716	-6,359,555
0.00	0.00	0.00	0.00	0.00	0.00	6.31%	-2.46%	-1,003,676	-957,771
-0.02	-0.02	-0.02	-0.02	0.00	0.00	0.08%	-5.09%	-561,788	-559,423
0.00	0.00	0.00	0.00	0.00	0.00	34.42%	19.38%	-19,151	-16,669
0.00	0.00	0.00	0.00	0.00	0.00	4.93%	-1.47%	-834,444	-857,023

7.29%	5.77%	-1,270.18	-1,217.85	-1,183.89	-1,151.45	-86.29	-66.40	7.29%	5.77%
6.91%	12.53%	-2,014.05	-1,949.69	-1,883.92	-1,732.63	-130.13	-217.06	6.91%	12.53%
6.33%	6.05%	-10,804.73	-10,384.28	-10,161.03	-9,791.87	-643.69	-592.41	6.33%	6.05%
5.61%	4.28%	-8,601.75	-8,299.52	-8,145.08	-7,958.66	-456.67	-340.87	5.61%	4.28%
13.98%	16.31%	-4,535.50	-4,249.08	-3,979.28	-3,653.39	-556.22	-595.69	13.98%	16.31%
-3.77%	2.59%	-495.87	-527.33	-515.31	-514.02	19.45	-13.31	-3.77%	2.59%
3.12%	5.31%	-925.81	-906.37	-897.78	-860.65	-28.02	-45.72	3.12%	5.31%
10.71%	4.68%	-4,459.66	-3,613.29	-4,028.27	-3,451.72	-431.39	-161.57	10.71%	4.68%
7.50%	11.56%	-11,982.48	-11,786.25	-11,146.41	-10,565.37	-836.07	-1220.89	7.50%	11.56%
27.45%	60.80%	-13,721.51	-13,701.87	-10,766.09	-8,520.82	-2955.42	-5181.06	27.45%	60.80%
13.17%	5.01%	-3,402.47	-3,111.35	-3,006.51	-2,962.91	-395.96	-148.43	13.17%	5.01%
6.99%	10.66%	-4,455.83	-4,292.40	-4,164.54	-3,878.93	-291.29	-413.47	6.99%	10.66%
9.92%	25.41%	-13,889.50	-13,733.60	-12,636.15	-10,951.02	-1253.35	-2782.57	9.92%	25.41%
-35.17%	11.34%	-2,661.38	-4,094.40	-4,104.87	-3,677.25	1443.48	-417.15	-35.17%	11.34%
4.90%	6.30%	-5,052.88	-4,957.72	-4,816.64	-4,663.73	-236.24	-293.99	4.90%	6.30%
14.45%	5.31%	-30,398.69	-27,715.64	-26,559.82	-26,318.54	-3838.87	-1397.11	14.45%	5.31%
-16.60%	-9.10%	-186.27	-201.81	-223.35	-222.02	37.08	20.21	-16.60%	-9.10%
28.50%	10.55%	-388.47	-322.82	-302.32	-292.03	-86.15	-30.80	28.50%	10.55%
11.47%	8.07%	-2,429.95	-2,281.12	-2,179.89	-2,110.79	-250.05	-170.33	11.47%	8.07%
8.11%	9.52%	-567.29	-541.68	-524.75	-494.57	-42.54	-47.11	8.11%	9.52%
15.73%	15.64%	-3,688.59	-3,382.28	-3,187.29	-2,924.86	-501.30	-457.42	15.73%	15.64%
12.39%	11.00%	-3,267.00	-3,072.92	-2,906.89	-2,768.38	-360.11	-304.54	12.39%	11.00%
7.30%	15.00%	-7,292.83	-7,153.32	-6,796.43	-6,220.11	-496.41	-933.21	7.30%	15.00%
3.29%	1.07%	-3,102.66	-3,024.69	-3,003.97	-2,992.81	-98.69	-31.89	3.29%	1.07%
0.16%	8.90%	-1,075.12	-1,094.64	-1,073.36	-1,005.15	-1.76	-89.49	0.16%	8.90%
11.63%	26.61%	-8,800.36	-8,555.24	-7,883.35	-6,757.41	-917.00	-1797.83	11.63%	26.61%
10.79%	13.17%	-2,102.52	-1,979.77	-1,897.71	-1,749.33	-204.81	-230.44	10.79%	13.17%
19.41%	12.68%	-5,002.46	-4,480.42	-4,189.44	-3,976.12	-813.02	-504.29	19.41%	12.68%
4.18%	11.89%	-3,075.74	-3,078.98	-2,952.28	-2,751.76	-123.45	-327.23	4.18%	11.89%
-1.45%	3.34%	-407.10	-407.80	-413.09	-394.63	5.99	-13.17	-1.45%	3.34%
-10.75%	5.18%	-2,102.50	-2,370.15	-2,355.83	-2,253.49	253.33	-116.65	-10.75%	5.18%
9.05%	20.19%	-1,424.70	-1,361.99	-1,306.47	-1,133.21	-118.23	-228.78	9.05%	20.19%
10.87%	17.37%	-3,283.56	-3,262.78	-2,961.76	-2,779.99	-321.80	-482.79	10.87%	17.37%
8.26%	11.36%	-22,566.85	-21,876.36	-20,845.30	-19,645.14	-1721.55	-2231.22	8.26%	11.36%
13.95%	12.62%	-1,165.72	-1,083.54	-1,023.04	-962.15	-142.69	-121.39	13.95%	12.62%
15.32%	7.28%	-1,362.08	-1,239.73	-1,181.08	-1,155.60	-181.00	-84.13	15.32%	7.28%
2.14%	13.42%	-4,160.14	-4,146.26	-4,072.85	-3,655.53	-87.29	-490.73	2.14%	13.42%
4.11%	10.48%	-4,294.32	-4,228.33	-4,124.80	-3,827.38	-169.52	-400.95	4.11%	10.48%
44.99%	26.85%	-5,045.68	-4,040.26	-3,479.97	-3,185.03	-1565.70	-855.24	44.99%	26.85%
18.42%	15.16%	-3,975.52	-3,575.56	-3,357.20	-3,104.74	-618.33	-470.82	18.42%	15.16%
7.12%	5.23%	-10,162.42	-9,660.87	-9,487.32	-9,180.80	-675.10	-480.06	7.12%	5.23%
8.17%	5.81%	-1,375.62	-1,312.70	-1,271.70	-1,240.63	-103.91	-72.07	8.17%	5.81%
8.66%	23.41%	-9,694.35	-9,653.54	-8,922.03	-7,822.54	-772.32	-1831.00	8.66%	23.41%
-14.62%	-24.17%	-76.50	-66.59	-89.60	-87.81	13.10	21.22	-14.62%	-24.17%
-1.76%	6.69%	-988.61	-1,015.36	-1,006.33	-951.64	17.73	-63.71	-1.76%	6.69%

