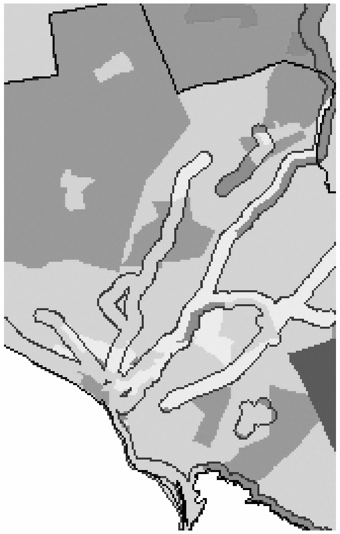
DESIGNING HEALTHY COMMUNITIES



PROJECT SUMMARY

Sprawl Patterns and Health: Impacts of Regional Land Use Patterns on Greenways and Transit

Regional Plan Association NJ NY CT

Designing Healthy Communities
Sprawl Patterns and Health: Impacts of Regional Land Use Patterns on Greenways and Transit

Regional Plan Association
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Regional Plan Association improves the quality of life and the economic competitiveness of the New York-New Jersey-Connecticut region through research, planning, and advocacy. For more than 80 years, RPA has been shaping transportation systems, protecting open spaces, and promoting better community design for the region's continued growth. We anticipate the challenges the region will face in the years to come, and we mobilize the region's civic, business, and government sectors to take action.

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1 Introduction

RPA is trying to clarify the relationship between healthy communities and regional settlement patterns, and in particular, the relationship between regional transportation and greenway infrastructure and the potential to promote physical activity at the neighborhood scale. In this way, the research will complement the extensive and multi-faceted research effort currently underway to describe the features of the physical, social and political environment at the neighborhood scale that contribute to active lifestyles. The New York Metropolitan region is used as the basis for these studies, but methodologies are described which are broadly applicable elsewhere.

This project has several components. The work begins with an assessment of regional settlement patterns and then derives from these, policy objectives and tools for healthy communities advocates.

I. Transit Accessibility

- Assess settlement patterns over three decades to establish the degree to which new development has or has not taken place within walking distance of public transit as mapped for rail lines and bus routes.

II. Greenway Accessibility to Potential Users

- Assess whether greenway creation and funding has been directed in areas that host large concentrations of potential greenway users including school children, train station commuters, and urban residents.

This information will be used as the basis for on-going advocacy work by RPA and our partners.

III. Where Transit Works: An Assessment Tool for Healthy Community Advocates

- Create a reference tool that can be used by healthy community advocates to assess the degree to which a place can support new bus and/or light rail transit based on not only the local attributes of density and land use mix, but on the larger regional context of transportation corridors.

Background

Most of the research to understand what features are associated with travel and leisure-time physical activity, as well as the assessment tools used to describe those features, has focused on the ¼ mile and ½ mile increments in the built landscape within which people are likely to walk or bike.

However, little work has been done to explain how the larger landscape and regional settlement patterns inform our assessment of what is or is not a “healthy community.” This is the link between sprawl, which is really a region-scale land use pattern, and activity, which is largely a function of land use and facilities on the neighborhood scale.

Thus, a variety of situations are as yet inadequately explained. Some development types most associated with auto dependency – such as regional malls, - may actually support transit and greenway connections if they can be captured within larger, region-scale greenway or transit corridors. Conversely, a “new community” which is constructed according to the best healthy communities design practices, and perfectly walkable and bikeable in and of itself, may never the less be considered sprawl if it was developed by “leap-frogging” over miles of farm land to a transit-inaccessible location.

The healthy communities assessment of “sprawl” has many dimensions: death or injury from accidents, air pollution, stress associated with auto congestion, over-all auto dependence (car culture). However, for this project, RPA is focusing only on how the potential for new improvements to transit or greenways in a particular location is impacted by its relationship to larger land use patterns and transportation networks. Products include accessible and user-friendly tools that provide some initial screening as to the feasibility and cost effectiveness for new transit and greenway improvements. By so doing, it can help healthy communities advocates make informed decisions about how design resources are best spent.

2 TRANSIT AND GREENWAY ACCESS:
MAPPING TRENDS IN REGIONAL SETTLEMENT PATTERNS

To map the regional settlement patterns the following maps and charts are created 1) the access to commuter rail stations, 2) access to bus routes, and 3) access to greenways and bikeways.

