The Connection between Land Use and Transportation in Land Use Plans

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16. Abstract

By examining how local land use plans anticipate and account for transportation projects and how related land management tools are actually being used by county and municipal governments in North Carolina, this study examines the degree to which indirect and cumulative land development impact assessments done for a proposed transportation project within a given locality could build on that locality's land use plan. Data for the study came from a survey of all counties and selected municipalities in the State, from planned transportation investments for all communities in the State for the 2004-2010 period and from an evaluation of 30 local plans from communities that have land use plans. The results suggest that transportation and land use planning are not as coordinated as they could or should be in land use plans. The absence of this coordination in land use plans limits the ability of planners to anticipate urban development from transportation investments. This lack of integration also means that assessments of indirect land development impacts of projects generally can not rely solely on local land use plans. Land use plans can be used a starting point for such assessments, but additional reliance on the plans requires that they incorporate the development impacts of transportation projects in a more systematic fashion. Recommendations include the provision of technical assistance for improving land use plans with respect to transportation; developing best-practice reports highlighting the use of land use and transportation indicators at different levels of aggregation and under different growth conditions; and strengthening regional and State Agencies in their ability to reach out to local land use planners to increase collaboration among parties and improve planning outcomes. This will enable localities to develop more transportation-aware land use plans.

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Summary

A recurrent challenge for conducting environmental impact assessments in the development process of a transportation project is the need to characterize and evaluate the potential for secondary and indirect impacts. This is especially true given their potential to induce new urban growth. Ideally, an assessment of the potential for secondary and cumulative land development impacts from a proposed transportation project within a given locality should build substantially on that locality's land use plan. This report documents how local land use plans in North Carolina anticipate and account for transportation projects and how related land management tools are actually being used by county and municipal governments in North Carolina. In addition, the report interprets the findings based on existing evidence regarding desirable characteristics that land use plans should have. The premise of the study is that local development plans should address the reciprocal relationship between future land uses and future transportation infrastructure and transportation service needs in a given community.

The study was developed in two phases. In the first phase we conducted a comprehensive literature review on the connection between transportation and land use; we surveyed all counties and selected municipalities in North Carolina regarding the presence and characteristics of land use plans and adopted tools and policies to manage land development, especially as they relate to transportation factors; and we examined planned transportation investments for all communities in the State for the 2004-2010 time horizon. In the second phase of the study we selected 30 local plans from communities that reported having land use plans in the first phase survey to analyze the content of their plans. We also developed a legal primer that can be used by state and regional planners to understand the relationship and potential inconsistencies between land use or comprehensive plans and zoning ordinances (included as an appendix to the report).

The literature review revealed principles that could assist planners in incorporating and accounting for connections between land use and transportation in land use plans. Land use plans connecting transportation and land use demonstrate a strong factual and analytical basis related to transportation and land use supply and demand; clearly relate transportation and land use policies to geographically identified areas; articulate goals, including transportation goals achieved with land use policies and objectives; incorporate currently planned federal, state and local transportation investments; employ policies that are both directive and reasonably designed to achieve desired ends; achieve a high degree of consistency; and facilitate participation and incorporate ongoing monitoring and implementation evaluation procedures, using indicators. Application of these principles to land use plans guide towards a more effective and productive use of land use plans in managing growth and improving community outcomes. We evaluated our survey of planners and the content analysis of the plans in the light of these guiding principals.

For the survey of planners, we received responses from 47 municipalities and 79 counties, for an overall response rate of 77%. We found that 98% of municipalities and 77% of counties reported having land use plans for managing land development. The majority of these plans were developed over the last 10 years, but some plans were developed as early as 1974 and have not been updated since then.

Both the survey and the content analysis suggest that planners are aware of the induced development caused by some transportation improvements. Furthermore, planners' attitudes reflected a belief that land use plans should embody the reciprocal relationship between transportation and land use. Although there is considerable awareness of the connection between land use and transportation, this connection is rarely visible in the analyses and policies of the land use plans. For example, few plans take into account all or most transportation improvements in the community and according to respondents almost a third of plans do not account for any improvements. The detailed analysis of the plans confirmed this finding: Seldom do land use plans use land policies or objectives to achieve transportation outcomes, and only a handful of plans explicitly reference the reciprocal connection between transportation and land development.[1]

The vast majority of planners reported familiarity with the State Transportation Improvement Program (TIP) as it affected their jurisdictions, and most were "familiar" or "somewhat familiar" with where and when such improvements would take place. Thus, despite a) awareness of the importance of the reciprocal relationship between transportation and land use; and b) knowledge about programmed transportation improvements, the connection remains unaccounted for in a high percentage of land use plans. It appears that a potential role for NCDOT and other state agencies may be to provide technical assistance enabling localities to develop more transportation-aware land use plans. Such assistance may take the form of a community guide of best practices in land use planning, with respect to transportation.

We found that plans included far more non-motorized transportation modes than what planners reported in the survey. In fact, the content analysis suggested that plans that included non-motorized transportation elements were also more likely to discuss the environmental impacts of transportation projects, had higher consistency ratings, and were more likely to include transportation facilities in their land suitability analyses. Likewise, we found that areas with significant non-motorized projects in the TIP seem to have a better integration of transportation and land use. The fact that metropolitan planning organizations (MPOs) tend to include more consideration of land use in transportation planning, may explain this association between non-motorized projects and land use-transportation integration. This finding supports the view that non-motorized modes are more scale dependent, and rely on supportive land uses to be viable. As such, when land use plans incorporate non-motorized modes, we detected a stronger connection between transportation and land use in the plan.

In contrast, plans that included predominantly motorized modes do not exhibit a strong land use-transportation connection. In fact, the presence of auto-related elements in the plan is associated with plans that were strong procedurally (i.e., generic plan quality, consistency in plan analysis

[1] These policies include infrastructure investments to manage growth, recreational opportunities within walking or biking distance, development with direct non-motorized links to surrounding areas, commercial centers providing pedestrian amenities, employer and/or government-sponsored commute reduction programs, parking demand/supply management, transit-oriented developments, regular performance monitoring of transportation modes, local relationship to regional transportation network, use of renewable resources and transfer development rights. For additional details regarding the policies examined, please see Appendix 2.

and policy recommendations) but weak in terms of substantive aspects of the connection between transportation and land use (i.e., goals and policies emphasized through the plans and plan implementation efforts). Of concern is that municipalities and counties with higher auto/road programmed TIP expenditures are significantly *less* likely to account for most or all land development impacts created by transportation projects. These results indicate that encouraging land planners to consider the development impacts of road improvements should be a priority.

The survey and content analysis indicate that the implementation of land use plans needs to be strengthened. Relevant aspects of plan implementation that need attention include:

- Development of land use indicators to monitor land use goals.
- Development of transportation-related indicators to quantify and monitor land use goals. None of the land use plans examined used basic indicators of accessibility, such as jobs-housing ratios, percent of population within reach of jobs centers, or percent of population within ¼ mile of transit. Although transportation plans commonly include some of these indicators, we suggest that land use plans should also include them.
- Joint presentation in the land use plan of the timing of the implementation of the land use plan and the timing of the planned transportation improvements in the TIP. This will encourage coordination and consistency.

The focus on implementation is important because plans that have better implementation programs, or that are used to guide policy decisions, are more likely to include multiple transportation modes.

Finally, we found that community planners that interact more frequently with their metropolitan planning organizations or their rural planning organizations appear to be more aware of current transportation conditions, including the need for non-motorized modes, and their plans reflect better use of measurable indicators to monitor transportation issues. In contrast, however, plans from respondents indicating frequent or periodic interaction with NCDOT are actually *less* likely to include non-motorized modes compared to those with infrequent interaction with NCDOT. Frequent interaction with NCDOT provides a natural opportunity to educate local planners about the benefits of accounting for the development impacts of transportation projects and of a land use system that supports multimodal transportation options.

Taken together, these findings suggest that transportation and land use planning are not as coordinated as they could or should be. The absence of this connection in land use planning limits the ability of community planners to anticipate growth from transportation investments. Moreover, the lack of integration between transportation and land use also means that the assessment of indirect and cumulative impacts can build on local land use plans, but cannot rely solely on them. Further reliance on land use plans requires that they incorporate the development impacts of transportation projects in a more systematic fashion.

In light of these findings, the report provides specific recommendations to NCDOT. These include:

- Working with the Division of Community Assistance (DCA) to provide technical assistance that enables localities to develop more transportation-aware land use plans.

Such assistance may take the form of a community guide of best practices in land use planning, with respect to transportation, following the guidelines developed in this report.

- Working with the DCA to develop brief best-practice reports highlighting the use of various indicators at different levels of aggregation and under different growth conditions. Such reports could become a key reference when land use planners are revising or updating their local plans.
- Working with the DCA to encourage comprehensiveness in land use planning. This involves not only involving other transportation modes, but including water, sewer, and other infrastructure and environmentally-related characteristics of a community that may be related to how and where the community wants to grow. This comprehensiveness can also aid in increasing the acceptance of the plan.
- Creation of institutional mechanisms that enable DCA, NCDOT planners, MPOs and Rural Planning Organizations (RPOs) to reach out to local land use planners to increase collaboration among parties and improve planning outcomes. This joint collaboration can increase the quality and effectiveness of the land use plans.

This study has answered initial questions regarding the strength of the land use-transportation connection in land use plans in North Carolina. Our focus on land use plans suggests that a similar study focusing on how land use elements are incorporated into transportation plans is warranted. This will help address questions such as: How is land use considered in transportation plans? Are land use plans considered when making local and regional transportation plans? How can such connections be strengthened? Related to this study is a recommendation to develop a community guide highlighting how attention to land use plans can help transportation planners. Although this study focused on land use plans, we believe that transportation plans, the other side of the land-use transportation connection, should also be emphasized.

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1 INTRODUCTION AND PURPOSE

A fundamental challenge for conducting environmental impact assessments is the need to characterize and evaluate the potential for secondary or indirect impacts from a proposed project, particularly with regard to development-related impacts. This is especially true for transportation projects given their potential to attract new urban growth (for a recent review of the evidence see: Guiliano, 2004). Ideally, an assessment of indirect impacts from a proposed transportation project within a given locality should build substantially on that locality's land use plan, to the extent that a well-executed planning effort will identify reasonably foreseeable alternative transportation improvements and evaluated those alternatives in terms of their potential benefits and impacts. In practice, however, this will be true only if the locality actually, through its land development planning efforts, prepared a land use plan that identified and anticipated potential transportation-related policies and improvements.

We note that land use plans should *ideally* contribute in this important way toward the study of indirect impacts in the project development process because it is not at all clear whether they in fact do so. As a general proposition, we know that regional transportation planners in practice tend to assume future land use patterns as given, usually based on market projections of land use rather than the land use plan. At best, several projections are provided and experts and professionals use their best judgment to project likely future outcomes. In this way, transportation plans either reinforce past development trends or stimulate development in locations and ways not contemplated in the land use plan. For their part, land use plans often fail to address explicitly the effects that large transportation investments can have on land development, especially the growth-inducing effects that such projects can generate. Similarly, planners often accept transportation plans as fixed inputs beyond the control of the locality, rather than as a plan element to be harmoniously developed and coordinated jointly with land use.

Beyond these general propositions, questions regarding the content and quality of local land use plans, as well as the use of those plans for various policy-making efforts, have received remarkably little systematic study. This is especially the case with regard to the relationship between transportation planning and land use planning. If transportation planners hope to build upon local land use plans to develop the assessment of indirect and cumulative impacts, a first step is to better understand the extent to which localities have addressed transportation-related issues through their planning efforts, particularly in terms of the potential for secondary impacts from new growth induced by transportation improvements. Such analysis would provide a better sense of the extent to which plans might be relied upon and, by extension, insights as to how local planning efforts might be improved. More generally, such an assessment would contribute as well to our understanding of how well both local land use planning and transportation planning account for the reciprocal relationships between land use patterns and transportation systems separately and how those endeavors might be better integrated.

Recognizing the need for this kind of systematic empirical study, a collaborative project was initiated in April, 2003 by the Department of City and Regional Planning at the University of North Carolina, Chapel Hill (UNC-CH), the University of Michigan, and the North Carolina Department of Transportation (NCDOT). The objective of the study is to examine how land

management plans at the county and municipal levels anticipate transportation projects that have local and regional significance. This understanding will improve the ability of planners to effectively account for the potential secondary and indirect impacts from proposed transportation projects. Furthermore, the project was designed to assess planners' familiarity with transportation plans and their perceptions of the connection between transportation and land use, under the premise that planners' views are a critical component of how this connection is manifested in planning practice.

The project was developed in two phases. The first phase consisted of several subtasks, including the development of a literature review on the connection between transportation and land use, and a survey of all counties and selected municipalities in North Carolina regarding the presence and characteristics of land use plans and adopted tools to manage land development, especially as they relate to transportation factors. The second phase of the project involved a review of methods for evaluating the content and quality of land use plans, the development of an evaluation protocol, the selection of a sub-sample of 30 local plans, and the evaluation itself. Also as an appendix to the second phase, we prepared a legal primer that can be used by state and regional planners to understand the relationship between land use or comprehensive plans and zoning ordinances.

With the results of this project, it is hoped that NCDOT, metropolitan planning organizations (MPOs), local planners and citizens will develop a more comprehensive view of the role played by local land use plans in managing development in North Carolina. By characterizing the extent to which current land use plans manage development pressures, this project will improve planners' abilities to anticipate potential impacts of transportation projects, increase their capacity to communicate those impacts effectively to the community, enhance the potential for coordination between transportation and land use planning, and ultimately contribute in a rigorous way to the evaluation of secondary impacts from proposed transportation improvements.

