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The Value of Balanced Growth for Transportation

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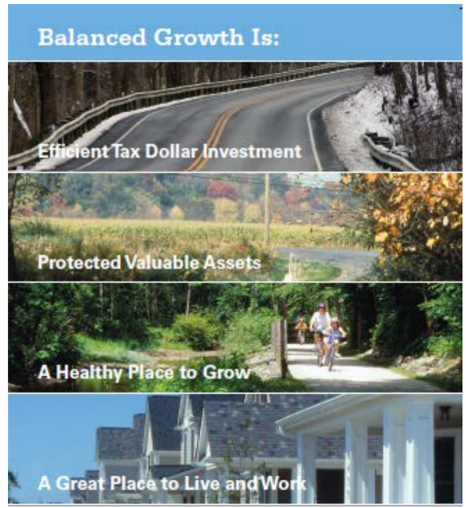

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16. Abstract

The Ohio Balanced Growth Program is a voluntary, locally-driven, incentive-driven program which aims to encourage compact, nodal development patterns. The Ohio Department of Transportation provided support for this research to evaluate potential links between Balanced Growth-type policy, land use and development patterns, and transportation benefits.

A literature review was completed to understand the existing body of knowledge regarding the connection between policy, land use, and transportation. This included a scan of Balanced Growth-type programs across the US. Twenty-six US Metropolitan Statistical Areas (MSAs) were selected and reviewed for general geographic and policy characteristics. Land use and transportation outcome data were examined via scatterplot and linear regression across all of the MSAs. The results were evaluated broadly in light of policy frameworks in effect in each MSA, by categorizing land use policy into "tiers" based on voluntary vs. mandatory provisions, and applicability to private and public investment. Finally, a policy review was completed to understand the potential benefits of policy change at the state, regional, and local agency levels.

Significant relationships were found between land use patterns, measured in terms of a sprawl composite index, and transportation outcomes for freeway lane miles, hours of delay, vehicle miles traveled, emissions, and safety. MSAs with "Tier 3" policies (mandatory, rigorous policy affecting both public and private investment) clustered together on both axes (transportation outcomes and sprawl); and MSAs within states clustered together along the sprawl score axis. Otherwise, there was no apparent pattern in the location of policy tiers along either the transportation or land use axes. Possible alternative explanations that could be evaluated in the future include overall transportation investment levels; inter-state and inter-regional travel demand; size and shape of the MSA; and market, economic and social factors. Conclusions included policy recommendations for ODOT in supporting compact, nodal development at the local, regional and state levels. Future study recommendations include pursuing future data collection, monitoring and evaluation over time.

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1.0 INTRODUCTION

1.1 BALANCED GROWTH, SPRAWL, COMPACTNESS AND NODALITY

Much has been written and observed about the decades-long pattern of outmigration from urban areas into suburban and exurban areas in the United States. Known as “sprawl”, this pattern is widespread, affecting metropolitan areas in both growth and low-growth regions of the country. Many of these observations have recognized the dual nature of drivers of this sprawling pattern: “push” factors that encourage people and business to move out of the central urban areas, such as deteriorating schools and increased crime and taxes, and “pull” factors that draw them to the suburbs, including new housing, lower taxes, and perceptions of better schools and reduced crime. Observed among the “pull” factors is the increased ease of transportation in the suburbs, with lower congestion, and new freeway investments that make a longer commute possible in less time.

With the national economic challenges since 2008, municipal, regional and state transportation budgets are constricted, and many government entities are exploring ways to reduce their costs for both capital improvements and maintenance. For transportation agencies, an obvious question is the role that the pattern of development plays in transportation benefits involving cost, efficiency, effectiveness, and safety, as well as related social factors such as emissions. How does new investment in low-density suburban areas stand up to the test of an affordable, efficient transportation system? Would higher-density development that is centered around activity nodes facilitate a more cost-effective, comprehensive transportation system for the future? What transportation benefits might accrue to state and regional agencies charged with providing a quality transportation system to support Ohio citizens, business and governments, through the support of programs that encourage more dense, activity-centered development?

As demonstrated in the literature review included in this study, there is much research that documents the connection between land use patterns and these transportation benefits. In particular, land use patterns that reflect higher densities, and a “nodal” character with development located around “activity centers”, have been shown to provide transportation benefits through reduced, more efficient, more effective, and more cost-effective transportation infrastructure. Compact (higher density) development and focused (nodal) development areas are strong candidates for the wider use of alternative modes of transportation, including bicycling, public transit and walking. A more diverse, compact and sustainable transportation system should result, with associated reduced costs and improved efficiency in transportation itself, as well as long term management, maintenance and development of the compact transportation system. In addition, there are other potential benefits to a dense, nodal pattern of development, such as better mobility for people, especially children and seniors; reduced commute times; easier access to goods and services; better business communication and connections; reduced emissions affecting public health; and so on.

1.2 BALANCED GROWTH-TYPE POLICY

In response to these findings, some states, regional agencies, and local governments in the US have implemented policy that attempts to encourage, or require, more dense, nodal development. These programs are known by a wide variety of labels, from “Smart Growth” to “Sustainable Growth” to “Balanced Growth” to “Traditional Neighborhood Development”. For the purposes of this study, this policy is identified as “Balanced Growth-Type policy” (BG-type).

Policy in effect, which usually is implemented at the state level, but also occurs at the individual regional or city level, is categorized into four tiers:

Tier 0 – states/regions with no policy related to Balanced Growth-Type development patterns;
Tier 1 – states/regions with *voluntary* Balanced Growth-Type policy that *encourages* both public and private investment decisions to align with Balanced Growth-Type principles, through incentives, technical assistance, education, and resources;
Tier 2 – states/regions with *mandatory* Balanced Growth-Type policy that affects state/regional (as applicable) public investment;
Tier 3 – states/regions with *mandatory* Balanced Growth-Type policy that requires all levels of government align with compact, nodal development patterns, affecting both public and private investment.

Ohio’s approach to “Balanced Growth-Type policy” is the Tier 1 Ohio Balanced Growth Program, a voluntary, incentive-driven program that encourages the implementation of local government planning and land use practices that have been shown to reduce watershed impacts and enhance economic benefit. The identified practices include compact development, and establishment of priority development, conservation and agricultural areas. These improved development patterns and practices have the potential to provide transportation benefits at the local, regional and state level, because focused development areas allow larger populations to be served with the same or lower levels of road and infrastructure investment, with more convenience and safety, and less cost.

Ohio’s infrastructure will require continued and substantial maintenance and restoration, even in the face of limited budgets. Many Ohio agencies, at all levels of government, are exploring ways to become more efficient in the use of their funds, and ensure that their missions are met, and infrastructure investments are wisely stewarded, into the future. The presence of the Ohio Balanced Growth Program offers the possibility of promoting patterns of growth that could reduce costs, improve safety and efficiency, and benefit the environment. However, the Ohio Balanced Growth Program is quite new, and there is a need to understand the effectiveness and application of balanced-growth-like policies as they are working in other areas around the country.

As stated above, Balanced Growth-type programs and policies are defined as those that seek to encourage higher density, nodal development patterns. It should be noted that land use comprehensive planning, even if mandatory, while enabling more efficient government decision-making, does not necessarily influence a compact, nodal pattern of development. It is quite possible to do an excellent job planning for a sprawling pattern of development.

1.3 REPORT OUTLINE

This project provides a review of existing research and policy frameworks, and application of analysis to focus areas in 26 MSAs around the United States, to illuminate methods, models, policy and recommendations that could provide benefits to ODOT and other state, regional and local agencies. The analysis evaluates land use characteristics and their relationship to transportation benefits, in light of a wide range of policy frameworks.

Aligning with the original research objectives, the study was conducted in four parts:

1) Literature Review
2) Data collection
3) Data analysis
4) Review of Policy

After a literature review to understand the existing state of study on this topic, the overall approach of the study was to link policy to resulting land use patterns, and then land use patterns to transportation outcomes, therefore enabling the identification of possible connections between policy and transportation outcomes. To do this, data was analyzed for 26 MSAs across the country. Finally, policy review looked at the range of policies utilized, the potential benefits of these policies, and their applicability to state, regional and local jurisdictions in Ohio. In particular, this research focused on policies that fell into the Tier 1 and Tier 2 categories, as they were most likely to be implementable in Ohio.

The compactness and nodality of development is tested here for its relationship to key transportation outcomes. These patterns may originate in historic patterns in a community, geographic, economic, and market factors, or may be the result of deliberate policy on the part of state, regional and/or local agencies.

1.4 TRANSPORTATION BENEFITS

Based on the literature review (see section 3.1), the following transportation benefits have been identified by others as associated with compact, nodal land use patterns. These are the potential benefits discussed and evaluated in this study.

TABLE 1A – TRANSPORTATION BENEFITS

POTENTIAL TRANSPORTATION BENEFITS OF COMPACT/NODAL LAND USE PATTERNS
1. TRANSPORTATION EFFECTIVENESS • Reduced lane miles overall • Associated reduced investment for construction • Associated reduced costs/investment for maintenance 2. TRANSPORTATION EFFICIENCY • reduced vehicle miles traveled per capita • increased opportunity for optimizing use of transit systems and other alternative modes • reduced peak travel demand

- reduced congestion and delay, travel times

3. ECONOMIC/COMMUNITY TRANSPORTATION BENEFITS
   - Increased safety
   - Increased mobility and access for non-driving population
   - Improved transportation choice
   - Reduced fuel consumption
   - Increased local jobs from system maintenance priority
   - Reduced transportation costs overall to citizens, business, and government
   - Reduced local highway capital and maintenance costs
   - Reduced emissions/air pollution
   - Increased local tax revenue per acre in redeveloped areas

These potential benefits are important because they can help ODOT to meet its mission going forward. ODOT's mission is to "Provide easy movement of people and goods from place to place". ODOT's objectives in meeting this mission include "taking care of what we have, making the system work better, improving safety, and enhancing capacity. "

An efficient system, which provides more choices for travel mode, reduced cost, minimized delay and travel distance, and increased safety, makes travel easier for citizens and business alike. Reduced costs to ODOT, through reduced capital and maintenance costs, mean that more funds are available to meet the objectives of taking care of existing infrastructure, improving system function and safety, and enhancing capacity. Reducing peak travel demand and improving optimization of travel modes (the highway-transit-bicycle-walking balance) will allow for enhanced capacity while limiting the need for expensive new infrastructure. Finally, part of "making the system work better" is integrating it well into the community and the economic environment, through community benefits such as increased mobility for the non-driving population, reduced fuel consumption, enhanced property values, job creation, and reduced pollution.

Summary:

This study is an attempt to answer the following questions:

- *How can land use policy influence land use patterns?*
- *How can land use patterns influence transportation outcomes, particularly transportation benefits?*
- *Are there transportation benefits that result from certain land use policies?*
- *What policies might be most effectively implemented in Ohio to achieve transportation benefits, and how?*
- *How might the Ohio Department of Transportation continue to pursue transportation benefits, through participation in the Ohio Balanced Growth Program, utilization of existing programs and processes, and future data gathering and research?*

2.0. RESEARCH OBJECTIVES

The project goals were outlined in the original proposal for this research, as shown in italics. The objectives were refined as the project developed, as noted where applicable after each objective.

2.1 OVERARCHING GOAL

The overall purpose of the research project was *to assist ODOT with understanding the relationship of transportation decisions to land use policy that supports transportation benefits, namely increased transportation efficiency and effectiveness.*

It was important to evaluate these relationships through existing conditions, going beyond the literature to generate a fresh analysis of regional land use and transportation characteristics that could be compared to Ohio regions. As outlined in the proposal for research, the following objectives were identified:

2.2 SPECIFIC GOALS

2.2.1 GOAL 1: Literature Review

Understand the full range of Balanced Growth programs in the nation, and existing research, modeling methods, and policy recommendations related to their effect on transportation planning, efficiency and effectiveness.

Recognizing that specific additional issues were involved in ODOT decision-making, literature related to transportation cost was also researched. Transportation-related community and economic benefits were also explored. A full inventory of Balanced Growth programs in the 50 states is included in the Appendix.

2.2.2 GOAL 2: Data Collection

Collect and develop data that documents the relationship of incentives and policy in Balanced Growth programs to transportation investment, efficiency and effectiveness.

The original intent was to collect and evaluate data for 12 “focus areas”; however, as data was collected, it became clear that the questions to be tested would be better answered with a larger group of focus areas. Ultimately, data was collected for 26 MSAs across the US.

2.2.4 GOAL 3: Data Analysis

Synthesize the new data, for use by state, regional MPO, and local governments in understanding the potential effects of Balanced Growth land use policy decisions on transportation investment, efficiency and effectiveness.

Data was synthesized using linear regression and scatterplot analysis.

2.2.5 GOAL 4: Policy Review

Develop recommendations for state, regional MPO, and local government policy related to land use that will improve transportation efficiency and effectiveness.

Specific benefits evaluated included transportation effectiveness (lane miles as a surrogate for cost/investment), transportation efficiency (vehicle miles traveled, mode choice and delay), and transportation-related community/economic benefits (safety and emissions).

Summary:

A four-step process was followed, as outlined in the original Request for Proposals and Research Project Proposal, to establish the existing knowledge, and generate new analysis relevant to Ohio, related to the transportation benefits that could result from Balanced Growth-Type Programs.

3.0 GENERAL DESCRIPTION OF RESEARCH

3.1 LITERATURE REVIEW

3.1.1 INTRODUCTION

The objective of this section is to review literature and information regarding Balanced Growth–type programs and policies across the country and their impact on transportation benefits, particularly with regard to: effectiveness, efficiency and transportation-related community benefits. A literature review and scan was done to discover key elements of policies and processes across the country that address the relationship between land use, transportation benefits, and Balanced-Growth-type policy. The review is organized into three parts:

1) National Program Scan. A broad scan of literature concerning Balanced-Growth-Type programs across the country was conducted. A web review was conducted to describe state-level Balanced-Growth-Type programs in all 50 states. These were supplemented by information request calls to state offices to clarify program descriptions, and to confirm implementation strength and operation of programs in effect.

2) Understanding the Land Use and Transportation Connection. The literature was reviewed on relationships and concepts related to the intersection of land use and transportation, including methodologies, road infrastructure and cost, commute times and distances, trip rates and mode choice, vehicle-miles traveled, emissions, and vehicle collisions.

3) ODOT Priorities and Processes. Key ODOT plans, priorities and processes were reviewed and summarized that could be utilized in implementation of study recommendations.

The literature related to Balanced-Growth-Type policy specifically relevant to ODOT was also reviewed, and is incorporated into Section 4.4, Policy Review Results.

All references cited are listed in Section 7.0, References and Bibliography.

3.1.2 SCAN OF STATE PROGRAMS

Broad Review

Many programs were identified across the country that attempt to influence growth patterns toward a more compact character, and/or with development focus areas. They follow a continuum from voluntary to regulatory, and differ in the extent to which they attempt to influence or regulate private vs. public investment. In most cases, a suite of different policy approaches is present in each state, and to some extent they differ among MSAs within a particular state. The following table summarizes the range of policies and types of programs found. They are categorized by the level of regulatory purpose required, from entirely voluntary, to mandatory public regional and state agency policy, to mandatory policy affecting all levels of government, and therefore both public and private investment.

Information sources for the inventory included literature resources noted in the references; state web sites; and information request calls to state agencies.

TABLE 3.A SUMMARY OF BALANCED GROWTH-TYPE POLICIES

Practice/Policy	Comments	Examples
TIER 1: Voluntary and incentive-driven programs		
Designated Protection/Development Focus zones/areas with incentives	Drinking water protection zones, coastal protection zones, priority development/conservation areas (voluntary alignment)	Texas, Ohio
Align existing programs/funding as incentives	Encourage denser, nodal development	Lancaster PA, VT, OH
Streamlining/reducing regulatory burdens for development in infill areas	Encourage infill	CO, FL, GA, ME, MD, NJ, PA
Facilitating brownfields redevelopment	Encourage infill	CO, CT, IL, MD, MA, MI, MO, OH, PA, WI
Infrastructure fix-it first policies	Emphasize enhancement of existing developed areas and de-emphasize development of new areas	AZ, IL, MD, MA, OH, WA
Supporting open space acquisition	Open space acquisition can constrain development	IN, ME, MD, MI, NJ, NC, OH, PA, TN, WA, AZ, CO, CT, FL, GA, IL, MA, NY, NC, RI, UT, SC, TX, VA, AL
Historic rehabilitation tax credits	Encourage redevelopment and reinvestment in existing areas	OH
Tax incentives for business location, etc.		CO, CT, IL, MD, NJ, PA
Support best practices through technical assistance	Encourage implementation of best practices	ME, MD, MA, MN, MO, NE, NJ, NC, OR, UT, WA WI WY
Telecommuting programs	encourage congestion reduction/reduce infrastructure needs	AZ
Support regional policy plans through incentives	Encourage denser, more nodal development	Minneapolis-St Paul, regions nationwide
TIER 2: Agency Administrative Programs	**State and local agencies create goals and guidelines for focused development, and align with those goals in infrastructure and capital investment decision making**	
Designated urban service areas for infrastructure (concurrency requirements)	Limit fiscal support for infrastructure expansion until needed	Butler County, OH; Boulder County, CO; Minneapolis-St Paul, TN

Practice/Policy	Comments	Examples
Eliminate state subsidies that promote sprawl	Focus on more dense, nodal development	AZ, CO, CT, DE, FL, ME, MD, MA, NH, NJ, OH, RI, SC, WA, WV
Require state agencies align capital investments with planning goals for Balanced-Growth type development patterns		CT, TN, WA, OR
TIER 3: Mandatory/Regulatory Programs or equivalent	**Requires funding, legislation, or political will**	
Urban growth boundaries	Infrastructure and development not permitted to expand beyond boundaries determined by land needs of projected growth	OR, WA
State or regional land use plan, mandatory consistency	State, regional and local decisions must align with compact/nodal development patterns	OR, WA
Mandatory transfer of development rights legislation	Mandatory participation in TDR program in order to achieve density increases; transfers development from outlying designated conservation areas to designated receiving development areas	PA, NJ
Rigorous Open Space Acquisition Programs	Aggressive funding of large open space acquisition areas can have an effect similar to urban growth boundaries; see text for further discussion	Boulder, CO

Land Use Planning Interventions Related to Balanced Growth

As the inventory indicates, states and regions across the country have implemented a wide range of programs and policies to control growth. These range from comprehensive statewide planning that include growth containment policies to the more voluntary/incentive Balance Growth-type of plans. The following summarizes the literature surrounding these interventions:

Comprehensive statewide Balanced Growth-Type land use plans. In late 2008, 14 states had laws that could be considered “smart growth programs” (Duran and Lahr, 2009). (Examples include Oregon, Washington, New Jersey, Tennessee, Maryland.) The Maryland legislature enacted Smart Growth Legislation that created, among other tools, priority funding areas to direct state spending to existing communities and places where local governments want state investment to support future growth. Other states such as Utah have legislation that gives states responsibilities for land use planning, and these plans may include Balanced Growth principles, but without regulatory authority for implementation.

Urban Growth Areas/Boundaries (UGB). UGBs seek to contain growth through land use policy. Growth areas are designated by either a state or a region as areas in which urban growth is encouraged, and outside of which growth can occur only if it is not urban in nature. An Urban Growth Boundary is a perimeter drawn around an Urban Growth Area that separates urbanizable land from rural land, for a set period of time specified by a growth management program. (Meck, 2002) Portland, Oregon is a prime example.

Urban Service Areas. Similar to Urban Growth Boundaries, Urban Service Areas are a planning tool designed to prevent sprawl by identifying areas in which local governments will provide public services such as water and sewer systems, roadway improvements, police and fire services. Examples include Lexington-Fayette, Kentucky, Orlando and Sarasota, Florida, and the Twin Cities, Minnesota. While often not specifically implemented for Balanced Growth purposes, these programs, if enforced, can have the effect of achieving more compact, nodal growth patterns.

Priority Investment Areas. States or regions identify urbanized or urbanizing areas tied to funding as a way to control growth. These can be incentive-driven, similar to Balanced Growth, or can involve capital investment priorities within agencies.

Incentive-Driven Programs. In strong home rule states and states without strong statewide planning functions, regions may prioritize areas for development and conservation, with a range of effects, depending on the strength of the implementation and incentives provided.

Regional Planning for Balanced Growth. Many regions have done land use plans that incorporate Balanced-Growth-Type principles, but leave implementation to individual municipalities or MPOs. An example is the Northeast Ohio Sustainable Communities Consortium (NEOSCC). Other examples include Atlanta, and Lancaster, Pennsylvania. A regional approach was effective in Lancaster but it included financial incentives for local governments to adopt Balanced-Growth-Type principles. The Atlanta experience offers an example of a regional effort to control growth that was not implemented by localities.

Transportation Planning Interventions Related to Balanced Growth

Concurrency. Concurrency is a mechanism for guiding development whereby public facilities and services needed to support development are required to be available concurrent with the impacts of development. For example, Florida adopted a statewide policy requiring local governments to establish level-of-service (LOS) standards for roadways. These standards were applied to ensure that appropriate roadway capacity would exist concurrent with new development. If the impact of a new development were to exceed level of service standards, the developer would be required to pay for roadway improvements to mitigate the impacts on level of service. This policy encouraged development in new areas, rather than infill in existing areas, because only late-coming developers to an area would push demand for roadways over capacity. Hence, the policy made building in lower density areas with plenty of roadway capacity less expensive than building in denser, infill areas (Seggerman et. al, 2009).

Six states, Georgia, Maine, Oregon, Rhode Island, Vermont, and Washington listed concurrency as a state goal. Florida listed concurrency as a statewide goal, but it also relies on local governments to establish level of service standards to which each new development must be assessed before a permit is issued. New Jersey's State Planning Act called for the State Plan to "promote development and redevelopment in a manner consistent with sound planning and where infrastructure can be provided at private expense or with reasonable expenditures of public funds." Five states, Connecticut, Delaware, Hawaii, Maryland, and New Hampshire incorporat concurrency provisions in other areas of their planning programs, with most requiring local governments to address it in their comprehensive plans (Purcell, 1997).

Level of service standards and other performance measures. Transportation departments often evaluate the performance of roads based on their level-of-service (LOS) and other performance measures. Smart Growth America recommends that LOS and traffic forecasts should be only one tool in project decisions especially for secondary and tertiary roads. Other factors to consider are maintaining or enhancing the quality of the community, including through other modes including walking, biking and transit in more densely developed areas. (Smart Growth America, 2010c) Examples include Oregon and Montana.

Transportation modeling methods evaluating Balanced Growth-Type factors. Transportation modeling is widely used by metropolitan planning organizations and some states to estimate the effects of proposed future transportation projects. These models feed into regional long-range transportation plans that are required for projects in order to receive federal transportation funding. They are also used to estimate air quality impacts. Smart Growth America and the U.S. Environmental Protection Agency have worked with the Institute of Traffic Engineers to develop Smart Trip Generation Formulas to model traffic impacts. This model is especially useful in urban areas because it takes into account transit availability, the amount of nearby activities that can be reached on foot, and quality of the pedestrian environment. Modeling should be able to accommodate all modes of transportation. The EPA models have been validated against actual traffic counts at mixed-use developments across the country. The method is currently used in several regions in California, Washington State, and New Mexico. The Virginia Department of Transportation recently adopted it as a statewide standard for determining the traffic impacts of urban developments. Oregon has also developed a well-integrated transportation, land-use and economic model. (U.S. Environmental Protection Agency)

Impact and other fees. Development impact fees are one-time charges applied to new developments to raise revenue for construction or expansion of the infrastructure needed to accommodate growth. (Levy, 2010) These fees are intended to disincent development in new areas and encourage infill development in existing areas, by reducing public subsidies for new infrastructure in new development areas. They have been found to be most effective when they are tied to a comprehensive plan. (Levy, 2010) However, they also have been criticized as simply raising the cost of housing without affecting the pattern of development. Some states require a comprehensive plan, including a capital improvement plan prior to a locality adopting impact fees (Nelson, 1988). They are generally viewed as a "fair and equitable method of distributing the cost of transportation improvements"—new development bears the cost. Different cost methods can be applied. Characteristics of communities with impact fees include:

- Large population base
- Moderate to rapid growth
- High property taxes
- Large capital investments in need of maintenance. (Levy, 2010)

Other Transportation Demand Management Strategies. Many localities have experimented with financial incentives and disincentives in order to change travel behavior and reduce emissions by reducing Vehicle Miles Traveled (VMT). Examples include:

- Parking fees and congestion fees. A British study shows doubling parking charges reduces central area car trips by 13%. (Timilsina and Dulal, 2010)

- Mobility Fee: A mobility fee is levied on new development on a geographic (district, municipality, or county) basis, and can be based on typical vehicle miles traveled, trips per household, and similar measures, for the type of development involved. Funds generated are used to help pay for multi-modal improvements. Florida enabled this after studies in 2009 as a replacement for the state mandated concurrency system. It is beginning to be adopted by counties as replacements for impact fees. Mobility fees capture the impact on bicycles, transit and pedestrians in addition to cars. The fee would be collected and directed not only to outer area growth but also to central city use. "Transportation facility and service improvements focused in urban areas would serve redevelopment and infill and address all modes of transportation including transit." (Seggerman, 2009).(Pasco County 2014)(FDOE 2014). While studies were done prior to its enactment in 2010, the effect of mobility fees on development patterns is not clear. It is possible that, similar to impact fees, such fees serve more to increase the cost of development than to influence development patterns.

Key Characteristics of the Ohio Balanced Growth Program

The Ohio Balanced Growth Program uses watersheds as the key organizing feature for land use planning. Watershed-scale land use planning allows coordinated, regional decision-making about how growth and conservation should be promoted by local and state policies and investments. A Balanced Growth plan takes into account a review of local development pressures and opportunities and an inventory of sensitive resources, as well as infrastructure that supports development.

The Ohio Balanced Growth Program has the following elements, as outlined in the Ohio Balanced Growth Strategy 2011 (Ohio Lake Erie Commission and Ohio Water Resources Council, 2011):

Voluntary (focus on education, provision of tools and resources, technical assistance and research). Localities that develop watershed Balanced Growth (BG) plans are not required to follow them whether the plan is endorsed by the state or not.

Incentive driven. Ohio has agreed to align the policies of various state agencies to support endorsed watershed BG districts. Watershed Balanced Growth Plans are intended to help public and private interests understand they can anticipate incentives such as streamlined decision making for development in the Priority Development Areas (PDAs), the preservation of agriculture in Priority Agricultural Areas (PAAs) and incentives for conservation in Priority Conservation Areas (PCAs).

Establishment of priority development, conservation and agricultural areas. Incentives are provided within these priority areas via various state agency programs, contingent on available funding where needed.

Incorporate "Best Local Land Use Practices". Voluntary practices recommended to be adopted by local governments include:

- Compact development
- Conservation development
- Conservation land use policy including stream, floodplain, and wetland protection; historic preservation; scenic protection; natural lands management; source water protection; agricultural lands protection; tree and woodland protection; steep slope protection.

- Adoption of comprehensive plans, code updates and enhancements
- Other land use policies that include: brownfields redevelopment, transfer of development rights, storm water management; historic and scenic protection, and access management.

Strong partnerships. Local governments within watersheds use the Balanced Growth Watershed Planning framework to work collaboratively to achieve consensus on priorities for development and conservation.

Support for economic development. The Balanced Growth Program has dual goals of environmental protection and economic development, and supports the economic benefit of recommended practices through its resources and education. (Ohio Balanced Growth Program, 2011)

Balanced Growth (BG)-Type Programs in Other States

Overview. By 2008, at least 14 states had enacted statewide Balanced Growth-Type (Smart Growth) planning legislation to guide future growth and development. This has expanded since then. A full summary as of 2014 is given later in this section, including a summary of an inventory of programs in the 50 states. A full inventory with more detail is included in the appendix. The following summary is intended to offer examples and a framework for understanding policy types.

An earlier study conducted by the New Jersey Office of State Planning looked at 13 state planning programs (Purcell, 1997). Ten states (Delaware, Florida, Hawaii, Maine, Maryland, New Jersey, Oregon, Rhode Island, Vermont, and Washington) created state-level planning practices and programs that rely on local comprehensive plans and ordinances in order to implement state goals and guidelines for growth. Three states (Connecticut, New Hampshire, and Georgia) did not rely solely on local comprehensive plans and ordinances, but rather called for regional plans and state agency plans to implement the state program.

All the programs reviewed shared a recognition of the inter-jurisdictional impacts of planning and zoning and took a systems approach to land use governance. Within these 13 states, local planning was the foundation for most state planning programs. However, the states had varying degrees of state planning, with most adopting strong statewide planning functions. Some states (CA and NC) enacted legislation that coordinates state and local planning and permitting activities within coastal areas. Nine of the states, including Connecticut, Delaware, Georgia, Hawaii, Maine, Maryland, New Hampshire, New Jersey, and Vermont had maintained “home rule” approaches to growth management giving localities more control, with several creating incentives rather than legal requirements for local governments to comply with state planning guidelines. Other states, including Vermont, rely on an incentive based approach.

Classifications. The programs summarized through the literature review and national scan were classified according to three tiers (a fourth, Tier 0, indicates states and/or regions without policy intended to encourage compact, focused development areas). See further discussion later in this report under Methodology, Findings and Results. Examples are given below for each tier.

Tier 1: Balanced Growth-Type programs that are voluntary and encourage Balanced Growth-Type development through incentives, technical assistance, education and collaboration.

Programs classified as Tier 1 give deference to local governments and communities. However, they can revise funding formulas and regulations to require or strongly encourage comprehensive planning by local governments and/or counties. States have also revised program guidelines to require or encourage transportation, land use and mobility programs that promote compact development patterns; or provided incentives to align with state goals. Others have implemented a state review and comment on local plans. Examples include New Hampshire, Vermont, Georgia, Pennsylvania, and Illinois. The Ohio Balanced Growth Program is a Tier 1 program.

Austin, Texas. At one time, the Austin area had a Desired Development Zone and Drinking Water Protection Zone. This is similar to Balanced Growth but on a smaller scale. The program discouraged development of buildings and water-related facilities within the DWPZ while encouraging them in the DDZ. This program has now been replaced with a more comprehensive approach to encouraging compact development and resource protection.

Atlanta, Georgia. The Atlanta region offers an example of a regional transportation planning authority trying to coordinate land use and transportation planning without a state mandate. The Georgia Regional Transportation Authority was created in 1998 to address air quality concerns and was given authority to approve regional land use plans. It soon found itself at odds with the Atlanta Regional Commission and the state Department of Transportation over land use and transportation plans that it felt did not go far enough to address air quality concerns through compact and transit oriented development plans. It even threatened to remove federal and state funding from communities that rejected such density-building measures. Amid lawsuits and federal intervention, the plan was eventually approved with slightly more stringent air quality regulations. The experience illustrates the impact of local opposition to compact development (Jaret 2002).

Tier 2: Administrative policies requiring state or regional agency investment and policy to align with an adopted agency guide plan recommending compact/focused growth. This approach requires state or regional agency collaboration with other state or local/regional agencies for success.

Several states require horizontal and vertical coordination to ensure that agencies prepare plans that are consistent with other state agency plans (horizontal coordination) and that address the goals and objectives of the overall state plan. Others require coordination with local planning entities (vertical coordination). For example, according to the New Jersey study, Connecticut requires integrated planning and New Jersey requires cross acceptance of plans. Four states, Florida, Oregon, Rhode Island, and Washington require local comprehensive plans be approved by the state (Purcell, 1997).

Connecticut. Integrated planning is the principal strategy for assuring that local, regional, and state-level development is consistent with the state’s plan. The state plan provides a blueprint by which planning can be coordinated both horizontally and vertically. Horizontal coordination involves communication between state agencies or contiguous municipalities which propose development projects with potential impact across agency or geographic lines. Developments carried out by units of state government should strive for vertical consistency with regional and local planning efforts and priorities. Integrated or coordinated planning systems, whether along horizontal or vertical lines, will enhance local, regional, and state development efforts. They are not intended as a strategy for eroding the authority of individual municipalities.

Vermont. Planning at the local level is optional; however, those towns that choose to adopt municipal plans consistent with state goals receive additional funding, technical assistance, and greater influence over state actions that affect their communities. If a town opts to prepare a comprehensive plan, it must include both land use and transportation elements. The Department of Transportation establishes its own capital budget outlining long-range projects and programs. The long-term capital needs for local governments are coordinated by Regional Planning Councils (Purcell, 1997).

Hawaii. The statewide planning system requires the preparation of state functional plans by state agencies in 11 functional areas: agriculture, conservation lands, housing, recreation, transportation, etc. The functional plans must conform to the objectives and policies of the state plan, and must take into consideration county general plans, development plans, and applicable federal laws.

Maryland. The Planning Act of 1992 established procedures that ensure state infrastructure improvements are consistent with the state's growth policy, and reinforce the pattern of development established in local plans. A premise of the Act is that comprehensive plans prepared by counties and towns are the best place for local governments to establish priorities for growth and resource conservation, and that once those priorities are established, it is the state's responsibility to back them up. Local construction projects involving the use of state funds cannot be approved by a local government unless the project is consistent with the local comprehensive plan. The state does not plan and zone like a local jurisdiction- local governments remain the principal players for decision making for land-use development. However, the state's public works projects shape growth as significantly as the local planning process.

Delaware. The Shaping Delaware's Future Act requires county governments to prepare comprehensive plans. The plans must include a mobility element that is consistent with the approved Area-wide Transportation Plan and has been developed in conjunction with the Delaware Department of Transportation. The mobility element shall include recommendations for land use regulations that promote a range of sustainable transportation choices for future transportation needs. Under the act, the state is not obligated to provide financial assistance or infrastructure improvements to support county land use or development decisions that are inconsistent with approved state plans and policies.

Tier 3. Mandatory regulation requires local, regional and state agency compliance with local, regional or state land use plans that emphasize compact/nodal development; or aggressive open space acquisition effectively confines development expansion. Both affect both private and public investment. When regulation is involved, a managing planning office (at the state, regional or local level) is responsible for reviewing plans and ensuring their compliance with the regulation. Two states have implemented Tier 3 type programs; and some municipalities and regions, lacking strong state programs, have implemented them within their jurisdictions. In one region that was identified (Boulder, Colorado), aggressive open space acquisition effectively confines development expansion. All of these approaches require additional funding, legislative action, and political will at the level implemented.

Oregon. Planning regulations put in place in 1973 require local, regional and state agency compliance with a state guide plan, as certified by a coordinating state planning office. The guide plan includes many Balanced Growth-Type elements, including mandatory urban growth boundaries, minimum densities for cities, agricultural zones, economic development based on competitive characteristics of area, and multi-modal transportation.

Boulder, Colorado. While the state of Colorado's Balanced Growth-Type policy has evolved from more stringent (Tier 2/3) to less stringent (Tier 1) over the years, a consortium of eight organizations in the Boulder area have been rigorously acquiring open space as a buffer around the city, and separating it from the City of Denver to the southeast. Begun in 1898, this coordinated effort has created an extensive no-build zone around the developed area, essentially acting as an urban growth boundary that has been pursued with widespread community support.

Inventory

Table 3B identifies the Balanced-Growth-Type programs in each state, along with a tier designation for those programs, according to the criteria outlined above. The reader is reminded that state law requiring planning in and of itself is not a "Balanced Growth-Type" policy; specific guidelines must be included that encourage compact, nodal patterns of development. It should also be noted that each state program is unique, and many fall into a "gray area" between two tiers. In addition, tier designations are cumulative. Tier 3 programs often incorporate elements of Tier 2 and Tier 1 programs; and Tier 2 programs often incorporate elements of Tier 1 programs. The most rigorous applicable tier was chosen as the designation for the state.

The National Programs table is an abbreviated summary of Tier 1, 2 and 3 state-level policy in the US. A more detailed inventory, including Tier 0 states, information on notable local programs, and information on implementation and effects, is included in the Appendix (8.1). Note that for this inventory, current policy (2014) is presented as the basis for Tier designations. In the analysis part of this research, the Policy Tier in effect as of 2010 is utilized for the selected MSAs, in order to align with the 2010 data available. See further discussion under Methodology later in this report.

As of 2014, there were 26 states with Balanced-Growth-Type programs in the US. Of these, 11 are classified as Tier 1 (AZ, CO, GA, HI, IA, KY, MN, OH, PA, UT, WI), 13 as Tier 2 (CA, CT, DE, FL, ME, MD, MA, NH, NJ, NY, RI, TN, VT) and two as Tier 3 (OR, WA). Note that the tier designation "on the face" of stated state program descriptions is modified based on implementation strength – the likelihood of meaningful consequences for non-compliance. Where there is law requiring, for example, mandatory local comprehensive plans that align with state Balanced-Growth-Type principles, often the lack of consequences for non-compliance, or administrative procedures to ensure compliance, has resulted in very little implementation. More detail on each state is given in the Appendix.

Tier 1 programs varied widely in their methods for encouraging Balanced-Growth-Type development patterns. The voluntary Ohio Balanced Growth Program, implemented in 2009, applies state program incentives to locally-designated priority areas for conservation, development and agriculture. The Utah Quality Growth Act provides similar incentives to local communities who are certified as "Quality Growth Communities" based on criteria involving Balanced Growth-Type principles. Both programs supplement the incentives and locally-driven planning efforts with technical assistance, guidance, and recommendations. In Wisconsin, a comprehensive planning grant program was very successful from 1999-2010, with participating communities selected based on Balanced Growth-Type criteria. In Kentucky, Balanced Growth-Type principles are incorporated into some state initiatives, but incentives are not provided.

Tier 2 policy states are those that were identified as consistently directing state (and in some cases regional) investment according to Balanced Growth-Type principles. There is some variation in implementation strength, but the states so designated appear to be implementing inter-agency coordination in order to align with state guidelines. Examples include California, which requires both state and regional MPO agencies to adhere to Balanced Growth-Type principles in state investments, funding programs, and Regional Transportation Plans. Florida, under the 2011 Community Planning Act, uses principles such as compact development and redevelopment to drive state investment. Some incentives are provided at the local level. Massachusetts aligns Department of Transportation investment with Balanced Growth-Type principles based for the purpose of reducing greenhouse gases. In Tennessee, urban growth boundaries were in place to manage infrastructure expansion costs, but have not been implemented across all regions of the state. The well-known Maryland Priority Funding Law of the 1990s mandated that local jurisdictions prioritize areas to receive state funding support for growth and conservation.

Tier 3 policy states, Oregon and Washington, are the only states that have strongly mandatory programs that affect state, regional and local government decisions. In Oregon, mandatory growth boundaries have been in place since 1973 and have had a strong effect on growth and development expansion. In Washington, the 1990 Growth Management Act identifies Urban Growth Areas, limiting expansion beyond specified boundaries.

It is difficult to define an exact implementation date for many of the programs. Many have evolved over the years with changing provisions along the way. All of the programs spread widely across implementation dates that range from the 1970’s to very recently. Two of the Tier 1 programs have been implemented since 2010, and four in the 1990’s-2000’s. Two date to before 1990, and three have no identified date of implementation. The Tier 2 programs range from the 1970’s (Vermont) to very recent (Florida and New York), with three each in the 1980’s, 1990’s and 2000’s. The two Tier 3 programs were implemented in 1973 (Oregon) and 1990 (Washington). In particular, their longevity, and implementation strength, may work together to show more consistent land use outcomes, as discussed in the technical analysis section of this report.

There are some clear areas where the strength of programs has been weakened over time. Colorado’s Land Use Planning Act, implemented in 1963, was repealed in 2005, changing the state’s overall designation from a likely Tier 3 to a Tier 1. Other programs in Florida, New Hampshire and Wisconsin have seen reduced implementation over time. Some program reduction is likely due to the contraction of state budgets for implementation and funding programs; some may be due to increasingly conservative public opinion regarding land use controls. On the other hand, states including New York, Massachusetts and Ohio, have been recently engaged in creating Balanced Growth-type policy, perhaps partially in response to the need to reduce expenditures for new infrastructure.

TABLE 3B – BALANCED GROWTH-TYPE PROGRAMS IN THE STATES 2014

STATE	POLICY TIER (as of 2014)	COMMENTS
Arizona	1	• Department of Transportation (ADOT)'s voluntary Arizona Smart Growth Scorecard is available for local jurisdiction use • 2014 ADOT "Guidelines for Long-Range Planning: Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands" includes coordinated inter-agency planning to link "transportation planning and land use."
California	2	• 2002 State Planning Priorities included smart growth principles. Used in grant criteria, requires state agencies to use these principles in their funding and development. • 2008 SB 375 requires Regional Transportation Plans to include sustainable strategies Local government funding for many programs is contingent on consistency with RTPs.
Colorado	1	• Mandatory Planning for local governments, addresses smart growth principles, but implementation is not strong. • 1963 Colorado Land Use Act was repealed in 2005.
Connecticut	2	• Conservation and Development Policies Plans since 2005 includes smart growth principles, state agencies must comply in decisions. • All MPOs required to prepare Regional Plan of Conservation and Development, updated every 10 years
Delaware	2	• 1999 overall guide to land use policy is updated every five years, incorporates smart growth principles to guide state investment in a four tier system of land use which does not have strong implementation. • Local comprehensive plans are certified by the State for consistency with State land use policies. Adherence to the State land use policies is not mandatory. • Preliminary Land Use Services (PLUS) review process requires review of major land-use change proposals for 50,000 sq.ft. or greater. • Healthy Communities program promotes higher densities and offers incentives to developers for infill.
Florida	2	• 2011 Community Planning Act (CPA), acknowledges compact development, infill, redevelopment through incentives; removed previous mandatory transportation concurrency by local governments; drives state investment.
Georgia	1	• 1989 Georgia Planning Act (GPA) local government linked comprehensive planning with the ability to receive certain types of state funding; recommended "quality growth" but did not require it.
Hawaii	1	• 1976 State Planning Act includes some voluntary sustainability principles. The State Land Use Commission review principles for County plans include compactness in development, avoiding leapfrogging, contiguity and protection of agricultural land. • 2013 Technical Assistance Memorandum issued by the Office of Planning included a list of "priority and guidelines and principles to promote sustainability"
Iowa	1	• Some incentives provided by the state to local governments that incorporate some smart growth-like policies as criteria for receiving funding. • 2010 voluntary smart growth principles adopted by the legislature

STATE	POLICY TIER (as of 2014)	COMMENTS
Kentucky	1	• Some state initiatives discuss smart growth-like policies (e.g. the Kentucky Transportation Cabinet's "Congestion Toolbox"; and the "Healthy Communities Initiative") without incentives.
Maine	2	• 1988 Comprehensive Planning and Land Use Regulation Act (Growth Management Act [GMA]) incorporated smart growth principles, compliance by state agencies required. • Local government comprehensive planning is required under State Planning Office (SPO) review; non-compliance subject to court action; implementation is not strong. • 1991 (amended 2011) Sensible Transportation Policy Act includes smart growth principles, offers incentives to communities who comply.
Maryland	2	• 1990s Priority Fundings Law mandated that local jurisdictions define Priority Funding Areas (PFA) in terms of density, sewer and water, to focus state expenditures. • 1992 Smart Growth Coordinating Committee can make exceptions to PFA funding. • 2010 Sustainable Communities Act increased incentives for developing in designated areas. • 2012 Agriculture Act further limited lot divisions and expansion of septic systems outside of urban areas. Implementation is strong, almost to Tier 3 levels.
Massachusetts	2	• 2012 MassDOT GreenDOT initiative includes smart growth-like principles as part of mission/core business (e.g. strategic planning, construction and system operations, etc.) in order to reduce greenhouse gases. • 2007 state Smart Growth/Smart Energy Toolkit focuses on state coordination around smart growth principles.
Minnesota	1	• Has some state agency smart growth funding incentives (i.e.The Minnesota Housing Finance Agency has scoring priority for local compact urban smart growth) but it is unclear how much the state promotes smart growth-like policies through other state agencies.
New Hampshire	2	• The state has a coordinated agency-wide effort in promoting smart growth-like development but offers little in the way of incentives. There are no mandates transmitted by the state to the cities as New Hampshire has a strong local government rights tradition. • The State Development Plan of 1985, which is the legislation that calls for the state to "maximize smart growth," and is supposed to be updated on a regular basis, has not be updated in over 10 years. Recent implementation is not strong.
New Jersey	2	• The state promotes smart growth-like development for local governments (i.e. by the DOT prioritizing projects in compact urban areas) . • Early 2000s Development and Redevelopment Plan, and recent NJDOT Long Range Transportation Plan incorporate smart growth principles, affecting state investment. • 1985 State Planning Act incorporated Smart Growth principles still guides the state's planning priorities.

STATE	POLICY TIER (as of 2014)	COMMENTS
New York	2	• 2010 State Smart Growth Priority Infrastructure Act requires all state agencies to consider defined criteria that incorporate smart growth principles in making new investment decisions. Implementation has not been strong to date. • 2014 NY State Supreme Court upheld local government moratoria on oil/gas development.
Ohio	1	• 2004 Ohio Balanced Growth Program began implementation in 2009. Voluntary program ties state agency incentives to locally determined priority areas for conservation, development and agriculture. Technical assistance provided.
Oregon	3	• 1973 state planning regulations require local government compliance with state guidelines which incorporate smart growth principles, including mandatory urban growth boundaries. • 1993 Transportation Planning Rule added principles for increasing modal choice and reducing auto reliance. • 1993 Transportation and Growth Management (TGM) grant program provides planning grants for projects ranging from street and bike plans to development plans to overall transportation plans, and requires walkability/smart growth-like development in comprehensive plans in order to be eligible.
Pennsylvania	1	• Governor's Center for Local Government Services provides assistance. State-run Growing Greener and other open space acquisition/reclamation programs act as incentives.
Rhode Island	2	• 1989 statewide land use plan incorporated some smart growth-like goals for local government entities. • 2006 Land Use 2025 mandates that Urban Service Areas and other smart growth-like policies must be in local comprehensive plans. Compliance is tied to incentives. Implementation strength is not clear. • Grow Smart Rhode Island, formed in the beginning of the 2000s, and the administration support smart growth-like policies.
Tennessee	2	• 1990s state mandated urban growth/service boundaries for every county. Implementation varies widely, less strength since 2010/2011. • 2012 Tennessee DOT completed a study with Smart Growth America of land use-transportation connection, is working on implementation. TDOT has assigned 1-2 land use planners to each of their four geographic divisions.
Utah	1	• 1999 Utah Quality Growth Act in 1999 enables state recommendations on growth. Utah Quality Growth Commission provides technical assistance, guidance, and recommendations. Local communities that are certified are eligible for incentives. • State-wide Utah Transit Authority is new but proactive and working with cities to encourage densification near rail lines.
Vermont	2	• 1970s Act 250, "Vermont's Land Use and Development Act", created local District Environmental Commissions to review development and subdivision plans according to environmental protection criteria. • 1988 Act 200, also known as the Growth Management Act, included smart growth principles but implementation is not strong. • The Legislature has set up a number of programs encouraging compact growth with incentives.

STATE	POLICY TIER (as of 2014)	COMMENTS
Washington	3	• 1990s Growth Management Act mandates local comprehensive plans and state/regional investment according to Smart Growth principles, including Urban Growth Areas.
Wisconsin	1	• Department of Administration provides technical assistance funding for local planning, resources and guidelines including support for conservation development and brownfields redevelopment. • 1999-2010 comprehensive planning grant program encouraged smart growth principles as a condition of receiving funds, had extensive influence. Program is not currently funded.

Summary:

The literature, and an inventory of programs across the 50 states, demonstrate that states, regional and local governments are implementing a wide range of programs in an attempt to achieve benefits associated with Balanced Growth-Type programs. The desired benefits include transportation (cost reduction, efficiency and effectiveness), economic (cost reduction, process simplification, market response), environmental (protection of resources) and social (providing a higher quality of life). These programs fall roughly into four categories, depending on the level of political support for government intervention: ranging from no programs (Tier 0), to voluntary/incentive driven programs (Tier 1), to regulating state and regional government public investment (Tier 2) , to mandatory regulation or land use control at all levels of government, including private investment (Tier 3).

3.1.3 UNDERSTANDING THE LAND USE-TRANSPORTATION CONNECTION

Previous research aimed at identifying the connection between land use and transportation were reviewed which revealed a number of associations that would be valuable for long-term transportation planning efforts. First, there appears to be a general agreement among researchers that less dense developments require more local lane-miles of road per dwelling than dense developments, and that the layout of the street network and shape of the development factor into this relationship. However, it is unclear how the total (local and regional) road infrastructure costs differ between contiguous, dense, developments located in the urban center and noncontiguous, less dense developments, located beyond the urban periphery. Second, transit oriented developments, with their high densities, mixed-uses, good access to transit, and integrated walking and cycling networks are associated with fewer vehicle trips and greater transit share compared to non-transit oriented developments. This relationship weakens when the distance to transit increases. Third, the balance between jobs and housing, and more specifically the accessibility to jobs that match the occupation of the residents within an area, is associated with lower vehicle miles traveled and commute times. Fourth, mixed-use developments can benefit from on-site synergy thereby reducing the number of trips expected as compared to if the same land uses were developed separately. It follows that a balance between jobs and housing and mixed-use developments, both of which can reduce the number of trips, are also associated with reduced emissions. The support for these associations is discussed within the following literature review.

Methodologies

In the literature, the relationship between land use and transportation has been examined through correlation analyses, the development of various mathematical and simulation models, statistical analyses, and forecasts of travel demand based on historical trends or development scenarios. Such work is constrained by the costs of collecting new data as well as the availability and usefulness of existing datasets, which have been previously collected for a variety of purposes and therefore differ in data quality and granularity.

The connection between land use and transportation has been examined from the metropolitan level to the household level. At the metropolitan level, it is difficult if not impossible to find similar areas for comparison. Geographic and topographic characteristics, as well as climactic, economic and political environment are just some of the external sources of factors that could influence travel and transportation. Additionally, the aggregation of data over large areas can hide the variability and trends being sought. However, trends which persist across such aggregated data are very valuable in understanding the general connections between land use and transportation as well as identifying outliers.

At the household level, there are concerns about the social and demographic factors of the individuals and households which may affect travel demand and mode choice. An example of this concern is the work by Dunphy and Fisher (1996). After finding the expected negative trend between density and vehicle miles traveled and positive trend between density and transit use, they showed that these trends are complicated by the relationship between density and socio-demographics. Using the 1990 National Personal Transportation Survey data, they found that there are consistent socio-demographic differences between households in low and high density communities, such that higher density communities tended to have smaller households, higher concentration of singles and couples without school-age children and therefore lower travel needs. These results give credence to the concern that socio-demographics factors play a role in the land use transportation connection.

While the examination of observational data can reveal correlations between variables, test the nature of the relationship (e.g. linear, non-linear), and measure the relative strengths of the trends between various factors, the results serve as evidence, not proof, of an actual cause and effect relationship. Even when there is general consensus that two variables have a specific relationship, the modeling approach, sampling method, selected variables and their specific definitions can change the outcome and even produce unexpected results. Inconsistent and contradictory results illustrate the complexities of this relationship and the difficulties isolating significant factors. Hence, the following review of the research needs to be considered critically and holistically and caution needs to be paid to both the strengths and the weaknesses as well as the purposes of the individual research studies when developing any generalized opinions.

Land use measures

The work on understanding the land use transportation connection has included land use measures describing density, diversity, and distance to transit, although the specific definitions and measures used differ. Density generally refers to some attribute(s) of interest, measured in units per geographic area. Common measures are population density and employment density, referring to the number of people and jobs per area respectively. They may be calculated in terms of the gross area or the net available area. Diversity refers to the mix of land uses within an area. For example, Frank (1994) developed an entropy index describing the degree of heterogeneity of a variety of land uses. Diversity also includes measures describing the balance between jobs and housing within an area. An example has been the use of a jobs-housing ratio which has been simply defined as the ratio of the number of employees to the number of households in a geographical area (Cervero 1989, Cervero 1991). The size of the geographical area chosen for analysis matters because for larger areas the aggregated number of jobs and housing is more likely to be balanced, as a consequence of the aggregation itself. Distance to transit refers to the physical distance to public transit. Less commonly used land use measures relate to the design of the street network and the destination accessibility. Together these land use measures are referred to as the 5 Ds of the built environment.

In addition to these land use measures, it is helpful to understand the concepts of transit oriented development (TOD) and sprawl. TOD is a somewhat flexible concept and applied with a variety of definitions. For example, Faghri and Venigalla (2013) defined TOD as moderate to high density, mixed use development which is located near a transit station and has good pedestrian and bicycle facilities.

The concept of sprawl has received many definitions in the planning and social sciences literature, as noted by Galster et al (2001). It has been defined by example, as a judgment about the aesthetics of a development pattern, as the cause, consequence or effect of an external condition or independent variable, such as automobile dependence or poor planning. Sprawl has also being defined in terms of one or more development patterns, such as low density and the dispersion of employment and residential developments.

Eidlen (2005) points out that low density alone is not always a good indicator of sprawl and discusses the point using Los Angeles, which is often dubbed as a sprawling metropolis and yet is among the densest metropolitan areas in the US. Eidlen argues that what Los Angeles suffers from is a high average density with a lower variation in distribution of population, as compared to cities such as New York and San Francisco, which is related to its decentralized employment, lower than average transit service provision, as well as its highest car density and vehicle travel intensity in the nation.

Ewing, Pendall and Chen (2002, 2002, 2003) tried to capture the complexity of sprawl. Using principal component analysis they consolidated twenty-two land use variables into four factors describing density, land use mix, degree of activity centering, and street accessibility for 83 metropolitan areas. The four factors were then combined and rescaled to arrive at a composite score with a mean value of 100 and a standard deviation of 25, thus providing a relative sprawl index that can be used for comparisons. They modeled the associations of the index to various transportation outcomes and concluded that less sprawling areas exhibit lower daily vehicle miles traveled per capita, lower annual traffic fatalities per capita, lower maximum ozone levels (based on the highest daily maximum 8 hour average ozone level), and higher shares of work trips by transit and walk modes. These models are described in the following sections.

Transportation measures

The focus of this research is the value of Balanced Growth-Type development patterns and policy on transportation. The intent is to understand how Balanced Growth will change the cost, effectiveness, and efficiency of the transportation system. Does this type of growth strategy change the *cost* of transportation, the need for transportation investment, the need to build new roads and maintenance of a larger road inventory? And at the same time, will the strategy lead to a more *effective* transportation system that can service the increase in travel demand resulting for the growth in population? Thus, will the strategy lead to a more *efficient* transportation system that makes greater use of the current and future road inventory?

In the literature, the land use transportation connection has been explored using a variety of transportation measures. The cost of the road infrastructure has been represented by the number of lane-miles, capital costs of new roads, and maintenance costs of the road infrastructure. Since the cost values are reflective of the time, economic environment, and location of the individual studies, they are difficult to compare. However comparing lane-miles is for the most part insensitive to these factors and thus applies to the current day and environment. Travel demand measures include the number of vehicle trips, trip rates, trip lengths, mode choice and mode share, as well as vehicle-miles traveled, which is the product of the number of trips and trip length. These measures reflect the effectiveness of the roadway system. The operation of road facilities has been described by the commute time and travel delays. These measures reflect the amount of congestion or the efficiency of the system.

In addition to the cost, effectiveness, and efficiency measures, the literature contains valuable information about the land use transportation connection and its impact on society. The first social impact is that of emissions. According to the US Environmental Protection Agency, the transportation sector is the second largest producer of greenhouse gases (EPA web reference http://www.epa.gov/climatechange/ghgemissions/usinventoryreport.html), which has been linked to a variety of respiratory conditions. Therefore reductions in the amount of trips, the trip length, and the overall amount of travel would reduce the amount of emissions to the benefit of the greater population. The second social impact is safety. According to the Center for Disease Control and Prevention, vehicle collisions are the leading cause of injury in the US (2014). In 2012, injuries resulting from vehicle collisions cost $18 billion in lifetime medical costs and another $33 billion in the loss of lifetime work. The discussion of emissions and safety is included in the literature review.

Road infrastructure and transportation cost

To first understand the magnitude of the transportation infrastructure needs of new developments and the potential savings that could be realized though a growth management strategy, consider the work by Burchell et al (1996). They prepared a projection of statewide infrastructure costs for 1995-2015 for South Carolina using the Resource Investment and Management Systems (TRIMS) model. The estimates included capital projects at the local, county, region and state levels needed to support future growth for seven infrastructure categories: transportation; commerce; public safety/administration/welfare; education; health; recreation/culture; and environment. The transportation category accounted for 51% of the statewide infrastructure needs, of which three quarters was for road infrastructure. The road infrastructure estimate considered deferred highway construction and a 10 year road resurfacing schedule.

An argument for managing growth, or an argument against urban sprawl, is that less dense developments built further from the urban center, especially those that leapfrog over empty lands, will require a greater amount of road to service the new travel demand generated by the development, as compared to similarly sized, more dense developments built within or near the urban center. The counter argument is that the noncontiguous developments and their roadway linkages provide inexpensive access to the empty lands, which can experience a second wave of development thus capitalizing on the initial infrastructure investment.

There appears to be general agreement that less dense developments will require more local roads than similarly sized dense developments. The Urban Land Institute (1958) studied the costs of large lots and found that the cost of on-site roads decreased linearly with greater density developments, assuming all roads were built to the same standard. However, the study raised the question about reduced standards for low density developments. If high density developments required paved roads with gutters, curbs, storm sewers, sidewalks and trails and low density developments required gravel roads with ditches, the cost relationship would change significantly.

The Real Estate Research Corporation (1974) study on the costs of sprawl examined six neighborhood designs, each for 1,000 dwelling units, varying in density from 3 to 30 units per net acre. These neighborhoods were simulated in two community contexts: adjacent to existing development; and separated from existing development by open tracts of land. The cost of community streets were lower for communities adjacent to existing development, and within those communities the highest density neighborhoods had the lowest cost for neighborhood streets and the highest cost for community streets. Frank (1989) criticized the study for ignoring the costs of facilities external to the new communities.

Peiser (1984) examined whether a planned development for a 7,500 acre tract of land in a Houston suburb would have lower land use and transportation costs than the same site developed in an unplanned, piecemeal pattern, typical of the Houston area. Both included the same type and amount of each land use. The planned development pattern yielded a cost savings of 3.2% for transportation infrastructure. The analysis was limited to the infrastructure on-site and did not take into account the impact on the surrounding road network.

Wheaton and Schussheim (1955) examined the differences in density, size, location and development pattern on costs. Facilities were classified by whether they exclusively served the new development, served the neighborhood, or the community. The costs included capital costs of new facilities, an allocated cost of inherited facilities to be used by the development, and the operation and maintenance costs. The capital, operation and maintenance costs for roads increased as the length of street increased, which was directly related to the lot size. The cost of inherited facilities varied by location because of the differences in the available capacity on neighborhood and community facilities.

Burchell and Mukherji (2003) and Burchell and Galley (2003) compared the national infrastructure requirement for two alternative development scenarios. The first was a conventional growth scenario, described by noncontiguous, subdivision style residential development with strip nonresidential development. The second was a managed growth scenario whereby growth was directed around existing urban centers and development in the peripheral rural areas and environmentally sensitive areas was limited. Using identical 25 year population and employment projections, the impacts of the scenarios on various infrastructures was predicted at the county level. Using resource consumption models, the conventional growth scenario was found to have a greater need for new local roads.

The Urban Land Institute (1958), Real Estate Research Corporation (1974), Peiser (1984) and Wheaton and Schussheim (1955), Burchell and Mukherji (2003), and Burchell and Galley (2003) all focused on the costs of on-site or local roads. Stone (1973), Burchell et al (1992), and Brunett et al (1997) looked beyond the development itself to evaluate the impact on main roads and state roads. These studies show that the more dense developments also reduce the need for regional and state roads.

Stone (1973) simulated the impact of the development size and structure on the capital costs of main roads, at a regional level. The costs of main roads increased as the size of the development and square or circular shaped developments were reported to be preferred over linear or star shaped development, under either dispersed or centralized travel patterns.

Burchell et al (1992) prepared the Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan (IPLAN) comparing the impact of the IPLAN focused development growth strategy to the historic or trend development pattern. Using a twenty year population and employment projection, growth scenarios were simulated and evaluated. For road infrastructure, the development prescribed by IPLAN was found to reduce the need for additional local roads from 5,500 to 3,900 lane-miles and state roads from 159 to 132 lane-miles.

Brunett et al (1997) prepared the Michigan Fiscal Impact Study which included a comparison of the costs of future growth under two development patterns. The first was a continuation of the historical growth pattern described as land-consumptive whereby development skipped over existing development into outlying and even distant rural areas. Communities were characterized as lower density, single family dwellings with strip commercial development. The second was a managed growth pattern where new compact development was directed into defined development zones located immediately adjacent to existing developed areas. This managed growth strategy resulted in a 50% reduction in the number of units in the peripheral areas and a savings of 188 lane-miles of local roads (i.e. 1,577 for historical and 1,389 for managed growth) and 9 lane-miles of state roads (i.e. 46.8 for historical and 37.9 for managed growth) over the projected 25 year period.

The research supports the argument that more compact developments will have reduced road investment needs both at the local and regional levels. These results are based on methodologies that compared compact, continuous development to less dense, noncontiguous development at a specific time horizon. However, the argument that supports a sprawling development pattern is that the noncontiguous developments which require the initial infrastructure investment will foster dense development to occur between the existing urban fringe and the sprawling development. To understand the development process, whereby the empty lands between urban areas and sprawling developments are in-filled requires an examination of the development patterns over time.

Harvey and Clark (1965) presented three major forms of urban sprawl: 1) low density continuous development; 2) ribbon development that extend radially outward from the urban area; and 3) development which “leap-frogs,” passing over empty lands as it spreads out. They contend that there are several causes or catalysts for urban sprawl that include the independence and competition of developers, market speculation, constraints imposed by the natural terrain, and the homeowners desire for the suburban environment. They argue that over time, the ribbon and leap-frog development patterns will experience compaction as unused lands become more valuable and developers build higher density dwellings to realize their profit margin. However, the question then becomes how long does it take for these development pattern to become a compact, continuous extension of the urban area?

Ohls and Pines (1975) argued that the noncontiguous development could be an efficient use of resources depending upon the ordering and location of the low density and high-density developments. They developed a simplistic conceptual model, based on the trade-off between accessibility and living space, to develop a set of 12 alternate programs allocating hypothetical housing units to three zones during two time periods. Some programs were obviously dominated by better alternatives and eliminated from further consideration. The remaining five alternatives were compared based on estimated construction costs and transportation costs. One alternative program, which allocated low density to the outer areas in the first time period, followed by higher density in the inner areas was found to be the most efficient development pattern. Ohls and Pines concluded that this development pattern may apply to very rapidly growing cities where large population increases would occur in over a small number of years.

Ottensmann (1977) argued that the development density is a function of land value, population growth, population and income. He argued that less expansive lands further out are developed first and then the intermediate lands gain in value and are developed at a higher density. He first tested the relationship between land value and the independent factors population growth, population and income using data at the metropolitan level and linear regression analysis to find the best indicator for land value. The best results were with the National Association of Home Builders' land prices for 1960 and 1964. Using this indicator, he then modeled density, using the percent of single family homes developed as a surrogate measure. For the 1960-70 decade, the model was significant and suggests that as the land value, population growth, population, and median income increases, the percent of single family homes developed decreases. The time required for the land use to foster such growth was not addressed, nor were the associated infrastructure needs.

Peiser (1989) argued that discontinuous developments promote higher density development than continuous developments because the value of the empty land increases faster than the lands at the urban fringe. To test his theory, he examined the decrease in development density extending out from the central business district, for Montgomery County, Maryland, Fairfax County, Virginia and Dallas, Texas. He reasoned that the density of development should increase with the land value and that the land value is a function of the age of the subdivision, the distance to the city center, the house size. He expected the models to be strong for Fairfax County and Dallas as these areas had the most flexible regulatory environment and would therefore the development would be market driven. The regression model and variables were found to be significant for Fairfax County. The models for Dallas and Montgomery County were less compelling. Breslaw (1990) criticized Peiser for his use of house value as a proxy for house size which caused a difficulty in the logic and thus the interpretation of his model. Breslaw also criticized Peiser for never showing that patchwork development leads to higher densities, which was the basis of his argument.

The counterargument to managed growth appears to be less compelling and perhaps only applicable to cities experiencing phenomenal growth. Under the particular circumstance of rapid population growth, whereby land values soar and developers are compelled to build high density developments to remain profitable, the ordering of low density and high density developments become less important. The initial infrastructure investments built to serve outlying areas quickly become the backbone for the intermediate high density developments. The same efficiency has not been shown for slow or even moderate growing cities.

Commuting times and distances

Users would prefer small commute times and shorter commuting distances. The shorter the commute distance the lower the vehicle fuel consumption, maintenance and repair costs. In addition, small commute times mean users spend less time in their vehicles and therefore have more time for their work, family, shopping, and recreational activities. The literature does not provide a clear picture of whether the urban form impacts the time or length of commuting.

Wachs and Taylor (1993) analyzed trends in residential and commuting patterns of 30,000 hospital system employees commuting to 134 sites within the Los Angeles metropolitan area. Over a 6year period there had been a 40 percent increase in the workforce and at the same time a dramatic increase in vehicle traffic congestion in the region. They found that the average commute distances had actually decreased by 2.5% and the median commute distance had not changed from 7 miles but the commute times had increased. Wachs and Taylor concluded that these patterns provided little evidence of an increasing job-housing imbalance and that the increasing commute times were the result of increasing congestion and not increasing commute distances.

Cervero (1996) used the 1985 American Housing Survey data to analyze the relationship between land use and commuting distance. He developed regression models for car ownership and commuting that were estimated simultaneously to account for their interdependence, assuming that car ownership can influence location and thus commuting distance and commuting can influence car ownership. As expected car ownership was shown to decline with neighborhood density and the presence on non-residential land uses and rises with household income and size. Additionally, commute distances tended to be shorter for those living in dense, mixed-use neighborhoods.

Trip rates and mode choice

Every day, users travel to various places to work, shop and socialize. If these activity places are grouped together at one location, then users benefit from the convenience of being able to do multiple activities with a single trip. If that location is serviced by transit, or connected by sidewalks and/or trails, then users have the freedom to choose their mode of travel. The choice of modes is extremely valuable and liberating for those with limited access to private vehicles. The literature supports the arguments that developments with greater density and diversity as well as the site and street designs can reduce the number of vehicle trips and that transit oriented developments increase the percentage of trips taken by transit.

The Institute of Transportation Engineers (2012) publishes trip generation rates, based on observed vehicle access and egress from a variety of land uses. ITE recognizes the potential synergistic effects of multi-use sites, but provides very little guidance about internal site capture rates. The use of observations from similar mixed-use sites is recommended. To better understand the mixed-use effect on internal capture, Ewing, Dumbaugh and Brown (2001) captured the number of trip ends observed at 20 mixed-use communities in south Florida. The internal capture rates ranged from 0 to 57 percent of all trip ends generated and was found to be positively associated with the size of the development and negatively associated with a measure of regional accessibility.

The ITE trip generation rates have been criticized (Ewing et al 1996, Shoup 2002) for reflecting suburban conditions and therefore overestimating the trips generated by transit oriented developments (TOD). Cervero and Arrington (2008) examined trip generation rates for 17 TOD housing projects and through regression analysis demonstrated that the pm trip rates increase as residential densities decrease and for developments further from the central business district. The trip rates for this sample of TOD housing projects were consistently less than that estimated by ITE.

Cervero and Kockelman (1997) used factor analysis to examine whether the density, diversity and design of the built environment influence travel demand for residents in the San Francisco Bay Area. For 50 neighborhoods, the travel and socio-economic data was extracted from the 1990 Bay Area Travel Survey and lane use data was compiled from field surveys, the Census Transportation Planning Package and the ABAG land use inventory. Density was described by population and employment densities and accessibility to jobs. Diversity was described by 7 types of measures including an index describing the dissimilarity of land uses, measures of development intensity, and proximity measures. Design was described in terms of the characteristics of the streets, pedestrian and cycling provisions, and site design. Various socio-demographic, transportation supply, and distance measures were used as control variables in the analysis. The results shown that density, diversity and design generally reduce trip rates and encourage non-automobile travel.

Boarnet and Sarmiento (1997) developed a regression model based on the joint hypothesis that land use patterns influence the time cost of travel and that changes in non-work trips will occur when time cost of travel is changed by land use. Various socio-demographic data were compiled from 769 travel diaries of a 1993 survey of southern California residents and used to estimate an ordered probit model. Based on the significance of the coefficients in the model, women make more non-work trips, older persons make fewer non-work trips, and those with children make more non-work trips. Five land use variables describing density, land use mix and street geometry were added to the model but none were found significant. These results were unexpected and do not support the notion that non-work travel and land use are linked.

Stringham (1982) examined the modal split of trips as a function of distance from rapid transit stations and the modal split of trips accessing the rapid transit station. Resident and employee surveys were conducted around four suburban rapid transit stations, two in Toronto and two in Edmonton, Canada. The rapid transit mode split was greater for high density residential than low residential land use, and reduced radially outward. The access mode split also shifted such that the share of walkers declined further from the station while the share of bus riders increased.

Cervero (1994) surveyed 27 condominium and/or rental complexes, all located within 360 to 3100 feet of suburban rail stations on 5 different rail lines. Although travel was predominately by automobile, the mode split varied by rail line and trip purpose. Rail use was greater for those without vehicles than those with vehicles, for those who had to pay for parking than those who didn’t, and for those headed downtown than for those destined to regional sub-centers. The greatest rail share was observed for higher density developments and those in close proximity to a station.

Dunphy and Fisher (1996) examined density and transportation data from the Federal Highway Administration’s 1990 Highway Statistics, Texas Transportation Institute’s 1989 congestion data, and the Federal Transit Administration’s transit trip data. Using simple linear regression models, the density explained 15 % of the variation in per capita travel for metropolitan areas larger than 1 million people, and 26% of the variation in transit travel. The expected negative relationship between density and vehicle miles traveled and positive relationship between density and transit use were found, confirming previous results.

Cervero and Radisch (1995) compared the mode split for two neighborhoods in the San Francisco Bay Area. The neighborhoods had similar income profiles, freeway and transit service levels, and are in the same geographic area but differed in their design. The neo-traditional neighborhood was found to have a greater share of non-automobile non-work trips than the conventional suburban neighborhood.

Cervero (1996) analyzed the land use and mode choice relationship using a binomial logic model assuming that mixed use neighborhoods induce higher shares of non-automobile commuting among residents. Using data from the 1985 American Housing Survey, six land use variables and six control variables were used to estimate utility expressions for three travel modes for commuting (i.e. private automobile, transit, walking/bicycling). Neighborhood densities were found to have a stronger influence than mixed land uses on private automobile and transit commuting mode choices. For walking/bicycling, the presence or absence of neighborhood shops was found to be a better predictor of mode choice than residential density.

Frank and Pivo (1994) compared mode choice across census tracts while considering the gross population density, gross employment density, and land use mix at both ends of the trip and a variety of non-urban form variables, which they thought could be confounding with density. They drew household travel behavior and demographics data from the Puget Sound Transportation Panel, which is a five year longitudinal cohort study. They found density and land use mix to be related to mode choice for work trips and shopping trips.

Chen, Gong and Paaswell (2008) examined whether residential and employment density would be significant if other factors such as generalized travel cost, accessibility, and access to transit stations are controlled. Using 1997/1998 travel diary data from 14,441 households in the New York Metropolitan Region they took a tour based approach to describe travel demand. The travel time and cost for both autos and transit were calculated using the regional travel demand forecasting model for a 2002 base year scenario. In the end, density was found to be significant in describing modal split, however employment density was found to be a greater influence in reducing auto use than residential density.

Zhang (2004) applied a conventional four step travel demand model of the Austin area to simulate travel demand under three transit oriented development scenarios. The 1997 base year model includes a multinomial model for mode choice based on the 1997 Austin Travel Survey. The model estimates show a slight increase in transit mode share and slight decrease in single occupant vehicle share when going from a no TOD scenario to a scenario with 10 TOD around proposed rail stations, to a scenario with the 10 TODs combined with a bus-based TOD corridor. The increase in TOD also resulted in an overall reduction in congestion and vehicle miles traveled, although the non TOD area benefited greater in these respects.

Vehicle-miles traveled

The aggregation of the number of trips and the length of those trips is captured in measures such as vehicle miles traveled and vehicle hours traveled and represent the demand for travel. Understanding the connection between land use and travel demand could curb the need for future infrastructure expansions. If the land can be developed such that the travel demand of the people is reduced, then the infrastructure requirements needed to serve that demand changes. Even if the population grows, a reduction in the demand per capita would translate into a reduction in the amount of new lane miles needed.

Peng (1997) conducted an empirical analysis of the links between the jobs-housing balance and commuting patterns at the traffic analysis zone level for the Portland, Oregon metropolitan area. To capture the interaction between adjacent traffic analysis zones he used a dynamic buffering technique to determine the jobs to housing ratios. He then modeled the relationship between this ratio and home-based VMT to test whether larger ratios will result in larger VMT for residents living within the area. He also modeled this ratio and total VMT to test whether the relationship was u-shaped, such that total VMT is greater when the ratio falls below, or rises above the balance point. The results support his hypotheses, however the total VMT was found to be relatively constant for ratios between 1.2 and 2.8 based on his ratio definition.

Cervero and Duncan (2006) examined the travel demand impacts of mixed use growth by studying the impact of accessibility on the amount of vehicle miles traveled (VMT) and vehicle hour traveled (VHT) for motorized vehicles. Accessibility was defined at the number of job and retail or service destinations within a specified distance from the homes surveyed for the 2000 Bay Area Travel Survey. Although a variety of radial distances were included in the analysis, a 4 mile radius provided the best statistical fit. The accessibility of jobs, which match the occupation of the residents, was associated with a significant reduction in VMT and VHT and the accessibility of retail and service jobs was also associated with a significant, however smaller, reduction in VMT and VHT.

Ewing, Pendall and Chen (2002, 2003) examined the association between their 2000 overall index of sprawl and the VMT per capita data drawn from the Federal Highway Administration's Highway Performance Monitoring System. The data from the HPMS was aggregated by urbanized area so several estimates of VMT for metropolitan areas were made, resulting in 72 data points for comparison. The VMT data appeared to be linearly and negatively associated with the index. A linear regression model which controlled for population, household size, percentage of the population of working age, and per capita income for each of the metropolitan areas showed the sprawl index variable to be significant at the 0.1 % level of significance.