	Up and Coming	3	298.3	491,945	147,496	547,177	163,669	-55,232	-16,17
	Industrial Legacy	5	837.8	223,190	65,207	255,574	74,743	-32,385	-9,53
	Industrial Legacy	4	229.0	158,259	46,899	167,622	48,479	-9,363	-1,58
	Big and Growing	6	1,582.0	1,100,228	323,750	1,174,244	345,791	-74,017	-22,04
	Growth Hub	6	908.4	923,069	273,030	983,018	290,786	-59,949	-17,75
	Slow and Steady	3	888.9	793,264	240,674	892,503	267,900	-99,239	-27,22
	Industrial Legacy	1	583.1	71,802	26,501	78,530	28,010	-6,728	-1,50
	Up and Coming	5	66.1	4,012	1,372	4,083	1,400	-71	-2
	Up and Coming	8	80.9	296,918	86,637	308,145	89,742	-11,226	-3,10
	Up and Coming	10	142.8	205,175	61,534	229,361	67,968	-24,187	-6,43
	Up and Coming	8	28.7	15,971	4,668	18,153	5,311	-2,182	-64
	Up and Coming	1	171.0	216,266	66,502	238,892	72,020	-22,626	-5,51
	Industrial Legacy	4	228.6	131,431	38,963	140,243	41,332	-8,812	-2,37
	Big and Growing	6	1,253.9	1,445,481	428,030	1,516,791	449,232	-71,310	-21,20
	Industrial Legacy	5	123.0	8,931	2,610	10,086	2,963	-1,155	-35
	Up and Coming	7	278.5	2,272	866	2,161	822	111	4
	Up and Coming	4	68.2	367,722	108,148	439,964	128,631	-72,242	-20,48
	Industrial Legacy	5	50.2	3,999	1,389	4,385	1,515	-385	-12
	Industrial Legacy	5	51.0	53,200	15,553	68,055	20,029	-14,855	-4,47
	Up and Coming	5	801.5	346,174	102,660	421,207	124,307	-75,034	-21,64
	Industrial Legacy	8	71.4	45,733	13,405	46,935	13,724	-1,202	-31
	Slow and Steady	1	419.7	658,503	193,644	711,947	207,817	-53,445	-14,17
	Up and Coming	7	95.4	194,512	56,890	202,890	58,498	-8,378	-1,60
	Industrial Legacy	4	336.6	216,995	66,118	220,910	67,113	-3,916	-99
	Up and Coming	4	1,016.9	107,614	37,266	112,052	37,939	-4,437	-67
	Up and Coming	4	1,164.4	150,064	47,801	135,404	42,748	14,660	5,05
	Stable Metropolis	9	1,675.8	2,629,061	774,831	2,746,008	807,678	-116,947	-32,84
	Slow and Steady	5	755.5	576,781	168,816	633,727	184,784	-56,946	-15,96
	Growth Hub	5	1,133.5	3,201,694	946,849	3,471,454	1,012,561	-269,760	-65,71
	Industrial Legacy	4	343.5	5,851	2,908	9,049	4,282	-3,198	-1,37
	Up and Coming	3	613.8	22,422	9,527	19,132	7,934	3,290	1,59
	Industrial Legacy	1	295.0	230,750	67,975	250,057	71,631	-19,307	-3,65
	Slow and Steady	6	528.5	121,584	36,104	132,413	38,923	-10,829	-2,81
	Up and Coming	8	344.3	100,734	30,599	101,244	30,514	-510	8
	Growth Hub	4	363.0	529,655	155,745	616,011	180,901	-86,356	-25,15
MD	Stable Metropolis	2	4,454.0	4,093,431	1,307,346	4,419,212	1,384,429	-325,781	-77,08
	Up and Coming	1	673.1	323,510	101,697	362,079	112,432	-38,569	-10,73
	Growth Hub	10	1,037.0	798,032	238,969	745,560	223,106	52,472	15,86
	Slow and Steady	2	241.1	103,846	30,872	111,441	33,137	-7,595	-2,26
	Growth Hub	9	1,220.4	4,834,620	1,425,107	6,373,529	1,820,306	-1,538,909	-395,19
	Slow and Steady	9	922.3	1,990,064	585,745	2,085,480	583,533	-95,416	2,21
	Growth Hub	10	658.3	1,257,588	371,372	1,388,196	404,562	-130,608	-33,19
	Industrial Legacy	6	729.6	310,077	91,315	340,340	100,024	-30,263	-8,70
	Industrial Legacy	9	58.0	4,480	1,218	5,060	1,349	-580	-13
	Industrial Legacy	5	250.3	34,246	9,909	38,412	11,183	-4,166	-1,27

	494.50	1,834.50	548.73	-185.18	-54.22	-10.09%	-9.88%	23.50	23.60	26.13
	77.83	305.06	89.22	-38.66	-11.38	-12.67%	-12.76%	20.54	20.55	23.52
	204.80	731.97	211.70	-40.89	-6.90	-5.59%	-3.26%	20.98	21.02	22.22
	204.65	742.26	218.58	-46.79	-13.93	-6.30%	-6.37%	24.92	24.92	26.60
	300.56	1,082.14	320.11	-65.99	-19.55	-6.10%	-6.11%	23.76	23.78	25.31
	270.74	1,004.01	301.37	-111.64	-30.63	-11.12%	-10.16%	20.46	20.61	23.02
	45.45	134.67	48.04	-11.54	-2.59	-8.57%	-5.39%	24.76	25.53	27.08
	20.76	61.77	21.17	-1.07	-0.41	-1.74%	-1.94%	25.55	25.90	26.00
	1,070.38	3,807.08	1,108.75	-138.70	-38.36	-3.64%	-3.46%	24.66	24.67	25.59
	430.94	1,606.28	476.00	-169.39	-45.06	-10.55%	-9.47%	25.08	25.29	28.04
	162.43	631.62	184.80	-75.92	-22.37	-12.02%	-12.11%	19.45	19.45	22.11
	388.86	1,396.87	421.12	-132.30	-32.26	-9.47%	-7.66%	23.58	23.78	26.05
	170.41	613.38	180.77	-38.54	-10.36	-6.28%	-5.73%	22.81	22.85	24.34
	341.35	1,209.62	358.26	-56.87	-16.91	-4.70%	-4.72%	25.72	25.74	26.99
	21.21	81.99	24.09	-9.39	-2.87	-11.45%	-11.92%	21.21	21.22	23.96
	3.11	7.76	2.95	0.40	0.16	5.14%	5.28%	28.05	28.86	26.68
	1,584.81	6,447.31	1,884.97	-1058.64	-300.16	-16.42%	-15.92%	21.09	21.09	25.23
	27.68	87.39	30.20	-7.68	-2.52	-8.79%	-8.34%	21.50	22.40	23.57
	304.91	1,334.16	392.66	-291.23	-87.75	-21.83%	-22.35%	20.02	20.02	25.60
	128.09	525.54	155.10	-93.62	-27.01	-17.81%	-17.41%	20.70	20.74	25.18
	187.78	657.44	192.23	-16.83	-4.46	-2.56%	-2.32%	23.71	23.73	24.33
	461.42	1,696.45	495.19	-127.35	-33.77	-7.51%	-6.82%	21.87	21.88	23.64
	596.27	2,126.50	613.12	-87.81	-16.85	-4.13%	-2.75%	24.60	24.61	25.66
	196.45	656.38	199.41	-11.63	-2.96	-1.77%	-1.48%	24.80	24.96	25.24
	36.65	110.19	37.31	-4.36	-0.66	-3.96%	-1.77%	24.55	25.06	25.56
	41.05	116.29	36.71	12.59	4.34	10.83%	11.82%	26.58	26.72	24.01
	462.38	1,638.66	481.98	-69.79	-19.60	-4.26%	-4.07%	20.99	20.99	21.93
	223.45	838.81	244.58	-75.37	-21.14	-8.99%	-8.64%	21.14	21.15	23.22
	835.36	3,062.71	893.34	-238.00	-57.97	-7.77%	-6.49%	24.38	24.40	26.44
	8.47	26.35	12.47	-9.31	-4.00	-35.34%	-32.09%	29.55	29.67	26.15
	15.52	31.17	12.93	5.36	2.59	17.20%	20.07%	27.55	28.10	23.50
	230.46	847.79	242.86	-65.46	-12.39	-7.72%	-5.10%	20.41	20.41	22.12
	68.31	250.54	73.65	-20.49	-5.33	-8.18%	-7.24%	21.69	21.76	23.65
	88.88	294.09	88.64	-1.48	0.25	-0.50%	0.28%	22.86	23.13	22.97
	429.06	1,697.05	498.36	-237.90	-69.30	-14.02%	-13.91%	20.59	20.60	23.95
MD	293.52	992.19	310.83	-73.14	-17.31	-7.37%	-5.57%	21.45	21.56	23.16
	151.10	537.97	167.05	-57.30	-15.95	-10.65%	-9.55%	22.62	22.84	25.31
	230.44	718.94	215.14	50.60	15.30	7.04%	7.11%	24.60	24.67	22.99
	128.07	462.29	137.46	-31.51	-9.40	-6.82%	-6.84%	23.32	23.37	25.07
	1,167.73	5,222.45	1,491.55	-1260.98	-323.82	-24.15%	-21.71%	19.12	19.13	25.20
	635.11	2,261.25	632.71	-103.46	2.40	-4.58%	0.38%	18.90	18.90	19.81
	564.15	2,108.82	614.57	-198.41	-50.42	-9.41%	-8.20%	20.67	20.68	22.82
	125.15	466.46	137.09	-41.48	-11.94	-8.89%	-8.71%	23.32	23.32	25.59
	21.02	87.32	23.28	-10.02	-2.27	-11.47%	-9.74%	21.75	21.75	24.56
	39.58	153.44	44.67	-16.64	-5.09	-10.84%	-11.40%	21.70	21.68	24.34