2 LITERATURE REVIEW

While planners have recognized for some time that transportation systems and land use have a reciprocal relationship—that is, land use patterns affect the viability of different kinds of transportation system options while the development of different kinds of transportation improvements yield different kinds of impacts in terms of land use and development patterns—much work remains to understand the particulars of the relationship given variations in time and place. In practice, the relationship is played out at many different levels, from decisions made by individuals to the observation of aggregate commuting and development patterns. At the most disaggregate level, the connection between transportation and land use is exhibited when transportation system considerations (e.g., commute time, availability of transit, parking availability, etc.) influence individuals' decisions on where to live and where to work Likewise, developers' decisions to develop or redevelop an area based partly on transportation or accessibility improvements is another example of the connection playing out at a disaggregate level. At an aggregate level, the capitalization of accessibility benefits in the land market or the degree to which commuting patterns criss-cross each other in space are areas where the relationship between transportation and land development becomes apparent.

Moreover, thinking about the "land use–transportation connection" requires not only understanding that reciprocal relationship at these various levels, but also addressing several closely related albeit distinct questions. First, to what extent do local land use plans take account of the ways in which transportation improvements affect land use and development patterns and attempt to direct land policy decisions accordingly? If indeed development is influenced by policy decisions in the land use plan and its application, then the connection between land use and transportation would be influenced by the plan as well. Second, to what extent do local land use plans influence the expectations of both residents and public officials about the tradeoffs that come with different types or configurations of transportation systems—tradeoffs not only in terms of convenience for system users but also in terms of larger social and environmental impacts? While this last question is most on point for evaluating local land use plans for the purpose of evaluating indirect and cumulative impacts, the more general question of how well-integrated transportation planning and local land use planning are in practice and how that integration can be improved in order to achieve better planning outcomes also merits further consideration.

In the following subsections we summarize the literature on the connection between land use and transportation at different level to provide adequate context for the motivation and relevance of this study. Because addressing the quality of the plans with respect to the connection requires an evaluation of the plan contents, we also detail below the plan evaluation literature. Researchers have only recently turned their attention to the systematic and comprehensive of plan making and plan implementation efforts. We summarize the contours of this recent work below also to provide context. The principal focus of our work presented in this report then builds on the plan evaluation work, focusing especially on the transportation-land use link as evidenced through those planning efforts. Finally, while not explored as deeply, we begin to address the expectations of local planning officials in terms of the relationships and tradeoffs between transportation improvements and land use development.

2.1 The transportation land use connection debate

Over the past four decades, federal transportation policy has sought to mitigate the negative externalities of automobile-based mobility. The policy agendas that have motivated this focus have included mitigation of air pollution and automotive congestion, promotion of urban vitality and improved economic integration of low-income people. Among the more visible bodies of research that have been developed to examine potential alternatives to automobile mobility are studies about transportation and land use seeking to measure the reciprocal influence between the two. Conceptually, by enhancing accessibility to certain locations over others, transportation projects influence where land development occurs. Likewise, where development occurs also dictates the type of transportation improvements that support the accessibility and mobility demands of the population. One way in which this relationship plays itself out is in terms of how important available transportation system options are to residents as they decide where to live relative to where they work. From this perspective, there continues to be some debate in the literature on whether the relationship is "strong" (i.e., the availability of options matters) or "weak" (i.e., the availability of options is not a driving factor).

If the reciprocal connection is strong, then a set of policies that include the targeting of transit investment in support of metropolitan clustering (Bernick & Cervero, 1997; Cervero, 1998) or caution in managing land development to avoid accelerating the decentralization of jobs and residences when new highways are built (Atash, 1996) would be warranted. Conversely, a weak link suggests that development and location decisions are dominated by socio-demographic trends (for example, two-worker households) and the relevance of neighborhood and community characteristics, such as school quality and crime. Under a weak connection, urban policies that hinge on the relationship would yield disappointing commuting consequences.

The empirical evidence supporting the presence of a weak or a strong connection between transportation and land use is equivocal, however. Supporting a weak view, empirical evidence suggests that households sort themselves into locations that provide services and goods that closely match the households' preferences. This view is consistent with the literature on municipalities as Tiebout-based club goods (Heikkila, 1996; Sandler, 1997). The evidence is interpreted as supporting Tiebout's view that residential location decisions are dominated by the public goods that a municipality can provide, like schools, police coverage, and the local environment (Tiebout, 1956). Because location decisions are not closely connected to regional accessibility, the connection between access and location decision-making is viewed as weak. By contrast, research relating accessibility improvements of transportation investments to land values that regularly demonstrate significant price impacts for proximity for urban rapid transit systems (e.g., Damm, Lerman, Lerner-Lam, & Young, 1980; Nelson, 1992; Voith, 1993) appear supportive of a strong connection. Likewise, the apparent market success of certain development patterns such as the new urbanism and transit-oriented developments advocated by some can be construed as evidence suggesting that multimodal access to destination is a valuable commodity –and thus, that the connection between transportation and land use is strong.

Studies comparing the journey-to-work trip required by the spatial distribution of jobs and houses and the observed commute provide additional evidence regarding the strength of the transportation-land use connection. A high difference between the minimum required commute and the actual commute means that the importance of the journey-to-work for residential location decisions is overshadowed by other factors. This has been interpreted as indicative of a weak connection between journey-to-work commuting and individual location decisions. Conversely, a small difference is interpreted as evidence of a strong relationship between transportation and land uses because the journey-to-work trip appears to explain people's location decisions. The evidence of these studies is decidedly mixed. Giuliano and Small (Giuliano & Small, 1993) conclude that commuters are taking little advantage of the cost minimizing opportunities afforded by the high level of decentralization of residences and workplaces observed. Similarly, Scott et al. (Scott, Kanaroglou, & Anderson, 1997) conclude that "policies advocating jobs-housing balance as the principal strategy for facilitating more efficient commuting are unlikely to meet the expectations of policy makers." In contrast, Kim (Kim, 1995) and Merriman et al. (Merriman, Ohkawara, & Suzuki, 1995) estimate "low" differences between actual and required commuting for different metropolitan areas and thus conclude that the connection is strong and therefore urban policies that hinge on the strength of the connection could result in significant reductions in commuting time.

Empirical models of location decision-making have also provided inconsistent results regarding the drivers of location. Indeed, most models of location decision-making include variables capturing job accessibility, usually using distance to work, travel time to work, or measures of the household's regional accessibility (Anas, 1981, 1982, 1995; Ben-Akiva & Bowman, 1998). On the one hand, the evidence of location models suggests that variables other than job access are relevant. Louviere (Louviere, 1979) finds that housing characteristics are more important than distance to work and to shopping activities and Timmermans et al. (Timmermans, Borgers, van Dijk, & Oppewal, 1992) find that individuals award more importance to residential environmental attributes than to distance to work attributes in forming their preferences. Others have found that location choices vary importantly over the household life cycle and are therefore less related to access to destinations (Beckmann & Papageorgiou, 1989; Evers, 1990; Fischer, Nijkamp, & Papageorgiou, 1990; McAuley & Nutty, 1982; Pollakowski, 1981). On the other hand, several studies of residential location regularly find commute travel time to be the single most influential factor in residential choice (Boyce & Mattsson, 1999; Lerman, 1975; Levine, 1998; Sermons & Koppelman, 2001).

What then can explain the empirical differences and varying interpretations related to the connection between transportation and land use? Common to previous studies is the implicit view that the observed connection between transportation and land use is the result of the aggregation of individuals' preferences. Personal decisions of where to locate, or where and when to develop land, can be aggregated to determine the strength of the connection, with polic y implications following. In that view, while the strength or weakness of the transportation-land use relationship is seen as highly relevant to processes of policy making, the relationship is taken as an input to policy. It is possible, however, that the connection between transportation and land use is more than an input to policy; it is an object of policy attention *per se*. Thus, we suggest that the connection is neither inherently strong nor inherently weak; rather, its strength or weakness can be a function of directed planning actions which can nourish, ignore, or stifle it.

One way to study the role that directed planning attention may have on the strength of the connection is to examine how practicing planners account for the links between land use and transportation in their plans. To the extent that plans are effective in influencing outcomes, we anticipate that differences in how plans account for the transportation-land use connection would be reflected in how development reacts to transportation investments and how development stimulated travel activity, in a given context. If our expectations that plans can be an instrument for influencing the connection between transportation and land use are warranted, then we must be able to demonstrate empirically that plans differentially account for this connection.

Plans can account for the land use and transportation relationship by singly focusing how each realm influences the other, or by accounting for their joint, reciprocal influence. For example by accounting for the second-order transportation impacts of induced development caused by a transportation investment, transportation plans integrate the transportation to land use link. Likewise, by forecasting future development patterns and their impact on travel patterns, transportation plans can account for the land use to transportation link. Indeed, the latter is somewhat institutionalized in standard transportation planning practice, where a key input into the transportation plan is a forecast or set of forecasts of future land patterns (Meyer & Miller, 2001; Ortúzar S & Willumsen, 2001). Much less is known about how comprehensive plans incorporate the connection between transportation and land use, however. For example, a

comprehensive community plan can account for programmed transportation investments by managing land development accordingly (the transportation to land use link). Similarly, such plans can promote development patterns that are explicitly developed to support future mobility options (the land use to transportation link).

2.2 Assessing the quality of local plans

With notable exceptions (e.g., Alterman & Hill, 1978), planning scholars have traditionally focused much of their attention on improving the process of plan-making rather than evaluating the quality or use of the plans produced. Indeed, despite much exhortation on the need to focus on planning outcomes, few studies until recently have focused on characterizing or measuring systematically the quality of plans (Dalton & Burby, 1994). In the past decade, however, theoretical and empirical work has appeared in the planning literature. Kaiser et al (Kaiser, Godschalk, & Chapin, 1995), Talen (Talen, 1996) and Baer (Baer, 1997), for example, have aided planners in re-conceptualizing what a good plan is and how it might be evaluated.

Empirically, work focusing on the quality of comprehensive plans has recently surfaced, building largely from the published findings of an extensive research project focused on local efforts to plan for and mitigate natural hazards in five different states, including North Carolina (Berke, Crawford, Dixon, & Ericksen, 1999; Berke & French, 1994; Burby et al., 1993; Burby & Dalton, 1994; Burby & May, 1997; Dalton & Burby, 1994; Deyle & Smith, 1998; Godschalk, Beatley, Berke, Brower, & Kaiser, 1999; May, 1993). Other researchers (e.g., Berke & Manta Conroy, 2000; Norton, 2003) have extended this work both theoretically and empirically. Summarizing the literature, a high quality plan is one that:

- Demonstrates a strong factual basis, including a land suitability analysis;
- Incorporates the concept of spatial specificity, clearly relating policies to geographically identified areas;
- Provides clearly articulated goals, including transportation goals achieved with land use policies and objectives, or land use goals achieved with transportation policies and objectives;
- Employs policies that are both directive (i.e., rather than exhortative) and appropriate (i.e., reasonably calculated to influence the desired goals);
- Achieves several types of consistency (internal, horizontal, vertical and implementation consistency—see Appendix 11 for more in depth discussion of these concepts); and
- Facilitates meaningful ongoing public participation and incorporates ongoing monitoring and implementation evaluation procedures, using indicators.

Given these characteristics of high quality plans, and based on the comprehensive literature review on the connection between transportation and land use, we formulated general principles for connecting land use and transportation in land use plans (see Box 1). These guiding principles build on those currently used by DCA (Kaiser & Moreau, 1999), extending them to address transportation. They should be viewed as useful extensions that will help in evaluating the plans and in drawing lessons that could be applicable for current planners. In developing these principles we draw from the collective work in the area of plan quality referenced above. Not every comprehensive plan will follow all of these principles, but the highest quality plans

with respect to transportation exhibited many of them—as will be discussed in more detail below.

Box 1. Fourteen Guiding Principles for Connecting Land Use and Transportation in Land Use Plans

Plan Presentation

Guiding principle 1: Plans should contain clear and readable land use maps, conveying usable information without the need to read accompanying text. Key landmarks and activity nodes should be clear. Relevant mobility alternatives should be clearly specified (roads, transit routes, major bike/greenways).

Guiding principle 2: The time horizon of the plan determines the extent to which certain impacts, such as the land development impacts of planned transportation projects, are to be examined. As a rule of thumb, plans with more than a 10-year time horizon should account for the development impacts of transportation projects. A shorter time-frame is appropriate for the transportation impacts of development projects, since these impacts occur as the development is completed.

Information Base and Content

Guiding principle 3: The plan should have spatially specific information. Differences in the quality and availability of transportation services, transportation infrastructure, and in land uses should be clearly related to geographically identified areas. Policies and goals should relate to specific geographic areas. It is important to identify as specifically as possible where current conditions or recommended actions are located in space.

Guiding principle 4: Travel demand and the supply of transportation infrastructure should be discussed in the plan. A snapshot of current conditions is useful for identifying areas of need and areas where there is a surplus of capacity.

Guiding principle 5: Plans should include assessments of transportation policies, such as minimum parking requirements, parking supply, and parking cost. These policies lie at the intersection between land use and transportation planning, and as such are rarely included explicitly in either type of plan. An open discussion about parking demand (including cost) and the regulations governing parking will help in guiding decision-makers.

Guiding principle 6: The presentation of future land uses in a community should be accompanied by their differential impacts on travel demand and transportation infrastructure. Although the detail of these transportation impacts will be captured in the community's transportation plan, a need to communicate broad transportation impacts remains. Indicators such as approximate number of trips in the peak period, number of auto trips, number

of walking trips, or mode shares are helpful in understanding these impacts. References to existing multimodal transportation plan should be provided.

Guiding principle 7: Plans should consider the cost and feasibility of the extension of transportation services (bus) and infrastructure (sidewalks and roads). When appropriate, such costs should be provided as part of the plan or references to capital improvement programs or transportation plans should be provided.