Congestion and travel delay

There are two contradicting theories about land use and congestions. Some argue that compact urban areas will result in congested local street network, while others argue that suburban developments with commuters traveling into the city center cause the congestion. The literature does not provide meaningful direction in this area.

Ewing, Pendall and Chen(2002, 2003) examined the association between Texas Transportation Institute's (2000) annual hours of delay per capita data for 55 urbanized areas which compared well to the definitions of the 83 metropolitan areas used to develop their 2000 overall index of sprawl. In a scatterplot of the data, the association appeared to be linear, such that delay increased for lower values of the index (i.e. more sprawling areas), however a linear regression model developed to describe the delay as a function of the sprawl index, population, household size, percentage of the population of working age, and per capita income showed the sprawl index variable was not significant.

Sarzynski, Wolman, Galster, Hanson (2006) suggested that congestion is a function of travel supply and demand and that current conditions are influenced by previous conditions and infrastructure changes that have occurred over time. Given the slow response of transportation to land use changes, they postulated that previous land use conditions are more appropriate for modelling current congestion. Based on this idea they first examined the bivariate relationship between 4 land use factors for 1990 and 7 traffic congestion measures for 2000 for 50 of the 100 largest US metropolitan statistical areas, according to 1990 population. The results showed density and the extent to which housing is located near the core of the extended urban area to be positively related to longer commutes times. The degree to which jobs were located near the core was found to be negatively related to the delay per capita.

Sarzynski, Wolman, Galster, Hanson (2006) also developed three regression models based on their idea of lagging transportation response to changing land use conditions by controlling for the 1990 level of congestion, change in transport network and change in demographic variables between 1990 and 2000. These models showed positive relationships between density and average daily travel per lane and delay per capita. The models also showed a positive relationship between housing centrality and delay per capita. The model showed housing-job proximity to be negatively related to commute time; in other words urban areas with housing located further from other jobs and housing had longer commute times.

Whether or not sprawl or compact development causes congested is unclear and not well examined in the literature. What is clear is that congestion and travel delays impact users every day. According to the Texas A&M Transportation Institute (2012) travel delays in 2011 cost urban Americans 5.5 billion hours. That time would have been better spent doing many other productive things, such as working to earn more income to provide for themselves and their families, shopping, and a variety of recreation and social activities.

Emissions

Directly related to the vehicle miles traveled measure is any measure of greenhouse gases for the transportation sector. The more miles driven, the greater the emissions. Thus, those land uses which encourage the use of alternate modes, the reduction of trips, or the reduction of trip lengths are argued to have lower emissions. Of course emissions contribute to air pollution and have been found to contribute to a number of respiratory conditions, so any reduction in emissions would be a benefit to users and society at large.

Ewing, Pendall and Chen (2002, 2003) examined the association between their 2000 overall index values of sprawl and the fourth highest maximum 8-hour average ozone level for 83 metropolitan regions. A linear regression model, with factors for population, household size, percentage of the population of working age, and per capita income for each of the metropolitan areas found the ozone variable to be significant at the 0.1 % level of significance. According to the model, for larger values of the sprawl index, smaller values of the ozone variable are expected.

Wang, Khattack and Zhang (2013) extracted data for 15,213 households from the 2009 National Household Travel Survey and modeled the choice to drive and associated emissions. They developed Heckman and Ordinary Least Squares regression models relating various socio-demographic, land use, and transportation infrastructure variables. A balanced land use mix and additional intersections of a grid street pattern showed a significant decrease in CO_2 emissions while longer roadway segments showed a significant increase.

Tirumalachetty, Kockelman and Nichols (2013) developed a microscopic model of the demographic and firmographic attributes of the Austin metropolitan region for the 2005 base year and applied 5 different land use and transport policy scenarios to demonstrate the forecasting of green house gases (GHG). The 2030 forecasts with a scenario defining an urban growth boundary provided the lowest vehicle miles traveled and GHG estimates whereas a scenario with network expansion provided the highest.

Vehicle collisions

An additional cost to users and society is that of vehicle collisions. There is a large body of evidence that supports the argument that the number of collisions increases with greater traffic exposure. This relationship is the basis for the collision prediction models contained within the Highway Safety Manual (2010) used to evaluate the safety impact of changes to highway design. Applied to the land use transportation connection, those land uses that are associated with lowering traffic demand would be expected to correlate with a reduction in traffic collisions. This relationship is supported by the work by Newman and Kenworthy (1999) and Ewing, Pendall and Chen (2002, 2003).

Newman and Kenworthy (1999) prepared a survey of major 37 metropolitan regions around the world to capture the impact of automobile dependence. Those regions with the most road length per capita were correlated with the lowest urban densities, the lowest percentage of workers using public or non-motorized transport, the highest percentage of Gross Regional Product spent on road expenditures, the highest percent of GRP spent on commuting, the lowest percentage of transit cost recovery, and the highest external costs, measured in terms of transport related deaths and per capita emissions. These regions were dominated by the cities in the US and Australia, although not surprisingly developing Asian cities had the largest road expenditures and second highest number of transportation deaths as their traffic regulatory systems are still developing.

Ewing, Pendall and Chen (2002, 2003) modeled the relationship between their 2000 sprawl index and highway fatalities. The highway fatality data was drawn from the National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS) database. A linear regression model, which included variables to control for population, household size, percentage of the population of working age, and per capita income for each of the metropolitan areas, found that the index was significant at the 0.1% level of significance. Those metropolitan areas, identified as more sprawling, were associated with greater number of vehicle collisions.

Summary:

A review of the literature generally found the following associations:

- *Less dense developments require more local lane-miles per dwelling than dense developments; development design is a factor in this association. (transportation effectiveness and investment)*
- *Transit-oriented developments are associated with fewer vehicle trips and greater transit share compared to non-transit-oriented developments. (transportation efficiency)*
- *The jobs-housing balance, and the jobs-nearby resident match, are associated with lower vehicle miles traveled and commute times. This balance is a key to the concept of "nodality", which describes development activity that is focused around central locations. (transportation efficiency)*
- *Mixed-use developments provide an opportunity to reduce trips, providing a pedestrian alternative to at least some daily trips. (transportation efficiency, and transportation-related community/economic benefits)*
- *Reduced number and length of trips are associated with reduced emissions and increased safety. (transportation-related community and economic benefits)*

These associations are the basis for Balanced Growth-Type programs seeking to achieve benefits through influencing land use mix, density, walkability, and nodality. Table 1A, in the introduction, summarizes the potential transportation benefits that are identified in the literature as arising from compact, nodal land use patterns.

3.1.4 OVERVIEW OF ODOT POLICIES AND PROGRAMS RELATING TO THIS STUDY

In order to more thoroughly understand the current role of government (federal, state and regional) with regard to Ohio's transportation needs, the following summary highlights some key points from the Ohio Department of Transportation (ODOT), Access Ohio 2040 (ODOT's long range draft transportation plan) and the federal government's comprehensive transportation bill, MAP 21 (Moving Ahead for Progress in the 21st Century Act) that pertain to this study.

ODOT Mission and Responsibilities

The Ohio Department of Transportation (ODOT) oversees the transportation needs of the state of Ohio. Their mission is "To provide easy movement of people and goods from place to place." Their mission further states they will achieve this by: taking care of what they have, make the system work better, improve safety, and enhance capacity. The agency is charged with ownership and maintenance of all Interstates and US routes within the state (excluding the Ohio Turnpike) and State Routes outside of municipalities (Ohio Department of Transportation, Access Ohio 2040), 2013).

It should be noted that most federal transit funds are sent directly to transit agencies; in addition, ODOT does have a portion of its budget dedicated to transit, as outlined below.

Municipalities are responsible for roads within their boundaries, although ODOT has programs that help fund municipal maintenance (Ohio Legislative Service Commission, 2012).

There are 49,250 lane miles in Ohio's state highway system, of which ODOT is responsible to maintain 39,799 lane miles, 80.8% (Ohio Legislative Service Commission, 2012).

Funding and Expenditures

Total capital expenditures on Ohio highways in FY 2010 were approximately $2.68 billion, of which $1.71 billion (63.8%) was spent on state-administered roads (Ohio Legislative Service Commission, 2012).

Federal highway funding to the state of Ohio for FY 2014 is expected to be more than $1.3 billion. The $1.3 billion is allocated within the following categories (CDM Smith, 2013):

NHPP	National Highway Performance Program	$763.4 million
STP	Surface Transportation Program	$351.1 million
CMAQ	Congestion Mitigation and Air Quality Program	$96.6 million
HSIP	Highway Safety and Improvement Program	$75.3 million
MPO	Metropolitan Planning Organization Planning	$11.3 million
	Railway-Highway Crossings	$8.6 million
	TOTAL =	**$1.3063 billion**

TA - Transportation Alternatives - is funding set aside proportionately from the state's National Highway Performance Program (NHPP, STP, and CMAQ, HSIP and Metro Planning apportionments) In 2014 the apportionment in Ohio was expected to be about $28 million (CDM Smith, 2013).

Of the $1.3 billion allocated above to Ohio, local governments are expected to receive approximately $328.5 million of the federal aid that is passed through the state in FY 2014. Of that amount, Metropolitan Planning Organizations (MPOs) and "large cities" are expected to receive the lion's share ($196.2 million from federal sources: STP, CMAQ and TA). "Large cities" have a population between 25,000 & 50,000, and are outside of a MPO (examples include Lancaster, Marion, Zanesville, Findlay, Wooster).

The following is a complete list of the $328.5 million federal pass-through aid allotted to local governments by Ohio (CDM Smith, 2013):

MPO Programs and "large cites" (STP, CMAQ, TA)	$196.2 million
MPO Planning and Research (STP)	$12.4 million
Municipal Bridges (STP)	$9.2 million
County Highway Assistance (STP and HSIP)	$64.8 million
Small Cities (STP)	$9.2 million
Transportation Alternatives (TA)	$11.0 million
Safe Routes to Schools (TA)	$5.7 million
Transit Assistance (STP and CMAQ)	$20 million
TOTAL =	**$328.5 million**

Transit funding in Ohio is primarily provided by the federal government (through the Federal Transit Administration [FTA]). Outside of the FTA, ODOT is expected to expend the following funds directly (from state funds) for transit needs around the state:

- $7.3 million from Ohio General Revenues ($400,000 subtracted for administration)
- $20 million in Federal Highway Funding (STP and CMAQ) passed through the state (as listed above). In 2012 and 2013 the majority of the $20 million in federal highway funds was flexed for transit use and went to eight large urban transit operations. The majority of the above General Revenue dollars goes to rural transit (which can be used for operations) (CDM Smith, 2013).

Ohio highway funding sources in FY 2013 included $1.799 billion from State Motor Fuel Tax Revenue. Although this is slightly down from the previous year ($1.819 billion), in general, over the previous four years there has been an upward trend from this source. (Ohio Department of Transportation – Financial & Statistical Report, Fiscal Year 2013.)

Non-highway modes of transportation accounted for only 2.5% of the 2011 spending on transportation while highways accounted for 92.0%. Public transportation funding in 2011 was $50.2 million or roughly 1.8% of total spending on transportation (Ohio Legislative Service Commission, 2012). This does not take into account the amount of federal funding support given directly to Ohio transit operators through the Federal Transit Administration (FTA).

ODOT "is committed to the preservation of its existing infrastructure by embracing a 'Fix –It-First' strategy." (State of Ohio Department of Transportation, 2013) This strategy can be defined as prioritizing maintenance of existing transportation infrastructure over construction of new infrastructure. The strategy is implemented across ODOT programs and processes, from project prioritization, to requirements for regional MPO decision making. This policy has had a significant impact on the pace and scale of transportation system expansion over the last decade.

Access Ohio 2040

Access Ohio 2040, ODOT's statewide long-range transportation planning document, was recently completed. It is planning for the next twenty-six years of Ohio transportation needs (through the year 2040). It is anticipated that it will be reexamined every 5 years. While providing guidance in decision making over the planning period, the plan also includes elements that respond to requirements in the federal MAP-21 transportation legislation (see further explanation below).

The document has established six "vision" goals:

- Preservation of Multimodal Assets
- Mobility and Efficiency – reduce congestion and increase travel reliability
- Accessibility and Connectivity – increase customer access to Ohio's multimodal transportation system and improve linkages between modes
- Safety
- Stewardship – advance financial, environmental and social objectives for transportation investments

- Economic development – develop and operate a state transportation system that supports a competitive and thriving economy, attracts new businesses, and provides for predictable freight movements

Of note in the Access Ohio 2040 report is a projected shortfall of $14 billion of revenue vs. costs for capital transportation needs over the 27 years of the report. Other funding items of note:

- Transit funding from the state is projected to be flat, without increase, through 2040
- Federal Transit Administration (FTA) funding from the federal government for transit is projected to have only a 3% growth rate

Access Ohio 2040 notes, "Based on the magnitude of these shortfalls [tens of billions of dollars], it will be impossible for Ohio to make up the difference without new innovative funding streams" (Ohio Department of Transportation, Access Ohio 2040).

Areas of innovative funding streams might result from the 2012 policy implementation of ODOT's Policy No. 34-001, which is "to develop, operate, and maintain transportation facilities through public-private initiatives" (Ohio Department of Transportation, Policy No. 34-001(P), 2012). These public-private agreements might include a variety of "design-build" type contracts. It is worth examining if ODOT would consider Balanced Growth-Type components in the design aspects of some of these contracts. As an example, the new highway exchange built north of Columbus involved public-private collaboration. See further discussion on public-private initiatives in the Policy Review section 4.4.

The Access Ohio 2040 document has established eleven recommendations. One of these is to "Expand Performance Management within ODOT by developing additional modal performance measures and expanding ODOT's reporting system. Need to report data to both US DOT and in-state stakeholders" (Ohio Department of Transportation. Access Ohio 2040). There is an important difference between state and federal policy regarding measuring and reporting: Environmental sustainability, freight movement and congestion reduction are in MAP-21, but are not addressed in Access Ohio 2040.

The Plan includes an Environmental Overview Goal to "Make sure planning decisions are informed if they have potential to impact Ohio's natural and human resources; ensuring that they comply with National Environmental Policy Act (NEPA) and related federal regulations" (Ohio Department of Transportation. Access Ohio 2040). This includes:

- An inventory of major ecological, endangered species, and cultural resources located within Ohio
- A review of climate variability and the need to analyze the risk posed to transportation facilities
- An assessment of potential sensitivities and risks to OH resources

The Federal Highway Administration (FHA) recently released an Interim Program Guidance Report (11/12/13) that relates to the above discussion of CMAQ. It states in part,
"In addition to the MAP-21 priority on cost-effectiveness, Section 176(c) of the Clean Air Act (CAA) requires that the FHWA and FTA ensure timely implementation of transportation control measures (TCMs) in applicable State Implementation Plans (SIPs). These and other CMAQ-eligible projects identified in approved SIPs should receive funding priority" (FHWA, 2013).

“The FHWA recommends that States and MPOs develop their transportation/air quality programs using complementary measures that provide alternatives to single-occupant vehicle (SOV) travel while improving traffic flow through operational strategies and balancing supply and demand through pricing, parking management, regulatory, or other means” (FHWA, 2013). Balanced Growth-Type programs could have relevant impacts regarding such measures.

The Plan notes, in regards to collecting additional revenues, that some states are looking to ATDM (Active Transportation and Demand Management) solutions that “involve dynamic management, control, and influence of travel demand, traffic demand, and traffic flow.” ODOT has begun such a study.

Other issues related to Access Ohio 2040 include:

“ODOT has established a statewide Transportation Asset Management (TAM) committee to develop a framework that will allow for the establishment of a centralized asset inventory database for all other assets (e.g. signs, signals, barriers, pavement marking, right of way, etc.) maintained by ODOT. The TAM database will support investment decisions and both quantitatively and qualitatively demonstrate the return on asset investments”. The TAM process could be utilized for collection of data related to transportation assets and their impacts on land uses and travel demand.

Access Ohio 2040 references the Ohio Mobility Improvement Study of 2012, which looked at how the State of Ohio efficiently and effectively provide basic mobility needs to the elderly, as well as people with low incomes and/or disabilities. Balanced Growth development patterns have been shown to improve access to transportation alternatives for the non-driving population.

Access Ohio 2040 references ODOT’s Strategic Transportation System (STS), identifying the STS as the “ tool that allows state, regional, and local transportation agencies to prioritize and coordinate additional discretionary transportation investments for those facilities that provide the greatest return on investments. “ The STS process could be a tool for prioritization of transportation investments that support transportation benefits through Balanced Growth development patterns.

MAP21

The Federal transportation reauthorization bill, Moving Ahead for Progress in the 21st Century Act (MAP 21) signed into law by President Obama in July of 2012, builds on ISTEA-era transit, bike and enhancement initiatives. One hundred federal funding programs were consolidated into fewer than 30.

Core Programs. Central programs of MAP-21 include:

- National Highway Performance Program (NHPP)
- Surface Transportation Program (STP)
- Congestion Mitigation and Air Quality Improvement Program (CMAQ)
- Highway Safety Improvement Program (HSIP)
- Railway-Highway Crossings
- Metropolitan Planning
- Transit (Most transit funding to Ohio comes from the Federal Transit Administration (FTA) and goes to Cleveland, Columbus and Cincinnati. The total for Ohio was $194 million in FY2006, down to approximately $161 million in FY2012)

The bulk of the funding for the above programs comes from 18.4 cents per gallon motor fuel tax, although it is not covering all the needs. MAP-21 includes about $1.8 billion in the federal transportation fund for Ohio state use.

Capturing Additional Revenues. The original MAP-21 expired September 30, 2014. Recently US congress passed a ten month extension to continue funding at this level, which will end on May 31, 2015. Future funding and changes to the federal motor fuel tax continue to be uncertain at this time. The following are some issues the federal government is looking at in order to capture additional revenue for transportation needs:

- The passage of MAP-21 revised the general prohibition of collecting tolls on interstates
- Using vehicle miles travelled (VMT) as a means to supplant or add to revenue collected by the gas tax
- There is discussion about an infrastructure bank that would initially have $10 billion as seed money. It has not been identified where this pot of money would come from

Other Questions & Issues related to MAP 21. The Center for Neighborhood Technology hosts an internet portal that allows the viewer to evaluate the affordability of purchasing or renting a housing unit in terms of transportation cost because of the unit's location. http://htaindex.cnt.org/ It is becoming more and more generally recognized that the true cost of housing is a factor of both variable housing cost and the associated variable transportation cost, depending on location. This is known as the "H+T index."

ODOT approach/policy regarding transit .The TRAC scoring system includes detailed criteria for evaluating funding requests. The Transit Needs Study (in progress at the time of this writing) will address existing criteria and recommendations for criteria related to transit projects.

ODOT Processes

Planning Process. Federal transportation planning regulations in U.S. 23 CFR 450 define the statewide and MPO planning processes. These processes require state DOTs and MPOs to continually update their plans, coordinate with stakeholders, cooperate with local governments and the private sector, and address a number of planning factors including environmental impacts of transportation. The National Environmental Policy Act, (NEPA) further requires that every project using federal funding address the environmental and social impacts of the project prior to funding being approved or used on the project. FHWA Ohio Division staffs regularly monitor and review state DOT and MPO planning departments and agencies to confirm they are addressing all these factors and conditions before approving any federal funding for projects or planning activities. While it has never happened in Ohio, FHWA potentially could withhold all federal transportation funding to the state or MPO if the Federal planning requirements are not met.

Project Selection Processes. ODOT funds, programs (i.e. schedules for implementation), and advances (i.e. constructs) hundreds of projects each year. All ODOT projects, large and small, are selected and advanced by basically the same process. The project selection process begins by ODOT Central office determining how much funding will be available in the coming two years and then allocating funds to various "program areas." Some Federal and State transportation funding is legislatively limited to specific program areas. Program areas include project types such as safety, bridges, maintenance, capacity adding, rehabilitation, and operational improvements as well as to its 12 Districts and 17 MPOs etc. The distribution of funding between theses program areas is based on availability of funds, need, equity across the state, and most important - goals and policy based priorities. For example, safety is a top priority for ODOT and therefore significant funding is allocated to the safety program area for projects to improve transportation safety conditions across the state.

In each of these program areas, projects are identified based on research conducted to evaluate conditions and need. A variety of ODOT central office and district staffs, local jurisdictions, MPOs, and other transportation stakeholders use this research and discussions with stakeholders to generate a listing of project needs. Projects are then reviewed and rated (not ranked) by program areas and based on factors such as severity of condition and congestion, safety, mobility, geometric issues, drainage problems, etc. Each of the staffs, program managers, or groups (such as District office staff) responsible for the program area or location (such as MPO area or District) prioritizes which project to advance within the budget available. Before any project using Federal funding can be advanced, it must have had a NEPA evaluation to determine its environmental and social impact.

TRAC Process. As described in the project selection process, TRAC (Transportation Review Advisory Council) is one of the “program areas” to which ODOT allocates funds. ODOT maintains a separate process to select, prioritize, and fund large-scale capacity adding projects evaluated under the TRAC program. The statewide TRAC is allocated a specific amount of funding each year and the appointed Advisory Council members annually review all capacity adding project requests. Projects are prioritized based on detailed quantitative factors and the judgment of Advisory Council members. Many of the prioritization factors as described below incorporate concepts supporting balanced growth.

It is noted that ODOT, through its TRAC process and overall decision-making processes, is committed to:

- The preservation of its existing infrastructure by embracing a “Fix –It-First” strategy. Preservation and management of the existing system shall be accomplished by funding system preservation needs first and providing funds for new construction only after the basic maintenance needs of the existing transportation system are being achieved.

- Enhancing Ohio’s comparative economic advantage and quality of life. Promoting the expansion and diversity of Ohio’s economy requires creating and maintaining a safe, convenient, and efficient transportation system that is sensitive to regional differences and is socially and environmentally responsible. The department emphasizes economic development in its project selection process, and encourages a new spirit of cooperation and innovation in order to maximize and capitalize on economic development opportunities and create jobs.

- Being a partner, not a barrier, to local governments and will continue to aid in the delivery of their projects statewide. In addition, the major new program is committed to transport people, goods, and services while focusing on growing Ohio’s economy. ODOT stands ready to partner with local governments while making itself more accessible and understandable.

The TRAC’s project selection criteria reflects the goals of ODOT and takes into consideration regional and local priorities by strongly encouraging metropolitan planning organizations (MPOs) to submit priority project lists. In addition, no project application will be accepted unless approved or reviewed and commented on by the appropriate MPO, or ODOT district in non-MPO areas.

Projects may be nominated by:

- The Ohio Department of Transportation
- The Ohio Rail Development Commission
- Metropolitan Planning Organizations
- County engineers
- Transit authorities
- County commissions
- Municipalities
- Port authorities
- Other public infrastructure development authorities authorized by the Ohio Revised Code

Currently TRAC includes points for project qualities such as:

- Transportation Factors (traffic, safety, cost/benefit, air quality, functional class, intermodal connectivity)
- Road Project Scoring (V/C, ADT, safety)
- Public Transit (ridership, reduction in VMT)
- Intermodal Freight: Water Port and Rail Capacity Projects (congestions and capacity)
- Transportation Benefit versus Cost
- Air Quality (reduction in fuel consumption/reduction in ozone)
- Functional Classification
- Intermodal Connectivity (connecting 2 or more modes)
- Economic Performance Factors (employment and job creations w/in a 1 mile radius)
- Existing Jobs Within the Project Area
- Estimated Jobs Created
- Considering Factors of Economic Distress (unemployment, poverty rate)
- Local Investments (built-out attributes and new investments)
- Project Funding Plan

Summary:

Achievement of transportation benefits including cost reduction, improved efficiency, improved effectiveness, improved safety and reduced emissions, are desirable goals that align with the goals of ODOT's new Access Ohio 2040 plan. To the extent that land use patterns can assist with achieving these benefits, ODOT can support its mission through alignment of processes and programs that influence land use patterns. ODOT planning, project selection and TRAC processes all provide opportunities for influencing infrastructure investment decisions that could potentially drive more dense development patterns, leading to transportation benefits.

3.2 METHODOLOGY

3.2.1 MSA SELECTION AND REVIEW

A key component of the study was the collection and analysis of data in selected Metropolitan Statistical Areas (MSAs) that represented a wide range of characteristics and policy approaches. Note that MSAs are US Census-defined regional areas comprised of census tracts, making data collection feasible for comparison on a wide range of data topics. These MSA areas were selected for study based on data availability, and providing a range of geographic, growth and policy tiers. After selection, MSAs were reviewed in depth to better understand the conditions that underlie land use, growth and transportation patterns present in the MSA.

Data collection and analysis was focused on 26 selected MSAs across the country. Sources for MSAs evaluated included two studies: Ewing et al (2014) work on measuring sprawl and its impact, and Texas A&M Transportation Institute's (2012) Urban Mobility Report. These two studies were identified as they incorporated key land use characteristic and traffic outcome data that could be utilized conveniently for further analysis. In addition, supplemental information on each MSA was collected from the U.S. Census for general characteristics such as population, gross domestic product (total and per capita), land area, overall area, and change in these characteristics over time (1990-2010).

From the MSAs in these studies, 26 were selected according to the following criteria:

1) Data from both studies was available for each MSA selected
2) MSAs representing very large metropolitan areas (over 7 counties, plus major metropolitan areas such as New York and Boston) were eliminated
3) States with unique planning frameworks that differed from the rest of the states were eliminated (Hawaii and Vermont)
4) A range of scores on Ewing's sprawl index was included
5) A range of MSAs with positive, negative and neutral population growth rates from 1990-2000 was included (positive growth rate = > 20% over 20 years; neutral = 0-20% over 20 years; negative = < 0% over 20 years).
6) After a preliminary review of state policy, MSAs with a range of state policies in Tiers 0, 1, 2 and 3 were selected. These tier designations were refined later in the study.
7) All Ohio MSAs with data in the two studies were included, without regard to the other criteria.

The resulting set of focus MSA areas included 21 in 13 states, plus five in Ohio.

Once the 26 MSAs were identified, key characteristics in each MSA were summarized through web research on both the states and the MSAs. After web review, informational calls were made to planning staff in the state and MPO associated with each MSA, to understand the effectiveness of policy outlined on official web pages. In some cases, the preliminary policy tier classification was refined to reflect the actual implementation of the policy, and any MPO- or City-specific policy that differed from state policy in that MSA. A working tier designation was assigned to each MSA for the purpose of technical analysis.

Summary:

The 26 MSA focus areas were selected to provide adequate data for comparative analysis, to provide a range of geographic, demographic, economic and transportation characteristics, and to emphasize metro areas of a scale similar to Ohio metro areas. The five Ohio metro areas that had adequate data were included for comparison. The MSA selection process was designed to provide data that was relevant to ODOT and Ohio conditions, while illuminating the similarities and differences between different policy frameworks.

3.2.2 LAND USE AND TRANSPORTATION DATA

The approach for this research was to look across metropolitan statistical areas with a range in policies that are believed to change development patterns and therefore influence the land use transportation connection. The intent was not to model the impact through any sort of scenario analysis. However, it was thought that the regional transportation forecasting models could be a good source of information to examine this relationship. The latest regional transportation plans were collected and reviewed for each of the selected metropolitan statistical areas. However these documents had very little comparable information and it became clear that collecting the models and or the land use, socio-demographic and transportation network data used to build such models would be a lengthy process, likely exceeding the life of the project. Therefore, alternate sources of land use and transportation data were sought. These sources and the extracted data are provided in the following sections. All the data was collected at the metropolitan statistical area level.

Please note that supplemental data on the linear regression models is included in the Appendix, section 8.3.

2010 Sprawl Index Values

When Ewing, Pendall and Chen (2002, 2002, 2003) developed their sprawl index, they used 2000 land use data, drawn from multiple sources, to define twenty-two land use measures. These measures were then consolidated into four factors describing the density, land use mix, degree of activity centering, and street accessibility for 83 metropolitan areas. The four factors were then combined and rescaled to arrive at a composite score with a mean value of 100 and a standard deviation of 25, thus providing a relative sprawl index that can be used for comparisons. Ewing et al (2014) later updated the definitions of some of the factors included in the sprawl index using 2010 land use data and expanded their analysis to 193 metropolitan areas.

Assuming Ewing et al's (2014) latest definition of sprawl is appropriate, which is reasonable considering it is the most comprehensive collection of land use variables describing smart growth and/or sprawl, the sprawl index appeared to be the best dataset available to examine the land use transportation connection. The 2010 sprawl index values and their constituent density, land use mix, activity centering and street accessibility scores were downloaded from http://gis.cancer.gov/tools/urban-sprawl/. The data is provided in the table below.

TABLE 3C - 2010 SPRAWL INDEX VALUES

Urban Area	Scores				
	Density	Land Use Mix	Activity Centering	Street Connectivity	Composite
Akron OH	94.55	113.13	90.69	106.81	103.15
Albany NY	95.40	105.96	108.19	86.04	95.12
Austin TX	100.42	99.66	138.78	102.88	102.44
Beaumont TX	85.37	88.45	112.62	113.76	111.54
Boulder CO	107.71	122.00	111.33	115.52	117.87
Bridgeport CT	110.63	132.86	118.02	100.81	121.64
Buffalo NY	107.94	127.67	102.46	95.10	106.36
Cleveland OH	105.11	132.72	95.54	84.96	85.62
Colorado Springs CO	102.94	108.37	75.94	121.76	106.33
Columbus OH	101.58	112.24	95.56	112.19	93.00
Corpus Christi TX	98.68	118.31	90.15	110.41	117.29
Dayton OH	93.65	114.40	95.13	105.55	101.48
Eugene OR	95.35	125.70	116.84	91.29	125.63
Grand Rapids MI	91.39	91.78	99.15	74.75	79.18
Knoxville TN	88.10	60.62	100.77	82.53	68.22
Laredo TX	104.20	117.12	99.89	106.87	131.25
Little Rock AR	88.00	75.36	93.55	90.35	76.08
Madison WI	101.00	115.83	168.11	94.85	136.69
Milwaukee WI	113.31	126.73	153.40	130.35	134.18
New Haven CT	106.86	127.52	113.51	97.82	116.29
Pittsburgh PA	96.16	115.14	107.78	119.33	95.45
Provo-Orem UT	104.53	123.55	77.37	100.08	108.45
Salem OR	93.11	123.48	113.50	97.10	123.35
Spokane WA-ID	98.98	115.82	108.57	128.26	129.40
Stockton CA	106.54	135.75	82.11	121.04	120.28
Toledo OH-MI	95.30	120.34	85.46	95.85	100.90

Land Use Data

Given the complexity of the 2010 sprawl index, and the potential difficulties in interpreting any modeling results, additional land use data was obtained from the 2010 Census and 2010 Longitudinal Employer-Household Dynamics database at http://lehd.ces.census.gov/. Queries and GSI analysis were conducted to extract the following measures and the data in the table below:

- Area - gross land area in square miles for each MSA
- Population - 2010 population of the metropolitan statistical area
- Population density – sum of all population in all qualifying tract in the metropolitan area, divided by the sum of the area for all qualifying tracts. A qualifying tract has at least 100 persons per square mile and at lease 0.001 square miles.
- Employment – 2010 employment of the metropolitan statistical area
- Employment density - total employment of the metropolitan area divided by the total land area
- Jobpop - balance between jobs and population. This measure was first calculated for each block group using block-level population data. The block group centroid was buffered with a one-mile ring, and jobs and population were summed for blocks within the

ring. The resulting job and population totals were used to compute a job-population balance measure. This variable equals 1 for block groups with the same ratio of jobs-to-residents within the one-mile ring as the metropolitan area as a whole; and 0 for block groups with only jobs or residents within the one-mile ring. All values were weighted by the sum of block group jobs and residents as a percentage of the county total to obtain countywide average job-population balance (jobpop).

TABLE 3D - LAND USE DATA

Urban Area	Area (square miles)	Population (000)	Population density	Employment (000)	Employment density	Jobpop
Akron OH	857.48	620	815	302	336	0.61
Albany NY	1098.2	615	710	412	146	0.57
Austin TX	1717.1	1,305	926	800	189	0.49
Beaumont TX	684.8	242	511	161	56	0.52
Boulder CO	206.9	150	1,327	152	209	0.55
Bridgeport CT	624.8	931	1,467	405	648	0.65
Buffalo NY	994.8	1,049	1,097	542	347	0.65
Cleveland OH	1712.6	1,706	1,200	957	479	0.60
Colorado Springs CO	532.9	549	1,117	212	79	0.55
Columbus OH	1779.9	1,276	959	877	182	0.58
Corpus Christi TX	343.9	334	1,152	168	94	0.61
Dayton OH	880.1	742	876	320	250	0.64
Eugene OR	366.7	255	812	136	29	0.59
Grand Rapids MI	1440.4	608	621	453	169	0.56
Knoxville TN	1728.1	504	444	349	99	0.43
Laredo TX	155.8	230	1,575	82	24	0.61
Little Rock AR	1080.6	459	554	329	80	0.49
Madison WI	584.7	398	823	344	104	0.56
Milwaukee WI	1344.5	1,492	1,150	794	545	0.58
New Haven CT	604.5	617	1,426	357	590	0.65
Pittsburgh PA	3299.9	1,759	676	1,093	207	0.61
Provo-Orem UT	422.1	470	1,202	164	30	0.65
Salem OR	622.4	244	572	146	76	0.62
Spokane WA-ID	416.4	381	1,034	225	39	0.54
Stockton CA	493.5	404	1,331	200	143	0.67
Toledo OH-MI	638.2	517	893	267	196	0.65

Travel, Network and Congestion Data

Traveler, network and congestion data were obtained from Texas A&M Transportation Institute's 2012 Urban Mobility Report Powered by INRIX Traffic Data 2012 at http://mobility.tamu.edu/ums/. The data is in the following table.

TABLE 3E - TRAVEL, NETWORK AND CONGESTION DATA

Urban Area	Population (000)	Commuters (000)	Freeway Daily VMT (000)	Freeway Lane-Miles	Arterial Street Daily VMT (000)	Arterial Street Lane-Miles	Public Transportation Annual Passenger-miles (million)	Public Transportation Annual Unlinked Passenger trips (million)	Total Delay Hours (000)
Akron OH	620	324	5738	470	4712	1200	27	6.8	9805
Albany NY	615	321	7161	705	5429	1162	46.4	13.3	13071
Austin TX	1305	689	12274	930	10677	2025	154.4	35.7	37168
Beaumont TX	242	127	2973	254	3253	980	3	0.6	4188
Boulder CO	150	79	673	63	1025	200	0	0	2208
Bridgeport CT	931	486	10692	686	5929	1360	36.1	10.5	26305
Buffalo NY	1049	471	6938	800	9613	2380	87.3	25	21566
Cleveland OH	1706	857	18635	1525	12265	3100	252.1	55.1	35103
Colorado Springs CO	549	287	4315	395	5055	1335	24.6	3.7	9798
Columbus OH	1276	673	16000	1065	10500	2160	60.3	15.9	35329
Corpus Christi TX	334	175	2916	320	2682	750	23.1	5.3	3132
Dayton OH	742	387	7318	655	6310	1520	45.6	10.3	12392
Eugene OR	255	134	1746	155	1860	412	41.1	11.1	2262
Grand Rapids MI	608	317	5527	505	7800	1760	37.4	8.7	9951
Knoxville TN	504	264	5395	373	6490	1180	14	3.5	13143
Laredo TX	230	120	574	77	1876	360	14.1	4.2	3009
Little Rock AR	459	240	7700	650	4830	1140	13.4	2.5	8044
Madison WI	398	208	3356	280	2899	750	46.1	13.1	5283
Milwaukee WI	1492	785	11459	830	15129	4006	170.8	51.3	27681
New Haven CT	617	322	7873	575	4025	1014	29.9	8.6	14584
Pittsburgh PA	1759	1046	11754	1320	16200	3700	307.7	66.1	46672
Provo-Orem UT	470	246	3955	292	3082	690	0	0	8156
Salem OR	244	128	1560	145	2032	425	19.1	5.3	4556
Spokane WA-ID	381	200	2300	240	4240	1200	49.7	11.3	6075
Stockton CA	404	212	3547	220	2208	486	64.9	5.3	3476
Toledo OH-MI	517	270	4021	380	4352	1217	28	6.7	9213

Emissions

The emission data was obtained from the National Emissions Inventory (NEI 2011) at http://www.epa.gov/ttnchie1/net/2011inventory.html. Queries were conducted for on-road sources of nitrogen oxides (NO), particulate matter (PM2.5 Primary), sulfur dioxide (SO), and volatile organic compounds (VOC). The results are provided in the following table.

TABLE 3F - EMISSIONS DATA

Urban Area	Nitrogen Oxides	PM2.5 Primary	Sulfur Dioxide	Volatile Organic Compounds
Akron OH	16146	750	89	6529
Albany NY	21656	864	149	9894
Austin TX	21215	652	191	9143
Beaumont TX	9636	348	39	2733
Boulder CO	3598	123	22	2102
Bridgeport CT	9166	331	67	5614
Buffalo NY	13575	562	95	6528
Cleveland OH	33683	1511	177	16603
Colorado Springs CO	9178	324	52	5018
Columbus OH	45345	1900	218	20610
Corpus Christi TX	7051	233	35	2601
Dayton OH	21286	902	105	9320
Eugene OR	5981	204	29	2486
Grand Rapids MI	17068	550	87	11276
Knoxville TN	16714	618	90	6518
Laredo TX	4741	183	9	1417
Little Rock AR	21067	793	93	6582
Madison WI	13762	549	67	5620
Milwaukee WI	30585	1270	175	13936
New Haven CT	9094	322	66	5155
Pittsburgh PA	31325	1093	167	17057
Provo-Orem UT	10335	419	49	3821
Salem OR	6730	234	33	2867
Spokane WA-ID	10402	400	41	5230
Stockton CA	8966	346	36	3082
Toledo OH-MI	18176	761	81	8334

Collision Data

The number of fatal collisions and the number of fatalities per MSA was obtained from National Highway Transportation Safety Administration's Fatal Accident Reporting System (FARS) through a series of county based queries at http://www.nhtsa.gov/FARS. The state based injury and property damage only collision data was downloaded from state websites and/or from state employees via telephone and/or email requests. The results are shown in the following table.

TABLE 3G - COLLISION DATA

Urban Area	FARS fatal Collisions	FARS Fatalities	State crash data Injury	State crash data Property Damage Only
Akron OH	38	42	4599	14043
Albany NY	53	97	N/A	N/A
Austin TX	116	131	5135	11069
Beaumont TX	50	57	1179	4661
Boulder CO	16	20	N/A	N/A
Bridgeport CT	28	32	5952	14654
Buffalo NY	52	68	N/A	N/A
Cleveland OH	103	122	12366	36644
Colorado Springs CO	36	39	N/A	N/A
Columbus OH	131	155	12967	36310
Corpus Christi TX	30	44	1178	5572
Dayton OH	56	61	4800	13240
Eugene OR	17	25	1616	1816
Grand Rapids MI	74	89	5180	22468
Knoxville TN	84	92	5054	14122
Laredo TX	11	17	654	3097
Little Rock AR	87	97	5564	12988
Madison WI	40	47	2953	8395
Milwaukee WI	110	137	11247	26199
New Haven CT	58	71	N/A	N/A
Pittsburgh PA	160	186	5350	5582
Provo-Orem UT	28	32	2688	5221
Salem OR	24	33	1991	2409
Spokane WA-ID	20	24	N/A	N/A
Stockton CA	52	75	3033	4892
Toledo OH-MI	58	66	5132	14237

Infrastructure Costs

The thought of examining the trends expenditures over subsequent years was considered. The team searched for a useable database for infrastructure expenditures, but no such database was found. An examination of the Survey of State Funding for Public Transportation (AASHTO 2012) revealed that there are multiple sources of funding and different investment and payment strategies that would make it very difficult to determine the actual cost of expansion, operation and maintenance for any one year for a specific MSA.

In addition, the annual expenditures are not likely to reflect the increase in road infrastructure that was needed to support the growth that occurred. This statement is explained in two ways. First, in areas where non-contiguous development previously occurred, the available capacity on linking roads between the suburban and urban areas could be used by additional development, without additional investment in state infrastructure. Second, the available funds are not sufficient to address all road improvement and expansion needs each year. Highway construction projects routinely get deferred or canceled and smaller, lower priority projects may be completed earlier than programed if the funds are not sufficient for the larger, higher priority projects.

As a surrogate measure for cost, the total lane-miles of freeway and arterial streets were used. These are directly related to cost. More infrastructure required greater capital costs and continues to require more for operation and maintenance. These surrogate measures actually provide a very efficient way to look at costs across MSAs because they are not impacted by the differences in construction costs, regional economies, or differences in maintenance costs due to climate and geography.

Land Use, Transportation and Policy Connections

While the policy-land use and land use-transportation benefits connections have been demonstrated in the literature, the purpose of this study was to test both of these relationships on real places, using selected focus areas. To do this, a scatterplot method was chosen that allowed the illustration of relationships between land use characteristics (x-axis) and transportation characteristics (y-axis). A linear regression analysis was done on each variable illustrated in the scatterplot diagram to test for possible statistical significance in the relationship between the land use and transportation characteristics. At the same time, each MSA data point in the diagram was identified by its MSA identification, and policy tier. This allowed, along with the information originally presented in the MSA summary table, a visual scan for possible patterns in policy related to both land use and transportation variables.

Summary:

A data gathering and analysis method was designed to identify possible patterns in relationships between land use factors and transportation benefits, and relationships between policy frameworks and land use outcomes, in the selected MSAs, thereby allowing interpretation of the relationships between policy and transportation outcomes. Key steps in the method included classification of policy frameworks into four tiers, as described above; utilization of land use and transportation measures identified by Ewing et al in 2003 and 2014; gathering of new transportation, household, congestion and emissions data from the US Census, Texas Transportation Institute, National Highway Transportation Safety Administration databases, and the National Emissions Inventory; and analysis using linear regression, and broad visual pattern evaluation. The method was designed to test associations as identified in the literature regarding the transportation benefits of land use policy and patterns, as applied to the selected MSAs, with an emphasis on relevance to Ohio.

3.2.3 POLICY REVIEW METHODOLOGY

Our review of policies and programs sought to identify transportation policy that influences Balanced Growth-Type development patterns, and how the mix of state investments, project funding programs and regional and local priorities interact.

The following were reviewed:

Current ODOT programs and funding mechanisms, including:

- ODOT Budget expenditures by categories
    - ODOT Direct Spending
        - New capacity, Maintenance, etc.
        - Decision making process; requests from districts; how prioritized
    - TRAC: ODOT Distribution to TRAC, decision making process, scoring rubric
    - ODOT distribution to local governments
- Current ODOT practices to interact with MPO/regional planning agencies and local governments in terms of decision making processes, available programs and funding streams; this includes identification of decision making criteria or rubrics for project awards and funding used by ODOT and MPO/regional planning agencies
    - Document review of MPO policies re: land development/balanced growth and their role in community planning and land use
    - MPO project selection process; ODOT and federal money in the mix
    - Consultation with staff at five MPOs in Ohio, asking them about the interaction with district and state units within ODOT, their experiences with the Balanced Growth Program, their interactions with local governments regarding transportation planning and projects, and their policies and practices related to smart growth or growth management practices.
    - Programs for Local Governments/Private Entities
- Results of relevant academic and agency research investigations on the outcomes of transportation policy in smart growth or "balanced growth" types of programs; these results were gleaned from gathering literature and policy evaluation reports.
    - After compiling a broad array of papers, a linked table was created with codes that indicated their subject matter. The literature review was organized in part by the type of land use policies used in each region or state as a way of comparing trends nationwide and identifying states with similar systems of regulations and incentives. An index to the literature with citations and links to HTML format literature is included. PDFs of all literature that could be downloaded are included in a folder transmitted to ODOT.
- Consultation with the National Smart Growth Center at the University of Maryland regarding current state of literature about policies and state practices.
- Review of the entire set of Endorsed Balance Growth Plans on the OLEC/Balanced Growth website, with particular attention to the approach used to define PDAs, the policies and mechanisms suggested for implementation of PDA investments, and the inclusion of transportation elements in the Balanced Growth Plan.

From the combination of these data, a set of policies, outcomes and benefits was identified that might accrue to state, local and regional governments, and the relevant policy areas for ODOT to consider in efforts to support the Ohio Balanced Growth Program.

Summary:

A final step in the method was to understand the potential implications in Ohio of existing and potential policy elements that characterize Balanced-Growth-Type programs. As the transportation benefits of land use policy are identified in the literature and going forward, it will be important for ODOT to have a "road map" for approaches to supporting these policies through their existing programs and processes, and through future research and collaboration. Initial concepts about this "road map" were outlined in terms of local, regional and state-level policy; potential outcomes; and potential benefits.

4.0 FINDINGS AND RESULTS

4.1 INTRODUCTION

The section presents the results of technical analysis and the policy review. Together they illuminate the connections between policy, land use and transportation benefits. The primary results of the study fell into two areas:

1) Specific analysis of the relationships between policy frameworks, land use characteristics, and transportation outcomes for 26 MSAs in 13 states, including Ohio. This allowed us to understand the potential for Ohio's Balanced Growth to influence development patterns, and transportation benefits, over time. Relationships were evaluated through regression analysis, and visual evaluation of scatterplot diagrams.

2) Recommendations for policy implementation by ODOT in support of land use characteristics that can provide transportation benefits.

4.2 SUMMARY OF MSA CHARACTERISTICS

The following is a brief summary of the general conditions (physical, geographic, and policy-related) that are at work in each MSA that was included in the focus set. A more detailed MSA summary is included in the Appendix, showing geographic location, population and economic characteristics, and policy elements.

As described earlier in this report, each of the states and MSAs was given a tier designation which reflects its policy framework in support of Balanced Growth land use patterns. Balanced Growth land use patterns include compact development, and development that is centered around activity nodes. Walkable block patterns, complete streets, and diverse choices in housing and transportation, are often present as well.

Please note that tier designations were assigned for policy that predominated in the period 2000-2010. Several states and regional agencies have adopted more recent changes in policy, which is not likely to have had an influence on land use and transportation data used in this study, which is typically dated 2010.

The information collected in the MSA summary, and briefly summarized in the tables below, was gathered through a combination of web research and requests for information to state and regional agencies. See the Appendix with detailed descriptions of the MSAs for agency information gathered for each MSA.

The MSAs were selected to provide a range of characteristics that centered around Ohio MSA characteristics, with higher and lower values for each characteristic provided for comparison. Characteristics of the group selected include:

Overall Geographic Characteristics

- The MSAs represented 13 states in all regions of the country: northwest, west, southwest, Midwest, northeast, south, and the mountain region. Five of the 26 MSAs were in Ohio.

- All of the MSAs were multi-county, ranging from 2 to 7 counties; Columbus, at 10 counties, was an exception chosen because of its Ohio location. Ohio MSAs ranged from 2 to 5 counties, excluding Columbus.
- MSA sizes ranged from 156 to 3300 square miles; Ohio's MSAs ranged from 638 to 1780 square miles.
- The selected MSAs included a range of special characteristics including lake and ocean coasts, county seats and state capitols, significant college populations, adjacent mountain ranges, and MSAs with no special characteristics.

Population and Demographics

- Population of the MSAs ranged from 250,000 to 2.1 million people; Ohio MSAs ranged from 610,000 to 2.1 million.
- Population growth over the 20-year period from 1990-2010 ranged from negative 4.5% (-4.5%) to 102%; Ohio's MSAs ranged from -1.2% to 30.1%.
- Population density, excluding census tracts that contained less than 100 people per square mile to allow comparison of primarily urbanized areas, ranged from 444 to 1575 people per square mile. Ohio's MSAs ranged from 816 to 1200 people per square mile.

Growth Characteristics

- GDP growth per capita from 1990-2010 ranged from 2.5% to 67.9% across the MSAs; Ohio's MSAs ranged from 7.6 to 20.5%.
- Housing growth was evaluated per decade to understand the era, or period, where most of the growth in the MSA took place. See Table 4D. MSAs were rated according to the decade when the highest percentage of their 2010 housing occurred. The decade of highest percentage of housing growth since 1940, across the MSAs, ranged from eight MSAs in the 1950s, to 12 in the 1970s, to 6 in the 2000s. In Ohio, 3 MSAs were in the 1950s, and two were in the 1970s.
- In the majority of MSAs, the largest percentage of their 2010 housing was in place prior to 1940 (18 MSAs), with 3 in the 1970s, one with a tie in the 1990's-2000s, and four in the 2000s. In all Ohio MSAs, the highest percentage of 2010 housing was present prior to 1940. See table 4D.
- The proportion of 2010 housing that was present in 1940 ranged from 8 to 57%; in Ohio, the range was 23 to 45%.

Sprawl Index Scores

- The sprawl indexes represented among the MSAs ranged from 68 to 137, out of a maximum of 200. Ohio's MSA sprawl indexes ranged from 86 to 103.

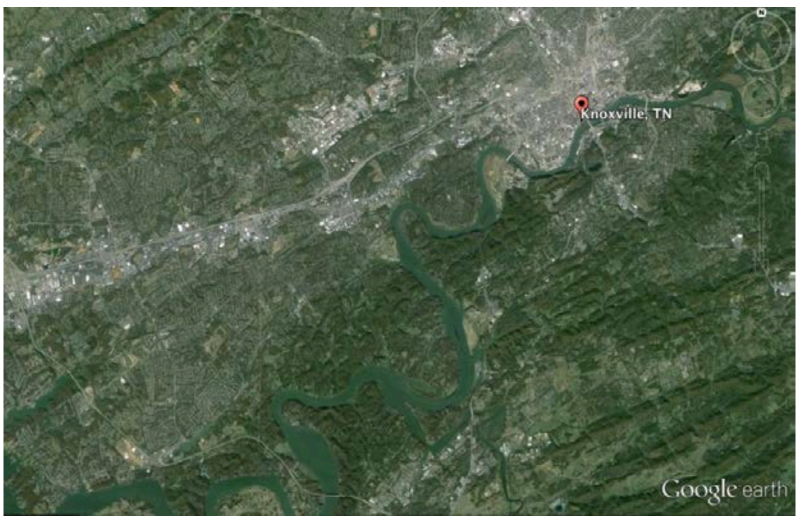
Effective Balanced-Growth-Type Policy in the MSAs

Note that policy tiers in the technical analysis were assigned by MSA. In some cases, the MSA had more stringent regional policy than their state, resulting in a higher tier assignment.

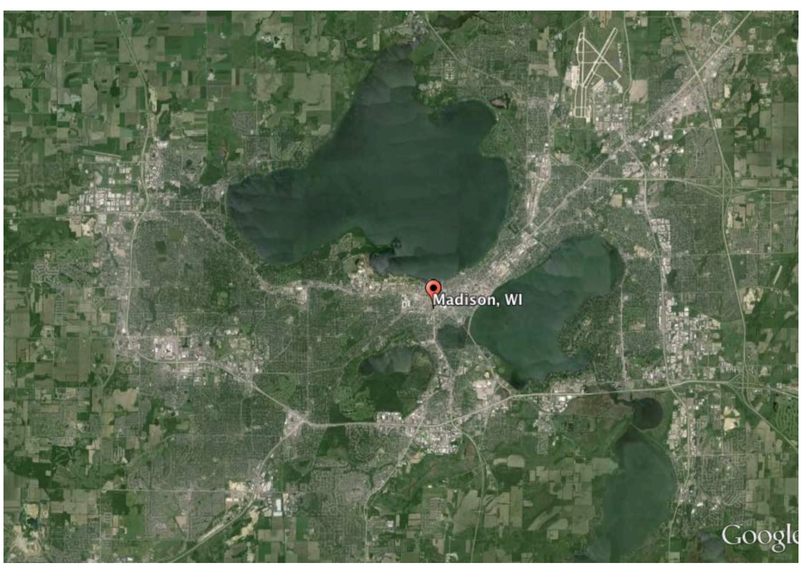
- Of all of the MSAs, 11 were classified as having Tier 0 policy – this included Ohio, which in the time period of 2000 to 2010 had little effective policy when the Balanced Growth Program was new.
- 7 were classified as having Tier 1 policy; 5 had Tier 2 policy; and 3 had Tier 3 policy. One MSA, Boulder, is noted as having "effective" Tier 3 policy due to its aggressive open space acquisition that has been in effect for many years.
- Of the Tier 1, 2 and 3 policy MSAs, implementation years of the policy ranged from 4 MSAs in the 1970's, to 7 in the 1990s, to 1 in the 2000's.

- 13 had no implementation year (two Tier 1 states had no specific program with an associated implementation year).
- 12 of the MSAs have newer policy that has been implemented since 2009. This policy was not incorporated into the technical analysis of this study, due to the likelihood that its effects could not yet be seen in 2010 data. Five of these are Ohio MSAs, with the Ohio Balanced Growth Program beginning implementation after 2009.

Of note, the aerial photographs show the pattern of development in the selected MSAs with the lowest sprawl rating (most sprawl)(Knoxville TN) and the highest sprawl rating (least sprawl)(Madison WI). Note the linear pattern of development in Knoxville, and the constraints on development in Madison that are created by significant lake area. Following the aerial photographs, Tables 4A through 4D summarize the various characteristics of the MSAs, and include the abbreviations used in the technical analysis.



Knoxville, TN. *Map source: Google Earth.*



Madison, WI. *Map source: Google Earth.*

TABLE 4A - MSA SOCIO-GEOGRAPHIC FACTORS

MSA	Abbreviation	Number of Counties	Population 2010	% Pop Growth 1990 -2010	% Growth in GDP per Capita 1990-2010 (1)	Square Miles in MSA	Population Density, people per sq mi (2)	Vehicles per 1,000 population 2010
Akron, OH	OH-A	2	703,200	6.9	19.9	857	816	401
Albany-Schenectady-Troy, NY	NY-A	5	870,716	7.6	25.9	1,098	710	397
Austin-Round Rock, TX	TX-A	5	1,716,289	102.8	45.5	1,717	926	378
Beaumont-Port Arthur, TX	TX-B	3	403,190	7.6	50.4	685	511	371
Boulder, CO	CO-B	1	294,567	30.7	67.9	207	1,327	408
Bridgeport-Stamford-Norwalk, CT	CT-B	1	916,829	10.8	38.0	625	1,467	363
Buffalo-Cheektowaga-Niagara Falls, NY	NY-B	2	1,135,509	-4.5	23.8	995	1,097	413
Cleveland-Elyria, OH	OH-Cl	5	2,077,240	-1.2	16.1	1,713	1,200	407
Colorado Springs, CO	CO-C	2	645,613	57.7	37.2	533	1,117	377
Columbus, OH	OH-Co	10	1,901,974	30.1	20.5	1,780	959	387
Corpus Christi, TX	TX-C	3	428,185	16.4	44.9	344	1,152	361
Dayton, OH	OH-D	3	799,232	-0.6	7.6	880	876	409
Eugene, OR	OR-E	1	351,715	24.3	27.0	367	813	414
Grand Rapids-Wyoming, MI	MI-G	4	988,938	24.9	4.5	1,440	621	373
Knoxville, TN	TN-K	9	837,571	28.5	28.8	1,728	444	409
Laredo, TX	TX-L	1	250,304	87.9	24.9	156	1,575	268
Little Rock-North Little Rock-Conway, AR	AR-L	5	699,757	30.8	27.1	1,081	555	393
Madison, WI	WI-Ma	4	605,435	30.9	43.1	585	823	415
Milwaukee-Waukesha-West Allis, WI	WI-Mi	4	1,555,908	8.6	23.9	1,345	1,150	398
New Haven-Milford, CT	CT-N	1	862,477	7.2	15.3	605	1,427	383
Pittsburgh, PA	PA-P	7	2,356,285	-4.5	43.9	3,300	677	420
Provo-Orem, UT	UT-P	2	526,810	95.5	31.9	422	1,203	274
Salem, OR	OR-S	2	390,738	40.5	23.4	622	573	361
Spokane-Spokane Valley, WA	WA-S	2	527,753	31.5	21.3	416	1,035	399
Stockton-Lodi, CA	CA-S	1	685,306	42.6	2.5	494	1,332	312
Toledo, OH	OH-T	3	610,001	-0.7	10.3	638	893	400

Notes:

(1) inflation-adjusted

(2) Population density excludes census tracts with less than 100 people per square mile

TABLE 4B - MSA POLICY FACTORS

MSA	Abbreviation	2014 Composite Sprawl Index(1)	Effective Policy Tier pre-2010(2)	Implementation Year(s) for Tier reference policy (3)	Implementation year of recent policy (4)
Akron, OH	OH-A	103	0	None	2009
Albany-Schenectady-Troy, NY	NY-A	95	2	1997	2010
Austin-Round Rock, TX	TX-A	102	1	None	2014
Beaumont-Port Arthur, TX	TX-B	112	0	None	None
Boulder, CO	CO-B	118	1	1978	1978
Bridgeport-Stamford-Norwalk, CT	CT-B	122	2	1979	1979
Buffalo-Cheektowaga-Niagara Falls, NY	NY-B	106	0	None	2010
Cleveland-Elyria, OH	OH-Cl	86	0	None	2009
Colorado Springs, CO	CO-C	106	1	None	None
Columbus, OH	OH-Co	93	0	None	2009
Corpus Christi, TX	TX-C	117	0	None	None
Dayton, OH	OH-D	101	0	None	2009
Eugene, OR	OR-E	126	3	1973	1973
Grand Rapids-Wyoming, MI	MI-G	79	0	None	None
Knoxville, TN	TN-K	68	2	1996	2011
Laredo, TX	TX-L	131	0	None	None
Little Rock-North Little Rock-Conway, AR	AR-L	76	0	None	None
Madison, WI	WI-Ma	137	1	1999	2010
Milwaukee-Waukesha-West Allis, WI	WI-Mi	134	1	1999	2010
New Haven-Milford, CT	CT-N	116	2	1979	1979
Pittsburgh, PA	PA-P	95	1	1999	1999
Provo-Orem, UT	UT-P	108	1	1999	1999
Salem, OR	OR-S	123	3	1973	1973
Spokane-Spokane Valley, WA	WA-S	129	3	1990	1990
Stockton-Lodi, CA	CA-S	120	2	2002	2008-13
Toledo, OH	OH-T	101	0	None	2009

Notes:

(1) Composite sprawl index is given based on Ewing study 2014. See references.

(2) "Effective policy tier 2010" indicates policies which were effective as of 2004 and could possibly have had an implementation effect as of 2010 data collection.

(3) Refers to year(s) of implementation for pre-2010 balanced-growth policies that were used to determine Tier designation

(4) "Implementation year of recent policy" refers to recent policy which supersedes the policy used for 2010 Tier designations. In some cases previous policy was rescinded as of the year given. See Appendix for more information.

TABLE 4C - MSA OTHER FACTORS

MSA	Abbreviation	Decade of highest % housing gain since 1940	Decade of largest % of 2010 housing (1)	% 2010 housing present in 1940	Geographic Constraining Factors	Other Factors
Akron, OH	OH-A	1950s	pre-1940	34	None	Legacy city (2)
Albany-Schenectady-Troy, NY	NY-A	1970s	pre-1940	43	None	Legacy city
Austin-Round Rock, TX	TX-A	2000s	2000s	8	None	State capitol
Beaumont-Port Arthur, TX	TX-B	1970s	pre-1940	32	Gulf of Mexico	
Boulder, CO	CO-B	1970s	1970s	11	Mountains - Denver MSA - greenbelt	College town
Bridgeport-Stamford-Norwalk, CT	CT-B	1950s	pre-1940	33	Adjacent MSAs, Long Island Sound	New York metro area
Buffalo-Cheektowaga-Niagara Falls, NY	NY-B	1950s	pre-1940	51	Canada Border across river	Legacy city
Cleveland-Elyria, OH	OH-Cl	1950s	pre-1940	43	Lake Erie	Legacy city
Colorado Springs, CO	CO-C	2000s	2000s	8	Mountains	College town
Columbus, OH	OH-Co	1970s	pre-1940	23	None	State capitol
Corpus Christi, TX	TX-C	1970s	pre-1940	22	Gulf of Mexico	
Dayton, OH	OH-D	1950s	pre-1940	30	Indiana border	Military Base town
Eugene, OR	OR-E	1970s	1970s	14	None	College town
Grand Rapids-Wyoming, MI	MI-G	1970s	pre-1940	27	None	
Knoxville, TN	TN-K	1970s	pre-1940	23	None	
Laredo, TX	TX-L	2000s	1990-2000s	15	Mexico border across River	
Little Rock-North Little Rock-Conway, AR	AR-L	1970s	pre-1940	22	None	State capitol
Madison, WI	WI-Ma	2000s	pre-1940	22	Many lakes	State Capitol, college town
Milwaukee-Waukesha-West Allis, WI	WI-Mi	1950s	pre-1940	38	Lake Michigan	legacy city
New Haven-Milford, CT	CT-N	1950s	pre-1940	38	Adjacent MSAs, Long Island Sound	New York Metro area
Pittsburgh, PA	PA-P	1950s	pre-1940	57	River Valleys	Legacy City
Provo-Orem, UT	UT-P	2000s	2000s	11	Smaller Lake	
Salem, OR	OR-S	1970s	1970s	20	None	State capitol
Spokane-Spokane Valley, WA	WA-S	1970s	pre-1940	28	None	
Stockton-Lodi, CA	CA-S	2000s	2000s	16	None	
Toledo, OH	OH-T	1970s	pre-1940	45	Lake Erie	Legacy City

Notes:

(1) "pre-1940" includes all decades prior to 1940

(2) "Legacy City" refers to former industrial cities, typically in the Northeast and Midwest of the US, which have experienced outmigration, employment and population decline, infrastructure decline, vacancy, and severely compromised budgets in recent decades

TABLE 4D - MSA % GAIN of 2010 HOUSING UNITS BY DECADE SINCE 1940

	% as of 1940	% 1940s	% 1950s	% 1960s	% 1970s	% 1980s	% 1990s	%2000s
Akron, OH	34%	11%	14%	9%	11%	5%	9%	7%
Albany-Schenectady-Troy, NY	43%	6%	10%	6%	13%	9%	6%	8%
Austin-Round Rock, TX	8%	3%	3%	5%	14%	19%	18%	30%
Beaumont-Port Arthur, TX	32%	17%	17%	6%	17%	4%	5%	3%
Boulder, CO	11%	2%	7%	15%	24%	16%	20%	6%
Bridgeport-Stamford-Norwalk, CT	33%	10%	15%	13%	11%	8%	4%	6%
Buffalo-Cheektowaga-Niagara Falls, NY	51%	10%	18%	5%	7%	4%	4%	1%
Cleveland-Elyria, OH	43%	10%	16%	10%	8%	3%	5%	5%
Colorado Springs, CO	8%	2%	8%	10%	18%	19%	15%	20%
Columbus, OH	23%	6%	10%	9%	14%	10%	14%	14%
Corpus Christi, TX	22%	12%	14%	4%	15%	14%	7%	12%
Dayton, OH	30%	12%	16%	13%	12%	6%	5%	5%
Eugene, OR	14%	12%	7%	13%	25%	4%	14%	11%
Grand Rapids-Wyoming, MI	27%	6%	9%	8%	14%	11%	14%	11%
Knoxville, TN	23%	10%	6%	7%	17%	9%	15%	12%
Laredo, TX	15%	4%	4%	3%	11%	13%	25%	25%
Little Rock-North Little Rock-Conway, AR	22%	6%	6%	10%	18%	11%	12%	15%
Madison, WI	22%	5%	8%	10%	15%	9%	15%	16%
Milwaukee-Waukesha-West Allis, WI	38%	7%	15%	7%	11%	6%	8%	8%
New Haven-Milford, CT	38%	7%	13%	8%	12%	11%	4%	6%
Pittsburgh, PA	57%	9%	11%	5%	10%	2%	3%	2%
Provo-Orem, UT	11%	5%	4%	5%	18%	7%	21%	29%
Salem, OR	20%	8%	5%	9%	22%	6%	18%	12%
Spokane-Spokane Valley, WA	28%	8%	11%	1%	19%	7%	13%	14%
Stockton-Lodi, CA	16%	10%	8%	7%	17%	13%	10%	19%
Toledo, OH	45%	8%	12%	7%	14%	4%	5%	5%

KEY: **Peak Decade** (shaded)

Summary:

MSAs selected represented a wide range of characteristics, with Ohio MSAs falling in the middle of each of the characteristic ranges. Selected MSAs demonstrate moderate highs and lows outside of the Ohio MSA characteristic ranges. Characteristics addressed included MSA land area and geographic and social/economic characteristics; population and population growth; housing construction era and housing growth; sprawl index ratings, and implementation years of policy frameworks. These characteristics demonstrate that the MSAs evaluated should represent the range of characteristics found in Ohio, with expanded ranges to help us understand the context for Ohio MSAs, and possible changes that could occur. The resulting analysis is therefore relevant to Ohio MSAs.

4.3 TECHNICAL ANALYSIS RESULTS: LAND USE, TRANSPORTATION AND POLICY

To understand the potential transportation benefits of Balanced Growth –Type policies, it is important to investigate the connection between policy, land use and transportation. If transportation benefits result from certain land use patterns, especially density and nodality, as demonstrated in the literature, then it would be desirable to demonstrate the efficacy of policy in driving those desirable patterns. A connection can then be made which demonstrates that certain policies (i.e. Balanced Growth-Type policies) can result in transportation benefits.

In the Ewing study of 2009, which established the sprawl index, the relationship between land use density and activity centering (nodality) and transportation benefits were shown to be significant. However, the Ewing 2014 study did not evaluate transportation-related variables. The current analysis in this study tested these transportation-related variables and found them to be significant. This evaluation demonstrated that less-sprawling MSAs do indeed produce transportation benefits through reduced lane miles, reduced congestion/delay, reduced vehicle-miles traveled, reduced collisions and reduced emissions. The current evaluation did not find, however, a significant relationship between the sprawl index and mode choice, and arterial lane miles. This finding is most likely due to the complexity of factors influencing local travel.

Some patterns in policy tiers were observed, and some possible explanations for these patterns were identified. More than any other tier group, Tier 3 policy MSAs (Oregon and Washington) tended to cluster across both the transportation variables and sprawl index scores. In addition, MSAs within the same state tended to cluster together related to the sprawl index, but not the transportation variable. There was no apparent pattern related to the primary era of growth and development, or to geographic constraints to development, related to the position of these clusters on the diagrams.

4.3.1 POLICY-SPRAWL-TRANSPORTATION CONNECTION

Scatterplot Analysis - Broad Patterns

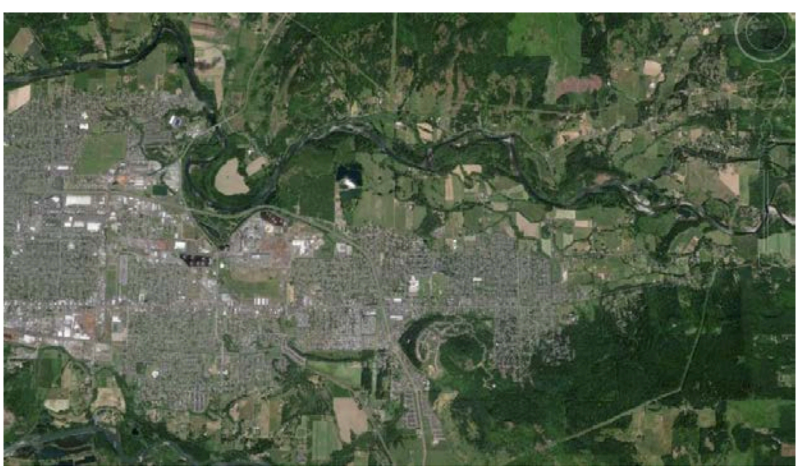
The collected transportation data were plotted against the 2010 composite scores or sprawl index values (Ewing et al 2014) for the selected MSAs. Generally speaking, the transportation data appears to show a negative relationship with the sprawl index, such that the transportation outcome value is smaller for larger values of the index. Remembering that larger values of the index represents less sprawling areas, the general negative relationship suggests that less sprawling areas perform better. However, this relationship does not appear to be very strong. The strength and significance of the relationship is examined using linear regression analysis.

In each of the plots, Tiers 0, 1, 2 and 3 are identified by red diamonds, yellow squares, green triangles and blue circles respectively. The purpose of utilizing the tiers in this analysis is to enable a broad, visual understanding of the relationship of the policy framework to the land use and transportation patterns present in the MSA. The intent was to identify possible trends that would indicate opportunity for further exploration of policy-land use-transportation relationships. While "causality" is not indicated in these relationships, there are some broad conclusions that can be drawn about the role of policy in influencing land use patterns.

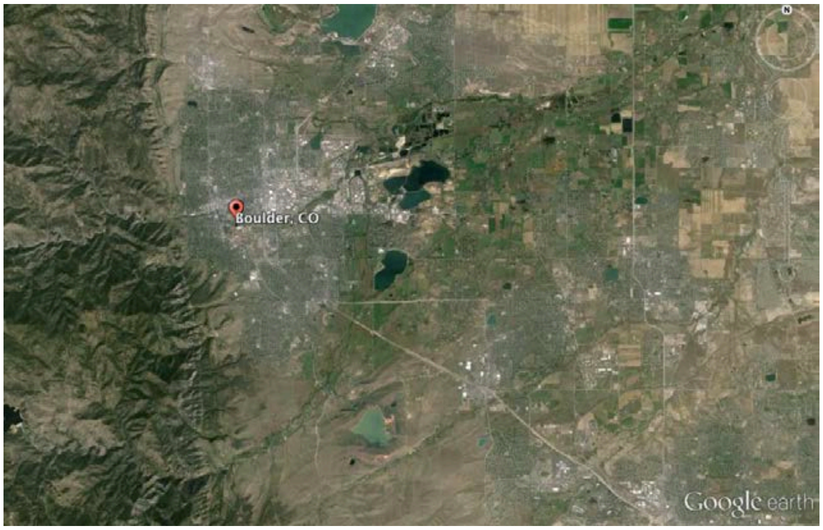
◆ Tier 0 ■ Tier 1 ▲ Tier 2 ● Tier 3

Across all of the plots, the Tier 3 MSAs, which are Eugene (OR-E), Salem (OR-S) and Spokane (WA-S), tended to cluster together, on both the sprawl index, which was constant through all diagrams, and the majority of the transportation measures examined. Above average scores for activity centering and land use mix scores also had above average street connectivity scores. This clustering of Tier 3 MSAs is the strongest notable pattern related to tier designations throughout the diagrams. Of interest, Boulder, Colorado, with its aggressive open space policy that acts as an effective urban growth boundary, often clusters in the vicinity of the Tier 3 MSAs.

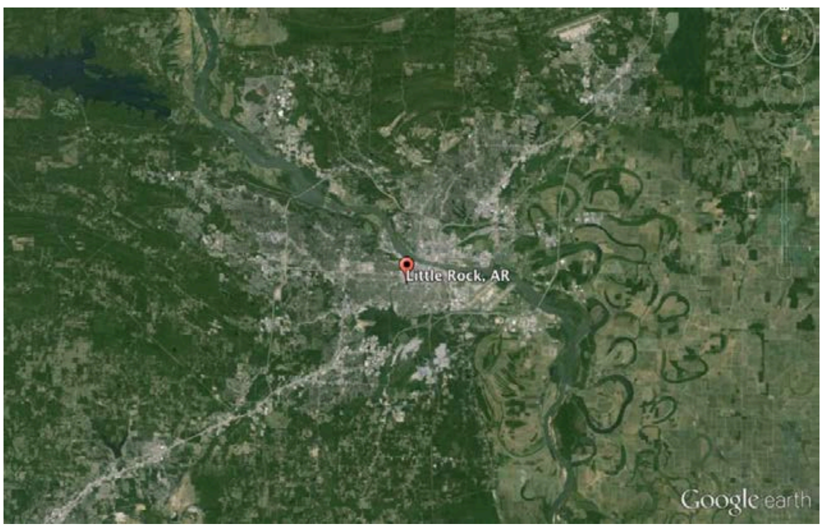
In the aerial photographs of eastern Eugene, Oregon, and Boulder, Colorado, note the distinct development line that is created by urban growth boundaries (Eugene) and open space (Boulder). Such longstanding policy could well be an affecting factor in these areas' high sprawl index ratings. Compare to the looser edge of non-urban-growth-boundary MSAs such as Little Rock. Aerial photographs of all 26 MSAs are included in the appendix.



Eugene, Oregon. *Map source: Google Earth.*



Boulder, Colorado. *Map Source: Google Earth.*



Little Rock, Arkansas. *Map source: Google Earth.*

A second note of interest is that the two Wisconsin MSAs were the only ones of the selected group that ranked higher on the sprawl index (less sprawl) than the Tier 3 MSAs. A review of their geographic characteristics notes that both have significant growth constraints at lake edges. However, other MSAs have lake, river and mountain geographic constraints without similar patterns. Future study would be warranted to understand the various market, socio-economic, and other forces that may be at work in influencing the sprawl ratings of these areas.

Third, the two Connecticut MSAs (CT-B and CT-N), which are adjacent to each other geographically, also tended to cluster. Both have above average scores for density, land use mix and activity centering, and it would be expected that they would have similar ratings to each other for transportation measures, as their close proximity probably means that similar external factors are at work in market, socio-economic, and transportation demand characteristics.

The fourth notable pattern across the diagrams was the general clustering of MSAs by state along the sprawl index axis. Where there were multiple MSAs for a particular state, they tended to fall in a similar range on the sprawl index. This general pattern has only one outlier; the Laredo TX (TX-L) MSA has a much higher sprawl index than the other Texas MSAs.

It is difficult to explain why the Tier 3 MSAs were clustered, and the MSAs in the same state might tend to cluster together along the sprawl index. The related historic development patterns, were examined, hypothesizing that development which occurred in earlier decades (pre-1940) would be denser than that occurring in later decades. Possible geographic constraints were also examined that could limit expansion of development, and perhaps result in more compactness and activity centering. In addition, patterns of positive and negative growth across the MSAs were examined. The longevity of policy was noted, observing that the Tier 3 policy states are among those with the longest-lived policies. None of these factors appeared to be related to the position of the states along the sprawl index.

There are additional factors that were not examined, as they would require new models and data outside the scope of this study. They include market and economic factors, land values, presence of significant amenities, interstate and inter-regional travel demand, size and shape of the MSA, and socio-demographic factors. Any of these factors, or combinations of them, could be a possible explanation for the clustering of the states along the sprawl index axis.