To create the maps and data for this research RPA used a regional GIS database. RPA first compiled a list of data needed. That list included bus routes, commuter rail lines and stations, trails and bikeways, schools, transportation improvements/enhancement projects (1995-2002).

RPA purchased data by GeoLytics called the US Census Neighborhood Change Database 1970-2000. The GeoLytics data is tract level geography. This data set provided the various types of population data.

RPA has created two major data tables. The first is an age database. The age database supplies age information on resident workers (18-65 years old) and school age children (9-18 years old).

The second is a population total/population density database. Dividing the total population by the tract area for each year from 1970-2000 derived the population density database. For this research RPA created eight density categories that included population living at 1) less than 500 people per square mile; 2) 500-1,000; 3) 1,000-2,000; 4) 2,000-3,000; 5) 3,000-5,000; 6) 5,000-10,000; 7) 10,000-20,000; 8) more than 20,000. A set of maps & data tables depicting settlement patterns across the region were developed 1970-2000. For our purposes the densities were then combined to create three densities categories 1) Less than 3,000 people per square mile; 2) 3,000-10,000; and 3) More than 10,000.

The data tables are then linked to the geography. GIS methods for creating the walking and driving distance to commuter train stations is explained in the first section followed by bus access and, finally, greenways/bikeways access.

Creating the Walking & Driving Distance to Commuter Train Stations

To tabulate population data we created a 2/3rd-mile buffer for walking distance access and a 4-Mile buffer for driving distance access. In order to reduce error in our assessment due to double counting overlapping station areas, we split all the overlapping polygons and then conducted a visual exercise of identifying the station areas by name to alter joint additional station information. The age and population density data are joined to the tract layer. Once this is complete a union of the walking distance layer to the tract layer is made. Once the two layers are combined, an area proportion was determined and multiplied by the population. This generates working age population totals for 1970, 1980, 1990, and 2000 for areas within the walking distance access and areas beyond for each county. The data table can be output to excel for further data analyses and chart creation.

Creating Bus Access Maps with Settlement Density

To tabulate population data for bus access working population totals for the 2000 bus route map layer it was buffered a ¼-mile and then we determined what densities the population resided within. We unioned the tract geography with the working age population data and the population density data to create our calculations for 1970, 1980, 1990, and 2000.

Creating Greenways and Bikeways Access

To tabulate population data for 2000 greenways & bikeways access we generated total population counts by buffering a ¼-mile from all the greenways and bike trails data. We only created population counts for 2000 data. For each county we derived the population that lived within and beyond access areas. Using the Transportation Improvements data we attached greenways & bikeways funding per county. We also looked at schools and total school age children within a buffered area of ¼ mile to 2 miles for access bike routes.

3 WHERE GREENWAYS AND BIKEWAYS WORK:

A HEALTHY COMMUNITIES ASSESSMENT

Greenways are growing in popularity across the county. These ribbons of parkland are seen as a means of providing an off-road landscaped corridor for bicyclists, skaters, and pedestrians in urban, suburban, and rural settings. Their creation has been supported by a variety of local, state, and federal programs, most notably the Enhancements and CMAQ funding stream established under the ISTEA and TEA21 amendments to the federal transportation act.

To begin to address this question, RPA will try to understand how regional settlement patterns are supported by access to greenways and the extent to which investments in greenways reflect access to potential greenway user populations. This research may yield insights into the kinds of relationships that have been established for public transit - for example, the most appropriate residential densities of potential users, and the minimum needed to support adequate greenway use. In addition, we are looking at national and local grant criteria for greenways to see whether healthy community considerations are being used to determine which projects are funded. To a certain extent all three states use smart growth/healthy community criteria in determining where to place their greenway investments. However there has been no evaluation of whether such funding is actually targeting the most viable locations from a regional perspective. This background research will be used to create an assessment methodology and as a basis for advocacy policy.

To begin to address these questions, RPA is developing and mapping a set of criteria for determining likelihood of greenway success from the healthy community perspective. These criteria are based on the concentrations of potential bicycle riders and pedestrians for trips to work and school in three categories:

- Urban Populations: High population densities and an average slope of less than 5% has the potential to generate more bicycle riders
- Potential Train Station Bicycle Commuters: People age 18 – 65 that live within 4miles from each train station in an area with an average slope of less than 5%
- School Age Population: Children age 9 -17 who live within 2 miles from elementary, middle and high schools in an areas with an average slope of less than 5%

This information is being compiled by county.