Guiding principle 8: Plans should examine the existing and proposed local, state, and federal transportation infrastructure investments. The plans should map and inventory the conditions and capacities of existing facilities and proposed changes in those systems. The State Transportation Improvement Program is a detailed source of information that can help localities identify and understand large transportation investments that may affect their locality.

Guiding principle 9: Plans should use various mobility and accessibility indicators. Indicators such as level of service, volume to capacity ratios, delay, commuting time, and daily traffic are expected. However, broader indicators of accessibility such as the % of population/jobs/retail within ¼ mile of transit, % of population/jobs/retail within a 20 minute walk/bike/drive, isochronal curves, or jobs/population ratios at various scales are recommended because they link land use and transportation. After all, people tend to travel to get to destinations.

Goals and policies

Guiding principle 10: The plan provides clearly articulated goals, including transportation goals achieved with land use policies and objectives, and land use goals achieved with transportation policies and objectives (see Kaiser et al, 1995). These goals may be mandated by state and federal policy which the local government is legally or politically bound to implement (such as VMT reductions). The plan may also include the community's judgments about how to meet or manage the demand for travel in the future. These judgments and values will determine infrastructure capacity needs.

Guiding principle 11: The transportation and land use goals should be reasonably achievable with the policies suggested in the plan. Otherwise, the policies are not efficacious and more suitable policies or revised goals are necessary.

Implementation

Guiding principle 12: The plan should facilitate meaningful ongoing public participation and incorporate ongoing monitoring and implementation evaluation procedures, using indicators.

Coordination and consistency

Guiding principle 13: The community should use a common, consistent, and persuasive set of assumptions in its integration of future land uses with transportation plans. Most importantly, estimates of the demand for land should be based on the same population and economic forecasts as the estimates used in the transportation plans. In that way, both land use and transportation planners will share similar assumptions about the size and shape of the future community.

Guiding principle 14: The plan should achieve internal consistency (between facts, goals, analyses, and policies), horizontal consistency (between the plan and plans of neighboring jurisdictions), vertical consistency (between the locality and state and federal plans and mandates), and consistency in implementation (between plan policies and implementation mechanisms such as land use regulations and building codes).

3 RESEARCH METHODOLOGY

3.1 Survey of officials

In view of the gaps in the literature regarding the land-use transportation connection and regarding plan quality analyses focused on transportation issues, we surveyed planning officials in North Carolina counties and municipalities regarding their land development management activities from June 1 through August 15, 2003. All 100 counties and 64 municipalities in the state with >10,000 residents were sampled to ensure geographic diversity with respect to the mountain/piedmont/coastal areas. Surveying all municipalities in the state was not practical because many are too small to have a plan and therefore would not have been able to answer the majority of survey questions.

The survey instrument, developed with input from NCDOT and administered by mail, included 24 multiple-choice and text questions which were designed to:

- Provide an up-to-date summary of which counties and municipalities in North Carolina have land use plans
- Provide a broad characterization of such plans
- Determine the extent to which zoning and other tools such as capital improvement programs (CIPs) and utility policies are used for managing land development in counties and selected municipalities throughout the state

In addition, the survey addressed issues such as official adoption of the plan, implementation tools, and the plans' prescriptive nature. A copy of the questionnaire is included in Appendix 1.

Survey responses were entered into an Excel spreadsheet, and each location was matched with data from the 1990 and 2000 U.S Population Census with respect to number of residents and growth characteristics. Text responses were reviewed by the Principal Investigator and were

subsequently recoded into new or existing categories as appropriate. The data was then imported into SAS (Version 8.2) software for statistical analysis. Frequencies and percentages were run for all survey questions. Analyses were conducted for the overall sample, as well as by subgroup as follows:

- Jurisdiction type: city or county;
- Location: Coastal, Piedmont or Mountain region;
- Growth: High growth (>25% according to the decennial population census) or low growth;
- Size: Large (> 50,000 residents) or small (= 50,000 residents)[2];
- Urban character: Whether a locality belongs to a metropolitan area as defined by the 2000 Population Census.

3.2 Content evaluation tool

The content evaluation tool was developed in order to provide a more detailed view on plan contents and plan quality. The tool was developed by synthesizing criteria drawn from the plan quality assessment literature summarized above and from requirements associated with our intent of examining the connection between transportation and land use. The protocol is divided into nine sections: general presentation/information, plan components, supporting data/information base, planning process, background goals and policies, detailed goals and policies, content, implementation, and consistency (See Appendix 2). The plan evaluation tool was developed, pilot-tested, and revised. Two graduate students were trained in the use of the plan evaluation tool. One of them had previous experience with plan content evaluation tools. Finally, plans were scored for the presence and strength of specified items related to the connection between transportation and land use, as specified next.

Scoring of content evaluation tool

Previous research has suggested several dimensions on which to evaluate existing plans, including the presence and quality of certain plan components (Kaiser & Godschalk, 1995), the plans' appropriateness for a given situation (Hopkins, 2001), its use and implementation (Burby & May, 1997; Norton, 2003) and if it achieves coordination of inter-dependent actions and actors resulting in internal consistency (between facts, goals, analyses, and policies), horizontal consistency (between the locality and neighboring jurisdictions), vertical consistency (between the locality and state and federal plans and mandates), and consistency in implementation (between plan policies and implementation mechanisms such as land use regulations and building codes).

These measures of plan quality speak to the procedural aspects of plan making. They gauge the quality of planning as a public decision-making process, where the plan itself serves both to

[2] This definition differs from the US Census definition, where areas are classified based on population as urbanized (>50,000) and urban clusters (<49,999 but more than 2,500). For details see Federal Register, Vol. 67, No. 51, March 15, 2002. No urban clusters were included in this study. For the census, and for transportation planning, municipal boundaries are less important than for land use planning. Thus, we prefer to use the definition provided above to the Census' current definition.

document the analytical rigor and comprehensiveness of the process employed to identify goals, evaluate alternatives, and establish policies, and as a document that provides well-justified and reasonably articulated policies for guiding future local development management decisions. However, planning outcomes can be evaluated in terms of their substantive aspects as well. This refers primarily to the policy emphasis of the planning endeavor.

We follow Norton (Burby & May, 1997; Norton, 2003) in scoring the plans in terms of process-oriented planning outcomes (i.e., overall plan quality, specific quality with respect to the transportation-land use connection, and general and specific consistency in the plan) and in terms of substantive planning outcomes (i.e., goals and policies emphasized through the plans and plan implementation efforts). In terms of substantive outcomes, we focus on the plan's transportation-land use connection emphasis. In terms of procedural outcomes, we define two variables that include (1) consistency and coordination and (2) plan quality (including generic quality as indicated by Kaiser and Godschalk (1995) and quality specific to transportation and land use). Our score considers neither the type of land use goals should be pursued, nor the type of transportation objectives and policies that will support them. The goals, policies and objectives are specific to the values and preferences of each community. Table 1 summarizes the main concepts we measured and data sources employed to calculate our scores. The measurement constructs and data sources used to operationalize the six key outcome variables summarized in Table 1 are detailed in Appendix 3.

Table 1. Plan attributes examined

Outcome	Measurement
Substantive planning outcomes	
Transportation-land use connection emphasis	From content analysis: Presence of land use and transportation goals in the plan with objectives and policies to support such goals.
Process-oriented planning outcomes	
Consistency and coordination	From content: Degree to which plan has vertical, horizontal, internal and implementation consistency.
Generic and specific plan quality	Generic quality of the plan in terms of its presentation, factual base, and general content.
	Quality assessment specific to transportation aspects of the plan: Presence of transportation elements in the plans' presentation, fact-base, reciprocity between land use and transportation goals and policies, and content.

Selection of plans for content analysis

We used geographic, demographic, and results from the survey of planners to inform our choice of communities from where to draw the plans. The following criteria were used:

- Population growth rate during the last decade (high if > 25%, low otherwise);
- Size (high if > 50,000, low otherwise. Measured using population in 2000);

- Geographic location within the state (Mountain, Piedmont, and Coastal);
- Geographic location with respect to the 14 DOT divisions[3];
- Geographic location with respect to urban regions (yes/no belongs to a metropolitan statistical area using the 2000 definition of the US Census Bureau);
- A measure of coverage of transportation elements in the plan (ranging from comprehensive to focused, derived from questions 8, 9 and 10 in the survey);
- A measure of local influence of the land use plan in directing development (ranging from high to medium, derived from question 12 in the survey); and
- A measure of extent of interaction of municipality/county with state and regional transportation planning agencies (ranging from consistent to infrequent; derived from questions 15 and 16 in the survey).

With these criteria, our aim was to get a broad cross-section of plans that reflect various growth rates, sizes, locations, and plan characteristics. Because the criteria are ambitious, we collected 30 plans rather than the 20 plans originally suggested in our proposal.

We applied the criteria to counties and municipalities that responded to the survey *and* that have a land use plan. Each respondent was classified based on the criteria outlined above. Then we selected two plans randomly across each of the categories implied by the criteria. In the end, we selected the 30 municipalities/counties, shown in Appendix 4. An extra plan, from Randolph County, was used to pilot test the protocol. Data from the 30 municipalities/counties included below are reported in the following sections. The percentage of plans selected for cities and counties for each criterion coincides with the percentage of plans received. A good representation of growth rates, different sizes, NC regions, belonging to an urbanized area, and the three factors derived from the survey questionnaire was obtained (see Appendix 5 for details).

3.3 State transportation improvement program

Because the presence of transportation projects is critical to understand if plans effectively connect those investments to their land development programs, we collected information from the State Transportation Improvement Program (TIP) to identify planned expenditures between 2004 and 2010 in each locality. We classified TIP capital expenditures as auto/road, safety, non-motorized, and transit. No operating expenditures were included in the TIP figures. Appendix 6 lists median and mean TIP expenditures overall and by jurisdiction, region, growth, population size, degree of urbanization, and CAMA status.[4]

[3] When municipalities overlap DOT regions, the primary county to which the municipality belongs determines the DOT region.

[4] The following criteria were used in calculating the TIP figures: Only capital expenses are included (feasibility studies and planning projects were excluded); unfunded projects or unfunded portions of projects were excluded from our figures; all projects must be in the design or construction phases; bridge and ferry projects were excluded from our figures; capital expenses for truck stops or for museums were excluded from our figures; intelligent

4 FINDINGS: CONNECTING LAND USE AND TRANSPORTATION IN LAND USE PLANS

In this section we review our main study results. The section begins with a general summary of the survey findings. We then turn to general findings of the content analysis. The third part of this section uses both the survey and the content analysis to elaborate on four topics related to the study: the transportation elements in the plan, how plans account for the land use-transportation connection, planners' views about the connection and the role of institutional coordination with local municipalities and counties. Then we integrate our findings to the guiding principles, providing selected examples of good plans. Finally, we explore community and plan-specific factors that help explain the plan scores obtained.

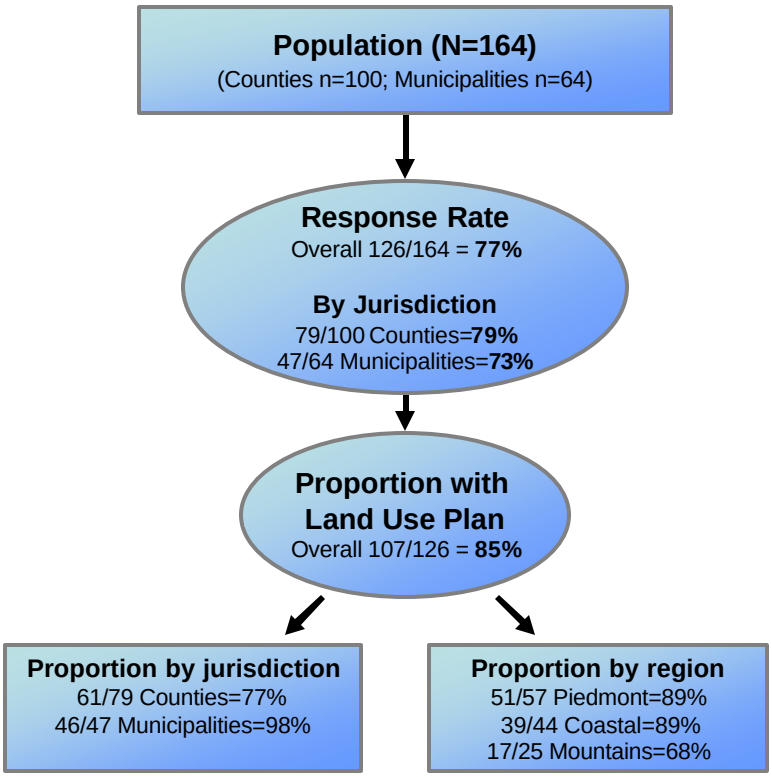
4.1 General survey findings

For the survey, we received responses from 47 municipalities and 79 counties, for an overall response rate of 77% (Figure 1). The data suggest that respondents in 98% of municipalities and 77% of counties report having land use plans to manage land development. The majority of these plans were developed over the last 10 years, but some plans were developed as early as 1974 and have not been updated since then. The average time horizon for plans is 14 years. Of those jurisdictions having a plan, the vast majority (93%) have adopted it. We found that jurisdictions in the Piedmont and the Coastal areas were more likely to have plans than jurisdictions in the Mountain area. Likewise, jurisdictions falling within a metropolitan statistical area (MSA) and jurisdictions with more than 10,000 inhabitants were more likely to have land use plans.