	-9.88%	0.08	0.08	0.09	0.09	-0.01	-0.01	-10.09%	-9.88%
	-12.76%	0.02	0.02	0.03	0.03	0.00	0.00	-12.67%	-12.76%
	-3.26%	0.09	0.09	0.10	0.09	-0.01	0.00	-5.59%	-3.26%
	-6.37%	0.02	0.02	0.02	0.02	0.00	0.00	-6.30%	-6.37%
	-6.11%	0.03	0.03	0.03	0.03	0.00	0.00	-6.10%	-6.11%
	-10.16%	0.02	0.02	0.03	0.03	0.00	0.00	-11.12%	-10.16%
	-5.39%	0.04	0.04	0.05	0.05	0.00	0.00	-8.57%	-5.39%
	-1.94%	0.39	0.39	0.39	0.40	-0.01	-0.01	-1.74%	-1.94%
	-3.46%	0.30	0.30	0.32	0.32	-0.01	-0.01	-3.64%	-3.46%
	-9.47%	0.18	0.18	0.20	0.20	-0.02	-0.02	-10.55%	-9.47%
	-12.11%	0.68	0.68	0.77	0.77	-0.09	-0.09	-12.02%	-12.11%
	-7.66%	0.14	0.14	0.15	0.15	-0.01	-0.01	-9.47%	-7.66%
	-5.73%	0.10	0.10	0.11	0.11	-0.01	-0.01	-6.28%	-5.73%
	-4.72%	0.02	0.02	0.02	0.02	0.00	0.00	-4.70%	-4.72%
	-11.92%	0.17	0.17	0.19	0.20	-0.02	-0.02	-11.45%	-11.92%
	5.28%	0.10	0.10	0.10	0.10	0.00	0.01	5.14%	5.28%
	-15.92%	0.31	0.31	0.37	0.37	-0.06	-0.06	-16.42%	-15.92%
	-8.34%	0.43	0.45	0.47	0.49	-0.04	-0.04	-8.79%	-8.34%
	-22.35%	0.39	0.39	0.50	0.51	-0.11	-0.11	-21.83%	-22.35%
	-17.41%	0.03	0.03	0.03	0.03	-0.01	-0.01	-17.81%	-17.41%
	-2.32%	0.33	0.33	0.34	0.34	-0.01	-0.01	-2.56%	-2.32%
	-6.82%	0.05	0.05	0.06	0.06	0.00	0.00	-7.51%	-6.82%
	-2.75%	0.26	0.26	0.27	0.27	-0.01	-0.01	-4.13%	-2.75%
	-1.48%	0.07	0.07	0.08	0.08	0.00	0.00	-1.77%	-1.48%
	-1.77%	0.02	0.02	0.03	0.03	0.00	0.00	-3.96%	-1.77%
	11.76%	0.02	0.02	0.02	0.02	0.00	0.00	10.71%	11.76%
	-4.08%	0.01	0.01	0.01	0.01	0.00	0.00	-4.29%	-4.08%
	-8.64%	0.03	0.03	0.03	0.03	0.00	0.00	-8.99%	-8.64%
	-6.49%	0.02	0.02	0.02	0.02	0.00	0.00	-7.77%	-6.49%
	14.34%	0.09	0.09	0.08	0.08	0.01	0.01	12.98%	14.34%
	20.07%	0.04	0.05	0.04	0.04	0.01	0.01	17.20%	20.07%
	-5.10%	0.07	0.07	0.07	0.07	-0.01	0.00	-7.72%	-5.10%
	-7.30%	0.04	0.04	0.04	0.04	0.00	0.00	-8.28%	-7.30%
	0.28%	0.07	0.07	0.07	0.07	0.00	0.00	-0.50%	0.28%
	-13.91%	0.06	0.06	0.07	0.07	-0.01	-0.01	-14.02%	-13.91%
MD	-5.57%	0.00	0.00	0.01	0.01	0.00	0.00	-7.37%	-5.57%
	-9.55%	0.03	0.03	0.04	0.04	0.00	0.00	-10.65%	-9.55%
	7.11%	0.02	0.02	0.02	0.02	0.00	0.00	7.04%	7.11%
	-6.91%	0.10	0.10	0.10	0.10	-0.01	-0.01	-6.96%	-6.91%
	-21.71%	0.02	0.02	0.02	0.02	0.00	0.00	-24.15%	-21.71%
	0.38%	0.02	0.02	0.02	0.02	0.00	0.00	-4.58%	0.38%
	-8.20%	0.03	0.03	0.03	0.03	0.00	0.00	-9.41%	-8.20%
	-8.71%	0.03	0.03	0.04	0.04	0.00	0.00	-8.89%	-8.71%
	-9.74%	0.38	0.38	0.42	0.42	-0.05	-0.04	-11.47%	-9.74%
	-11.40%	0.09	0.09	0.10	0.10	-0.01	-0.01	-10.84%	-11.40%