Next RPA is mapping existing Greenway/Bikeway access maps. These maps are created by compiling existing and proposed greenways and bikeways in the metropolitan and buffering their distance by ¼ mile to show their service area. The population of these areas is calculated by county.

RPA is also preparing Greenway/Bikeway investment maps. These maps are created by calculating the amount of capital funding made available through the ISTEA programs by county. Using county data on potential greenway users, the population that is already serviced by existing greenways or planned greenways can be correlated with the current distribution of funding and health data. RPA will be able to use this information to prioritize and advocate for funding of greenway and ISTEA enhancements.

Subsequent phases of work could build on this assessment tool by testing our criteria against the results of focus groups being conducted on current and prospective users of greenways. The focus groups would clarify how greenways are likely to be used as a substitute for other healthy (e.g. recreational) activity; for sedentary leisure activity; for other transit modes; and for automobile use. Based on both the assessment criteria and the focus group study, RPA would develop and distribute a graphic publication on how greenway planners, funders, and advocates can increase the likelihood of making greenway a successful part of healthy communities. The publication will include recommendations for siting and connectivity; design considerations; park programming; and marketing materials.

4 RESIDENTIAL DENSITIES TO SUPPORT TRANSIT:

A STEP TOWARD HEALTHIER COMMUNITIES

Introduction

Access to transit is one of the centerpieces of the healthy communities agenda. While there are many indirect health consequences associated with transportation choices, from air pollution to stress, the healthy communities movement is most interested in the direct impact on activity levels of reduced dependence on the automobile and in particular, the walking that typically occurs at either end of a transit trip (especially for bus, and especially for the journey to work).

This study attempts to provide a missing link between two areas of research: the first, is the current research by healthy communities advocates that is focusing on the characteristics of neighborhoods that promote or discourage walking - including walking to and from transit stations. The second, is past research by RPA that established the relationship between density and levels of service for various public transit modes.

The missing link between these two is an explanation as to how the larger regional context of a place impacts the feasibility of providing transit. The viability of public transit depends not only on the design of a community but on how that community fits into surrounding areas and in the character of those surrounding areas. After all, public transit connects communities to one another. The regional context is important because a place that in and of itself does not meet the density thresholds to support transit – perhaps some prototypical feature of the sprawl landscape such as a stand-alone office park – *may never the less be a candidate for transit because it is part of a corridor that can support transit.* Conversely, a place that meets all of the active community criteria for density, diversity and design – perhaps a model “new urban” development – *may not support transit because it is a stand-alone development that is not part of a corridor that can support transit.*

This study will provide an easy-to-use tool for healthy community advocates that can provide some initial screening as to the likelihood that a particular place, both by virtue of its density and its larger regional context, can support transit, and is therefore a productive and cost effective target for policies and interventions that support transit. Similarly, the tool can be used by policy makers and developers to determine if new development will support transit or not.

Public Transportation and Land Use Policy (PTALUP)

In 1977, Regional Plan Association published Public Transportation and Land Use Policy, co-authored by RPA's Senior Fellow for Transportation, Jeff Zupan.[1] This book established the threshold densities and land-use patterns necessary to support transit – including local bus, light rail, and heavy rail.

This work confirms quantitatively what had been understood intuitively, that generally speaking, the greater the density the more intense public transit use would be which in turn would lead to a more workable transit service. The analysis explicitly addresses the first two of the three issues cited above. The book defines density, measured either as dwellings per net acre or non-residential density, measured as millions of square feet of non-residential space as the most appropriate and encompassing metrics to define community design. Density is shown to be directly related to auto ownership, traffic congestion and ultimately to public transit use, and importantly to the cost of providing public transit. The book also considers how particular areas fit into transit corridors, including the juxtaposition of residential areas to non-residential ones.

RPA is able to use Public Transportation and Land Use Policy as the foundation to assess a community design's ability to support public transit. The product is a series of matrices and curves that help to define whether a community design supports public transit. Separate material is produced for local bus service and light rail transit (express bus service is addressed in narrative form as a variation). The series considers a number of variables including where the community fits in a typical public transit corridor, i.e., how far is it from non-residential activities (both downtowns and auto-oriented sprawl) of various sizes. From this information it is possible to state the threshold residential densities needed to support each of these modes of public transit as a function of distance from and character and size of non-residential activities. Several examples of how this can be applied are included. The results are documented in a report that describes the assumptions and methodology and is written in a non-technical form for use by planners and healthy community activists. The final document will include illustrative graphics, either in drawing or photographic formats that show communities of various densities that are representative of a range of viable transit communities. It will serve as a quick-reference tool that can be a useful addition to the healthy communities' movement.