As noted above, Tier designations were assigned based on policy in effect in 2010. Policies in place before 2004 were deemed to be effective as of 2010.

Linear Regression Analysis

Three factors were identified as characterizing transportation benefits:

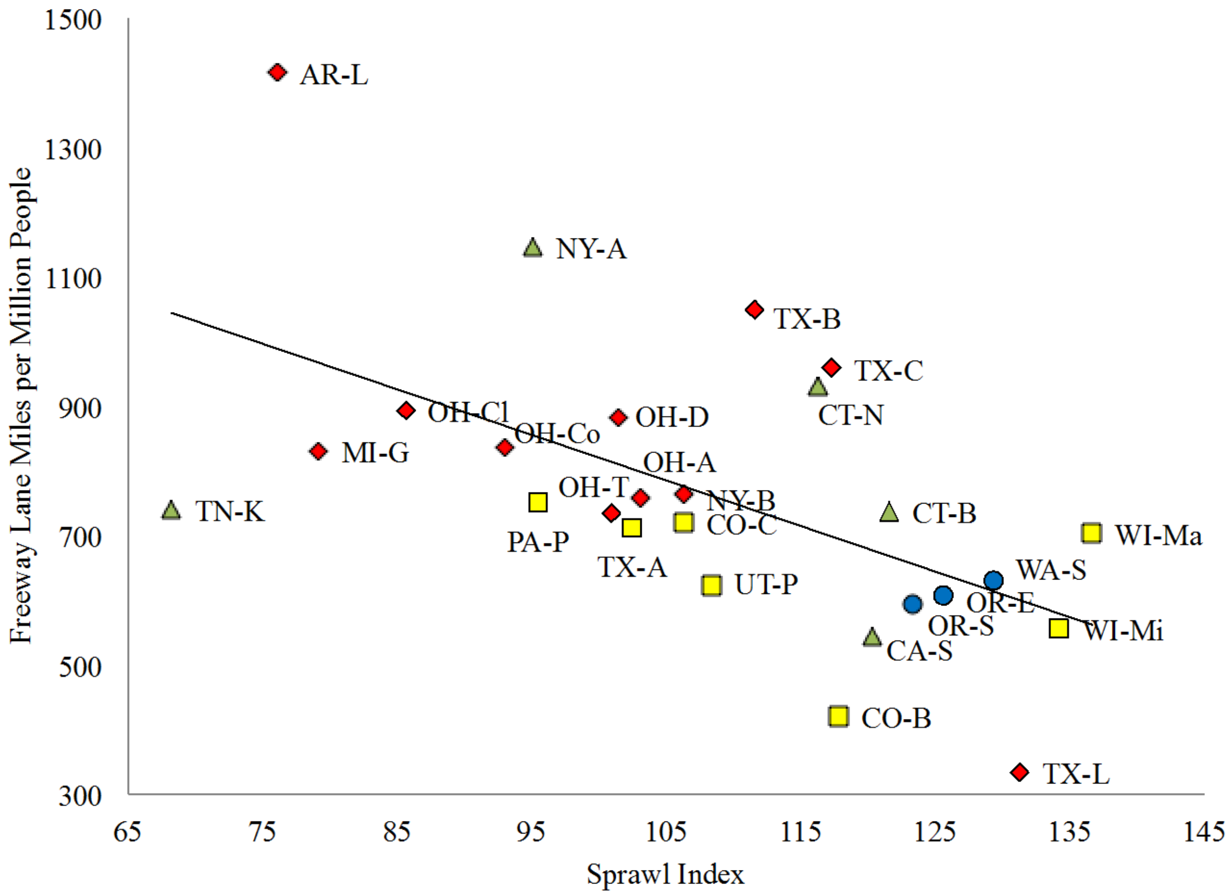
1) Transportation System Effectiveness Benefits – measured in lane miles as a surrogate for total expenditures
2) Transportation System Efficiency Benefits – measured in vehicle miles traveled, transit system miles per capita, and delay (congestion)
3) Transportation-Related Community Benefits – measured in collisions and emissions

4.3.2 TRANSPORTATION EFFECTIVENESS

Transportation benefits associated with effectiveness include road infrastructure lane miles, as a surrogate for cost. The number of lane miles will influence both construction and maintenance cost over time.

The number of lane-miles per million people was used as a surrogate for the cost of road infrastructure. Based on the findings of the literature, this measure was expected to be higher for MSAs with lower values of the sprawl index. In other words, areas with a greater amount of less dense, noncontiguous development would require more road infrastructure. The measure was given in terms of per million people to control for the differences in sizes of the MSAs. The relationship was examined separately for arterial streets and freeways as well as the total lane-miles. The linear regression models for arterial streets and total lane miles were not significant, however the linear regression model for freeway lane-miles per million people was significant ($p<0.01$, adj. $R^2=0.30$).

FIGURE 4AA – FREEWAY LANE MILES PER MILLION PEOPLE



Legend:

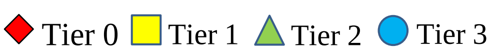
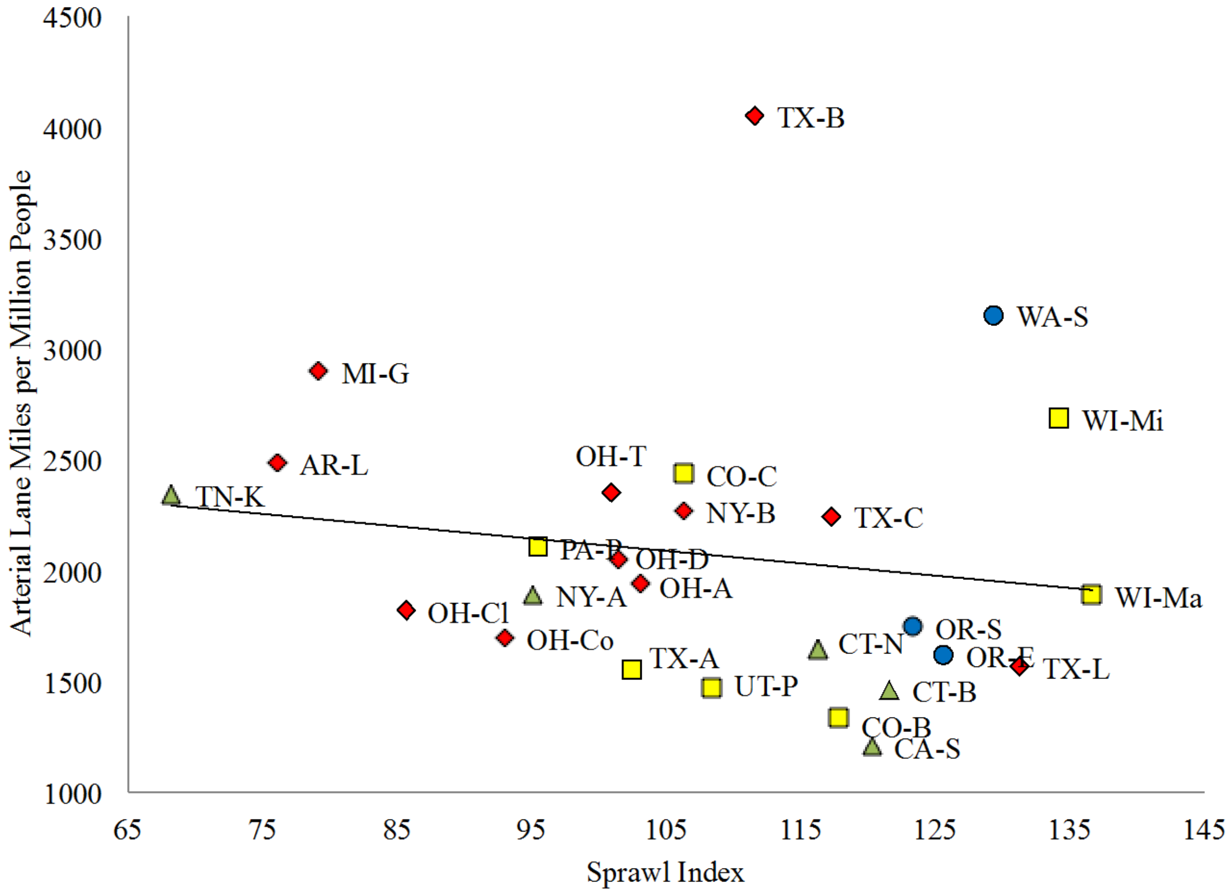


FIGURE 4BB – ARTERIAL LANE MILES PER MILLION PEOPLE



Legend:

Policy Tiers Observations

In general, the MSAs of all policy tiers are roughly positioned with a downward trend in freeway lane miles as the sprawl index rises (less sprawl). There are no clear patterns related to policy tiers except for the above-noted clustering of Tier 3 MSAs relative to both the sprawl index and freeway lane miles. This observation does not hold up for arterial lane miles, where the Spokane MSA stands at much higher arterial lane mile levels than the other two Tier 3 MSAs.

In the freeway lane miles diagram, obvious outliers include Little Rock (AK-L), with the highest quantity of lane miles per capita, and Laredo, Texas (TX-L), with the lowest; both are Tier 0 MSAs. Little Rock has few geographic constrictions; Laredo has a significant restriction in the Mexico/Rio Grande River international border. However neither of these is an outlier on arterial lane miles. As noted in the introduction, these could be explanations, or larger factors, such as level of transportation investment, market forces, and external travel demand could be at work.

In the arterial lane miles diagram, the outlier is Beaumont Texas (TX-B), with very high arterial lane miles relative to the other MSAs. The characteristics evaluated did not provide a likely explanation for this measure.

Boulder, Colorado, is close to the Oregon Tier 3 MSAs, with even more favorable ratings (lower lane miles) than any of the Tier 3 states. The constrained development pattern in this MSA could be a factor in this measure.

4.3.3 TRANSPORTATION EFFICIENCY

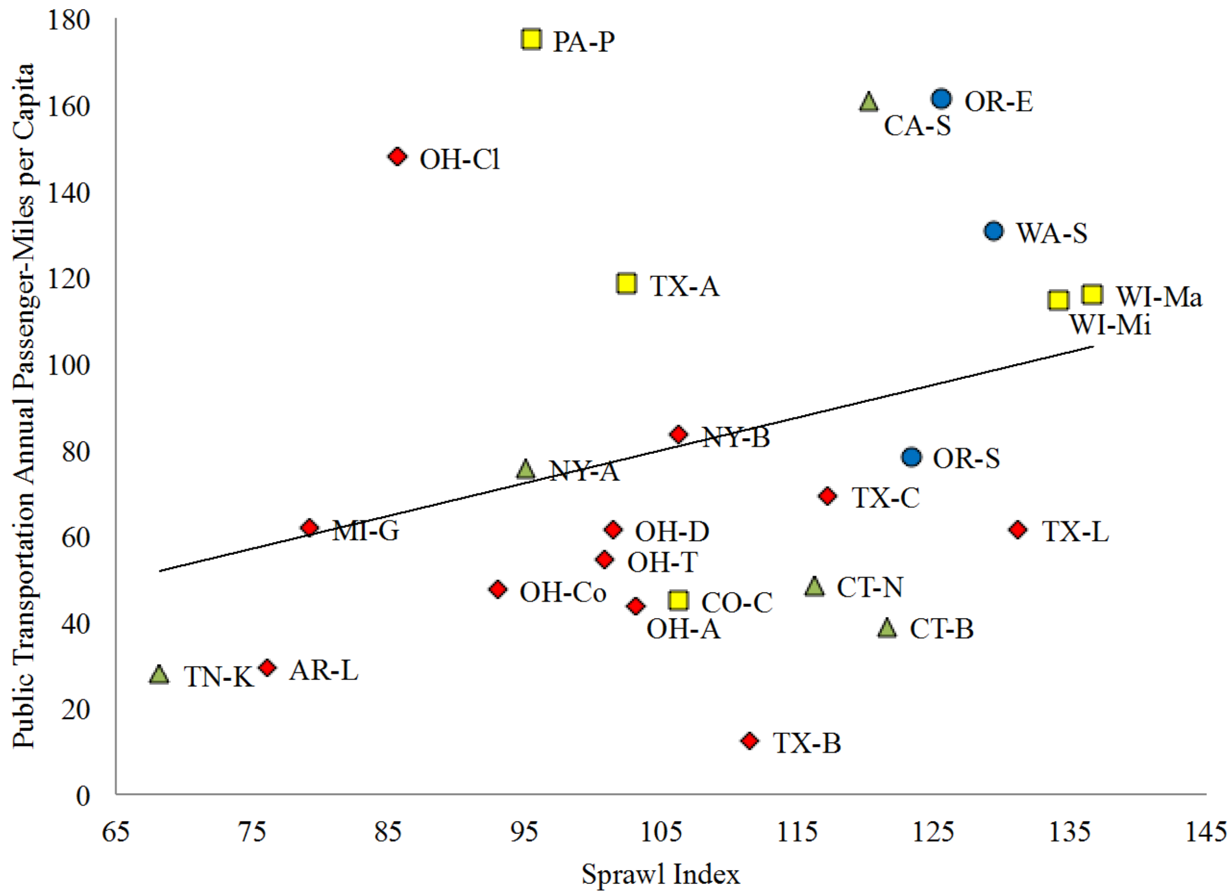
As noted in the "Transportation Benefits Table" (Table 1A), transportation efficiency involves measures of mode choice, vehicle miles traveled, and delay.

Trip rates and mode choice

Overall mode choice is important to an efficient transportation infrastructure because the use of transit (and other modes such as bicycling and walking) reduces the demand on road infrastructure. The balance of usage between modes can be influenced by land use characteristics, as demonstrated in the literature.

The measure public transportation annual passenger miles per capita was used to represent mode choice. Transit use was expected to increase with the sprawl index, however the linear regression model was not significant ($p=0.15$, adj. $R^2=0.05$). This finding is an indication of the complexity of the mode choice decision, which is based on much more than land use characteristics alone – factors such as overall transit investment, ridership patterns, convenience of routes, and geographic location of populations to be served and key destinations, all factor into the rate of the public use of transit.

FIGURE 4CC – PUBLIC TRANSPORTATION ANNUAL PASSENGER MILES PER CAPITA



Legend:

Policy Tiers Observations

The MSAs are particularly widespread across this diagram, with even the Tier 3 policy MSAs, which cluster in other measures, widespread in their scores for mode choice. High passenger – miles per capita were achieved by MSAs in all policy tiers and sprawl index scores, as were low passenger-miles per capita. This is an indicator that significant non-land-use forces are likely at work. Possibilities include overall commitment to transportation investment; convenience of transit systems; market demand and social desirability of transportation; population and household characteristics and locations related to jobs; weather factors; and ease of driving and parking as an alternative to transit use.

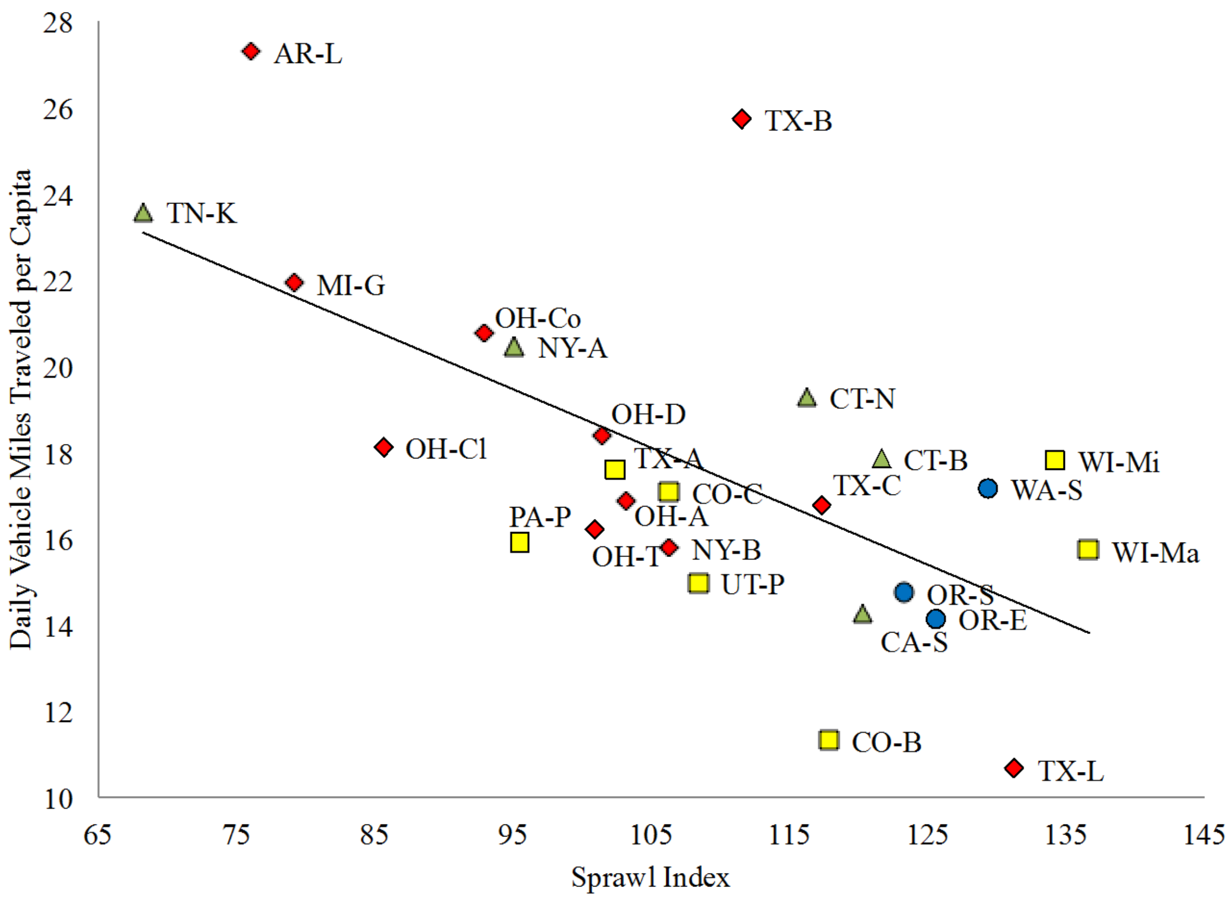
The three Tier 3 MSAs, Eugene (OR-E), Spokane (WA-S) and Salem (OR-S), are also widely spread, from 80 to 160 passenger miles per capita. Spokane and Eugene are in the top third of the MSAs studied, joining Pittsburgh (PA-P), Cleveland (OH-Cl), Stockton (CA-S), Austin (TX-A), Madison (WI-Ma) and Milwaukee (WI-Mi) in a range of 115 to 175 annual passenger miles per capita. Data was not available for Boulder, Colorado for this measure.

Vehicle miles traveled

The vehicle miles traveled measure represents the combination of the number of trips and trip length, and is a strong measure of the demand for road infrastructure. The demand is expected to increase as development sprawls into rural areas; therefore this measure is expected to decrease with the sprawl index, remembering that sprawling MSAs have smaller values of the sprawl index.

The linear regression models for arterial daily vehicle miles traveled per capita (p=0.03, adj. R^2=0.14), freeway daily vehicle miles traveled per capita (p<0.01, adj. R^2=0.27) and total daily vehicle miles traveled (p<0.01, adj. R^2=0.38) were significant.

FIGURE 4DD – DAILY VEHICLE MILES TRAVELED PER CAPITA



Legend:

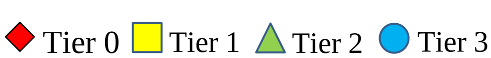
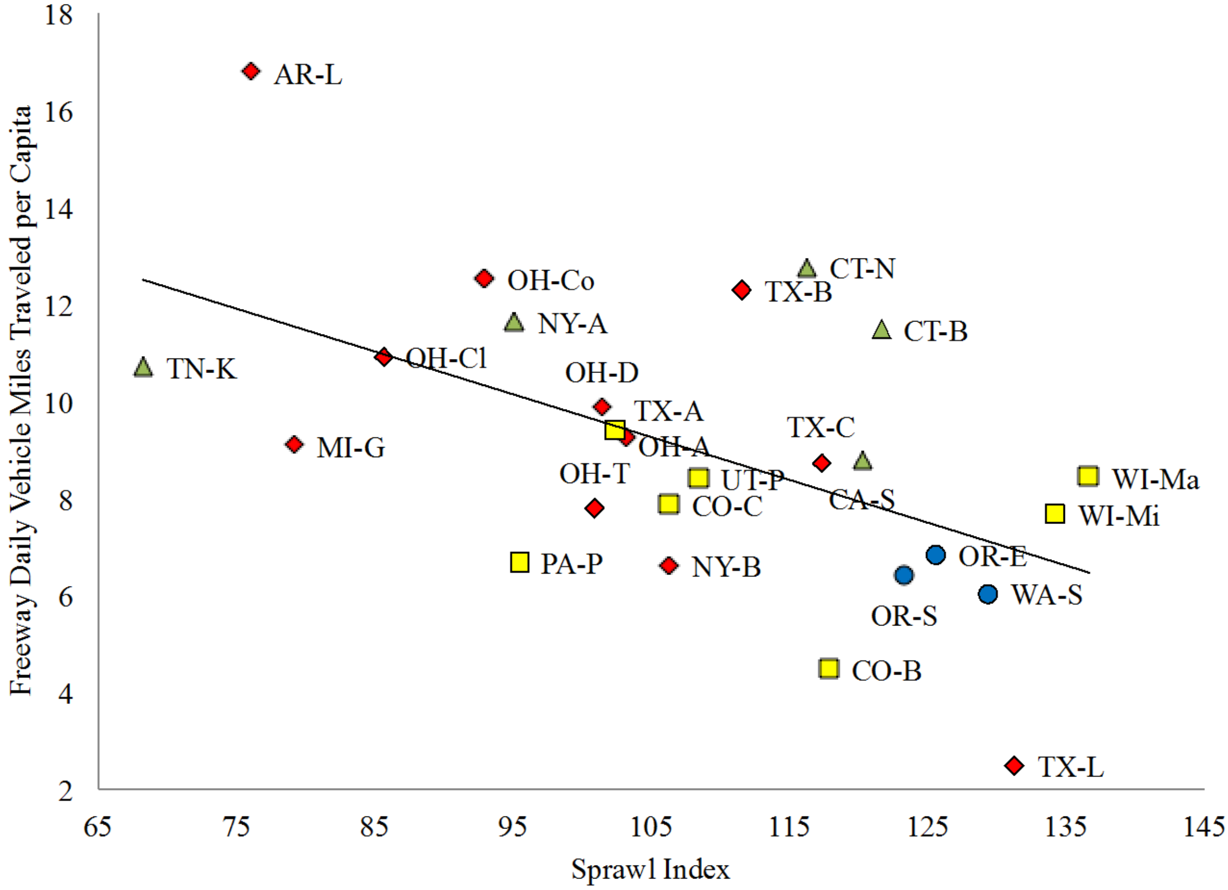


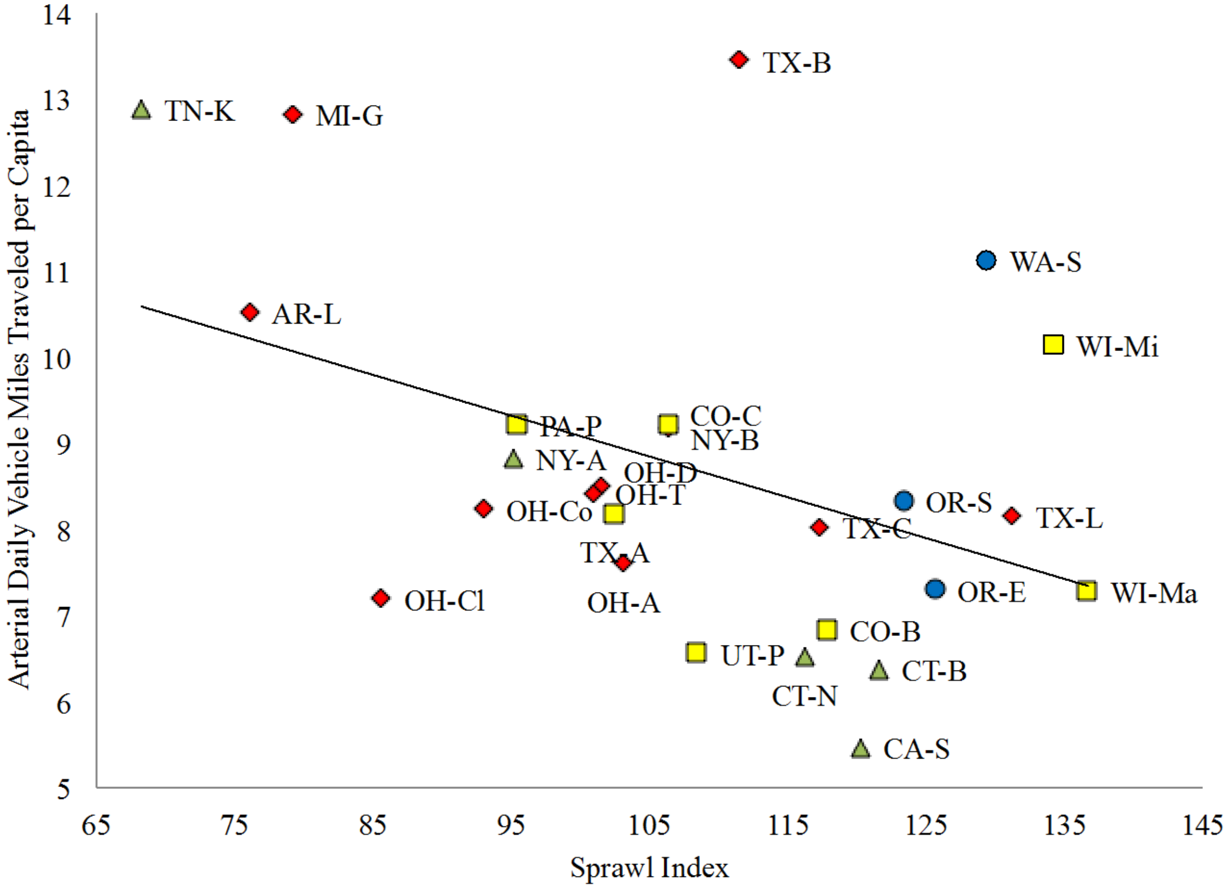
FIGURE 4EE – FREEWAY DAILY VEHICLE MILES TRAVELED PER CAPITA



Legend:

◆ Tier 0 ☐ Tier 1 △ Tier 2 ◯ Tier 3

FIGURE 4FF – ARTERIAL DAILY VEHICLE MILES TRAVELED PER CAPITA



Legend:

Policy Tiers Observations

The three Tier 3 MSAs (Eugene Oregon OR-E, Salem Oregon OR-S and Spokane Washington WA-S) were clustered close together for the freeway and total daily VMT measures. These MSAs were wider spread on arterial measures with Eugene and Salem closer in rating to each other than to Spokane, and more in the moderate level in relation to other MSAs.

These patterns could reflect the power of the primary policy characteristic of the Tier 3 frameworks, namely the presence of Urban Growth Boundaries. With more compact, less sprawling development occurring, there is less need for drivers to travel extensive miles on freeways. This concept compares favorably in Boulder, with similarly constrained development, which has even lower VMT than the Tier 3 MSAs in all three measures.

In the total daily VMT diagram, the MSAs generally fall together in the 14-22 daily VMT range, with several notable outliers: on the high end, Little Rock Arkansas (AK-L), Beaumont Texas (TX-B), and Knoxville Tennessee (TN-K); on the low end, Laredo Texas (TX-L) and Boulder Colorado (CO-B). Boulder's location could be related to the significant college population in its environs, which likely does less freeway driving, and its constrained development pattern. Laredo's location could be related to the international border, although Buffalo, NY has a similar international border and is not affected. The other locations are not as easily explained by the characteristics evaluated. Laredo does have a much lower car ownership rate than the other MSAs, which could contribute to its location on the diagram. Fewer cars could mean fewer total vehicle miles traveled, although other factors such as jobs-housing relationships will also affect VMT per vehicle.

Laredo (TX-L), and Boulder (CO-B) are the lowest, perhaps indicating a high proportion of people who are not driving. This could be the case in Boulder, a college town, which has a high rate of vehicle ownership but could actually have less driving of those vehicles on a daily basis. The possible reasoning for Laredo is unknown, based on the characteristics evaluated. It is possible that international borders could be a factor affecting their locations on the diagrams.
Of interest, Laredo has the lowest number of vehicles owned per 1,000 population among the MSAs evaluated (268 in a range of 268-420).

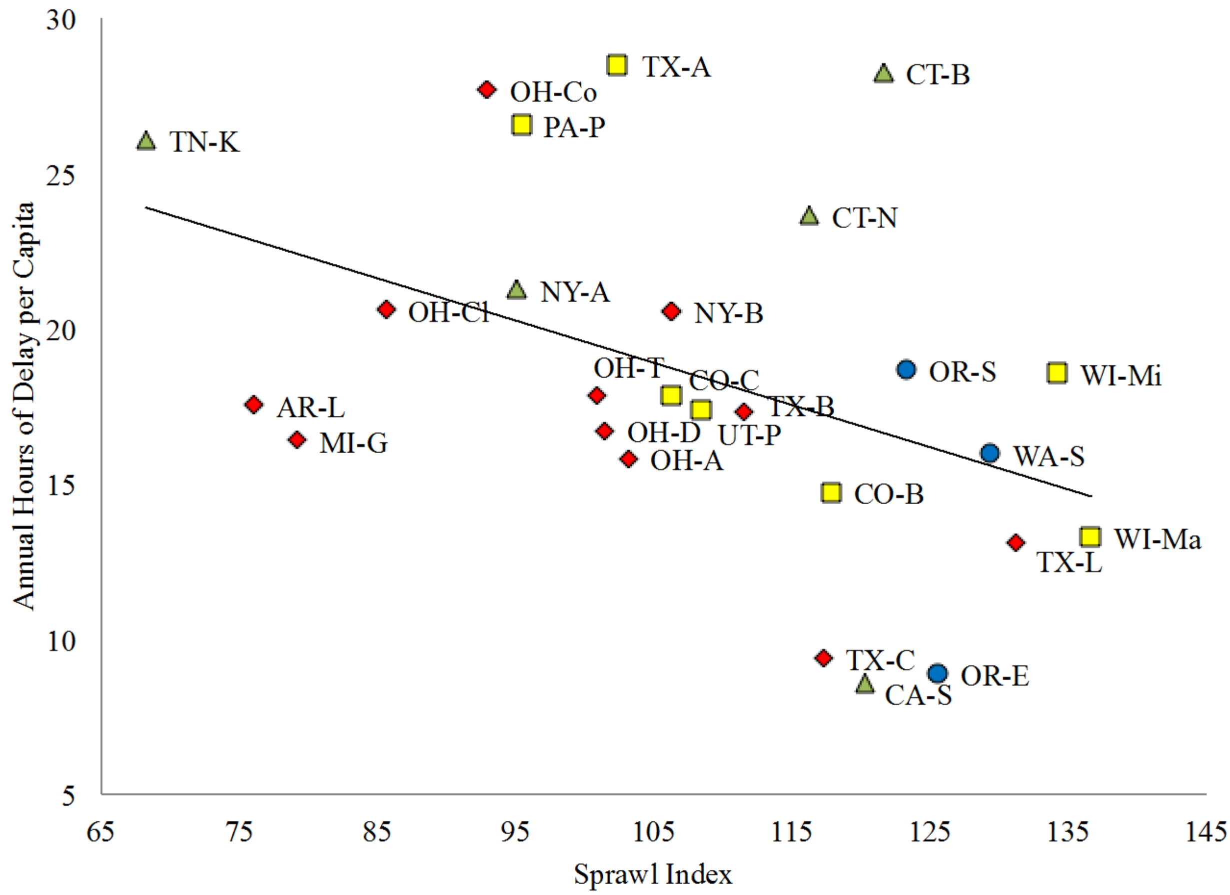
In the Freeway VMT diagram, the MSAs generally fall in the moderate level from 4 to 12 daily VMT per capita. There is no apparent strong pattern among tier designations, although the Tier 1 group range is lower overall than the Tier 0 group range for freeway VMT. The two outliers, similar to the Freeway Lane Miles diagram, are Laredo, Texas (TX-L), and Little Rock, Arkansas (AK-L). Reasons for these locations were noted in the previous paragraph. As noted, Tier 3 MSAs cluster favorably for both sprawl index and lower freeway VMT.

These patterns were least evident in the Arterial VMT diagram. The majority of MSAs fell in a relatively low level from 5 to 9 arterial daily VMT; their policy tiers were mixed. There were six MSAs, however, with much higher arterial daily VMT at a score range of 10-14, including those that were relatively high on the sprawl index (Spokane WA-S and Milwaukee WI-Mi) and those that were relatively low (Knoxville TN-K and Little Rock AK-L). While the statistical analysis for the relationship between sprawl index and arterial daily VMT is significant, the policy tier relationships are not strongly evident here.

Congestion and travel delay

Both the annual hours of delay per capita and annual hour of delay per commuter data sets were examined for a relationship with the sprawl index. The literature did not provide strong evidence of whether congestion and therefore travel delay increases with sprawl. The annual hours of delay per capita model was significant (p= 0.03, adj. R^2=0.154) as was the annual hour of delay per commuter (p=0.04, adj. R^2=0.036). These measures are related as the ratio of the number of commuters to population for each MSA is relatively constant (mean=0.52, standard deviation = 0.02). One exception is Buffalo (NY-B), which has a commuter to population ratio of 0.45.

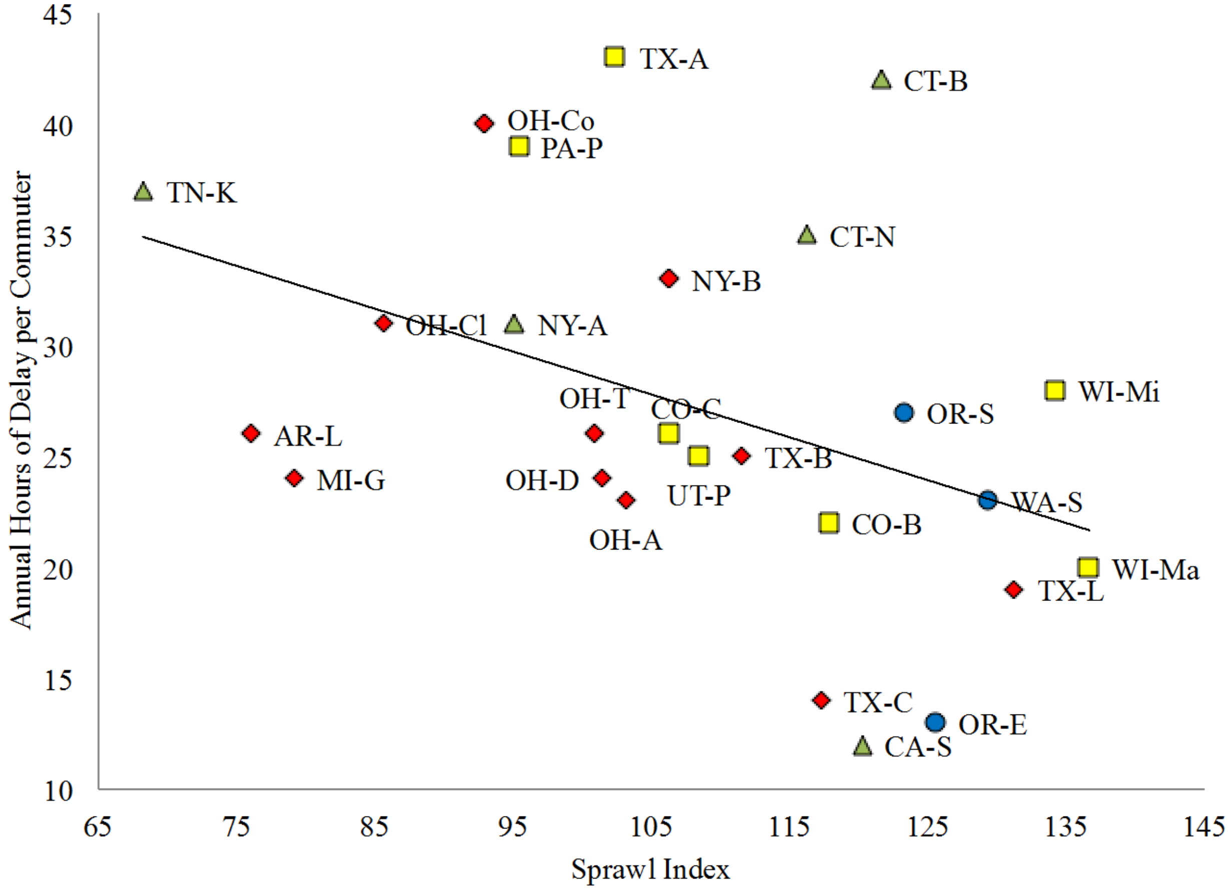
FIGURE 4GG – ANNUAL HOURS OF DELAY PER CAPITA



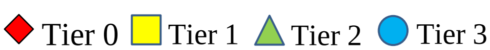
Legend:

Tier 0 Tier 1 Tier 2 Tier 3

FIGURE 4HH – ANNUAL HOURS OF DELAY PER COMMUTER



Legend:



Policy Tier Observations

In spite of the significant relationships in this analysis, there are no clear patterns in the policy tier locations on the diagrams. The MSAs are widely spread across the delay range, from 10 to 45 hours of delay per commuter and 5 to 30 annual hours per capita, with no discernible patterns among tier groups, beyond the clustering of individual state MSAs along the sprawl index.

Delay is one measure where the Tier 3 MSAs are not clustered closely, with their delay ratings ranging from about 8 hours to about 18 hours per capita, and about 12 hours to about 27 hours per commuter. While Boulder, Colorado is still favorable in lower levels of delay, it is closer to the regression line in these measures. This would indicate that some other characteristics of each MSA are bigger factors than sprawl in influencing hours of delay. For example, Eugene (OR-E) rates among the lowest in delay. It is a significant college town, housing the University of Oregon, which likely contributes to lower delay ratings. Boulder is similarly a college town.

Of interest, Knoxville (TN-K), Columbus (OH-Co), Austin (TX-A), Pittsburgh (PA-P), Bridgeport (CT-B) and New Haven (CT-N) are all rated highest in terms of annual delay, although the corresponding sprawl index values cover a wide range from 70 to 120 (out of 160). Reviewing the profiles of these MSAs, there is no outstanding character that would indicate their placement at this high level. The other two MSAs that are rated lowest in delay are Corpus Christi (TX-C) and Stockton (CA-S), which are under 10 hours of delay per capita, and under 15 hours of delay per commuter. At this broad visual level it is difficult to identify what might be influencing this rating.

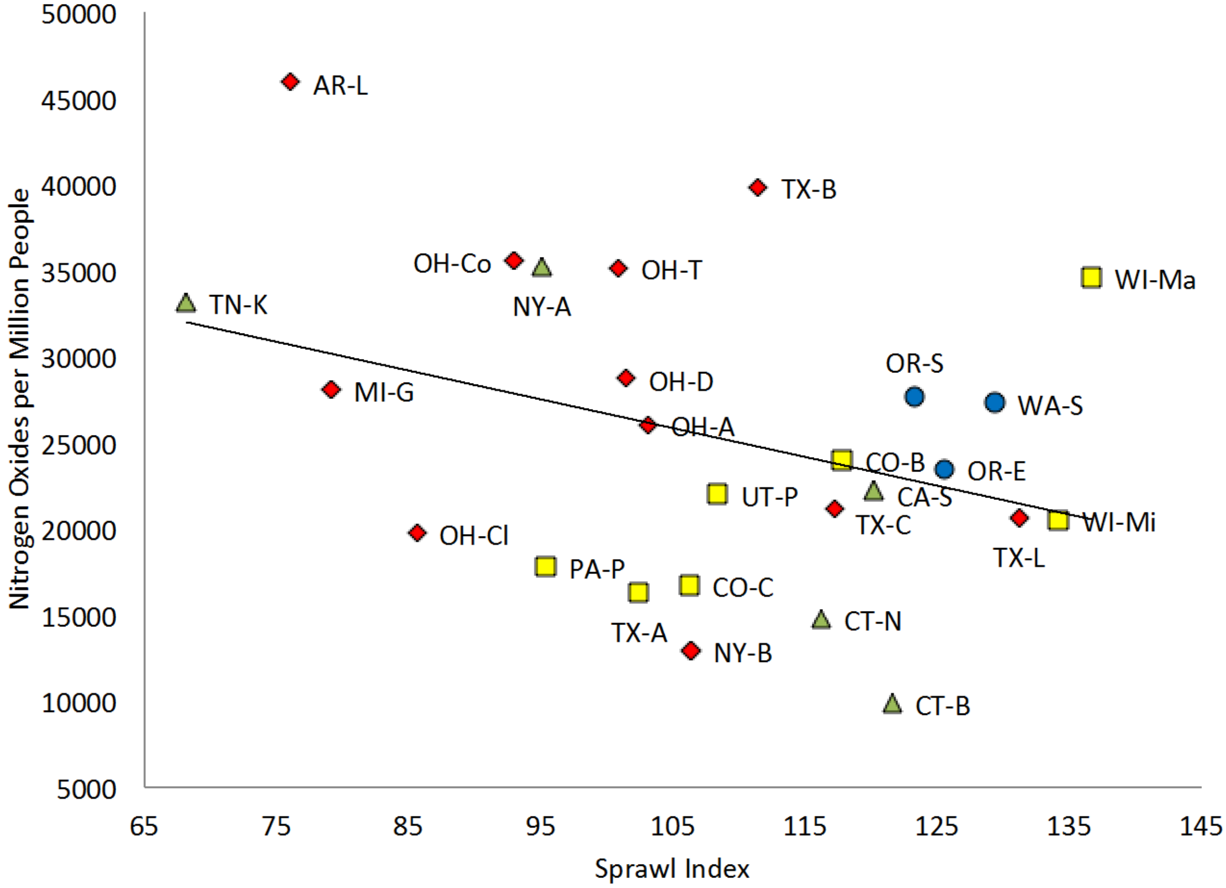
4.3.4 TRANSPORTATION-RELATED COMMUNITY AND ECONOMIC BENEFITS

As noted in the "Transportation Benefits Table", (Table 1A), community and economic benefits measured included emissions and safety (collisions).

Emissions

Tailpipe emissions are directly related to the amount vehicles are operated. Emissions are also directly related to air quality and public health impacts. The gathered emissions data was specific to on-road vehicles therefore were expected to increase with higher sprawl index values. These emissions measures were given in terms of per million people to control for the differences in the sizes of the MSAs. The regression models for nitrogen oxides per million people (p=0.08, adj. R^2=0.08), sulfur dioxides per million people (p=0.01, adj. R^2=0.20), and volatile organic compounds per million people (p=0.04, adj. R^2=0.13) were significant.

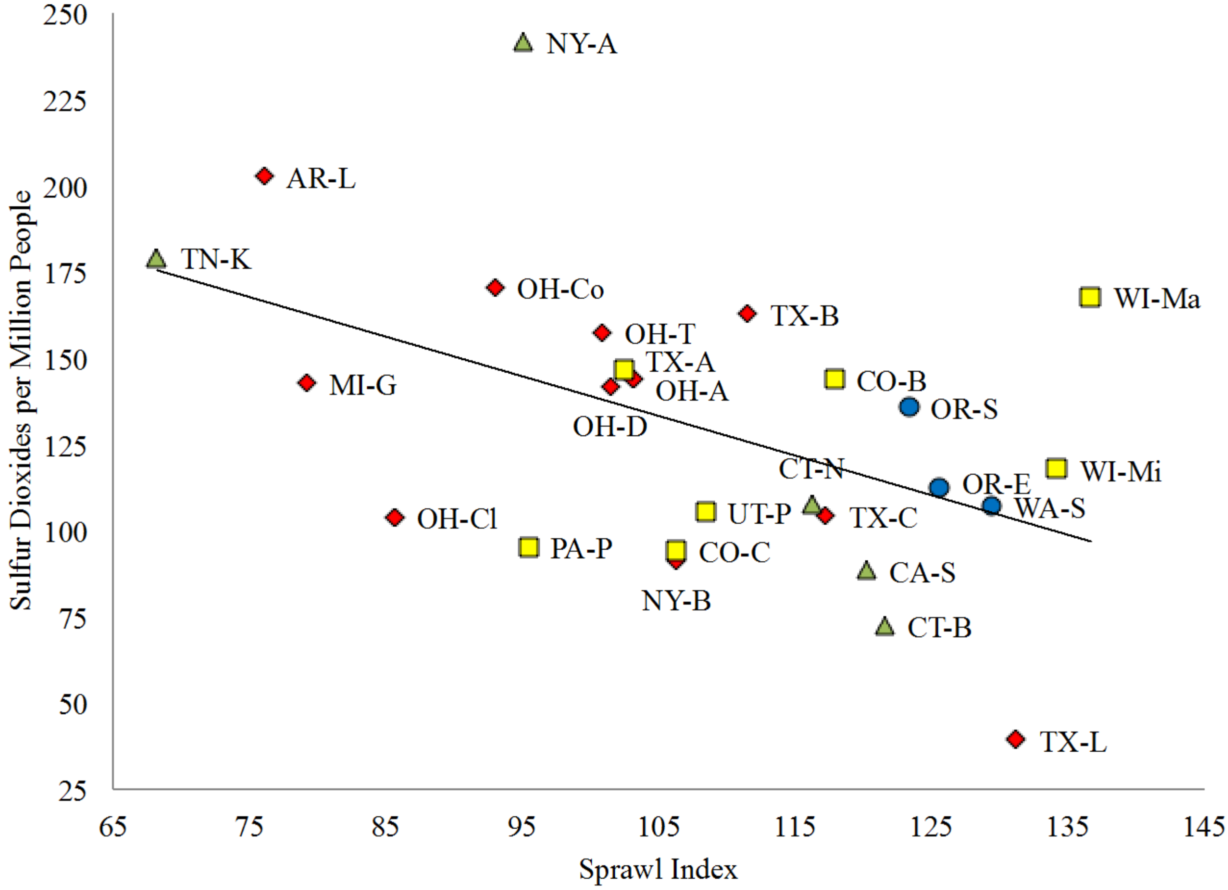
FIGURE 4II – NITROGEN OXIDES PER MILLION PEOPLE



Legend:

◆ Tier 0 ◻ Tier 1 △ Tier 2 ● Tier 3

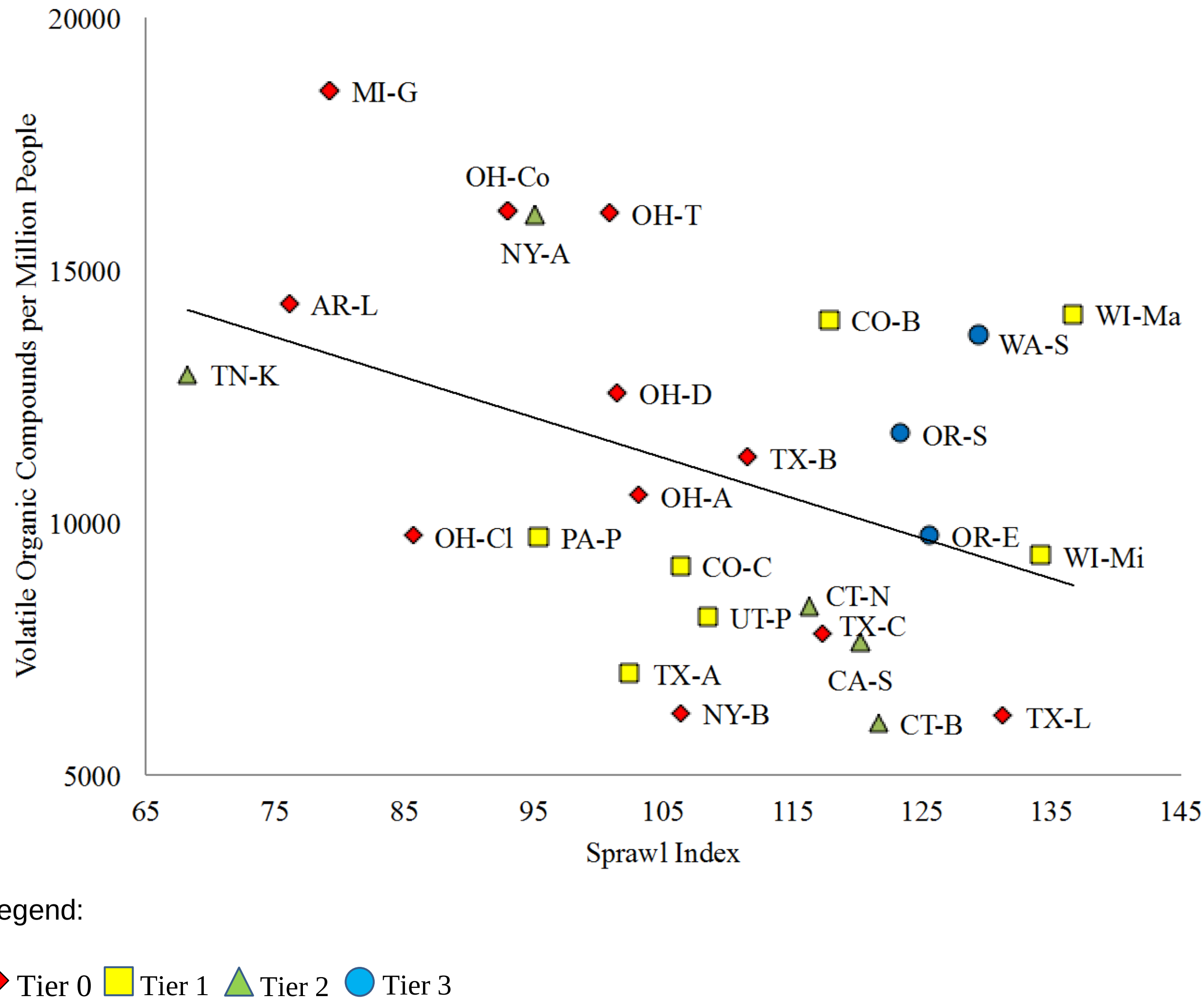
FIGURE 4JJ – SULFUR DIOXIDES PER MILLION PEOPLE



Legend:

◆ Tier 0 □ Tier 1 △ Tier 2 ● Tier 3

FIGURE 4KK – VOLATILE ORGANIC COMPOUNDS PER MILLION PEOPLE



Policy Tier Observations

These measures, especially nitrogen oxides, should be understood with caution, as many other sources contribute to them, such as industrial emissions. According to USEPA (2014) estimates, mobile contributions to nitrogen oxides emissions constitute approximately 57% of the total. The other sources include fuel combustion (24%), industrial processes (8%), biogenics (6%), and others. (USEPA 2014b)

Little Rock (AK-L) and Beaumont (TX-B) appear in the emissions diagrams with high ratings, which parallels high ratings in arterial and freeway daily miles per capita.

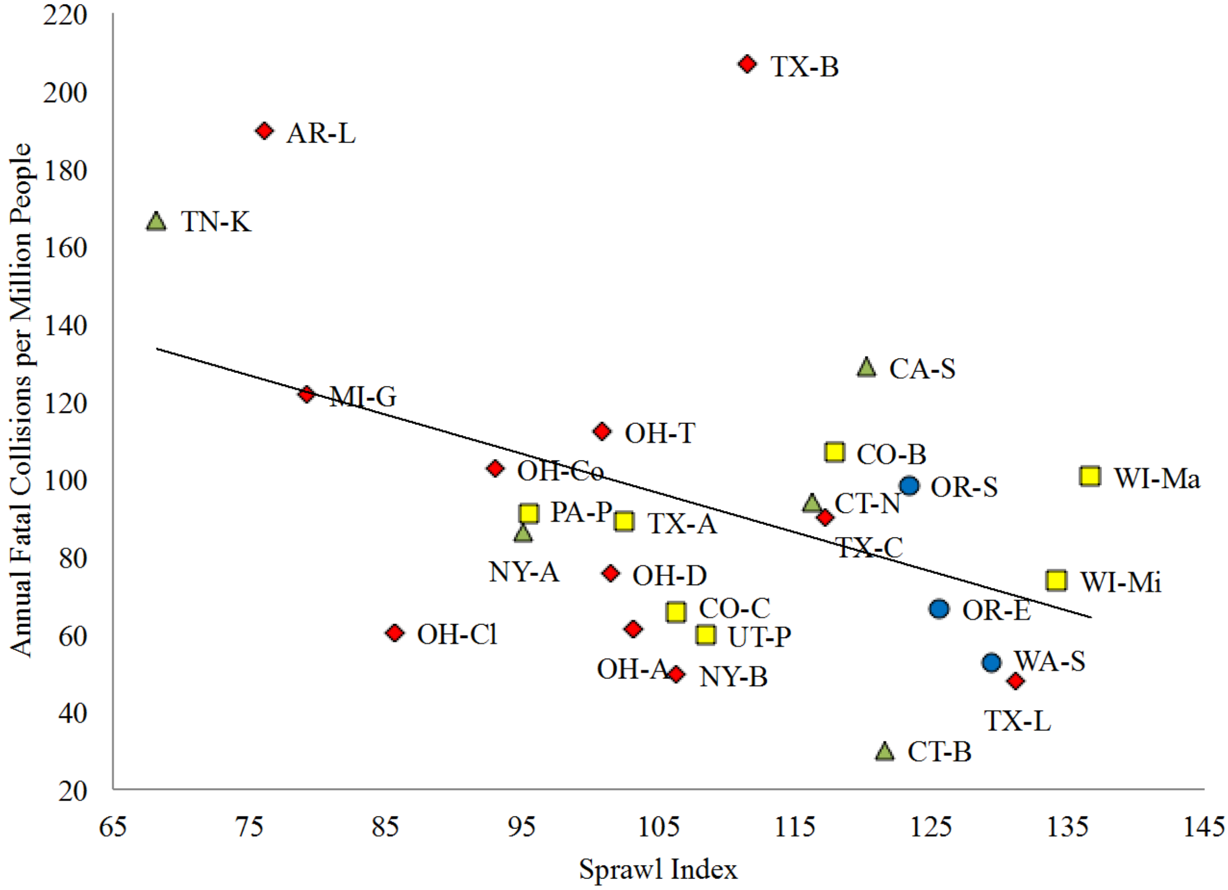
The two Connecticut MSAs (CT-B and CT-N) have the lowest ratings here, with moderate freeway and arterial miles per capita. Of interest, once again the Tier 3 MSAs are clustered, although at the moderate level, compared to other MSAs. This could indicate similarity of industry characteristics as well as driving characteristics. Boulder, Colorado, has varying measures, near the Tier 3 MSAs but in two cases higher than the others. It would be interesting to investigate the role of altitude and mountain constraints in emissions ratings.

Vehicle collisions

Rates of collision have been linked to traffic exposure, or traffic volumes. Since the amount of travel, represented by the vehicle miles traveled increases with sprawl, then the rate of collisions is expected to increase as well. The collision measures were given in terms of per million people to control for the differences in the sizes of the MSAs. The linear regression models for fatal collisions per million people ($p=0.03$, adj. $R^2=0.15$), injury collisions per million people ($p=0.04$, adj. $R^2=0.17$), and property damage only collisions ($p=0.01$, adj. $R^2=0.27$) were significant.

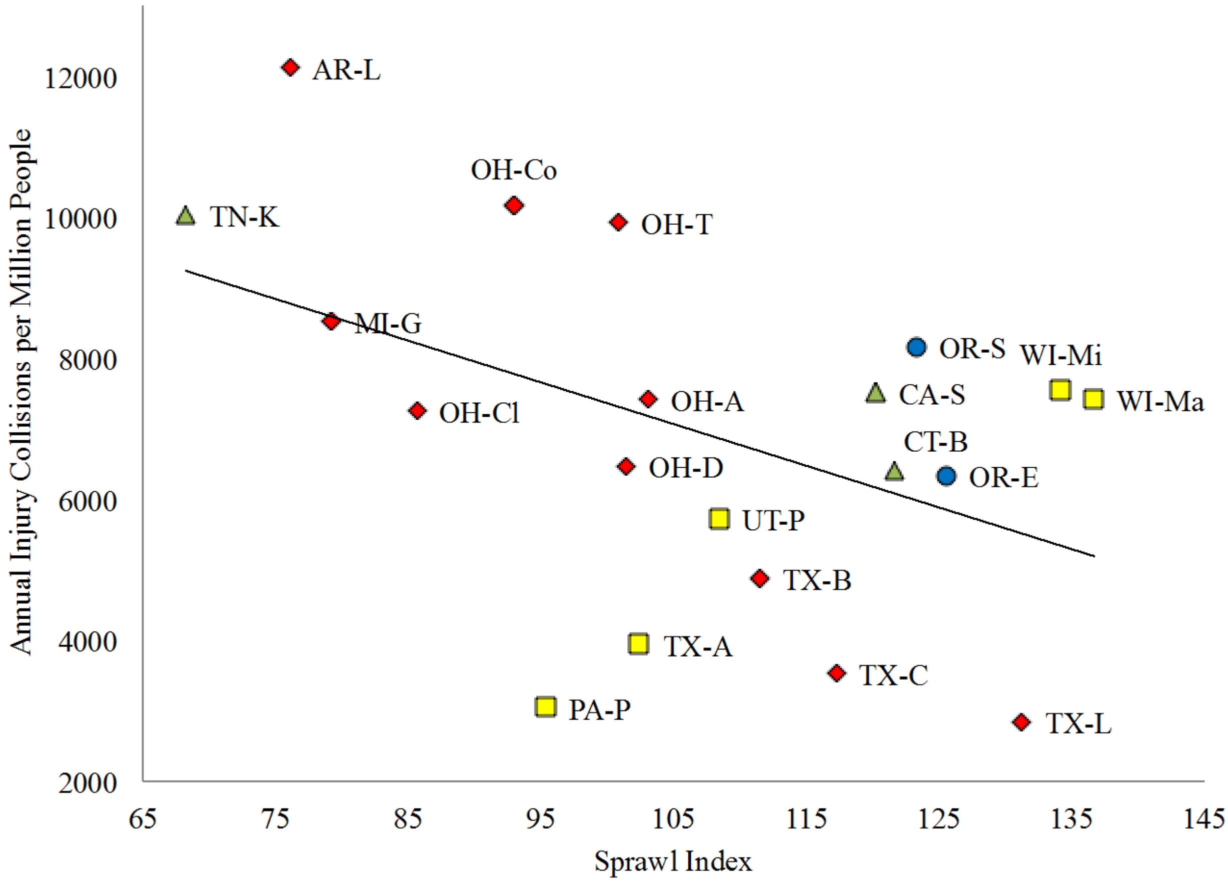
Note that data on all 26 MSAs was not available for property damage and injury-only collisions. 20 MSAs were included in the analysis.

FIGURE 4LL – ANNUAL FATAL COLLISIONS PER MILLION PEOPLE



Legend:

FIGURE 4MM – ANNUAL INJURY COLLISIONS PER MILLION PEOPLE



Legend:

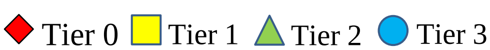
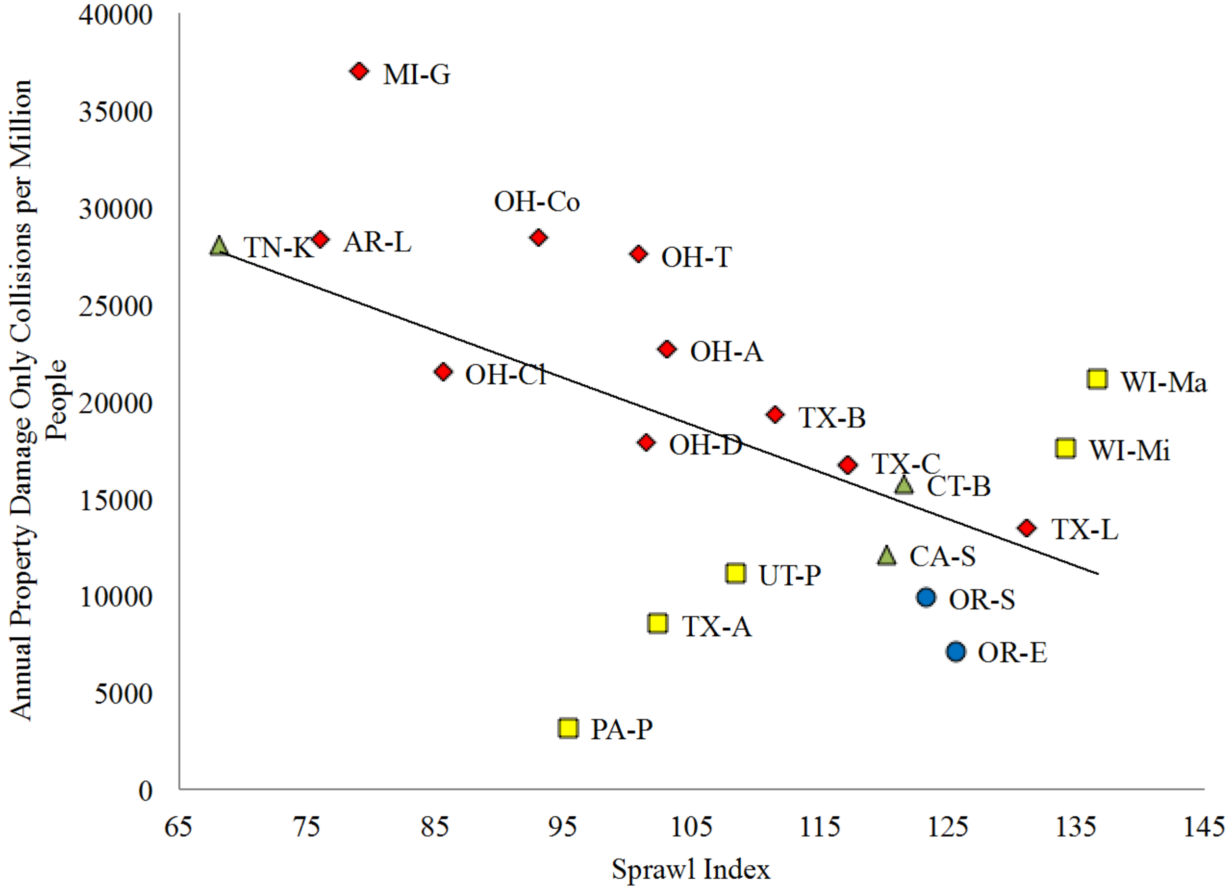


FIGURE 4NN – ANNUAL PROPERTY DAMAGE ONLY COLLISIONS PER MILLION PEOPLE



Legend:

◆ Tier 0 ◻ Tier 1 △ Tier 2 ● Tier 3

Policy Tier Observations

In the Annual Fatal Collisions diagram, the MSAs generally were grouped below 120 fatal collisions per million people. There were no policy tier groupings evident beyond MSAs grouped by states along the sprawl index.

Little Rock (AK-L). Knoxville (TN-K) and Beaumont (TX-B) are the high values, paralleling their high ratings for freeway and arterial daily VMT per capita. Bridgeport, CT (CT-B) is the lowest at less than 40 fatal collisions per million people, but does not have an outlier position on daily VMT.

The Annual Injury Only and Property Damage Only collisions diagrams roughly parallel each other, with the property damage only diagram somewhat more spread out proportionally. It is interesting to note that the majority of the MSAs fall in the upper portion of the range in each diagram, from 6,000 to 12,000 annual injuries per million people, and from 15,000 to 40,000 property damage events per million people, respectively. This includes the Tier 3 MSAs, and all of the Ohio MSAs. However, all of the Texas MSAs fall below 6,000 annual injuries per million people. A review of state speed limits does not indicate a relationship between the location of

MSAs on the diagram; in fact, Texas' speed limit is higher than most, at 75 miles per hour. Again, Knoxville TN (TN-K) and Little Rock (AK-L) could be considered outliers, although their location is not as strongly outside the group as in other diagrams. Boulder rates higher than the other Tier 3 MSAs for fatal collisions. Data is not available for the other two measures.

The reasons for these locations are not evident in the factors evaluated. Once again, it is likely that many other factors, including car ownership, population locations, typical routes and distances to work, weather, and external travel demand play a role in these factors.

4.3.5 TECHNICAL ANALYSIS RESULTS

The data is highly variable, as seen in the low R^2 values, however most of the models are significant, as shown below.

TABLE 4E – TECHNICAL ANALYSIS RESULTS

Measure	p-value	Adjusted R^2	Significant?
Freeway lane-miles per million people	p<0.01	0.30	Yes
Arterial lane-miles per million people	p=0.43	-.015	No
Public Transportation annual passenger miles per capita	p=0.15	0.05	No
Total daily vehicle miles traveled per million people	p<0.01	0.38	Yes
Freeway daily vehicle miles traveled per capita	p<0.01	0.27	Yes
Arterial daily vehicle miles traveled per capita	p=0.03	0.14	Yes
Annual hours of delay per capita	p= 0.03	0.15	Yes
Annual hours of delay per commuter	p=0.04	0.14	Yes
Nitrogen oxides per million people	p=0.08	0.08	Yes
Sulfur dioxides per million people	p=0.01	0.20	Yes
Volatile organic compounds per million people	p=0.04	0.13	Yes
Fatal collisions per million people	p=0.03	0.15	Yes
Injury collisions per million people	p=0.04	0.17	Yes
Property damage only collisions per million people	p=0.01	0.27	Yes

The relationship between policy and land use outcomes is less clear. MSAs with Tier 3 policies were found to cluster near each other for several factors, including freeway lane miles, total daily and freeway daily VMT, emissions and collisions. They did not cluster for hours of delay, arterial vehicle miles traveled, transit miles per capita, and arterial lane miles. As the only strong policy tier cluster evident for transportation outcomes, it is interesting to note and would be worth further exploration to explain. Factors evaluated, including policy longevity, growth trends, and geographic trends, did not indicate a strong explanation. It is possible that the strength of these policies, implemented over a long period of time, has resulted in more consistent outcomes on the transportation as well as the sprawl scales.

An additional observed pattern was the clustering of MSAs in individual states near each other on the sprawl index. There was only one outlier to this pattern, Laredo, Texas (TX-L). As the characteristics evaluated did not align with these patterns, they are not likely to be related to historic development and growth patterns, geographic constraints, or longevity of policy.

In both observed patterns, it is likely that larger forces are at work, including total transportation investment commitment, market and economic forces, interstate and inter-regional travel demand, size and shape of the MSA, and social and demographic factors.

Summary:

The analysis confirms that the relationships between land use factors and transportation outcomes that were demonstrated in Ewing's 2009 sprawl index analysis, still hold with new 2010 data. While the models were "weak", with a wide range of variation from the regression line, the relationships were significant. There is a significant relationship between the sprawl index and freeway lane miles, hours of delay, vehicle miles traveled, emissions, and safety factors. This finding indicates that there are likely to be transportation benefits in the areas of cost, effectiveness, efficiency, and community impacts that could result from land use patterns that are denser and more nodal (less sprawl).

The relationship of policy to land use patterns is less clear, based on our visual and broad evaluation of scatterplot locations, as well as geographic, growth history, and general MSA characteristics. Of interest, Tier 3 MSAs generally cluster across both the variable and sprawl index axes, and states generally cluster along the sprawl index. Modeling to control for complex factors such as market demand, property values, size and shape of the MSA, external travel demand, and socio-demographic factors, was beyond the scope of this study, and is recommended as a next step.

4.4 POLICY REVIEW RESULTS: BENEFITS FROM ADOPTION OF POLICIES SUPPORTING PDAS AND THE BALANCED GROWTH PROGRAM

4.4.1 INTRODUCTION

The previous section discussed policy in terms of overall frameworks, classifying the range of policies possible into groups based on their level of voluntariness, and the level of government at which they apply. It is also important to more fully understand the policy framework in Ohio, and how it can be leveraged to provide transportation benefits. In this section, the connection between a range of policies, their land use and transportation outcomes, and subsequent transportation benefits to both ODOT and regional and local agencies, is discussed. This section is supplemented by a more detailed discussion in Appendix 8.4, Policy Review.

In this discussion, it should be noted that Tier 1 and Tier 2 policies are seen as more likely to be implementable in Ohio, due to their focus on voluntary opportunities, incentives, and state/regional public investment. Tier 3 policies require mandatory compliance at all levels of government, affecting local as well as regional/state agency action, and both public and private investment. They are not seen as viable in Ohio at this time, due to the state's home rule land use authority framework, the strong respect for property rights in the state, and the increased costs (political and budgetary) that would be involved in administering a Tier 3 framework. For these reasons, this discussion focuses on Tier 1 and Tier 2 policies.

Finally, this discussion recognizes that in Ohio, much of the authority for land use change rests with local government – at the city, village, township, and county level. Any attempt to influence development patterns must engage local governments in their decision-making capacity. While on the surface, state and regional transportation agencies do not appear to have much relationship to local government land use decisions, there is much these agencies can do to influence development patterns through existing programs and processes. The Ohio Balanced Growth Program itself provides many opportunities for implementation of incentives and priorities that can help to influence land use patterns that are beneficial to transportation.

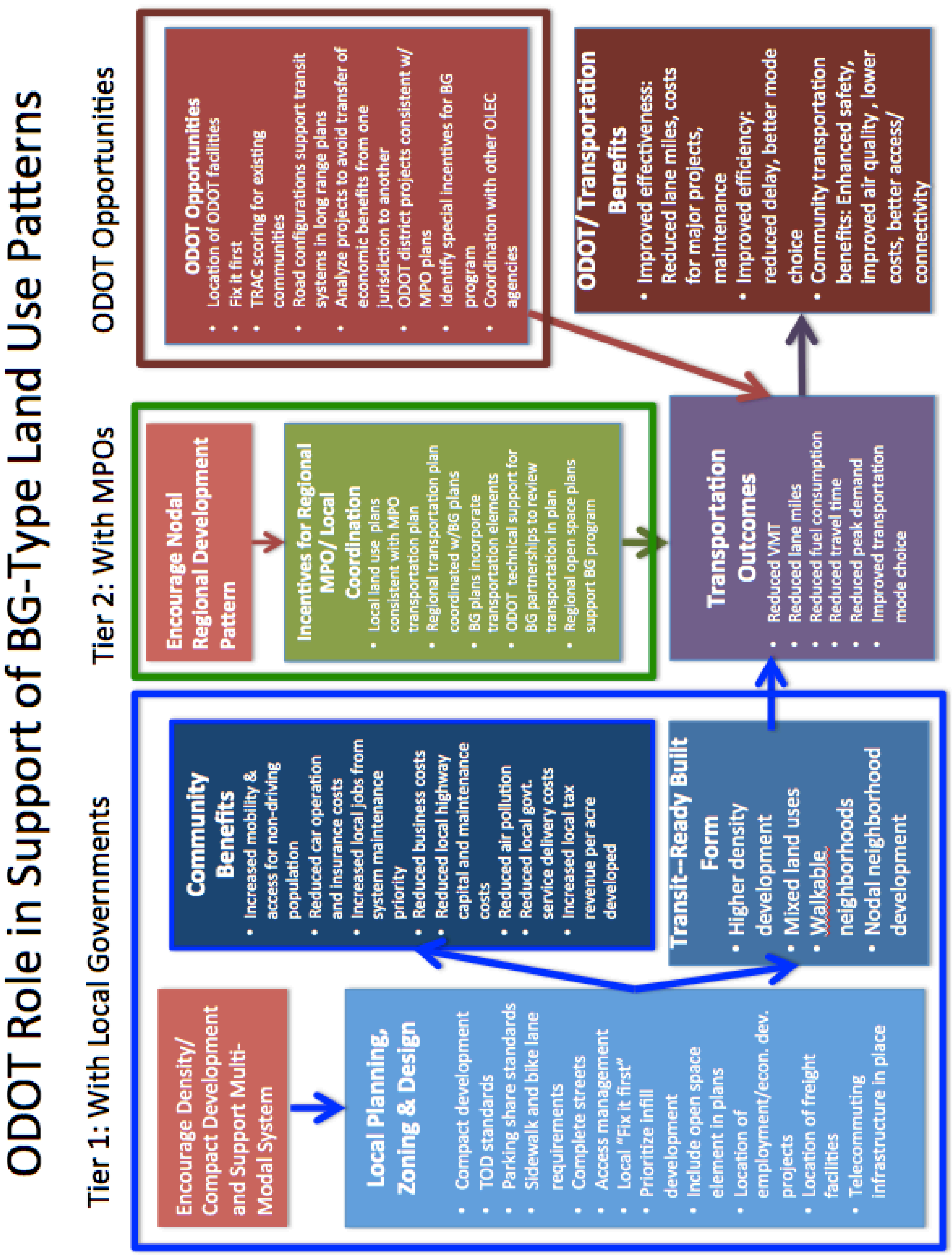
4.4.2 TRANSPORTATION BENEFITS

The Ohio Balanced Growth Program is designed to encourage development in locally designated "priority development areas" or PDAs, which are intended to encourage development in existing communities according to their land use plans. The value of the Balanced Growth Program for ODOT stems from the two parameters for land development: higher densities in existing communities, and encouraging new development in or contiguous to these existing communities, to create over time a more nodal land development pattern at the regional scale. These two mechanisms will enable expansion of transit use as part of ODOT's multi-modal system, one that will enable mobility across several different transportation modes.

If ODOT supports implementation of the PDAs and the Balanced Growth Program, benefits to local governments and to ODOT as an agency can be anticipated. These benefits result from the higher densities, and a nodal development pattern at the regional scale (supporting existing communities rather than enabling continued low-density development on farms and forests.)

Figure 4OO Presents the role for ODOT in support of density and nodal development, and the resulting benefits. The figure is arranged by Tier 1 and 2 policy types used in the analysis of the MSAs for this study. Tier 1 and Tier 2 policies that can influence land use patterns are implemented by local governments, regional agencies and by ODOT itself. The policy areas outlined in the boxes are explained in more detail in the Appendix 8.4, Detailed Policy Review Analysis.

FIGURE 4OO – ODOT ROLE IN SUPPORT OF BALANCED-GROWTH-TYPE LAND USE PATTERNS



4.4.3 ODOT ROLE WITH LOCAL GOVERNMENTS

ODOT has three potential major roles in supporting the Balanced Growth Program. First, ODOT can educate, provide incentives and provide technical assistance to local governments (Tier 1 activities) to encourage density and more compact development. These are presented in the figure on the left, and in blue in the box labeled Tier 1. Higher densities of people and the built form are a prerequisite for alternative mobility, including walking, biking and the use of transit. The low density suburbanization of metropolitan areas in Ohio over the last 50 years undermined this density, and results in very high costs for transit agencies, sometimes to the point that provision of transit is prohibitive. ODOT encouragement and support for more dense land development in and around existing communities through its programs could reverse this situation over time.