	Industrial Legacy	5	743.5	1,291,268	1,489,460	1,292,843	1,491,686	-1,575	-2,226
	Industrial Legacy	2	322.7	2,734,948	3,055,439	2,756,000	3,063,855	-21,052	-8,416
	Up and Coming	3	298.3	3,561,869	3,957,310	3,577,595	3,963,026	-15,727	-5,716
	Industrial Legacy	5	837.8	2,144,816	2,331,727	2,153,395	2,335,486	-8,580	-3,758
	Industrial Legacy	4	229.0	1,522,600	1,653,518	1,541,190	1,659,744	-18,591	-6,227
	Big and Growing	6	1,582.0	28,238,145	29,090,963	28,269,230	29,106,963	-31,085	-16,000
	Growth Hub	6	908.4	12,885,023	13,620,960	12,949,597	13,641,236	-64,574	-20,276
	Slow and Steady	3	888.9	9,601,376	10,260,793	9,653,062	10,283,586	-51,686	-22,793
	Industrial Legacy	1	583.1	568,653	619,860	569,142	619,823	-489	37
	Up and Coming	5	66.1	109,564	112,287	109,619	112,205	-55	82
	Up and Coming	8	80.9	357,371	578,249	361,830	580,037	-4,459	-1,788
	Up and Coming	10	142.8	3,240,824	3,408,518	3,251,050	3,412,563	-10,227	-4,045
	Up and Coming	8	28.7	2,228,669	2,242,801	2,235,281	2,267,478	-6,611	-24,678
	Up and Coming	1	171.0	1,050,445	1,222,407	1,057,160	1,222,965	-6,715	-558
	Industrial Legacy	4	228.6	1,386,552	1,487,183	1,389,625	1,488,672	-3,072	-1,489
	Big and Growing	6	1,253.9	46,611,062	47,762,771	46,739,381	47,905,661	-128,318	-142,890
	Industrial Legacy	5	123.0	1,520,829	1,529,849	1,524,548	1,540,646	-3,719	-10,797
	Up and Coming	7	278.5	3,407,881	3,410,784	3,412,033	3,417,592	-4,152	-6,808
	Up and Coming	4	68.2	3,328,022	3,656,648	3,353,690	3,665,493	-25,668	-8,845
	Industrial Legacy	5	50.2	38,516	41,376	38,645	41,875	-129	-499
	Industrial Legacy	5	51.0	2,322	50,419	2,272	50,874	50	-455
	Up and Coming	5	801.5	3,593,206	3,903,493	3,611,759	3,910,327	-18,553	-6,834
	Industrial Legacy	8	71.4	84,430	117,728	84,793	117,524	-363	204
	Slow and Steady	1	419.7	3,152,606	3,673,005	3,178,263	3,682,071	-25,657	-9,066
	Up and Coming	7	95.4	683,911	835,329	696,410	839,541	-12,498	-4,212
	Industrial Legacy	4	336.6	2,322,888	2,480,805	2,326,392	2,479,314	-3,505	1,491
	Up and Coming	4	1,016.9	3,487,280	3,562,085	3,488,796	3,563,599	-1,516	-1,514
	Up and Coming	4	1,164.4	1,733,348	1,827,289	1,736,870	1,829,853	-3,522	-2,564
	Stable Metropolis	9	1,675.8	41,786,942	43,982,609	42,156,494	44,351,224	-369,553	-368,616
	Slow and Steady	5	755.5	3,945,747	4,422,737	3,984,931	4,441,850	-39,184	-19,114
	Growth Hub	5	1,133.5	14,430,300	17,049,509	14,681,534	17,148,373	-251,234	-98,864
	Industrial Legacy	4	343.5	1,388,865	1,394,307	1,389,410	1,397,638	-545	-3,331
	Up and Coming	3	613.8	487,988	499,298	488,966	500,233	-978	-935
	Industrial Legacy	1	295.0	1,885,769	2,074,530	1,904,152	2,083,349	-18,383	-8,820
	Slow and Steady	6	528.5	3,453,970	3,555,258	3,463,853	3,568,086	-9,883	-12,828
	Up and Coming	8	344.3	2,309,873	2,383,736	2,315,919	2,387,013	-6,046	-3,277
	Growth Hub	4	363.0	12,066,941	12,513,277	12,085,353	12,521,528	-18,411	-8,251
-DE-MD	Stable Metropolis	2	4,454.0	12,992,513	16,167,086	13,230,549	16,272,713	-238,035	-105,628
	Up and Coming	1	673.1	1,650,406	1,908,815	1,662,844	1,912,567	-12,438	-3,752
	Growth Hub	10	1,037.0	9,529,192	10,101,783	9,601,883	10,134,583	-72,692	-32,800
	Slow and Steady	2	241.1	2,897,528	2,975,925	2,898,965	2,984,140	-1,437	-8,214
A	Growth Hub	9	1,220.4	2,618,489	7,217,739	2,821,022	7,382,250	-202,533	-164,511
	Slow and Steady	9	922.3	8,138,992	9,873,384	8,509,898	10,033,075	-370,905	-159,691
	Growth Hub	10	658.3	15,038,951	16,129,927	15,192,048	16,181,177	-153,097	-51,250
	Industrial Legacy	6	729.6	1,106,380	1,352,814	1,115,849	1,355,884	-9,469	-3,070