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[1] Indiana University Press, Boris S. Pushkarev and Jeffrey M. Zupan, 1977.

Approach for Bus Service

In this report the approach taken is to construct a series of hypothetical but realistic corridors, defined by the amount of non-residential activities concentrated at the end of the corridor, the residential density gradient in the corridor leading out from this non-residential concentration, the amount and distribution of non-residential activities along the corridor and the length of the corridor. The PTALUP relationships are then used to estimate demand, the cost of meeting that demand in the particular land use setting is hypothesized, and then the cost per unit of demand is estimated and compared to actual transit cost per unit of demand for reasonableness based on the national median cost per passenger mile of .75 cents. For a particular residential development proposal the closest matching hypothetical corridor is determined to see whether the development will add to, subtract from or be in line with the transit demand in the corridor.

For local bus service, hypothetical corridors were constructed assuming that they connect to downtowns of 5, 10, 20 or 35 million square feet (msf) of non-residential floor space. For each of these downtown sizes a distinct residential density gradient, expressed in dwelling units per net acre, was assumed with gradients near the downtowns starting at higher densities and extending further from the downtowns. The densities conform to empirical data developed in PTALUP, with densities declining with increased distance from the downtown. A second and lower density gradient was also assumed to cover a greater range of possible residential situations. Three sets of non-residential activity variations were also established, expressed in millions of square feet (msf) for each square mile centered on the bus line, i.e., one-half mile on each side of the route: the first, with no added non-residential activity in the corridor; the second, with some non-residential activities in the corridor equal to half the amount in the downtown and evenly spread in the corridor; and the third, with non-residential activities in the corridor totally the amount in the downtown and spread with its own gradient from the downtown.

A second set of hypothetical corridors was tested for corridors without downtowns, but rather with “spread” non-residential activities totally 10 and 20 msf of activity. This was necessary because PTALUP demonstrated that travelers to these “spread” clusters behave differently than to downtowns. The corridors were also defined by their length to approximate likely viable bus routes as found in PTALUP. Table 1 documents these land use assumptions showing the number of dwellings per net residential acre[2] at each mile for each downtown or spread cluster size, and the “some” and “high” non-residential activity distributions assumed.

Whether a non-residential concentration is a downtown or spread cluster is open to some interpretation. A downtown is defined loosely as an area with a variety of office, retail, restaurant, and other non-residential uses

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[2] The residential density unit used throughout this report is dwellings per net residential acre, where the area is that solely devoted to residential uses. This measure reciprocal at low densities is lot size. For example, 4 dwelling units per net acre is equivalent to ¼-acre lots.

located contiguous along a grid of streets, and is typically characterized as having a walking environment. A spread cluster, while containing many if not all the same land uses, is characterized by abundant parking, absence of sidewalks, numerous curb cuts, and detached buildings. Four examples – two for each type are illustrated here.

In Figures 1 through 4 the cost per passenger mile curves are illustrated for local bus service for a series of hypothetical corridors based on the assumptions in Table 1. A number of assumptions were used to create these curves. First, the daily bus service frequency was assumed to be at 40 buses (the intermediate bus frequency assumption in PTALUP), with more buses provided in the peak period if needed to carry the estimated demand. Second, the cost of providing bus service was established at $70 per vehicle hour, equal to the median cost per vehicle-hour for the 161 bus transit operator with fleets of 40 or more buses in the United States in 2001. Third, vehicle-miles of service were converted to vehicle-hours using speed-density relationships developed in PTALUP.

In Figures 1 through 4 the cost per passenger-mile curves are drawn for both downtowns and spread cluster size. Each chart has three curves to represent a) no, b) some and c) high non-residential activities along the corridor, as defined in Table 1. Figures 1 and 2 are for downtowns (base residential gradient for Figure 1 and low residential density gradient in Figure 2). Similarly, Figures 3 and 4 depict curves for spread clusters. All figures indicate the threshold cost per passenger-mile of $0.75, the median cost per passenger-mile of the 161 bus operators in the United States with a fleet of 40 or more buses. The use of these curves is demonstrated in the next section.