Of the 107 respondents that reported having land use plans, 31% of the plans were developed since 2000. The remaining plans were developed between 1990 and 1999 (50%) and between 1974 and 1989 (19%). Forty-one percent of respondents had updated their land use plans (44 out of a possible 107). The majority of these updates (85%) occurred since 1998. Several respondents reported that they were currently in the process of updating their plans.

transportation systems investments were considered automobile/road expenses; the cost of projects that crossed boundaries (two counties or more, or that spanned an urban area and a county) were allocated to each jurisdiction based on the size of the project (length) that belongs to each; and the jurisdiction to which a project belongs is determined by the TIP map available at the NCDOT website, and not their administrative assignment.

Figure 1. *Response Rate and Proportion of Respondents with Land Use Plans*



All respondents felt that state transportation improvement projects would affect future land development in some way. Fifty-two percent felt that such improvements would support new growth, 13% felt that growth would be redirected from other places, and 35% felt that major new growth would be initiated. Among respondents who felt that the effect of state transportation improvements would be to "Support New Growth", almost half said their plans do not account for the land development impacts created by transportation improvements, while 33% said their plans accounted for "certain" transportation improvements, and 22% said their plans accounted for "most or all" state transportation improvement projects. Among respondents who said that the effect of state transportation improvements would be to "Redirect Growth", 25% said their plans do not account for land development impacts of transportation improvements, 50% said their plans accounted for "certain" transportation improvements, and 25% said their plans accounted for "most or all" transportation improvements. A similar pattern was observed among respondents who said that the effect of state transportation improvement projects would be to "Initiate Major New Growth".

Ninety-five percent of respondents stated that their plans included specific tools and policies to influence growth. Zoning was by far the most commonly reported implementation tool, cited by 92% of respondents. Approximately half of respondents utilized site design guidelines, capital improvement programs, planned unit development, and designated growth areas. In contrast, few respondents cited land trusts, impact fees, local impact assessment, concurrency requirements, or transfer/purchase of development rights. As expected, respondents from cities reported implementation tools more frequently than those from counties. Regionally,

respondents from the Piedmont area reported more implementation tools compared to respondents from Mountain or Coastal areas. Similarly, respondents from urbanized regions were more likely to report 3 or more implementation tools compared to those from non-urbanized regions (75% and 46%, respectively). No differences were observed between respondents from large versus small population areas. Details of the main findings from the survey are included in Appendix 7.

4.2 General plan content analysis findings

Of those municipalities and counties responding to our survey and having a plan, we collected the plans for 30 of them either through the internet, through the University of Chapel Hill libraries, or by purchasing copies of the plan directly from localities. Each of the 30 plans was scored independently by two graduate student raters who had received training in the use of the coding protocol. The scores were entered into an Excel database and screened for any data entry errors. Data were then imported into SAS (Version 8.2) software for statistical analysis. Following the scoring approach described previously, we developed specific indices of plan content and quality pertaining to land use and transportation. Disaggregate results by each category of the coding protocol are provided in Appendix 8. Aggregate results for the substantive scores, procedural scores and the sum of both (total scores) are provided in Table 2. The highest possible Total Score is 76; the highest possible Substantive Score is 24, and the highest possible Procedural Score is 52.

Recall that we use the term "substantive" here as a measure of whether a plan in fact includes clearly articulated goals and policies that address directly the relationship between transportation and land use. Plans with high substantive scores did a good job of clearly articulating such goals and policies, although the score gives no indication of the content or emphasis of those goals and policies (e.g., whether they were more focused on automobile mobility or pedestrian accessibility and the relationships between those systems and land use). The term "procedural" is used as a measure of the extent to which the plan reflects a comprehensive and rigorous analytical and policymaking process. Plans with high procedural scores reflect (or appear to be a product of) more rigorous planning efforts, while the plans themselves are stronger in terms of providing clear and tangible policy guidance for local officials. In order to provide more clarity for the purposes of this study, we also subdivided to the total procedural score into several components, including a score for plan consistency, generic quality, and specific quality with regard to transportation-related land use issues (see Table 1 above).

Several generic findings can be identified from the plan content analysis (Table 2). On the positive side and as expected, cities have significantly higher substantive scores compared to counties; high growth areas and urbanized regions also have significantly higher substantive scores on average. This is not entirely surprising, given that urbanized areas tend to belong to metropolitan planning organizations (MPOs), which are required to conduct more multimodal planning. Indeed, an analysis of counties and municipalities that belong to MPOs versus those that do not belong to MPOs suggest that those belonging have significantly higher substantive plan scores and are more likely to include non-motorized transportation modes. However, MPO communities are similar to non-MPO communities in terms of plans' procedural scores, in the

inclusion of transportation-related objectives or policies to achieve land use goals, and in explicitly referencing the transportation-land use connection in their plans.

Table 2. Summary statistics for total, substantive and procedural scores by different groupings

	Average total Score	SD	Average substantive Score	SD	Average procedural Score	SD	N
All	29.70	6.86	6.80	3.92	22.90	4.71	30
Cities	30.54	8.54	8.46*	3.67	22.08	5.82	13
Counties	29.06	5.44	5.53*	3.71	23.53	3.73	17
CAMA counties	26.75	2.99	2.50*	2.38	24.25	3.20	4
All other counties	29.77	5.92	6.46*	3.60	23.31	3.97	13
Coastal	27.00	5.56	4.90	3.67	22.10	4.07	10
Mountain	31.20	3.42	6.40	2.07	24.80	3.96	5
Piedmont	31.00	8.16	8.20	4.14	22.80	5.40	15
High Growth	32.54	6.85	8.64**	3.83	23.91	5.09	11
Low Growth	28.05	6.48	5.74**	3.65	22.32	4.52	19
Urban Area	30.53	7.65	7.95**	3.84	22.58	5.17	19
Non-Urban Area	28.27	5.27	4.82**	3.34	23.45	3.98	11
Large Population	30.80	7.87	7.20	4.60	23.60	4.61	15
Small Population	28.60	5.74	6.40	3.20	22.20	4.87	15
Low TIP[1] (Auto)	29.13	6.62	6.67	3.26	22.47	5.36	15
High TIP (Auto)	30.27	7.28	6.93	4.59	23.33	4.12	15
Low TIP (Non-Auto)	28.40	6.45	5.60*	2.92	22.80	4.94	15
High TIP (Non-Auto)	31.00	7.21	8.00*	4.49	23.00	4.64	15

[1] High TIP (Auto) > $70,000, 000 (above the 50th percentile)

[2] High TIP (Non-Auto) > $850,000 (above the 50th percentile)

**, * indicate statistically significant differences between groups at a 95% ad 90% confidence levels, respectively

Localities having programmed non-motorized TIP expenditures in excess of $850,000 tend to have higher substantive plan scores. In fact, localities having higher non-auto TIP expenditures were more likely to have three or more non-motorized policies (47%) compared to 33% of those

with lower non-auto TIP expenditures. This encouraging finding suggests that areas with significant non-motorized projects in the TIP seem to have better land use plans with respect to the transportation connection. This supports our idea that non-motorized modes serve as bridges between transportation and land use.

On the negative side, we find that only 33% of plans use land use policies to achieve transportation goals. Likewise, only 13% of plans explicitly reference the reciprocal connection between transportation and land development and less than 25% of plans received high scores in terms of articulating relationships between goals, objectives, and polices. CAMA counties had lower substantive scores compared to other counties. However, because our sample only included four CAMA counties this result should be interpreted cautiously. Likewise, localities with higher road/auto oriented-TIP expenditures (defined as >$70,000,000, above the 50th percentile) showed no difference in substantive scores compared to counties with lower auto/road-oriented TIP expenditures. This finding is important, because it underscores the fact that road investments can result in unexpected and unplanned growth in many communities in the state, partly because such improvements are not accounted for in the land use plans. Furthermore, this finding highlights current difficulties in using land use plans generally for assessing indirect and cumulative impacts.

In summary, the plans tend to have better procedural scores than substantive scores. This is not surprising given the emphasis that the field has placed on procedural planning. Despite this, procedural areas of improvement are: a) to broaden the focus of plans to include accessibility, thereby bridging land use and transportation; b) to improve plan implementation by providing transportation-related indicators to quantify land use goals, and providing measurable objectives including the timing and implementation of the land use plan.

4.3 Transportation elements included in the land use plan

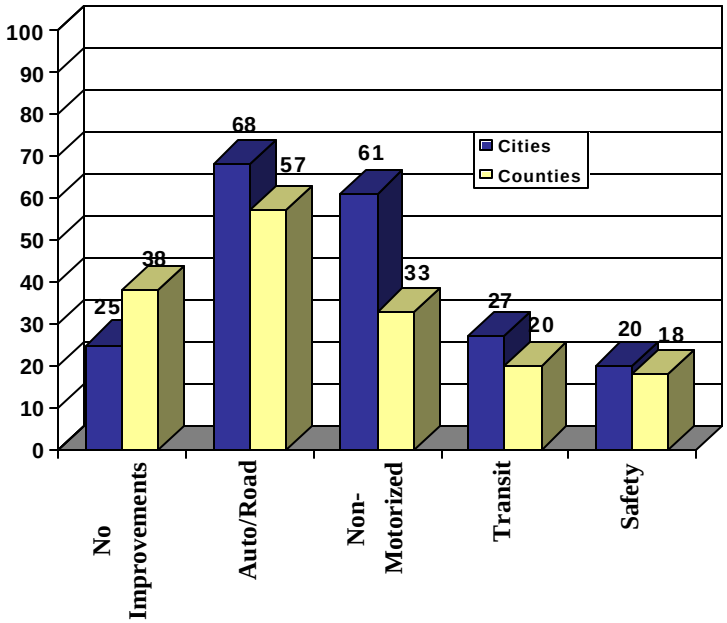


Figure 2. *Transportation improvement domains in the plan*

Sixty-eight percent of the survey re % lents reported that their land use plan included specific transportation improvements. Of the 30 plans content analyzed, twenty-three (76%) included specific transportation improvements, which is fairly consistent with the survey findings. To further explore the connection between transportation and land use, we grouped transportation improvements into five domains: 1) No Transportation Improvements, 2) Auto/Road Improvements (including Collectors Streets, Highways, Connectivity Improvement, and Driveway/Access Management), 3) Non-Motorized Improvements, 4) Transit, and 5)

Safety. As shown in Figure 2, jurisdictional differences were greatest with respect to non-motorized transportation improvements, followed by roads and transit. Safety improvements showed little variation across jurisdictions.

Analyses comparing the number of implementation tools to the number of transportation improvement domains (Auto/Road, Non-Motorized, Transit, and Safety) included in land use plans showed that survey respondents who cited three or more implementation tools were more likely to report multi-modal improvements compared to those who cited fewer implementation tools. Those who cited no implementation tools also reported no transportation improvements within any domain. This suggests that quality of land use plan implementation, imperfectly measured as the number of land use implementation tools in place in a community, is associated with having a higher number of multimodal transportation improvements accounted for in the plan.

Examining the survey and the plan content analysis together, we find no differences between the plans of those who reported having auto improvements and those who did not in terms of inclusion of auto/road related policies in the plan, the use of mobility indicators, the inclusion of motorized modes, the assessment of current transportation conditions, or the assessment of environmental impacts of transportation projects. In contrast, plans that reported motorized improvements in the survey were also more likely to include a specific transportation component in the land use plan (77% vs. 17% of those reporting no motorized improvements) and to include a discussion of induced development from previous expansions to transportation capacity (45% vs. 33% of those reporting no motorized improvements). However, survey responses suggesting that plans contained motorized improvements were less likely to include land suitability analyses accounting for transportation facilities than those reporting no motorized improvements (77% vs. 100%, respectively).

A significant finding is that plans with non-motorized improvements, according to survey respondents, are more likely to include non-motorized policies (53% vs.27% of those reporting no non-motorized improvements). Plans having non-motorized improvements were also more likely to include non-motorized modes in the land use plan (94% vs. 54% of those reporting no non-motorized improvements), to achieve non-motorized planning integration (23% vs. 9%), to include a specific transportation component (71% vs. 55%), to include land suitability analyses accounting for transportation facilities (88% vs. 73%), and to assess the environmental impacts of transportation projects (18% vs. 9%). No meaningful differences were observed between localities that reported non-motorized improvements and those that did not in terms of assessing current transportation conditions, the use of mobility indicators, or the inclusion of a discussion of induced development from previous expansions to transportation capacity. This means that communities with stronger plans on a number of measures were also more likely to include policies for non-motorized improvements, although the causal origin of this relationship remains to be explored.

Finally, localities for which the planner's responses to the survey suggested that the plan contained transit improvements were less likely to have a plan that actually included a transportation-related capital improvements program in the plan, compared to localities for which respondents indicated that the plan included no improvements (11% vs. 37% of those survey respondents indicating no transit improvements). Surveys reporting plans with transit

improvements were more likely to include non-motorized modes (100% vs. 68% of those reporting no transit improvements), to include a specific transportation component (78% vs. 58%), to include land suitability analyses accounting for transportation facilities (100% vs. 74%), and to assess the environmental impacts of transportation projects (33% vs. 5%). No meaningful differences were observed between surveys reporting plans with transit improvements and those that did not in terms of assessing current transportation conditions, the use of mobility indicators, or the inclusion of a discussion of induced development from previous expansions to transportation capacity. These observations suggest that localities whose plan accounted for future transit improvements appear to have better plans than localities that do not account for such improvements.

In summary, both the survey and the content analysis do suggest that auto modes are more prevalent than non-auto modes in land use plans. Perhaps as a result of the general auto inclusion of plans, there is awareness of the induced development caused by transportation improvements. However, such awareness does not seem to translate into suitability analyses to inform better land use planning. When included, transit and non-motorized modes appear to be better integrated to the land use planning process, and this inclusion was also reflected in non-auto projects programmed in the TIP. Interestingly, plans that included transit and non-motorized modes were more likely discuss the environmental impacts of transportation projects and to include transportation facilities in their land suitability analyses.