	1,738.98	2,006.44	-2.12	-2.99	-0.12%	-0.15%	24.67	24.65	24.70	24.69
	8,541.50	9,495.62	-65.25	-26.08	-0.76%	-0.27%	26.16	26.21	26.37	26.28
	11,994.49	13,286.71	-52.73	-19.16	-0.44%	-0.14%	26.39	26.44	26.50	26.48
	2,570.36	2,787.71	-10.24	-4.49	-0.40%	-0.16%	23.98	24.01	24.08	24.05
	6,730.09	7,247.79	-81.18	-27.19	-1.21%	-0.38%	23.85	23.92	24.15	24.01
	17,869.41	18,398.96	-19.65	-10.11	-0.11%	-0.05%	27.07	27.08	27.10	27.09
	14,255.39	15,016.77	-71.09	-22.32	-0.50%	-0.15%	26.01	26.06	26.14	26.10
	10,859.07	11,568.37	-58.14	-25.64	-0.54%	-0.22%	23.77	23.80	23.90	23.86
	976.03	1,062.94	-0.84	0.06	-0.09%	0.01%	27.13	27.16	27.15	27.16
	1,658.38	1,697.50	-0.83	1.24	-0.05%	0.07%	26.01	26.02	26.03	26.00
	4,470.35	7,166.25	-55.09	-22.09	-1.23%	-0.31%	25.59	25.71	25.91	25.79
	22,768.05	23,899.18	-71.62	-28.33	-0.31%	-0.12%	28.29	28.33	28.38	28.37
	77,775.95	78,896.26	-230.04	-858.66	-0.30%	-1.09%	23.01	23.02	23.08	23.27
	6,181.50	7,151.00	-39.27	-3.26	-0.64%	-0.05%	26.45	26.52	26.62	26.54
	6,077.78	6,510.99	-13.44	-6.51	-0.22%	-0.10%	24.60	24.61	24.65	24.64
	37,274.02	38,204.11	-102.33	-113.95	-0.27%	-0.30%	27.96	27.99	28.04	28.07
	12,393.69	12,524.56	-30.23	-87.77	-0.24%	-0.70%	24.52	24.55	24.58	24.72
	12,249.70	12,269.66	-14.90	-24.44	-0.12%	-0.20%	27.36	27.37	27.39	27.43
	49,145.51	53,714.73	-376.14	-129.62	-0.77%	-0.24%	26.19	26.24	26.39	26.30
	770.28	834.66	-2.57	-9.94	-0.33%	-1.19%	24.01	23.94	24.09	24.23
	44.55	997.34	0.98	-8.91	2.19%	-0.89%	26.09	25.59	25.53	25.82
	4,506.36	4,878.88	-23.15	-8.53	-0.51%	-0.17%	25.64	25.70	25.78	25.74
	1,187.74	1,646.22	-5.08	2.86	-0.43%	0.17%	24.26	24.30	24.37	24.26
	7,573.24	8,773.73	-61.14	-21.60	-0.81%	-0.25%	24.09	24.15	24.29	24.20
	7,299.13	8,799.30	-131.00	-44.15	-1.79%	-0.50%	26.26	26.41	26.74	26.54
	6,912.27	7,366.63	-10.41	4.43	-0.15%	0.06%	25.53	25.55	25.57	25.54
	3,430.88	3,504.44	-1.49	-1.49	-0.04%	-0.04%	25.72	25.72	25.73	25.73
	1,491.64	1,571.50	-3.02	-2.20	-0.20%	-0.14%	24.32	24.32	24.36	24.36
	25,156.64	26,466.33	-220.53	-219.97	-0.88%	-0.83%	23.14	23.22	23.35	23.42
	5,274.49	5,879.27	-51.86	-25.30	-0.98%	-0.43%	23.90	23.99	24.14	24.09
	12,952.85	15,129.23	-221.65	-87.22	-1.71%	-0.58%	27.28	27.43	27.75	27.59
	4,045.45	4,069.41	-1.59	-9.70	-0.04%	-0.24%	26.32	26.34	26.33	26.40
	796.66	815.02	-1.59	-1.52	-0.20%	-0.19%	24.31	24.30	24.36	24.35
	6,455.85	7,063.40	-62.33	-29.90	-0.97%	-0.42%	23.20	23.24	23.43	23.34
	6,554.00	6,751.22	-18.70	-24.27	-0.29%	-0.36%	24.35	24.39	24.42	24.47
	6,727.24	6,933.75	-17.56	-9.52	-0.26%	-0.14%	23.57	23.58	23.63	23.62
	33,293.90	34,495.52	-50.72	-22.73	-0.15%	-0.07%	24.22	24.23	24.26	24.25
-DE-MD	2,970.50	3,653.52	-53.44	-23.72	-1.80%	-0.65%	23.69	23.82	24.12	23.98
	2,470.61	2,841.64	-18.48	-5.57	-0.75%	-0.20%	25.88	25.93	26.08	25.98
	9,259.11	9,772.79	-70.10	-31.63	-0.76%	-0.32%	24.12	24.18	24.31	24.26
	12,025.91	12,379.24	-5.96	-34.08	-0.05%	-0.28%	25.37	25.36	25.38	25.43
A	2,311.54	6,048.99	-165.95	-134.80	-7.18%	-2.23%	24.61	25.34	26.52	25.92
	9,227.12	10,878.67	-402.17	-173.15	-4.36%	-1.59%	21.34	21.67	22.31	22.02
	23,078.40	24,580.99	-232.57	-77.85	-1.01%	-0.32%	24.32	24.39	24.56	24.47
	1,529.36	1,858.34	-12.98	-4.21	-0.85%	-0.23%	25.79	25.88	26.01	25.94

	0.03	0.03	0.03	0.03	0.00	0.00	-0.12%	-0.15%
	0.08	0.08	0.08	0.08	0.00	0.00	-0.76%	-0.27%
	0.09	0.09	0.09	0.09	0.00	0.00	-0.44%	-0.14%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.40%	-0.16%
	0.10	0.10	0.11	0.10	0.00	0.00	-1.21%	-0.38%
	0.02	0.02	0.02	0.02	0.00	0.00	-0.11%	-0.05%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.50%	-0.15%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.54%	-0.22%
	0.05	0.05	0.05	0.05	0.00	0.00	-0.09%	0.01%
	0.39	0.39	0.39	0.39	0.00	0.00	-0.05%	0.07%
	0.32	0.32	0.32	0.32	0.00	0.00	-1.23%	-0.31%
	0.20	0.20	0.20	0.20	0.00	0.00	-0.31%	-0.12%
	0.80	0.80	0.80	0.81	0.00	-0.01	-0.30%	-1.09%
	0.15	0.16	0.16	0.16	0.00	0.00	-0.64%	-0.05%
	0.11	0.11	0.11	0.11	0.00	0.00	-0.22%	-0.10%
	0.02	0.02	0.02	0.02	0.00	0.00	-0.27%	-0.30%
	0.20	0.20	0.20	0.20	0.00	0.00	-0.24%	-0.70%
	0.10	0.10	0.10	0.10	0.00	0.00	-0.12%	-0.20%
	0.38	0.38	0.39	0.39	0.00	0.00	-0.77%	-0.24%
	0.48	0.48	0.48	0.48	0.00	-0.01	-0.33%	-1.19%
	0.51	0.50	0.50	0.51	0.01	0.00	2.19%	-0.89%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.51%	-0.17%
	0.34	0.34	0.34	0.34	0.00	0.00	-0.43%	0.17%
	0.06	0.06	0.06	0.06	0.00	0.00	-0.81%	-0.25%
	0.28	0.28	0.28	0.28	-0.01	0.00	-1.79%	-0.50%
	0.08	0.08	0.08	0.08	0.00	0.00	-0.15%	0.06%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.04%	-0.04%
	0.02	0.02	0.02	0.02	0.00	0.00	-0.20%	-0.14%
	0.01	0.01	0.01	0.01	0.00	0.00	-0.89%	-0.84%
	0.03	0.03	0.03	0.03	0.00	0.00	-0.98%	-0.43%
	0.02	0.02	0.02	0.02	0.00	0.00	-1.71%	-0.58%
	0.08	0.08	0.08	0.08	0.00	0.00	-0.04%	-0.24%
	0.04	0.04	0.04	0.04	0.00	0.00	-0.20%	-0.19%
	0.08	0.08	0.08	0.08	0.00	0.00	-0.97%	-0.42%
	0.05	0.05	0.05	0.05	0.00	0.00	-0.28%	-0.36%
	0.07	0.07	0.07	0.07	0.00	0.00	-0.26%	-0.14%
	0.07	0.07	0.07	0.07	0.00	0.00	-0.15%	-0.07%
-DE-MD	0.01	0.01	0.01	0.01	0.00	0.00	-1.80%	-0.65%
	0.04	0.04	0.04	0.04	0.00	0.00	-0.75%	-0.20%
	0.02	0.02	0.02	0.02	0.00	0.00	-0.76%	-0.32%
	0.11	0.11	0.11	0.11	0.00	0.00	-0.05%	-0.28%
A	0.02	0.02	0.02	0.02	0.00	0.00	-7.18%	-2.23%
	0.02	0.02	0.02	0.02	0.00	0.00	-4.36%	-1.59%
	0.04	0.04	0.04	0.04	0.00	0.00	-1.01%	-0.32%
	0.04	0.04	0.04	0.04	0.00	0.00	-0.85%	-0.23%