Tier 1 policies and practices at the local level include local zoning, design standards and overall land use decisions. A "transit ready" built form depends upon zoning that mixes land uses, and focuses them on neighborhood centers, so that housing is in close enough proximity to jobs and businesses to allow walking, biking and short transit rides. Mixed land uses, nodal development at the neighborhood and regional scales, and higher population densities make creation of an efficient multi-modal transportation system feasible. Local zoning and design standards to create this environment include: enabling infill development and compact development of residential areas to achieve a higher population density; adoption of standards for creating transit oriented development to give developers clear signals about what is required; reduction of the square footage and number of parking areas and sharing these across business and residents to reduce impervious surface and create a pedestrian, rather than auto, dominated environment ; and including sidewalks and bike lanes as part of complete streets so that people can walk and bike and not have to use their automobiles.

Greater access to modes other than automobiles will reduce many of the road-related costs borne by local governments and by ODOT. The community benefits that might result are included in the Tier 1 section of Figure 4OO. The description of these policies and practices and the literature supporting their adoption is presented in Appendix 8.3.

ODOT can identify incentives, information and technical assistance it can provide to local governments that would encourage them to develop a built environment and land use decisions that support a more transit-ready built form. One option would be to take advantage of new, more flexible MAP-21 regulations and explore possible use of federal monies for TOD development and transit expansion. A second may include adopting a complete streets policy that prioritizes multi-modal projects through the TRAC process and urge MPOs to take this approach.

4.4.4 ODOT ROLE WITH REGIONAL MPOS

Tier 2 policies (identified in green on figure 4OO) Include two aspects: ODOT's role with regional MPOs and their transportation planning function, and direct actions that the agency takes. These policies are oriented on creating a more nodal regional landscape where existing communities are encouraged to grow rather than promoting land development in high value natural resource or agricultural areas. This nodal development pattern is at the core of the PDA/PCA/PAA framework in the Balanced Growth Program.

Tier 2 policies include support of coordinated planning between the MPOs and ODOT districts, and support of MPO efforts to encourage consistency among local governments in terms of land use plans and transportation planning. This study's policy review process included interviews with MPO agencies, and apparently there has been a wide range of experience with the Balanced Growth Program at the regional level. This provides an opportunity for ODOT to engage with the MPOs in support of the Balanced Growth Program and in support of ODOT's own activities. The key policy approach regarding regional transportation policy is to ensure consistent and meaningful coordination between MPOs and local governments toward Balanced Growth goals. Because planning occurs at a number of levels, coordination between agencies is essential for achieving the best outcome from each policy intervention. Implementation of plans must be consistent between planning agencies within a region, but also consistent between local and regional agencies. This can be challenging in Ohio as a home rule state.

Three policy strategies might ensure that transportation planning at the regional level supports the Balanced Growth program: regional transportation plans that are coordinated with Balanced Growth plans; inclusion of transportation as a strong element in Balanced Growth plans; and local plan consistency with MPO Long Range Transportation Plans. It is suggested that ODOT can provide education, technical assistance and incentives to MPOs to work with their local governments to incorporate transportation elements into considerations for balanced growth plans, including coordination among local governments for designation of PDAs to ensure the highest degree of transportation system efficiencies for roads and transit. This is a vital role ODOT could play in support of the balanced growth program, but one that would ultimately results in benefits to the agency from associated transportation outcomes (in purple box in figure ??).

4.4.5 ODOT ROLE IN DIRECT ACTIVITIES

ODOT also can play a role through its direct activities to support development in PDAs. These policies and practices are listed in Figure 4OO in the red box. The definitions and literature of items on this list are presented in detail in Appendix 8.4. Overall, ODOT's direct practices influence land values, which can stimulate land development. The agency can assess its own investments and activities for this effect to ensure its actions support development in PDAs. An important contribution by ODOT is to identify the "special incentives" that can be provided to local governments and MPOs in a short time frame. Coordination with the other OLEC and OWRC agencies is a critical aspect of ODOT's direct actions to ensure that agencies are aligning their priorities and programs to support the balanced growth program objectives related to PDAs and PCAs, rather than unintentionally working at cross-purposes.

The combination of a more transit-ready built form in existing communities and a more nodal form supporting existing communities will result in transportation outcomes that will benefit Ohio's communities and ODOT. These include reduced VMT, reduced fuel consumption, reduced travel times, and opportunities for operating transit between communities. Together, and with other benefits that may accrue, direct benefits to ODOT and its programs would be anticipated. These include reduced major project costs, reduced highway maintenance costs, additional money available for system maintenance, enhanced safety and cost effectiveness, and improved air quality to meet federal standards in metropolitan areas.

Public-private partnerships is a relatively recent area of focus in ODOT's current policy. Of note, a review of the analyses that have been done of Public-Private Initiatives suggests a cautious approach. If ODOT seeks to support the Balanced Growth Program's nodal land development emphasis, PPPs may result in counter-effects including congestion and disinvestment in existing areas. For further discussion, see the Policy Review section in Appendix 8.4. Taking these studies into account, ODOT's use of PPPs should be carefully observed to ensure that PPP-based projects are subject to the same analysis and consideration suggested as part of ODOT's support of the Balanced Growth Program, including consideration of how the project fits into regional MPO long range plans.

4.4.6 EVALUATION OF BALANCED GROWTH POLICY OUTCOMES

Assessment of effectiveness of the suite of policies and activities of the Balanced Growth Program depends upon development of appropriate metrics. Limited progress was made on this issue as part of a roundtable organized by the Ohio Lake Erie Commission and the Great Lakes Commission in 2005.

Tracking effectiveness of ODOT policies to support the Balanced Growth Program and the benefits to ODOT will require appropriate data and analysis over the next decade and more. The data needed for this tracking will include ODOT investments and funding to regional and local governments, the location of these investments (whether in PDAs, existing communities or contiguous), land use value changes, and development completed. Sources of these data include the agency project databases, local governments and the private sector. ODOT could provide valuable support by working with OLEC and OWRC agencies to plan a monitoring strategy for the Balanced Growth program.

Summary:

Transportation benefits can be achieved through ODOT's participation in the Ohio Balanced Growth Program, and alignment of programs and processes that affect land use and development patterns. Participation in the Ohio Balanced Growth Program involves education, technical assistance and incentives related to transportation projects to local governments which have endorsed BG Watershed Plans . Other programs and processes which could be aligned to support compact, nodal development patterns include support of MPO collaboration with local governments; support of regional MPO investment in compact, nodal development through the TRAC and project prioritization processes; aligning direct ODOT investments with compact, nodal development patterns through the project planning and prioritization processes. Ongoing evaluation of the results of ODOT programs, policies and processes with regard to land use effects and outcomes, and related transportation benefits, will be crucial going forward to ascertain the most effective ways for ODOT to achieve its goals.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 TECHNICAL ANALYSIS CONCLUSIONS AND RECOMMENDATIONS

The results of previous investigations into the connection between land use and transportation generally support that higher population and employment densities, mixed land uses, a good balance between jobs and housing, and good access to transit are associated with transportation benefits. Transportation outcomes may include a reduction in the number of trips, reduced vehicle miles traveled, increased transit use, reduced fatalities and reduced emissions, resulting in benefits to transportation system effectiveness and efficiency, as well as transportation-related community benefits.. These ideas map well to the concepts of transit oriented developments and are the basis of the definition Ewing et al (2002, 2003, 2014) used in developing their sprawl index.

The current work reaffirmed the value of the sprawl index as the anticipated relationships between the sprawl index and transportation outcomes were observed for the gathered 2010 data. The current work also reaffirmed the difficulties of modeling this relationship. Although the models developed using a small number of land use variables and not the sprawl index generally produced expected results, they also resulted in some unexpected and unexplained results. The drawn conclusion is that additional variables to control for confounding factors, and more advanced modeling approaches to better represent the complexities of the land use and transportation connections, are needed. In particular, evaluation of external factors such as total transportation investment commitment, market and economic forces, interstate and inter-regional travel demand, size and shape of the MSA, and social and demographic factors, was beyond the scope of this study. They will need to be addressed through both the collection of new data, and development of complex models that control for these factors.

The scatterplots, combined with comparison of the characteristics of the MSAs, were a useful tool to examine the correlation of the tier designations for the 26 MSAs with the sprawl index and transportation outcome data. Generally speaking, the MSAs appeared to be randomly dispersed by Tier, however Tier 3 MSAs appeared to be well clustered in the majority of the plots. Although no definitive reasoning is possible based on this examination, this pattern suggests a connection between the policy characteristics of this tier designation and the relative consistency in the sprawl index and transportation outcomes. The relative strength of these policies, their longevity, and their impact on economic and market factors, could all be elements of the explanation.

Many of the policies determining tier designations for the various MSAs are relatively new, less than 10 years old; furthermore, many states (including Ohio) have recently adopted Balanced-Growth-Type policy that could influence land use patterns, and transportation benefits, over time. This research examination did not identify possible relationships between policy longevity and results; however, it is likely that multiple decades are needed for land use policy to take effect and be reflected in land development patterns. This is an indication of the need for additional research over time, and for a strategic approach that optimizes potential benefits before full causality is known.

The review of previous work also served to identify what aspects of the relationship remain unexplained. For instance, there has apparently been little work done in the areas of cost, other than commute time, which would be useful to understand. Further, the work on commute time has not yet successfully isolated whether changes are related to changes in trip length or congestion levels. If congestion is a contributing factor, then issues such as the utilization of the transportation network become relevant. The current work briefly examined the relationship between utilization of the freeway and arterial networks but the results were not significant, which is likely due to the simplistic nature of the variable definition and/or the use of a multiple regression model with few control variables. If travel demands are increasing but the transportation network is not expanding, then the congestion can spread in time. To capture this phenomenon would require a robust measure of utilization or perhaps a sophisticated time based modeling approach.

In terms of modeling the relationship between land use and transportation, the following areas for future investigations are recommended. First, the influence of external factors at the macro level need to be better understood. Do geographic, topographic, economic, and climactic characteristics influence travel demand and mode choice behavior? If not, it may be fair to compare areas that are dissimilar in these characteristics. If so, perhaps these variables can be controlled for in such a way as to improve the current models.

Second, the influence of socio-demographic characteristics needs to extend beyond travel demand and mode choice into areas such as housing location choices. Dunphy and Fisher (1996) found consistent differences in travel demand between those living in more dense areas versus those living in less dense areas, which raises questions about who is expected to live in which areas and how transportation planners and others could better consider these preferences in their plans and/or models. Such investigation may lead into areas such as understanding the link between housing choice and quality of schooling, proximity to particular activity centers, community safety and security and other community characteristics. A “next step” study would involve a literature review of such factors and their influence on overall development patterns.

Third, the balance of transportation supply and demand over time and its relationship to land use needs to be better understood. The majority of models use annual, daily or peak transportation measures which could be hiding the influence of land use on the utilization of the transportation network. This investigation could include looking at how travel demand management approaches change the utilization of the transportation networks and what transportation benefits are likely to result from such measures.

Finally, the role of total investment in transportation must be considered. It is possible that proportionally higher levels of commitment in some states may drive the amount of transportation infrastructure developed, independent of the land use characteristics of the areas served. More ample transportation infrastructure (especially roads) could have an impact on mode choice, vehicle miles traveled, congestion/delay, emissions, and safety, as well as total lane miles provided. The challenge will be to define a model for evaluation of this relationship that controls for confounding factors, such as interstate and intra-regional travel demand, market value of property, and socio-demographic characteristics of the population.

Summary:

Conclusions and recommendations for technical analysis center around areas that need to be better understood in order to describe the potential transportation benefits associated with land use policy and development patterns. These areas include transportation system cost and utilization; the influence of geographic, economic, travel demand, and socio-demographic external factors; travel demand management and utilization; and the role of total transportation investment commitment.

5.2 POLICY REVIEW CONCLUSIONS AND RECOMMENDATIONS

The technical analysis identified relationships that occur between land use patterns and transportation benefits. While the causality of these patterns, and the relationship of policy to land use patterns, is not demonstrated in this study, the existence of relationships, and demonstrated relationships in the literature, indicate that explanations for the relationships should continue to be sought over the long-term time frame that it takes for policy effects to be seen. It is recommended that further research be done to collect data, and develop models, to control for external factors; and that this research be done over a long period of time.

Given the long-term nature of policy effects, it is also recommended that ODOT consider taking action that can be implemented now, without major changes in existing practices or processes. This section addresses some of the opportunities that exist for ODOT policy to support Balanced-Growth-Type development patterns. Such incremental investments may show their effects in time, and with little cost until causality can be demonstrated.

As noted in the results, there are a number of opportunities that exist for ODOT to support Balanced-Growth-Type development patterns, i.e. compactness and nodality, that have been demonstrated in the literature to result in transportation benefits such as reduced cost, increased efficiency, and increased effectiveness, as well as community/economic benefits. The following identified options are organized around levels of government interaction as outlined in the Policy Review section of this report (Section 4.4). This is a comprehensive list intended to explore broad categories of opportunities that exist; the highest priority for "next steps" are outlined in Section 6.

5.2.1 ODOT POLICY OPTIONS TO ENCOURAGE COMPACT DEVELOPMENT AND SUPPORT MULTI-MODAL SYSTEMS

Balanced-Growth-Type development within local communities can reduce the need for expansion of transportation infrastructure. Support that could be provided by ODOT at the local level involves utilizing ODOT programs and policies to encourage adoption of compact, nodal development patterns through locally-identified Balanced Growth Priority Development Areas. The opportunities and options include:

- Provide special incentives through state transportation funding programs and processes to projects that locate inter-modal facilities in PDAs. (see the Policy Review section 4.4, and Appendix 8.4, for more information).

- Do further research to identify the specific programmatic incentives that can be used to support applications from PDAs within Balanced Growth plan communities, as have other Balanced Growth Program (OLEC/OWRC) agencies
- Identify and publish "special incentives" for BG programs that can be used to encourage development in PDAs. For example, review each program and identify reduction in interest rates, criteria for scoring, etc. as appropriate that can support PDAs. Communicate with local MS4 jurisdictions about accommodating their permit requirements.
- Continue to encourage use of innovative and best management practices for storm water management elements in transportation projects
- Prioritize for PDAs: public transit; projects with regional benefit based on Cost/Benefit analysis; projects that are consistent with recent local comprehensive plans or Balanced Growth Plans; offer reduced interest rates if inter-local collaboration and PDA focus is involved.
- Take advantage of new, more flexible MAP-21 regulations and explore possible use of federal monies for TOD development and transit expansion
- Adopt a complete streets policy that prioritizes multi-modal projects through the TRAC process and urge MPOs to take this approach.
- Prioritize investments in existing communities through the TRAC process
- Coordinate with MPOs to encourage land development in existing community core areas

5.2.2 ODOT POLICY OPTIONS TO SUPPORT A NODAL REGIONAL DEVELOPMENT PATTERN

ODOT's opportunities to support nodal regional development patterns involve collaboration with MPOs, encouragement of MPO/local coordination, and encouragement of coordination among local governments. Opportunities and options include:

- Emphasize consistency of locally proposed projects with comprehensive plans updated within last 5 years when evaluating projects
- Continue practice for MPOs to assess locally proposed road projects to evaluate future maintenance costs and demonstrate capacity/plan for paying for these functions (fiscally conservative approach) and prioritize on this basis
- Provide funding to MPOs to assist local jurisdictions on fiscal impact analysis of projects; an example is the OKI fiscal impact model provided to member communities.
- Continue practice for MPOs to assess the regional impacts regarding economic development impacts of transportation projects to avoid transfer of economic benefits from one jurisdiction to another; consider expanding the economic impact analysis buffer from 1 mile to an area large enough to encompass changes in real estate markets and land values across multiple jurisdictions as appropriate. Disclosure of real impacts could help local and regional officials to make better-informed decisions.
- Emphasize collaboration by ODOT districts for project consistency w/ MPO Long Range Transportation Plans (LRTP)
- Strengthen collaboration of ODOT districts with MPOs to select district projects on the basis of input from MPO LRTP as reflection of local priorities
- Encourage collaboration among local governments to invest in PDAs. Consider adding additional points to TRAC funding, in appropriate projects, for local governments who provide evidence that the project is an outcome from a joint planning exercise with multiple communities.

- Work with MPOs to support regional economic impact assessment of TRAC-funded capacity projects to make transparent the potential transfer of benefits

5.2.3 ODOT POLICY OPTIONS FOR PARTICIPATION IN THE BALANCED GROWTH PROGRAM

ODOT's participation in the Balanced Growth Program can help to support Balanced Growth-Type development patterns at the local, regional and state level, providing transportation benefits as outlined in Table 1A.

- Enhance direct technical assistance for support of Balanced Growth Program. Develop technical support program for BG partnerships to review transportation aspects of BG plans.
- Develop a set of guidelines for transportation aspects for next round of BG Watershed Plan development and to include in BLLUP materials.
- Provide funding of BGP. Review MAP-21 regulations and consider if ODOT can use federal money to fund additional BG Plan development.
- Compare ODOT project priorities with PDA criteria used in BG plans and make recommendations for alignment if needed
- Consider incorporating Balanced Growth Watershed Plans when planning projects
  - Ensure that the review and promotion of PPP (public-private partnership) projects by Innovations Division takes Balanced Growth Plans and regional plans into account
  - Additional search of research literature could identify more explicitly whether studies have been completed to determine the effect that private, unsolicited proposals have on traffic demand, land use/demand and sprawl.
- Develop and support an educational outreach program to ODOT and MPO staff by BGP staff regarding BGP across the state to ensure common goals and recognition of Balanced Growth Program opportunities across state agencies and levels of government. The SAWG could coordinate funding.
- The State Agency Working Group (SAWG) could coordinate to identify how policies and programs affect land development or work at cross-purposes regarding land development patterns that undermine the Balanced Growth Program
  - Continue and expand coordination with other agencies that fund transportation improvements related to economic development;
  - Coordinate with ODNR and OEPA to ensure water and sewer finance programs and road and transit programs are working together to prioritize development in PDAs;
  - Limit road size and use access management guidelines to limit land urbanization effects in cases where ODOT central or district road infrastructure needs to go through PCAs
  - Collaborate through SAWG to develop programs to collect data regarding state investments and local land development to assess whether Balanced Growth Program is having an effect on land development patterns
  - Track ODOT investments in PDAs vs. PCAs vs. other areas in the state

5.2.4 ODOT POLICY OPTIONS FOR DIRECT ACTION

As initiator, owner and manager of significant infrastructure assets, ODOT has some additional policy options which leverage ODOT's direct decisions on these assets. Opportunities and options include:

- Evaluate and consider adopting a policy to locate any new ODOT facilities within PDAs when feasible, subject to customary negotiations with local jurisdictions. It is noted that most new state facilities are located on the site of existing facilities.
- Publish an assessment of implementation of the statewide fix it first policy. ODOT's "fix it first" policy has been in effect for nearly a decade. It is unlikely that the general public, and perhaps even some local officials, are aware that this policy has been guiding ODOT investment decisions. Transparent assessment of the implementation and outcomes of this policy, published in outlets accessible to the general public, would inform the public regarding how this policy improves the transportation system and its maintenance in Ohio. It is suggested that the agency put in place the data collection and analysis infrastructure to evaluate and consider *how well "fix it first" is supporting community-designated PDAs*, particularly if this data analysis is coordinated with state-level economic development programs.
- Collect data on the amount of ODOT funding that has been invested in PDAs over time, which can be used to encourage participation of local governments to devote the time and effort invested in focusing their redevelopment efforts on the PDAs. Such data will also be necessary to assess the success of the use of PDAs and related agency incentives in shifting land development patterns as intended by the Balanced Growth Program. The example of Maryland is noted, where data to assess the success of priority investment areas was difficult to assemble after the fact (Knaap & Lewis 2007).
- When MPO plans are based on plans to enhance investment in existing infrastructure and decrease low-density development in exurban areas, ensure that Central and District Projects are consistent with MPO Plans to respond to local preferences.

Summary:

ODOT has multiple opportunities to influence development patterns that can provide transportation benefits. These include support of desirable development patterns in local jurisdictions through project prioritization and investment; support of regional nodality patterns through collaboration with MPOs; participation in and support of the Balanced Growth Program; and support of desirable development patterns through ODOT's own processes, investment projects, and prioritization of the use of funds.

6.0 RECOMMENDATIONS FOR IMPLEMENTATION

The purpose of this research report is to identify transportation benefits resulting from Balanced Growth-Type (BG) programs and policies. As the first study of its kind in Ohio, this research took a comprehensive approach, relying on nationally available data to look at MSAs across the country in broad comparison to each other, and taking a first look at areas of transportation and land use policy that could drive transportation benefits.

While the policy analysis sections and its appendix discuss and identify broad qualitative community-based, socio-economic and transportation benefits from implementing BG policies, the technical analysis, based on currently available data, identifies relationships, but does not quantitatively demonstrate a direct causality or benefit. More detailed models, case studies and the generation of additional data will be needed to continue to develop information that can help ODOT make investment and project decisions that benefit the efficiency, effectiveness and cost of transportation for the long-term.

Two primary factors qualify the technical findings of this study. First, many BG programs and policies that have been implemented across the nation have only been in effect for a relatively short time (many less than 10 years, and several, including Ohio, less than 5 years). Land development patterns and transportation impacts often take decades to demonstrate consistent, long-term patterns. Second, there is a lack of the specific data needed to conduct adequate modeling and analysis that directly connects BG and its transportation benefits, and controls for external factors. These reasons lay the foundation for the recommendations for implementation.

6.1 RECOMMENDATIONS FOR IMPLEMENTATION

The next-step recommendations for ODOT for implementing the findings from this report include:

- Developing models that can control for external factors, and can demonstrate causality, if it exists; and identifying and beginning to collect relevant data to support the models
- Conducting case studies of Ohio transportation and development projects to understand the potential for change induced by both transportation and development
- Conducting a subsequent research study similar to this in approximately 8-10 years, after the current and any new BG programs and policies have been in place long enough to identify and measure long-term patterns and impacts, utilizing the developed models and collected data
- Explore ways to advance BG principles through policies, programs and project selection processes to provide the groundwork and basis for continuing study. Areas of exploration could include staff and inter-agency education, incentives for BG planning partnership communities, and collaboration in decisionmaking with other state agencies, MPOs, and local governments in ways that affect land use patterns and transportation benefits.

Model Design and Associated Data Needs

As noted throughout the technical analysis section of this report, many of the relationships discovered are not adequately explained by the data and models available. Collection of data on an ongoing basis, and development of models that control for significant external factors, will be important to monitoring and understanding trends in the policy-land use-transportation connection in the future. In particular, the following needs are identified:

- Conduct a study to design and recommend models that control for external factors such as total transportation investment; cost, geographic size and shape of MSAs, market and economic factors; land values; external travel demand; and socio-demographic factors such as housing choice factors. In the study, evaluate the most appropriate scale for future study, whether it be MSA, MPO/regional, county, or state, or some combination of these.
- As part of the study, identify key data needs, both existing and new, required to feed the models. Some suggestions include expanding the Ewing data collection to more MSAs across the country; in-depth budget and expenditure per state and per MSA, broadly across the 50 states; budget and expenditure data in Ohio, per MSA/MPO/county and per project, keyed to GIS location; property values, economic and market conditions; population and socio-demographic data including housing choice and preference; study area shape and size; external vs. local travel demand; change in land use, transportation, budget and economic data over time as transportation projects are completed. Develop a plan for collection of recommended data into the future. Perhaps a collaborative of state DOTs could agree on a set of key data that could be collected across the states in order to provide comparisons.

Case Studies

Develop case studies of individual ODOT-funded transportation projects and their economic, social, and land use impact on surrounding areas; and major land use projects in Ohio and their transportation impacts. These studies could include pre- and post-project analysis of land use characteristics, transportation factors, economic and socio-demographic factors, and costs to communities and state agencies. While it will be difficult to control for the myriad of factors influencing change at the site-specific level, such case studies could contribute valuable information to the understanding of how transportation and land use interact in Ohio regions. As these case studies would be initiated in the short term, they would rely on existing data and the beginning of collection of new data. Much of the data needed could be collected as part of the transportation project application, prioritization and selection process. Projects identified could be residential, commercial/retail, office, industrial, and/or mixed uses, in both compact and less-dense settings. This would also be an opportunity to evaluate pilot projects which could be implemented to test innovative development approaches. It would also be interesting to conduct additional literature review for evaluations of private investment's impacts on transportation.

Examples of data that could be collected include:

- Population and household change in the census tract affected
- Development characteristics and quantitative information (number and type of units, square feet of commercial/office, rents, vacancy rates) both in the project and in the surrounding area
- Before- and after-project traffic counts, turns and other characteristics in the immediate area
- Census information before and after, utilizing American Community Survey estimates for the census tract, of transportation-related factors such as commute characteristics, car ownership, errand trips, and other travel; and land use factors such as housing size, ownership and quality, rents and values, income, and household expenditures on transportation, goods and services)
- Confirmation of travel information by telephone survey of users

- Cost information for transportation improvements and their maintenance, on the part of agencies at local, regional, and state levels.
- Mode utilization information per household and/or worker, addressing bicycle, pedestrian, transit, and automobile usage

Analysis in the case studies would look at change over time, and attempt to draw conclusions about the possible reasons for that change, with particular attention to areas where transportation influences quality of life and lifestyle, and neighborhood characteristics influence transportation choices.

Long-Term Research

The research conducted for this report compared geographic study areas that were classified into four policy framework tiers. In comparing the "clusters" of impacts identified through the modeling, the amount of time that BG policies were in effect could make a significant difference in demonstrating transportation impacts and benefits. The study areas showing the greatest correlations were from Oregon and Washington State where strong BG policies have been in place since the 1990's. Clearly, BG tools and policies are relatively new, many of them implemented for less than 10 years in metropolitan areas in Ohio and throughout the nation.

Most land development patterns evolve over long periods of time. The economic downturn around 2007-8 slowed development in many areas of the U.S. Transportation impacts need to be studied after they have adequate time to demonstrate that they are a result of implementing BG principal, are lasting and not resulting from a short term events or other conditions. Also, unique conditions, (such as local, historic patterns of development), the availability of public transit, and geographic characteristics of a region (such as a river, ocean or mountain constraining development) need to be factored into any analysis. In depth analysis of this and other factors was beyond the scope of this study. It is therefore recommended that a subsequent research study be conducted in 8-10 years, utilizing additional data and new models, and after Balanced Growth policies have had more time to be implemented. This additional time, combined with the "right" data as recommended above, will provide for a significantly improved quantitative analysis than can be conducted today and more valid and reliable results.

Continue to Advance BG Programs and Policies

In order to conduct a future study to determine quantitatively if BG has transportation benefits, it will be necessary to continue to support and implement BG policies and tools so that policies are in effect and comparative quantitative data can be available. Implementing a variety of BG programs and policies may also allow for a new kind of study in the future that more specifically analyzes and compares various types of BG policies to determine which works best.

The report recognizes that in many ways, through existing policies and collaboration, ODOT currently supports BG policies and is working to advance a BG state-wide agenda. In fact, ODOT's decision and actions to solicit and fund this research demonstrates ODOT's commitment to BG. To support a future study, the following is recommended. See the discussion under Conclusions (5.0) for more detailed descriptions.

It is suggested that ODOT define its specific BG policies and integrate these into existing planning, environmental, and project selection decision making processes including:

- Supporting local land use planning for compact, nodal development

- Supporting regional nodal development through local/MPO/ODOT collaboration
- Participating in the Balanced Growth Program, particularly providing incentives for BG programs through existing programs and processes such as TRAC scoring and project prioritization
- Aligning direct ODOT decisions with Balanced Growth principles
- Pursuing staff and inter-agency education and collaboration in order to integrate BG support into daily practices, and to identify relevant areas where support could be provided.

NOTE: No changes from current ODOT practices or policies are being recommended. It is recommended that ODOT define its BG policies to make them easy to identify and compare in future research. This will also permit more focused study in the future evaluating specific ODOT BG programs and policies for specific transportation benefits.

6.2 STEPS FOR IMPLEMENTATION

Many excellent research studies have had little impact on transportation decision making because practitioners are not aware of them or view their recommendations as too difficult to extract and implement. The following steps are suggested as a relatively easy approach to implement the recommendations from this research report.

Identify an ODOT staff member/ Office responsible for Implementation

The purpose for a research study does not end when the research is completed. To be useful, its findings and recommendations need to be shared and implemented. For this to happen a staff person must be given the responsibility to distribute the findings and encourage implementing its recommendations. Therefore, the first step in implementation is to identify and assign an ODOT Office and staff person the responsibility for getting information out about this report and implementing its recommendations.

Further Research

The Research division should develop follow-on research projects, as outlined above, focused on three areas:

1) Development of models and data recommendations to enable analysis which can control for external factors and identify causality, if possible
2) Development of case studies evaluating the interaction of transportation and development. These will need to be developed slowly over time, as new projects are identified, so that adequate before- and after- data can be collected.
3) In 8 to 10 years, conduct a study, using the models and data from the first research project above, to test the relationships of policy frameworks to land use outcomes and transportation benefits.

Coordination, Collaboration and Outreach

Transportation project design and selection is done by many decision makers inside and outside ODOT. MPOs, local governments and other Ohio state and regional agencies have staffs that already embrace and are implementing BG principles. In addition, it may be in the interest of other state DOTs to participate in answering similar questions. The availability of this report should be shared with this audience. These transportation partners can assist in implementing the recommendations in this report. Implementation steps could include:

- Identifying a list of individuals, transportation agencies (ODOT, MPO, and others), and other agencies who could benefit from this report
- Sending an e-mail with an executive summary or brief description of the report, its findings, and explain how individuals could receive a copy of it.
- Identifying meetings during which a presentation of the finding from this report could be given and who would be the best persons to give the presentation. (The presentation could be given jointly by an ODOT planning staff and the CSU authors of this report.) The presentation could include how ODOT districts and Ohio MPOs could assist ODOT in implementing the recommendations from this report. Potential meetings may include:
  - Ohio Transportation Engineering Conference (OTEC) annual meeting – typically held in late October
  - Office of Environmental Services Consultant update meetings
  - Ohio Association of Regional Councils (OARC) – both their executive directors and their transportation study directors meetings are held quarterly.
  - National transportation conferences and collaborations, such as NARC – the National Association of Regional Councils; AMPO – Association of MPOs, TRB specialty meetings and committees on Planning and committees on the environment; and the university transportation resource centers that exist around the US. (Ex. U Wisconsin, CFIRE)

As part of its federally approved planning process, ODOT coordinates with MPOs, regional planning agencies and local jurisdictions. This coordination and collaboration has been in place for years and is expected to continue. The concept of BG should be “considered” part of this collaboration.

6.3 EXPECTED BENEFITS FROM IMPLEMENTATION

Benefits from implementing the recommendations are that a subsequent research study will have the data necessary and the amount of time necessary to properly evaluate and to quantitatively determine if there are transportation benefits from implementing BG programs and policies. It is also noted that there is no harm and many potential benefits to implementing BG programs and policies. The bottom line is if ODOT wants to test the impact of these policies, ODOT needs to implement the policies as the basis for the testing.

A review of the literature suggests that BG policies will have a transportation benefit. This is supported by relationships identified in the technical analysis of this study, although causality has yet to be determined. As suggested by the report and discussed in detail in the Policy Review (Appendix 8.4), the potential benefits to ODOT for incorporating BG principles and policies into its decision making process could include economic and community benefits and increased efficiency (and associated reduced cost) in the transportation system. While these are discussed anecdotally at a policy level and to a limited extent by the currently available data analysis, the anticipated transportation benefits from implementing BG policies that could be tested in a future study include:

ODOT Effectiveness Increased

- Reduced lane miles overall
- Reduced major project costs
- Reduced highway maintenance costs

ODOT Efficiency Increased

- reduced vehicle miles traveled per capita
- increased opportunity for optimizing use of transit systems and other alternative modes
- reduced peak travel demand
- reduced congestion and delay, travel times

Transportation-related Economic and Community Benefits

- Increased safety
- Increased mobility and access for non-driving population
- Improved transportation choice
- Reduced fuel consumption
- Increased local jobs from system maintenance priority
- Reduced transportation costs overall to citizens, business, and government
- Reduced local highway capital and maintenance costs
- Reduced emissions/air pollution
- Increased local tax revenue per acre in redevelopment areas

6.4 POTENTIAL RISKS AND OBSTACLES TO IMPLEMENTATION

Building, maintaining and operating a safe, multi-modal transportation system such as Ohio's is complicated. Many priorities such as adequate funding, federal requirements, safety, intermodal connectivity, and public opinion, demand the attention of the lean, ODOT staff responsible for the system. Other work such as maintaining and operating the existing system, meeting federal requirements, staff turn-over, and many other issues demand the attention and priority of ODOT staffs and can be impediments to successful implementation. Requiring additional data collection can be an additional burden to ODOT staff. Maintaining the data in a format that it can be used in the future may be a low priority compared to the many other staff responsibilities.

6.5 STRATEGIES TO OVERCOME POTENTIAL RISKS AND OBSTACLES

Overcoming these risks may just require patience and perseverance. One strategy is waiting to bring up the topic of the transportation benefits of BG until a time it does not need to compete for attention with what may be considered a "transportation" crisis. A second strategy is to identify someone in ODOT leadership who will be a "champion" for the transportation benefits of BG. Having a high level staff who is an advocate can help to advance the recommendations in this document and the benefit of future research.

6.6 POTENTIAL USERS AND OTHER ORGANIZATIONS THAT MAY BE AFFECTED

ODOT, Ohio MPOs, state and regional agencies and local jurisdictions all are affected by sprawl and poor land use planning and in turn may be positively impacted by the information contained in this report and findings from a future report. The quantitative analysis was conducted at the metropolitan level and therefore Ohio's MPOs may be a group to both enact and implement BG programs and collect the data needed for a subsequent study. The best level for the study remains at the statewide or even a national level

6.7 SUGGESTED TIME FRAME FOR IMPLEMENTATION

Much of the "active" implementation recommended involves data collection and will require years to implement. As stated, a subsequent study should be conducted in 8-10 years. However, the overall understanding of the transportation benefits of Balanced Growth, BG principles, and their integration into ODOT policies and decision making processes should begin now and continue at least until the findings have been identified by the next study. In particular, the suggested research for model and data development, and case study development, could be implemented in the immediate future, especially as they both involve the passage of time.

6.8 ESTIMATED COSTS

Data collection: Since most of the implementation activities focus on data collection and coordination, staff time will be the primary costs for implementation. It is estimated that active implementation will require from at most 4 to 8 hours per month of a mid-level ODOT staff.

Outreach and coordination: Should ODOT decide it wants to produce a pamphlet or short paper for distribution covering this report, several staff hours and publication costs would also be required.

Ongoing policy integration: Activities required for implementing BG test policies will be part of everyday activities for ODOT staffs and not require any additional costs.

Subsequent study: As BG policies continue to be implemented throughout the nation a subsequent study may best be conducted at a multi-state or national level. This type study could use SPR Pooled-funds or TRB research funding. Cost for future studies could range from $350,000 to $750,000. Costs for Ohio case studies could be done on a project basis at a much lower cost, perhaps $50,000 per case study.

6.9 RECOMMENDATIONS ON HOW TO EVALUATE THE ONGOING PERFORMANCE OF THE IMPLEMENTED RESULT

Ultimately, the intended impacts from the implementation of this report would be to have the models and data needed, together with locations that have active long-term BG programs and policies and be able to conduct a quantitative evaluation and demonstration of a direct cause and effect between BG and improvement to transportation conditions. Transportation is complicated; and as discussed in this report it is and will continue to be very difficult to demonstrate this direct correlation. The long term evaluation of the recommendations in this report will be successful if models are developed and data is collected, and if ODOT pursues a subsequent research study within the next decade.

Evaluating the level of understanding of BG principles before and after outreach activities could be conducted through a survey distributed to the audiences to whom the BG program is presented. Developing and distributing a survey or survey questions before and after the presentation on BG -- or even a year following the presentation is a method to evaluate the performance of the implementation of the findings from this report. The ODOT staff identified as responsible for advancing this report should develop, distribute, and tabulate the survey results.

Summary:

The findings of this research indicate a relationship, or association, between certain land use characteristics and transportation benefits; however they do not indicate causality (the reasons for the association), and do not indicate the role that policy plays, if any, in land use and transportation outcomes.

In order to demonstrate causality, and to better understand the role of policy in determining land use patterns, more time is needed for policy frameworks across the country to take effect. In addition, to control for significant external influences, the development of new analysis models is needed, along with new data to support them. Case studies of development and transportation projects in Ohio, and their effects on each other, will help to develop an understanding among ODOT and other state, regional and local agencies, of the interrelationships and effects of land use and transportation projects, and their effect on cost, effectiveness and efficiency of the transportation system.

Given the noted associations between land use and transportation benefits, and the alignment of these potential benefits with ODOT's Access Ohio 2040 goals, ODOT should continue to participate in the Ohio Balanced Growth Program, finding affordable and workable ways to integrate staff education, incentives and collaboration into their current programs and processes. The downside of waiting until causality is demonstrated could mean lost potential benefits over the long term.

7.0 BIBLIOGRAPHY AND REFERENCES

1000 Friends of Oregon. (1997). Making the connections - a summary of the LUTRAQ project: Integrating land-use and transportation planning for livable communities, Vol. 7. Portland, OR: 1000 Friends of Oregon.

American Association of State Highway and Transportation Officials (2010) Highway Safety Manual, Washington, DC.

Bartholomew, K. & Ewing, R. (2009). Land use-transportation scenarios and future vehicle travel and land consumption: A meta-analysis. Journal of the American Planning Association, 75(1), 13-27.

Bel-O-Mar Regional Council (2012). Belmont, Ohio, and Marshall Counties: Transportation plan for 2035. Wheeling, WV.

Bhatt, N. Peppard C. & Potts, S. (2010). Getting back on track: Aligning state transportation policy with climate change goals. Smart Growth America and Natural Resources Defense Council.

Boarnet, M. & Haughwout, A. (2000). Do highways matter? evidence and policy implications of highways' influence on metropolitan development. Washington, D.C.: Brookings Institution.

Boarnet, M. G., and Sarmiento, S. (1998) Can Land-Use Policy Really Affect Travel Behaviour? A Study of the Link Between Non-work Travel, Urban Studies, Routledge, 35(7), 1155-1169.

Bolen, E., Brown, K., Kiernan, K. & Donschnik, K. (2001). A review of programs state by state. Hastings West-Northwest Journal of Environmental Law and Policy, 8 (2), 145-234.

Bowles, B., Fleming, K., Fuller, K., Lankford, J., & Printz, J. (2012). Economic and health benefits of bicycling in Iowa. Iowa Bicycle Coalition. Retrieved from http://iowabicyclecoalition.org/wp-content/uploads/2012/04/2012-Economic-Impact-Study.pdf

Brandes, U., MacCleery, R., Peterson, S., & Johnston, M. (2010). Land use and driving: The role compact development can play in reducing greenhouse gas emissions. Washington, DC: Urban Land Institute.

Breslaw, J. A. (1990) Density and Urban Sprawl: Comments, Land Economics, 66(4), 464-468.

Brunett, P., Burchell, R., Neuman, N., Schmid, A. and Wyckoff, M. (1997) Fiscal Impacts of Alternative Land Development Patterns in Michigan: The Costs of Current Development Versus Compact Growth, Southeast Michigan Council of Governments (SEMCOG).

Burchell R. W. (1992) Impact Assessment of the New Jersey Interim State Development and Redevelopment Plan – Executive Summary, New Jersey, Office of State Planning, Rutgers University, Center for Urban Policy Research.

Burchell, R. W., Zakrewsky, A., Zuelsdorf, R. J., Hart, A., Siemon, C. L., Larsen, W. U., and Neuman, N. (1996) South Carolina Infrastructure Report #1 Projection of Statewide Infrastructure Costs 1995-2015, State of South Carolina State Budget and Control Board, Advisory Commission on Intergovernmental Relations.

Burchell, R., and Galley, C. (2003) Projecting Incidence and Costs of Sprawl in the United States, Transportation Research Record 1831, Journal of the Transportation Research Board, Washington, DC, 150-157.

Burchell, R. W., and Mukherji, S. (2003). Conventional Development Versus Managed Growth: the Costs of Sprawl. American Journal of Public Health, 93(9), 1534-1540. DOI:10.2105/AJPH.93.9.1534

Calthorpe, P. 1993. The next American metropolis: Ecology, community and the American dream. New York: Princeton Architectural Press.

Carruthers, J. I. (2002) The impacts of state growth management programs: A comparative analysis. Urban Studies, 39 (11), 1959-1982.

Carruthers, J. I. and Ulfarsson, G. F. (2002). Fragmentation and sprawl: Evidence from interregional analysis. Growth and Change. 33, 312-340.

CDM Smith. (2013). *Technical Memorandum No. 9 - Finance (Subtask 9.1)*. Prepared for: Ohio Department of Transportation.

Center for Disease Control and Prevention (2014) Motor Vehicle Crash Injuries: Costly but Preventable, CDC Vital Signs, October, National Center for Injury Prevention and Control, Retrieved November 1, 2014, from www.cdc.gov/vitalsigns.

(CEE) Center for Energy and Environment (1999). Two roads diverge: Analyzing growth scenarios for the twin cities. Retrieved from http://www.mncee.org/getattachment/fbac3fc1-9a95-4915-9a6d-894ab58a0f3f/

CNT (Center for Neighborhood Technology). (2013). Transit-oriented development in the Chicago region: Efficient and resilient communities for the 21st century. Retrieved from http://www.cnt.org/media/CNT_TODInChicagoRegion.pdf

CNT (Center for Neighborhood Technology) (2014), H+T Affordability Index, http://htaindex.cnt.org/

Cervero, R. (1994) Transit-based Housing in California: Evidence on Ridership Impacts, Transport Policy, 1(3), 174-183.

Cervero, R. (1989) Jobs-Housing Balancing and Regional Mobility, Journal of the American Planning Association, 55(2), 136-150, DOI: 10.1080/01944368908976014

Cervero, R. (1991) Jobs/Housing Balance as Public Policy, Urban Land, October, 10-14.

Cervero, R. (1996) Jobs-housing Balance Revisited, Journal of the American Planning Association, 62(4), 492.Cervero, R. (1996) Mixed Land-Uses and Commuting: Evidence from the American Housing Survey. Transportation Research Part A, Elsevier Science Ltd, 30(5), 361-377.

Cervero, R., and Arrington, G. B. (2008) Vehicle Trip Reduction Impacts of Transit-Oriented Housing, Journal of Public Transportation, 11(3), 17p.

Cervero, R., and Duncan, M. (2006) Which Reduces Vehicle Travel More: Jobs-Housing Balance or Retail-Housing Mixing?, Journal of the American Planning Association, 72(4), 475-490.

Cervero, R., and Kockelman, K. (1997) Travel Demand and the 3Ds: Density, Diversity, and Design, Transportation Research Part D Transport and Environment, Elsevier Science Ltd. 2(3), 199-219.

Cervero, R., and Radisch, C. (1995) Travel Choices in Pedestrian Versus Automobile Oriented Neighborhoods, UCTC No 281, The University of California Transportation Center, University of California at Berkeley, Berkeley, CA, 30p.

Chen, C, Gong, H, and Paaswell, R. (2008) Role of the Built Environment on Mode Choice Decisions: Additional Evidence on the Impact of Density, Transportation, Springer US, 35(3), 285-299. DOI: 10.1007/s11116-007-9153-5

City of Long Beach (2013). Broadway and Third Street protected bikeway study. Retrieved from http://www.bikelongbeach.org/archives/5534.

Coyne, W. (2003). The fiscal cost of sprawl: How sprawl contributes to local governments' budget woes. Denver, CO: The Environment Colorado Research and Policy Center.

Cradock, A., Troped, P., Fields, B., Melly, S., Simms, S. & Grimmler, F. (2009). Factors associated with federal transportation funding for local pedestrian and bicycle programming and facilities. Journal of Public Health Policy, 30,38-72.

Drennan, M. & Brecher, C. (2012). Can public transportation increase economic efficiency? Access Magazine (Spring) 40, 29-33. Berkeley, CA: University of California Transportation Center/Regents of the University of California.

Dunphy, R. T., and Fisher, K. (1996) Transportation, Congestion, and Density: New Insights, Transportation Research Record 1552, Journal of the Transportation Research Board, Washington, DC, 89-96.

Duran, Rodrigo and Michael L. Lahr, "On the Effectiveness of Smart Growth Programs in Curbing Urban Sprawl", Draft, February 27, 2009, Rutgers University, unpublished.

Durand, C., Andalib, M & Pentz, M. (2012). A systematic review of built environment factors related to physical activity and obesity risk: Implications for smart growth urban planning. National Institutes of Health. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3079793/

Durning, A. (2013). Parking break. Sightline. http://daily.sightline.org/2013/10/16/parking-break/Eidlin, E. (2005) The Worst of All Worlds: Los Angeles, California, and the Emerging Reality of Dense Sprawl, Transportation Research Record 1902, Journal of the Transportation Research Board, Washington, DC, 1-9.

Eriksson, U., Arvidsson, D., Gebel, K. & Sundquist, K. (2012). Walkability parameters, active transportation and objective physical activity: Moderating and mediating effects of motor vehicle ownership in a cross-section study. International Journal of Behavioral Nutrition and Physical Activity 9, 1-10.

Ewing, R., Bartholomew, K., Winkelman, S., Walters, J., & Chen, D. (2008). Growing cooler: The evidence on urban development and climate change. Washington, DC: The Urban Land Institute.

Ewing, R., Cervero, R. (2010), "Travel and the Built Environment", Journal of the American Planning Association, 76:3, 265-294

Ewing, R., Dumbaugh, E., and Brown, M. (2001) Internalizing Travel by Mixing Land Uses: Study of Master-Planned Communities in South Florida, Transportation Research Record 1780. Journal of the Transportation Research Board, Washington, DC, 115-120.

Ewing, R., DeAnna, M and Li, S. (1996) Land Use Impacts on Trip Generation Rates. Transportation Research Record 1518, Journal of the Transportation Research Board, Washington, DC, 1-6.

Ewing, R., Hamidi, S. (2014) Measuring Sprawl 2014, Smart Growth America, Washington, DC.

Ewing, R., Pendall, R., and Chen, D. (2002) Measuring Sprawl and Its Impact, Smart Growth America, Washington, DC.

Ewing, R., Pendall, R., and Chen, D. (2003) Measuring Sprawl and Its Transportation Impacts. Transportation Research Record 1831, Journal of the Transportation Research Board, Washington, DC, 175-183.

Faghri, A. and Venigalla, M. (2014) Measuring Travel Behavior and Transit Trip Generation Characteristics of Transit-Oriented Developments. Transportation Research Record 2397, Journal of the Transportation Research Board, Washington, DC, 72-79.

Farber, N. (2008). Avoiding the pitfalls of public private partnerships: Issues to be aware of when transferring transportation assets. Transportation Law Journal, 35, 25-46.

FDOE (Florida Department of Economic Opportunity) (2014). Mobility Fees. Retrieved from http://www.floridajobs.org/community-planning-and-development/programs/technical-assistance/planning-initiatives/urban-planning/mobility-fees

FHWA (Federal Highway Administration) (2014), MAP-21, https://www.fhwa.dot.gov/map21/

FHWA (Federal High Way Administration.) (2006). Ch. #3 Transportation demand management strategies. In Multi-pollutant emissions benefits of transportation strategies. Washington, DC. Publication Number FHWA-HEP-07-004.

Fitzpatrick, K., Carlson, P., Brewer, M. Wooldridge, M. D., & Miaou, S. (2003). Design speed, operating speed, and posted speed practices. Texas Transportation Institute. Retrieved from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_504.pdf.

Forkenbrock, D. & G. Weisbrod. (2001). Guidance for assessing the social and economic effects of transportation projects. National Cooperative Highway Research Program Report # 456. Transportation Research Board—National Research Council. Washington, D.C.: National Academy Press

Frank, J. E. (1989) Costs of Alternative Development Patterns: A Review of the Literature, Urban Land Institute, 46p.

Frank, L.D., Kavage, S. & Litman, T. (2005). Promoting public health through smart growth. Victoria Transportation Planning Institute. Retrieved from http://www.vtpi.org/sgbc_health.pdf

Frank, L. D., and Pivo, G. (1994) Impacts of Mixed Use and Density on Utilization of Three Modes of Travel: Single-Occupant Vehicle, Transit, and Walking, Transportation Research Record 1466, Journal of the Transportation Research Board, Washington, DC, 44-52.

Frank, L. D. (1994) An Analysis of Relationships Between Urban Form (Density, Mix and Jobs: Housing Balance) and Travel (Mode Choice, Trip Generation, Trip Length, and Travel Time), WA-RD 351.2, Washington State Department of Transportation, Olympia, WA. 284p.

Friedman, M., Powell, K., Hutwagner, L., Graham, L., & Teague, G. (2001). Impact of changes in transportation and commuting behaviors during the 1996 summer olympic games in Atlanta on air quality and childhood asthma. Journal of the American Medical Association. 285, 7, 897-905.

Fulton, W., Preuss, I., Dodds, A., Absetz, S., & Hirsch, P. (2013). Building better budgets: A national examination of the fiscal benefits of smart growth development. Washington, DC: Smart Growth America.

Galster, G., Hanson, R., Ratcliffe, M. R., Wolman, H., Coleman, S., and Freihage, J. (2001) Wrestling Sprawl to the Ground: Defining and Measuring an Elusive Concept, Housing Policy Debate, 12(4), Fannie May Foundation, 681-717.

Grabow, M., Hahn, M., & Whited, M. (2010). Valuing bicycling's economic and health impacts in Wisconsin. Retrieved from http://www.sage.wisc.edu/IGERT/download/bicycling_Final_Report.pdf

Guerra, E. & Cervero, R. (2012). Transit and the "D" word. Access Magazine (Spring) 40, 2-8. Berkeley, CA: University of California Transportation Center/Regents of the University of California.

Harvey, R. O., and Clark, W. (1965) The Nature and Economics of Urban Sprawl, Land Economics a quarterly journal of Planning, Housing and Public Utilities, 41(1), 1-10.

Ingram, G., Carbonell, A., Hong, Y., & Flint, A. (2009). Smart growth policies: An evaluation of programs and outcomes. Cambridge, MA: Lincoln Institute of Land Policy.

Institute of Transportation Engineers. (2012) Trip Generation Manual, 9th ed., Washington, DC.

ITDP (Institute for Transportation Development and Policy). (2014a). About the TOD standard. Retrieved from https://go.itdp.org/display/live/About+the+TOD+Standard

ITDP. (2014b). The TOD standard scorecard. Retrieved from https://go.itdp.org/display/live/The+TOD+Standard+Scorecard?moved=true

Jaret, Charles. "Suburban Expansion in Atlanta: 'The City Without Limits' Faces Some". 165-205. Urban Sprawl: Causes, Consequences and Policy Responses. Ed. Squires, Gregory D. 2002.

Kahn, M. & Levinson, D. (2011). The Hamilton Project--fix it first, expand it second, reward it third: A new strategy for America's highways. Washington, DC: Brookings. Retrieved from http://www.brookings.edu/~/media/research/files/papers/2011/2/highway%20infrastructure%20kahn%20levinson/02_highway_infrastructure_kahn_levinson_paper.pdf.

Kellogg, W. (2007). The state role in guiding land use change in the Ohio Lake Erie basin: Key policies, programs, and incentives for the Ohio balanced growth program--final report. Cleveland: Ecocity Cleveland.

Knaap, G. & Moore, T. (2000). Land supply and infrastructure capacity monitoring for smart urban growth. Working Paper. Cambridge, MA: Lincoln Institute of Land Policy.

Knaap, G. & Lewis, R. (2007). State agency spending under Maryland's smart growth areas act: Who's tracking, who's spending, how much and where? College Park, MD: National Center for Smart Growth.

Kooshian, C. & Winkelman, S. (2011). Growing Wealthier: Smart Growth, Climate Change and Prosperity. Washington, DC: Center for Clean Air Policy.

Kuzmyak, J., Pratt, R. & Douglas, G. (2003). Land use and site design: Traveler response to transportation system changes. Washington, DC: Transportation Research Board/National Academy of Sciences.

Levy, Andrew. "Overview of Impact Fees in Illinois: An Introduction to Impact Fees for Communities and Residents of Champaign County, Illinois"June 2010. Champaign County Regional Planning Commission. Retrieved fro http://www.ccrpc.org/planning/pdfs/OverviewOfImpactFees.pdf

London, J. & Williams-Derry, C. (2013). Who pays for parking? how the oversupply of parking undermines housing affordability. Sightline. Retrieved from http://www.sightline.org/wp-content/uploads/downloads/2013/12/Who-Pays-for-Parking-Sightline-Dec-2013.pdf

Metropolitan Sewer District of Greater Cincinnati & Hamilton County, Ohio .2007. Green infrastructure program. Cincinnati, Ohio: MSDGC.

Meck, Stuart, FAICP, Editor, Growing Smart Legislative Guidebook: Model Statutes for Planning and the Management of Change, American Planning Association. 2002 Edition. http://www.planning.org/growingsmart/guidebook/

Mildenberg, D. (2013), States roll the dice on highway traffic. Bloomberg Businessweek. Dec 16, 2013, Issue 4359, 42-45.

Montgomery County Department of Transportation. (2011). Montgomery county parking policy study. Retrieved from http://www6.montgomerycountymd.gov/content/dot/parking/pdf/study_summary.pdf

MORPC (Mid-Ohio Regional Planning Commission). (2010). Dense by design: A compact guide to compact development. Columbus, Ohio.

MORPC .(2014). MORPC complete streets policy (03312010). Retrieved from http://www.morpc.org/trans/CompleteStreets_MORPC_CS_PolicyFINAL2010-03-31.pdf. Accessed August 2014.

NCSC (National Complete Streets Coalition). 2014. Complete streets: Fundamentals. Retrieved from http://www.smartgrowthamerica.org/documents/cs/cs-brochure-features.pdf

Nelson, A. & Duncan, B. (1995). Growth management principles and practices. Chicago: Planners Press, American Planning Association

Nelson, A. C., ed. 1988. Development Impact Fees: Policy Rationale, Practice, Theory, and Issues. Chicago: Planners Press.

Nelson, A., Anderson, G., Bartholomew, K., Perlich, P., Sanchez, T.& Ewing, R. (2009). The best stimulus for the money: Briefing papers on the economics of transportation spending. Smart Growth American/University of Utah.

Nelson/Nygaard Consulting. (2007). Ann Arbor downtown parking study—Phase II. Retrieved from http://www.a2dda.org/about-the-dda/data-reports-studies/parking/

Newman, P., and Kenworthy, J. (1999) Costs of Automobile Dependence: Global Survey of Cities, Transportation Research Record 1670, Journal of the Transportation Research Board, Washington, DC, 17-26.

NOACA (Northeast Ohio Areawide Coordinating Agency). (2014). Congestion management process: existing traffic congestion & recommended strategies to address congestion in the NOACA region. Cleveland, OH: NOACA.

Ohio Department of Transportation (2013), Access Ohio 2040, http://www.dot.state.oh.us/divisions/planning/spr/statewideplanning/access.ohio/pages/default.aspx

Ohio Department of Transportation (2014), Transportation Review Advisory Countil (TRAC) program, http://www.dot.state.oh.us/TRAC/Pages/Default.aspx

Ohio Lake Erie Commission (2000), Lake Erie Protection and Restoration Plan, http://lakeerie.ohio.gov/Portals/0/Reports/2000LEPRplan.pdf

Ohio Lake Erie Commission (2011). Ohio Balanced Growth Strategy. http://balancedgrowth.ohio.gov/Portals/0/BG%20Documents/Ohio%20Balanced%20Growth%20Strategy%202011%20FINAL%202011-12-21.pdf

Ohio Sierra Club (2011). Fixing-it-first: the benefits of repairing Ohio's road infrastructure. Retrieved from http://ohiosierraclub.org/wp-content/uploads/2011/06/Fix-It-First-White-Paper.pdf.

Ohls, J. C., and Pines, D. (1975) Discontinuous Urban Development and Economic Efficiency, Land Economics, 51(3), 224-234.

Ottensmann, J. R. (1977) Urban Sprawl, Land Values and the Density of Development, Land Economics, 53(4), 389-400.

Pasco County (2014). Mobility Fees. Retrieved from http://www.pascocountyfl.net/index.aspx?NID=329

Peng, Z. (1997) The Jobs-Housing Balance and Urban Commuting, Urban Studies, Routledge, 34(8), 1215-1235. DOI:10.1080/0042098975600

Peiser, R. B. (1984) Does it Pay to Plan Suburban Growth?, Journal of the American Planning Association, 50(4), 419-433, DOI: 10.1080/01944368408976774

Peiser, R. B. (1989) Density and Urban Sprawl, Land Economics, 65(3), 193-204.

Pucher, J., & Renne, J. (2003). Socioeconomics of urban travel: Evidence from the 2001 NHTS. Transportation Quarterly, 57, 49-77. Retrieved from http://policy.rutgers.edu/faculty/pucher/TQPuchRenne.pdf

Purcell, N. S. (1997). Creating communities of place: Statewide planning and growth management programs in the United States. New Jersey Department of Planning.

Real Estate Research Corporation (1974) The Costs of Sprawl: Detailed Cost Analysis, Washington, DC.

Sanchez, A. (2014). Clean water, strong communities: Translating the value of water infrastructure using community benefit strategies. Washington DC: Green for All.

Sarzynski, A., Wolman, H. L., Galster, G., and Hanson, R. (2006) Testing the Conventional Wisdom About Land Use and Traffic Congestion: The More We Sprawl, the Less We Move?, Urban Studies, Routledge, 43(3), 601-626. DOI:10.1080/00420980500452441

Schrank, D., Eisele, B., and Lomax, T. (2012) TTI's 2012 Urban Mobility Report Powered by Inrix Traffic, Texas A&M Transportation Institute, Southwest Region University Transportation Center, 64p.

Seattle City Council (2012). Removing minimum parking requirements where unneeded. Retrieved from http://council.seattle.gov/2012/05/10/removing-minimum-parking-requirements-where-unneeded

Seggerman, K. E., Williams, K. M., Lin, P., & Fabregas, A. (2009). Evaluation of the mobility fee concept. Retrieved from http://www.floridajobs.org/fdcp/dcp/MobilityFees/Files/CUTRMobilityFeeFinalReport.pdf

Shoup, D. (2002) Roughly Right or Precisely Wrong?, Access, Spring, 20-25.

Siemiatycki, M. (2010). Delivering transportation infrastructure through public-private partnerships: Planning concerns. Journal of the American Planning Association, 76(1), 43-58.

Smart Growth America. (2010). Reform level-of-service standards. Retrieved from http://www.smartgrowthamerica.org/guides/smart-growth-at-the-state-and-local-level/transportation/reform-level-of-service-standards/

Stone, P. A. (1973) The Structure, Size, and Costs of Urban Settlements, Cambridge, England: Cambridge University Press.

Stringham, M. G. P. (1982) Travel Behavior Associated with Land Uses Adjacent to Rapid Transit Stations, ITE Journal, April, 16-18.

Stromberg, E. (2014a). By the numbers: Transportation inequality. Planning Magazine 80 (5), 40. Chicago, IL: American Planning Association.

Stromberg, E. (2014b). By the numbers: Fear on foot. Planning Magazine 80(7), 39. Chicago, IL: American Planning Association.

Texas A&M Transportation Institute (2000). Urban Mobility Report. http://mobility.tamu.edu/

Timilsina, Govinda R. and Hari B. Dulal. "Urban Road Transportation Externalities: Costs and Choice of Policy Instruments" 2010. The World Bank Observer. Oxford, UK: Oxford University Press.

Tirumalachetty, S., Kockelman, K. M., and Nichols, B. G. (2013) Forecasting Greenhouse Gas Emissions from Urban Regions: Microsimulation of Land Use and Transport Patterns in Austin, Texas, Journal of Transport Geography, 220-229. DOI:10.1016/j.jtrangeo.2013.08.002

TRB (Transportation Research Board). (1998). Guidance for estimating the indirect effects of proposed transportation projects. Washington, DC: National Academy of Sciences.

TRB. (2004). Transit-oriented development in the United States: Experiences, challenges and Prospects. Washington, DC: National Academy of Sciences.

TRB. (2013). Critical issues in transportation. Washington, DC: National Academy of Sciences.

Urban Land Institute (1958) Effects of Large Lot Size on Residential Development. Technical Bulletin No. 32, Washington, DC

USEPA (United States Environmental Protection Agency). (2000) Low impact development (LID): A literature review. Office of Water: Washington DC. EPA-841-B-00-005.

USEPA.(United States Environmental Protection Agency) (2013). Case studies analyzing the economic benefits of low impact development and green infrastructure programs. Office of Wetlands, Oceans and Watersheds: Washington DC. EPA 841-R-13-004

USEPA (United States Environmental Protection Agency)(2014a), Office of Sustainable Communities, "Trip Generation Tool for Mixed Use Developments" http://www.epa.gov/dced/mxd_tripgeneration.html

USEPA (United States Environmental Protection Agency)(2014b), Air Emission Sources, Nitrogen Oxides by Source Sector, http://www.epa.gov/cgi-bin/broker?_service=data&_debug=0&_program=dataprog.national_1.sas&polchoice=NOX

U. S. House. Committee on Transportation and Infrastructure**.** (2007). Public-Private Partnership Innovative Financing and Protecting the Public Interest Hearing, 13 February, 2007. Washington: Government Printing Office, 2007, (34-778 PDF).

Voorhees Transportation Center (2003). Evaluation of the New Jersey transit village initiative. Rutgers, NJ: Rutgers University.

Wachs, M., and Taylor, B. D. (1993) The Changing Commute: A Case-Study of the Jobs-Housing Relationship Over Time, Urban Studies, Routledge, 30(10), 1711.

Wang, X., Khattak, A., and Zhang, Y. (2013) Is Smart Growth Associated with Reductions in Carbon Dioxide Emissions?, In Proceedings of the 2013 Annual Meeting of the Transportation Research Board, Washington DC.

Wheaton , W. L. and Schussheim, M. J. (1955) The Cost of Municipal Services in Residential Areas, Washington, DC, US Department of Commerce.

Winkelman, S., Bishins, A. & Kooshian, C. (2009). Cost-effective GHG reductions through smart growth & improved transportation choices: An economic case for investment of cap-and-trade revenues. Washington, DC: Center for Clean Air Policy.

Wolfson, H., (2011). Memorandum on bike lanes, City of New York, Office of the Mayor. Retrieved from http://www.nyc.gov/html/om/pdf/bike_lanes_memo.pdf

Zehngebot, C. & Peiser, R. (2014). Complete streets come of age: Learning from Boston and other innovators. Planning Magazine 80(5), 26-32. Chicago, IL: American Planning Association.

Zhang, M. (2004) The Role of Land Use in Travel Mode Choice: Evidence from Boston and Hong Kong. Journal of the American Planning Association. 70 (3), 344-360, DOI: 10.1080/01944360408976383

Zimbler, R. (2002). Driving urban environments: Smart growth parking best practices. Madison, WI: Governor's Office of Smart Growth. Retrieved from http://www.dot.wisconsin.gov/localgov/docs/smart-growth-parking.pdf

8.0 APPENDIX

8.1 SUMMARY OF STATE PROGRAMS

Tier Definitions

- 0 = no state policies that promote local government smart growth-like land use (compact, nodal development)
- 1 = has some state policy(ies) that encourages local, state and regional governments to engage in smart growth-like land use policies through incentives, technical assistance, education, and collaborative decision-making
- 2 = Have a unified and coordinated state policy in directing state and regional (MPO) investment according to smart growth principles
- 3 = State mandates that state, regional and local governments adhere to certain smart growth-like policies (i.e. Oregon's Urban Growth Boundaries) affecting both public and private investment.

STATE	TIER (as of 2014)	COMMENTS
Alabama	0	• Aside from the state implementing a federal coastal management program which limits some land use in some of the coastal counties, essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Alabama. • Counties don't have home rule and can't enact zoning laws (except for three county exceptions) like cities and townships can. • There is some encouragement of smart growth-like policies by organizations/programs such as the League of Cities and the Main Street Program.

STATE	TIER (as of 2014)	COMMENTS
Alaska	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Alaska. • One of the Office of Governor's (Sean Parnell) priorities is in developing transportation infrastructure. He writes, "We must have access to our lands to spur economic growth and create opportunities for Alaskans. We will do it, in part, by building roads to resources." • The Division of Community and Regional Affairs: Planning & Land Management does acknowledge "climate change" and its impact. The state will help assess the hazards' impact on the community and develop recommendations for how the community might best mitigate those hazards impacts. There are some planning grants available. • Alaska is unique among states in that vast majority of the land is owned by government entities. Private interest own less than 1% of Alaska. The formation of the state in 1959, and the Alaska Native Claim Settlement Act of 1971, left millions of federal acres subject to transfer to the state and Alaska Native entities. The state manages the acquired land and will sell it off to private interests for the "maximum public benefit." There are no smart growth-like policies that guide these transactions.
Arizona	1	• Although the Department of Transportation (DOT) has an Arizona Smart Growth Scorecard that local jurisdictions can voluntarily use to evaluate their planning and development efforts, there do not appear to be any rewards or consequences for use or non-use. When it was created between 2006 and 2008, it was part of the previous governor's smart growth agenda. It was to be a factor in federal aid to local jurisdictions. But the governor left in 2008 and the plan was never implemented. • Previous statewide initiatives to conserve land have failed. • Over all, there are not many indicators of smart growth- like policies or laws promulgated by the state of Arizona. • "Guidelines for Long-Range Planning: Guidelines for Highways on Bureau of Land Management and U.S. Forest Service Lands" (2014) was issued by the ADOT in order to coordinate inter agency planning efforts in linking "transportation planning and land use."
Arkansas	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Arkansas. • Local government planning is optional. • In this very property rights/libertarian oriented state, some individual municipalities are moving toward redevelopment/infill, but this is market, not state, driven. • The DOT is very powerful, has been resistant to planning, and is just now getting started doing modeling (which Metropolitan Planning Organizations [MPOs] have been doing for decades).
California	2	• Local government comprehensive planning is mandated, with requirements for consistency, annual reports, and review/approval by the state planning office. The California Environmental Quality Act (CEQA) requires environmental impact assessment/reports on all decisions by local legislative/judicial bodies; decisions made in spite of significant impacts must include a statement of overriding considerations. However, neither of these really influences patterns

STATE	TIER (as of 2014)	COMMENTS
		of development. • In 2002, state planning priorities were set, which included infill development, protection of resources, efficient development patterns, etc. This is used as criteria in grant programs for state funds, such as Strategic Growth Grants, and Prop 84 water programs, etc. In addition, all state agencies are supposed to use these principles in their funding and development. • There are two jurisdictions only in the state, municipalities (cities) and counties, which hold all land use authority. • Some cities and counties, such as Ventura County, which requires urban growth boundaries, have strong smart growth-like policies. • Regional Housing Needs Assessments may somewhat influence growth patterns because they require affordable housing of every county in the state, and affordable housing allocations are required to go into areas near transit and existing infrastructure. • Also, SB 375, 2008, requires regions to do RTPs (Regional Transportation Plans) and include sustainable strategies such as multi-modal transportation options, infill, and compact neighborhoods. Local government funding of all sorts of programs are contingent on the plans being consistent with RTPs. More and more programs are tying in to this. Ultimately this will have a greater influence on growth patterns. So far they are starting to see changes in patterns, but this is new enough that it does not influence 2010 observations. • A new policy, SB743, 2013, exempts anything that is already under an approved specific plan (i.e. already-approved infrastructure) from needing to comply with further CEQA analysis. This is a big incentive, making it easier and cheaper and less risky to build in areas that area already planned. This should encourage more infill in the long run.
Colorado	1	• There is mandatory local plan consistency with state goals; designated protection areas; a state planning/smart growth office; restricted annexation; and support for major open space protection funding. • Planning law is in place but there are no teeth. Local boards take state goals and plans into consideration but if they do not comply in their plans, there is no consequence. • Home rule of counties and cities is paramount. • The DOT does not align with state goals.
Connecticut	2	• State policies regarding plans for investments have been in place since early 2000s. State agency policies must be consistent with state development goals/policies. • Municipalities must only “note inconsistencies” with the state goals/policies. • Conservation and Development Policies Plan 2005-2010 includes priority funding areas, Designated Regional Centers (focused development areas) and Neighborhood Conservation Areas, and Conservation Areas as mapped in Locational Guide Maps. The Policies Plan also included these components: focus on existing areas; conservation of open space; providing choice in housing and meeting household needs; transportation focus on designated nodes; and coordination and integration. • The State Office of Policy and Management developed new Conservation and Development Policies Plan in 2013. This strengthened the process wherefore projects outside of priority funding areas must be consistent with local plans. A previous Conservation and Development Policies Plan of 2005 had similar

STATE	TIER (as of 2014)	COMMENTS
		policies which required project investments to be consistent with previous plans. It was criticized for being weak, by enabling local governments to just use a map to determine consistency. • All MPOs are required to prepare a Regional Plan of Conservation and Development and update it every 10 years • All government entities are either state or municipality. There are no counties. • Limited funding has likely stopped infrastructure expansion since 2008.
Delaware	2	• The state of Delaware has implemented a number of smart growth-like policies and strategies. Further research is needed to ascertain how they are enforced and what is the extent of the mandate from the state towards local jurisdictions; and if the state might therefore warrant a Tier 3 designation. • The State's overall guide to land use policy, which is articulated in the *Strategies for State Policies and Spending*, was developed in 1999 and is updated every five years (2004 and 2010). The purpose is "to guide state investment decisions to promote efficient development patterns, protect agriculture and open space, discourage sprawl, and communicate with local governments on land-use matters." • Delaware is a small, home rule state, with 57 towns and cities, along with 3 counties. All have comprehensive plans with zoning that has to be in compliance with the state plan. • The State maintains a map that highlights land areas labeled as Levels 1-4 (plus "Out of Play") that are open to varying and different levels of development. • The Governor's Land Use Agenda (from the "2010 Strategies for State Policies and Spending") calls for coordinating local land use actions with state infrastructure and service delivery; and fostering economic growth by enabling a predictable and transparent land use review and permitting process and leveraging state and local investments in infrastructure. • The (local) comprehensive plans are certified by the State as to their consistency with the State land use policies in particular, as to the State's responsibility to provide infrastructure and services in support of land use decisions. • Another major tool the State uses to coordinate land use with local governments is the Preliminary Land Use Services (PLUS) review process, whereby major land-use change proposals (anything 50,000' sq. or greater - e.g., large subdivisions proposals, comprehensive plan amendments and comprehensive plan updates) are reviewed by State agency representatives along with local government representatives and developers. Schools for example cannot be located in Level 4 areas (i.e. agriculture). • Developers going thru the PLUS process must be in compliance with local comprehensive plans. • In order to promote more compact urban development, the state is using the Healthy Communities program to promote higher densities and offering incentives to developers (investing at least $25,000) for infill • The Delaware Economic Development Office notes that "The Cabinet Committee on State Planning Issues is established [in State code] to 'consider matters relating to the orderly growth and development of the State.' The Cabinet Committee is charged with recommending 'the most desirable general pattern of land use within the State,' advising on transportation issues, recommending 'proposed general location of major public and private works and facilities,' and 'recommendations on land use planning actions that are subject to review and comment' under the Preliminary Land Use Service

STATE	TIER (as of 2014)	COMMENTS
		(PLUS)." • State statistics of note include: the State maintaining 90% of roads (compared to the national average of 20%); and the State providing 70-80% of school operating funding; and 60-75% of educational-facility capital-construction funding. • Local comprehensive plans are given the force of law. Further research is needed to find out how the "force of law" is implemented and played out. • Historically, former Governors Minner and Carper, along with current Governor Markell and the League of Women Voters, are entities that have been key players in promoting Delaware's smart growth-like policies.
Florida	2	• Of note, "since 2008, lane mile growth, though modest, has outpaced VMT [vehicle miles traveled] growth, reversing a trend of demand growth outpacing new capacity" (*A Pocket Guide: Florida Transportation Trends and Conditions* [2012, p. 27]). • The 1975 Planning Act had no concurrency requirements (in general concurrency is defined as local governments being required to have enough infrastructure [i.e. sewer, roads, transit, etc.] to meet the induced needs that new development brings) or consistency with state planning requirements. • In 1985/86 the Growth Management Act (GMA) was implemented. It had concurrency requirements and provisions for the State Planning Agency to review local comprehensive plans. • In 2011, the above GMA above was amended and became known as the Community Planning Act (CPA). Language in the act refers to compact modes of development and reducing vehicle miles traveled (VMT) although local governments can have their own standards for types of highways projects. They are required to consult with the DOT but can then go their own way in this regard. It recognizes that infill development and redevelopment are important components and useful mechanisms for promoting and sustaining urban cores. State and regional entities and local governments are told to provide incentives to promote urban infill and redevelopment. Existing programs and incentives are to be integrated to the extent possible to promote urban infill and redevelopment and to achieve the goals of the state urban policy. • Even though the CPA removed mandatory concurrency requirements for transportation infrastructure (while others infrastructure concurrency requirements for sanitary sewer, solid waste, drainage, and potable water remained mandatory) most entities are keeping the transportation provision. At the same time, some localities are replacing it with such things as a mobility fee. • Local governments are given leeway on how they will accomplish compact urban growth (whose provision must be in their local comprehensive plans). • Although the Land Commission could penalize local governments for failing to comply with the planning acts, few cases went to hearings. Most disagreements were settled outside the hearing venue. • Implementation of the smart growth-like policies varies by locale. Some "are doing the right thing, some not." • Florida's Strategic Intermodal System Plan (SIS) does not appear to address land use patterns to any sufficient degree.