Examples for Bus Service

Let us say that you are a developer with a piece of property intended for residential use. You wish to know if the density that you intend to build at will result in a healthier community, i.e., will transit be improved in the corridor if the development is built? Figures 1 through 4 can help with this, but the curves are complex, the assumptions many, so that the best way to illustrate their application is by example.

- The first step would be to determine the appropriate set of curves to use. Is the development nearest to a traditional downtown (use Figures 1 or 2) or to a more amorphous auto-oriented spread cluster (use Figures 3 or 4)?
- How large (non-residential square feet of floor space) is the downtown or cluster?
- What is the existing residential density gradient like? If it is closer to the density gradient shown in Table 1 use Figures 1 or 3, or if much less use Figures 2 or 4.
- Are there substantial non-residential activities in the corridor between the proposed development site and the downtown or spread cluster? This will determine which of the three curves within the chosen set of curves (Figures 1-4) should be used.

In our first example, we will assume that there is a downtown of 10 msf three miles from a proposed residential density development of 7 dwelling units per net acre, that the existing residential character in the corridor conforms to the residential density gradient in Table 1 line 2 ***and*** that there is only a modest amount of other non-residential activities in the corridor. This brings us to Figure 1 because it is a corridor with an average residential density gradient leading to a downtown (as opposed to a corridor with a low residential density gradient or one leading to a spread cluster) and the long dashed curve, because there is some non-residential development in the corridor. Figure 1 shows that a bus route entering the downtown in this corridor would have a cost per passenger-mile below the $0.75 line, and consequently it would be a viable bus route. Reference to Table 1 shows us that at three miles from the 10 msf downtown 5 dwellings per net residential acre or more would be suitable for this location. And since the developer is proposing 7 dwellings per net acre the development would strengthen the bus route and would create a more “healthy community-strong transit” environment. Had the development been only two miles from the downtown it would have to be designed to at least 10 dwellings per net acre to be “healthy” since that is the density to be expected at two miles from a downtown of 10 msf. And if the residential density gradient had been very low (requiring the use of Figure 2) the bus route to the 10msf downtown would not have been viable since the dashed curve is above the cost threshold, suggesting that “building for health” would have been futile.

Similarly, if this development were not near a traditional downtown, but rather three miles from a spread cluster (necessitating the use of Figures 3 or 4) the curves all would extend above the cost per passenger-mile threshold, suggesting that it would be impossible to build a development dense enough to support transit.

Suppose that there was a large downtown of 35 msf 8 miles away from the 7 dwellings per acre development site. In this case, all curves are well below the cost per passenger-mile threshold (as shown in both Figures 1 and 2) and that the 3.5 dwellings per net acre from Table 1 at eight miles would be all that would needed to support transit (and health). Recalling that the developer had contemplated 7 dwellings per net acre, it suggests that at that residential density a very supportive community would be possible.

A review of Figures 1 through 4 suggests a number of conclusions. First, with expected residential density gradients outside downtowns, a moderate frequency of bus service is possible in corridors leading to downtowns of as little as 8 msf. Even with lower density gradients, this level of service is possible with downtowns in the 10 msf to 12 msf range. This suggests that “healthy community” residential developers should seek sites that conform to the densities found near downtowns of these sizes. Developments near “spread clusters” require higher concentrations of activities – about 15 msf of clustered non-residential floor space with “normal” residential gradients in the corridor and about 20 msf with low gradients. But spread clusters of these sizes are rare. The cluster size could be lower if there are substantial non-residential activities in the corridor.

Approach for Light Rail Transit

We now turn to the discussion of light rail transit and the creation of guidelines similar to those for local bus service to determine whether particular residential developments can support light rail. The number of light rail transit systems has been expanding in the United States in recent years. Just 24 years ago there were only seven in the nation, all vestiges of street trolleys from the early part of the 20th Century. Since then, 13 cities have added light rail, and 2 more are opening this year, with many others in the planning stage. And in almost every city with light rail, these systems have either been expanded or there are plans to do so. Appendix A traces this history in ten-year increments. This growth is, in large part, a reaction to slow bus service caused by street congestion and the desire to offer a mode of travel separated from that congestion. By constructing light rail systems on separate rights-of-way higher speeds can be attained, producing both greater efficiencies and more attractive alternatives for the potential rider. But like bus service the number of people that use light rail depends on the use of land, its density and arrangement. Unless the land uses create enough riders, the efficiencies of light rail cannot be achieved. Accordingly, in the following discussion we present what densities are necessary to support efficient light rail service.