4.4 Accounting for the land use-transportation connection in land use plans

In the survey, the connection between land use and transportation was examined by explicitly asking whether the land use plan accounted for transportation improvements. Results suggest that 69% of respondents reported that their land use plans account for transportation improvements, while 31% percent reported that their plans do not account for such improvements.

Accounting for transportation improvements does not necessarily mean that their land development impacts are accounted for in the plan. The survey suggests that 60% of respondents reported that their plans account for the transportation impacts of land development projects to some extent (Figure 3). Respondents whose plans accounted for most or all transportation impacts of land development and, reciprocally, for most or all land development impacts of transportation improvements, were more likely to cite three or more implementation tools in their land use plans compared to those whose plans accounted for fewer impacts. These results are underscored by the content analysis. Of the 30 plans that we analyzed in additional detail, 66% accounted for the land development impacts created by transportation improvements to some extent, while 34% percent did not account for such impacts.

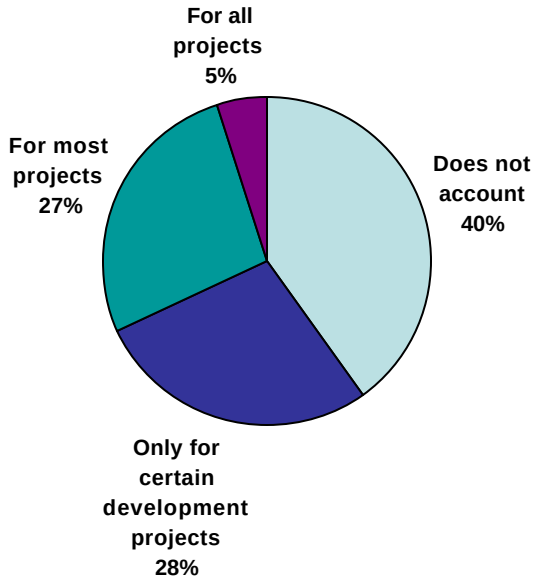


Figure 3. *Does the land use plan account for the transportation impacts of land development?*

We also found that the degree to which plans accounted for the reciprocal impacts of land development projects and transportation improvements was related to the perceived importance of the plan to elected officials. For example, survey respondents who considered the plan "Very Important" for decision-making were more likely to report that the plan accounted for "Most" or "All" land development impacts created by transportation improvements, compared to those who considered the plan to be of lesser importance. Those who considered the plan less important to elected officials were less likely to report that the plan accounted for any transportation or development impacts.

Turning to how the content analysis of the plans selected can further inform these results, we focused on the subset of plans (n=7) that according to survey respondents accounted for "most" transportation improvements. Although caution should be used when interpreting statistical associations with small sample sizes, we found that plans accounting for "most" transportation improvements were more likely to:

- Reinforce explicitly the transportation-land use connection in the plan (43% compared to only 4% of respondents who reported that their plans accounted for no transportation improvements or only certain transportation improvements).

- Include transportation goals with land use-related objectives or policies (71% compared to 22% of respondents who reported that their plans accounted for no transportation improvements or only certain transportation improvements).

- Contain high quality transportation maps (71% compared to 13% of respondents who reported that their plans accounted for no transportation improvements or only certain transportation improvements).

- Have higher scores for internal consistency, although scores for vertical, horizontal, and implementation consistency were not meaningfully different.

- Account for non-motorized modes (86% compared to 74% of other plans), although this association did not achieve statistical significance.

- Provide spatial specificity for relevant policies (71% vs. 61%), and to include a discussion of induced development from previous expansions to transportation capacity (57% vs. 39%), although these associations did not achieve statistical significance.

Next, we examined the characteristics of plans that account for "most" or "all" transportation impacts of land development (n=9). We found that plans that account for most or all development effects, as determined by the survey, are:

- More likely to reinforce explicitly the transportation-land use connection in the plan (22% compared to 9% of respondents who reported that their plans accounted for no transportation development projects or only certain projects), although this relationship did not achieve statistical significance.

- More likely to include non-motorized modes (100% compared to 67% of plans that accounted for no transportation development projects or only certain projects).

- As likely to link land use goals with specific transportation-related objectives or policies and vice versa.

A comparison between programmed TIP expenditures and survey responses suggest that areas with higher auto/road programmed TIP expenditures (>$70,000,000) were significantly *less* likely to account for most or all land development impacts created by transportation projects (7%) compared to those with lower auto/road TIP expenditures (40%). Respondents suggesting that the plan was "very important" to elected officials were more likely to have higher non-auto TIP expenditures (60%) compared whose plans were less important to elected officials (40%), although this relationship did not reach statistical significance. Similarly, more frequent interactions with MPOs and RPOs were associated with higher non-auto TIP expenditures, but the result was not statistically significant. We elaborate on the latter in section 4.6.

4.5 Planners' attitudes regarding the connection between transportation and land use plans

Planners' attitudes reflected a belief that land use plans should embody the reciprocal relationship between transportation and land use. All respondents felt that land use plans should consider planned transportation infrastructure improvements to some extent; the majority (97%) felt that plans should "always" or "usually" do so. Similarly, all respondents felt that transportation plans should take future land use changes into account to some degree. Likewise, the vast majority of respondents (93%) demonstrated familiarity with the State TIP as it affected their jurisdictions. Most respondents (94%) were "familiar" or "somewhat familiar" with where and when such improvements would take place. In summary, these results suggest that planners appear knowledgeable about programmed transportation improvements and the majority believes that plans should address the reciprocal connection between transportation and land use. Yet, this connection remains unaccounted for in a high percentage of land use plans. It appears that a potential role for NCDOT and other state agencies may be to provide technical assistance enabling localities to develop more transportation-aware land use plans.

4.6 Municipality/county coordination with NCDOT, MPOs, and RPOs

When asked to describe the extent of interaction with NC DOT when their land use plan was developed or updated, most respondents described such interaction as "Limited" or "Periodic" (31% each). Less than one quarter of respondents described such interactions as "Frequent". In contrast, most respondents described the extent of interaction with the local RPO or MPO as "Frequent" (63%), or "Periodic" (21%). Few respondents felt such interaction was limited or nonexistent (16%) (Figure 4).

For the 30 plans whose content was analyzed, over 73% reported "frequent" interaction with MPOs or RPOs. Those reporting frequent interactions with MPOs or RPOs were significantly more likely to include non-motorized modes (86%) compared to those with less interaction with their MPO or RPO (50%) ($p=0.04$). Frequent interactions with MPOs and RPOs was also

associated with higher scores for discussion of current transportation conditions, inclusion of a specific transportation component in the plan, better use of mobility indicators, higher quality of transportation maps, and higher scores for vertical consistency. However, plans reporting frequent interactions were no different in terms of reinforcing the transportation-land use connection in the plan, or in terms of linking land use goals with specific transportation-related objectives or policies and vice versa. In sum, planners that interact more frequently with their MPOs or RPOs appear to be more aware of current transportation conditions, including the need for non-motorized modes, and their plans reflect better use of measurable indicators to monitor transportation issues.

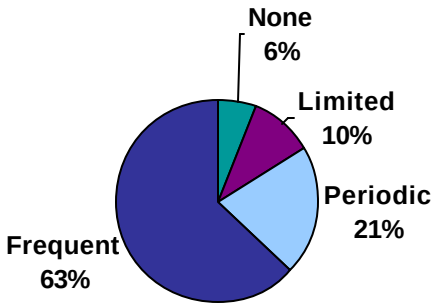


Figure 4. *Extent of interaction with local RPOs and MPOs*

In terms of interaction with NCDOT, 55% of their planners reported "periodic" or "frequent" interactions with NC DOT compared to 45% that reported "no interaction" or "limited interaction". However, plans were no different in terms of reinforcing the transportation-land use connection in the plan, or in terms of linking land use goals with specific transportation-related objectives or policies and vice versa.

Localities with planners who reported more interaction with NC DOT were significantly more likely to have plans that achieved high motorized planning integration scores (56%) compared to those with less interaction with NCDOT (21%) ($p=0.05$). However, those where the planner reporting more interaction with NC DOT were actually less likely to have plans that included non-motorized modes (69%) compared to those with less interaction with NCDOT (86%), and they were also less likely to achieve high non-motorized planning integration scores (12%) compared to those with less interaction with NCDOT (21%). Of course the causality of this relationship may be that because communities have more auto-related projects, they have more interaction with NCDOT. This suggests that planners may use their interactions with NC DOT to develop better auto-related improvements, but that they coordinate less with NCDOT when developing plans pertaining to non-motorized modes.

In summary, better land use plans and better mechanisms to implement the plans are associated with having accounted for the connection between land development and transportation. This finding is consistent with Norton's (2001) evaluation of CAMA plans in coastal North Carolina, where higher quality plans in terms of planning process also tended to address more thoroughly natural area resource protection issues associated with land development. Although planners' responses to the survey reflected considerable awareness of the connection between land use and transportation issues, this connection was more tenuous in terms of its reported application to land planning practice. Only 28% of the plans take into account all or most transportation improvements in the area. Likewise, almost a third of plans do not account for any improvements. MPOs and RPO interaction appears to be related to higher quality plans, and

plans that include more non-motorized travel options, but this interaction does not seem related to the transportation –land use connection in the plan.

4.7 Guiding principles and study results

In this section we review the detailed results of the plan content analysis with respect to the guiding principles we suggested previously. For brevity's sake please note that the statements of the principles have been shortened here. Refer to Box 1 for an expanded discussion of each principle.

Plan Presentation

Guiding principle 1: Plans should contain clear and readable land use maps, conveying usable information without the need to read accompanying text.

Results: Although most plans (86.7%) provided a table of contents, only 16.7% provided a glossary of terms and 30% provided an executive summary. The majority of plans (80%) provided land use maps, but only 26.7% of these were rated as "extensive, clear, and usable". Landmarks and key activity points were included in land classification maps of only 20% of plans, while transit routes and non-motorized infrastructure routes were each included in only 1 out 30 plans (3.3%). Finally, the majority of plans (73%) did not provide transportation maps.

Guiding principle 2: The time horizon of the plan determines the extent to which certain impacts, such as the land development impacts of planned transportation projects, are to be examined.

Results: Sixty-three percent of plans mentioned a time horizon; 23.4% mentioned a time horizon of 10 years or less, and approximately 40% mentioned a time horizon of 15-25 years (see Box 2).

Information Base and Content

Guiding principle 3: The plan should have spatially specific information. Differences in the quality and availability of transportation services, transportation infrastructure, and in land uses should be clearly related to geographically identified areas.

Results: Spatial specificity with respect to relevant policies was included in 63.3% of plans (59% of counties and 69% of municipalities) (protocol item 7.5). Sixty-seven percent of land use plans included a specific transportation component.

Guiding principle 4: Travel demand and the supply of transportation infrastructure should be discussed in the plan.

Results: Plans depicted fairly clearly current transportation conditions. More than 80% of plans had moderate or good descriptions. Although road supply was discussed in the majority (90%) of plans, road demand was discussed in only 60% of plans, with only 36.7% providing an extensive discussion. Transit was discussed less frequently in terms of both supply (47%) and demand (17%). A discussion of other infrastructure capacity (e.g. police, schools, water and sewer) was provided in 90% of plans (protocol item 3.18).

Guiding principle 5: Plans should include assessments of transportation policies, such as minimum parking requirements, parking supply, and parking cost.

Results: A discussion of parking demand/supply was included in only 2 out of 30 plans (6.7%) (protocol item 6.2.14).

Box 2. Time horizon of Transportation Improvements

The Kannapolis plan provides a clear articulation of the scheduled transportation improvements. This is helpful in anticipating the impacts in the land use plan.

"Without question, the dominant form of transportation in our region (as well as the majority of the Nation) is the single-occupancy vehicle. As a result, a substantial amount of funding and focus is shifted towards highway/roadway improvements. With this in mind, the following tables highlight the projected horizon years and estimated costs for identified Kannapolis area projects as set forth by NCDOT."

2000 to 2005 Horizon Years		
From	**To**	**Estimated Cost**
Dale Earnhardt Blvd , I-85 Interchange	NC 136 /Centergrove Rd	$ 6,213,000.00
Kannapolis Train Depot	Downtown Depot	$ 240,000.00
US 29-601	Cabarrus Avenue/ Jackson Park	$ 1,650,000.00
NC Highway 73	US 29/601 I-77	$ 240,000.00
		$8,343,000.000
2006 to 2015 Horizon Years		
I-85 Westside Bypass	NC 73	$25,648,000.00
I-85 NC 73	US Hwy 29/601 connector in Rowan Co.	$126,470,000.00
Odell School Road	NC 136 NC 73	$2,065,000.00
		$154, 183, 000.00
2016 to 2025 Horizon Years		
NC 136	MAB Loop Road	$11,304,000.00
NC 136	Dale Ernhardt Blvd. NC 73	$10,671,000.00
Old Beattys Ford Road	US 29 MAB	$3,934,000.00
US Hwy 29	I-85 NC 136	$6,368,000.00
Westside Bypass (U-2009) I-85	Tuckaseegee Road	$23,481,000.00
West "C" Street Enochville Avenue	NC 136	$480,000.00
		$56, 238, 000.00

The Horizon Years tables give a clear picture of the demand for transportation dollars ($) as compared to the actual amount of funding that is typically available to the Cabarrus-South Rowan area each year. The CSRMPO relies primarily on state and federal funding as levied from gasoline taxes."

Source*: City of Kannapolis 2015 Comprehensive Plan*

Guiding principle 6: The presentation of future land uses in a community should be accompanied by their differential impacts on travel demand and transportation infrastructure. Indicators such as approximate number of trips in the peak period, number of auto trips, number of walking trips, or mode shares are helpful in understanding the impacts.