STATE	TIER (as of 2014)	COMMENTS
Georgia	1	• After looking at its neighbor to the south (Florida) and their unchecked growth in the 1980s, The Georgia Planning Act (GPA) was enacted in 1989. It linked local government comprehensive planning (the state had to approve the proposed comprehensive plan) with the ability to receive certain types of state financial funding. • The GPA required comprehensive plans that included some elements of land use. Although the GPA recommended "quality growth" (similar to "smart growth") components, it could not require them. • The GPA also initially promoted state agency coordination in promoting certain smart growth-like policies. • Regarding if the GPA was effective in promoting smart growth-like (compact urban) development, an informant said that the "urban areas understood the program and ran with it while the rural areas did not." • By the late 2000s, changes in political leadership had eroded the power of the state to guide local planning. Thus while Georgia might have been a solid Tier 2 for the time-period of the 1990s thru the early 2000s, it had by 2010 slipped closer to a Tier 1. • This year (2014) Georgia's Department of Community Affairs rolled out Plan First, a program that allows local governments to apply more often for state financial programs if they have accomplished comprehensive community involved planning. There does not appear to be any criteria for meeting smart growth-like goals in the application process. • Regarding the prospects of smart growth-like development in Georgia, it was noted that there is a little bit of concern for the future with "the glass [being] both half empty and half full."
Hawaii	1	• The most recent administration (Governor Abercrombie) was an advocate of smart growth-like policies. This includes the DOT, which in 2013 was to begin implementing these policies. Beginning in 2013, for those entities seeking funds from the DOT smart growth consideration was supposed to be a factor in approval but it has not yet been implemented. Since then (2013), Hawaii might be considered a Tier 2 state. However, it is uncertain how the newly elected governor might follow on previous executive policies. • Prior to the Abercrombie administration's actions in 2013, there was not much work on smart growth-like policies, and Hawaii might have been considered a Tier 1 state. • The State Planning Act, (becoming law in 1978), has some provisions of sustainability guidelines. But compliance with comments made by the State Land Use Commission on development review was voluntary in nature. There are no incentives for compliance. The Commission reviews County plans and in reviewing has a charge to encourage plans to have compactness in development, should not have leapfrogging, should be contiguous and should protect agricultural land. There are four types of land use districts that are designated (Conservation [48%], Agriculture [47%], Urban [5%], and Rural [less than ½%]) when considering development. • In Dec, 2013 a Technical Assistance Memorandum was issued by the Office of Planning regarding what Hawaii decision makers should consider when reviewing local "program and plan development" when they come before the State Land Use Commission. This included a list of "priority guidelines and principles to promote sustainability." Sustainability includes "encouraging balanced economic, social, community, and environmental priorities"; "encouraging planning that respects and promotes living within the natural

STATE	TIER (as of 2014)	COMMENTS
		resources and limits of the State…"; and "smart growth and livability principles."
Idaho	0	• In 1975 the Idaho Local Land Use Planning Act was passed. Although it requires cities and counties to have comprehensive plans and land use zoning there are no smart growth-like provisions and no provisions for state enforcement. • The above act has a provision for cities and counties to negotiate urban growth, with something like planned urban service boundaries. In practice it is not happening. • Aside from the Excellence in Transportation Award, that is conferred by the Idaho Transportation Department and has criteria that "promotes the coordination of transportation systems with land use and economic development," (which may reward smart growth-like policies as well as the opposite) there is essentially no smart growth-like policies in effect in Idaho. • Idaho operates under Dillon Rules (i.e. local governments have only those powers that are specifically conferred on them). This has impeded some local governments from implementing any smart growth-like policies. A local government wants to implement a transportation tax, but they can't get authorization from the state.
Illinois	0	• The Illinois policies of Context Sensitive Solutions and Complete Streets contain some Balanced Growth-Type principles but implementation is not very strong. • We were told that "Land use planning is all local." There is not much of any type of a smart growth-like policy that unifies state government decisions. • A "Balance Growth Cabinet" was formed by Governor Ryan in 2000. It was a chance to coordinate/communicate among different state agencies and a variety of citizen interests. Some grants were given out, and the program was considered to be popular, but it currently is unfunded. • Although we have given the state a Tier 0 designation and there do not appear to be any significant incentives used by the state in order to encourage local land use that incorporates smart growth-like principles, smaller efforts could lean toward a Tier 1 designation.
Indiana	0	• There do not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Indiana. • There is limited home rule in the state. But the state allows far more home rule in practice than is written. Cities, towns and counties can do land use planning and zoning on their own. • Although there may be some movement by MPOs in NW Indiana (near Chicago) in terms of implementing some smart growth-like policies, the future does not look encouraging for smart growth-like policies in the state as a whole.
Iowa	1	• There do not appear to be any significant state mandates regarding local smart growth-like development. • There are some incentives provided by the state to local governments that incorporate some smart growth-like policies as criteria for receiving funding. These include the Green Streets Criteria that are used in disbursing CDBG

STATE	TIER (as of 2014)	COMMENTS
		funding to non-entitlement cities in Iowa; and the same criteria for disbursement of the Greyfield and Brownfield Tax credit program. • In 2010 the legislature passed 10 smart growth-like planning principals that communities should consider when updating comprehensive plans. Although the communities must have a comprehensive plan in order to do zoning, there is no requirement that the plans line up with any state mandates.
Kansas	0	• There do not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Kansas. Land use is considered a local decision.
Kentucky	1	• Although there are some state initiatives that discuss smart growth-like policies (e.g. the Kentucky Transportation Cabinet's "Congestion Toolbox"; and the "Healthy Communities Initiative") there appear to be no incentives or mandates directed at local governments to implement these type of policies. The state could be considered to be leaning towards a Tier 0 designation.
Louisiana	0	• There do not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Louisiana. • The state has no say in local land use. • Although New Orleans may be looking at smart growth-like policies, most of the state is very rural and has not much interest in this type of development.
Maine	2	• The Comprehensive Planning and Land Use Regulation Act (also known as the Growth Management Act [GMA]) was adopted in 1988, "establishing state goals and minimum procedures for local comprehensive planning and regulation. Compliance with the Act is encouraged through financial and technical assistance and through permit exemptions and grant incentives linked to a voluntary certification process. Additionally, local governments that choose to adopt zoning, impact fee or rate of growth restriction ordinances must base these ordinances on a comprehensive plan developed under the Act. The intent of the Act is to protect rural character, make efficient use of public services, and prevent development sprawl..." There is a State Planning Office (SPO) that coordinates reviews of local comprehensive plans. • Initially, the GMA required that every local government enact a comprehensive plan consistent with the GMA, which has a smart growth-like philosophy. Then a couple of years later it backed off, only requiring one of those towns that wished to use zoning authority. There is no expectation that the town will limit rural growth, nor are there mandates for urban growth boundaries. The law is enforced by the ability of entities to bring suit against non-compliant local governments. The state has not brought suit, but some private parties have done so. • The GMA calls for other state agencies to make their capital investment choices to favor designated growth areas in a given local government. State agencies are mindful of this provision and for the most part are adhering to this. • Reports are made every four years but it is difficult to measure the effectiveness of the GMA. Two-thirds of the 451 towns in the state have not done comprehensive plans. • In 1991 (amended in 2011) the Sensible Transportation Policy Act, complementary to the GMA, was passed in order to implement a statewide transportation policy, lessen dependence on foreign oil, and promote alternative transportation modes before increasing highway capacity through road building

STATE	TIER (as of 2014)	COMMENTS
		along with other transportation/development concerns. Incentives are provided to communities that adhere to these guidelines. • In 1989 another strategy used by the state to implement smart growth-like policies was a requirement for state approval of subdivisions (three or more lots or dwelling units within five years) only if it "will not cause unreasonable congestion or unsafe conditions on highways or roads." .
Maryland	2	• The Priority Fundings Law of the 1990s mandated that local jurisdictions define Priority Funding Areas (PFA) in terms of density, sewer and water. This established a baseline of how the state was going to go forward in funding infrastructure improvements. • In 1992 the Smart Growth Coordinating Committee was set up. They can make exceptions to PFA funding. • In 2010 the Sustainable Communities Act combined the growth programs into one umbrella. This increased incentives for developing in designated areas. The Maryland Department of Planning maintains maps of PFAs and Sustainable Communities area maps. • In 2011 "Plan Maryland" called for greater coordination between state agencies and municipalities and directing more resources toward those that comply with acts and policies promoting the smart growth-like development. • In 2012 legislation (Agriculture Act) was passed further limiting dense development outside of urban areas. Lots being subdivided were limited to no more than seven for the whole property (no matter the size of the property. And growth of septic systems outside of designated growth areas was limited. This has the effect of currently designating Maryland as nearly a Tier 3 type state. • Montgomery County and the City of Baltimore are noted as examples of having strong controls on how urban growth develops (with urban growth like boundary lines).
Massachusetts	2	• While Massachusetts has strong local governmental control over local land use decisions (most counties, with a few exceptions, do not have such land use control), MassDOT, through their GreenDOT initiative (2012) will strongly support smart growth-like development as part of their core business. • The 2008 Global Warming Solutions Act commits the commonwealth to reducing Greenhouse Gases although it does not mandate land use prescriptions for development. • In 2007 the state released the "Smart Growth/Smart Energy Toolkit which brings about state coordination around the issue. Nothing was mandated for localities.
Michigan	0	• There are no state efforts related to planning or land use at all, while even the Complete Streets initiatives at the DOT level did not receive a good response. • The state has a strong home rule and township form of government that resists local collaboration and land use planning. There is a rule that allows Joint Economic Development District (JEDD)-like collaboration for tax sharing to stave off annexation. There are fewer issues related to state control of local land use (i.e. utilities, Concentrated Animal Feeding Operations [CAFOs], oil/gas) than in Ohio. • There are brownfields initiatives at the state level and farmland preservation efforts at the county level but there are no other smart growth-like efforts. • Limited funding has likely stopped infrastructure expansion since 2008.

STATE	TIER (as of 2014)	COMMENTS
Minnesota	1	• There are very few state policies that are used to promote smart growth-like local policies. One such policy is the Minnesota Finance Agency's scoring priority for local compact urban space. • Although statewide there is no strong cohesive smart growth-like policy, the Minneapolis/St. Paul region is part of a seven county Metropolitan Council (MC). Authorized in the 1960s, the local governments that are part of the MC must have comprehensive plans that are in compliance with the MC. The MC, which has not always used its authority in being able to reign in sprawl, operates sewer, water, parks, transit and other infrastructure while setting up urban service boundaries for sewer and water.
Mississippi	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Mississippi.
Missouri	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Missouri.
Montana	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Montana.
Nebraska	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Nebraska. • In regards to local government entities considering smart growth-like policies, the MPO that Lincoln is part of, did a scenario study with three different proposed growth patterns. One of the scenarios included the concept of compact urban growth.
Nevada	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Nevada. • Nevada is a state that is "very bottom up in planning." The counties and cities are free to promulgate their own land use and zoning codes without having to comply with state criteria. • 86.4% of the land is federally managed. This means that a major component of the State Land Use Planning Agency (Agency) purpose is to work with the federal government in regards to National Environmental Policy Act (NEPA) compliance. This conceivably has the effect of pushing the state toward a Tier 1 status. • Other work by the Agency consists of helping the local governments write their required comprehensive plans. The Agency cannot require any of the components of the plan be aligned with smart growth-like policies.
New Hampshire	2	• The state has a coordinated agency-wide effort in promoting smart growth-like development but offers little in the way of incentives. There are no mandates transmitted by the state to the cities as New Hampshire has a strong local government rights tradition. • The State Development Plan of 1985, which is the legislation that calls for the

STATE	TIER (as of 2014)	COMMENTS
		state to "maximize smart growth," and is supposed to be updated on a regular basis, has not be updated in over 10 years. Recent governors have not made it a priority. • The lack of incentives and enforcement would perhaps in reality put New Hampshire's Tier designation somewhere between a one and two.
New Jersey	2	• The state has a coordinated approach that promotes smart growth-like development for local governments. • In the early part of the 2000s, the state enacted the Development and Redevelopment Plan that has some components of smart growth. • The DOT's Long Range Transportation Plan refers to "smart growth as the foundation" for the plan. • In 1985 the State Planning Act was passed. Its purpose was to "conserve its natural resources, revitalize it urban centers and protect the quality of its environment…" • While the current Governor (Christie, 2014) wants to increase state promotion of smart growth-like policies, he has run into opposition. New Jersey is a strong home rule state that protects the rights of local governments to make final decisions on land use issues.
New Mexico	0	• With the exception of the Department of Transportation (DOT) looking at different scenarios that might include some smart growth-like policies for locals, there essentially does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of New Mexico.
New York	2	• The Tier designation is somewhat weak as there is no state plan or planning office. • Local governments have authority to do land use plans, but it is not required. When a local government has a plan, consistency of local decisions is required. However there is no definition of a plan and meeting notes can suffice. • The state is a home rule state and many local government have no zoning • The State Smart Growth Priority Infrastructure Act went into effect in 2010. It requires all state agencies to consider a set of defined criteria (i.e. development in existing development areas first, retaining open space, etc.) in making new investment decisions. However it has had little effect for two reasons: 1) there has been no new capacity expansion since the 2008 recession, because there is a lack of financial resources; and 2) it is a weak law with no consequences for noncompliance. Agencies must just explain why if they choose not to comply. • Another impact on land use has been the local government moratoria on oil/gas development upheld by the New York State Supreme Court in 2014.
North Carolina	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of North Carolina.
North Dakota	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of North Dakota.

STATE	TIER (as of 2014)	COMMENTS
Ohio	1	• Essentially, until 2010 there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Ohio that would have the effect of bringing about compact urban development. • The state currently has a Balanced Growth Program (BG) that has some incentives for promoting aspects of smart growth-like development. It is voluntary, and incentive-driven by alignment of state policies/programs. It focuses on watershed planning partnerships of local governments, determining their own criteria to set priority development/conservation/agricultural areas. State programs align with incentives tied to location of proposed projects. • The earliest endorsed BG plans were in NE Ohio in 2009, and were likely not implemented prior to 2010. Therefore, the Tier basis since 2010 would be Tier 1. • Local governments have authority to plan, but no requirements to do so. • The Clean Ohio Fund provides funding for open space and brownfields initiatives. • There is an Ohio Development Services Agency (ODSA) brownfield redevelopment program. • ODSA may begin allowing local government funding applications for comprehensive planning. • There is an Ohio Department of Agriculture (ODA) farmland preservation office. • Limited funding for new infrastructure has had a significant influence in all of Ohio's MSAs. The state's DOT "Fix it First" policy is weighted toward redevelopment and infill, especially since 2006.
Oklahoma	0	• Aside from multi-state habitat protection of the endangered Lesser Prairie Chicken, there do not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Oklahoma. • Only local governments can limit growth. And contrary to attempts at building dense urban cores, cities are trying to grow out.
Oregon	3	• A statewide planning office prepares state planning guidelines. The state certifies compliant local plans. The state also manages the coastal zone program. Planning regulations were put in place in 1973. • Local governments are required to plan. The local plans must have required elements such as consistency, minimum densities established for cities, and agricultural zones. • Statewide planning goals include: basic quality planning requirements (e.g. citizen involvement, coordinated plans, thorough evaluation of issues, and fiscal analysis). The goals also include: preservation of agricultural lands/forest land, base/open space/natural areas of many categories; economic development based on competitive characteristics of area; housing and development based on need; urban growth boundaries (UGB) based on demonstrated need; and multi-modal transportation. • The Transportation Planning Rule of 1993 was the result of acknowledgement that UGBs didn't influence development patterns, walkability, etc. So two rules were put in place: 1) reduce reliance on automobiles; and 2) increase modal choice. This resulted in transit-supportive densities along transit routes. Local governments began to incorporate specific policies in their comprehensive planning (such as higher densities, and measures/benchmarks that include jobs in transit areas, jobs in nodes, density in nodes, bike lanes, rideshare

STATE	TIER (as of 2014)	COMMENTS
		participants, etc.). • Enforcement of the above has not been well planned or pursued, but communities are incorporating it into their plans. • The Transportation and Growth Management (TGM) grant program has been in place since 1993. It provides planning grants for projects ranging from street and bike plans to development plans to overall transportation plans. It requires walkability/smart growth-like development in comprehensive plans in order to be eligible. Statewide, $2-3 million per year in planning grants of $50,000-200,000 have been dispersed going to 10-20 communities per year for 20 years. Just about every city in the state has made use of it. Category 1 grants focus on transportation only and Category 2 grants focus on land use improvements to support better transportation (through compact and mixed use development). • Probably the biggest smart growth-like influence has been Urban Growth Boundaries. Although it does not mandate compact development, it does mandate infill before expanding, a demonstrated need for expansion, and efficient use of infrastructure. In order to expand UGBs, the local government must apply to the state for approval. • The Oregon DOT has been slow to incorporate these ideas into their policy, partly because most funding is restricted to highways. However, more compact growth has influenced where they build highways and interchanges, and the pacing of what they build. (i.e. If an interchange is built outside an urban growth boundary, there will be no retail development there.) In the last 5 years, ODOT has been making some headway in shifting policy to align with statewide goals. • All 3 programs/rules, working together, have been very effective in controlling "sprawl." Some cities embrace them more readily than others, but all have seen a lot more compact development, infill, less expansion of infrastructure, and more cottage type development, etc. • The largest driver of the above regulations has been the resource industries and their desire to maintain their resource base – farm soils, forest lands, fishing base, etc. They have continued to be a strong force in the legislature since the 1970s. State planning rules are heavily weighted toward resource protection as a result.
Pennsylvania	1	• There is no state planning office or plan. The Governor's Center for Local Government Services provides assistance only. Growing Greener and other open space acquisition/reclamation programs are run by the state and act as smart growth-like incentives. • Local governments have authority to plan, but no requirement. The municipality planning code is critical, which places all authority on individual local municipalities. On that basis, a recent State Supreme Court case struck down the state's attempt to wrest land use control from local governments regarding oil/gas drilling. • Municipalities are in three classes: 1) Philadelphia; 2) Pittsburgh; and 3) all others, including townships, boroughs, villages, small cities. All have same powers regarding land use (total power). All municipalities may resist annexation from all others. • Local government code permits locally designated growth areas; protects municipalities against legal challenges; and promotes consistency and collaboration. It has collaborative tax-sharing agreements, and Purchase of Development Rights (PDR) programs for agricultural land and brownfields programs.

STATE	TIER (as of 2014)	COMMENTS
Rhode Island	2	• By 1989 the state had a statewide land use plan that had some smart growth-like goals for local government entities. • Land Use 2025, adopted by the state in 2006, mandates that Urban Service Areas and other smart growth-like policies must be in local comprehensive plans. If local governments don't comply they are not certified and don't get a number of incentives offered by the Division of Planning and some in the Transportation Division. There are no substantial penalties for non-compliance. • The above provisions may move the state's Tier designation closer to being a Tier 3. • The state has recently been funded by a HUD grant in order to implement sustainability measurements and metrics. • Grow Smart Rhode Island, formed in the beginning of the 2000s, and the current Governor (Chafee, 2014) support the promotion of smart growth-like policies.
South Carolina	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of South Carolina. We were informed that the state believes in "very strong local governments in the state, small government [and it is] unlikely you'll see us try to move that needle [from being a Tier 0]." • Yet the SCDOT Multimodal Long Range Plan (2008) recommended, "Where local governments are committed to focusing development in patterns and densities that make mass transit, intercity rail, walking and bicycling more attractive and feasible, SCDOT can assist such efforts with design flexibility, and policies that support these alternatives to automobile travel. • There may be some local governmental subdivisions such as Richland County (home to the capital city), Greenville County and Charleston County that may have plans in place that are supportive of some smart growth-like initiatives.
South Dakota	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of South Dakota. We were informed that in a state the size of South Dakota, with only 850,000 people, any growth is "smart" growth. In other words, the state does not do anything to reign in development patterns • The city of Sioux Falls has robust planning, and looks at planned growth as an option.
Tennessee	2	• There is no state-level plan or guide for land use policy. However in the 1990s, the state mandated urban growth/service boundaries for every county. This was in place and active until it was softened in approximately 2006 and 2011 (when the state planning office that provided oversight was removed). The law requires logical development of urban growth areas, and then compliance in subsequent annexation, utilities/infrastructure plans. While the law has not been repealed, it is just much less effective especially since 2010. Two items of note: 1) UGBs were put in place as an anti-annexation measure to control city annexation "cherry picking" of commercial areas only. It was not intended to be a growth management measure. It just required cities to plan more cohesively; and 2) Counties varied widely in how they implemented the mandates – some counties just designated their whole jurisdiction as an urban growth area. Others (such as Knoxville) were more rigorous in implementation. • Until 2010, the state planning office provided technical assistance, and planning staff support for communities in implementing Urban Growth Planning. In 2011,

STATE	TIER (as of 2014)	COMMENTS
		the new Governor administration dismantled the state planning office. Since then, state agencies, regional agencies and some counties have put land use planners and capacity in place to replace lost state-level assistance. • The state overall has home rule for counties, cities, and towns (being limited cities). • The trend since 2011 has been much more conservative, more anti-municipality, anti-urban, and anti-city. The state legislation has limited local government's ability to define land use and other issues. Annexation has been on a moratorium since 2013. • The state DOT is plugged in to the land use-transportation connection. They have recently (2012) completed a study with Smart Growth America of land use-transportation connection. Current conversation is on how to put talk and ideas into action. • In order to replace the state planning office capacity, TDOT has assigned 1-2 land use planners to each of their four geographic divisions.
Texas	0	• There do not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Texas. • Texas is a home rule state. Local governments are authorized to plan but there is no requirement to do so. • Some individual cities such as Austin have instituted some smart growth-like policies.
Utah	1	• While there is no state plan or planning office there is a state planning coordinator (operating under the Governor's office) whose job it is to work with local and regional governments on Quality Growth Strategy, and to be a resource on planning issues. • The Utah Quality Growth Act in 1999 enables recommendations (not regulatory) authority by the state. Under the Governor's Office of Management and Budget, the Utah Quality Growth Commission provides technical assistance, guidance, and recommendations. It is somewhat similar to Ohio's Balanced Growth program. Communities who plan are certified as Quality Growth Communities, and then are eligible for preferred access to funding sources for development and conservation, and favorable points on loans, etc. Recommended planning principles are more limited, focused on fiscal alignment and fiscal responsibility, efficient use of infrastructure, broad "conservation ethics," and a variety of choices in housing and transportation. • In general, local communities, and regional and state agencies are reactionary rather than strategic/regulatory. • Envision Utah is a private nonprofit that has worked on regional visioning and scenario planning since 1997. Various regions have had scenario plans developed (especially the Wasatch region), and pioneered these ideas for the country. • Land use control is at the local level: Cities, towns (small cities, same authorities), and counties have all land use regulatory authority. • Generally, urban areas in the state are booming, and the economy is strong. • Transit is coordinated under one agency, the Utah Transit Authority (UTA). The first commuter rail line opened in 2012 and Bus Rapid Transit (BRT) is planned for the near future. UTA is proactive and getting involved in working with cities to encourage densification near rail lines.

STATE	TIER (as of 2014)	COMMENTS
		• Water is probably the largest potential limiter of growth for the long run. Urban areas are in the Great Basin (Great Salt Lake) while water is in the Colorado River Basin across the Wasatch Mountains. Water must be transferred across. • Open space programs exist, but the largest owners of open land are US Bureau of Land Management and US Forest Service. So far this has not been a limitation on growth. • Every city has provisions for impact fees. They do not influence growth patterns, as the builders just pass them on to the buyers.
Vermont	2	• In the 1970s the state passed Act 250, "Vermont's Land Use and Development Act." It created nine District Environmental Commissions made up of lay citizens. It looks at 10 criteria in reviewing development and subdivision plans that have a significant impact on the environment. Some of the impact criterion to be considered in granting permits to build includes, water and air pollution, soil erosion, traffic, anticipated costs of public facilities, and educational services. Commercial or industrial purpose construction taking place on more than 10 acres, of 10 or more houses (outside of downtown) within a five year period and within five miles, and construction above 2,500 feet in elevation, are some of the projects requiring Act 250 approval. Approximately 98% of the applications are approved. "Vermont's experience has shown that protecting environmental integrity and the strength of communities benefits everyone, forming a strong basis for both Vermont's economy and its way of life" ("Act 250" Brochure, revised 2006). • Act 200, also known as the Growth Management Act was enacted in 1988. The mechanisms were established to provide coordination both horizontally (between state agencies) and vertically (between local, regional and state levels). Act 200 includes "Process Goals" such as "consider the use of resources and the consequences of growth and development for the region and the state, as well as the community in which it takes place," and "Planning Goals" such as, "To plan development so as to maintain the historic settlement pattern of compact village and urban centers separated by rural countryside" ("Status Report: 15 Years After Act 200"). Act 200, though broad in its goals, does not appear to engender strong statutory mandates for smart growth-like development. • The Legislature has set up programs encouraging compact growth. Although VTrans, the Vermont Agency of Transportation, has no smart growth-like mandates they do sit on boards that are tasked with promoting these compact growth programs (which include some incentives). • In 2008 The Climate Change Action Plan was passed. A "Cabinet" was formed and they are charged to implement policies, some of which could include smart growth-like policies. • Vermont, along with other northeast states has been working on a "cap and invest" for transportation fuels policy that is similar to California's. In theory this would bring a more sustainable transportation policy that reduces Greenhouse Gases.

STATE	TIER (as of 2014)	COMMENTS
Virginia	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Virginia. • We were informed that "by and large, the state is very deferential to local planning decisions. The local plans rule the day." And, although the governor has stated he is in favor of smart growth, there have not been indications of any executive orders.
Washington	3	• The Growth Management Act of the 1990s put multiple policies in place that promote smart growth-like policies. • Some of the above policies include: comprehensive plans being required for cities and counties over a certain size and/or growth rate; special purpose districts such as infrastructure districts; and mandating that city plans must be consistent with counties, with state Growth Management Guidelines, and with other jurisdictions. • Plans are reviewed by the state's Office of Growth Management (within the Department of Commerce). Plan requirements include urban growth areas (UGA), and conservation of resource lands. UGAs are a big part of the policy with the size of areas determined by 20-year growth projections. Annexations or extensions of improvements are not allowed outside of UGAs. • The state has detailed planning/development guidelines for state agencies and authorizes development rights, easements, and impact fees. • These policies have been in place a long time and have had a definite effect on growth patterns. Larger counties must do Buildable Land Reports, which includes an assessment of the effect of the program. • Local government services are provided by the Municipal Research and Services Center (MRSC), a nonprofit based in Seattle that works under agreement with state government.
West Virginia	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of West Virginia. It is a strong property rights state, and we have been informed that congestion is not a problem in a state of only 1.8 million people.
Wisconsin	1	• There is no statewide plan. In 2010 the requirement for mandatory local comprehensive plans (only if changes are made to zoning or land use plans) with required elements and consistency went into effect. It was adopted in 1999, but communities were given 10 years to comply. However plans can promote either sprawl or smart growth-like development. There is no indication of intent beyond broad goals in the law that are generally not enforceable. Also, there is no consequence or recourse for noncompliance except legal action, and to date there have been no legal challenges. The Comprehensive Plan law is supported by realtors, builders, and environmentalists, but is still subject to regular attempts in the legislature to weaken/strip it. • The Department of Administration provides technical assistance funding for local planning, resources and guidelines. It supports conservation development and brownfields initiatives. • A key operative influencing growth patterns is a comprehensive planning grant

STATE	TIER (as of 2014)	COMMENTS
		program, in effect from 1999 - 2010. Of 1,900 local governments in Wisconsin, 1,000 of them have plans that were done with grants from the state. Compact development and other policies such as infill, revitalization, and resource conservation was encouraged as a condition of receiving funds. Grants ranged from $10,000 to several hundred thousand, based on population. There have been no funds for grants since 2010. • Wisconsin is a home rule state with counties (having a lot of jurisdiction over towns), “towns” (townships), and municipalities (cities and villages). Incorporated areas have much control over their own planning. • There is little application of other mechanisms such as impact fees. There is a requirement for utility boundaries in the comprehensive planning law, but this is generally not addressed well in local plans. A couple of towns have Transfer of Development Rights (TDR) programs but these are self-funded and very limited.
Wyoming	0	• Essentially there does not appear to be any type of smart growth-like incentives, mandates, promotion or statewide agency coordination around the issue by the state of Wyoming.

8.2 SUMMARY OF FOCUS AREA MSAs

CONTEXT

This is a working document that was used by team members to provide context in discussions of policy, determining tier designations, and synthesizing data analysis results. It was built using web research, as well as information request calls to numerous agencies. See the references section for web sites accessed. Agencies contacted are noted under each state and MSA.

POLICY TIER DEFINITIONS

A policy tier designation was assigned to each state for state policy, and to each focus area MSA for its state, regional and local policy. The policy tiers were intended to indicate in a general way the policy framework that was at work in the MSA for the period 2000-2010. For more discussion see the main body of the report, 3.3 Methodology.

Each MSA's assigned Tier, and background information on the Tier decision, is included here. For more detailed information on each state, see the previous appendix 8.1, State Programs Summary.

"Balanced Growth-Type" Land Use Patterns include compact development, an emphasis on infill before expanding infrastructure, and activity-centering for land uses around nodes (nodal rather than linear). Walkable block patterns, and complete streets are sometimes present as well. Note that policies related to mandatory planning, while requiring political will, are not in and of themselves BG-type programs.

Tier 0: No known land-use-related policies or programs in place that are intended to encourage/mandate BG-Type land use patterns.

Tier 1: Incentives and resources provided only; encouragement of BG patterns through program incentives, technical assistance, education, provision of resources, and streamlined approval processes. Can be done now by Ohio, with no additional funding, legislation, state-level political will, or significant administrative change – mostly involves state and/or regional government action via incentives, technical assistance, etc.

Tier 2: State agencies align their policy to encourage investment and review of state/local action to align with BG-type patterns. Includes state-designated priority areas for capital improvements, infrastructure expansion, without legislation requiring implementation of BG-type patterns by local government. In Ohio, would require new state-level administrative policy, such as funding/staff reallocation, new agency collaboration, new eligibility rules for participation/funding; mostly state agency rules/implementation.

Tier 3: State actively mandates BG-type growth patterns on the part of state, regional and local government. Usually a state planning office is involved, requiring compliance with a state set of planning rules that mandate BG-type patterns. Requires significant funding, legislation, or political will at the state level.

OTHER MEASURES NOTED

Sprawl Index
Sprawl index ratings noted were from Ewing, 2014. Index ranges from 1 to 200; lower number indicates less sprawl; 1998 index rated 83 MSAs nationwide; 2014 index rated 221 MSAs (not necessarily overlapping). Index is a composite of many scores related to land use, street and development patterns.

Population Densities
Population density is given two ways: "Overall" signifies the overall land area of the MSA. "Center" gives the net density in areas of the MSA that are more than 100 people per square mile, excluding the most rural and outlier parts of the MSA. Both measures exclude large water areas.

High = over 1000 people/sq mi
Med High = 500-999 people/sq mi
Med Low = 200-500 people/sq mi
Low = less than 200 people/sq mi

Governments
This summary includes a general attempt to indicate the jurisdictional environment in each MSA. There was no comprehensive source or list of governments in each MSA, and a methodical count was not done, so this information is likely not complete or accurate.

SOURCES

Maps
These were intended to be quick maps to give a sense of geographic context. Included are snapshots from the US Census web viewer, and from Google Earth. Maps sources: MSAs: http://tigerweb.geo.census.gov/tigerweb/ ; State Location "Key" Maps: Wikipedia (for convenience) where available. Aerial photographs: Google Earth.

NOTES ON FUNDING LIMITATIONS

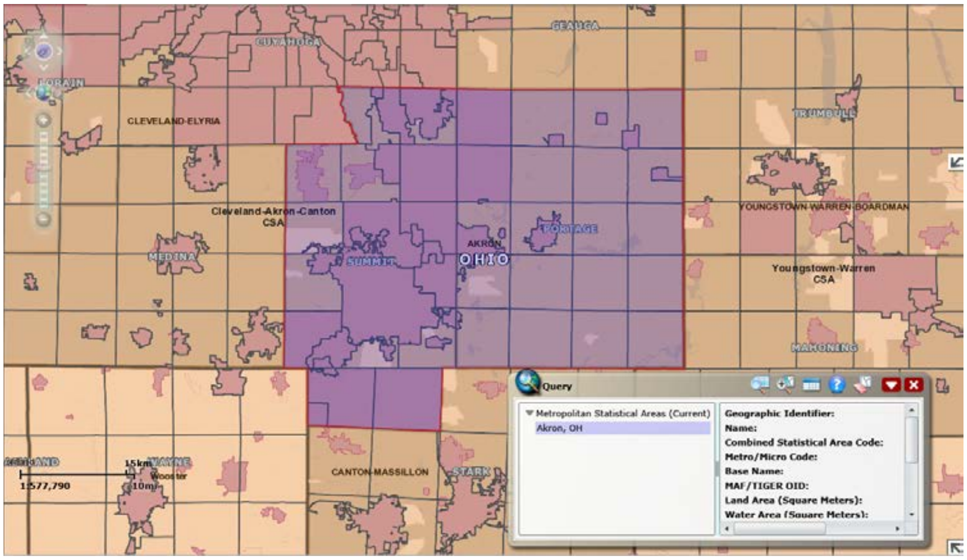
Many of the MSAs, particularly those in the Northeast and Midwest, have experienced significant constraints in public funding since 2006. In many of these areas, "Fix It First" policies, and/or sheer lack of funding for new transportation and infrastructure projects, have effectively limited expansion of development into new areas. While these are not intended as Balanced Growth-Type programs, and are not identified as such in this analysis, they do have the potential to influence and explain increased densification/infill development in existing areas, and are so noted in the policy summaries.

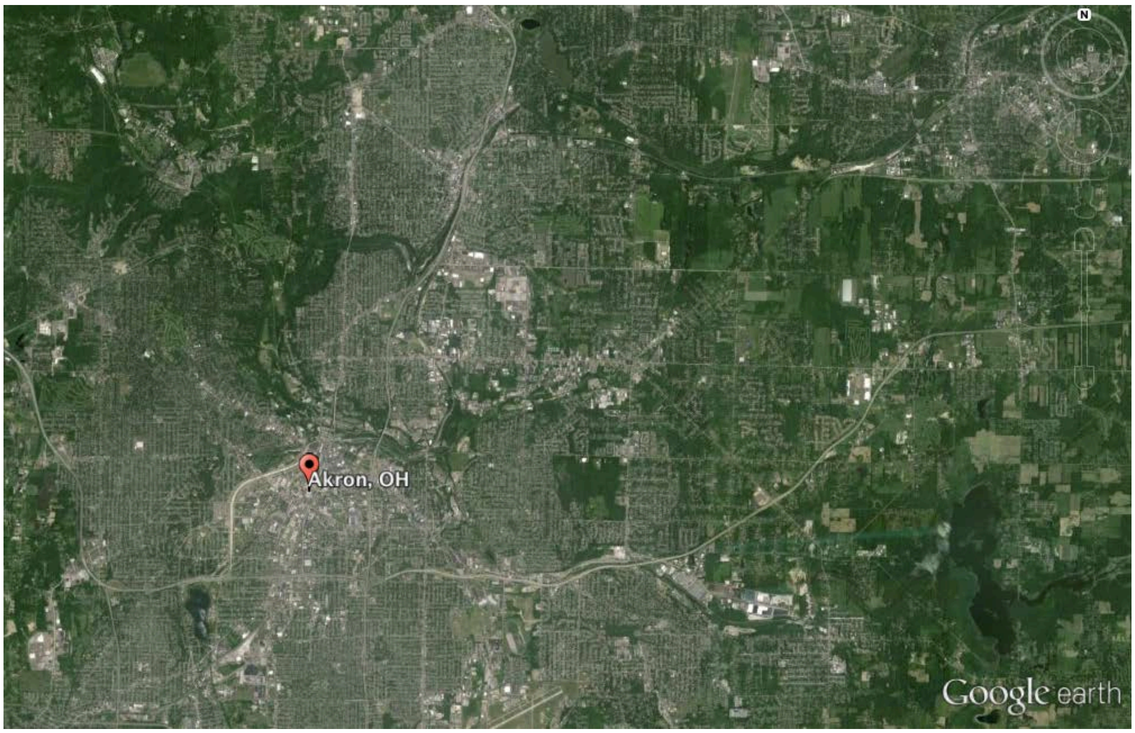
OHIO

AKRON PMSA, OHIO

MPO: Akron Metropolitan Area Transportation Study (AMATS)

Location: see green area in first map, purple area in second map.



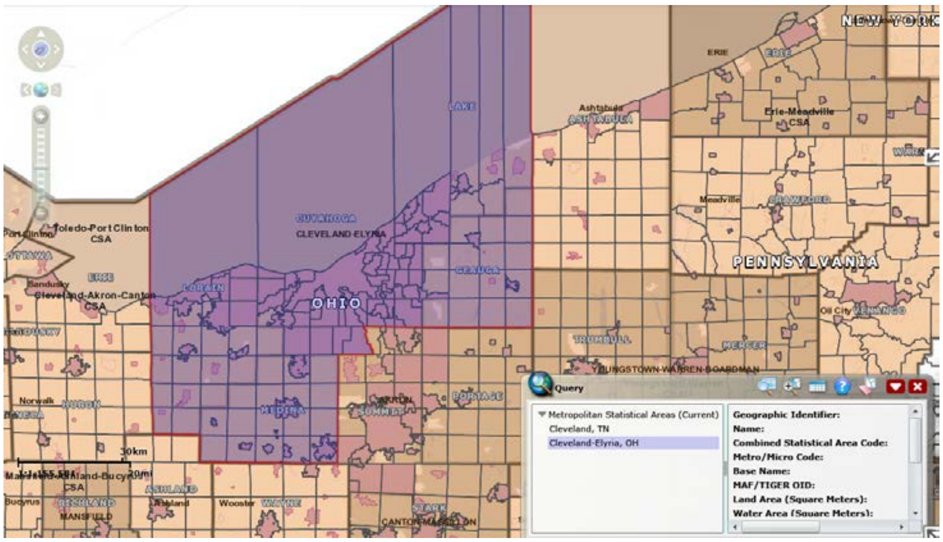


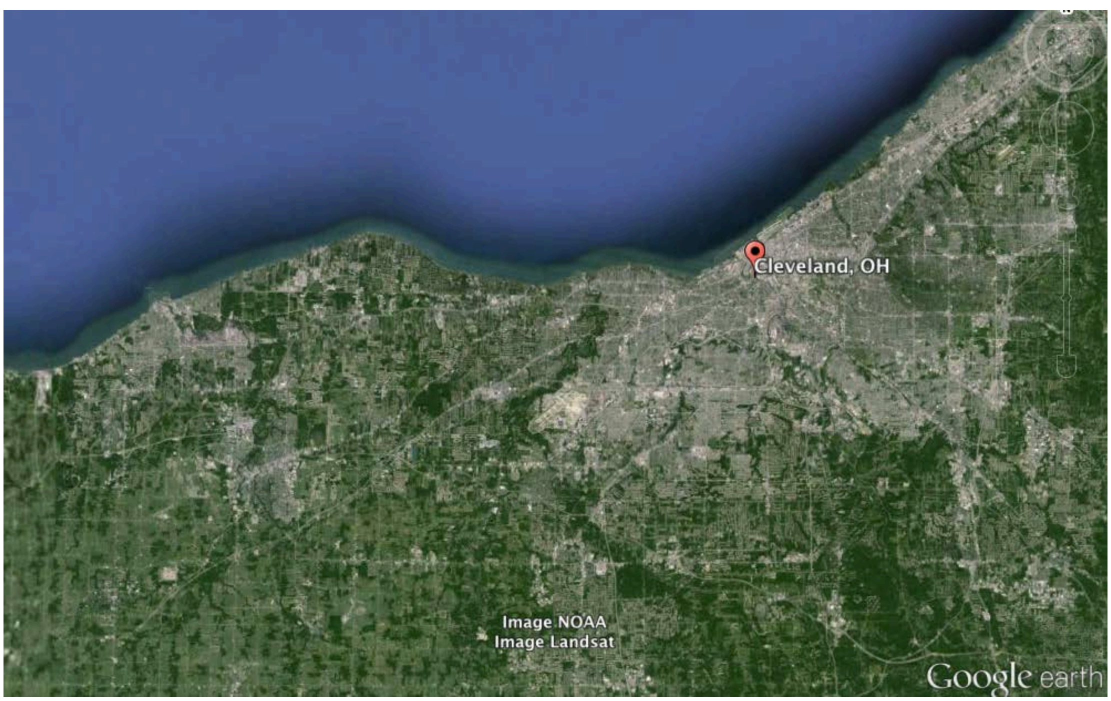
- 2010 Tier Designation: Tier 0 based on state. Ohio Balanced Growth Program implemented beginning in late 2009, and is not included in the Tier designation for this study.
- Land area: 2 counties, (Summit and Portage). 900 sq mi.
- Pop Density: Overall 781/sq mi. (Med-Hi); Center 815.97 (med-hi)
- Urban location: Part of larger CSA 3.5 million (Cleveland-Akron-Canton area). NE Ohio. Industrial valley. Akron is seat of Summit County, Ravenna is seat of Portage county.
- Population 2010: 703,200; % Pop change 1990-2010 6.94%
- Govts: 2 counties; 1 large city (Akron, county seat), pop. 198,549 2012; 5 cities 25-50,000; 15 communities with 10-25,000; 42 communities with under 10,000.
- Households 2010: 285,003; % change since 1990 14.35%.
- GDP 2010: $27.27B; % change since 1990: 26.15%; Per capita DP 2010: $38,790

- Sprawl Ranking 1998: 105.8; 2014: 103.85
- Region-specific programs/laws in effect: None. Cleveland and other cities have some compact development/form-based codes. Funding limitations (see notes above).

CLEVELAND-ELYRIA MSA, OHIO

MPO: Northeast Ohio Areawide Coordinating Agency (NOACA)



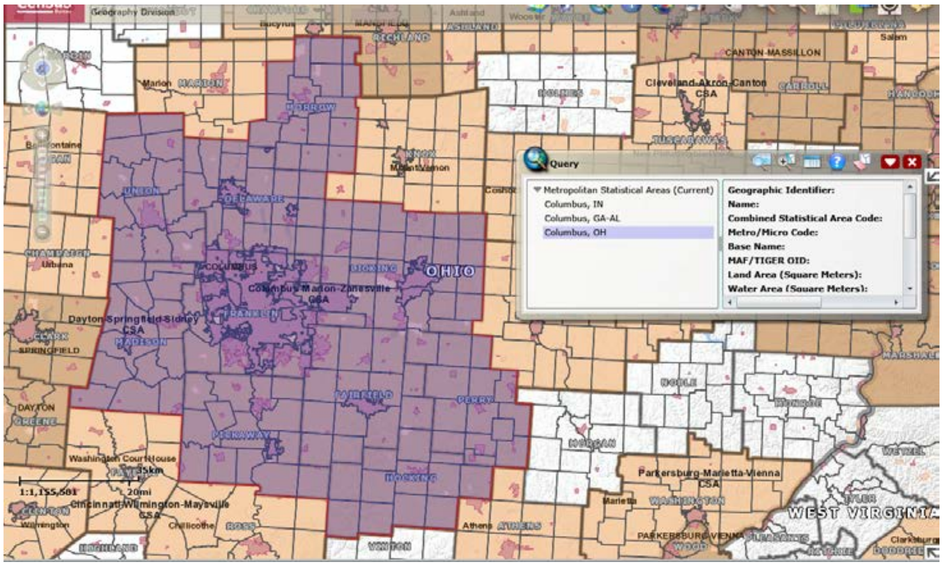


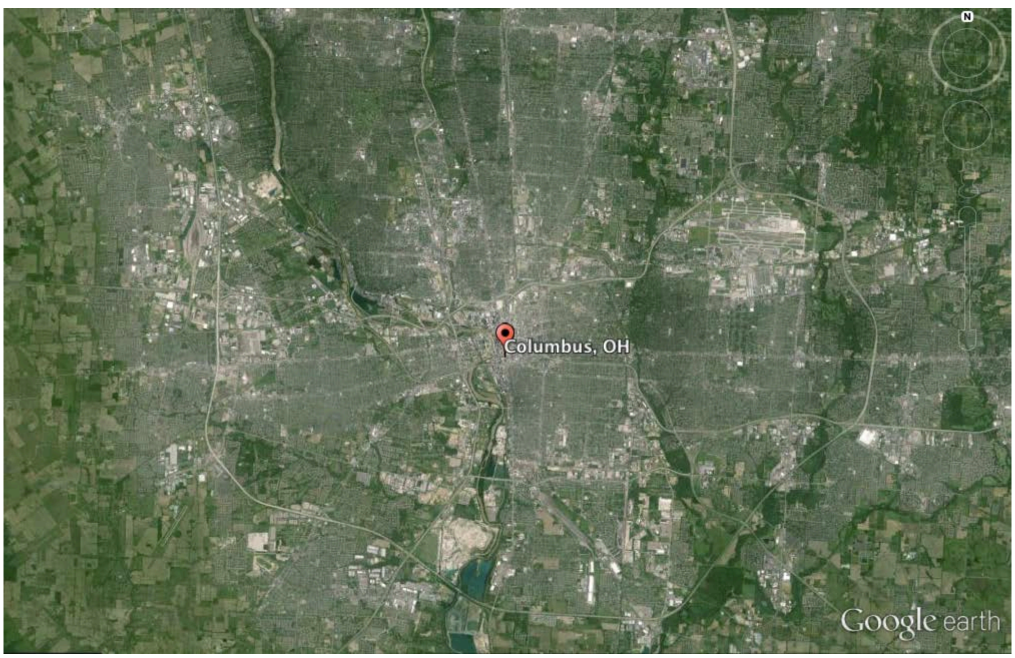
- 2010 Tier Designation: Tier 0 based on state. Ohio Balanced Growth Program implemented beginning in late 2009, and is not included in the Tier designation for this study.
- Land area: 5 counties, (Lorain, Medina, Cuyahoga, Geauga, Lake) 1997 sq mi;

- pop density overall: 1040/sq mi (High); center 1201 (High)
- Urban location: along Lake Erie; central city of NE Ohio, overall CSA 3.5 million (Cleveland-Akron-Canton).
- Region-specific programs/laws: Funding limitations.

COLUMBUS MSA, OHIO

MPO: Mid-Ohio Regional Planning Commission (MORPC)



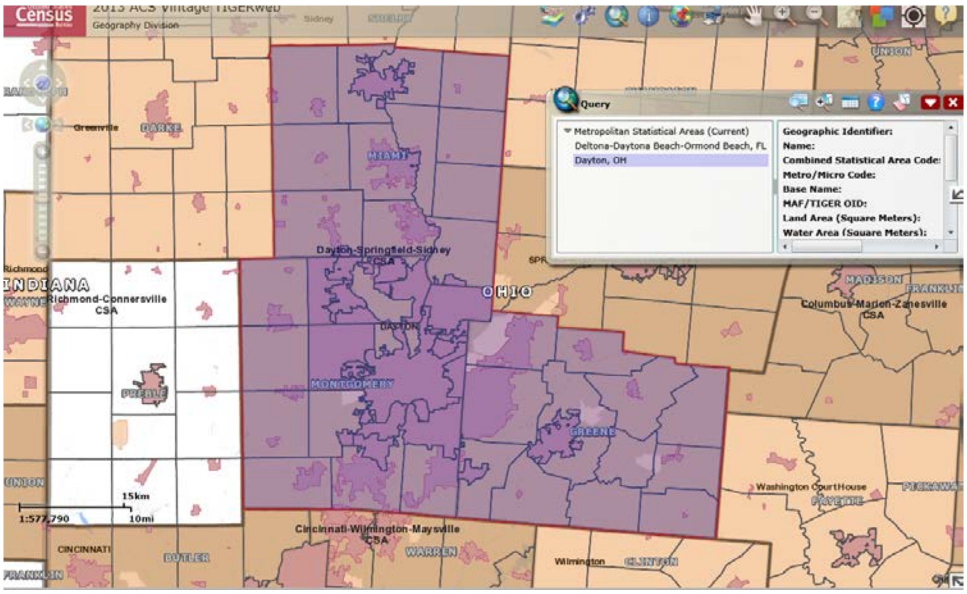


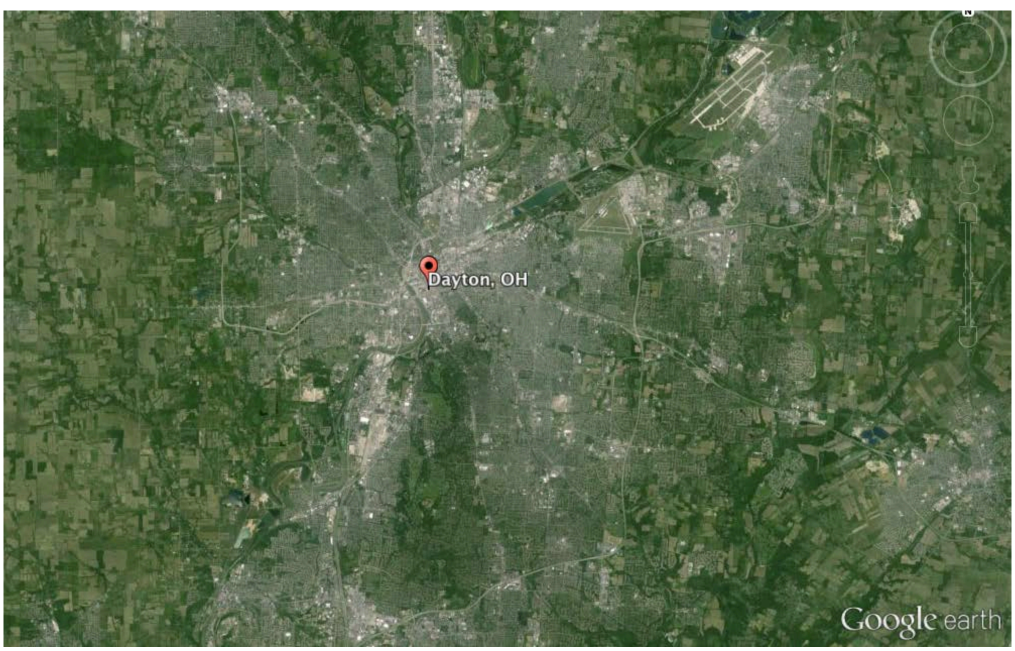
- 2010 Tier Designation: Tier 0 based on state. Ohio Balanced Growth Program implemented beginning in late 2009, and is not included in the Tier designation for this study.
- Land area: 10 counties (Delaware, Fairfield, Franklin, Hocking, Licking, Madison, Morrow, Perry, Pickaway, and Union), 4796 sq mi
- pop density overall: 397/sq. mi. (Med-Low); central 959 (med-hi)

- Urban location: central city in sprawling Central Ohio; State capital. Surrounded by farmland.
- Population: % Pop change 1990-2010
- Govts: 30 cities, 76 villages, at least 86 townships/communities/census-designated places
- Region-specific programs/laws: Funding limitations (see notes above).

DAYTON MSA, OHIO

MPO: Miami Valley Regional Planning Commission (MVRPC)



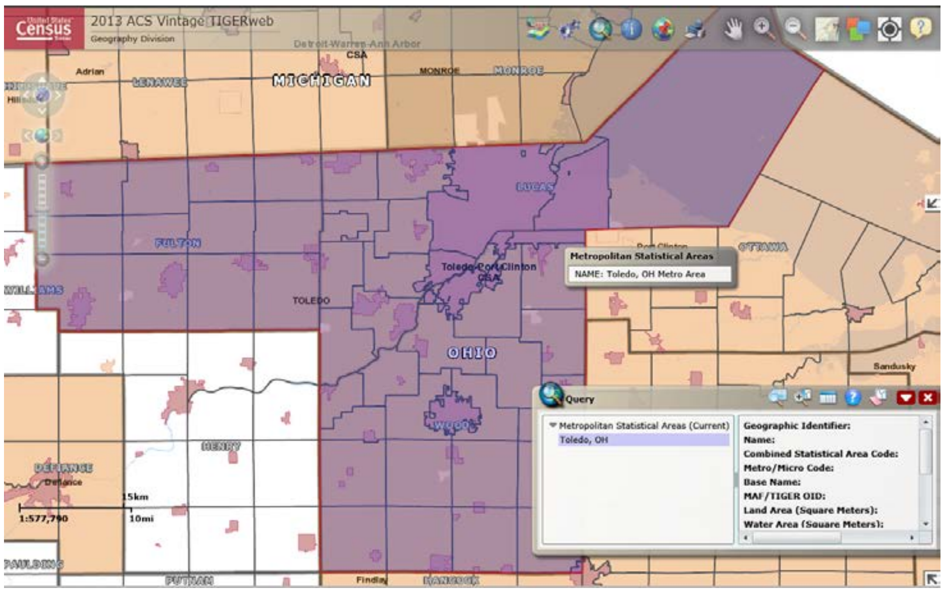


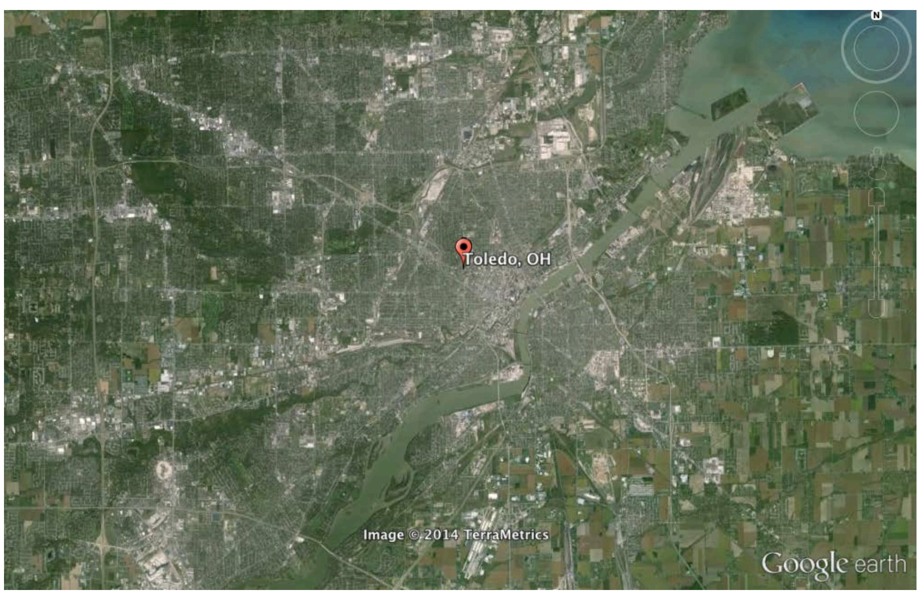
- 2010 Tier Designation: Tier 0 based on state. Ohio Balanced Growth Program implemented beginning in late 2009, and is not included in the Tier designation for this study.
- Land area: 1282 sq mi; 3 counties (Montgomery, Greene, Miami)
- pop density overall 623/sq mi.(med-hi); central 876 (med-hi)

- Urban location: Western Ohio, near Indiana border. Major air force base.
- Govts: 4 cities over 30,000; 38 other municipalities; 33 townships
- Region-specific programs/laws: Funding limitations (see notes above).

TOLEDO MSA, OHIO

MPO:
Toledo Metropolitan Area Council of Governments (TMACOG)





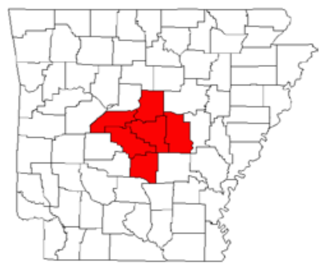
- 2010 Tier Designation: Tier 0 based on state. Ohio Balanced Growth Program implemented beginning in late 2009, and is not included in the Tier designation for this study.
- Land area: 3 counties (Fulton, Lucas, Wood) Land area 1363 sq mi;
- pop density overall 447/sq mi (Med-Low); central 893 (med-hi)
- Urban location: On Lake Erie at western edge; Maumee River drains large agricultural area; old industrial city.

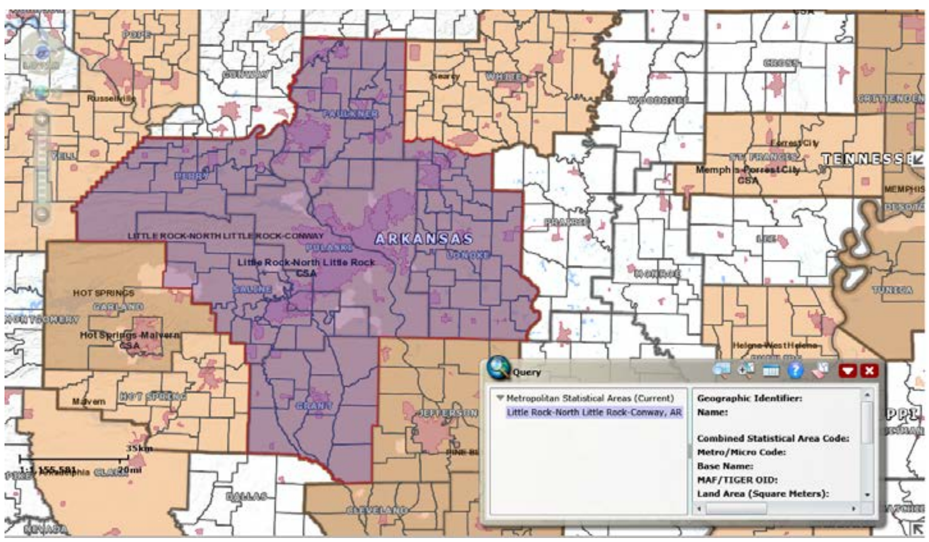
- Govts: 50 municipalities, 54 townships
- Region-specific programs/laws: Funding limitations (see notes above).

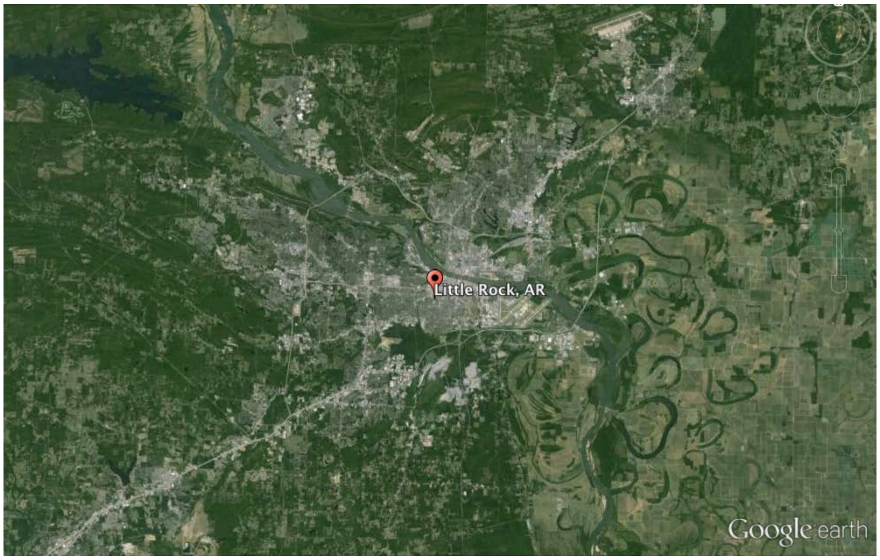
ARKANSAS

LITTLE ROCK-NORTH LITTLE ROCK-CONWAY MSA, ARKANSAS

MPO: Metroplan
www.metroplan.org





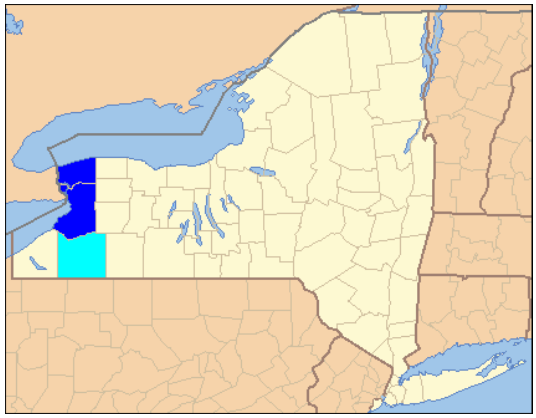


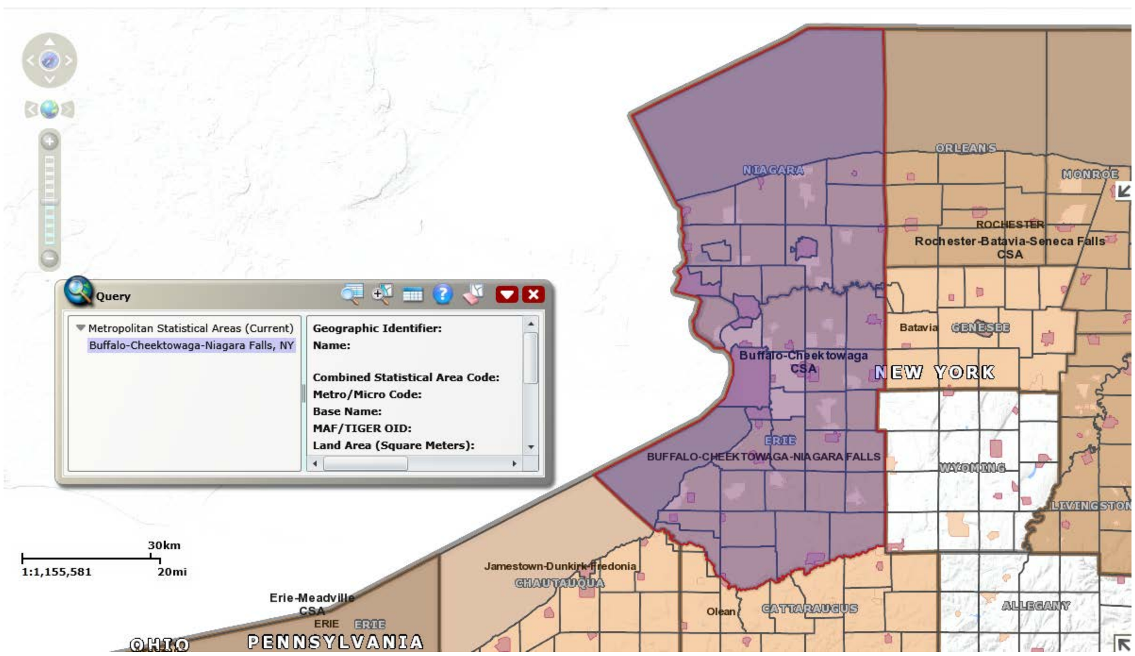
- 2010 Tier Designation: Tier 0 based on state Tier. (note historic patterns, not policies, that were highly dense and walkable).
- Land area: 6 counties (Pulaski, Faulkner, Saline, Lonoke, Perry, Grant), 4085 sq mi;
- pop density overall 171/sq mi (Low); central 555 (med-hi)
- Urban location: central state of Arkansas; state capital; largest city in state; also county seat, Pulaski County. Located on Arkansas River. Good business climate.
- Govts: 3 cities over 50,000; 6 places 10-50,000; 51 places under 10,000
- Region-specific programs/laws: MPO has official requirement that participating member communities must make decisions consistent with their master street plans, but not enforced. MPO is considered innovative, is attempting to address complete streets and recognize new market-driven models for development in their current Long Range Plan that is underway. Has a "Transit-Supported Vision Plan", possible future light rail corridor from east to west through residential neighborhoods and medical employment areas and downtown – much of Little Rock has densities that would support transit. No implementation yet. However, bow to economic development 'cartel", several outlying (30 miles) suburbs have freeway corridors leading to them, very expensive to build and maintain.
- Of note, Little Rock is historically a dense town, was one of the most dense/walkable in the nation until 1970's. Is a pretty town with nice historic neighborhoods. In 1980's desegration led to ive white flight, town almost emptied out completely. Led to sudden expansion of suburbs. Lately "new millennials" have been coming back into city, development is expanding in some urban neighborhood "nodes" as a result.
- Also of note, Conway is relatively liberal city which has complete street/form based codes, is relatively dense, and walkable; one of the faster growing communities in the area; instituted impact fees in 2003 which greatly influenced development patterns. No other communities, including Little Rock, could do impact fees.
- No other policies such as farmland preservation, etc. May be some brownfield programs in cities.
- MPO has tried to encourage surface road widenings be limited to 4 lanes in order to be more pedestrian friendly, worked for a while, but has not been implemented consistently recently.
- Note newsletters on web site under "publications": includes analysis of density and impacts on transportation in 2008, 2011.

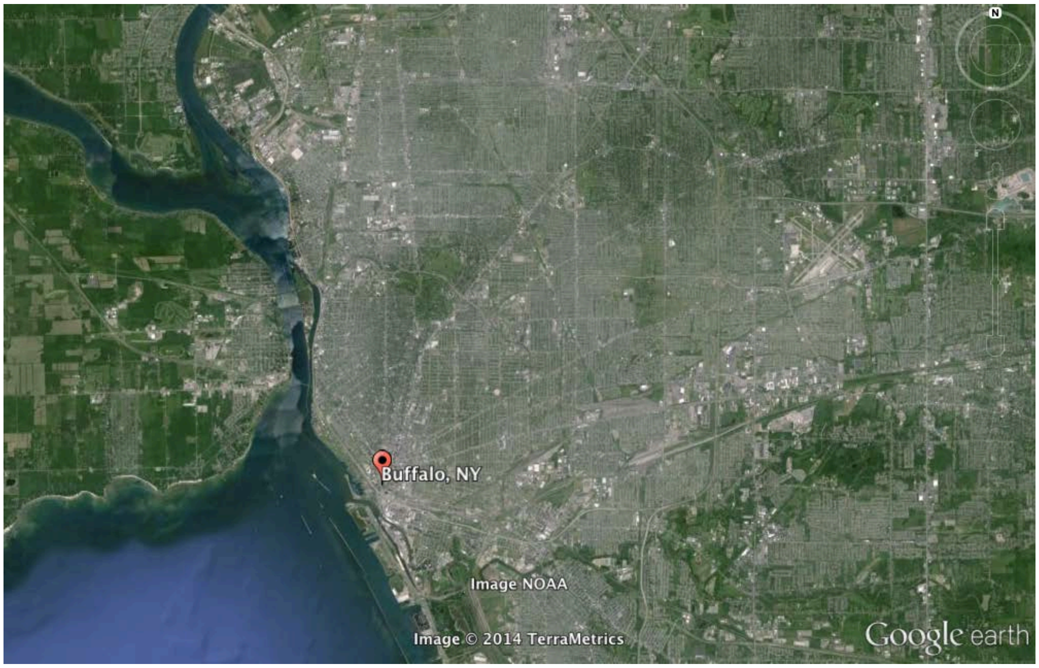
NEW YORK

BUFFALO-CHEEKTOWAGA-NIAGARA FALLS MSA, NEW YORK

MPO: Greater Buffalo-Niagara Regional Transportation Council
www.gbnrtc.org



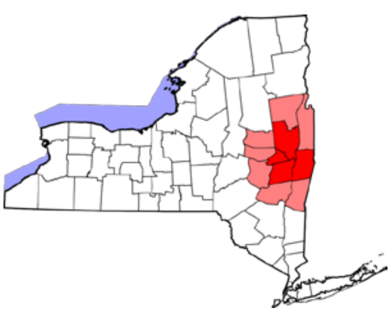


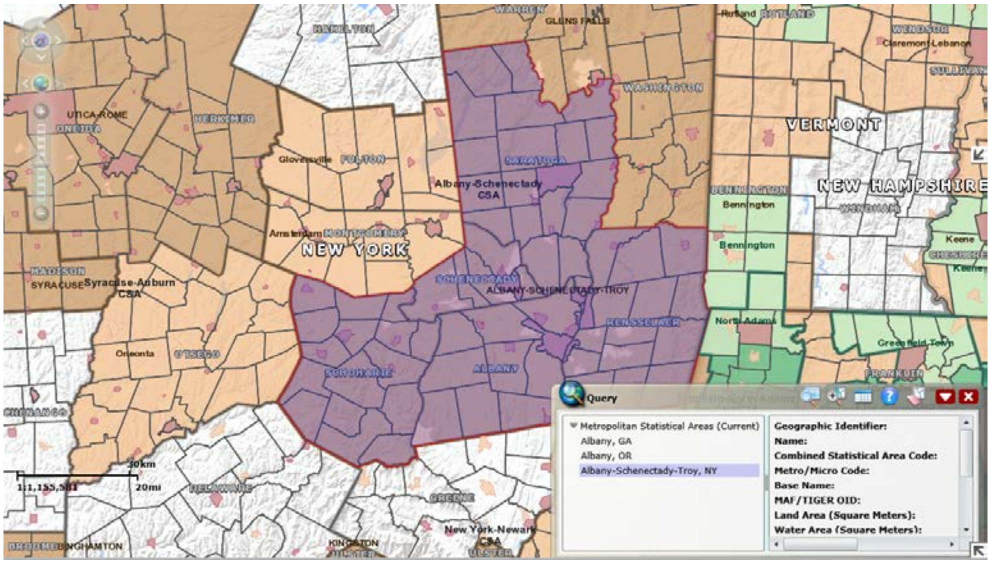


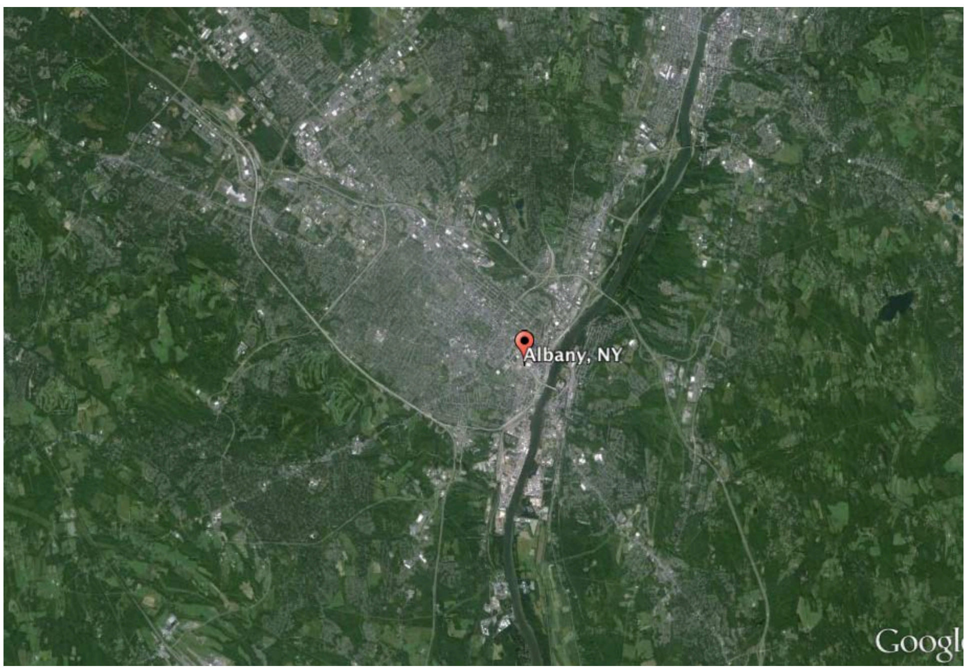
- 2010 Tier Designation: Tier 0, based on State Tier 2010.
- Land area: 2 counties (Niagara, Erie); 1565 sq mi;
- pop density overall 726/sq mi (Med-Hi); central 1097 (high)
- Urban location: on eastern shore of Lake Erie (Great Lakes); adjacent to Niagara Falls on Niagara River; 3 bridges connect to Canada. County seat, Erie County. Older heavy industrial/shipping city. Classically planned city (by FL Olmsted) with radiating parkway system, spectacular architecture in downtown, unique neighborhoods. Several key corporate headquarters.
- Govts: 7 cities, 37 towns, 21 villages, 19 CDPs, 3 indian reservations
- Region-specific programs/laws: more recent laws related to BG have been put in place at the state level.

ALBANY-SCHENECTADY-TROY MSA, NEW YORK

MPO: Capital District Transportation Committee (CDTC)
[www.cdtc**mpo**.org/](www.cdtcmpo.org/)







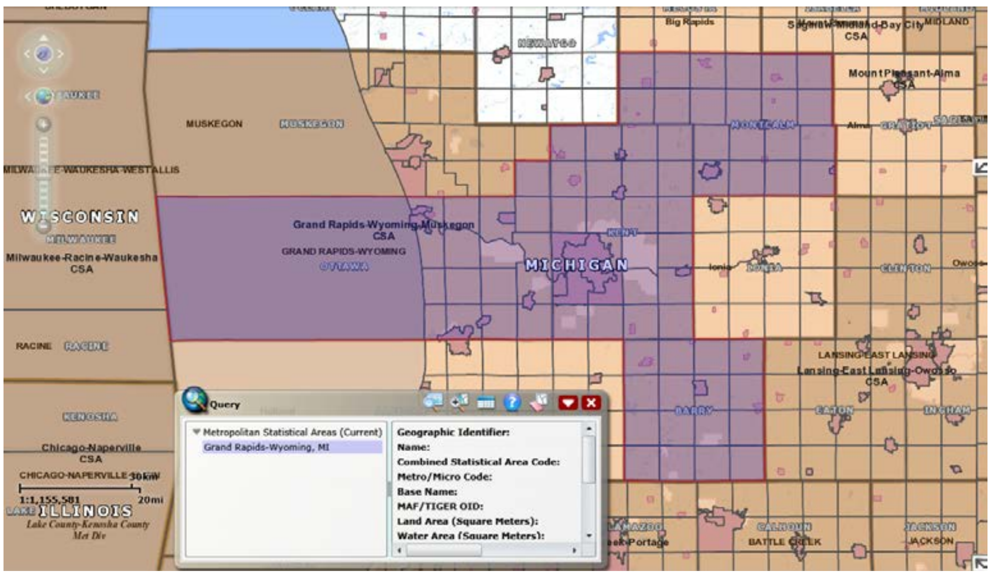
- 2010 Tier Designation: Tier 2. (regional policy requiring investment focus on priority areas)
- Land area: 5 counties (Saratoga, Schenectady, Albany, Rensselaer, Schoharie); 2812 sq mi;
- pop density overall 310/sq mi (Med-Low); central 710 (med-high)
- Urban location: Interior location on eastern NY state border, adjacent to CT/VT/NH/NJ; state capitol; county seat, Albany County. On west bank of Hudson River, near Schenectady.
- Govts: 4 cities, 78 municipalities
- Sprawl Ranking 1998: (score 83.4) 2014: 133 of 200 (score 95.12); streets index 2014
- Region-specific programs/laws: SINCE 1997, this MPO has had smart growth principles in its long range plan, requiring focus of investment on already developed areas. However has had little effect lately because there is no planned capacity expansion due to little funding.