In PTALUP a series of light rail corridors were hypothesized for downtowns of 20, 35, 50 and 100 msf. The residential density gradients for these four downtown sizes were assumed based on empirical data taken from PTALUP; these density gradients are shown in Table 2. The corridors were also hypothesized to have either a) no non-residential activities within them, b) some non-residential activities and c) a high level of such activities, with the assumptions made consistent with those derived for bus service, described earlier. Similarly, these indicators were derived assuming a lower residential density gradient as was done for the bus service corridors. Assumptions are shown in Table 2. The commuter-shed or tributary area from which the light rail line would draw riders is also shown in Table 2. This exercise was not performed for downtowns smaller than 20 msf or for “spread clusters” (which typically have less than 10msf) since light rail lines in those circumstances would not approach cost-effective levels.

The estimated ridership for each corridor and for each residential and non-residential assumption is shown in Table 3, and includes average weekday passenger-miles, ridership entering the downtown, and maximum load points in the peak hour. The maximum load points were converted into vehicles needed in the peak and then expanded to determine daily vehicle-miles operated in the system. The vehicle-miles were converted to vehicle hours assuming an average speed for light rail systems of 17.5 mph based on the average of 14 US light rail systems operating largely on their own rights-of-way.[3] Daily vehicle-miles and vehicle-hours are both shown in Table 3. Assuming the median cost per vehicle-hour of these 14 systems of $200, the daily cost of operating a

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[3] Excluding four light rail systems operating mostly on city streets at slower speeds.

light rail line in each corridor was calculated. The cost per passenger-mile, the threshold performance criteria used here, was then derived from this operating cost and the daily passenger-miles.

In Figures 5 and 6 the cost per passenger-mile for all hypothesized corridors shown in Table 3 are depicted as families of curves, with the downtown size on the X-axis and cost per passenger-mile on the Y-axis. The median cost per passenger-mile for 18 US light rail systems is shown too. Figure 5 is based on corridors with the “normal” residential density gradient and Figure 6 assumes a lower gradient, as was done for the bus analysis. The use of these curves is demonstrated in the next section.

Examples for Light Rail Service

As was the case with the bus analysis, the use of these relationships is best described by example. Suppose it is desired to know if a proposed residential development is suitable to support light rail in a corridor. It is essential first to know the setting – the distance to the downtown, the size of downtown measured in millions of square feet of non-residential floorspace, the residential density gradient and the extend of non-residential activities in the corridor. Suppose a residential development of 5 dwellings units per net acre is contemplated at a site four miles from a downtown of 50 msf in a light rail corridor (either within the square mile surrounding a station or within the tributary area described in Table 2. The corridor’s residential gradient fits within the norm (Figure 5) and there is some non-residential activities in the corridor. Based on Table 2 we can expect that at four miles from a 50 msf downtown of this size residential density should be on the order of 14 dwellings units per net acre. Thus, placing only 5 units per acre at that site would be of much lower density than should be expected there and would tend to weaken the potential for the light rail line. Figure 5 does show, however, a large “margin for error” since the light rail line in this setting would fall well below the cost per passenger-mile of the average in the nation (about $0.44 versus $0.64 per passenger-mile). In fact, Figure 5 shows that with a “normal” residential gradient, light rail can do quite well in a broad range of downtown sizes from 20 msf to 100 msf and only approaches the median cost per passenger-mile when there is little non-residential activity in the corridor for smaller downtowns, i.e., 20 msf. On the other hand, if the residential densities in the corridor are low, as depicted in Figure 6, downtowns of upwards of 50 msf are needed to ensure a cost-effective light rail line.

On the other hand, suppose a residential development of 15 dwelling units per net acre is proposed eight miles outside a downtown of 35 msf within the tributary area of a light rail line. The expected residential density in this area is much lower, 3.5 units per acre, as shown in Table 2. The high density, while welcome, is much more than required as part of a light rail corridor.

Closing

In sum, it is possible to estimate whether a residential proposal can be supportive of bus or light rail service, and if not how it might have to be altered to achieve that worthy aim. Yet, the use of the data requires some dexterity with interpolation, since it is impossible to depict all possible land use combinations that could be encountered. Moreover, these relationships reflect average situations; specific analysis recognizing actual arrangements of land uses in corridor should be considered wherever possible.