Results: Seventeen percent of plans discussed level of service, and 26.7% included indices of average daily traffic (protocol item 7.8). In terms of mode share, auto modes were discussed in all plans; transit was mentioned or discussed in 66.7% of plans (16.7% provided an extensive

discussion). Pedestrian modes were discussed in 73.3% of plans; 13.3% gave an extensive discussion. Bicycle modes were discussed in 60.0% of plans; only 6.7% gave an extensive discussion. Carpools were discussed in 16.7% of plans, while vanpools were discussed in 23.3% of plans (neither provided an extensive discussion) (protocol item 7.9).

Despite the fact that a large majority of plans discussed non-motorized modes, only 5 plans (21%) mentioned the existence of other transportation plans, such as a transit plan, a transit oriented plan, a greenway plan or a sidewalk plan. It seems that most of the planning for non-motorized modes, given their dependence on land use, is occurring in the land use plan. A larger percentage of plans (40%) mentioned the presence of an additional thoroughfare plan.

Induced development from previous expansions to transportation capacity was discussed in almost 45% of plans; while induced development from previous expansions to other infrastructure capacities was discussed in 20% of plans (protocol items 3.19 and 3.20).

Guiding principle 7: Plans should consider the cost and feasibility of the extension of transportation services (bus) and infrastructure (sidewalks and roads).

Results: A transportation-related capital improvements program was included in 30% of plans (protocol item 7.11). Strategies for prescribing physical design for particular modes were included as follows: Road improvements/thoroughfare plan 43.3%, transit plan 0%, transit oriented development plan 0%, sidewalk plan 3.3%, greenway plan 16.7%, bike path/pedestrian plan 10% (protocol items 7.10.1-7.10.6)

Guiding principle 8: Plans should examine the existing and proposed local, state, and federal transportation infrastructure investments.

Results: Ninety percent of plans considered land suitability and infrastructure capacity constraints for prescribing relevant land development policies (e.g. land classification scheme, TIP priorities); 70% of these demonstrated a strong relationship between constraints and policies (protocol item 7.13).

Guiding principle 9: Plans should use various mobility and accessibility indicators.

Results: Unfortunately, none of the plans examined used indicators of accessibility, such as jobs-housing ratios, % of population within reach of jobs centers, and % of population within ¼ mile of transit. Plans did not provide discussions of volume-to-capacity ratio, delay, vehicles per hour, percent using non-auto modes, percent of population within a transit route, percent of population with sidewalks or bikeways/trails, or the percent of destinations accessible within time ranges. Only one plan provided information on average commute to work time. Fifty-seven percent of plans did not mention transportation indices.

Goals and policies

Guiding principle 10: The plan provides clearly articulated goals, including transportation goals achieved with land use policies and objectives, and land use goals achieved with transportation policies and objectives.

Results: In terms of specific transportation and land use goals, 40% of plans included a goal of having public transportation and associated infrastructure (bus centers, park & ride, etc); while 60% of plans included a goal of having pedestrian and bicycle access connections (greenways, sidewalks) and infrastructure (bike racks, showers, etc) (protocol items 6.2.9-6.2.10). Twenty-three percent of plans included a goal of having office, research, industrial, and commercial areas with direct non-motorized links to surrounding areas (protocol item 6.2.3). Seventeen percent of plans included a goal of having recreational opportunities within walking or biking distance (protocol item 6.2.2). Only 6.7% of plans included goals to develop traffic management plans to reduce peak period congestion (protocol item 6.2.12), and 20% included traffic calming goals (protocol item 6.2.13). Ten percent of plans mentioned employer and/or government sponsored commute reduction programs as goals (protocol item 6.2.11). The local relationship to the regional transportation network was mentioned as a goal in 36.7% of plans (protocol item 6.2.17). Coordinated interagency infrastructure planning (local, state, regional) was included as a goal in 26.7% of plans (protocol item 6.1.9). Only 13.3% of plans include objectives or policies that address land development and related environmental impacts of transportation projects (protocol items 7.14 and 7.15). Box 3 shows how Gastonia linked transportation and land use through the land use plan's goals and objectives.

Box 3. Connecting Land Use and Transportation through Goals and Policies

Gastonia's plan illustrates how the connection between land use and transportation can be emphasized in the plan by linking land use goals with transportation-related objectives and policies, and vice versa. However, note that this community's approach is generally more qualitative and the objectives are not quantifiable.

Objective 2: The impact of land use on the transportation system should always be evaluated when plans are adopted and policy decisions are being made.

2-a) Development that caters to the transit-dependent population (e.g., elderly, disabled, or disadvantaged persons) should be located on or within walking distance of a bus route, unless private on-site transportation services are provided.

2-b) Implement land use policies to restore downtown, the focus of the transit system, as a destination rather than just a transportation junction.

2-c) If light rail transit becomes a likelihood by 2010, designate a mixed-use, high density zone around the future rail station.

2-d) Large regional shopping centers should be supported by at least two major thoroughfare streets and located so that they do not cause traffic back-ups onto freeways.

2-e) Approval of major traffic-generating developments through re-zoning or conditional use should be granted only if the road capacity is in place or improvements are scheduled within the scope of the seven year TIP.

2-f) Improvements to and new construction of roads should be routed and designed to minimize negative impacts on established neighborhoods.

2-g) The transportation system should be structured to encourage through traffic on thoroughfares and discourage it on collector and local streets.

2-h) The community's parking requirements should include adequate, safe, and convenient bicycle parking for institutions and businesses that can reasonably be reached by bicycle.

2-i) Remove regulatory barriers to quality infill housing in central city neighborhoods that already have their transportation infrastructure in place.

2-j) Create "traditional neighborhoods" zoning tools that emphasize small lots, mixed uses, and shops and services within walking distance.

Objective 3: Assist the development of pedestrian and bikeway systems for both recreation and transportation purposes.

3-a) Develop a policy and plan for sidewalk construction with an eye toward more and better walkways. The sidewalk policy will cover sidewalk construction funded by the City and sidewalk construction in new development. Moreover, the sidewalk policy will determine the location and priority of new sidewalks on street projects constructed by the City.

3-b) All urban bridge projects should include at least one sidewalk.

3-c) Sidewalks should be constructed in a manner that feels safe for the user, particularly on busy streets. Sidewalks should be separated from the traffic lanes, either by on-street parking or a planting strip.

3-d) Prepare and implement a bikeway plan that designates and marks safe, efficient, and pleasant routes for bicycle travel within the area.

3-e) Where greenways are built, they should be built with a transportation function in mind. Greenways can then be used to connect sidewalks and bikeways.

3-f) Transit stations and stops should be reachable from sidewalks, greenways, or bikeways.

3-g) Examine the feasibility of coordinating and linking Transit with bikeways and bike users.

3-h) Develop a safe circulation system for bicycles by designating routes over lightly traveled streets and ensuring continuity along those streets, and encouraging new commercial developments to provide safe storage areas for bicycles.

3-i) Petition the State to use "enhancement" funds provided under the Intermodal Surface Transportation Efficiency Act on the Interstate 85 corridor.

Source: *City Vision 2010:* Gastonia's Comprehensive Plan

Guiding principle 11: The transportation and land use goals should be reasonably achievable with the policies suggested in the plan. Otherwise, the policies are not efficacious and more suitable policies or revised goals are necessary.

Results: Eighty-three percent of plans' actions relating to specific land use policies were rated as efficacious (protocol item 9.4.2), meaning that they are able to produce the intended effect. However, only fifty-three percent of plans' actions related to specific transportation policies

were rated as efficacious (protocol item 9.4.5). The most frequently cited policies were infrastructure investments to manage growth (76.7%), locally and regionally appropriate façades, landscaping, and site designs (66.7%), auto-oriented retail development that deliberately promotes or avoids certain areas (60%), and pedestrian and bicycle access, connections, and infrastructure (60%). Transfer of development rights and public transportation and concomitant infrastructure were each cited as policies in 40% of plans; the local relationship to the regional transportation network was cited in 36.7% of plans, as were commercial centers providing pedestrian amenities (36.7%). Transit-oriented developments were cited as policies in 30% of plans; policies regarding non-motorized links to office, research, industrial and commercial areas were included in 23.3% of plans, and traffic calming policies were cited in 20% of plans. All other policies were included in fewer than 20% of plans. Excerpts from the Kannapolis plan provide further examples (Box 4).

Box 4. Land Use Policies and Objectives Supporting Transportation Goals

The Kannapolis plan does a very good job identifying goals and objectives and then proposing specific policies to make them happen. Below are selected goals, objectives and policies. Notice how language in the policies is exhortative, when it could be made more directive.

GOAL: Decrease travel time
Objective: Provide a roadway network that is interconnected.
Objective: Provide for a system of collectors that augment the thoroughfare system.

Policy: All new subdivisions shall provide a collector standard road, if the tract of land being subdivided has a collector street designated on the Cabarrus-Rowan MPO Collector Plan map. The final alignment may be adjusted, as needed, for existing building or natural features. The intent of the collector map is to show the approximate location.
Policy: All new subdivisions are required to connect to adjacent subdivisions that have existing stub-out roads or where other opportunities for connection exists, as determined by the public works or planning department. Requirements for stub-out connections to be made to allow for future subdivisions are in the unified development ordinance.
Policy: All new subdivisions will have a connectivity ratio of 1.4 or more. A connectivity ratio is the number of street links divided by the number of street nodes.
Policy: Designate on the Collector Plan corridors reserved for new collector roads and existing roads that should be upgraded to collector standards.

GOAL: Improve transportation safety
Objective Traffic calming designed on all new collectors.
Objective: Common design standards for all jurisdictions within the MPO.

Policy: All collector streets shall use traffic calming devices to limit speeds. The spacing of the devices shall not exceed 1,500 ft. Devices used can be selected from items 3, 4, and 6-8 in Figure 4-5 on page 4-6. Items 3, 4, and 6 should be used in areas of expected pedestrian activity and utilized as a crosswalk. This may be areas that connect residential to commercial or recreational areas.
Policy: Commercial development along routes designated as minor or major thoroughfares on the latest Thoroughfare Plan Map shall maintain a minimum of 1,000 ft. between driveways and allow interparcel access to adjoining properties for future development. Alternatively, a frontage or backage road may be provided with access points to the thoroughfare a minimum of 1,000 ft. apart.
Policy: Develop and implement a UDO.

GOAL: Reduce congestion

Policy: Businesses that use an employee trip reduction (ETR) program to reduce single-occupancy vehicles for their employees shall be given tax incentives and transit system discounts.

GOAL: Improve livability of the community
Objective: Bike facilities and sidewalks on all new collectors.

Policy: All collector streets shall have a marked bike lane, 4 ft. wide with curb and gutter and 5 ft. wide without. Where parking is prohibited, a wide travel lane may be used instead of a marked bike lane.
Policy: In areas zoned for commercial activity, sidewalks shall be a minimum of 8 ft. wide. In all other areas, sidewalks shall be a minimum of 5 ft. wide. Where a new sidewalk is being built to meet an existing sidewalk, a transition from the width of the new sidewalk to the width of the existing sidewalk shall be a minimum of 10 ft.

Source: City of Kannapolis' *2015 Comprehensive Plan*

Implementation

Guiding principle 12: The plan should facilitate meaningful ongoing public participation and incorporate ongoing monitoring and implementation evaluation procedures, using indicators.

Results: On the positive side, the majority of plans did well in terms of documenting public participation. A description of the public participation process was included in 76.7% of plans; 46.7% provided a detailed description. Eighty-three percent provided an explanation of the planning process; 53.3% provided a detailed explanation (Box 5). Most plans (63.3%) also discussed the planning or steering committee, and other public participation mechanisms were discussed in 80% of plans. However, only 33.3% of plans included a survey of public opinion, 13.3% mentioned a publicly circulated preliminary draft, and 3.3% discussed stakeholder involvement (section 4 of the coding protocol).

On the negative side, implementation and monitoring (section 8 of the coding protocol) was a weak area for the majority of plans in our sample. Only 7% of plans received high implementation scores. Examining the implementation score subcomponents further, we found that only one plan included transportation-related indicators to quantify land use goals, and four plans quantified land use goals based on measurable objectives. One third of plans provided information on the timing and implementation of the land use plan. Box 5 shows the use of indicators to monitor implementation in the Winston-Salem plan.

Coordination and consistency

Guiding principle 13: The community should use a common, consistent, and persuasive set of assumptions in its integration of future land uses with transportation plans. Most importantly, estimates of the demand for land should be based on the same population and economic forecasts as the estimates used in the transportation plans.

Box 5. Plan Implementation

The Winston-Salem plan identifies benchmarking as a way to monitor implementation:

"Benchmarking or defining a set of standards to be achieved and then measuring progress in reaching those benchmarks are a common practice in the business world. Benchmarking in Winston-Salem's plan is used to set targets and measure our community's progress and success in achieving its goals and objectives. Benchmarking will help the community monitor implementation of the plan in future years.

"Progress in reaching the benchmarks will be assessed annually and a major review of indicators and benchmarks will take place in 2005 when a review of the Plan is scheduled to take place. The benchmark figures for the year2005 were derived by combining projections available from relevant agencies with City-County Planning Board projections based on implementation of the policies and actions proposed in the plan. In some instances projections were not available from other sources and City-County Planning Board projections were used."

Examples of specific transportation-related benchmarks from this plan are listed below.