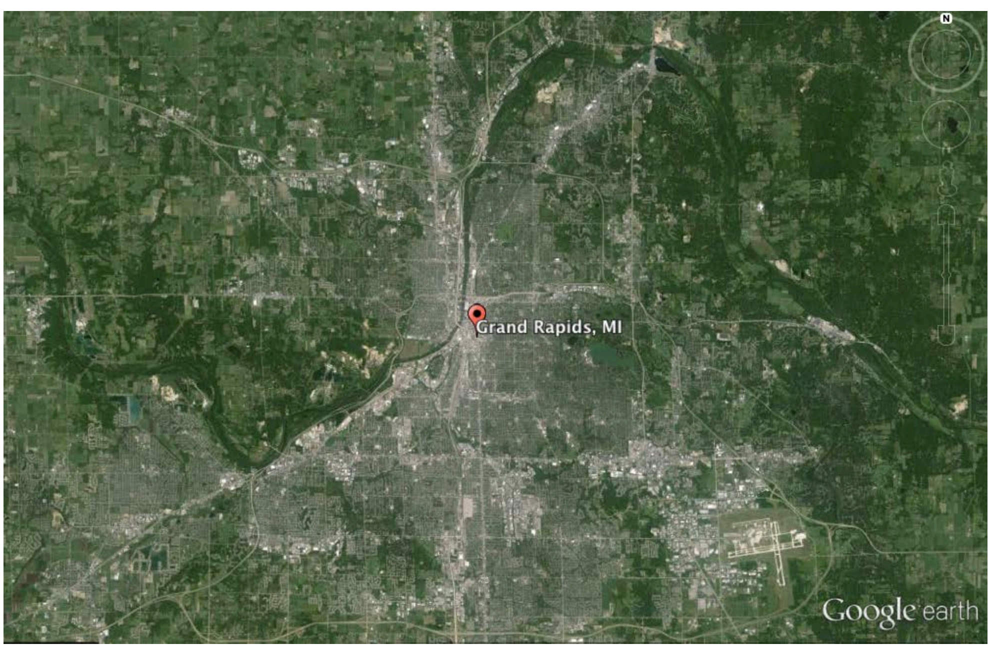
- Area is struggling, as NE Ohio; home rule communities compete for business, will incent businesses with tax abatement. No gas shale here, so little effect from that. However, 2010 census showed small growth in all 4 cities, first time in many years, reversing a long-time trend.

MICHIGAN

GRAND RAPIDS-WYOMING MSA, MICHIGAN
(no key map available)(located on east shore of Lake Michigan)

MPO: Grand Valley Metropolitan Council (GVMC)
[**http://**gvmc.org](http://gvmc.org)



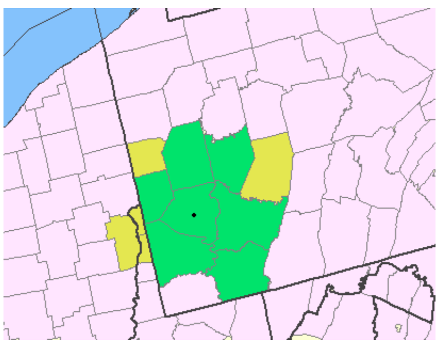


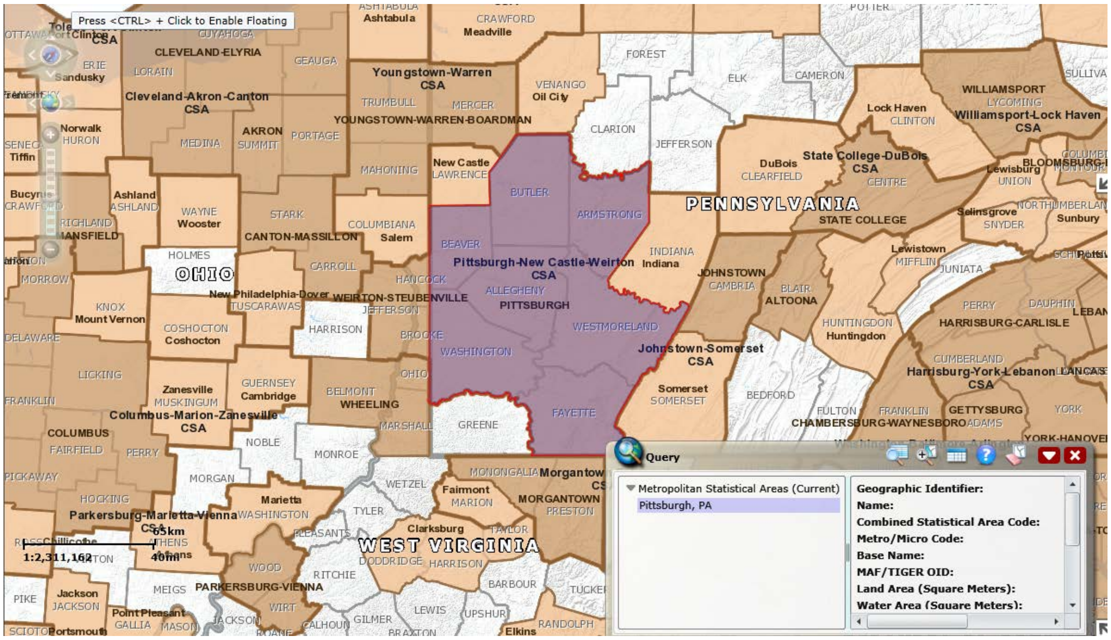
- 2010 Tier Designation: Tier 0, based on state Tier.
- Land area: 4 counties (Barry, Kent, Montcalm, Ottawa); 2669 sq mi;
- pop density overall 371/sq mi (Med-Low); central 621 (med-hig)
- Urban location: City is on Grand River, 25 mi east of Lake Michigan. MSA includes portion of the lake. City is county seat, Kent County.
- Govts: 2 cities over 50,000; 33 places 10-50,000; at least 170 place less than 10,000.
- Region-specific programs/laws: Little support at MPO level for land use or smart growth policy. Land use planning staff is no longer in place. However transportation planners meet with individual communities and encourage complete streets, smart growth/planning concepts implementation, and collaboration through information and technical assistance on a case-by-case basis.
- Kent County, pop 627,000, has no planning staff.
- Individual communities such as Grand Rapids and Wyoming (cities) do implement Smart Growth and complete streets, form based codes, etc in their own planning/zoning.
- It is important to note that between no population growth and no funding, there is no real capacity-building of transportation system in this area. Board decisions are all about allocation of scarce funding to maintenance projects. The last major freeway expansion piece was done with federal funding and finished in 2005.

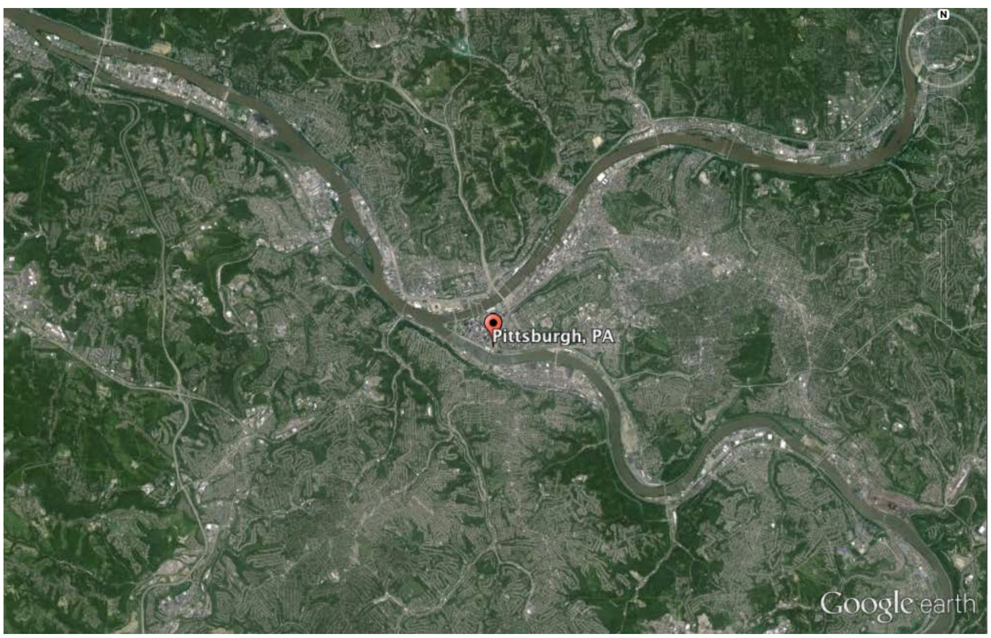
PENNSYLVANIA

PITTSBURGH MSA, PENNSYLVANIA

MPO: Southwestern Pennsylvania Commission (SPC)
Spcregion.org







- 2010 Tier Designation: Tier 1 based on state Tier.
- Land area: 7 counties (Allegheny, Armstrong, Beaver, Butler, Fayette, Washington, Westmoreland); 5281 sq mi;
- pop density overall 446/sq mi (Med-Low); central 677 (med-hi)
- Urban location: SW Pennsylvania, at confluence of Allegheny, Monongahela and Ohio Rivers. City has many bridges and rivers lined with old mills and manufacturing. Revitalizing old industrial city, many corporate HQ remain. Deep river valley terrain, with many small steel towns along the river in tributary valleys. Outlying commercial area developments often require massive grading and retaining wall work to achieve a flat area for shops/parking. City is county seat, Allegheny County. Second largest city in PA after Philadelphia.
- Govts: 19 cities, 240 boroughs, 203 townships

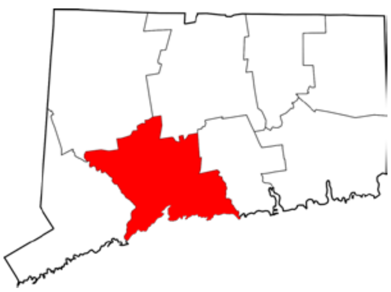
- Region-specific programs/laws: See notes about state in Appendix 8.1. No special smart growth type programs at MPO level, everything is at municipal level, with incentives provided by state. To MPO's knowledge, no significant smart growth efforts within its municipalities. Has 1 large city (Pgh) and 130 other municipalities.

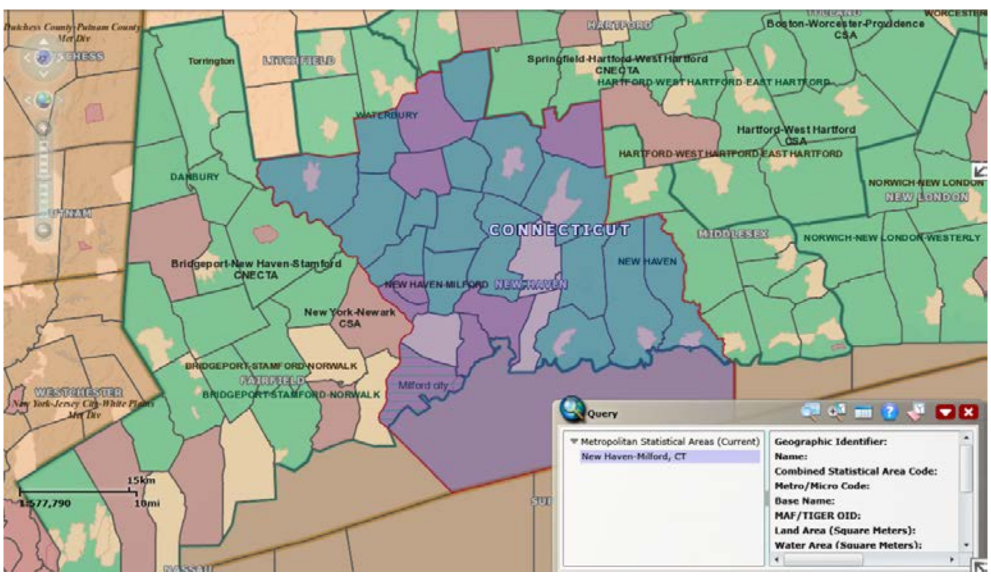
CONNECTICUT

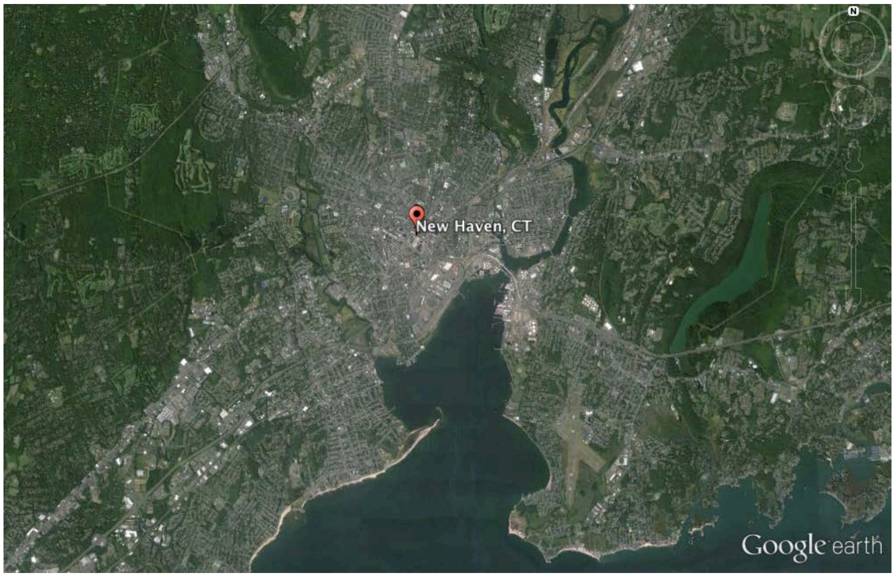
NEW HAVEN-MILFORD MSA, CONNECTICUT

MPO: South Central Regional Council of Govts
www.scrcog.org

Includes 15 towns, a subset of the MSA on the western end, including New Haven and Milford.





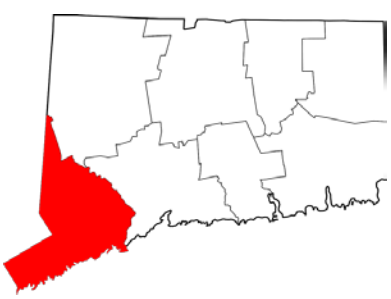


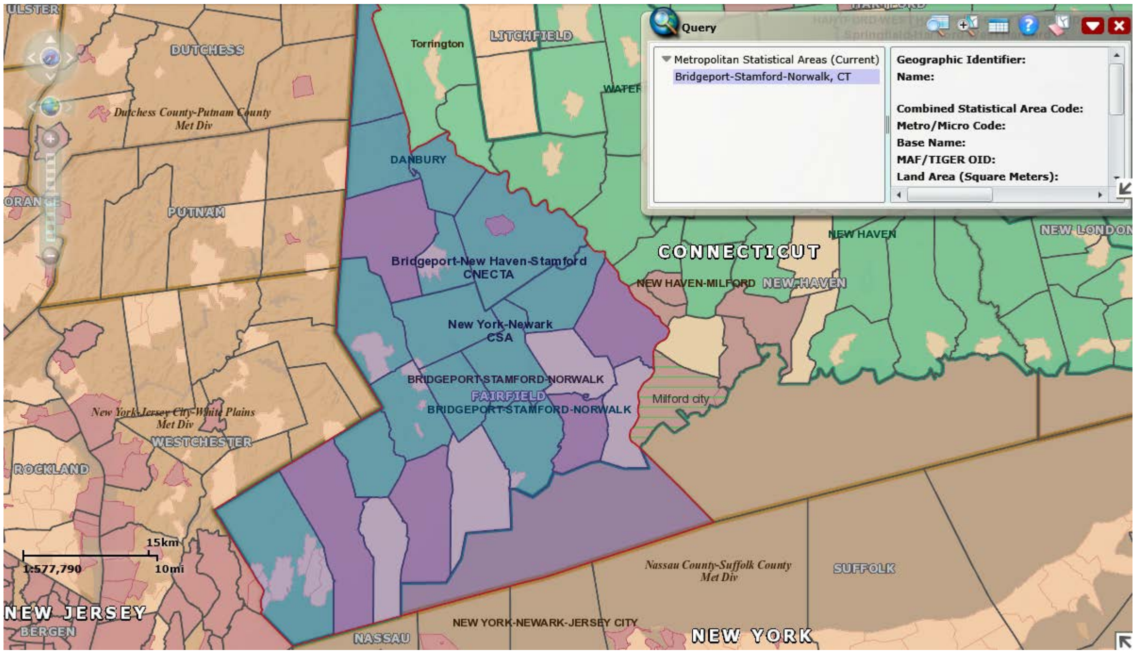
- 2010 Tier Designation: Tier 2 based on state Tier.
- Land area: 1 county (New Haven); 605 sq mi;
- pop density overall 1427/sq mi (high); central 1427 (high)
- Urban location: New Haven is second largest city in Connecticut; on northern shore of Long Island Sound; overall part of Greater New York metro area. Home of Yale university.
- Govts: 1 city, 27 towns
- Region-specific programs/laws: none beyond state regulations.

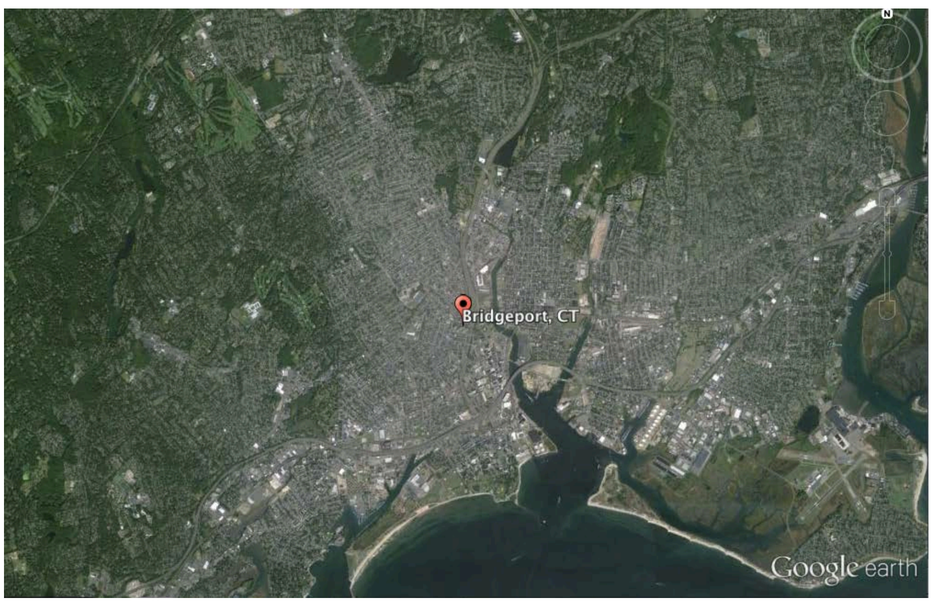
BRIDGEPORT MSA, CONNECTICUT

MPO: Greater Bridgeport and Valley Metropolitan Planning Organization (GBVMPO)
www.gbrct.org
Includes 6 Bridgeport area towns plus four in adjacent county to the east

plans/policies:
Locational Guide Map for region (2013-2018):
ftp://ftp.state.ct.us/pub/opmigpdata/cd_access/RPO_Pdfs/Greater_Bridgeport.pdf





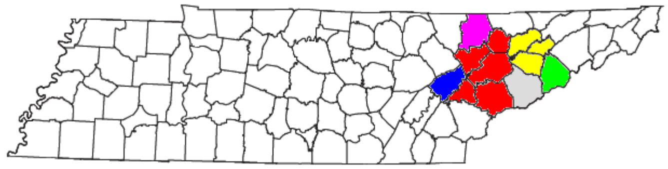


- 2010 Tier Designation: Tier 2 based on state Tier.
- Land area: 1 county (Fairfield); 625 sq mi;
- pop density overall 1467/sq mi (high); central 1467 (high)
- Urban location: Also on northern end of Long Island Sound; Bridgeport is largest city in CT; Stamford is third largest. part of overall NY metro area.
- Govts: two cities, 23 towns.
- Region-specific programs/laws: None beyond state programs.

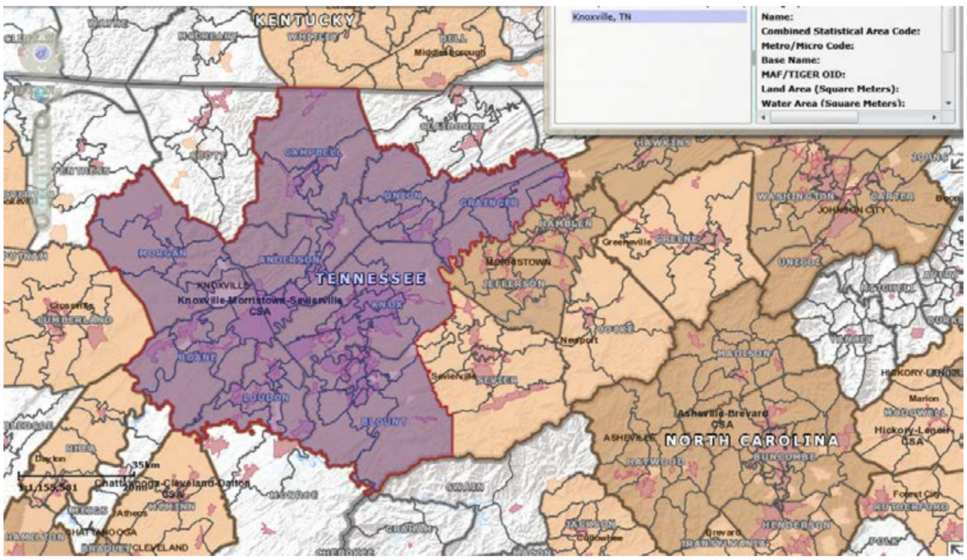
TENNESSEE

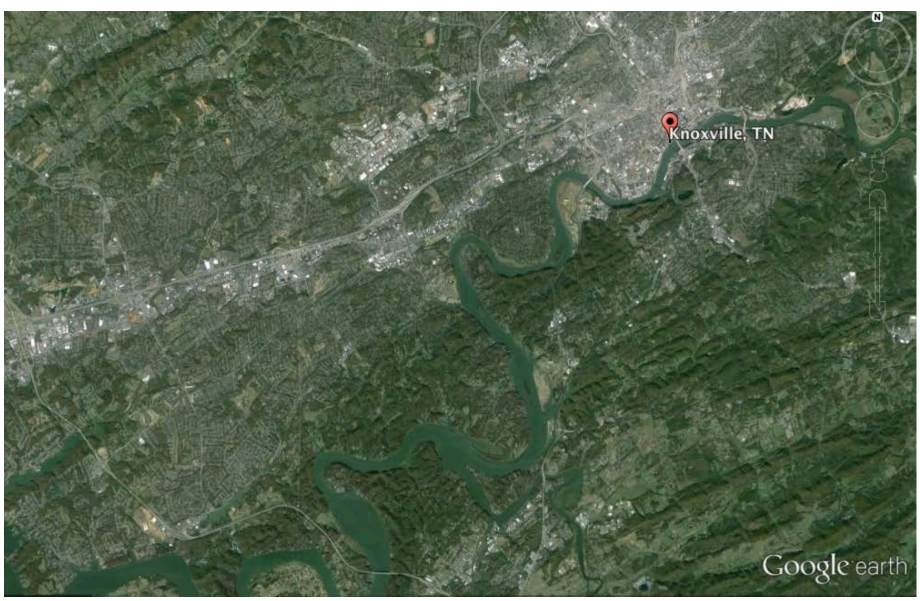
KNOXVILLE MSA, TENNESSEE

MPO: Knoxville Transportation Planning Organization (KTPO)
http://knoxtrans.org.



Note: Knoxville MSA is not accurate in this map; for key purposes only. See map below for correct counties.





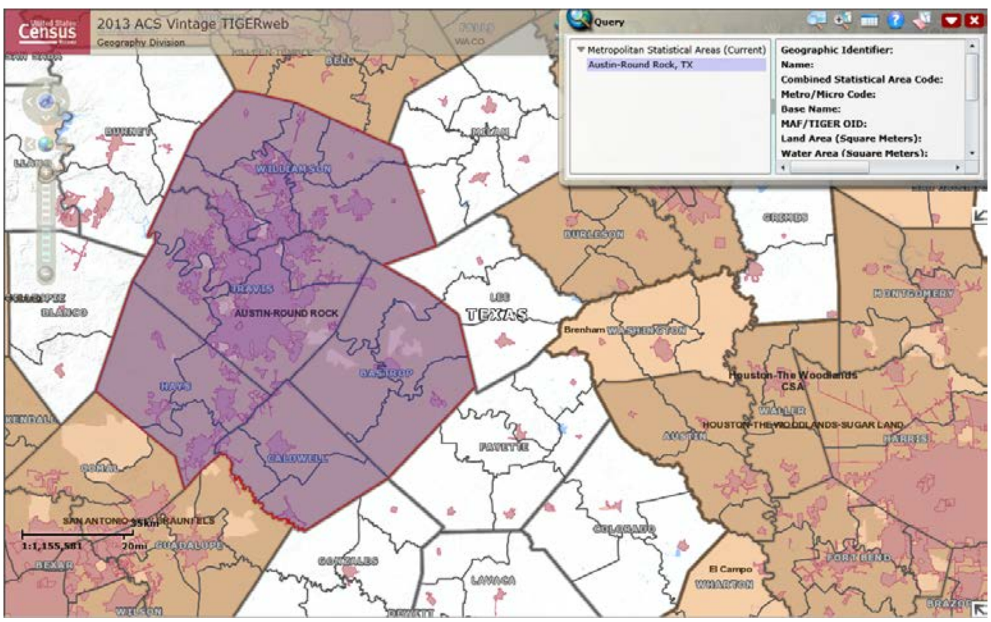
- 2010 Tier Designation: Tier 2 based on state Tier.

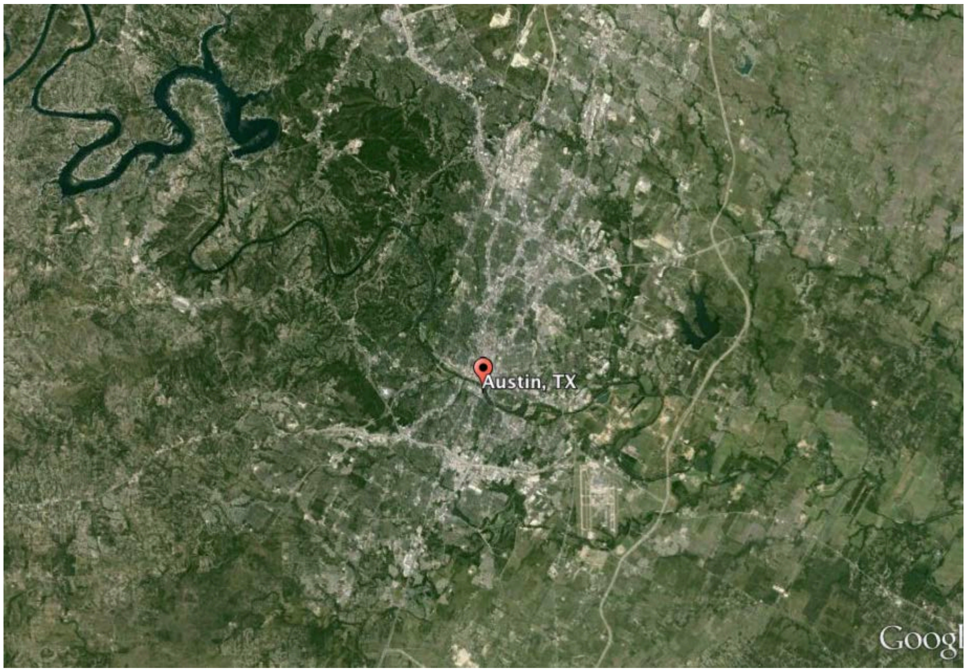
- Land area: 9 counties (Anderson,Blount,Knox,Loudon,Union,Campbell, Grainger, Morgan and Roane) 3501 sq mi; until ~2010 was five counties.
- Pop density overall 239/sq mi (med-Low); central 444 (med-low)
- Urban location: eastern end of state, in Appalachian mts, tourism a big factor, gateway to Smoky Mts National Park; county seat, Knox County; home of University of Tennessee. Located on the Tennessee River, in the Tennessee Valley.
- Govts: 1 city over 100,000; 6 places 10-32,000; 52 places under 10,000.
- Region-specific programs/laws: See state discussion in Appendix 8.1. In Knoxville area, Urban Growth Boundaries have been in place and effectively reducing sprawl, especially in Knox County, less so in other counties. Extensive open space easement program, and open space zoning, has been used. Area was a recipient of a US Sustainable Communities grant, has just finished in 2014. Is only a guide and resource, but is expected to influence transportation decision making going forward.

TEXAS

AUSTIN-ROUND ROCK MSA, TEXAS

MPO: Capital Area Metropolitan Planning Organization
Campotexas.org

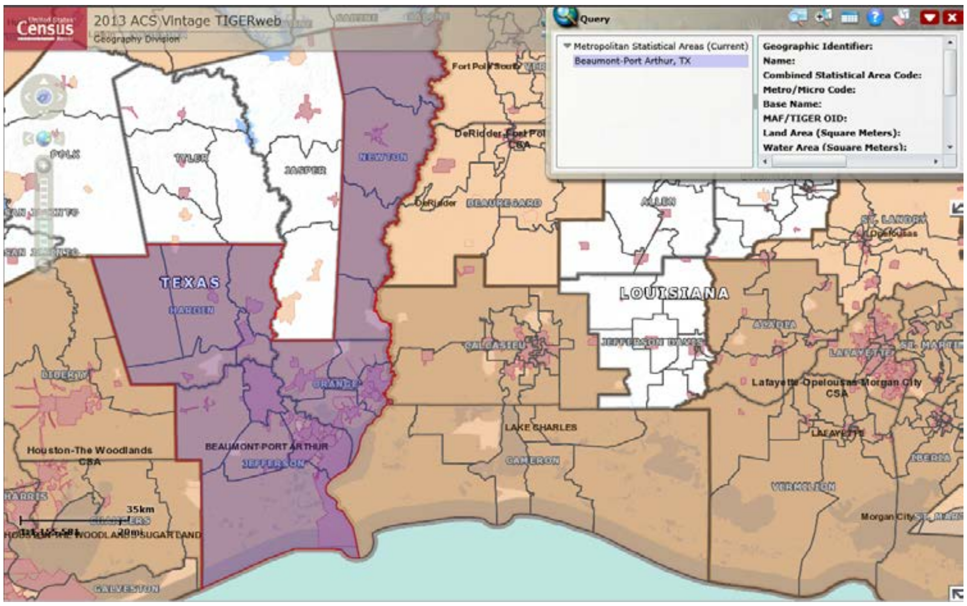


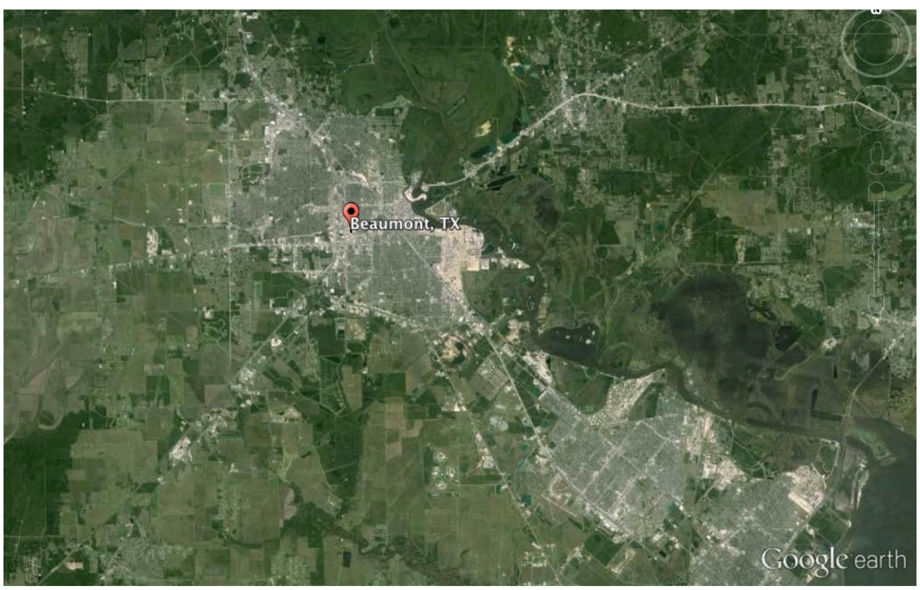


- 2010 Tier Designation: Tier 1 based on regional implementation (State Tier is 0). Note “Envision Central Texas” voluntary plan below. Note recent Austin plan is post-2010.
- Land area: 5 counties (Bastrop, Caldwell, Hays, Travis, and Williamson); 4220 sq mi;
- pop density overall 407/sq mi (Med-Low); central 926 (med-high)
- Urban location: Central Texas. State capitol, Travis county seat. Fourth largest city In Texas, second largest state capitol in US. University of Texas at Austin. Many corporate HQ. 160 mi south of Dallas, 75 mi n of San Antonio. Colorado River goes through city. Several lakes.
- Govts: 2 large cities plus 6 over 25,000; 14 places 5-25,000; 46 places under 5,000.
- Region-specific programs/laws: Austin, comprising a large part of the MPO area, is now a Level 3 Tier with recent serious smart growth policy. Recent plan approved with focus development areas, ecological/water recharge zones, controlled utilization of resources, focus on existing areas and infill. Headed to land development code rewrite in coming year, will likely include form based code and other smart growth provisions. Last plan before this was 1979.
- At MPO level, a privately funded and endorsed plan called “Envision Central Texas” was done in 2007-8. This included focus of investment on “centers”. This led CAMPO to include focus on centers in their decisionmaking, although it is “soft”, not codified in their regional long range transportation plan. CAMPO has tried to support development in regional centers by focusing 50% of some funding streams to those areas. Also has funded rail and bike path projects in those areas.

BEAUMONT-PORT ARTHUR MSA, TEXAS

MPO: Southeast Texas Regional Planning Commission (SETRPC)
http://SETRPC.org



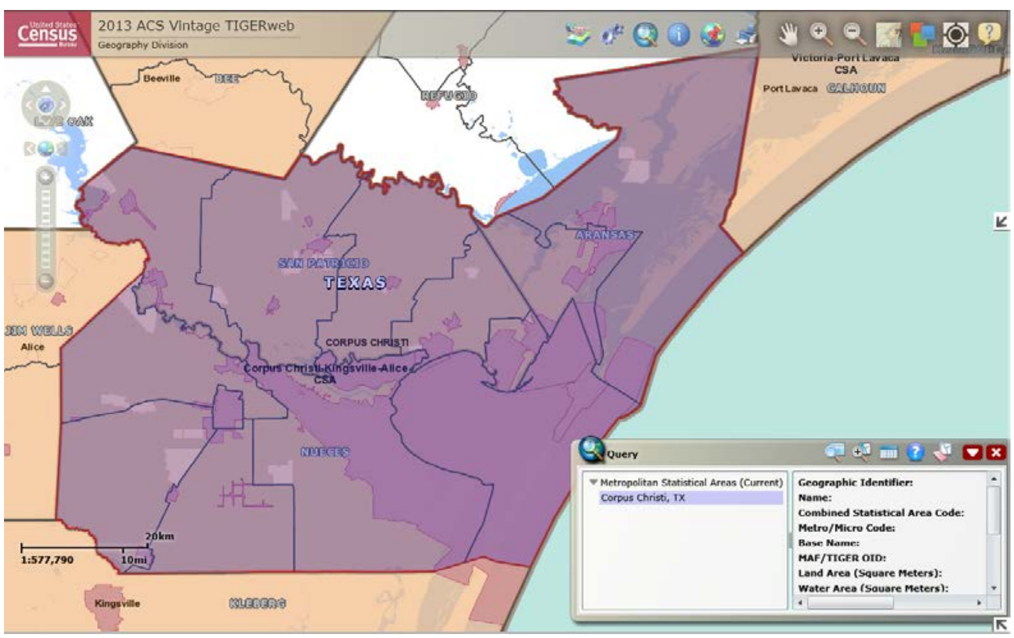


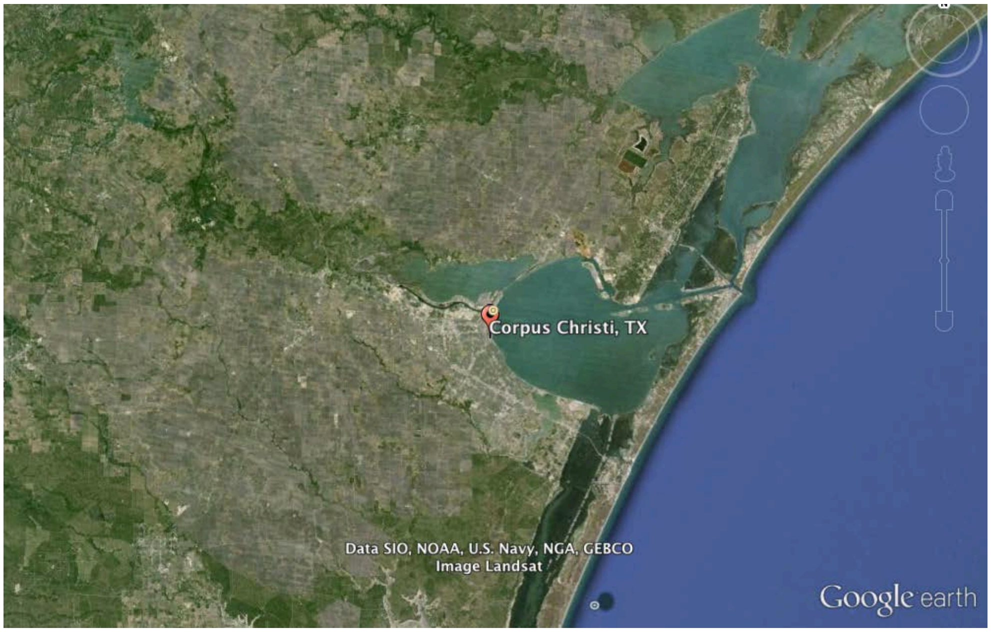
- 2010 Tier Designation: Tier 0, based on state.
- Land area: 4 counties (Hardin, Jefferson, Orange, Newton) 3034 sq mi;
- pop density overall 133/sq mi (low); central 511 (med-hig)

- Urban location: Beaumont is seat of Jefferson County.Part of Golden Triangle, major industrial area on Gulf Coast. Located on coast of Gulf of Mexico. Low-lying flat area bounded by Neches River on east. Beaumont and Port Arthur are main cities.
- Govts: 2 cities over 50,000; 6 places 10-50,000; 29 places less than 10,000.
- Region-specific programs/laws: None known beyond state programs.

CORPUS CHRISTI MSA, TEXAS

MPO: Corpus Christi MPO
corpuschristi-mpo.org

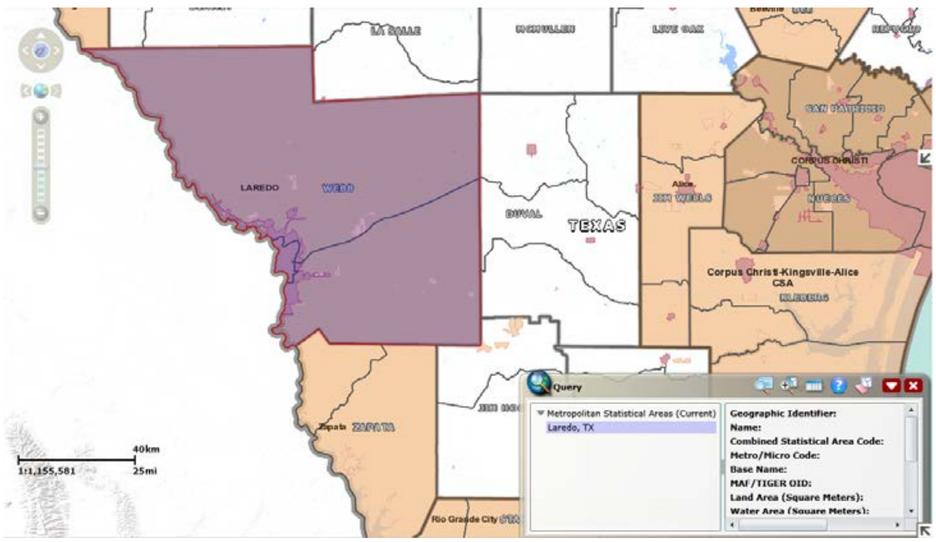


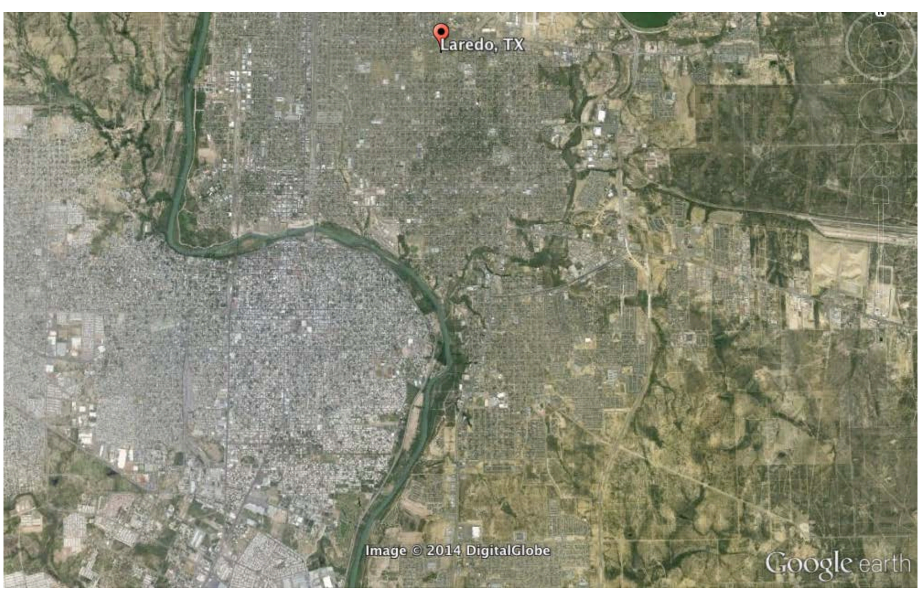


- 2010 Tier Designation: Tier 0 based on state Tier.
- Land area: 1784 sq mi; 3 counties (Aransas, Nueces, and San Patricio.)
- pop density overall 240/sq mi (med-low); central 1152 (high)
- Urban location: on Texas Gulf Coast. Corpus Christi is fifth largest port in US, deepest in-shore port in the Gulf. Seat of Nueces County, Corpus Christi extends into three other counties.Water is provided via 100-mile pipeline from Lake Texana. Several major military bases.
- Govts: one city over 325,000; 3 cities 10-30,000; 35 places less than 10,000.
- Region-specific programs/laws: None known.

LAREDO MSA, TEXAS

MPO: Laredo Urban Transportation Study MPO
http://www.ci.laredo.tx.us/city-planning/departments/MPO/index.html



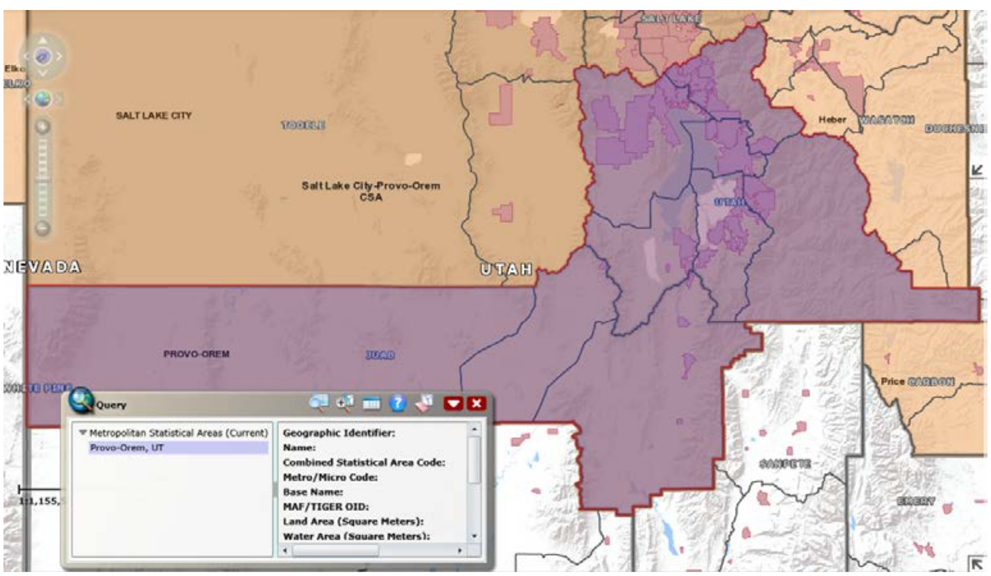


- 2010 Tier Designation: Tier 0 based on state Tier.
- Land area: 1 county (Webb); 3361 sq mi;
- pop density overall 74/sq mi (low); central 1575 (high)
- Urban location: Metropolitan area includes 3 Mexico municipalities. On the Rio Grande across from Mexico; several major tributaries. County seat of Webb County. Economic base is international with Mexico (banking, import/export, cross-border retail shopping, largest inland US port).
- Govts: 3 cities; 9 CDPs; 69 unincorporated, many of them “colonias”
- Region-specific programs/laws: None known.

UTAH

PROVO-OREM MSA, UTAH

MPO: Mountainland Council of Govts

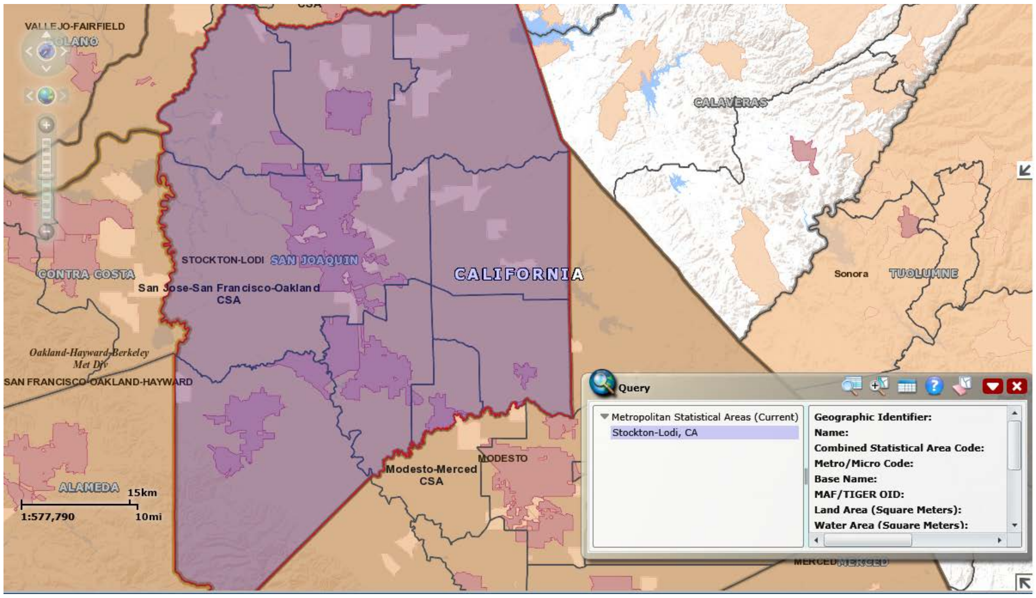


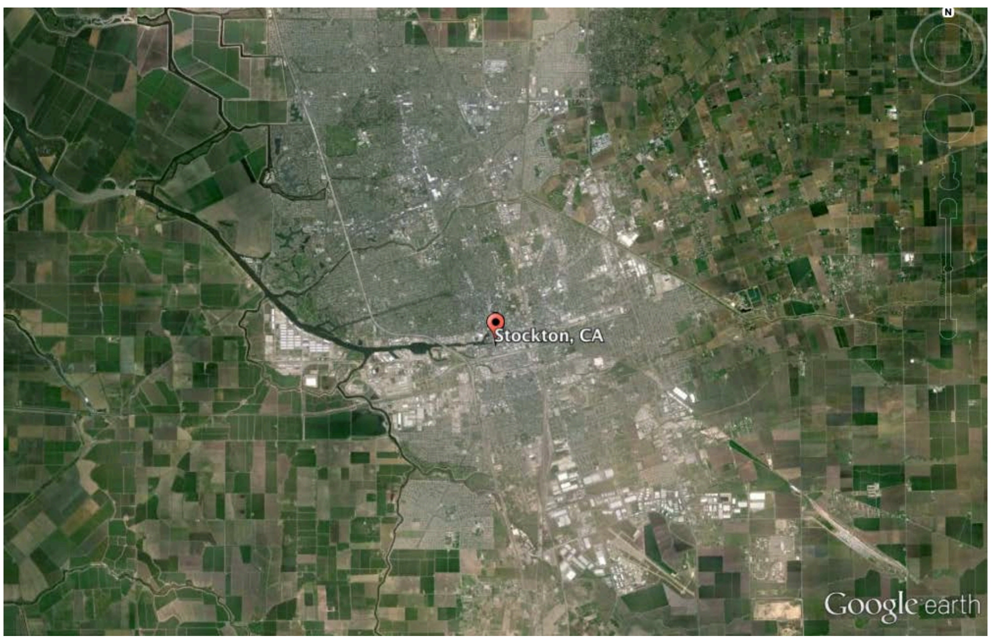
- Land area: 2 counties (Juab, Utah); 5396 sq mi; includes substantial lake area
- 2010 Tier Designation: Tier 1, based on state Tier.
- pop density overall 98/sq mi (low); central 1203 (high)
- Urban location: central-eastern shore of Utah Lake, smaller lake south of Great Salt Lake; about 45 minutes south of Salt Lake City; county seat of Utah County; Provo and Orem are second and third largest cities in Utah (Salt Lake City is first). Lake is largest freshwater lake in Utah, an oasis in desert.
- Govts: 2 cities (Provo, Orem); 39 other places, including unincorporated, CDPs, others.
- Region-specific programs/laws: recommendations only through state incentives and Wasatch Choice 2040. Provo-Orem area was in Sustainable Communities grant program, resulted in Wasatch Choice 2040, which was recommendations for growth, included toolbox, best practices, GIS program (scenario planning), toolkit for creating centers. http://envisionutah.org/about-wc2040
- Only recently (since 2010) some local communities have chosen to implement form based codes and smart growth. Key examples: City of Provo, City of American Forks, City of Santaquin.

CALIFORNIA

STOCKTON-LODI MSA, CALIFORNIA

MPO: San Joaquin Council of Govts



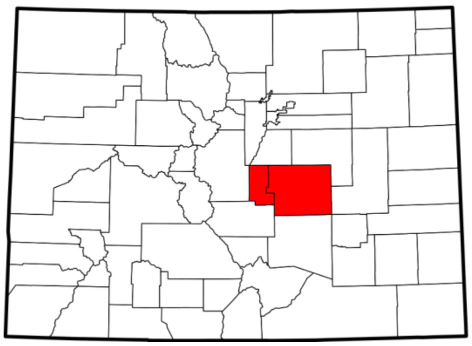


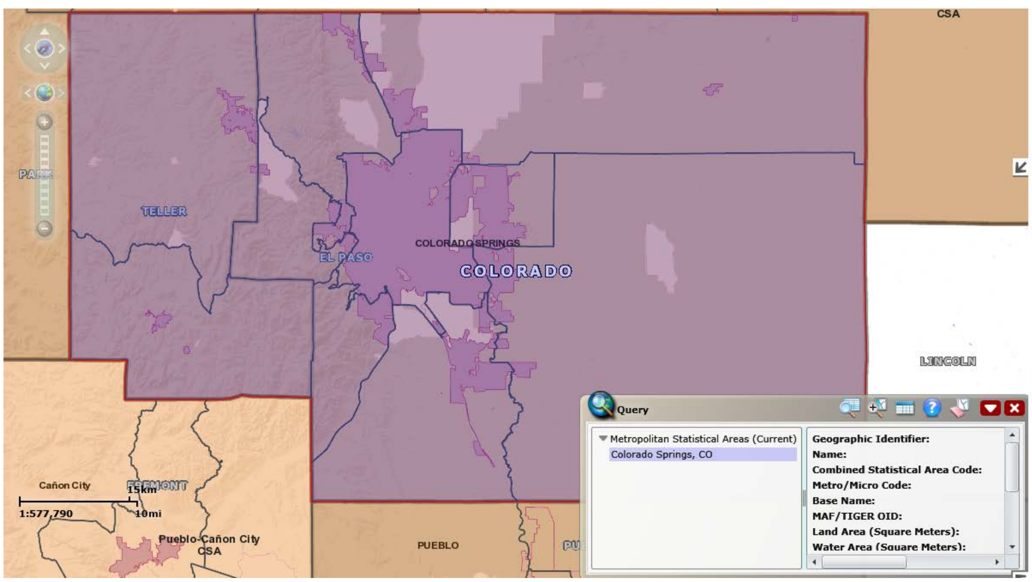
- 2010 Tier Designation: Tier 2 based on state Tier.
- Land area: 1 county (San Joaquin); 1391 sq mi
- pop density overall 493/sq mi (med-low); central 1332 (high)
- Urban location: Stockton: County seat San Joaquin County; both northern part of Ca's central Valley; flat, surrounded by farmland, mountains to east and west; depressed area, Stockton has filed for bankruptcy (was largest city until Detroit). Led US in 2007 rate of foreclosure.
- Govts: 7 cities; 21 CDPs; 6 unincorporated.
- Region-specific programs/laws: none known

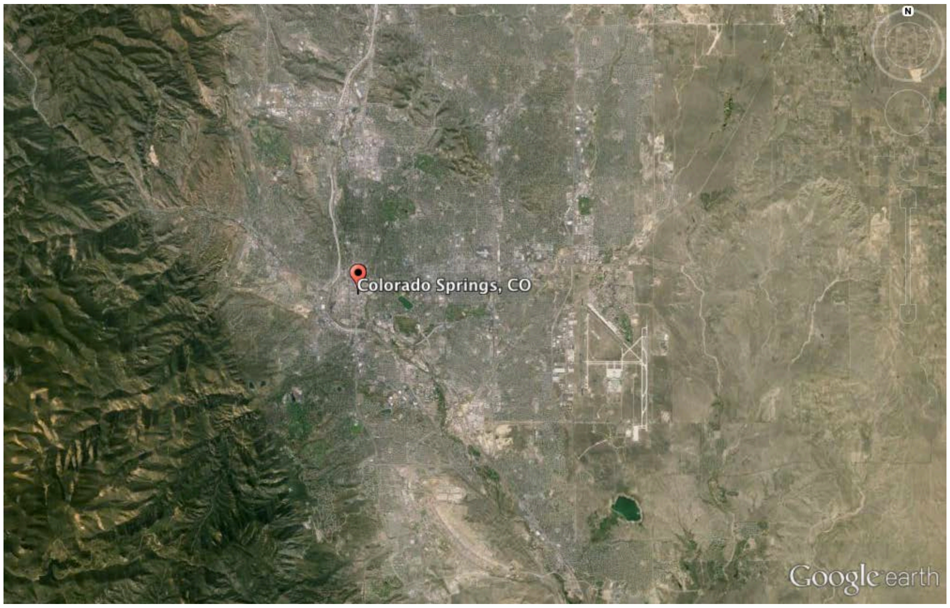
COLORADO

COLORADO SPRINGS MSA, COLORADO

MPO:
Pikes Peak Area Council of Govts



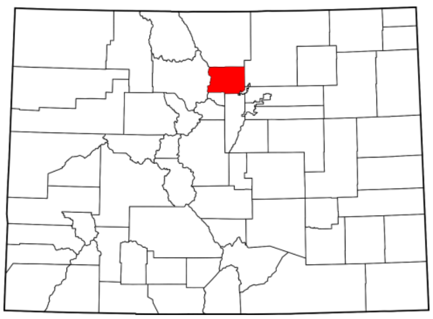


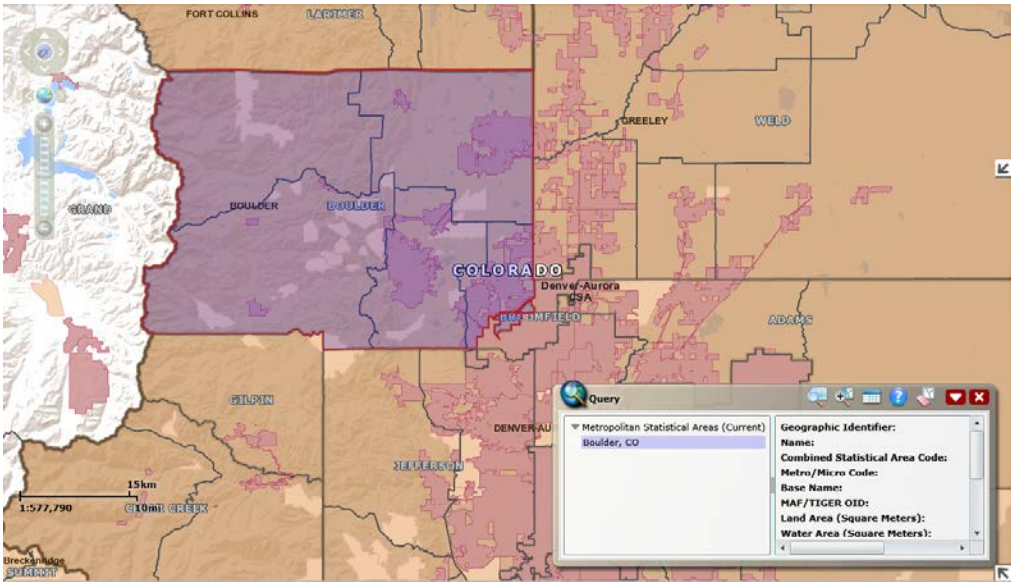


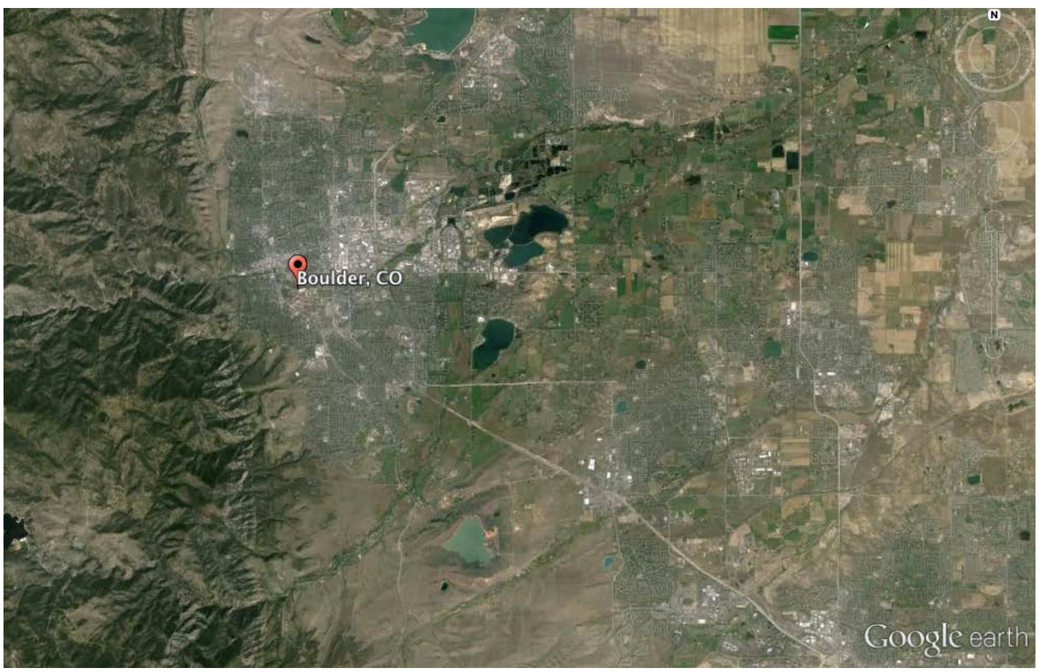
- Tier Designation (2010): Tier 1. State laws are in place but implementation is not strong. Any effects are voluntary.
- Land area: 2 counties (El Paso, Teller); 2684 sq mi;
- pop density overall 241/sq mi (med-low); central 1117 (high)
- Urban location: county seat, El Paso County; east central part of state, 60 miles south of Denver (state capitol); in plain at immediate base of Rocky Mts; below Pikes Peak, much tourism; major military base, US Air Force Academy.
- Govts: 1 city over 430,000 (Colo Springs); 5 cities 10-33,000; 21 places less than 10,000.
- Region-specific programs/laws: city is Home Rule Municipality. Locally, Banning-Lewis Ranch, owned by developer-families, was designated by City of Colorado Springs as only area for development – development agreement and regulations were put in place to require development there to pay for itself. Annexation beyond the area was not permitted. Caused leapfrog development in unincorporated areas, which decided not to put any requirements on developers. This has only slowed since 2010 with water shortages. Water is greatest constraint, but until 2010 the impending water crisis was not considered in major plans. In spite of compact development and infill being part of state goals, the overall trend is toward more sprawl.

BOULDER MSA, COLORADO

MPO: Denver Regional Council of Governments (DRCOG)
http://drcog.org







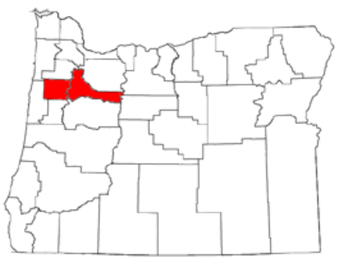
- Tier Designation (2010): Tier 1 (voluntary); note that they have 80% alignment of local governments with voluntary goals for compactness; everyone takes it quite seriously.
- Land area: 1 county (Boulder); 726 sq mi;
- pop density overall 406/sq mi (med-low); central 1327 (high)
- Urban location: Base of Rocky Mts, elevation 5000 feet. 30 miles NW of Denver. County seat, Boulder County. Home to University of Colorado main campus.
- Population: % Pop change 1990-2010
- Govts: 4 cities; 6 towns; 8 CDPs; 2 uninc.
- Households 2010: % chage 1990-2010:
- GDP 2010: % chge 1990-2010: Per capita DP 2010: %change 1990-2010:
- Sprawl Ranking 1998: 2014: streets index 2014

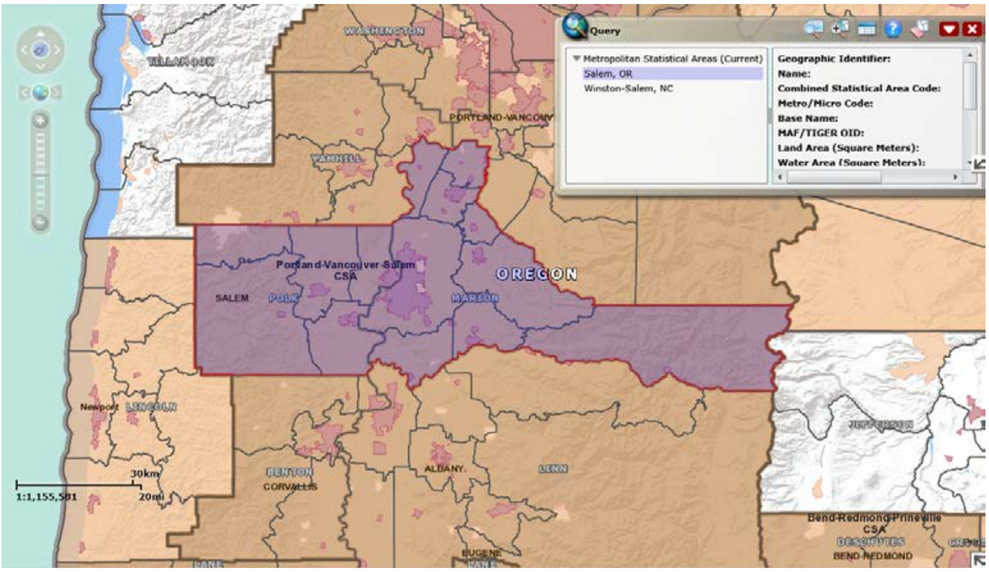
- Region-specific programs/laws: Boulder is home rule municipality. Boulder is part of Denver Regional Council of Governments (DRCOG). COG has its own policies/strategies which have been in place since about 2000 and have been effective, including: 1) Establishment of MetroVision goals which include an urban centers policy, and establishment of designated Urban Boundaries OR Urban Areas (acreage) for each community; 2) TIP policy includes criteria for alignment with MetroVision goals (25% of points for alignment; additional points if project is in urban center; COG has established criteria for what is an urban center; 3) Mile High Compact – voluntary agreement to align with metrovision goals – 80% of jurisdictions have signed on.

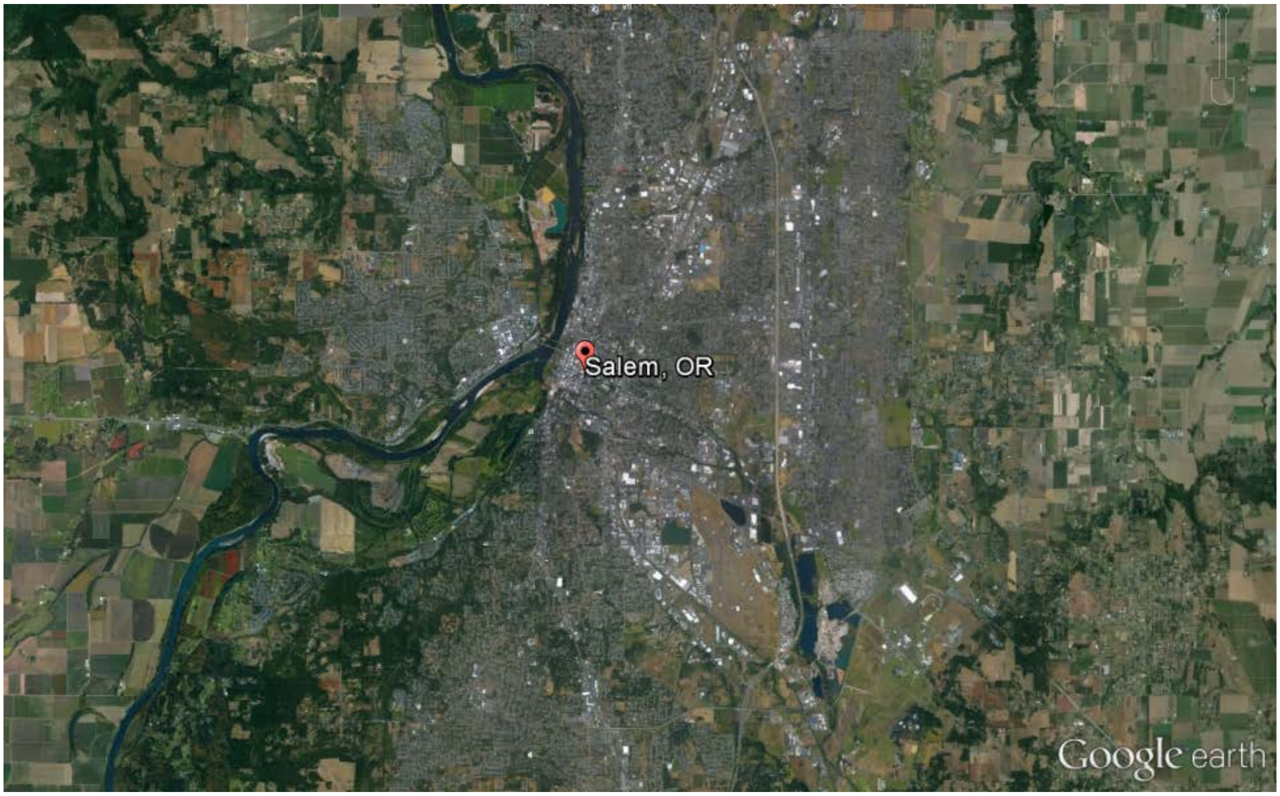
OREGON

SALEM MSA, OREGON

MPO: Salem-Keizer MPO



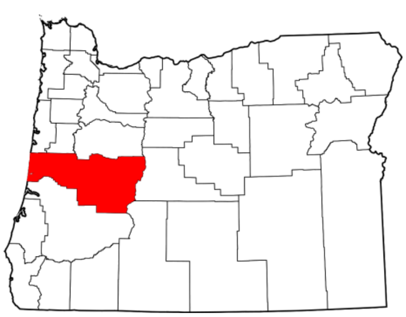


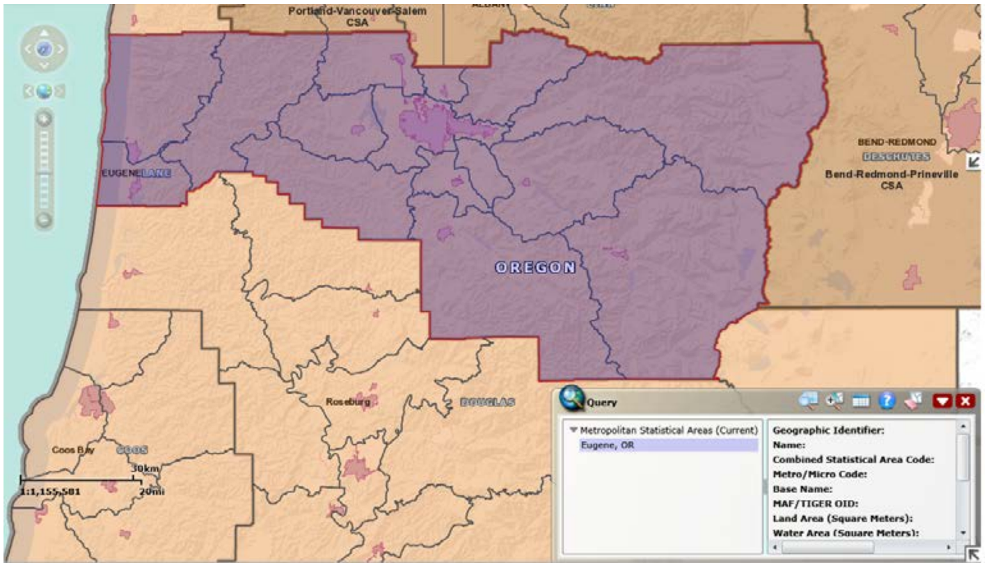


- 2010 Tier Designation: Tier 3, based on state Tier.
- Land area: 2 counties (Polk, Marion) 1923 sq mi;
- pop density overall 203/sq mi (med-low); central 573 (med-low)
- Urban location: state capitol; central Willamette Valley, alongside Willamette River, one hour south of Portland, one hour from Pacific coast. . Second largest city in state. Major ag food processing center. Some silicon industries.
- Govts: One city over 125,000 (Salem); 5 places 10-40,000; 38 places less than 10,000.
- Region-specific programs/laws: none beyond state program.

EUGENE-SPRINGFIELD MSA, OREGON

MPO: Central Lane Metropolitan Planning Organization
http://thempo.org





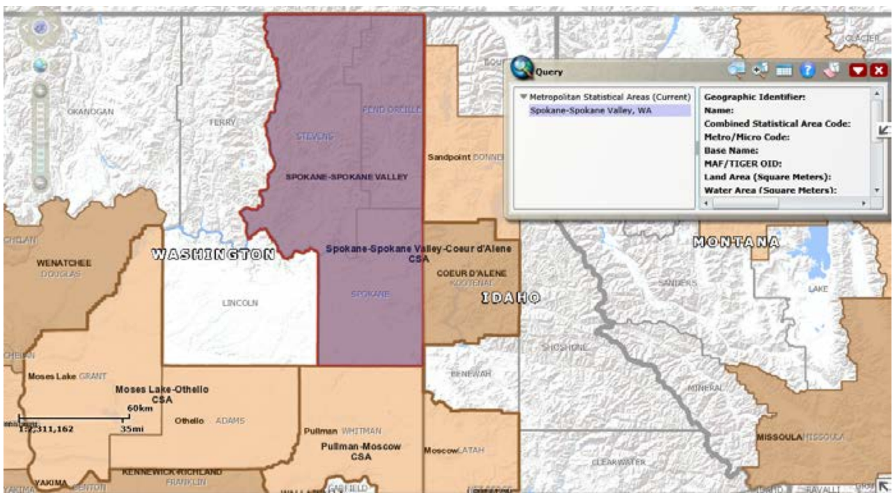
- 2010 Tier Designation: Tier 3 based on state Tier.
- Land area: 1 county (Lane); 4553 sq mi;
- pop density overall 77/sq mi (low); central 813 (med-hi)
- Urban location: 50 miles east of Pacific coast, at south end of Willamette Valley. County seat, Lane County. Home to University of Oregon. Economy based on recreation, tourism, university, wood products, alternative lifestyles.
- Govts: 12 cities; 78 unincorporated communities
- Region-specific programs/laws: None known beyond state program.