	Industrial Legacy	2	322.7	3,112,718	3,167,874	3,190,104	3,191,493	-77,386
	Up and Coming	3	298.3	4,053,814	4,104,806	4,124,773	4,126,695	-70,959
	Industrial Legacy	5	837.8	2,368,005	2,396,935	2,408,970	2,410,228	-40,964
	Industrial Legacy	4	229.0	1,680,859	1,700,417	1,708,812	1,708,224	-27,954
	Big and Growing	6	1,582.0	29,338,373	29,414,712	29,443,474	29,452,754	-105,102
	Growth Hub	6	908.4	13,808,092	13,893,990	13,932,615	13,932,022	-124,523
	Slow and Steady	3	888.9	10,394,640	10,501,467	10,545,564	10,551,486	-150,924
	Industrial Legacy	1	583.1	640,455	646,361	647,672	647,834	-7,217
	Up and Coming	5	66.1	113,576	113,660	113,702	113,605	-126
	Up and Coming	8	80.9	654,289	664,886	669,975	669,779	-15,685
	Up and Coming	10	142.8	3,445,999	3,470,052	3,480,412	3,480,531	-34,413
	Up and Coming	8	28.7	2,244,640	2,247,469	2,253,433	2,272,790	-8,793
	Up and Coming	1	171.0	1,266,711	1,288,909	1,296,052	1,294,985	-29,341
	Industrial Legacy	4	228.6	1,517,983	1,526,145	1,529,867	1,530,004	-11,884
	Big and Growing	6	1,253.9	48,056,544	48,190,801	48,256,172	48,354,893	-199,629
	Industrial Legacy	5	123.0	1,529,760	1,532,459	1,534,633	1,543,609	-4,874
	Up and Coming	7	278.5	3,410,153	3,411,650	3,414,194	3,418,414	-4,041
	Up and Coming	4	68.2	3,695,744	3,764,796	3,793,654	3,794,124	-97,910
	Industrial Legacy	5	50.2	42,515	42,765	43,030	43,390	-514
	Industrial Legacy	5	51.0	55,522	65,973	70,328	70,903	-14,806
	Up and Coming	5	801.5	3,939,379	4,006,153	4,032,966	4,034,634	-93,587
	Industrial Legacy	8	71.4	130,163	131,134	131,727	131,248	-1,565
	Slow and Steady	1	419.7	3,811,109	3,866,650	3,890,210	3,889,888	-79,102
	Up and Coming	7	95.4	878,423	892,219	899,299	898,039	-20,876
	Industrial Legacy	4	336.6	2,539,882	2,546,922	2,547,303	2,546,427	-7,421
	Up and Coming	4	1,016.9	3,594,895	3,599,350	3,600,848	3,601,538	-5,953
	Up and Coming	4	1,164.4	1,883,412	1,875,090	1,872,274	1,872,601	11,138
	Stable Metropolis	9	1,675.8	44,416,003	44,757,439	44,902,502	45,158,903	-486,499
	Slow and Steady	5	755.5	4,522,528	4,591,552	4,618,658	4,626,635	-96,130
	Growth Hub	5	1,133.5	17,631,994	17,996,358	18,152,988	18,160,934	-520,994
	Industrial Legacy	4	343.5	1,394,715	1,397,215	1,398,458	1,401,920	-3,743
	Up and Coming	3	613.8	510,410	508,825	508,098	508,168	2,312
	Industrial Legacy	1	295.0	2,116,519	2,142,505	2,154,209	2,154,980	-37,690
	Slow and Steady	6	528.5	3,575,554	3,591,362	3,596,266	3,607,009	-20,712
	Up and Coming	8	344.3	2,410,607	2,414,335	2,417,163	2,417,527	-6,555
	Growth Hub	4	363.0	12,596,596	12,669,022	12,701,364	12,702,429	-104,768
A-NJ-DE-MD	Stable Metropolis	2	4,454.0	17,085,944	17,474,432	17,649,761	17,657,142	-563,817
	Up and Coming	1	673.1	1,973,917	2,010,511	2,024,923	2,024,999	-51,007
A	Growth Hub	10	1,037.0	10,327,224	10,340,752	10,347,443	10,357,689	-20,220
	Slow and Steady	2	241.1	3,001,374	3,006,797	3,010,405	3,017,277	-9,031
e, CA	Growth Hub	9	1,220.4	7,453,109	8,642,845	9,194,551	9,202,556	-1,741,442
	Slow and Steady	9	922.3	10,129,056	10,459,129	10,595,377	10,616,608	-466,321
	Growth Hub	10	658.3	16,296,539	16,501,299	16,580,244	16,585,739	-283,705
	Industrial Legacy	6	729.6	1,416,457	1,444,129	1,456,189	1,455,908	-39,732