Indicator	Measurement	Level
Vehicle use	Ratio of growth in vehicle miles traveled to population growth	94-99- 2.94 to 1 99-05- 2.76 to 1
Transit use	Annual fixed route transit passenger trips	93/94- 3,062,180 96/97- 3,370,065 99-05- 3,808,051
Vanpooling use	Annual regional vanpool passenger trips	92/93- 209,037 96/97- 417,358 99-05- 485,536 to 600,000

"[The vehicle use indicator] will be used to determine whether one of the objectives of Winston-Salem's plan to reduce the number and length of automobile trips is being met. At present the growth rate of vehicle miles traveled is higher than the population growth rate. Based on population data and data on vehicle miles traveled from The 2025 Multi-Modal Long Range Transportation Plan for Forsyth County, the Regional Transportation Study for the Piedmont Triad Region, and the 1998-1999 Air Quality Report for Forsyth County the ratio of growth in vehicle miles traveled to population growth between 1994 and 1999 has been calculated as 2.94 to 1. Projections indicate that, for the period 1999 to 2005, this ratio should decrease to 2.76 to 1. This projection is the benchmark for 2005 and is intended to reflect changing patterns of growth and development that reduce vehicle miles traveled."

"[The transit use] indicators will be used to determine whether the Plan's objective of expanding public transit services is being met by setting benchmarks for ridership levels for the year 2005. Annual transit passenger trips are limited to bus users. Existing data and projections for transit passenger trips to 2005 were available from the Winston-Salem Transit Authority. Existing data on transit passenger trips shows a decline in trips over the last few years. It is hoped that implementation of policies proposed in the Plan to increase transit ridership can contribute to reversing this trend.

"Vanpooling provides an alternative to single occupancy vehicles and therefore contributes to reduced congestion. The regional vanpooling program has been fairly successful. Vanpool passenger trips have been increasing over time though the rate of increase has varied widely. A 5% yearly rate of increase has been used to obtain a benchmark for 2005."

Source: *The Legacy Comprehensive Plan for Winston-Salem*

Results: Twenty-three percent of plans provided a summary of land use-related data collection and analyses, and a summary of demographic and economic analyses. Eighty-seven percent of plans gave population trends, eighty percent provided information pertaining to development trends, 73% discussed primary economic bases, 60% discussed economic trends, and 53% discussed environmental trends or problems. Eighty three percent of plans discussed existing undeveloped land and water bodies.

Guiding principle 14: The plan should achieve internal consistency (between facts, goals, analyses, and policies), horizontal consistency (between the plan and plans of neighboring jurisdictions), vertical consistency (between the locality and state and federal plans and mandates), and consistency in implementation (between plan policies and implementation mechanisms such as land use regulations and building codes).

Results: The majority of plans achieved a high level of *internal consistency*. Ninety-three percent of plans connected land use elements to other infrastructure investments. Seventy-nine percent of plans were rated as having compatible goals and objectives throughout the plan, and 69% were rated as having compatible policies. Sixty-seven percent of plans demonstrated consistency with current TIPs. However, only 30% of plans demonstrated consistency with a long-range transportation plan for the area or region (Figure 5).

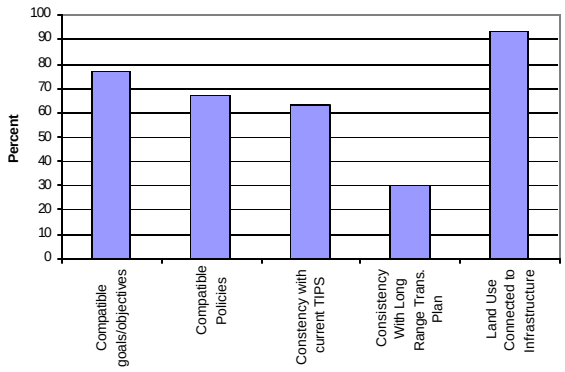


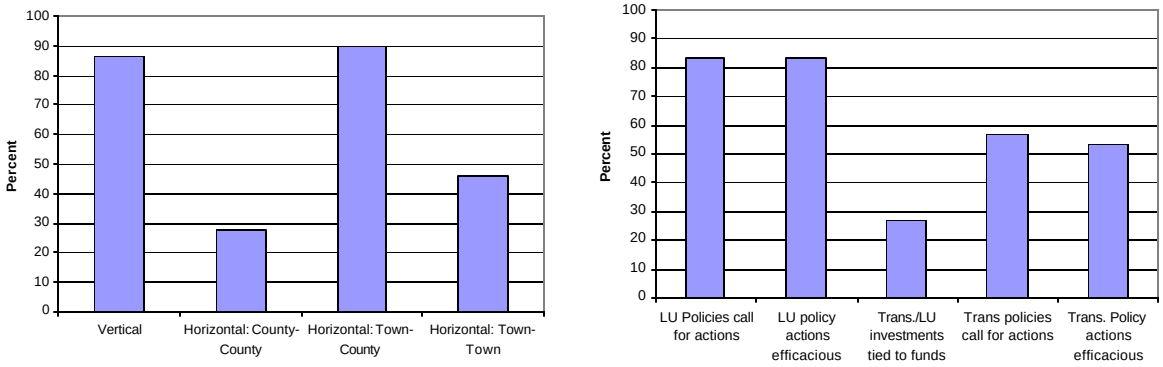
Figure 5: *Internal consistency*

With respect to *horizontal consistency*, 90% of plans demonstrated town-county coordination (protocol item 9.2.1.3). Town-town coordination was demonstrated by 46% of towns (n=13). County-county coordination was less prevalent: 72.2% of counties were rated as having no county-county coordination (Figure 6).

The majority of plans (86.6%) achieved *vertical consistency*; the plan mentioned authorizing legislation or state requirements (Figure 6).

Implementation consistency showed mixed results (Figure 6). Plans received high ratings on two indices: a) 86.7% of plans' land use policies called for certain actions to implement the policies (protocol item 9.4.1); and b) 83.3% of plans' actions relating to specific land use policies appeared efficacious (protocol item 9.4.2). Plans scored lower on 3 indices of implementation consistency with respect to transportation: a) 56.7% of plans' transportation policies specifically call for new actions to implement those policies (protocol item 9.4.4); b) 53.3% of plans' actions related to specific transportation policies appeared efficacious (protocol item 9.4.5); and c) only 30% of plans tied specific transportation and land use investments to specific funding sources (protocol item 9.4.3). Box 6 summarizes Mint Hill's effort to achieve consistency with other plans and policies.

Figure 6: *Left panel- Vertical and horizontal consistency. Right panel- Implementation consistency*



Box 6. Plan Consistency

Mint Hill's plan illustrates efforts to achieve consistency with other plans and policies. Although the plan may be inconsistent with current plans and policies, the needs for consistency and steps to achieve it are identified.

Recommendations [regarding the thoroughfare plans]
- Amend Section 7, "General Requirements" to address subdivision consistency with adopted public plans and policies. At present, this section does address this as a general requirement for [thoroughfare] plans. Such an addition will ensure that subdivisions and roads are planned within the scope of adopted plans, such as the MPO's Thoroughfare Plan, and a Collector Street Plan. Such an amendment might read as follows:

Consistency with Adopted Public Plans and Policies:
All subdivision of land approved under these regulations should be consistent with the most recently adopted public plans and policies for the area in which it is located. This includes general policy regarding development objectives for the area, as well as specific plans for public facilities such as streets, parks and open space, schools, and other similar facilities. Adopted plans are on file at the Town Hall offices.

Elsewhere in the report, the plan calls for additional consistency:

Support the Master Sidewalk Plan developed in 1999, with particular emphasis and priority given to implementing the sidewalks recommended in the traditional downtown area. The plan attempts to link various destinations with sidewalks: the Downtown area, schools, parks, library, Town Hall, etc. and also provide safety for children, pedestrians, and bicyclists using the sidewalk.

Source: *2000 Land Use Plan for Town of Mint Hill*

With regard to the principal purpose of this study, these findings taken altogether suggest that the potential for relying on local land use plans as a means to partly assess indirect and cumulative impacts of transportation projects should be approached with some caution. Based on our survey of planners and analysis of plans across the State of North Carolina, the level of detail and

analytical rigor provided by local planning efforts, as a general rule, are not sufficiently strong to build upon for assessing indirect and cumulative impacts—particularly with regard to the land use-related impacts from proposed or anticipated transportation improvements—although plans from given communities might be sufficiently strong on a case-by-case basis. If and once the accounting of transportation impacts on land development becomes the norm, however, this approach could be used more generally. More detailed justifications for this bottom-line conclusion are provided in the conclusions section.

4.8 What explains better substantive scores in plans?

Up to this point, we have discussed plans with varying substantive and procedural scores in their content analysis. Recall that these scores measure the degree to which land use goals in the plan are supported with transportation objectives and policies. This is the clearest expression of a community's ability to link transportation to land use in the plan. Although the previous section provided a glimpse into possible relationships between plan characteristics, area characteristics and the transportation land use connection, in this subsection we pursue this idea further by examining relationships between plan scores, and area characteristics (such as jurisdiction type, growth, population size, degree of urbanization, and CAMA legislation), while controlling for TIP expenditures. Controlling for the presence of TIP expenditures is important, because this identified areas that are receiving transportation investments as therefore where connecting the improvements to land use plans should be a high priority.

Specifically, we develop a series of regression models utilizing the plan scores as the dependent variable, and the TIP expenditures and area characteristics as independent variables. In addition, separate models were developed for auto/road TIP expenditures and for non-auto TIP expenditures (output not included for the sake of brevity). Several trends emerged from these analyses:

? Auto/Road TIP expenditures are not significantly associated with higher total plan quality scores

? Non-motorized TIP expenditures and non-auto TIP expenditures are significantly associated ($p<.10$) with higher total plan quality scores in models that controlled for jurisdiction or degree of urbanization, but not in models controlling for growth, population size, or CAMA.

• None of the area characteristics (jurisdiction, population, growth, degree of urbanization, or CAMA) are significantly associated with total plan quality scores once TIP expenditures were controlled for.

The above results suggest that higher auto/road TIP expenditures are generally associated with better total plan scores, but that this effect appears to stem from the process-oriented portion of the score rather than through the substantive component.

In a few instances we disaggregated the total scores into substantive and process-oriented plan scores, using the former as our dependent variable and the latter as an additional independent variable.[5]

- Auto/Road TIP expenditures are not significantly associated with higher substantive plan quality scores.

- Non-auto TIP expenditures are significantly associated with higher substantive plan quality scores in three out of five models, each controlling for process-oriented scores and one area characteristic (growth, CAMA legislation, and jurisdiction).[6]

- Cities are significantly ($p<0.02$) associated with higher substantive plan quality scores compared to counties, controlling for process-oriented scores and TIP expenditures (using either non-motorized TIP, non-auto TIP, or auto/road TIP expenditures).

- High growth areas are significantly ($p<0.10$) associated with higher substantive plan quality scores compared to low growth areas, controlling for process-oriented scores and TIP expenditures (using either non-motorized TIP, non-auto TIP, or auto/road TIP expenditures).

- Urbanized regions are significantly ($p<0.05$) associated with higher substantive plan quality scores compared to non-urbanized regions in models controlling for process-oriented scores and TIP expenditures (using either non-motorized TIP, non-auto TIP, or auto/road TIP expenditures).

- Population size is not significantly associated with substantive plan quality scores.

- CAMA counties are significantly associated with *lower* substantive plan quality scores compared to all other counties, controlling for process-oriented scores and TIP expenditures (using either non-motorized TIP, non-auto TIP, or auto/road TIP expenditures). However, because there were only four CAMA counties in our sample, these results may not be generalizable to other CAMA jurisdictions.

The above analyses confirm that higher auto/road TIP expenditures are generally associated with better process-oriented scores, but not substantive scores. For non-motorized TIP expenditures, in contrast, higher expenditures are associated with higher substantive plan quality scores, but are not as consistently associated with total scores (presumably because the procedural component is unaffected). The same is true for an analysis using non-auto TIP expenditures instead of non-motorized TIP expenditures. Cities, urbanized regions, and higher growth areas also have higher substantive plan scores, regardless of TIP expenditures or procedural scores.

[5] These models would test if better plans in terms of their general and specific procedural quality, as defined in the body of the report, are related to better substantive scores, while controlling for the presence of various motorized and non-motorized TIP projects.

[6] The nonsignificant models were those containing population and degree of urbanization as area-level covariates.

4.9 Reliability of protocol and validity of survey instrument

Reliability of the content analysis protocol

To what extent is the plan evaluation protocol developed and applied in this study reliable? That is, do the protocols measure what they are supposed to measure, independent of the person conducting the evaluation? If the measurements resulting from the application of the protocols are unreliable, then the information resulting from them will also be unreliable. Thus, the quality of our findings depend partly the agreement between raters of the plans' contents.

The results, provided in additional detail in Appendix 9, suggest that the General Information and Plan Components/Presentation sections of the protocol were the most reliable sections, as determined by kappa coefficients and percent agreement measures. By contrast, the least reliable sections of the protocol were the Supporting Data and the Background Goals and Policies sections. For the less reliable sections, results should be interpreted more cautiously since the ratings of our raters were not highly consistent with each other.

Validity of survey instrument

A question that emerged from the application of the survey of planners in the Phase I survey is the degree to which such surveys accurately depict what is in the plan. On the one hand, it is possible that planners' may wish to suggest that their plans are better than they really are. On the other hand, responses may reflect expectations and policies that are not contained explicitly in the plan, but that guide planning practice. In general, self-reports tend to be considered less valid than objectively derived measures. Thus, the quality of our results also depends on the validity of the survey instrument.