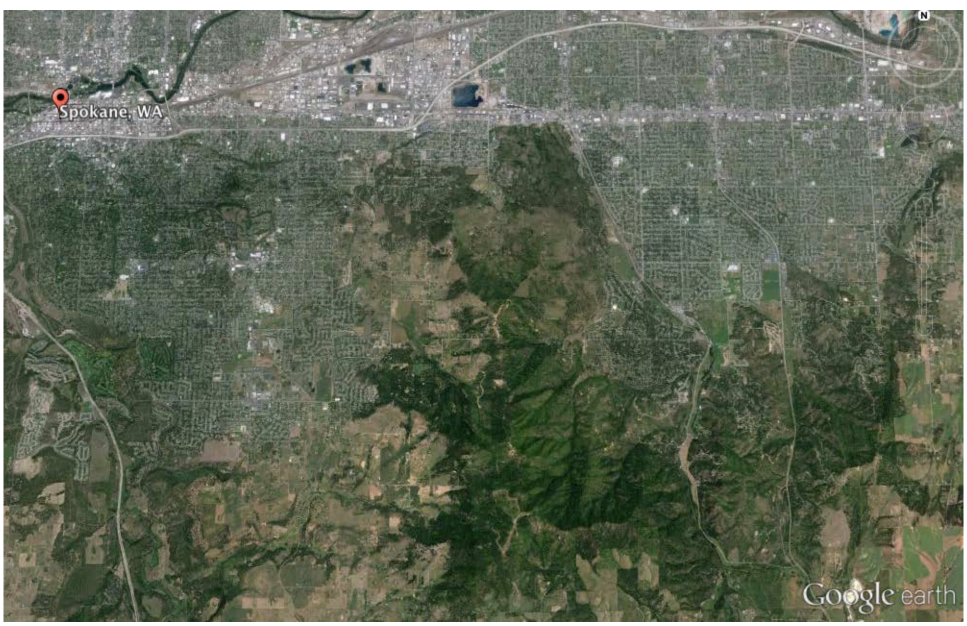
WASHINGTON STATE

SPOKANE-SPOKANE VALLEY MSA

MPO: Spokane Regional Transportation Council

(note: 2 additional counties have been recently added to the north, per map below)





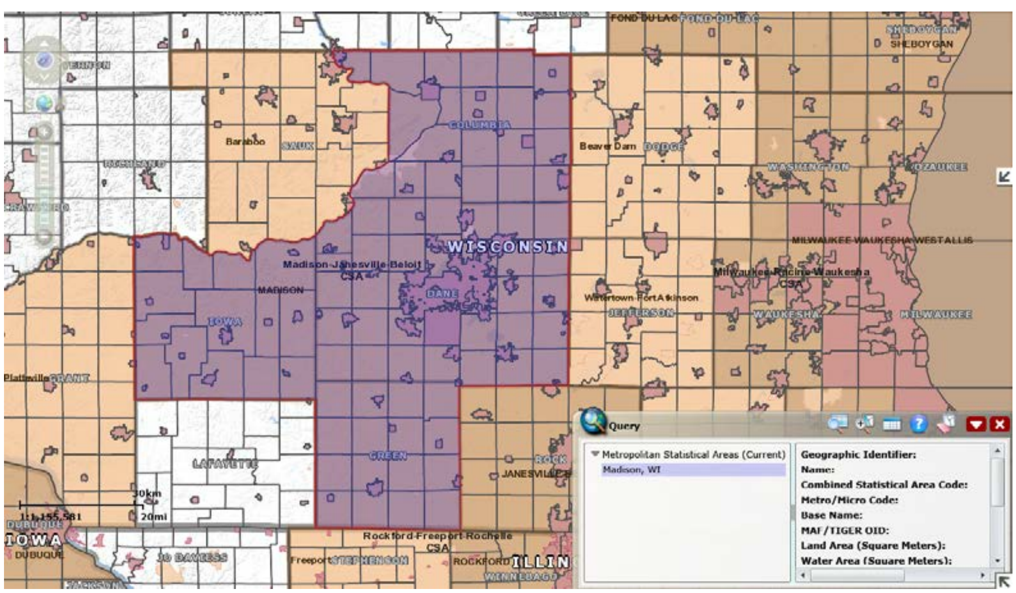
- 2010 Tier Designation: Tier 3 based on state Tier.
- Land area: 3 counties (Stevens, Pend Oreille, Spokane); 5642 sq mi;
- pop density overall 94/sq mi (low); central 1035 (high)
- Urban location: on the east border of Washington, city is 20 miles from border with Idaho panhandle, city is 90+ miles south of Canadian border . Spokane is seat of Spokane County. Located on the Spokane River. Economy based on resources (mining, timber, agriculture), rail and shipping center. Second largest city in the state. Area includes mountains (foothills of Rockies) and a high valley at 1800 feet, several large lakes.
- Govts: 24 cities; 9 CDPs; 37 other communities.
- =Region-specific programs/laws: None known beyond state programs.

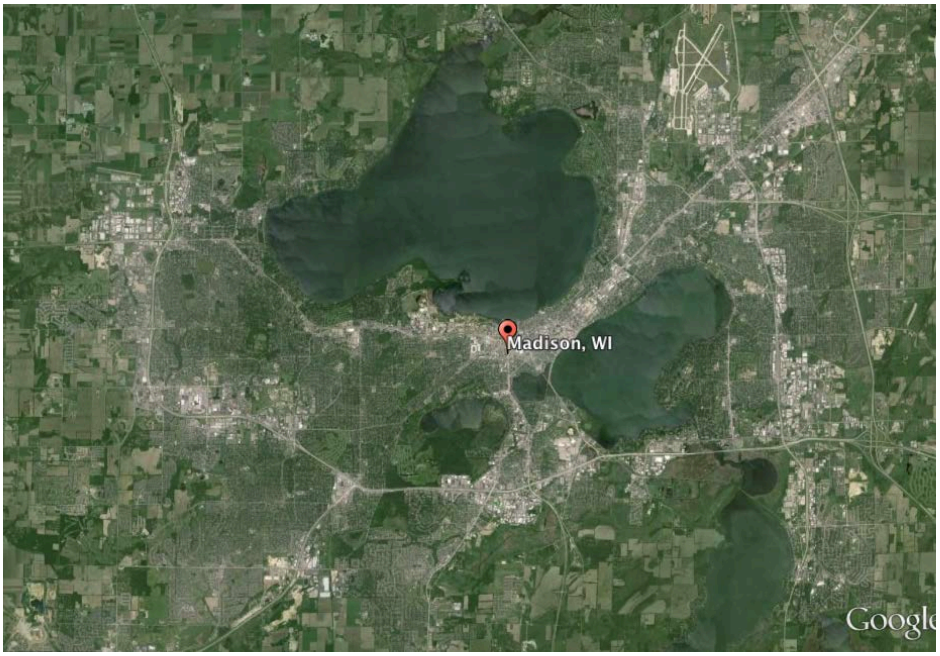
WISCONSIN

MADISON MSA, WISCONSIN

MPO: Madison Area Transportation Planning Board

Note: MSA is red area only, plus Green Co. which has been added to the south (see map below).

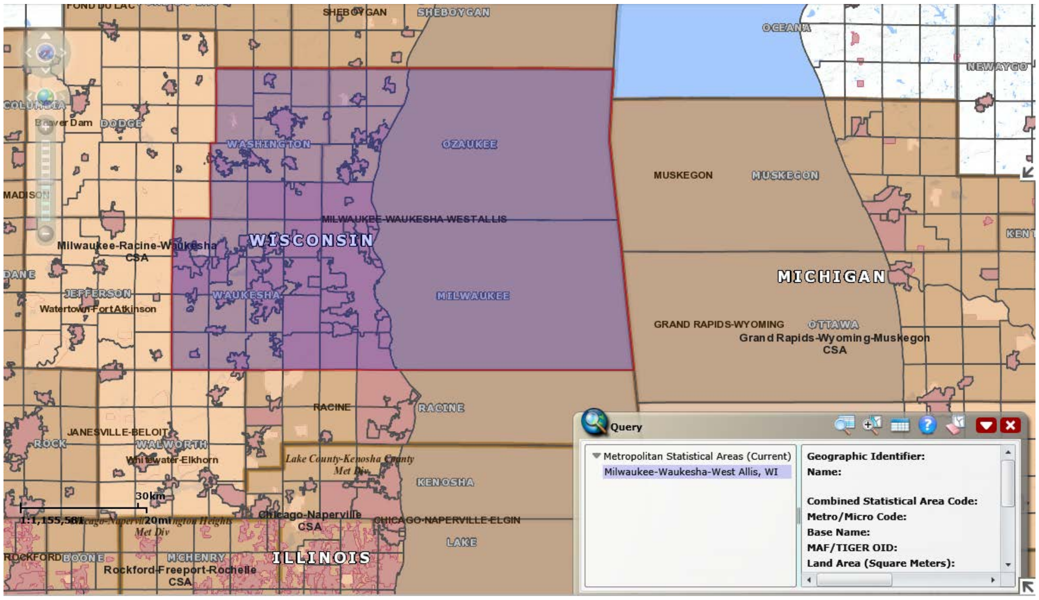


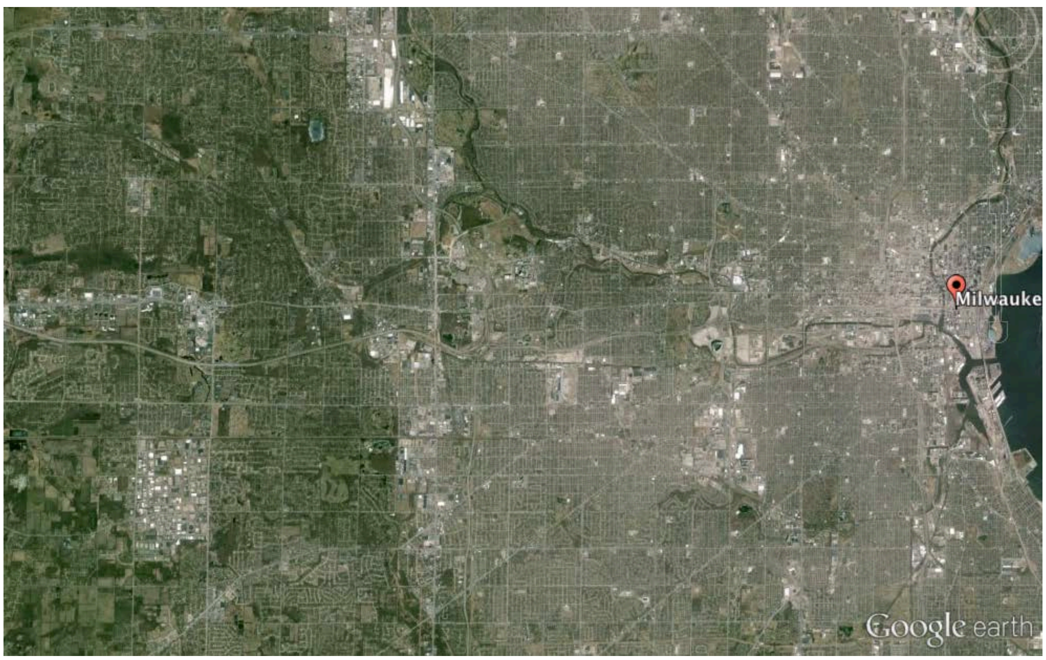


- 2010 Tier Designation: Tier 1 based on state Tier.
- Land area: 4 counties (Columbia, Dane, Iowa, Green); 3309 sq mi;
- pop density overall 183/sq mi (low); central 823 (med-high)
- Urban location: state capitol, home of University of Wisconsin, county seat Dane County. Flat terrain, on Yahara River, which has five lake impoundments, city sits on peninsula between two large ones (Mendota-Monona).
- Govts: 15 cities; 46 villages; 2 CDPs; 25 unincorporated; 69 towns.
- Region-specific programs/laws: None known beyond state programs.

MILWAUKEE-WAUKESHA-WEST ALLIS MSA, WISCONSIN

MPO: Southeast Wisconsin Regional Planning Commission (SEWRPC)





- 2010 Tier Designation: Tier 1 based on state.
- Land area: 4 counties (Milwaukee, Waukesha, Washington and Ozaukee); 1455 sq mi;
- pop density overall 1070/sq mi (high); central 1150 (high)
- Urban location: county seat, Milwaukee County, located on southwestern shore of Lake Michigan. City is at confluence of 3 rivers, many inland lakes. Economy based on heavy industry, now revitalizing rustbelt economy. Large brewery industry.
- Govts: 3 principal cities; plus 34 places over 10,000; plus 46 places under 10,000; plus 18 unincorporated.
- Region-specific programs/laws: none known beyond state programs.

8.3 TECHNICAL ANALYSIS: REGRESSION MODEL INFORMATION

TOTAL LANE MILES PER MILLION PEOPLE

Total lane miles per million versus Sprawl Index				
Urban area		Tier	total lane miles per million people	Composite(total)score
OH-A	Akron OH	0	2694	103.15
NY-A	Albany NY	2	3036	95.12
TX-A	Austin TX	1	2264	102.44
TX-B	Beaumont TX	0	5099	111.54
CO-B	Boulder CO	1	1753	117.87
CT-B	Bridgeport-Stamford CT-NY	2	2198	121.64
NY-B	Buffalo NY	0	3031	106.36
OH-Cl	Cleveland OH	0	2711	85.62
CO-C	Colorado Springs CO	1	3151	106.33
OH-Co	Columbus OH	0	2527	93
TX-C	Corpus Christi TX	0	3204	117.29
OH-D	Dayton OH	0	2931	101.48
OR-E	Eugene OR	3	2224	125.63
MI-G	Grand Rapids MI	0	3725	79.18
TN-K	Knoxville TN	2	3081	68.22
TX-L	Laredo TX	0	1900	131.25
AR-L	Little Rock AR	0	3900	76.08
WI-Ma	Madison WI	1	2588	136.69
WI-Mi	Milwaukee WI	1	3241	134.18
CT-N	New Haven CT	2	2575	116.29
PA-P	Pittsburgh PA	1	2854	95.45
UT-P	Provo-Orem UT	1	2089	108.45
OR-S	Salem OR	3	2336	123.35
WA-S	Spokane WA-ID	3	3780	129.4
CA-S	Stockton CA	2	1748	120.28
OH-T	Toledo OH-MI	0	3089	100.9

total lane miles	
Mean	2835.758215
Standard Error	146.5269133
Median	2782.457094
Mode	#N/A
Standard Deviation	747.1435901
Sample Variance	558223.5443
Kurtosis	2.048928567
Skewness	1.026542583
Range	3351.648801
Minimum	1747.524752
Maximum	5099.173554
Sum	73729.71359
Count	26
Largest(1)	5099.173554
Smallest(1)	1747.524752
Confidence Level(95.0%)	301.7778269

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.307217224
R Square	0.094382423
Adjusted R Square	0.056648357
Standard Error	725.6728586
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	1317162.261	1317162.261	2.501252404
Residual	24	12638426.35	526601.0977	
Total	25	13955588.61		

	Coefficients	Standard Error	t Stat	P-value
Intercept	4196.745413	872.2369895	4.811473789	6.70724E-05
Composite(total)score	-12.60536948	7.970339494	-1.581534825	0.126846238

RESIDUAL OUTPUT

Observation	Predicted total lane miles	Residuals	
1	2896.501551	-202.9531641	Akron OH
2	2997.722668	38.04968965	Albany NY
3	2905.451363	-641.0835474	Austin TX
4	2790.742501	2308.431052	Beaumont TX
5	2710.950512	-957.6171791	Boulder CO
6	2663.42827	-465.79132	Bridgeport-Stamford CT-NY
7	2856.038315	175.4202168	Buffalo NY
8	3117.473678	-406.4537485	Cleveland OH
9	2856.416476	294.7674946	Colorado Springs CO
10	3024.446051	-497.0165843	Columbus OH
11	2718.261627	485.3311876	Corpus Christi TX
12	2917.552518	13.71432817	Dayton OH
13	2613.132845	-389.6034335	Eugene OR
14	3198.652258	526.6766898	Grand Rapids MI
15	3336.807107	-255.4579007	Knoxville TN
16	2542.290669	-642.2906688	Laredo TX
17	3237.728903	662.0532321	Little Rock AR
18	2473.717459	114.2222396	Madison WI
19	2505.356936	735.929927	Milwaukee WI
20	2730.866996	-155.5023285	New Haven CT
21	2993.562896	-139.668638	Pittsburgh PA
22	2829.693093	-740.3313908	Provo-Orem UT
23	2641.873088	-305.8075139	Salem OR
24	2565.610602	1213.916957	Spokane WA-ID
25	2680.571572	-933.0468195	Stockton CA
26	2924.863632	164.1112224	Toledo OH-MI

FREEWAY LANE MILES PER MILLION PEOPLE

Freeway lane miles per million people versus Sprawl Index				
Urban area		Tier	freeway lane miles per million	Composite(total)score
OH-A	Akron OH	0	758	103.15
NY-A	Albany NY	2	1146	95.12
TX-A	Austin TX	1	713	102.44
TX-B	Beaumont TX	0	1050	111.54
CO-B	Boulder CO	1	420	117.87
CT-B	Bridgeport-Stamford CT-NY	2	737	121.64
NY-B	Buffalo NY	0	763	106.36
OH-Cl	Cleveland OH	0	894	85.62
CO-C	Colorado Springs CO	1	719	106.33
OH-Co	Columbus OH	0	835	93
TX-C	Corpus Christi TX	0	958	117.29
OH-D	Dayton OH	0	883	101.48
OR-E	Eugene OR	3	608	125.63
MI-G	Grand Rapids MI	0	831	79.18
TN-K	Knoxville TN	2	740	68.22
TX-L	Laredo TX	0	335	131.25
AR-L	Little Rock AR	0	1416	76.08
WI-Ma	Madison WI	1	704	136.69
WI-Mi	Milwaukee WI	1	556	134.18
CT-N	New Haven CT	2	932	116.29
PA-P	Pittsburgh PA	1	750	95.45
UT-P	Provo-Orem UT	1	621	108.45
OR-S	Salem OR	3	594	123.35
WA-S	Spokane WA-ID	3	630	129.4
CA-S	Stockton CA	2	545	120.28
OH-T	Toledo OH-MI	0	735	100.9

freeway lane miles per million	
Mean	764.2920209
Standard Error	43.94621597
Median	738.4607352
Mode	#N/A
Standard Deviation	224.0826128
Sample Variance	50213.01734
Kurtosis	1.963290632
Skewness	0.840100489
Range	1081.339396
Minimum	334.7826087
Maximum	1416.122004
Sum	19871.59254
Count	26
Largest(1)	1416.122004
Smallest(1)	334.7826087
Confidence Level(95.0%)	90.50892603

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.572299412
R Square	0.327526617
Adjusted R Square	0.299506893
Standard Error	187.5469875
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	411152.4927	411152.4927	11.6891449
Residual	24	844172.9407	35173.87253	
Total	25	1255325.433		

	Coefficients	Standard Error	t Stat	P-value
Intercept	1524.681089	225.4258484	6.76355928	5.38057E-07
Composite(total)score	-7.042671056	2.059899504	-3.418939148	0.002250294

RESIDUAL OUTPUT

Observation	Predicted freeway lane miles per million	Residuals	
1	798.2295693	-40.16505314	Akron OH
2	854.7822178	291.5592456	Albany NY
3	803.2298657	-90.58618755	Austin TX
4	739.1415591	310.4452178	Beaumont TX
5	694.5614513	-274.5614513	Boulder CO
6	668.0105814	68.83152383	Bridgeport-Stamford CT-NY
7	775.6225952	-12.99151796	Buffalo NY
8	921.6875929	-27.78372419	Cleveland OH
9	775.8338753	-56.34389352	Colorado Springs CO
10	869.7126805	-35.07318206	Columbus OH
11	698.6462005	259.4376318	Corpus Christi TX
12	809.9908299	72.75849622	Dayton OH
13	639.9103239	-32.06718666	Eugene OR
14	967.0423945	-136.4502892	Grand Rapids MI
15	1044.230069	-304.1507042	Knoxville TN
16	600.3305126	-265.5479039	Laredo TX
17	988.8746748	427.2473296	Little Rock AR
18	562.018382	141.4992059	Madison WI
19	579.6954864	-23.39521829	Milwaukee WI
20	705.6888716	226.2398156	New Haven CT
21	852.4581364	-102.0317578	Pittsburgh PA
22	760.9034127	-139.6268169	Provo-Orem UT
23	655.9676139	-61.70531884	Salem OR
24	613.359454	16.56180581	Spokane WA-ID
25	677.5886141	-133.0341586	Stockton CA
26	814.0755791	-79.06590796	Toledo OH-MI

ARTERIAL STREET LANE MILES PER MILLION PEOPLE

Arterial street lane mile per million people versus Sprawl Index				
Urban area		Tier	arterial street lane mile per million	Composite(total)score
OH-A	Akron OH	0	1935	103.15
NY-A	Albany NY	2	1889	95.12
TX-A	Austin TX	1	1552	102.44
TX-B	Beaumont TX	0	4050	111.54
CO-B	Boulder CO	1	1333	117.87
CT-B	Bridgeport-Stamford CT-NY	2	1461	121.64
NY-B	Buffalo NY	0	2269	106.36
OH-Cl	Cleveland OH	0	1817	85.62
CO-C	Colorado Springs CO	1	2432	106.33
OH-Co	Columbus OH	0	1693	93
TX-C	Corpus Christi TX	0	2246	117.29
OH-D	Dayton OH	0	2049	101.48
OR-E	Eugene OR	3	1616	125.63
MI-G	Grand Rapids MI	0	2895	79.18
TN-K	Knoxville TN	2	2341	68.22
TX-L	Laredo TX	0	1565	131.25
AR-L	Little Rock AR	0	2484	76.08
WI-Ma	Madison WI	1	1884	136.69
WI-Mi	Milwaukee WI	1	2685	134.18
CT-N	New Haven CT	2	1643	116.29
PA-P	Pittsburgh PA	1	2103	95.45
UT-P	Provo-Orem UT	1	1468	108.45
OR-S	Salem OR	3	1742	123.35
WA-S	Spokane WA-ID	3	3150	129.4
CA-S	Stockton CA	2	1203	120.28
OH-T	Toledo OH-MI	0	2354	100.9

arterial street lane mile per million	
Mean	2071.466194
Standard Error	124.09332
Median	1912.457383
Mode	#N/A
Standard Deviation	632.7542602
Sample Variance	400377.9538
Kurtosis	2.542272286
Skewness	1.348677969
Range	2846.61648
Minimum	1202.970297
Maximum	4049.586777
Sum	53858.12104
Count	26
Largest(1)	4049.586777
Smallest(1)	1202.970297
Confidence Level(95.0%)	255.5749767

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.160082734
R Square	0.025626482
Adjusted R Square	-0.014972415
Standard Error	637.4735905
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	256506.9581	256506.9581	0.631211286
Residual	24	9752941.888	406372.5786	
Total	25	10009448.85		

	Coefficients	Standard Error	t Stat	P-value
Intercept	2672.064324	766.2241173	3.487314304	0.001901071
Composite(total)score	-5.562698422	7.001613571	-0.794488066	0.434697775

RESIDUAL OUTPUT

Observation	Predicted arterial street lane mile per million	Residuals	
1	2098.271982	-162.7881109	Akron OH
2	2142.94045	-253.5095559	Albany NY
3	2102.221498	-550.4973598	Austin TX
4	2051.600942	1997.985835	Beaumont TX
5	2016.389061	-683.0557278	Boulder CO
6	1995.417688	-534.6228438	Bridgeport-Stamford CT-NY
7	2080.41572	188.4117348	Buffalo NY
8	2195.786085	-378.6700243	Cleveland OH
9	2080.582601	351.1113882	Colorado Springs CO
10	2154.733371	-461.9434022	Columbus OH
11	2019.615426	225.8935558	Corpus Christi TX
12	2107.561688	-59.04416805	Dayton OH
13	1973.222521	-357.5362469	Eugene OR
14	2231.609863	663.126979	Grand Rapids MI
15	2292.577038	48.69280349	Knoxville TN
16	1941.960156	-376.7427649	Laredo TX
17	2248.854228	234.8059025	Little Rock AR
18	1911.699077	-27.27696627	Madison WI
19	1925.66145	759.3251453	Milwaukee WI
20	2025.178125	-381.7421441	New Haven CT
21	2141.10476	-37.63688027	Pittsburgh PA
22	2068.78968	-600.7045739	Provo-Orem UT
23	1985.905474	-244.1021951	Salem OR
24	1952.251148	1197.355151	Spokane WA-ID
25	2002.982958	-800.0126609	Stockton CA
26	2110.788053	243.1771304	Toledo OH-MI

DAILY VEHICLE MILES TRAVELED PER CAPITA

Daily VMT per Capita versus Sprawl Index				
Urban area		Tier	Daily VMT per capita	Composite(total)score
OH-A	Akron OH	0	16.85483871	103.15
NY-A	Albany NY	2	20.47154472	95.12
TX-A	Austin TX	1	17.58697318	102.44
TX-B	Beaumont TX	0	25.72727273	111.54
CO-B	Boulder CO	1	11.32	117.87
CT-B	Bridgeport-Stamford CT-NY	2	17.8528464	121.64
NY-B	Buffalo NY	0	15.7778837	106.36
OH-Cl	Cleveland OH	0	18.11254396	85.62
CO-C	Colorado Springs CO	1	17.06739526	106.33
OH-Co	Columbus OH	0	20.76802508	93
TX-C	Corpus Christi TX	0	16.76047904	117.29
OH-D	Dayton OH	0	18.36657682	101.48
OR-E	Eugene OR	3	14.14117647	125.63
MI-G	Grand Rapids MI	0	21.91940789	79.18
TN-K	Knoxville TN	2	23.58134921	68.22
TX-L	Laredo TX	0	10.65217391	131.25
AR-L	Little Rock AR	0	27.29847495	76.08
WI-Ma	Madison WI	1	15.7160804	136.69
WI-Mi	Milwaukee WI	1	17.82037534	134.18
CT-N	New Haven CT	2	19.28363047	116.29
PA-P	Pittsburgh PA	1	15.89198408	95.45
UT-P	Provo-Orem UT	1	14.97234043	108.45
OR-S	Salem OR	3	14.72131148	123.35
WA-S	Spokane WA-ID	3	17.16535433	129.4
CA-S	Stockton CA	2	14.2450495	120.28
OH-T	Toledo OH-MI	0	16.19535783	100.9

Daily VMT per capita	
Mean	17.70270946
Standard Error	0.76053202
Median	17.1163748
Mode	#N/A
Standard Deviation	3.877967609
Sample Variance	15.03863277
Kurtosis	0.855486403
Skewness	0.715323928
Range	16.64630103
Minimum	10.65217391
Maximum	27.29847495
Sum	460.2704459
Count	26
Largest(1)	27.29847495
Smallest(1)	10.65217391
Confidence Level(95.0%)	1.566345015

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.433533371
R Square	0.187951184
Adjusted R Square	0.154115817
Standard Error	5.250056785
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	153.1095118	153.1095118	5.55487346
Residual	24	661.5143099	27.56309625	
Total	25	814.6238217		

	Coefficients	Standard Error	t Stat	P-value
Intercept	33.16935408	6.310410635	5.256290912	2.17468E-05
Composite(total)score	-0.135905498	0.05766336	-2.356877905	0.026926967

RESIDUAL OUTPUT

Observation	Predicted annual hours of delay per capita	Residuals	
1	19.15070196	-3.336185829	Akron OH
2	20.24202311	1.01163543	Albany NY
3	19.24719486	9.234031192	Austin TX
4	18.01045483	-0.704669706	Beaumont TX
5	17.15017303	-2.430173027	Boulder CO
6	16.6378093	11.61675568	Bridgeport-Stamford CT-NY
7	18.71444531	1.844181955	Buffalo NY
8	21.53312534	-0.956923696	Cleveland OH
9	18.71852247	-0.871527939	Colorado Springs CO
10	20.53014276	7.157161313	Columbus OH
11	17.22899822	-7.851752707	Corpus Christi TX
12	19.37766414	-2.676855514	Dayton OH
13	16.09554636	-7.224958128	Eugene OR
14	22.40835674	-6.041580429	Grand Rapids MI
15	23.897881	2.17949995	Knoxville TN
16	15.33175746	-2.249148769	Laredo TX
17	22.82966379	-5.304609322	Little Rock AR
18	14.59243156	-1.318562209	Madison WI
19	14.93355436	3.619394706	Milwaukee WI
20	17.36490371	6.272049284	New Haven CT
21	20.19717429	6.33608324	Pittsburgh PA
22	18.43040282	-1.077211329	Provo-Orem UT
23	16.4054109	2.266720249	Salem OR
24	15.58318264	0.361699254	Spokane WA-ID
25	16.82264078	-8.218680381	Stockton CA
26	19.45648933	-1.636373274	Toledo OH-MI

FREEWAY DAILY VEHICLE MILES TRAVELED PER CAPITA

Freeway VMT per Capita versus Sprawl Index				
Urban area		Tier	freeway daily VMT per capita	Composite(total)score
OH-A	Akron OH	0	9.25	103.15
NY-A	Albany NY	2	11.64	95.12
TX-A	Austin TX	1	9.41	102.44
TX-B	Beaumont TX	0	12.29	111.54
CO-B	Boulder CO	1	4.49	117.87
CT-B	Bridgeport-Stamford CT-NY	2	11.48	121.64
NY-B	Buffalo NY	0	6.61	106.36
OH-Cl	Cleveland OH	0	10.92	85.62
CO-C	Colorado Springs CO	1	7.86	106.33
OH-Co	Columbus OH	0	12.54	93
TX-C	Corpus Christi TX	0	8.73	117.29
OH-D	Dayton OH	0	9.86	101.48
OR-E	Eugene OR	3	6.85	125.63
MI-G	Grand Rapids MI	0	9.09	79.18
TN-K	Knoxville TN	2	10.70	68.22
TX-L	Laredo TX	0	2.50	131.25
AR-L	Little Rock AR	0	16.78	76.08
WI-Ma	Madison WI	1	8.43	136.69
WI-Mi	Milwaukee WI	1	7.68	134.18
CT-N	New Haven CT	2	12.76	116.29
PA-P	Pittsburgh PA	1	6.68	95.45
UT-P	Provo-Orem UT	1	8.41	108.45
OR-S	Salem OR	3	6.39	123.35
WA-S	Spokane WA-ID	3	6.04	129.4
CA-S	Stockton CA	2	8.78	120.28
OH-T	Toledo OH-MI	0	7.78	100.9

Column1	
Mean	8.998451087
Standard Error	0.579042268
Median	8.755120946
Mode	#N/A
Standard Deviation	2.952547823
Sample Variance	8.717538644
Kurtosis	1.059668102
Skewness	0.333007361
Range	14.27994695
Minimum	2.495652174
Maximum	16.77559913
Sum	233.9597283
Count	26
Largest(1)	16.77559913
Smallest(1)	2.495652174
Confidence Level(95.0%)	1.192559874

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.543929227
R Square	0.295859004
Adjusted R Square	0.266519796
Standard Error	2.528664079
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	64.47905754	64.47905754	10.08408279
Residual	24	153.4594086	6.394142024	
Total	25	217.9384661		

	Coefficients	Standard Error	t Stat	P-value
Intercept	18.52079233	3.039378306	6.093612072	2.70791E-06
Composite(total)score	-0.088195267	0.027773274	-3.175544487	0.004074687

RESIDUAL OUTPUT

Observation	Predicted freeway daily VMT per capita	Residuals	
1	9.423450512	-0.168611802	Akron OH
2	10.13165851	1.512243931	Albany NY
3	9.486069152	-0.080705167	Austin TX
4	8.683492219	3.601631748	Beaumont TX
5	8.125216177	-3.63854951	Boulder CO
6	7.792720019	3.69170533	Bridgeport-Stamford CT-NY
7	9.140343704	-2.526425687	Buffalo NY
8	10.96951355	-0.046301355	Cleveland OH
9	9.142989562	-1.283244571	Colorado Springs CO
10	10.31863247	2.220552478	Columbus OH
11	8.176369432	0.55416949	Corpus Christi TX
12	9.570736608	0.291797085	Dayton OH
13	7.440820903	-0.593762079	Eugene OR
14	11.53749107	-2.447030543	Grand Rapids MI
15	12.5041112	-1.799746119	Knoxville TN
16	6.9451635	-4.449511326	Laredo TX
17	11.8108964	4.964702731	Little Rock AR
18	6.465381246	1.966779558	Madison WI
19	6.686751367	0.993543539	Milwaukee WI
20	8.264564699	4.49556496	New Haven CT
21	10.10255407	-3.420348271	Pittsburgh PA
22	8.956015595	-0.541121978	Provo-Orem UT
23	7.641906112	-1.248463489	Salem OR
24	7.108324745	-1.071579338	Spokane WA-ID
25	7.912665583	0.867037388	Stockton CA
26	9.621889863	-1.844327001	Toledo OH-MI

DAILY ARTERIAL STREETS VEHICLE MILES TRAVELED PER CAPITA

Arterial VMT per Capita versus Sprawl Index

Urban area		Tier	arterial daily VMT per capita	Composite(total)score
OH-A	Akron OH	0	7.6	103.15
NY-A	Albany NY	2	8.827642276	95.12
TX-A	Austin TX	1	8.181609195	102.44
TX-B	Beaumont TX	0	13.44214876	111.54
CO-B	Boulder CO	1	6.833333333	117.87
CT-B	Bridgeport-Stamford CT-NY	2	6.368421053	121.64
NY-B	Buffalo NY	0	9.163965682	106.36
OH-Cl	Cleveland OH	0	7.18933177	85.62
CO-C	Colorado Springs CO	1	9.207650273	106.33
OH-Co	Columbus OH	0	8.228840125	93
TX-C	Corpus Christi TX	0	8.02994012	117.29
OH-D	Dayton OH	0	8.504043127	101.48
OR-E	Eugene OR	3	7.294117647	125.63
MI-G	Grand Rapids MI	0	12.82894737	79.18
TN-K	Knoxville TN	2	12.87698413	68.22
TX-L	Laredo TX	0	8.156521739	131.25
AR-L	Little Rock AR	0	10.52287582	76.08
WI-Ma	Madison WI	1	7.283919598	136.69
WI-Mi	Milwaukee WI	1	10.14008043	134.18
CT-N	New Haven CT	2	6.52350081	116.29
PA-P	Pittsburgh PA	1	9.209778283	95.45
UT-P	Provo-Orem UT	1	6.557446809	108.45
OR-S	Salem OR	3	8.327868852	123.35
WA-S	Spokane WA-ID	3	11.12860892	129.4
CA-S	Stockton CA	2	5.465346535	120.28
OH-T	Toledo OH-MI	0	8.417794971	100.9

Column1	
Mean	8.70425837
Standard Error	0.405166182
Median	8.278354489
Mode	#N/A
Standard Deviation	2.065950269
Sample Variance	4.268150512
Kurtosis	0.394154199
Skewness	0.92352718
Range	7.976802226
Minimum	5.465346535
Maximum	13.44214876
Sum	226.3107176
Count	26
Largest(1)	13.44214876
Smallest(1)	5.465346535
Confidence Level(95.0%)	0.834455372

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.417969628
R Square	0.17469861
Adjusted R Square	0.140311052
Standard Error	1.915536954
Observations	26

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	18.64099906	18.64099906	5.08028545
Residual	24	88.06276375	3.669281823	
Total	25	106.7037628		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	13.82424696	2.30241791	6.004230117	3.37205E-06
Composite(total)score	-0.047420981	0.021039067	-2.253948857	0.033604583

RESIDUAL OUTPUT

Observation	*Predicted arterial daily VMT per capita*	*Residuals*	
1	8.932772781	-1.332772781	Akron OH
2	9.313563258	-0.485920981	Albany NY
3	8.966441678	-0.784832482	Austin TX
4	8.534910752	4.907238008	Beaumont TX
5	8.234735943	-1.40140261	Boulder CO
6	8.055958845	-1.687537793	Bridgeport-Stamford CT-NY
7	8.780551433	0.383414249	Buffalo NY
8	9.764062576	-2.574730805	Cleveland OH
9	8.781974062	0.425676211	Colorado Springs CO
10	9.414095737	-1.185255612	Columbus OH
11	8.262240112	-0.232299992	Corpus Christi TX
12	9.011965819	-0.507922693	Dayton OH
13	7.866749132	-0.572631485	Eugene OR
14	10.06945369	2.759493676	Grand Rapids MI
15	10.58918764	2.287796485	Knoxville TN
16	7.60024322	0.55627852	Laredo TX
17	10.21645873	0.306417084	Little Rock AR
18	7.342273084	-0.058353486	Madison WI
19	7.461299746	2.678780683	Milwaukee WI
20	8.309661093	-1.786160283	New Haven CT
21	9.297914334	-0.088136051	Pittsburgh PA
22	8.681441583	-2.123994774	Provo-Orem UT
23	7.974868968	0.352999884	Salem OR
24	7.687972034	3.44063689	Spokane WA-ID
25	8.120451379	-2.655104845	Stockton CA
26	9.039469988	-0.621675017	Toledo OH-MI

PUBLIC TRANSIT ANNUAL PASSENGER MILES PER CAPITA

Public Transportation Annual Passenger-miles per capita versus Sprawl Index				
Urban area		Tier	Annual Passenger-miles per capita	Composite(total)score
OH-A	Akron OH	0	43.5	103.15
NY-A	Albany NY	2	75.4	95.12
TX-A	Austin TX	1	118.3	102.44
TX-B	Beaumont TX	0	12.4	111.54
CT-B	Bridgeport-Stamford CT-NY	2	38.8	121.64
NY-B	Buffalo NY	0	83.2	106.36
OH-Cl	Cleveland OH	0	147.8	85.62
CO-C	Colorado Springs CO	1	44.8	106.33
OH-Co	Columbus OH	0	47.3	93
TX-C	Corpus Christi TX	0	69.2	117.29
OH-D	Dayton OH	0	61.5	101.48
OR-E	Eugene OR	3	161.2	125.63
MI-G	Grand Rapids MI	0	61.5	79.18
TN-K	Knoxville TN	2	27.8	68.22
TX-L	Laredo TX	0	61.3	131.25
AR-L	Little Rock AR	0	29.2	76.08
WI-Ma	Madison WI	1	115.8	136.69
WI-Mi	Milwaukee WI	1	114.5	134.18
CT-N	New Haven CT	2	48.5	116.29
PA-P	Pittsburgh PA	1	174.9	95.45
OR-S	Salem OR	3	78.3	123.35
WA-S	Spokane WA-ID	3	130.4	129.4
CA-S	Stockton CA	2	160.6	120.28
OH-T	Toledo OH-MI	0	54.2	100.9

Column1	
Mean	81.68116246
Standard Error	9.62913656
Median	65.33741727
Mode	#N/A
Standard Deviation	47.17294247
Sample Variance	2225.286501
Kurtosis	-0.771100996
Skewness	0.628309411
Range	162.5322427
Minimum	12.39669421
Maximum	174.9289369
Sum	1960.347899
Count	24
Largest(1)	174.9289369
Smallest(1)	12.39669421
Confidence Level(95.0%)	19.91938663

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.303893425
R Square	0.092351214
Adjusted R Square	0.051094451
Standard Error	45.95200442
Observations	24

ANOVA

	df	SS	MS	F
Regression	1	4726.681913	4726.681913	2.238450304
Residual	22	46454.90762	2111.58671	
Total	23	51181.58953		

	Coefficients	Standard Error	t Stat	P-value
Intercept	-0.029282007	55.41362495	-0.000528426	0.999583139
Composite(total)score	0.759840932	0.507865787	1.496145148	0.14882476

RESIDUAL OUTPUT

Observation	Predicted Annual Passenger-miles per capita	Residuals	
1	78.34831017	-34.79992308	Akron OH
2	72.24678749	3.200366985	Albany NY
3	77.80882311	40.50535313	Austin TX
4	84.7233756	-72.32668138	Beaumont TX
5	92.39776902	-53.62225881	Bridgeport-Stamford CT-NY
6	80.78739957	2.434716734	Buffalo NY
7	65.02829863	82.74426878	Cleveland OH
8	80.76460434	-35.95586117	Colorado Springs CO
9	70.63592471	-23.37887142	Columbus OH
10	89.09246096	-19.93078431	Corpus Christi TX
11	77.07937582	-15.62385021	Dayton OH
12	95.42953434	65.74693625	Eugene OR
13	60.13492302	1.378234871	Grand Rapids MI
14	51.8070664	-24.02928863	Knoxville TN
15	99.69984038	-38.39549255	Laredo TX
16	57.77941613	-28.58551635	Little Rock AR
17	103.833375	11.99577068	Madison WI
18	101.9261743	12.55103749	Milwaukee WI
19	88.33262003	-39.87232829	New Haven CT
20	72.49753499	102.4314019	Pittsburgh PA
21	93.69709701	-15.41840848	Salem OR
22	98.29413465	32.15205957	Spokane WA-ID
23	91.36438535	69.27917901	Stockton CA
24	76.63866808	-22.48006073	Toledo OH-MI

ANNUAL HOURS OF DELAY PER CAPITA

Annual hours of delay per capita versus Sprawl Index				
Urban area		Tier	annual hours of delay per capita	Composite(total)score
OH-A	Akron OH	0	15.8	103.15
NY-A	Albany NY	2	21.3	95.12
TX-A	Austin TX	1	28.5	102.44
TX-B	Beaumont TX	0	17.3	111.54
CO-B	Boulder CO	1	14.7	117.87
CT-B	Bridgeport-Stamford CT-NY	2	28.3	121.64
NY-B	Buffalo NY	0	20.6	106.36
OH-Cl	Cleveland OH	0	20.6	85.62
CO-C	Colorado Springs CO	1	17.8	106.33
OH-Co	Columbus OH	0	27.7	93
TX-C	Corpus Christi TX	0	9.4	117.29
OH-D	Dayton OH	0	16.7	101.48
OR-E	Eugene OR	3	8.9	125.63
MI-G	Grand Rapids MI	0	16.4	79.18
TN-K	Knoxville TN	2	26.1	68.22
TX-L	Laredo TX	0	13.1	131.25
AR-L	Little Rock AR	0	17.5	76.08
WI-Ma	Madison WI	1	13.3	136.69
WI-Mi	Milwaukee WI	1	18.6	134.18
CT-N	New Haven CT	2	23.6	116.29
PA-P	Pittsburgh PA	1	26.5	95.45
UT-P	Provo-Orem UT	1	17.4	108.45
OR-S	Salem OR	3	18.7	123.35
WA-S	Spokane WA-ID	3	15.9	129.4
CA-S	Stockton CA	2	8.6	120.28
OH-T	Toledo OH-MI	0	17.8	100.9

Column1	
Mean	18.49579427
Standard Error	1.119494269
Median	17.67258526
Mode	#N/A
Standard Deviation	5.708323122
Sample Variance	32.58495287
Kurtosis	-0.453849531
Skewness	0.186972371
Range	19.87726566
Minimum	8.603960396
Maximum	28.48122605
Sum	480.8906511
Count	26
Largest(1)	28.48122605
Smallest(1)	8.603960396
Confidence Level(95.0%)	2.305641606

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.433533371
R Square	0.187951184
Adjusted R Square	0.154115817
Standard Error	5.250056785
Observations	26

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	153.1095118	153.1095118	5.55487346
Residual	24	661.5143099	27.56309625	
Total	25	814.6238217		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	33.16935408	6.310410635	5.256290912	2.17468E-05
Composite(total)score	-0.135905498	0.05766336	-2.356877905	0.026926967

RESIDUAL OUTPUT

Observation	*Predicted annual hours of delay per capita*	*Residuals*	
1	19.15070196	-3.336185829	Akron OH
2	20.24202311	1.01163543	Albany NY
3	19.24719486	9.234031192	Austin TX
4	18.01045483	-0.704669706	Beaumont TX
5	17.15017303	-2.430173027	Boulder CO
6	16.6378093	11.61675568	Bridgeport-Stamford CT-NY
7	18.71444531	1.844181955	Buffalo NY
8	21.53312534	-0.956923696	Cleveland OH
9	18.71852247	-0.871527939	Colorado Springs CO
10	20.53014276	7.157161313	Columbus OH
11	17.22899822	-7.851752707	Corpus Christi TX
12	19.37766414	-2.676855514	Dayton OH
13	16.09554636	-7.224958128	Eugene OR
14	22.40835674	-6.041580429	Grand Rapids MI
15	23.897881	2.17949995	Knoxville TN
16	15.33175746	-2.249148769	Laredo TX
17	22.82966379	-5.304609322	Little Rock AR
18	14.59243156	-1.318562209	Madison WI
19	14.93355436	3.619394706	Milwaukee WI
20	17.36490371	6.272049284	New Haven CT
21	20.19717429	6.33608324	Pittsburgh PA
22	18.43040282	-1.077211329	Provo-Orem UT
23	16.4054109	2.266720249	Salem OR
24	15.58318264	0.361699254	Spokane WA-ID
25	16.82264078	-8.218680381	Stockton CA
26	19.45648933	-1.636373274	Toledo OH-MI

ANNUAL HOURS OF DELAY PER AUTO COMMUTER

Annual hours of delay per commuter versus Sprawl index				
Urban area		Tier	Annual hours of delay per auto commuter	Composite(total)score
OH-A	Akron OH	0	23	103.15
NY-A	Albany NY	2	31	95.12
TX-A	Austin TX	1	43	102.44
TX-B	Beaumont TX	0	25	111.54
CO-B	Boulder CO	1	22	117.87
CT-B	Bridgeport-Stamford CT-NY	2	42	121.64
NY-B	Buffalo NY	0	33	106.36
OH-Cl	Cleveland OH	0	31	85.62
CO-C	Colorado Springs CO	1	26	106.33
OH-Co	Columbus OH	0	40	93
TX-C	Corpus Christi TX	0	14	117.29
OH-D	Dayton OH	0	24	101.48
OR-E	Eugene OR	3	13	125.63
MI-G	Grand Rapids MI	0	24	79.18
TN-K	Knoxville TN	2	37	68.22
TX-L	Laredo TX	0	19	131.25
AR-L	Little Rock AR	0	26	76.08
WI-Ma	Madison WI	1	20	136.69
WI-Mi	Milwaukee WI	1	28	134.18
CT-N	New Haven CT	2	35	116.29
PA-P	Pittsburgh PA	1	39	95.45
UT-P	Provo-Orem UT	1	25	108.45
OR-S	Salem OR	3	27	123.35
WA-S	Spokane WA-ID	3	23	129.4
CA-S	Stockton CA	2	12	120.28
OH-T	Toledo OH-MI	0	26	100.9

Column1	
Mean	27.23076923
Standard Error	1.670842894
Median	26
Mode	26
Standard Deviation	8.519660521
Sample Variance	72.58461538
Kurtosis	-0.462386025
Skewness	0.175142858
Range	31
Minimum	12
Maximum	43
Sum	708
Count	26
Largest(1)	43
Smallest(1)	12
Confidence Level(95.0%)	3.441165356

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.412896872
R Square	0.170483827
Adjusted R Square	0.135920653
Standard Error	7.919524422
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	309.3625751	309.3625751	4.932528114
Residual	24	1505.25281	62.71886707	
Total	25	1814.615385		

	Coefficients	Standard Error	t Stat	P-value
Intercept	48.08855908	9.51903059	5.051833653	3.64538E-05
Composite(total)score	-0.19318341	0.086983132	-2.220929561	0.036046691

RESIDUAL OUTPUT

Observation	Predicted delay per commuter	Residuals	
1	28.16169036	-5.161690362	Akron OH
2	29.71295314	1.287046857	Albany NY
3	28.29885058	14.70114942	Austin TX
4	26.54088155	-1.540881554	Beaumont TX
5	25.31803057	-3.31803057	Boulder CO
6	24.58972911	17.41027089	Bridgeport-Stamford CT-NY
7	27.54157162	5.458428383	Buffalo NY
8	31.54819554	-0.548195536	Cleveland OH
9	27.54736712	-1.547367119	Colorado Springs CO
10	30.12250197	9.877498028	Columbus OH
11	25.43007695	-11.43007695	Corpus Christi TX
12	28.48430666	-4.484306657	Dayton OH
13	23.81892731	-10.81892731	Eugene OR
14	32.7922967	-8.792296695	Grand Rapids MI
15	34.90958687	2.090413133	Knoxville TN
16	22.73323655	-3.733236546	Laredo TX
17	33.39116527	-7.391165266	Little Rock AR
18	21.6823188	-1.682318797	Madison WI
19	22.16720916	5.832790844	Milwaukee WI
20	25.62326036	9.376739643	New Haven CT
21	29.64920262	9.350797382	Pittsburgh PA
22	27.13781829	-2.13781829	Provo-Orem UT
23	24.25938548	2.740614516	Salem OR
24	23.09062585	-0.090625854	Spokane WA-ID
25	24.85245855	-12.85245855	Stockton CA
26	28.59635303	-2.596353034	Toledo OH-MI

FATAL COLLISIONS PER MILLION PEOPLE

Fatal collisions per million versus Sprawl Index				
Urban area		Tier	fatal collisions per million	Composite(total)score
OH-A	Akron OH	0	61	103.15
NY-A	Albany NY	2	86	95.12
TX-A	Austin TX	1	89	102.44
TX-B	Beaumont TX	0	207	111.54
CO-B	Boulder CO	1	107	117.87
CT-B	Bridgeport-Stamford CT	2	30	121.64
NY-B	Buffalo NY	0	50	106.36
OH-Cl	Cleveland OH	0	60	85.62
CO-C	Colorado Springs CO	1	66	106.33
OH-Co	Columbus OH	0	103	93
TX-C	Corpus Christi TX	0	90	117.29
OH-D	Dayton OH	0	75	101.48
OR-E	Eugene OR	3	67	125.63
MI-G	Grand Rapids MI	0	122	79.18
TN-K	Knoxville TN	2	167	68.22
TX-L	Laredo TX	0	48	131.25
AR-L	Little Rock AR	0	190	76.08
WI-Ma	Madison WI	1	101	136.69
WI-Mi	Milwaukee WI	1	74	134.18
CT-N	New Haven CT	2	94	116.29
PA-P	Pittsburgh PA	1	91	95.45
UT-P	Provo-Orem UT	1	60	108.45
OR-S	Salem OR	3	98	123.35
WA-S	Spokane WA-ID	3	52	129.4
CA-S	Stockton CA	2	129	120.28
OH-T	Toledo OH-MI	0	112	100.9

Column1	
Mean	93.31233417
Standard Error	8.357636681
Median	89.35462409
Mode	#N/A
Standard Deviation	42.61575253
Sample Variance	1816.102363
Kurtosis	1.437824384
Skewness	1.2084246
Range	176.5363823
Minimum	30.07518797
Maximum	206.6115702
Sum	2426.120689
Count	26
Largest(1)	206.6115702
Smallest(1)	30.07518797
Confidence Level(95.0%)	17.21287496

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.431764559
R Square	0.186420635
Adjusted R Square	0.152521494
Standard Error	39.23146335
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	8463.97388	8463.97388	5.49927324
Residual	24	36938.5852	1539.107717	
Total	25	45402.55908		

	Coefficients	Standard Error	t Stat	P-value
Intercept	202.4115321	47.15504112	4.292468574	0.000251059
Composite(total)score	-1.01046924	0.430894001	-2.345052929	0.027627

RESIDUAL OUTPUT

Observation	Predicted fatal collisions per million	Residuals	
1	98.18162998	-36.8913074	Akron OH
2	106.295698	-20.11683619	Albany NY
3	98.89906315	-10.01017426	Austin TX
4	89.70379306	116.9077772	Beaumont TX
5	83.30752277	23.3591439	Boulder CO
6	79.49805374	-49.42286577	Bridgeport-Stamford CT
7	94.93802372	-45.36700371	Buffalo NY
8	115.8951558	-55.52000922	Cleveland OH
9	94.9683378	-29.39456731	Colorado Springs CO
10	108.4378928	-5.773315969	Columbus OH
11	83.89359493	5.926764351	Corpus Christi TX
12	99.86911362	-24.3974155	Dayton OH
13	75.46628147	-8.799614801	Eugene OR
14	122.4025777	-0.692051354	Grand Rapids MI
15	133.4773205	33.18934613	Knoxville TN
16	69.78744434	-21.96135738	Laredo TX
17	125.5350323	64.00745135	Little Rock AR
18	64.29049167	36.21202089	Madison WI
19	66.82676947	6.89977209	Milwaukee WI
20	84.90406417	9.099177321	New Haven CT
21	105.9622431	-15.00146997	Pittsburgh PA
22	92.82614301	-33.25167493	Provo-Orem UT
23	77.77015134	20.5905044	Salem OR
24	71.65681243	-19.16337411	Spokane WA-ID
25	80.8722919	47.84057938	Stockton CA
26	100.4551858	11.73050088	Toledo OH-MI

INJURY COLLISIONS PER MILLION PEOPLE

Injury collisions per million versus Sprawl Index				
Urban area		Tier	injury per million	Composite(total)score
OH-A	Akron OH	0	7418	103.15
TX-A	Austin TX	1	3935	102.44
TX-B	Beaumont TX	0	4872	111.54
CT-B	Bridgeport-Stamfo	2	6393	121.64
OH-Cl	Cleveland OH	0	7249	85.62
OH-Co	Columbus OH	0	10162	93
TX-C	Corpus Christi TX	0	3527	117.29
OH-D	Dayton OH	0	6469	101.48
OR-E	Eugene OR	3	6337	125.63
MI-G	Grand Rapids MI	0	8520	79.18
TN-K	Knoxville TN	2	10028	68.22
TX-L	Laredo TX	0	2843	131.25
AR-L	Little Rock AR	0	12122	76.08
WI-Ma	Madison WI	1	7420	136.69
WI-Mi	Milwaukee WI	1	7538	134.18
PA-P	Pittsburgh PA	1	3042	95.45
UT-P	Provo-Orem UT	1	5719	108.45
OR-S	Salem OR	3	8160	123.35
CA-S	Stockton CA	2	7507	120.28
OH-T	Toledo OH-MI	0	9926	100.9

Column1	
Mean	6959.340397
Standard Error	562.4431786
Median	7333.13826
Mode	#N/A
Standard Deviation	2515.322361
Sample Variance	6326846.582
Kurtosis	-0.368746883
Skewness	0.081094851
Range	9278.526096
Minimum	2843.478261
Maximum	12122.00436
Sum	139186.8079
Count	20
Largest(1)	12122.00436
Smallest(1)	2843.478261
Confidence Level(95.0%)	1177.207102

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.465700348
R Square	0.216876814
Adjusted R Square	0.17336997
Standard Error	2286.910881
Observations	20

ANOVA

	df	SS	MS	F
Regression	1	26070780.25	26070780.25	4.984889633
Residual	18	94139304.8	5229961.378	
Total	19	120210085.1		

	Coefficients	Standard Error	t Stat	P-value
Intercept	13270.39859	2872.548633	4.619729824	0.000212817
Composite(total)score	-59.09728527	26.46913553	-2.23268664	0.038509649

RESIDUAL OUTPUT

Observation	Predicted injury per million	Residuals	
1	7174.513613	243.2283229	Akron OH
2	7216.472685	-3281.606785	Austin TX
3	6678.687389	-1806.786563	Beaumont TX
4	6081.804808	311.3208633	Bridgeport-Stamford CT
5	8210.489023	-961.9544395	Cleveland OH
6	7774.351058	2387.874647	Columbus OH
7	6338.877999	-2811.931891	Corpus Christi TX
8	7273.206079	-804.2033836	Dayton OH
9	5846.00664	491.2482621	Eugene OR
10	8591.07554	-71.33869833	Grand Rapids MI
11	9238.781787	788.9959908	Knoxville TN
12	5513.879897	-2670.401636	Laredo TX
13	8774.277125	3347.727233	Little Rock AR
14	5192.390665	2227.207325	Madison WI
15	5340.724851	2197.478903	Milwaukee WI
16	7629.562709	-4588.061856	Pittsburgh PA
17	6861.298001	-1142.149065	Provo-Orem UT
18	5980.74845	2179.087615	Salem OR
19	6162.177116	1345.248627	Stockton CA
20	7307.482504	2619.016528	Toledo OH-MI

PROPERTY DAMAGE ONLY COLLISIONS PER MILLION PEOPLE

Property Damage Only collisions per million versus Sprawl Index				
Urban area		Tier	PDO per million people	Composite(total)score
OH-A	Akron OH	0	22650	103.15
TX-A	Austin TX	1	8482	102.44
TX-B	Beaumont TX	0	19260	111.54
CT-B	Bridgeport-Stamfo	2	15740	121.64
OH-Cl	Cleveland OH	0	21479	85.62
OH-Co	Columbus OH	0	28456	93
TX-C	Corpus Christi TX	0	16683	117.29
OH-D	Dayton OH	0	17844	101.48
OR-E	Eugene OR	3	7122	125.63
MI-G	Grand Rapids MI	0	36954	79.18
TN-K	Knoxville TN	2	28020	68.22
TX-L	Laredo TX	0	13465	131.25
AR-L	Little Rock AR	0	28296	76.08
WI-Ma	Madison WI	1	21093	136.69
WI-Mi	Milwaukee WI	1	17560	134.18
PA-P	Pittsburgh PA	1	3173	95.45
UT-P	Provo-Orem UT	1	11109	108.45
OR-S	Salem OR	3	9873	123.35
CA-S	Stockton CA	2	12109	120.28
OH-T	Toledo OH-MI	0	27538	100.9

Column1	
Mean	18345.2628
Standard Error	1928.385122
Median	17701.65862
Mode	#N/A
Standard Deviation	8624.000438
Sample Variance	74373383.56
Kurtosis	-0.340664747
Skewness	0.277419711
Range	33780.55339
Minimum	3173.393974
Maximum	36953.94737
Sum	366905.2561
Count	20
Largest(1)	36953.94737
Smallest(1)	3173.393974
Confidence Level(95.0%)	4036.156446

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.55696307
R Square	0.310207861
Adjusted R Square	0.271886075
Standard Error	7358.824376
Observations	20

ANOVA

	df	SS	MS	F	Significance F
Regression	1	438352956.1	438352956.1	8.094817522	0.010743496
Residual	18	974741331.5	54152296.2		
Total	19	1413094288			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%
Intercept	44223.64603	9243.290184	4.784405244	0.000148364	24804.21395
Composite(total)score	-242.3273799	85.17241373	-2.84513928	0.010743496	-421.2679811

RESIDUAL OUTPUT

Observation	edicted PDO per million peop	Residuals	
1	19227.57679	3422.423207	Akron OH
2	19399.62923	-10917.6369	Austin TX
3	17194.45008	2065.880502	Beaumont TX
4	14746.94354	993.1209072	Bridgeport-Stamford CT
5	23475.57576	-1996.091589	Cleveland OH
6	21687.1997	6768.913154	Columbus OH
7	15801.06764	881.5670885	Corpus Christi TX
8	19632.26352	-1788.597749	Dayton OH
9	13780.05729	-6658.488667	Eugene OR
10	25036.16409	11917.78328	Grand Rapids MI
11	27692.07217	327.769098	Knoxville TN
12	12418.17742	1047.039972	Laredo TX
13	25787.37897	2508.91733	Little Rock AR
14	11099.91647	9993.048351	Madison WI
15	11708.1582	5851.493278	Milwaukee WI
16	21093.49762	-17920.10364	Pittsburgh PA
17	17943.24168	-6834.731042	Provo-Orem UT
18	14332.56372	-4459.6129	Salem OR
19	15076.50878	-2967.597885	Stockton CA
20	19772.8134	7764.904204	Toledo OH-MI

NITROGEN OXIDES PER MILLION PEOPLE

Nitrogen Oxides per million versus Sprawl Index				
Urban area		Tier	Nitrogen Oxides per million	Composite(total)score
OH-A	Akron OH	0	26042.43704	103.15
NY-A	Albany NY	2	35213.18035	95.12
TX-A	Austin TX	1	16257.04942	102.44
TX-B	Beaumont TX	0	39816.65384	111.54
CO-B	Boulder CO	1	23984.19922	117.87
CT-B	Bridgeport-Stamford CT-NY	2	9845.692064	121.64
NY-B	Buffalo NY	0	12940.93533	106.36
OH-Cl	Cleveland OH	0	19744.03852	85.62
CO-C	Colorado Springs CO	1	16718.29937	106.33
OH-Co	Columbus OH	0	35536.99682	93
TX-C	Corpus Christi TX	0	21110.73102	117.29
OH-D	Dayton OH	0	28687.13687	101.48
OR-E	Eugene OR	3	23453.31125	125.63
MI-G	Grand Rapids MI	0	28073.15235	79.18
TN-K	Knoxville TN	2	33163.30731	68.22
TX-L	Laredo TX	0	20612.62239	131.25
AR-L	Little Rock AR	0	45896.75031	76.08
WI-Ma	Madison WI	1	34578.96492	136.69
WI-Mi	Milwaukee WI	1	20499.50277	134.18
CT-N	New Haven CT	2	14739.52324	116.29
PA-P	Pittsburgh PA	1	17808.22099	95.45
UT-P	Provo-Orem UT	1	21990.09843	108.45
OR-S	Salem OR	3	27582.2518	123.35
WA-S	Spokane WA-ID	3	27300.62577	129.4
CA-S	Stockton CA	2	22192.8995	120.28
OH-T	Toledo OH-MI	0	35155.82451	100.9

Column1	
Mean	25344.01559
Standard Error	1730.188483
Median	23718.75524
Mode	#N/A
Standard Deviation	8822.264837
Sample Variance	77832356.86
Kurtosis	-0.245480978
Skewness	0.430885379
Range	36051.05825
Minimum	9845.692064
Maximum	45896.75031
Sum	658944.4054
Count	26
Largest(1)	45896.75031
Smallest(1)	9845.692064
Confidence Level(95.0%)	3563.389884

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.344966867
R Square	0.11900214
Adjusted R Square	0.082293895
Standard Error	8451.463129
Observations	26

ANOVA

	df	*SS*	*MS*	*F*
Regression	1	231555425	231555425	3.241836876
Residual	24	1714253496	71427229.02	
Total	25	1945808921		

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	43389.22311	10158.40495	4.271263386	0.000264955
Composite(total)score	-167.1334663	92.82561633	-1.800510171	0.084362152

RESIDUAL OUTPUT

Observation	*Predicted Nitrogen Oxides per million*	*Residuals*	
1	26149.40605	-106.9690154	Akron OH
2	27491.48779	7721.692559	Albany NY
3	26268.07082	-10011.02139	Austin TX
4	24747.15627	15069.49756	Beaumont TX
5	23689.20143	294.9977943	Boulder CO
6	23059.10826	-13213.4162	Bridgeport-Stamford CT-NY
7	25612.90763	-12671.97229	Buffalo NY
8	29079.25572	-9335.217198	Cleveland OH
9	25617.92163	-8899.622261	Colorado Springs CO
10	27845.81074	7691.186078	Columbus OH
11	23786.13884	-2675.407817	Corpus Christi TX
12	26428.51894	2258.617924	Dayton OH
13	22392.24573	1061.065522	Eugene OR
14	30155.59524	-2082.442893	Grand Rapids MI
15	31987.37803	1175.929278	Knoxville TN
16	21452.95565	-840.3332628	Laredo TX
17	30673.70899	15223.04133	Little Rock AR
18	20543.74959	14035.21533	Madison WI
19	20963.25459	-463.7518285	Milwaukee WI
20	23953.27231	-9213.749071	New Haven CT
21	27436.33375	-9628.11275	Pittsburgh PA
22	25263.59868	-3273.500256	Provo-Orem UT
23	22773.31003	4808.941763	Salem OR
24	21762.15256	5538.473208	Spokane WA-ID
25	23286.40978	-1093.510271	Stockton CA
26	26525.45635	8630.368161	Toledo OH-MI

SULFUR DIOXIDES PER MILLION PEOPLE

Sulfur Dioxides per million versus Sprawl Index				
Urban area		Tier	sulfur dioxide per million	Composite(total)score
OH-A	Akron OH	0	143.6275639	103.15
NY-A	Albany NY	2	241.7725672	95.12
TX-A	Austin TX	1	146.6078013	102.44
TX-B	Beaumont TX	0	162.8411124	111.54
CO-B	Boulder CO	1	143.8613191	117.87
CT-B	Bridgeport-Stamford CT-NY	2	72.27723157	121.64
NY-B	Buffalo NY	0	91.03643251	106.36
OH-Cl	Cleveland OH	0	103.8014627	85.62
CO-C	Colorado Springs CO	1	94.24183254	106.33
OH-Co	Columbus OH	0	170.5329693	93
TX-C	Corpus Christi TX	0	104.2240363	117.29
OH-D	Dayton OH	0	141.6935863	101.48
OR-E	Eugene OR	3	112.4473864	125.63
MI-G	Grand Rapids MI	0	142.6204025	79.18
TN-K	Knoxville TN	2	179.1686708	68.22
TX-L	Laredo TX	0	39.16887857	131.25
AR-L	Little Rock AR	0	202.760895	76.08
WI-Ma	Madison WI	1	167.7277719	136.69
WI-Mi	Milwaukee WI	1	117.5930739	134.18
CT-N	New Haven CT	2	107.6671478	116.29
PA-P	Pittsburgh PA	1	95.20338391	95.45
UT-P	Provo-Orem UT	1	105.1955901	108.45
OR-S	Salem OR	3	135.8277882	123.35
WA-S	Spokane WA-ID	3	107.0478646	129.4
CA-S	Stockton CA	2	88.41000792	120.28
OH-T	Toledo OH-MI	0	157.5422591	100.9

Column1	
Mean	129.8038091
Standard Error	8.49108405
Median	126.7104311
Mode	#N/A
Standard Deviation	43.29620326
Sample Variance	1874.561217
Kurtosis	0.754883602
Skewness	0.468062763
Range	202.6036886
Minimum	39.16887857
Maximum	241.7725672
Sum	3374.899036
Count	26
Largest(1)	241.7725672
Smallest(1)	39.16887857
Confidence Level(95.0%)	17.48771496

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.482991562
R Square	0.233280849
Adjusted R Square	0.201334218
Standard Error	38.69299549
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	10932.48082	10932.48082	7.302204959
Residual	24	35931.5496	1497.1479	
Total	25	46864.03042		

	Coefficients	Standard Error	t Stat	P-value
Intercept	253.7958369	46.50781892	5.457057389	1.31275E-05
Composite(total)score	-1.148405602	0.424979805	-2.702259232	0.012442059

RESIDUAL OUTPUT

Observation	Predicted sulfur dioxide per million	Residuals	
1	135.337799	8.289764957	Akron OH
2	144.559496	97.2130712	Albany NY
3	136.153167	10.45463432	Austin TX
4	125.702676	37.13843645	Beaumont TX
5	118.4332685	25.42805057	Boulder CO
6	114.1037794	-41.82654784	Bridgeport-Stamford CT-NY
7	131.651417	-40.61498449	Buffalo NY
8	155.4693492	-51.66788648	Cleveland OH
9	131.6858692	-37.44403663	Colorado Springs CO
10	146.9941159	23.53885341	Columbus OH
11	119.0993438	-14.87530748	Corpus Christi TX
12	137.2556363	4.437949916	Dayton OH
13	109.5216411	2.92574534	Eugene OR
14	162.8650813	-20.24467877	Grand Rapids MI
15	175.4516067	3.717064101	Knoxville TN
16	103.0676016	-63.898723	Laredo TX
17	166.4251386	36.33575632	Little Rock AR
18	96.82027509	70.90749681	Madison WI
19	99.70277315	17.89030079	Milwaukee WI
20	120.2477494	-12.58060157	New Haven CT
21	144.1805221	-48.97713822	Pittsburgh PA
22	129.2512493	-24.05565917	Provo-Orem UT
23	112.1400058	23.68778241	Salem OR
24	105.1921519	1.855712669	Spokane WA-ID
25	115.665611	-27.2556031	Stockton CA
26	137.9217116	19.62054749	Toledo OH-MI

VOLATILE ORGANIC COMPUNDS PER MILLION PEOPLE

Volatile Organic Compounds per million versus Sprawl Index				
Urban area		Tier	Volatile Organic Compounds per million	Composite(total)score
OH-A	Akron OH	0	10530.14928	103.15
NY-A	Albany NY	2	16087.34694	95.12
TX-A	Austin TX	1	7006.507008	102.44
TX-B	Beaumont TX	0	11292.80351	111.54
CO-B	Boulder CO	1	14010.77145	117.87
CT-B	Bridgeport-Stamford CT-NY	2	6030.059807	121.64
NY-B	Buffalo NY	0	6223.00137	106.36
OH-Cl	Cleveland OH	0	9731.946105	85.62
CO-C	Colorado Springs CO	1	9140.563606	106.33
OH-Co	Columbus OH	0	16152.3687	93
TX-C	Corpus Christi TX	0	7786.694708	117.29
OH-D	Dayton OH	0	12560.78211	101.48
OR-E	Eugene OR	3	9748.028212	125.63
MI-G	Grand Rapids MI	0	18546.6801	79.18
TN-K	Knoxville TN	2	12933.5122	68.22
TX-L	Laredo TX	0	6161.019292	131.25
AR-L	Little Rock AR	0	14340.58596	76.08
WI-Ma	Madison WI	1	14120.81891	136.69
WI-Mi	Milwaukee WI	1	9340.662214	134.18
CT-N	New Haven CT	2	8354.145789	116.29
PA-P	Pittsburgh PA	1	9697.037369	95.45
UT-P	Provo-Orem UT	1	8129.485219	108.45
OR-S	Salem OR	3	11749.41539	123.35
WA-S	Spokane WA-ID	3	13727.06841	129.4
CA-S	Stockton CA	2	7629.210644	120.28
OH-T	Toledo OH-MI	0	16119.18826	100.9

Column1	
Mean	11044.2251
Standard Error	696.0046669
Median	10139.08875
Mode	#N/A
Standard Deviation	3548.941378
Sample Variance	12594984.9
Kurtosis	-0.855367194
Skewness	0.366077137
Range	12516.62029
Minimum	6030.059807
Maximum	18546.6801
Sum	287149.8526
Count	26
Largest(1)	18546.6801
Smallest(1)	6030.059807
Confidence Level(95.0%)	1433.448444

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.408712648
R Square	0.167046029
Adjusted R Square	0.132339613
Standard Error	3305.778195
Observations	26

ANOVA

	df	SS	MS	F
Regression	1	52598555.22	52598555.22	4.81311672
Residual	24	262276067.4	10928169.47	
Total	25	314874622.6		

	Coefficients	Standard Error	t Stat	P-value
Intercept	19644.67773	3973.446143	4.943989933	4.79112E-05
Composite(total)score	-79.65679855	36.30861233	-2.193881656	0.03816579

RESIDUAL OUTPUT

Observation	Predicted VOC per million	Residuals	
1	11428.07896	-897.9296739	Akron OH
2	12067.72305	4019.623891	Albany NY
3	11484.63528	-4478.128275	Austin TX
4	10759.75842	533.0450972	Beaumont TX
5	10255.53088	3755.240566	Boulder CO
6	9955.22475	-3925.164944	Bridgeport-Stamford CT-NY
7	11172.38063	-4949.379262	Buffalo NY
8	12824.46263	-3092.516529	Cleveland OH
9	11174.77034	-2034.20673	Colorado Springs CO
10	12236.59546	3915.773242	Columbus OH
11	10301.73182	-2515.037116	Corpus Christi TX
12	11561.10581	999.6763019	Dayton OH
13	9637.394124	110.6340878	Eugene OR
14	13337.45242	5209.227682	Grand Rapids MI
15	14210.49093	-1276.978732	Knoxville TN
16	9189.722916	-3028.703624	Laredo TX
17	13584.38849	756.1974653	Little Rock AR
18	8756.389932	5364.428973	Madison WI
19	8956.328496	384.3337179	Milwaukee WI
20	10381.38862	-2027.242833	New Haven CT
21	12041.4363	-2344.398936	Pittsburgh PA
22	11005.89792	-2876.412704	Provo-Orem UT
23	9819.011625	1930.403763	Salem OR
24	9337.087994	4389.980421	Spokane WA-ID
25	10063.558	-2434.347353	Stockton CA
26	11607.30675	4511.881504	Toledo OH-MI

8.4 DETAILED POLICY REVIEW

INTRODUCTION

Balanced Growth Program Goals

The goal of the Lake Erie Protection and Restoration Plan of 2000 is: "Attaining a living equilibrium between a strong, diversified economy and a healthy Lake Erie ecosystem." The Balanced Growth Program is one of the strategies adopted by the executive agencies of the Ohio Lake Erie Commission to implement the Lake Erie Protection Plan. The overall approach of the Balanced Growth program recognizes the reciprocal relationship between stewardship of the natural environment and the economic prosperity and well being of the people in communities in the Lake Erie basin of Ohio. Said another way, the goals of the LEPP and the Balanced Growth Program are not based on a zero-sum model of imagined *tradeoffs* between the health of Lake Erie's ecosystem and economic prosperity, including land development. Prosperity and well being will be enhanced by efforts to protect the lake, requiring protection of the land that surrounds it as well.

Of note, in 2009, the Ohio Balanced Growth Program expanded statewide. The Ohio River Basin part of the Program, forming the lower 2/3 of the state, is sponsored by the Ohio Water Resources Council, which comprises the same state agencies forming the Ohio Lake Erie Commission, plus some additional commissions and offices. The principles of water resource protection of the Program, originally formulated for Lake Erie, were expanded to incorporate the rivers, lakes, streams, and aquifers of the Ohio River Basin in Ohio. The BG land use principles, and watershed planning partnership strategy, were refined to reflect the needs of the entire state, but the basic recommendations for development and collaborative planning practices remained the same. To date, there are twelve BG Watershed Planning Partnerships in Ohio, including five in the Ohio River Basin and seven in the Ohio Lake Erie Basin. For more information, see http://balancedgrowth.ohio.gov

Principles Driving the Policy Review

The Lake Erie Protection and Restoration Plan is based on ten principles guiding activities of OLEC agencies. Four of these principles (#2, #3, #4, and #5) focus on habitat, water quality, pollution loads and ecological restoration. Two principles focus on enjoyment of natural areas and public access to historic, cultural and scenic resources (#9 and #10). The remaining four principles frame land development practices and the function of Ohio's economy in relationship to Lake Erie and its tributaries:

1. Maximize investment in existing core urban areas, transportation, and infrastructure networks to enhance the economic vitality of **existing** communities.

6. Encourage the inclusion of **all economic** and environmental factors into cost / benefit accounting in land use and development decisions.

7. Avoid development decisions that **shift economic benefits** or environmental burdens from one location to the other.

8. Establish and maintain a safe, efficient, and accessible transportation system that

integrates highway, rail, air, transit, water, and pedestrian networks to foster economic growth and personal travel.

These four original principles form the basis of the policy review described in this portion of the study report. These four principles are the most directly related to the operations and programs of the Ohio Department of Transportation, particularly and obviously #8 and #1. It is suggested that #6 and #7 are relevant to ODOT decision making on project location and funding as well in order for the agency to support the Ohio Balanced Growth Program.

Benefits of Balanced Growth Planning

Benefits to local communities from planning for Balanced Growth Priority Development Areas may accrue in two broad categories: to the Ohio River and Lake Erie and their tributary streams and rivers in terms of improved water quality, reduction in risk from flooding, and reduction in public health hazards; and to the overall economic prosperity of the communities in Ohio. These in turn result from a set of outcomes or changes in the physical and social-economic qualities of communities that originated from a set of policies and practices put in place at the local, regional and state level.

No one benefit flows from any one policy outcome or policy. Rather, it is the various *combinations* of public sector policies (local land use decisions, regional/MPO decisions, and state transportation and other public sector decisions), and how these polices shape private sector land markets and business development decisions, that enable the generation of benefits. Benefits accrue to individuals, private sector business, and governments. Benefits from adoption of this overall approach may accrue to ODOT in terms of reduced costs for major projects, reduced highway maintenance costs, increased funds for system maintenance, and enhanced cost effectiveness.