	9,647.05	9,818.00	9,886.89	9,891.19	-239.84	-73.20	-2.43%	-0.74%	25.59
	13,591.09	13,762.05	13,828.99	13,835.43	-237.90	-73.39	-1.72%	-0.53%	26.00
	2,826.52	2,861.06	2,875.42	2,876.92	-48.90	-15.87	-1.70%	-0.55%	23.61
	7,339.99	7,425.40	7,462.06	7,459.49	-122.07	-34.09	-1.64%	-0.46%	23.55
	18,545.23	18,593.49	18,611.67	18,617.53	-66.44	-24.05	-0.36%	-0.13%	26.98
	15,200.45	15,295.01	15,337.53	15,336.88	-137.08	-41.87	-0.89%	-0.27%	25.85
	11,693.30	11,813.47	11,863.08	11,869.74	-169.78	-56.27	-1.43%	-0.47%	23.48
	1,098.33	1,108.45	1,110.70	1,110.98	-12.38	-2.53	-1.11%	-0.23%	26.84
	1,718.24	1,719.51	1,720.15	1,718.68	-1.90	0.83	-0.11%	0.05%	26.00
	8,083.64	8,214.55	8,277.42	8,275.00	-193.79	-60.45	-2.34%	-0.73%	25.16
	24,133.33	24,301.79	24,374.34	24,375.18	-241.01	-73.39	-0.99%	-0.30%	28.08
	78,101.60	78,200.03	78,407.56	79,081.06	-305.96	-881.03	-0.39%	-1.11%	22.98
	7,406.80	7,536.60	7,578.37	7,572.12	-171.56	-35.52	-2.26%	-0.47%	25.91
	6,639.18	6,674.88	6,691.16	6,691.76	-51.98	-16.88	-0.78%	-0.25%	24.43
	38,324.44	38,431.50	38,483.64	38,562.37	-159.20	-130.86	-0.41%	-0.34%	27.89
	12,436.06	12,458.00	12,475.68	12,548.64	-39.62	-90.64	-0.32%	-0.72%	24.50
	12,242.96	12,248.33	12,257.46	12,272.61	-14.51	-24.28	-0.12%	-0.20%	27.36
	54,158.04	55,169.92	55,592.82	55,599.70	-1434.78	-429.78	-2.58%	-0.77%	25.58
	847.42	852.40	857.68	864.86	-10.25	-12.46	-1.20%	-1.44%	23.75
	1,088.45	1,293.33	1,378.71	1,389.99	-290.25	-96.66	-21.05%	-6.95%	20.21
	4,915.13	4,998.44	5,031.90	5,033.98	-116.77	-35.54	-2.32%	-0.71%	25.12
	1,823.27	1,836.87	1,845.18	1,838.46	-21.92	-1.59	-1.19%	-0.09%	24.06
	9,081.20	9,213.55	9,269.69	9,268.92	-188.49	-55.37	-2.03%	-0.60%	23.68
	9,206.82	9,351.42	9,425.63	9,412.42	-218.81	-61.00	-2.32%	-0.65%	25.88
	7,546.60	7,567.51	7,568.64	7,566.04	-22.05	1.47	-0.29%	0.02%	25.47
	3,535.22	3,539.60	3,541.07	3,541.75	-5.85	-2.15	-0.17%	-0.06%	25.68
	1,617.50	1,610.35	1,607.93	1,608.21	9.57	2.14	0.59%	0.13%	24.48
	26,504.99	26,708.74	26,795.31	26,948.31	-290.32	-239.57	-1.08%	-0.89%	23.00
	5,986.06	6,077.42	6,113.30	6,123.86	-127.24	-46.43	-2.08%	-0.76%	23.51
	15,555.90	15,877.36	16,015.55	16,022.56	-459.65	-145.20	-2.87%	-0.91%	26.70
	4,060.90	4,068.18	4,071.80	4,081.87	-10.90	-13.70	-0.27%	-0.34%	26.34
	831.60	829.02	827.83	827.94	3.77	1.07	0.46%	0.13%	24.44
	7,175.86	7,263.96	7,303.64	7,306.26	-127.78	-42.30	-1.75%	-0.58%	22.86
	6,765.35	6,795.26	6,804.54	6,824.86	-39.19	-29.61	-0.58%	-0.43%	24.25
	7,002.29	7,013.11	7,021.33	7,022.39	-19.04	-9.27	-0.27%	-0.13%	23.54
	34,702.32	34,901.85	34,990.95	34,993.88	-288.62	-92.03	-0.82%	-0.26%	24.04
A-NJ-DE-MD	3,836.11	3,923.33	3,962.69	3,964.35	-126.59	-41.02	-3.19%	-1.03%	23.11
	2,932.79	2,987.16	3,008.58	3,008.69	-75.78	-21.52	-2.52%	-0.72%	25.28
A	9,958.56	9,971.60	9,978.06	9,987.94	-19.50	-16.33	-0.20%	-0.16%	24.16
	12,450.73	12,473.23	12,488.20	12,516.70	-37.47	-43.47	-0.30%	-0.35%	25.29
e, CA	6,107.05	7,081.92	7,533.99	7,540.54	-1426.93	-458.62	-18.94%	-6.08%	20.74
	10,982.74	11,340.64	11,488.37	11,511.39	-505.62	-170.75	-4.40%	-1.48%	20.81
	24,756.24	25,067.30	25,187.22	25,195.57	-430.98	-128.27	-1.71%	-0.51%	23.99
	1,941.36	1,979.29	1,995.82	1,995.43	-54.46	-16.14	-2.73%	-0.81%	25.21

	-0.64	-0.19	-2.43%	-0.74%	0.08	0.08	0.08	0.08	0.00
	-0.46	-0.14	-1.72%	-0.53%	0.09	0.09	0.09	0.09	0.00
	-0.41	-0.13	-1.70%	-0.55%	0.03	0.03	0.03	0.03	0.00
	-0.39	-0.11	-1.64%	-0.46%	0.10	0.10	0.10	0.10	0.00
	-0.10	-0.03	-0.36%	-0.13%	0.02	0.02	0.02	0.02	0.00
	-0.23	-0.07	-0.89%	-0.27%	0.03	0.03	0.03	0.03	0.00
	-0.34	-0.11	-1.43%	-0.47%	0.03	0.03	0.03	0.03	0.00
	-0.30	-0.06	-1.11%	-0.23%	0.05	0.05	0.05	0.05	0.00
	-0.03	0.01	-0.11%	0.05%	0.39	0.39	0.39	0.39	0.00
	-0.60	-0.19	-2.34%	-0.73%	0.31	0.32	0.32	0.32	-0.01
	-0.28	-0.09	-0.99%	-0.30%	0.20	0.20	0.20	0.20	0.00
	-0.09	-0.26	-0.39%	-1.11%	0.80	0.80	0.80	0.81	0.00
	-0.60	-0.12	-2.26%	-0.47%	0.15	0.15	0.16	0.15	0.00
	-0.19	-0.06	-0.78%	-0.25%	0.11	0.11	0.11	0.11	0.00
	-0.12	-0.10	-0.41%	-0.34%	0.02	0.02	0.02	0.02	0.00
	-0.08	-0.18	-0.32%	-0.72%	0.20	0.20	0.20	0.20	0.00
	-0.03	-0.05	-0.12%	-0.20%	0.10	0.10	0.10	0.10	0.00
	-0.68	-0.20	-2.58%	-0.77%	0.37	0.38	0.38	0.38	-0.01
	-0.29	-0.35	-1.20%	-1.44%	0.47	0.48	0.48	0.48	-0.01
	-5.39	-1.79	-21.05%	-6.95%	0.40	0.47	0.50	0.51	-0.11
	-0.60	-0.18	-2.32%	-0.71%	0.03	0.03	0.03	0.03	0.00
	-0.29	-0.02	-1.19%	-0.09%	0.34	0.34	0.34	0.34	0.00
	-0.49	-0.14	-2.03%	-0.60%	0.06	0.06	0.06	0.06	0.00
	-0.61	-0.17	-2.32%	-0.65%	0.27	0.28	0.28	0.28	-0.01
	-0.07	0.00	-0.29%	0.02%	0.08	0.08	0.08	0.08	0.00
	-0.04	-0.02	-0.17%	-0.06%	0.03	0.03	0.03	0.03	0.00
	0.14	0.03	0.59%	0.13%	0.02	0.02	0.02	0.02	0.00
	-0.25	-0.21	-1.10%	-0.90%	0.01	0.01	0.01	0.01	0.00
	-0.50	-0.18	-2.08%	-0.76%	0.03	0.03	0.03	0.03	0.00
	-0.79	-0.25	-2.87%	-0.91%	0.02	0.02	0.02	0.02	0.00
	0.00	-0.06	0.01%	-0.21%	0.08	0.08	0.08	0.08	0.00
	0.11	0.03	0.46%	0.13%	0.04	0.04	0.04	0.04	0.00
	-0.41	-0.13	-1.75%	-0.58%	0.08	0.08	0.08	0.08	0.00
	-0.14	-0.11	-0.58%	-0.43%	0.05	0.05	0.05	0.05	0.00
	-0.06	-0.03	-0.27%	-0.13%	0.07	0.07	0.07	0.07	0.00
	-0.20	-0.06	-0.82%	-0.26%	0.07	0.07	0.07	0.07	0.00
A-NJ-DE-MD	-0.76	-0.25	-3.19%	-1.03%	0.01	0.01	0.01	0.01	0.00
	-0.65	-0.19	-2.52%	-0.72%	0.04	0.04	0.04	0.04	0.00
A	-0.05	-0.04	-0.20%	-0.16%	0.02	0.02	0.02	0.02	0.00
	-0.08	-0.09	-0.30%	-0.35%	0.10	0.11	0.11	0.11	0.00
e, CA	-4.85	-1.56	-18.94%	-6.08%	0.02	0.02	0.02	0.02	0.00
	-0.96	-0.32	-4.40%	-1.48%	0.02	0.02	0.02	0.02	0.00
	-0.42	-0.12	-1.71%	-0.51%	0.04	0.04	0.04	0.04	0.00
	-0.71	-0.21	-2.73%	-0.81%	0.03	0.04	0.04	0.04	0.00

APPENDIX F: TEMPORAL ANALYSIS FOR DETERMINING BROWNFIELD REDEVELOPMENT COMPELTION

A temporal analysis of the allocation results for the BFR scenario was performed to determine the expected year of brownfield redevelopment completion (i.e., when available brownfield site capacity was filled). The methodology that was followed for the analysis consisted of the following steps.