This multi-variant aspect of the policy implementation process is what necessitates a comprehensive view of policy interactions, and a coordinated policy planning and implementation effort that spans jurisdictional scale and responsibilities. The need for a high level of coordination is one of the most dominant themes in the policy literature.

Policy Review Framework

This conceptual model focuses on the **Priority Development Areas** as the opportunity in the Balanced Growth Program where adoption of a “smart growth” model in the built form is intended. The policies/tools, outcomes, and benefits related either directly to Ohio water resources and their watersheds from policy implementation in the PDAs, or the community function in the PDAs associated with transportation systems, have been identified. (It does not, therefore, address broad water management issues associate with PCAs or the role of the other state agencies in support of the BGP.) The specific items included on the model are based on the review of academic literature, existing evaluations of state policies and programs, interviews with regional MPO/planning organizations, and adopted aspects of Ohio’s Balanced Growth Endorsed Plans.

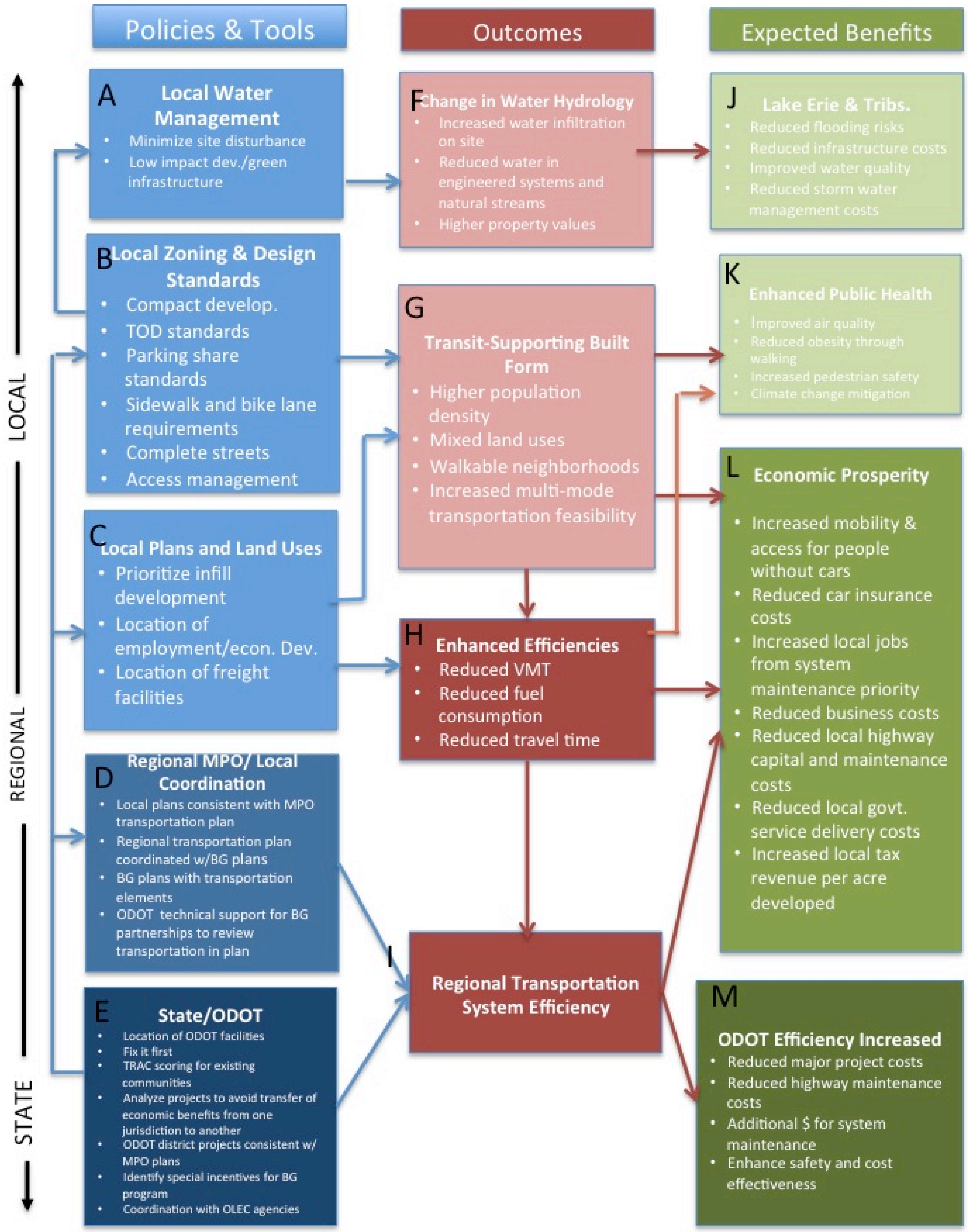
The conceptual model that organizes this section (Figure 4.3.1) presents the logic of the relationship among government policy (at the local, regional and state level), the intermediary outcomes in communities, and the benefits that may accrue to local communities. The left hand column presents (in blue) the policies and policy tools that were found to be included in literature on “smart growth” built forms that are relevant in generating a set of intervening policy outcomes (in red), which in turn generate a set of benefits (presented in the right hand column in green). The policies are clustered within the boxes, each including specific policies, outcomes or benefits as listed. The boxes are organized generally from locally implemented policies and tools at the top, moving downward to regional and then state policies near the bottom of the model. Darkening shades reflects the different jurisdictional types, running from local policies at the top to regional and then state at the bottom. Note that the arrows used to connect the boxes do not begin to show all the specific connects between policy tools listed by bullets and specific outcomes or benefits. The connections have been visually simplified, but are addressed in the narrative.

This investigation began with the definition of “smart growth” and “conventional” development offered by Fulton, Preuss, Dodds, Absetz and Hirsch (2013) in a study for Smart Growth America to categorize these policies and mechanisms:

> Smart growth = efficient use of land; a mixture of homes, businesses and services located closer together; and better connections between streets and neighborhoods.
>
> Conventional suburban development= is characterized by less efficient use of land with homes, schools and businesses separated and areas designed primarily for driving

Please note that for the purposes of this study, “Smart Growth” and “Balanced-Growth-Type” are used interchangeably. See more discussion of this in the Introduction.

Figure 4.2.1 Policies, Outcomes & Benefits from PDAs



LOCAL WATER MANAGEMENT IN PDAS, OUTCOMES AND BENEFITS

(Boxes A, F and J)

Local Water Management
- Minimize site disturbance
- Low impact dev./green infrastructure

Box A

Lake Erie & Tribs.
- Reduced flooding risks
- Reduced infrastructure costs
- Improved water quality
- Reduced storm water management costs

Box J

Change in Water Hydrology
- Increased water infiltration on site
- Reduced water in engineered systems and natural streams
- Higher property values

Box F

Why is transportation policy important for stormwater management? Urbanized areas, from suburbs to the urban core, are constituted by predominantly impervious surfaces. Increasing land development in the headwater areas of watersheds over the last several decades has resulted in more severe downstream flooding. Communities in the built-up areas have begun to reconfigure their storm water management systems and how storm water is addressed through site design processes. Two key policy tools for this shift are low impact development (LID) or green infrastructure focused on water management for site and subdivision design and the use of green infrastructure at the community level linking development sites across the landscape to reduce storm water production.

LID is an approach to land development (or re-development) is designed to manage storm water as close to its source as possible by keeping rainfall on site. Phase 2 of the Clean Water Act requires that land development practices maintain or replicate the pre-development hydrological regime (USEPA, 2000). LID focuses on preserving and recreating natural landscape features to minimize disruption to natural hydrological patterns and minimizing impervious surfaces to enhance on-site infiltration.

LID/green infrastructure incorporates site features to sequester stormwater, including bioretention facilities, rain gardens, vegetated rooftops, rain barrels, grass swales, and permeable pavements (USEPA, 2013). Stormwater can become a resource rather than a waste product using LID practices.

Adoption of these practices can result in an increase in rainfall infiltration on site, thereby lowering the water flowing into engineered systems, reducing needs for conventional stormwater infrastructure. Higher infiltration rates also lower overland flow and channel flow into streams, reducing the flooding in down stream areas as these systems are over run (Box F). LID principles and practices can reduce the impact of built areas on natural movement of water within an ecosystem or watershed (USEPA, 2013).

The benefits to local communities from using LID/green infrastructure include reduced pollution and reduce costs. LID and green infrastructure can result in reduced costs for storm water management at the local level, reduce flooding incidents and reduce development costs for local jurisdictions (Box J).

Evaluation of LID practices establish lower construction and maintenance costs than for conventional storm sewer infrastructure and significant pollutant removal, particularly for metals and nutrients from vegetated surfaces such as bioretention ponds, rain gardens and green roofs (USEPA, 2000). Pervious pavement can reduce the volume of runoff significantly. A recent review of LID/GI projects at the local level found that this approach can cost less than conventional grey infrastructure and resulted in multiple benefits beyond costs, including water conservation, recreational opportunities, increased property values, and reduced urban heat stress (USEPA, 2013).

These storm water management tools relate to PDAs because they will be increasingly important for the well being of Ohio water resources and the down stream portion of their tributaries. The outcome desired through use of these tools is to increase the infiltration of water into the ground during rain events, thus reducing the volume of water flowing into urbanized streams and storm sewers, and reducing flooding in streamside communities. Flooding is not only a water volume event, but also introduces high levels of pollutants into tributary streams from parking lots and other impervious areas. In many of the PDAs that have been designated in older communities, combined sewer overflows result in severe bacterial pollution as well during rain events. LID/green infrastructure offers opportunities to retrofit existing highly urbanized areas with pollution controls that reduce the volume of stormwater entering streams during rainfall periods. These techniques are useful in areas with high levels of impervious cover that cannot be removed, including parking lots and roofs in urban areas (USEPA, 2000, p. 3).

Cities and regions all over the United States are adopting an approach to storm water management focused on green infrastructure. A recent study found that eleven cities (Washington DC, Philadelphia, New York, Milwaukee, Los Angeles, Kansas City, MO, Portland, Detroit and Seattle will spend nearly $9 billion on green infrastructure over the next two decades (Sanchez, 2014).

Ohio's regional planning and infrastructure organizations and MPOs have adopted a range of LID/GI programs. For example, the Northeast Ohio Regional Sewer Districts' Green Infrastructure Plan, developed as part of the districts consent decree to address combined sewer overflow, seeks to identify and retrofit areas in NEORSD service area that can be used for green infrastructure projects. A focal point is use of vacant land. The implementation strategy for the plan includes a component of community development.

The City of Philadelphia, also responding to a USEPA consent decree, has instituted an integrated program to address Combined Sewer Overflow, Stormwater management and Source Water Protection programs. The city instituted a Triple-Bottom-Line analysis to assess the financial, social and environmental benefits that might accrue from green vs. grey infrastructure capacity enhancement. The city investigated a range of land-based approaches for storm water management, including disconnection of impervious cover, bioretention, subsurface storage and infiltration, green roofs, swales, green streets, permeable pavements, and urban tree canopy (USEPA 2013, Appendix).

Cincinnati, Ohio, is also integrating LID/GI approaches into its respective long-term storm water control plans as part of its consent decree response for CSO pollution and storm water management.
(http://www.msdgc.org/downloads/wetweather/greenreport/Files/Green_Report.pdf.)

Analyses for assessing viability to use LI/GI suggested that this approach would significantly reduce costs over conventional grey construction projects such as deep tunnels (Metropolitan Sewer District of Greater Cincinnati & Hamilton County, Ohio, 2007).

LOCAL ZONING AND DESIGN STANDARDS FOR THE BUILT FORM IN PDAS, OUTCOMES AND BENEFITS
(Boxes B, G, K and L)

Local Zoning & Design Standards
- Compact develop.
- TOD standards
- Parking share standards
- Sidewalk and bike lane requirements
- Complete streets
- Access management

Box B

Enhanced Public Health
- Improved air quality
- Reduced obesity through walking
- Increased pedestrian safety
- Climate change mitigation

Box K

Transit-Supporting Built Form
- Higher population density
- Mixed land uses
- Walkable neighborhoods
- Increased multi-mode transportation feasibility

Box G

Box L

Economic Prosperity

- Increased mobility & access for people without cars
- Reduced car insurance costs
- Increased local jobs from system maintenance priority
- Reduced business costs
- Reduced local highway capital and maintenance costs
- Reduced local govt. service delivery costs
- Increased local tax revenue per acre developed

The built form consists of buildings, roads, other infrastructure and designed open space in urbanized areas. The configuration of the built form is largely a result of local zoning, building and design standards.

Local governments control land use, the particular regulations governing use and form (zoning) and physical design standards. Together these regulations and standards are the "DNA" that creates the overall scale, density, aesthetic qualities of the built form and the ambient environment in communities. A variety of types of standards are part of many smart growth initiatives in American cities. All are designed to enable a denser built form that will support an efficient transit system (Calthorpe, 1993) (Box G) and reduce dependency on automobiles. A transit-ready built form depends upon necessary conditions of higher population densities (which is the demand side of transit), mixed land uses (to decrease the travel distance to employment and services), walkability (appropriate distance to the transit stop and feasibility of transportation options (i.e., multi-modal connections).

This transit ready environment depends upon zoning that mixes land uses so that housing is in close enough proximity to jobs and businesses to allow walking, biking and short transit rides (Boxes B and C). Mixed land uses and higher population densities make creation of an efficient multi-modal transportation system feasible. Local zoning and design standards to create this environment include: enabling infill development and compact development of residential areas to achieve a higher population density; adoption of standards for creating Transit Oriented Development to give developers clear signals about what is required; reduction of the square footage and number of parking areas and sharing these across business and residents to reduce impervious surface and create a pedestrian, rather than auto, dominated environment ; and including sidewalks and bike lanes as part of complete streets so that people can walk and bike and not have to use their automobiles.

The following sections describe the elements listed in Box B that can be encouraged and supported by state agencies working with local governments and regional transportation and transit agencies.

Compact Development

Compact development promotes more dense building development and has the potential to reduce costs of public infrastructure development and maintenance by shortening the distances between buildings and serving a higher density of people with fewer lane miles. The American Journal of Public Health published a study that estimated an $8.6 billion cost savings across the midwest ($106.7 billion nation-wide) for projected local infrastructure between “managed growth” and “conventional growth” development patterns. The analysts studied growth at the county level and compared projections for the amount of undeveloped land to be developed over a 25-year period. After completing this analysis, the study found that sprawl growth patterns produce a 10% increase in local road lane miles and an equal increase in public service deficits. The method of containing sprawl that was favored in this study more closely resembles the urban growth boundaries and service areas of cities like Portland - explicit limitations of the locations of new growth and construction in urbanized areas rather than a more lenient system that allows cities more control over project prioritization (Burchell & Mukherji, 2003).

In a study of the Twin Cities area, the Center for Energy and Environment of Minnesota defined sprawl and smart-growth development within the region as 2.1 units/acre and 5.5 units respectively. The Metropolitan Council in the Twin Cities region doesn’t define sprawl simply as growth, as population growth was expected to occur at a rate that would require new infrastructure regardless of where the population was settled. The CEE was concerned primarily about development in the outer “collar” counties which occurred at 2.1 to 4.1 units per acre in 1990 rather than the 7.9 units per acre of the two core cities. Projections estimated a $10,561 savings per housing unit in infrastructure development costs ($3 billion across the region) over a twenty-year period between standard and smart-growth development patterns (CEE 1999). Most cities in Ohio don’t yet face the same rapid growth issue found in the Twin Cities, so on a local scale the savings difference may not be as extreme. However, any savings in development costs would be a benefit to both local governments and the overall transportation budget for the state (Box L).

Compact development also has the potential to increase physical activity among residents, which can lead to potential health benefits (Box K). The National Institutes of Health performed a meta-analysis of 204 articles on the link between a variety of “smart growth” planning factors and changes to obesity rates nationwide and found that compact building design was found to correlate significantly with an increase in the rate of walking in 56% of studies. Similarly, some studies in this meta-analysis also reported a significant positive correlation between physical activity and open space preservation and between walking and infill development and mixed land use (Durand, Andalib & Pentz, 2012). While there are too many compounding factors to make a causal link to health benefits such as weight loss, the correlation between increased physical activity and decreased risk of illnesses like diabetes and high blood pressure is widely accepted.

Transit Oriented Development

Transit Oriented Development (TOD) combines transit of various types with land use regulation that allows for a mixed-use development at access points/stations along the transit system. TODs can be large and very dense, as when located in the CBD, or can be small and relatively less dense when located at the neighborhood bus or transit station (Calthorpe 1993). TOD standards adopted by local jurisdictions focus development around transit stations, encouraging mixed-use buildings and zoning, higher population densities, and connections to bicycle and pedestrian infrastructure. These standards seek the same outcome as Priority Development Areas—to encourage denser development in a small area while discouraging low-density development. The objective is to create sufficient population and job densities for support of a transit system. TODs prioritize transit access for larger numbers of people. Zoning standards for TODs need to take population density and transit system cost into account to ensure the most benefits. Guerra and Cervero (2012) studied the relationship between density, heavy and light rail transit, system operating costs and economic benefits. They conclude that net costs for system operation per passenger mile decrease as jobs and populations surrounding transit systems increase. It takes density and a mix of residential and economic facilities to support transit. In cities with large central business districts, the minimum housing densities to support light rail are 9 units per acre and 12 dwelling units per acre for heavy rail cost-effective systems. However, TODs can be developed at bus stop access points as well.

The Institute for Transportation Development and Policy has developed an updated set of standards and a scoring system (not unlike the LEED certification process) that would allow developers to identify projects as being transit-oriented. These standards identify the qualities of development that encourage such pedestrian and transit access (ITDP, 2014a). The largest point value is attributed to shifting the community's preferred mode overall by reducing lane miles and available off-street parking. Creating density of buildings is also a factor with a high point value, especially when comparing the density in the immediate vicinity of the transit station to that of the surrounding area. Having a short block length and mixing residential development with retail are also factors that play a role in this style of development and the latter may require Ohio cities to change zoning codes to permit such a mix (ITDP, 2014b).

For example, Cleveland's Uptown development earned a silver rating from the ITDP by ensuring a mix of uses, access to bike parking, providing ample pedestrian spaces and linking to the city's Healthline, so we can see that TOD standards have the potential to be useful to municipalities in determining building priorities. All other projects that have successfully applied to the ITDP are outside of Ohio and most are outside of the United States (ITDP, 2014a), but the model the organization has established may still serve as a helpful guideline for successful TOD development regardless of whether or not communities choose to seek out the organization's rating.

Remarkably, in a study of TOD areas in greater Chicago, the Center for Neighborhood Technology noticed a higher rate of job loss in the city's "transit shed" as compared to non-TOD areas. They also noticed an overall increase in the number of households in areas with transit access both in urban environments and in the suburbs (CNT, 2013), suggesting that transit access is an appealing factor when households choose their place of residence, but that employment does not necessarily follow that move. While this shouldn't be taken as a discouragement from developing with TOD standards in mind, local transportation agencies should be aware of this danger and coordinate efforts with the state development services agency to ensure coordination of efforts in geographic areas that might see transit-oriented development.

In New Jersey, the state's support for smart growth and the Transit Village Initiative Task Force has also been essential to the programs' continuance. Early assessment of the initiative recommended it as a model for the entire state (Voorhees Transportation Center, 2003). The state passed the Department of Transportation Act, which requires the DOT to coordinate with the Office of Smart Growth to ensure that planning follows a uniform compact growth vision (Renne, 2008, p. 93). Similarly, the Transit Village Initiative is a NJDOT project that requires coordination with an outside body—in this case, a Transit Village Initiative Task Force. This task force consists of representatives from nine agencies (Renne 2008, p. 94). Political will is cited as a major factor in the program's success in implementation, and task force members are able to "cut through red tape" within their agencies to help projects go through the approval system. The goal of the initiative is to encourage development within half a mile of a defined transit corridor. Transit Village status gives municipalities priority for state funds (Rutgers 1). Similar to the ITDP standard described above, municipalities and developers enjoy being associated with the Transit Village label for its prestige. By making smart growth a point of pride and an indication of value, the state has positioned TOD as a goal to work toward as private-sector investors rather than forcing the development with regulation (Renne, 2008, p. 103).

A study done for the Lincoln Institute of Land Policy identifies New Jersey as a leader in Smart Growth for this reason, as the Transit Village Initiative is an encouragement that doesn't require cities to make major changes but still promotes the compact development that is beneficial to communities. Of the eight states studied by the Lincoln Institute, only Oregon saw a higher percentage of growth concentrated in urban areas, with 45% in NJ and 49% in OR. For comparison, Indiana (another state surveyed in this particular study) had only 6% of its new population growth centered in urban areas (Ingram, Carbonell, Hong & Flint, 2009, p. 137).

A study completed in 2001 by Hersh (cited in TRB 2004, p. 47), entitled *The Role of State Government in Transit-Oriented Development*, highlighted the role of states with smart growth programs in supporting TODs, including:

- Promote regional coordination;
- Forge collaborative working relationships among state entities such as transportation, transit, highways, community development, and housing;
- Develop a set of goals to promote tax savings and environmental well-being through new community design strategies such as TOD;
- Implement programs and funding initiatives (often using federal dollars) that achieve these goals;
- Provide financial incentives;
- Remove regulatory and statutory barriers to land use;
- Promote public-private partnerships;
- Provide planning, policy research, technical assistance, and information support and help local governments employ innovative redevelopment strategies; and
- Establish pilot programs to test and show by example how new modes of thinking can work.

Parking standards

Parking standards play an important role for encouraging non-automobile transportation patterns. Cities can push visitors and residents alike to choose non-automotive transportation by reducing the amount of available parking space in a number of ways. Typically, city zoning codes will require a minimum number of parking spaces for each building in a development. However, in especially dense areas this can present either unused excess or an encouragement to drive even when transit is available. The alternative approach is to limit the maximum number of spaces allowed, to calculate adequate parking for a given development to include sharing of parking spaces by business and residential entities and inclusion of travel demand strategies.

For example, the City of Seattle reformed their parking requirements in order to reduce the demand on employers to provide on-site parking for their staff. The Municipal Code now states that office and manufacturing buildings with more than forty required parking spaces may substitute up to forty percent of their minimum spaces with travel demand programming. These programs include carpool spaces, purchased carpool vehicles, transit passes given to employees when transit is accessible, and bicycle parking facilities (Zimbler, 2002). Projects built in the downtown area were already exempt, as well as some commercial districts, but additional exemptions were added. Low-income housing projects and senior housing units became exempt (Seattle City Council, 2012). The first exemptions from parking minimums were granted in the early 1990s, and in-city residential parking spaces peaked shortly after (around 1999, at 1.3 spaces per unit). Today they've returned to levels last seen in the 1960s. Residential developers are also 'unbundling' parking spaces, giving car-free residents the opportunity to go without parking. This solution to over-parking has proven to only be cost-effective in dense areas without minimums, as drivers are unwilling to pay a premium for a parking spot when free parking is abundant (Durning, 2013). In a study of twenty-three multi-family housing units in the city, just over a third of parking spots were empty at night, the time assumed to be the highest-demand for residential parking. For tenants without cars, this represents an estimated $246 "hidden fee" to cover the cost of their unused spot (London & Williams-Derry, 2013). For low-income families and seniors, this 'hidden' fee makes affordable housing less affordable. Developers can gain more money from charging for parking (as could any institution managing parking systems, including cities or private firms) and city streets will see less congestion as the 'added' cost makes other transportation options seem cheaper. In Portland, city codes have dealt with their density by assigning parking maximums. Portland's maximums vary with the accessibility (Zimbler, 2002). Portland previously exempted urban residences from parking minimums, but has returned those regulations recently (Durning, 2013).

Cities also have the opportunity to encourage shared parking, combining responsibility for a set of parking spaces to downsize the overall amount of parking in an area without eliminating the number of parking spaces available to a business. In Montgomery County, MD, the city established a zoning code that allowed businesses within 500 meters of a shared parking space to overlap their parking requirements based on a calculation related to their overall size and transit access (Zimbler, 2002). The county established parking districts in its four major cities (Bethesda, Silver Springs, Montgomery Hills, Wheaton) and established a voluntary tax for those businesses who elected to fulfill their parking requirements using off-site municipal parking (paid for with those taxes). The county also re-examined its zoning codes to identify land use types with the highest (restaurant and event-based) and lowest (general commercial and some hotel spaces) parking requirements and better define the parking requirements for each land use in accordance with the length and time of each area's typical parking stay.

Montgomery county identified alterations in parking minimums as a potential driver of increased infill development, as oddly placed or shaped lots would not be excluded from development by an inability to fulfill parking requirements in a traditional way. In the future, the county also intends to examine bicycle parking minimums and the integration of car-share parking in municipal lots (Montgomery County DOT, 2011).

In its parking study, Montgomery County cited Ann Arbor's parking policy as a model for how revenue generated by parking policy can improve non-automobile options (Montgomery County DOT, 2011). In 2006 and 2007, Ann Arbor studied the availability of parking downtown and considered the possibility for changes to local policy. Though the policies haven't been in place for enough time to have had a long-term evaluation of benefits and successes, the changes to downtown parking policies have been well-received by residents and show potential for leadership among other cities. Revenue generated by the downtown parking scheme is reserved not only for maintaining the parking system, but also for providing alternatives to parking that might decrease demand for downtown parking spaces. The city notes that non-motorized methods of commuting already represented 20% of the total downtown commuting landscape, so nudging others who work in the CBD away from car use may not seem like a difficult task (Nelson/Nygaard Consulting, 2007).

As with any major city project, public-private partnerships and employer-driven demand management programs can play an important role in implementing parking management programs in Ohio. Employers who elect to move operations into parking-restricted developments may find that transit benefits or bonuses for commuting by bike attract and retain employees who don't live within walking distance of their place of employment (Zimbler, 2002). Similarly, as walkable development gains in popularity, developers may benefit from the establishment of shared municipal parking structures when new residents and business tenants elect to inhabit spaces with such parking policies. While determining a concrete value for the more efficient allocation of parking spaces is difficult to determine, city economic development offices may educate developers about the financial benefits of parking management to in order to encourage new projects.

Complete Streets

Complete Streets is an approach to street design that considers a roadway and its surrounding area as a single public space, integrating consideration of sidewalks, crossings, and multi-modal transportation, including spaces for non-motorized travel. Complete Streets are roadways designed to safely and comfortably accommodate all users, including, but not limited to motorists, cyclists, pedestrians, transit and school bus riders, delivery and service personnel, freight haulers, and emergency responders. "All users" includes people of all ages and abilities (MORPC, 2014).

While compact development on its own may provide the benefit of physical activity on its own by promoting walking, that practice on its own can also cause the amount of air pollutants to go up by maintaining the same number of car trips into a smaller space (Frank, Kavage & Litman, 2005). Designing roadways in such a way as to actively promote linkages between parking and transit infrastructure with non-motorized transportation options is necessary to keep compact development from becoming its own health hazard.

Cities and regions may require local projects to either devote a certain percentage of their budget to bike lanes, separated cycle tracks, bus-only lanes and pedestrian/multi-use paths.

Through comprehensive plans or bike master plans cities and regions can identify priority areas that might be best suited to having additional bike and pedestrian infrastructure (especially those with high residential density or high level of land use mix) in the same way that they might identify priority development areas.

In Ohio, the Mid-Ohio Regional Planning Commission leads in adoption of complete streets. MORPC's Complete Streets policy is promoted through out the region, and will "seek incorporation of the Complete Streets concept and policy into the development of all transportation infrastructures within the region at all phases of their development, including planning and land use control, scoping, design approvals, implementation, and performance monitoring and.. requires all projects receiving MORPC-attributable federal funding adhere to this policy"…The Complete Streets Policy "applies to all projects, including the new construction, reconstruction, rehabilitation, repair, maintenance, or planning of roadways, trails and other transportation facilities that will use federal funds allocated through MORPC" (MORPC, 2014). Other MPOs in Ohio that also have Complete Streets policies include the Miami Valley Regional Planning Commission (MVRPC), the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), and the Toledo Metropolitan Area Council of Governments (TMACOG).

Outcomes and Benefits to a Transit-Enabled Built Form
(Box B to E, G)

Local Zoning & Design Standards

- Compact develop.
- TOD standards
- Parking share standards
- Sidewalk and bike lane requirements
- Complete streets
- Access management

BOX B

Local Plans and Land Uses

- Prioritize infill development
- Location of employment/econ. Dev.
- Location of freight facilities

BOX C

Regional MPO/ Local Coordination

- Local plans consistent with MPO transportation plan
- Regional transportation plan coordinated w/BG plans
- BG plans with transportation elements
- ODOT technical support for BG partnerships to review transportation in plan

BOX D

State/ODOT

- Location of ODOT facilities
- Fix it first
- TRAC scoring for existing communities
- Analyze projects to avoid transfer of economic benefits from one jurisdiction to another
- ODOT district projects consistent w/ MPO plans
- Identify special incentives for BG program
- Coordination with OLEC agencies

BOX E

Transit-Supporting Built Form

- Higher population density
- Mixed land uses
- Walkable neighborhoods
- Increased multi-mode transportation feasibility

BOX G

Enhanced Efficiencies

- Reduced VMT
- Reduced fuel consumption
- Reduced travel time

BOX H

Regional Transportation System Efficiency

BOX I

Enhanced Public Health

- Improved air quality
- Reduced obesity through walking
- Increased pedestrian safety
- Climate change mitigation

BOX K

The Role of Bicycling. The addition of bike infrastructure has benefits community health by removing cars - and the emissions they create - from the road. A study by the FHWA in 2006 found that Bicycle/Pedestrian projects introduced as part of travel demand management strategies would reduce all of the Clean Air Act priority emissions by reducing auto emissions, as did inclusion of walkways in transportation projects (FHWA 2006).

In Wisconsin, it's estimated that the value of these emissions savings caused by biking is around $90 million every year. If bike share among commuters increased to 20% in Madison, Wisconsin or Milwaukee, it would save 16,687 tons (Madison) or 40,718 tons (Milwaukee) of carbon dioxide emissions, with a combined value of $1,187,859. A 20% decrease in shorter car trips would also save emissions with a value of $1.2 million (Grabow, Hahn & Whited, 2010). This can also improve community health - hospital visits for asthma decreased 41% during the Atlanta Olympics at the same time that morning traffic was reduced by 23% from car travel restrictions (Friedman, Powell, Hutwagner, Graham & Teague, 2001) (Box B to G to K).

Adding infrastructure that increases access to bicycles has also been shown to decrease accidents for all users, not only cyclists and pedestrians (Box B to G to K). In 2013, the City of Long Beach released a study about the benefits gained from the addition of one city bike lane to the overall roadway network. Beyond the increased ridership one might expect from such an installation, the city noted a 10% decrease in both car speeds and volume as well as a 50% decrease in all vehicular accidents (City of Long Beach 2013). The City of New York has noticed a similar trend, with a typical decrease in injury-causing crashes among all road users of 40% on roads with bike lanes (Wolfson, 2011). According to the Texas Transportation Institute, between 36% and 77% of cars speeding are doing so on non-highway streets (Fitzpatrick, Carlson, Brewer, Wooldridge, and Miaou, 2003).

Improving access for cyclists has economic benefits for cities as well. Between 2007 and 2012 over 27 million Americans are said to have taken cycling-related vacations. States like Wisconsin and Iowa that promote bike tourism see bike manufacturing, retail and maintenance jobs supported by this industry alongside the hotel and restaurant activity typical of all tourism. The Bicycle Federation of Wisconsin estimates 1.5 billion dollars in annual economic activity as a result of promoting cycling. This includes a substantial amount of bicycle manufacturing revenue. Iowa was said to gain $16,908,642 from its major long-distance bicycle race called RAGBRAI. On a smaller scale, IMPLAN modeling software estimates that $51,965,317 in both direct and indirect economic activity is generated by Iowa's typical level of bike commuting (Bowles, Fleming, Fuller, Lankford, & Printz, 2012).

Links to Transit. However, a "complete street" is one that not only includes safe access for bicycles and pedestrians but also links them effectively with transit. One of the benefits from zoning and design standards that encourage a transit-ready built form is an increase in access to transportation for low-income individuals and families (Box L). Low income and minority commuters constitute the core of transit ridership in the United States, making up two thirds of the nations transit commuters (Stromberg, 2014a). The majority of carless workers in the United States earn less than $32,000; 5% of American households with an income of $20,000 to $39,999 don't have motor vehicle access (Pucher & Renne, 2003), making provision of an accessible transportation system offering well-connected modes essential (Stromberg, 2014a). The National Complete Streets Coalition estimates a savings of $9,581 per year for individuals who elect to use transit over car travel. For the average family, 18 cents of each dollar of income is spent on transportation, but in low-income families this figure is more than double (NCSC, 2014). While car access does provide mobility, for low-income families to have the less expensive option of transit, cycling or walking in addition to driving means having the option to spend less of their income on transportation and have greater savings and spending power.

Pedestrian Safety. Attention to pedestrian safety is a key component of complete streets approach. As more and more Americans recognize the health benefits of walking, they are moving into neighborhoods where the built form supports walking for recreation or for commuting. However, many American cities prove dangerous to walking residents. Stromberg (2014b) reports that as a percentage of total transportation fatalities, pedestrian deaths are on the rise after falling off significantly between 2005 and 2009. Minorities and elder pedestrians make up a disproportionate share of pedestrian deaths. The report advocates for a complete street policy that can address the needs of all types of transportation system users.

Economic Benefits. Complete streets and a transit-ready built environment can also provide enhanced economic benefits for revitalization. Zehngebot and Peiser (2014) suggest that complete streets enhanced higher pedestrian traffic and potential for increased spending in retail establishments in the area based on experiences in Boston, MA. Nelson, Anderson, Bartholomew, Perlich, Sanchez and Ewing (2009) concluded that investments in transit created 31% more jobs than new highway construction.

Public Health Benefits. The overall public health benefits (Box K) from this transit-ready built form, if implemented and supported, include several public health improvements, including better air quality (from reduction in automobile emissions), increased pedestrian safety (from reduced time in automobiles) and the potential for reduce obesity, when people can realistically walk to work or shop, or walk to transportation hubs (Cradock, Troped, Fields, Melly, Simms & Grimmler, 2009; Eriksson, Arvidsson, Gebel & Sundquist, 2012).

For example, Portland, OR was projected to reap a net benefit of $1.2 billion from fuel and health care cost savings by investing about $7 per resident per year in bicycling according to the Rails-to-Trails Conservancy (Winkelman, Bishins & Kooshian, 2009).

Reduced VMT and fuel consumption reduces air pollution contributing to mitigation of climate change emissions. The Transportation Research Board's report on critical issues in transportation (2013) noted the nation's transportation system is unsustainable in terms of its impact on energy, climate and the environment (TRB 2013). Reaching emissions goals for the country will depend on reducing emission from the transportation sector, which produces 1/3 of U.S. carbon dioxide emissions. One key strategy for reducing green house gas emissions is to reduce VMT and increasing walkability of the built form, thereby supporting transit and non-motorized mobility.

In a study done for Smart Growth America, Bhatt, Peppard & Potts (2010) note that state transportation policies and investments drive transportation emissions, largely through the influence on travel choices which are influenced by availability of alternatives to automobile travel. The study notes the importance of adoption of smart growth types of policies that will work with MPOs and local governments to develop multiple modes of transportation in metropolitan regions to reduce VMT and GHG emissions .

LOCAL PLANS AND LAND USE FOR PRIORITY DEVELOPMENT AREAS
(Boxes C, H and L)

Local Plans and Land Uses
- Prioritize infill development
- Location of employment/econ. Dev.
- Location of freight facilities

Box C

Enhanced Efficiencies
- Reduced VMT
- Reduced fuel consumption
- Reduced travel time

Box H

Economic Prosperity
- Increased mobility & access for people without cars
- Reduced car insurance costs
- Increased local jobs from system maintenance priority
- Reduced business costs
- Reduced local highway capital and maintenance costs
- Reduced local govt. service delivery costs
- Increased local tax revenue per acre developed

Box L

High density, infill development is among the prominent strategies found across the United States in states and metropolitan regions adopting Balanced Growth-Type planning and operational frameworks.

High Density Infill Development

High density and infill development (HDID), usually eight or more living units per acre, is a key component of smart growth for two purposes: to ensure densities sufficient to support transit (discussed above), and to encourage people to live in the center of settlements. Dense infill, with mixed uses (residential, commercial, retail, recreational, etc.) can results in reduced vehicle miles traveled (VMT) which leads to less future infrastructure costs on a per capita basis (Box H to L).

Ewing, Bartholomew, Winkelman, Walters and Chen (2008) note the need for reduction of VMT as part of an overall approach to reduce CO2 from automobiles, and suggest compact development approaches can reduce the need to drive. They cite recommendations by the American Association of Highway and Transportation Officials (ASSHTO) that the US needs to cut the growth in VMT experienced over the last decade in half, despite a growing population (Ewing et al, 2008, p. 4). Their study suggests that compact development can reduce the need to drive by 20% to 40% and estimate a reduction in VMT of 30% from this decrease, and estimate that land use changes could reduce co2 emissions by up to 10% alone. Two additional studies find similar results and suggest that compact development strategies are key to reducing CO2 emissions by reducing overall driving (Brandes, MacCleery, Peterson & Johnston, 2010).

Along with decreased VMT, high-density infill development (HDID) leads to increased economic benefits for the region and individuals. Kooshian and Winkelman (2011) note that higher densities support economic efficiencies, as "denser central cities have enhanced productivity due to agglomeration effects" (p. 57). A study by Drennan and Brecher (2012) did not show transit increasing agglomeration effects (measure in office rents) significantly except in cities with very dense central business districts. (Box L)

Households with access to public transportation, and with one car, annually save an average of $6,251 "when compared to an equivalent household with two cars and no access to public transportation" (Winkelman, et al, 2009, p. 10). HDID often allows households to have greater transportation options. In addition, "people in compact, connected metro areas have greater [upward] economic mobility (Ewing & Hamidi, 2014, p. 9). (Box L)

As early as 2000, states across the country encouraged HDID using a variety of tools and methods. Some examples of tools used from the past include the siting of government buildings and facilities in existing communities (Box E), reducing regulatory burdens in preferred development areas, encouraging brownfield redevelopment, and offering tax breaks for those businesses that locate within existing communities (Bolen, Brown, Kiernan & Donschnik, 2001, p. 148).

In a study for the TRB, Kuzmyak, Pratt, and Douglas (2003) focused on the land use and site design aspects of density (those things that are subject to local control in large part) and concluded that higher densities typically result in more walking, reduced use of automobiles, and reduce VMT.

Infill development encouraged at the local level is reasonable due to market demand as well. Researchers expect increasing demand for small lot single family and attached housing types over the next 20 years (Winkelman, et al 2009, p. 7). A strong trend of “back to the city” exists among retiring baby boomers and younger singles as well, contributing to an already declining VMT (Cleveland Plain Dealer, 2014). Local policy can support these trends and provide benefits to individuals and local governments.

In Ohio, the Mid-Ohio Regional Planning Commission (MORPC) suggests local communities adopt a “dense by design” approach for compact development (a strategy advocated by the Best Local Land Use project of the Balanced Growth Program) (MORPC, 2010). MORPC’s overall strategy for the regional transportation system includes programs for complete streets, transit, bicycle and pedestrian access along with highway and freight programs.

Location of Employment/Economic Development

As noted above HDID, mixed use and access to public transit go hand-in-hand. They all help enhance the movement towards decreased VMT. Kooshian and Winkelman (2011) note that getting a "jobs/housing balance" right is essential, as it will lower VMT and lessens exposure to congestion. Mixed housing (of different price points) creates jobs in construction and helps to attract additional residents and employers (p. 38).

Transit investments coupled with HDID strategies have been shown to leverage up to 31 times their amount in private investment according to The Center for Transit Oriented Development (Winkelman, et al, 2009, p. 11). How do you get to a state of a compact metro area? According to Smart Growth America's report released in 2014, Santa Barbara, CA is the fourth most compact metro area nationally. They do it in part by enacting a zoning code that allows "residential uses in most commercial zones," and by including it in the city's 2011 General Plan Update (Ewing and Hamidi, 2014, p. 9).

As noted above the time is right for this type of investment as entities such as the National Homebuilders Association told their members in 2005, even before the recession, "that homebuilders and land developers should not underestimate the growing opportunities within the mixed-use sector, not just in large metropolitan areas, but also in smaller communities as well" (Kooshian & Winkelman, 2011, p. 49).

Careful coordination of the location of economic development among local, regional and state agencies, including consideration of transportation aspects, can focus on encouraging economic development and employment in PDAs, thereby increasing the efficiency of the economy and reducing local and state highway maintenance costs. It is not likely this will occur at the highest level of efficiency without such coordination. Coyne (2003) suggested that each development project permitted by local government should undergo a fiscal impact analysis that considers the true long term cost of service provision, and that projects funded or permitted by state agencies should be evaluated on the basis of their likely impact to land use densities and sprawl.

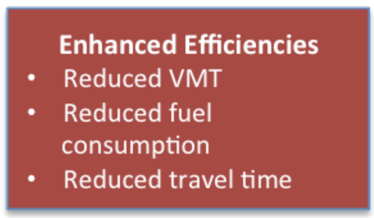
Location of Freight Facilities and Distribution Centers

Location of freight facilities and distribution centers can impact (or exacerbate) sprawl conditions and add to highway infrastructure costs (through repair and maintenance). Freight tonnage is expected to grow by 73% by the year 2035 from 2008 levels. In addition the Panama Canal is expanding its locks, which should bring more freight to the east coast for off-loading. Many entities expect expanded warehouse and distribution activities, exacerbated by the growing concept of on-time delivery. A significant amount of this freight will travel by truck through Ohio, especially on the I-70 interstate where truck traffic is expected to grow over 2% over the next 20 years (Bel-O-Mar Regional Council, 2012, p. 31)

The State of Ohio completed a Statewide Freight Study in 2013. The study predicts that truck freight will increase by 67% by 2040 from 2013 levels, and notes that while other freight modes will remain flat, there has been significant investment in inter-modal facilities which have helped to keep rail freight traffic strong. (http://www.dot.state.oh.us/Divisions/Planning/SPR/StatewidePlanning/access.ohio/Ohio%20Freight%20Study%20Reports/Ohio%20Statewide%20Freight%20Study%20Final%20Report.pdf

ENHANCED EFFICIENCIES OUTCOMES

(Box H)



Box H

Reduced VMT & Fuel Consumption

This information supplements the literature review on these topics contained in the main body of the report.

Access Ohio 2040, the state's long-range transportation plan, projects that by 2040 the gap between Ohio government transportation anticipated expenses and anticipated income will be close to $15 billion. Lower vehicle miles traveled (VMT), obtained through policies that encourage high-density infill development (HDID), can significantly lower this deficit while encouraging other economic and environmental benefits.

The literature suggests that factors of mixed use, centeredness, transportation investments, and demand management may be important in explaining variations in VMT (Ewing, Pendall & Chen, 2002). HDID helps to lower VMT by making destinations more accessible by travel modes other than an exclusive private vehicle.

Bartholomew and Ewing's (2009) meta-analysis of transportation/land use scenarios reveals that compact land scenario produces 17% fewer VMT than trend conditions (conventional lower density development). In 2009, the National Research Council's Transportation Research Board projected that "doubling residential density across a metropolitan area might lower household VMT by about 5 to 12 percent, and perhaps by as much as 25 percent, if coupled with higher employment concentrations, significant public transit improvements, mixed uses, and other supportive demand management measures" (Kooshian & Winkelman, 2011, p. 21).

Compact regions tend to have lower automobile use per capita and greater uses of alternative transportation modes than do sprawling areas (Ewing, et al, 2002), reducing per capita fuel emissions and reducing VMT by automobile.

Winkelman, et al (2009) make clear that "unchecked VMT growth is a policy choice, not a foregone conclusion. Recent studies make it clear that where and how we invest in our transportation infrastructure matters make a difference - people drive less in areas with greater walkability and transportation choices" (p. 3).

With oil prices expected to more than double by 2035, according to The International Energy Agency (Kooshian & Winkelman, 2011, p.2) numerous scenario plans indicate a significant return on an area's investment in smart growth strategies to reduce VMT. Sacramento, CA's "Preferred Blueprint Scenario" plan that features infill development envisions a saving of $9.4 billion dollars by 2050 vs. a more traditional development schema. Significant fuel saving accrue to the "Preferred" plan (vs. the other "Base Case" plan) because while there is a projected $120 million per year in increased spending on transit operating costs, annual consumer fuel expenditures would be $380 million lower (Winkelman et al, 2009, p. 8).

A very recent report completed by the Northeast Ohio Areawide Coordination Agency (NOACA) reveals that roadway congestion in northeast Ohio has decreased by 5% between 2008 and 2011, resulting in only 2% of roadways in the region rated as congested (38 out of 2400 roadway segments). The report notes the role that public transit, park and ride and bicycle facilities play in reducing congestion, and suggest expansion of public transit and bike lanes and paths as part of its congestion mitigation strategies (NOACA, 2014).

ECONOMIC PROSPERITY BENEFITS

(Boxes C and G to L)

Local Plans and Land Uses
- Prioritize infill development
- Location of employment/econ. Dev.
- Location of freight facilities

Box C

Transit-Supporting Built Form
- Higher population density
- Mixed land uses
- Walkable neighborhoods
- Increased multi-mode transportation feasibility

Box G

Enhanced Efficiencies

- Reduced VMT
- Reduced fuel consumption
- Reduced travel time

Box H

Regional Transportation System Efficiency

Box I

Lake Erie & Tribs.

- Reduced flooding risks
- Reduced infrastructure costs
- Improved water quality
- Reduced storm water management costs

Box J

Enhanced Public Health

- Improved air quality
- Reduced obesity through walking
- Increased pedestrian safety
- Climate change mitigation

Box K

Economic Prosperity

- Increased mobility & access for people without cars
- Reduced car insurance costs
- Increased local jobs from system maintenance priority
- Reduced business costs
- Reduced local highway capital and maintenance costs
- Reduced local govt. service delivery costs
- Increased local tax revenue per acre developed

Box L

For many years, as Gross Domestic Product and VMT mirrored each other in growth, it was assumed that the economy of the United States was tied to expansion of access to roadways. In fact from 1977 to 2007, VMT grew by 110% as the population only grew by 37%. But since the 1990s, a number of studies show a decoupling of this link. Growth in VMT, relative to GDP has halted and travel has declined as an important component of the US economy (Kooshian, 20011, p. 13 & 27).

Currently, many think that GDP is an outdated measure of the common well being of the people (Kooshian & Winkelman, 2011). For instance some of the negative aspects of highway travel - "fuel consumed waiting in traffic jams, oil spills, vehicle repairs and medical treatment resulting from collisions, costs of air pollution, and defense operations to protect US petroleum interests around the world" - count as economic productivity in GDP reckoning (Kooshian & Winkelman, 2011, p. 28). Further, it has been found at the state level that there is a negative relationship between vehicle travel and productivity; that is, many states with higher VMT per capita actually performed worse economically than those with lower rates of driving.

Economic Benefits

Benefits in this area include enhanced economic prosperity for individuals and businesses and improved fiscal conditions for local governments (from both reduced costs and increased tax revenues). These benefits are derived from the enhanced efficiencies listed in box H. Reduced VMT and the reduced fuel consumption occurring as a result of a transit-ready built form (Box G) generated by the transit-ready built form of Box G, created by Local zoning, design and planning practices (Boxes B and C) reduces the cost of automobile travel.

Increased mobility & access. Many residents living in Ohio's core urban areas and older ring suburbs do not own automobiles. Creating a transit-ready built form with densities and connections to employment centers will increase the mobility and accessibility of these residents to employment and reduce their time costs for daily life

The economic benefits of a transit enabled built form (created from policies in Boxes B and C) are many, come in many forms and continues to be well documented. As noted above, being less susceptible to the increasing costs of oil and increased health are two. Savings become manifest and especially accrue to lower income populations. In a 1995 review of three previous studies, Burchell and Listokin found that the costs of compact development of roads, schools and water & sewer was 75%, 95% and 95% respectively of the costs of standard development (1000 Friends of Oregon, 1997, p. 4)

Mixed use found in smart HDID allows those with limited car ownership to access jobs that move out of reach in traditional sprawl development (Winkelman, et al, 2009, p. 10). People in more compact, connected metro areas have more disposable income because they spend less on the "combined expenses of housing and transportation" (Ewing & Hamidi, 2014, p. 9)

Reduced car insurance. A more densely and better connected road infrastructure resulting in reduced VMT will push auto insurance costs lower in many communities as individuals drive fewer miles per year. Cities built at high densities have fewer cars and people spend less time driving (Smart Growth America, 2014, p. 10). Smart Growth America notes "counties with less sprawl have more car crashes, but fewer of those crashes are fatal" (p. 10). In general people with more transportation choices and less driving have fewer collisions. (Bhatt, 2010, p. 61)

The above reduction in car driving, collisions and fatalities should lead to lower insurance costs in general. Specifically, a "pay as you drive" (PAYD) insurance system could save consumers and insurance companies $50 to $60 billion annually. A Brookings study found that a universal PAYD system in California would reduce VMT by 8 percent (Winkelman, et al, 2009, p. 14).

Reduced business costs. As the built form becomes more dense, and the road network is more connected and VMTs are reduced, or transit can be used more efficiently, travel costs to businesses will be reduced. Secondary effects might include reduction in purchase costs of services from other business, which may also find reduced costs and pass these along to customers.

Not only will a mixed use, transportation option environment be a financial asset in regards to car insurance costs, but it can benefit businesses as well. According to the Urban Land Institute "'mixed use development can achieve economies of scale in operation, including savings on items such as parking operations, common area maintenance, central HVAC systems and marketing and promotion'" (Kooshian & Winkelman, 2011, p. 31)

Increased local jobs from highway maintenance priority. There is some evidence that highway maintenance projects tend to employ more local residents than highway capital investment projects by employing more local residents. Job access is not the only benefit of a smart growth type plan. One report on the American Recovery and Reinvestment Act showed that transportation construction that was public transportation oriented produced twice as many jobs as the same investment in highway projects (Kooshian & Winkelman, 2011, p. 6)

Local Government Fiscal Conditions

Three types of fiscal benefits have been shown to accrue from adopting smart-growth-like policies at the local level: infrastructure capital and maintenance costs, service delivery costs and tax revenues.

In a meta-analysis of planning studies estimating development costs conducted by 17 municipalities and regions in the United States, Fulton et al (2013) concluded that configuration of the built form in a smart growth model results in reduced costs to local governments when compared to conventional suburban development. These benefits accrued in infrastructure costs, savings on delivery of services, and increased local tax revenue.

Reduced local infrastructure capital and maintenance costs. Ingram et al (2009) found that states and counties that had adopted smart growth policies regarding infrastructure saw positive fiscal impacts between 1992 and 2002, meaning that tax revenues were greater than expenditures (p. 110).

Fulton et al (2013) found that, on average, smart growth patterns costs local governments 38% less than conventional suburban development, with some municipalities anticipating savings of nearly 50%. The infrastructure measured included roads, water and sewer lines. These results imply a reduction in local highway capital and maintenance costs, as less infrastructure needs to be built for new development, resulting in lowered maintenance costs for that infrastructure into the future when compared to conventional suburban development patterns (p. 4). The examples given in the report include savings in Champaign, IL; Mount Pleasant, SC; Phoenix, AZ; and the states of Maryland and California.

Two Sacramento, CA studies show tremendous savings realized with what one of them calls transportation demand management. The Sacramento region's Preferred Blueprint Scenario reduces greenhouse gases and saves $9.4 billion dollars through 2050. "One third of the savings are from transportation infrastructure, another third from water infrastructure, and the last third from flood control and dry utilities" (Kooshian, 2011, p. 31). The other report in 1997 by Johnston and Rodier concluded that "the Sacramento region could defer roadway projects for 7-24 years, saving federal and state agencies $100-223 million (in 1992 dollars)" (Winkelman, 2009, p. 8) as the Blueprint is adopted.

Reduced local government service delivery costs. The more dense built form associated with smart growth results in a reduction in costs for public service delivery as well, including police, ambulance and fire. These services are sensitive to the development pattern in a community because they results in fewer miles traveled by service vehicles, a possible reduction in the number of facilities to cover smaller geographies, and a possible reduction in personnel to cover the territory (Fulton et al, 2013, p. 5). The same study found an average of 10% savings in service delivery costs, with a few municipalities expecting savings of nearly 25% over 20 years (e.g., Champaign, IL).

Increased local tax revenue. Ingram et al (2009) found that localized property tax rates in urban/suburban counties that had adopted smart growth policies rose more than counties that had not (p. 111).

Fulton et al (2013) found that smart growth development patterns generate **10 times more** tax revenue per acre than conventional suburban development. Tax revenue included property taxes, sales taxes, and licensing fees. The higher tax revenue is generated as land use is mixed (retail and residential). Municipal property taxes per acre are highest for multi-story mixed-use development. An example is Raleigh, NC where property tax on a single-family residential unit was $2,800 per acre. In that same community property tax in 3-4 story residential development was $22,000; property tax on a three-story office building was $30,000; and on 6 story mixed-use developments were $110,000 per acre. These taxes are generated because of the higher land value associated with the different types of development (Source: Fulton, et al, 2013, Figure 3, p. 7).

Tax revenues are highest when land values are highest. Development of infrastructure at the periphery increases land values there, reducing the value of land in the core of each community, no matter what size. The combination of increased tax revenue and reduced infrastructure costs can result in significant improvement in fiscal conditions for local governments.

REGIONAL/MPO & LOCAL COORDINATION FOR TRANSPORTATION AND BALANCED GROWTH

(Box D)

Box D

One mechanism by which to increase economic efficiency among transportation projects is to adopt a more regional approach to project assessment that is based on land use plans developed by communities in conjunction with regional planning agencies. Ohio's weak land use planning culture poses a significant challenge to this approach. First, the state does not require incorporated jurisdictions to adopt a comprehensive plan (in which a community identifies the expected future needs of different types of land uses that would need to be served by different types of roads and highways). Second, the state itself does not provide guidance to local communities in terms of priority land uses, economic efficiencies, or the issues that should be addressed through community planning. Under these conditions it is unclear that local requests for transportation funding are based on reasonable projections or expectations. Metropolitan Planning Organizations play a critical role in facilitating the connection between local land use and state infrastructure investments.

Local Plans and MPO Plans

An MPO is made up of locally elected officials and other representatives, who are mandated to carry out the region's transportation planning in cooperation with public transit operators. They are responsible for preparing a long-range transportation plan and a shorter-range transportation improvement plan (NOACA, 2014). MPOs are, by definition, collaborative entities. Although local communities are required to coordinate transportation projects through their MPO, there is no mandated land-use planning

MPO plans are a product of considerable deliberation among local governments that make up the MPO boards. Ohio's home rule legal environmental does not require local incorporated jurisdictions to complete comprehensive plans, and so does not require or suggest elements to be included for consideration by communities that do complete master plans. However, many communities in Ohio today are developing comprehensive plans, if only to promote efficient use of scarce public resources. The Balanced Growth Best Local Land Use Practices encourages local jurisdictions to complete comprehensive plans to ensure that local polices do not operate a cross-purposes and decrease overall benefits to local policies. We suggest this approach is useful at the regional scale in terms of MPO interaction with local governments, and ODOT's support of the Balanced Growth Program.

Knaap and Moore (2000) confirm this approach. Land use needs are based on expected increases in housing units and nonresidential square footage to support continued economic prosperity. Infrastructure then is planned and developed to support those uses. As the Knaap and Moore state, "The central problem when implementing growth management practices for infrastructure is to accommodate market forces while preventing the spoil of sprawl" (p. 1). The key questions then become how much land and infrastructure is currently available for urban development, when must the supply of land and infrastructure be augmented, and how much land and infrastructure must be provided to accommodate future urban development (p. 3). Building excess capacity, or over-investment, in infrastructure distorts the land use market away from responding to need to one of stimulating un-needed development into areas (Nelson & Duncan, 1995). Answering these questions, of course, assumes a planning function in the region that can determine how much "new" land, that is land with infrastructure to support an urbanized built form, is "needed."

Various studies suggest that "communities are more likely to realize long-term benefits from development when growth and change conform to a shared vision, developed with the participation of all stakeholders" (Kooshian & Winkelman, 2011, p. 31). If metropolitan areas are to increase high-density compact development and decrease vehicle miles traveled it takes a collaborative and consistent effort between local, regional and state policies.

For example, during the 1990s in Portland, OR, the Land Use, Transportation, Air Quality (LUTRAQ) was formed. They worked under “the assumption that good planning for metropolitan areas must integrate three key elements: land-use policy, transportation investments, and supportive market strategies" (1000 Friends of Oregon, 1997, p. 4).

So called "smart growth" states, although not able to implement all of the accepted smart growth principals were able to perform well in areas that were a high priority for the state. Making coordinated smart growth planning a priority is key to its success along coordinating policies at the regional level (Ingram, et al, 2009, p. 146, 148). Others suggest that **o**rienting policy around travel efficiency and accessibility, along with other smart-growth principles, will require a “transformative change in the goals and processes of land use and transportation planning" (Kooshian & Winkelman, 2011, p. 65-66).

In their study on the effects of governance on land use, Carruthers and Ulfarsson (2002) found that coordinated land use efforts among local jurisdictions is a worthwhile policy approach if increased density is desired, and that political fragmentation lowers density. This coordination regarding land use is precisely what the Balanced Growth Plans have intended on facilitating through the watershed planning process.

Burchell, in his landmark report on the costs of sprawl noted that if "managed growth policies were able to shift a modest 15% of expected new growth into more developed areas by the year 2025, the country could save $109 billion in reduced road infrastructure alone” (Kooshian & Winkelman, 2011, p. 58)

REGIONAL MPO PLANS COORDINATED WITH BALANCED GROWTH PLANS

The key policy approach regarding regional transportation policy is to ensure consistent and meaningful coordination between MPOs among MPOs and local governments toward Balanced Growth goals. Because planning occurs at a number of levels, coordination between agencies is key to achieving the best outcome from each policy intervention. Implementation of plans must be consistent between planning agencies within a region, but also consistent between local and regional agencies. This can be challenging in Ohio as a home rule state. Three policy strategies might ensure that transportation planning at the regional level supports the Balanced Growth Program: regional transportation plan coordination with Balanced Growth Plans, inclusion of transportation as a strong element in Balanced Growth Plans, and local plan consistency with MPO LRTP.

Upon reviewing the endorsed Balanced Growth Plans it becomes clear that transportation planning and the role of MPOs in the BG program varies considerably across the state. This also results in variation in the degree to which transportation is taken in to consideration in designation of PDAs and in the policies and tools proposed to implement the plans.

A policy mechanism employed in many states, which is relatively new in Ohio, is the Public-Private Initiatives Policy (Policy No. 34-001). Implementation of this policy rests in the Innovative Delivery unit of ODOT. By the 1980s new PPPs models arrived as budget deficits soared in the federal and state governments. Some of these included:

- Design-Build-Operate (DBO)
- Design-Build-Maintain (DBM)

- Design-Build-Operate-Maintain (DBOM)

There is a growing body of analysis of PPPs both nationally and internationally. Most prominent of the PPPs are highways financed with the expectation of tolls being collected. Farber (2008) notes that recent studies completed for other states demonstrated that toll roads in fact increase congestion and promote disinvestment in urban areas by aggravating urban sprawl.

The long-term financial viability of the PPPs is equivocal. In 1988 Virginia became the first state to enact legislation enabling private development of highways. Dulles Greenway in Virginia, opening in 1995, became the "first purely private toll road build in the United States in more than 100 years" (US House, 2007, viii). Interestingly, the initial traffic demand on the PPP highway was only 23% of the expected 35,000 vehicles per day projected. The original company, which paid $350 billion to build the transportation project, sold it in 2005 for $617.5 billion (U.S. House, 2007).

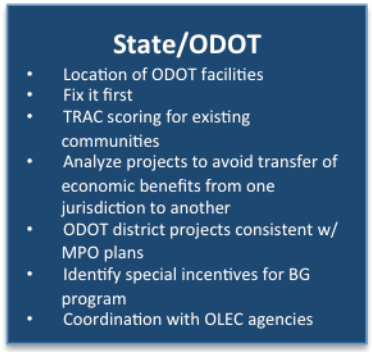
Mildenberg (2013) discovered that traffic forecasts done by consultants for states and investors typically are overly optimistic. The first-year revenue of 26 public and private toll roads that opened from 1986 to 2004 averaged one-third less than projected, according to a 2009 analysis of federal data. U.S. miles traveled peaked in 2007 at 3.03 trillion, then declined 2.5 percent through 2012, according to the Federal Highway Administration. 'You never see a consulting report be negative or else they won't be able to sell the bonds,' says Howard Cure, managing director of municipal bond research at Evercore Wealth Management" (Mildenberg, 2013, p. 44).

Siemiatycki (2010) used three case studies (Croydon Tramlink in London, SR 91 lane expansion from Riverside to Orange County, CA, and the Cross City Tunnel in Sydney, Australia) in order to explore PPPs and how best to evaluate them. Among his conclusions:

- "the private sector involvement in project financing and delivery does not appear to have significantly distorted the government's regional planning objectives or investment priorities.
- the introduction of market imperatives and greater private sector involvement at earlier stages of the planning process did result in the implementation of innovative technical and cost recovery models; and
- Similar to other research cited above he found that private entities significantly overestimated traffic volumes in two of the three cases" (Siemiatycki, 2010, 55).

Because of the varied implementation results, use of this policy should be considered in relation to regional transportation and spatial location of the projects developed through the Innovation Unit in relationship to PDAs.

STATE LEVEL TRANSPORTATION POLICIES TO SUPPORT PRIORITY DEVELOPMENT AREAS (PDAS)
(Box E)



Box E

Location of State Facilities

A report completed in 2006 for the Ohio Balanced Growth Program suggested that all OLEC agencies should adopt a policy to locate government facilities in existing settlements and within designated PDAs in the basin. Facilities under this policy would include location of state service yards. New state facilities should be used as an important economic development tool to catalyze and influence private sector to invest in existing settlements and PDAs (Kellogg, 2007). Of note, many, if not most, new state facilities, including ODOT facilities, are built on existing facility locations.

Fix-It-First Policy

By prioritizing maintenance over development, cities can keep larger, capacity-increasing and sprawl-inducing projects in a secondary role for the sake of improving overall system quality. Instituting a fix-it-first policy like the policy that already exists in the state of Ohio doesn’t necessarily cut back sprawl or prevent future sprawling development; it is merely a policy that expresses values of maintenance of existing structures over expanding capacity. Whatever built environment exists at the time of the policy’s implementation can be considered equivalent to a ‘development area’ depending on the level of enforcement of this policy. Development can still occur on the fringes of the urban area, but at a slower pace than without this restriction.

The Hamilton Project, an initiative of the Brookings Institute, cited the example of the now-collapsed I-35 bridge in Minneapolis when discussing the difficulties of ignoring fix-it-first priorities. At the time of the bridge’s collapse, government agencies had already labeled the bridge structurally deficient, and had decided to replace the bridge rather than repair it. The difference in budget between those two potential projects meant that replacing the bridge was not possible until 2020 and the bridge was not able to last that long. Had funds in the Twin Cities area been prioritized for maintenance rather than rebuilding, the repairs could have been completed sooner (Kahn & Levinson, 2011). Forty percent of vehicle damage claims due to potholes were left uncompensated (Ohio Sierra Club, 2011). Utilizing fix-it-first policies, Ohio could spare itself liability for damage to vehicles in the short term while also preventing major structural damage in the future.

Though opponents to fix-it-first policies may claim that such a policy could be damaging to our economy by eliminating jobs in the skilled trades, that complaint may not hold true. One of the benefits of the fix it first policy can be to enhance economic prosperity in project communities (Box L). Prioritizing maintenance over new construction provides more employment opportunity, especially to local residents. Smart Growth America estimates that 14,790 jobs are directly and indirectly supported by every billion dollars of repair projects while only 12,638 come from new construction - by this report's estimation, only inland waterways and transit systems support more jobs per dollar (Nelson, et al, 2009). Citing a Michigan State University study, the Hamilton Project report notes that a dollar spent on preventative maintenance saves cities and states between four and ten dollars in replacement or rehabilitation (Kahn & Levinson, 2011). If this cost-savings holds in all states/cities and climate environments, tightened budgets at all levels of government could be allowed to stretch farther and ensure a higher level of overall service.

TRAC Factors and Scoring

Utilizing project prioritization systems such as the one found in TRAC can incentivize development within urban areas. By attributing value within the scoring rubric, cities are encouraged to increase density while still being able to request projects outside the urban core as is necessary in the overall regional and local development vision.

Local Investment Factors. Currently TRAC includes fifteen points for project qualities such as proximity to existing transit routes and employment centers. By promoting urban and infill projects through this scoring process, regions may begin to see some of the associated cost-savings benefits listed above without losing local control over development patterns. This allocation should support transportation investment in PDAs in Balanced Growth Watersheds if these projects are indeed funded.

Economic Development Factors. New capacity projects change access, commute time, and consequently land values (Forkenbrock and Weisbrod 2001), as reported in a study conducted for the Transportation Research Board of the National Research Council.

Land values change as a result of changes in accessibility to an area brought by new projects, which makes the place more desirable (particularly to the extent it is near or adjacent to an existing commute shed). This raises demand for land in the area, which in turn either immediately raises property value, or a least raises expectations that property values will soon increase for landowners. More expensive land will tend to be used intensively with increased access. Current landowners, anticipating increasing values, begin selling land in the area. As long as appropriate zoning is in place, and other economic factors are supportive, development will flow into the area. If transportation projects affect the desirability of a place to live or engage in commerce, the property value will increase, and the intensity of use of the land will increase. TRB Report 403, published in 1998, provided guidance on assessing direct, indirect and cumulative effects of transportation projects. The report notes that indirect and cumulative effects could potentially occur before the project is built (i.e., speculators requesting land use actions in anticipation of project construction) (TRB, 1998).

Forkenbrock and Weisbrod (2001) also discussed how transportation projects affect economic development, as the "end result of other direct effects that a transportation project has on travelers and non-travelers (p. 108)." These effects include improvements in business travel costs (for shipping or clients) and reliability; expanded breadth of markets for suppliers, customers, and workers; reduce household travel costs; increased access to jobs outside the area; and improved the visual appearance of the area. All these changes can potentially increase property values in an area providing economic benefit. The changes to land value and economic development effects are particularly relevant for commercial land uses, which tend to need direct access to highways or major arterial roads, and therefore particularly relevant to PDAs designated in Balanced Growth Plans.

The changes in land value and the direct infrastructure investment bring localized benefits to a particular part of the region. This localized benefit, however, is financed by state and federal money, so in effect each locality "buys" local gains with money that comes from other jurisdictions in the metropolitan area. Forkenbrock and Weisbrod (2001) note the need for assessment of locally-proposed projects on two bases: whether a given project advances community development and land use goals as stated in the community's adopted comprehensive plan.

Boarnet and Haughwout, (2000) recommend that local projects should be financed on the geographic area of benefit, requiring a correspondence between types and levels of funding with the dispersal of economic benefits. This practice would reduce regional cross subsidies (p. 14). Said another way, benefits that are purely local should be purchased with local funds; funds transferred from state or federal levels should provide a regional benefit, and should not be given if they generate intra-regional negative externalities. Such a shift would require a stronger role by MPOs to ensure that the appropriate analysis of projects occurs and intra-regional negative externalities are discussed. This is the policy framework that was initiated through both ISTEA and TEA 21 (Boarnet & Haughwout, 2000, p. 17).

These two studies suggest that transportation decision makers should be aware of the size of the study are about which they are measuring potential changes stimulated by a given transportation project, in that *if the geographic scope of the analysis is too small, the assumed economic growth generated by a project might in fact merely be a case of relocation of businesses from outside the project study area (emphasis added).* (p. 161).

In order to avoid transfer of economic benefits from one jurisdiction to another (LEPP Principle #7) and include economic cost/benefit assessments into transportation projects (LEPP Principle #6), new capacity projects should be carefully assessed.

COORDINATION WITH STATE BALANCED GROWTH AGENCIES REGARDING OVERALL POLICY APPROACH REGARDING THE BALANCED GROWTH PROGRAM

State Agencies that serve on the Ohio Lake Erie Commission (OLEC) and the Ohio Water Resources Council (OWRC), co-sponsors of Ohio's Balanced Growth Program, are in a position to support Balanced Growth policy through their programs, investment decisions, and processes. Key agencies include the Ohio Department of Natural Resources, the Ohio Environmental Protection Agency, the Ohio Department of Transportation, the Ohio Department of Health, the Ohio Development Services Agency, the Ohio Department of Agriculture, the

Ohio Public Utilities Commission, and the Ohio Water Development Authority, as well as the Executive Branch through the Governor's Office.

In states that passed legislative-based growth management programs during the 1980s and 1990s a high level of inter-agency collaboration was mandated or required for effective change. Ohio's Balanced Growth Program is not based in legislation but rather comes from the Executive Branch of the State. Collaboration among the OLEC and OWRC agencies is not, however, less important for the success of the program.

ODOT POLICY OPTIONS TO SUPPORT LOCAL WATER MANAGEMENT

How is storm water management through LID/GI related to transportation? In two aspects: development of complete streets (see section on Local Zoning and Design Standards) and for road capacity and maintenance projects. Because LID/GI tools focus on land use and land management modifications, these often can require changes in roads, access management and movement of sub-surface infrastructure.

Resources can be most efficiently used through ODOT coordination with ODNR and OWRC on funding for combined transportation and GI projects. Coordination of green infrastructure projects with ongoing road maintenance and capacity projects (e.g. the Opportunity Corridor) can leverage additional funding to accomplish multiple community development, transportation and storm water goals.

Transportation projects focused on highway and road capacity and maintenance can play a key role by including pervious surfaces, green infrastructure and other storm water management components as part of the project.

Approaches by ODOT that can support local benefits based on the above literature and approaches in other locations include:

- Provide incentives (priority points or ratings in project ranking and funding) to MPOs and local governments to include green infrastructure and LID features into transportation project;
- TRAC: include coordination with state agencies with storm water funding to maximize leverage of funds when LID/GI projects require road modifications;
- Prioritizing inclusion of storm water management elements into ODOT central and district capacity enhancement projects and maintenance projects by assigning higher points, shorter time frame for project implementation, etc.

8.5 LIST OF ACRONYMS AND ABBREVIATIONS USED IN THIS REPORT

ABAG: Association of Bay Area Governors
AMATS: Akron Metropolitan Area Transportation Study
ARC: Atlanta Regional Commission
ATDM: Active Transportation Demand Management
BG: Balanced Growth
BGP: Balanced Growth Watershed Plan
BGWPP: Balanced Growth Watershed Planning Partnership
CAMPO: Capital Area Metropolitan Planning Organization
CBD: Central Business District
CEE: Center for Energy and Environment
CMAQ: Congestion Mitigation and Air Quality Program
COMPASS: Community Planning Association of Southwest Idaho
CorPlan: Community Oriented Regional Planning Model
CSO: Combined Sewer Overflow
DBM : Design-Build-Maintain
DBO : Design-Build-Operate
DBOM : Design-Build-Operate-Maintain
ESRI: Ergonomics and Safety Research Institute (UK)
FARS: Fatal Accident Reporting System
FHWA: Federal Highway Administration
FTA: Federal Transit Administration
GHG: Green House Gases
GRP: Gross Regional Product
HDID: High density and infill development
HPMS: Highway Performance Monitoring System
HSIP: Highway Safety and Improvement Program
HVAC: Heating, Ventilation, & Air Conditioning
IMPLAN: Impact Analysis for Planning
ISTEA: Intermodal Surface Transportation and Efficiency Act of 1991
ITD: Idaho Transportation Department
ITDP: Institute for Transportation and Development Policy
ITE: Institute of Transportation Engineers
LEPP: The Lake Erie Protection and Restoration Plan
LID: Low Impact Development.
LOS: Level Of Service
LTRP: Long Range Transportation Planning
LUTRAQ: Land Use, Transportation, Air Quality
MAP 21: Moving Ahead for Progress in the 21st Century act.
MDOT: Maryland Department of Transportation
MORPC: Mid-Ohio Regional Planning Commission
MPO: Metropolitan Planning Organization
MPO: Metropolitan Planning Organization Planning Railway-Highway Crossings
MRC: Metropolitan Research Center
MSA: Metropolitan Statistical Area
NCSC: National Complete Streets Coalition
NEFCO: Northeast Ohio Four County Regional Planning and Development Organization
NEORSD: Northeast Ohio Regional Sewer District

NEOSCC: North Ohio Sustainable Communities Consortium.
NEPA: National Environmental Policy Act
NHPP: National Highway Performance Program
NJDOT: New Jersey Department of Transportation
NOACA: Northeast Ohio Areawide Coordinating Agency
OARC: Ohio Association of Regional Councils
ODNR: Ohio Department of Natural Resources
ODOT: Ohio Department of Transportation
OEPA: Ohio Environmental Protection Agency
OKI: Ohio-Kentucky-Indiana Regional Council of Governments
OLEC: Ohio Lake Erie Commission
OTEC: Ohio Transportation Engineering Conference
OWRC: Ohio Water Resources Council
PAAs: Priority Agricultural Areas
PAYD: Pay As You Drive
PCAs: Priority Conservation Areas
PDAs: Priority Development Areas
PLAC3S: Planning for Community Energy, Economic and Environmental Sustainability
PPP: Public- Private Initiatives Policy
RAGBRAI: Register's Annual Great Bicycle Ride Across Iowa
SAWG: The State Agency Working Group
SEWPC: Southeast Wisconsin Regional Planning Commission
SOV: Single Occupant Vehicle
STP: Surface Transportation Program
STS: Strategic Transportation System
TA: Transportation Alternatives
TAM: Transportation Asset Management
TCSP: Transportation Community and System Preservation
TEA 21: Transportation Equity Act for the 21st Century
TJPDC: Thomas Jefferson Planning District Commission
TMACOG: Toledo Metropolitan Council of Governments
TOD: Transit Oriented Development
TRAC: Transportation Review Advisory Council
TRPC: Thurston Regional Planning Council
UGB: Urban Growth/Boundaries.
USEPA: United States Environmental Program Agency
VHT: Vehicle Hours Traveled
VMT: Vehicle Miles Traveled