1. For each CBSA, interpolate year-over-year growth based on 2013 existing households (HH) and jobs and the 2030 HH and jobs control totals, using a compound annual growth rate formula. This gives an estimate of how much activity is added to each CBSA from one year to the next.
2. Using the trend growth attractiveness inputs for census block groups (CBGs), estimate how much growth in each year would go to each block group on a proportionate-attractiveness basis. Recall that housing and employment have different attractiveness scores in each CBG.
3. For any CBG with one or more brownfield sites located in it, assume any growth in that CBG goes to the brownfield site(s) first.
4. For each brownfield CBG, record the year in which the cumulative activity added to that CBG matches the activity allocated in our brownfield redevelopment simulation. Any later year growth in the CBG is assumed to occur at non-brownfield sites.

For any given aggregation (by CBSA, by EPA Region, or Growth Profile), this methodology resulted in the mean year (or the “expected year of completion”) for when brownfield sites filled up across all CBGs.

The tables below show reasonable timeframes for the brownfield redevelopment modeled in our growth simulations. The “earliest” and “latest” expected years of brownfield redevelopment completion are driven by the different results for the base and aggressive configurations.

EXPECTED YEAR OF BROWNFIELD REDEVELOPMENT COMPLETION BY CSBA (HH v JOBS)

		HH		Jobs	
CBSA	CBSA Name	Earliest	Latest	Earliest	Latest
10420	Akron, OH	2026	2028	2016	2017
10580	Albany-Schenectady-Troy, NY	2023	2027	2021	2023
10740	Albuquerque, NM	2018	2021	2018	2020
10900	Allentown-Bethlehem-Easton, PA-NJ	2023	2025	2018	2019
11460	Ann Arbor, MI	2021	2024	2017	2019
12060	Atlanta, GA	2021	2025	2017	2019
12420	Austin-Round Rock, TX	2017	2019	2015	2016
12580	Baltimore, MD	2023	2026	2019	2021
12620	Bangor, ME	2021	2023	2016	2017
13660	Big Rapids, MI	2016	2017	2015	2016
13740	Billings, MT	2019	2020	2021	2023
14260	Boise City, ID	2018	2021	2017	2019
14500	Boulder, CO	2016	2021	2015	2018
15540	Burlington-South Burlington, VT	2019	2020	2016	2017
16860	Chattanooga, TN-GA	2022	2026	2017	2018
19100	Dallas, TX	2018	2021	2017	2019
19380	Dayton, OH	2028	2029	2015	2015
19780	Des Moines-West Des Moines, IA	2023	2023	2014	2014
20500	Durham-Chapel Hill, NC	2026	2028	2018	2018
23140	Frankfort, IN	2026	2027	2016	2019
23300	Freeport, IL	2017	2017	2019	2022
24340	Grand Rapids-Wyoming, MI	2020	2022	2016	2018
24500	Great Falls, MT	2023	2026	2019	2022
25540	Hartford, CT	2021	2024	2018	2020
26980	Iowa City, IA	2018	2021	2018	2021
27140	Jackson, MS	2015	2017	2018	2022
28940	Knoxville, TN	2023	2024	2016	2017
29460	Lakeland-Winter Haven, FL	2021	2023	2019	2021
31080	Los Angeles, CA	2021	2024	2018	2020
33340	Milwaukee, WI	2019	2023	2019	2022
33460	Minneapolis, MN	2020	2023	2017	2018
33860	Montgomery, AL	2021	2023	2014	2014
34060	Morgantown, WV	2020	2022	2016	2017
35300	New Haven-Milford, CT	2025	2028	2017	2018
35380	New Orleans, LA	2022	2026	2015	2017
36260	Ogden-Clearfield, UT	2019	2024	2019	2023
36740	Orlando-Kissimmee-Sanford, FL	2020	2023	2016	2017
37980	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2023	2026	2020	2023
38860	Portland-South Portland, ME	2020	2023	2017	2018
38900	Portland-Vancouver-Hillsboro, OR-WA	2016	2018	2017	2019
40380	Rochester, NY	2024	2027	2017	2018
40900	Sacramento--Roseville--Arden-Arcade, CA	2022	2024	2018	2020
41860	San Francisco, CA	2021	2025	2020	2022
42660	Seattle, WA	2018	2020	2018	2020
43340	Shreveport-Bossier City, LA	2026	2028	2015	2016
44700	Stockton-Lodi, CA	2028	2030	2016	2019
44780	Sturgis, MI	2025	2027	2016	2018
48620	Wichita, KS	2024	2024	2015	2015
48980	Wilson, NC	2019	2021	2013	2013
49180	Winston-Salem, NC	2024	2029	2014	2014

PPENDIX F

XPECTED YEAR OF BROWNFIELD REDEVELOPMENT COMPLETION BY EPA REGION (HH v JOBS)

	HH		Jobs	
EPA Region	Earliest	Latest	Earliest	Latest
1	2022	2024	2017	2019
2	2023	2026	2020	2022
3	2022	2024	2018	2021
4	2021	2023	2017	2018
5	2021	2024	2017	2019
6	2020	2023	2016	2018
7	2023	2024	2015	2016
8	2020	2024	2019	2022
9	2021	2025	2018	2021
10	2017	2019	2017	2019

HH - # Yrs to BF Redev Complete (from 2013)		JOBS - # Yrs to BF Redev Complete (from 2013)	
Earliest	Latest	Earliest	Latest
9	11	4	6
10	13	7	9
9	11	5	8
8	10	4	5
8	11	4	6
7	10	3	5
10	11	2	3
7	11	6	9
8	12	5	8
4	6	4	6

XPECTED YEAR OF BROWNFIELD REDEVELOPMENT COMPLETION BY GROWTH PROFILE (HH v JOBS)

	HH		Jobs	
rowth Profile	Earliest	Latest	Earliest	Latest
g and Growing	2019	2023	2017	2019
rowth Hub	2019	2021	2017	2019
dustrial Legacy	2023	2025	2017	2018
ow and Steady	2021	2025	2018	2020
able Metropolis	2022	2025	2019	2022
p and Coming	2020	2022	2017	2018

HH - # Yrs to BF Redev Complete (from 2013)		JOBS - # Yrs to BF Redev Complete (from 2013)	
Earliest	Latest	Earliest	Latest
6	10	4	6
6	8	4	6
10	12	4	5
8	12	5	7
9	12	6	9
7	9	4	5