Only certain items were suitable for direct comparison between the survey and the coding instrument, and some variation is expected due to differences in the wording between the survey questions and the content evaluation items (for details, see Appendix 10). To summarize our results, survey respondents achieved high levels of sensitivity (>70%) for most items, with two exceptions: 1) Inclusion of transit routes in the plan (sensitivity 42%) and 2) consistency with long range transportation planning for the area or region (sensitivity 56%). This means that planners were generally able to identify items that were truly present in the land use plans. In terms of specificity, only one item achieved high specificity and high sensitivity: inclusion of non-motorized modes (83% and 73%, respectively). This indicates that planners are able to correctly identify the presence of non-motorized modes when they existed in the land use plans, and to correctly report non-motorized modes as missing when they were absent from the plans. However, specificity was generally low (<70%) for eight out of the twelve items studied, suggesting that respondents were less able to identify when an element was *absent* in their plan than they were when an element was *present* in their plan. Detailed results of the validity analyses are shown in Appendix 10.

Several possible explanations are possible for this result. The first is that planners may be less likely to distinguish items that are absent from the plans (e.g., they may tend to over-report items as being present). Second, planners may be reflecting informal rules or priorities that guide decision-making but that are not included in the plan. A third possibility is that low specificity

can be an artifact of the distribution generated by small sample sizes. This appears to have happened for the items pertaining to "consistency" (protocol items 9.1.2.1, 9.3.6, and 9.4.1). For example, all plans had high scores for those three questions according to the gold standard, so in these cases the low specificity ratio is simply a result of dividing zero by a very small number.

In sum, we can reasonably assume that the planners' survey responses correctly identify items that are present in the land use plans, but we should not rely upon the survey responses alone to provide information about specific items pertaining to the transportation-land use connection that may be missing from the plans.

5 CONCLUSIONS AND RECOMMENDATIONS

The aim of this study is to improve NCDOT's understanding of how land use plans and related land management tools are being used by county and municipal governments in North Carolina and the degree to which such plans account for the effects of transportation projects. A related aim was to raise awareness in local areas of the relationship between transportation and land use. Developing such understanding in localities and at NCDOT is important because it contributes to the efficient use of public resources devoted to land development and to transportation infrastructure investments. The current and future quality of our air, our water, and how much land we consume and how much we preserve is at stake.

The premise of this study is that local development plans should address the reciprocal relationship between future land uses and future transportation infrastructure and services in a given community. A coordinated approach to transportation and land planning yields many benefits to communities: land planners can better anticipate which areas, previously inaccessible or less accessible, are likely to become attractive for development due to a transportation project. This information can be used to manage development that fits the character of the area and help anticipate the demand for public services in the area, including water, sewerage, and schools. Conversely, with knowledge about land use plans, transportation planners can better anticipate future demands for transportation and the land development impacts of their projects. In addition to the benefits to infrastructure planning and land development planning, addressing the reciprocal relationship is also beneficial for improving quality of life. A multi-modal and safer transportation system, combined with various land development patterns, enhances the choices that residents can make regarding where to live and how to travel. In the end, such choices also have important bearing on a community's sustainability and quality of life.

A comprehensive literature review revealed principles that should assist planners in understanding the link between land use and transportation, and in identifying ways in which plans can incorporate or account for that link. Land use plans connecting transportation and land use demonstrate a strong factual and analytical basis related to transportation and land use supply and demand; clearly relate transportation and land use policies to geographically identified areas; articulate goals, including transportation goals achieved with land use policies and objectives; incorporate currently planned federal, state and local transportation investments; employ policies that are both directive and appropriate; achieve high degree of consistency; and facilitate participation and incorporate ongoing monitoring and implementation evaluation procedures,

using indicators. We evaluated our survey of planners and the content analysis of the plans in the light of these guiding principals.

The results of our survey of planners in NC, and the content analysis of thirty county and municipal plans selected at random to ensure that they are representative of the state, suggest that although there is considerable awareness of the connection between land use and transportation issues, this connection is rarely visible in the land use plans. For example, few plans take into account all or most transportation improvements in the community and according to respondents almost a third of plans do not account for any improvements. The detailed analysis of the plans confirmed this finding: In general, most land use plans can improve the way in which they account for transportation improvements in the plan. Rarely do such plans use land policies or objectives to achieve transportation outcomes, and only a handful of plans explicitly reference the reciprocal connection between transportation and land development. Thus, despite a) awareness of the importance of the reciprocal relationship between transportation and land use; and b) knowledge about programmed transportation improvements, the connection remains unaccounted for in a high percentage of land use plans. It appears that a potential role for NCDOT and other state agencies may be to provide technical assistance enabling localities to develop more transportation-aware land use plans. Such assistance may take the form of a community guide of best practices in land use planning, with respect to transportation.

Throughout both studies we found that the implementation of land use plans needs to be strengthened. Only 7% of plans received high implementation scores. Examining the relevant aspects of implementation that need most help we identify that only one out of the thirty plans content-analyzed included transportation-related indicators to quantify land use goals, and four plans quantified land use goals based on measurable objectives. None of the plans examined used basic indicators of accessibility, such as jobs-housing ratios, % of population within reach of jobs centers, and % of population within ¼ mile of transit. In light of this, we recommend that NCDOT and DCA put together brief best-practice reports highlighting the use of various indicators at different levels of aggregation and under different growth conditions. Such reports could become a key reference when land use planners are revising or updating their local plans.

Although strengthening plan implementation is useful for its own sake, it is also relevant to the connection between transportation and land use. Plans that do a better job in their implementation (imperfectly measured as the number of land use implementation tools in place in a community) also tended to account for the transportation-land use connection. Similarly, the perceived usefulness of the plan in guiding decisions, another measure of implementation, also is related to the degree to which plans accounted for the reciprocal impacts of land development projects and transportation improvements.

The content analysis revealed important complexities that the survey missed. For example, the vast majority of survey respondents interact frequently or periodically with local agencies preparing and coordinating transportation plans in their area. However, we could not detect the effect of this frequent or periodic interaction on the connection between land use and transportation in the plan. Only occasionally did the plans explicitly acknowledge regional or statewide transportation plans, but they did so more frequently for other local plans (such as water, sewer, or school plans). As a result, we recommend that NCDOT, MPOs and RPOs reach

out to localities generally and to land use planners specifically, to identify mechanisms that increase collaboration among parties and improve planning outcomes.

We found that plans included far more non-motorized transportation modes than what planners reported in the survey. This is relevant because communities with more non-motorized transportation improvements also tended to have better land use plans, in terms of their generic content and structure, and their content specific to the transportation-land use connection. This agrees with the view that non-motorized modes are more scale dependent, and rely on supportive land uses to be viable. As such, when land use plans incorporated non-motorized modes, we detected a stronger connection between transportation and land use in the plan. The opposite, when plans incorporated motorized modes, was not associated with a strong land use-transportation connection in the plan. In fact, the presence of auto-related elements in the plan was associated with plans that were strong procedurally (i.e., generic plan quality, consistency in plan analysis and policy recommendations) but weaker in terms of substantive aspects of the connection between transportation and land use (i.e., goals and policies emphasized through the plans and plan implementation efforts). These results indicate that encouraging planners to consider multiple transportation modes, beyond the automobile, may have the added benefit of accounting for broader issues between transportation and land use.

An encouraging finding is that cities, high growth areas, and urbanized areas tend to account for the connection between transportation and land use more than other areas. Although this is partly the result of planning requirements related to transportation planning, this is encouraging, not because other areas should not account for the connection, but because these urban, fast-growing areas are ones where accounting for the connection is likely to be most critical.

Taken together, these findings suggest that transportation and land planning are not as coordinated as they could or should be, thereby depriving communities from many of its benefits. As a result, the potential for relying on local land use plans as a means to partly assess indirect and cumulative impacts of certain transportation projects should be approached with some caution. The level of detail and analytical rigor provided by local planning efforts, as a general rule, do not seem sufficiently strong to provide a solid basis for assessing land use-related impacts from proposed or anticipated transportation improvements, although plans from given communities might be sufficiently strong on a case-by-case basis. As the quality of the land use plans improves, so will the ability to rely on them for indirect and cumulative impact assessment. Currently, such assessments can cautiously build upon existing plans. This limitation is exacerbated by the fact that the courts have not required strict adherence between adopted plan and local regulation, as outlined in the consistency primer in Appendix 11. Indeed, zoning was the most frequently reported tool to manage the location and timing of land development in our survey.

Finally, our analysis of the planners' survey, in light of the plan content analysis, underscores the strengths and weaknesses of using surveys for research and analysis. Planners were generally able to identify items that were truly present in the land use plans. However, planners were less able to identify items that were truly absent from the plan. One notable exception is non-motorized modes, where planners correctly identified the presence of non-motorized modes when they existed in the land use plans, and correctly reported non-motorized modes as missing

when they were absent from the plans. To our knowledge, this is the first time that such an analysis is conducted to gauge the reliability of survey responses. Such analysis should not be viewed as a test of the adequacy of the planner's responses, but rather a divergence that raises academic and practical interest. The divergence can be the result of lack of knowledge regarding the plan, of an interest in portraying the plan better than what it is, or a reflection of local priorities and policies that are not reflected in the land plan, yet they guide local decision-making. It is also possible that the divergence is an artifact of the distribution generated by small sample sizes.

Our study has answered initial questions regarding the strength of the land use-transportation connection in land use plans. Our focus on land use planners suggests that a similar study focusing on transportation planners' incorporation of land use elements is warranted. How is land use considered in transportation plans? Are land use plans considered when making local and regional transportation plans? How can such connections be strengthened? Related to this study is a recommendation to develop a community guide highlighting how attention to land use plans can help transportation planners. Although this study focused on land use planners, we believe that transportation planners, the other side of the connection, should also be emphasized.

Another study can examine communities where land use planning is mandated (e.g., CAMA plans). In such communities, can land plans be used in conducting indirect and cumulative impact assessments of transportation investments, as they relate to induced land development? Likewise, a comparison between the CAMA plans, with a strong hazard mitigation focus, and plans of communities in other parts of the United States (e.g., California, Florida or Oregon) where the motivation is animated partly by transportation and growth concerns, can determine the degree to which the intent of the mandate may influence the quality of the plan and its usefulness for such cumulative impact analyses.

6 IMPLEMENTATION AND TECHNOLOGY TRANSFER PLAN

We recommend several steps to strengthen land use planning in the State, thereby enabling further reliance on land use plans for the assessment of indirect and cumulative land development impacts. The natural party for leading such strengthening efforts is the Department of Commerce's Division of Community Assistance. Through MPOs and RPOs, DCA can provide assistance for educating and integrating local land use planners to the importance of better coordinating transportation and land use planning, and specifically about accounting for planned transportation projects when land plans are developed. In addition to State-level actions, our results suggest specific actions that localities can take in order to improve their ability to connect transportation and land use, such as developing plan implementation tools that match transportation and land development priorities at the local level, as well as identifying funding sources that can be used to support alternatives to automobile travel. Particular implementation and technology transfer suggestions at the State-level are:

- Provide technical assistance that enables localities to develop more transportation-aware land use plans. Such assistance may take the form of a community guide of best practices in land use planning, with respect to transportation, following the guidelines developed in this report;

- Develop brief best-practice reports highlighting the use of various indicators at different levels of aggregation and under different growth conditions. Such reports could become a key reference when land use planners are revising or updating their local plans;

- Creation of institutional mechanisms that enable DCA, NCDOT planners, MPOs and RPOs to reach out to local land use planners to increase collaboration among parties and improve planning outcomes; and

- Expand DCA's land development planning guidelines (Kaiser & Moreau, 1999) to include guidelines that connect transportation to land development. Such guidelines, developed as part of this report, are summarized in Box 7, below. For an extended discussion of each of the guidelines, see Box 1 in section 2.2. The principles in Box 7 should be viewed as useful extensions that will help in evaluating the plans and in drawing lessons that could be applicable for current planners. Not every comprehensive plan will follow all of these principles, but the highest quality plans with respect to transportation exhibited many of them.

Box 7. Summary of Fourteen Guiding Principles for Connecting Land Use and Transportation in Land Use Plans

Plan Presentation

Guiding principle 1: Plans should contain clear and readable land use maps, conveying usable information without the need to read accompanying text.

Guiding principle 2: The time horizon of the plan determines the extent to which certain impacts, such as the land development impacts of planned transportation projects, are to be examined.

Information Base and Content

Guiding principle 3: Differences in the quality and availability of transportation services, transportation infrastructure, and in land uses should be clearly related to geographically identified areas.

Guiding principle 4: Travel demand and the supply of transportation infrastructure should be discussed in the plan.

Guiding principle 5: Plans should include assessments of transportation policies, such as minimum parking requirements, parking supply, and parking cost.

Guiding principle 6: The presentation of future land uses in a community should be accompanied by their differential impacts on travel demand and transportation infrastructure.

Guiding principle 7: Plans should consider the cost and feasibility of the extension of transportation services (bus) and infrastructure (sidewalks and roads). When appropriate, such costs should be provided as part of the plan or references to capital improvement programs or transportation plans should be provided.

Guiding principle 8: Plans should examine the existing and proposed local, state, and federal transportation infrastructure investments.

Guiding principle 9: Plans should use various accessibility indicators to monitor the connection between transportation and land use, such as the % of population/jobs/retail within ¼ mile of transit, % of population/jobs/retail within a 20 minute walk/bike/drive, isochronal curves, or jobs/population ratios at various scales.

Goals and policies

Guiding principle 10: The plans should provide clearly articulated goals, including transportation goals achieved with land use policies and objectives, and land use goals achieved with transportation policies and objectives.

Guiding principle 11: The transportation and land use goals should be reasonably achievable with the policies suggested in the plan.

Implementation

Guiding principle 12: The plan should facilitate meaningful ongoing public participation and incorporate ongoing monitoring and implementation evaluation procedures, using indicators.

Coordination and consistency

Guiding principle 13: The community should use a common, consistent, and persuasive set of assumptions in its integration of future land uses with transportation plans. Most importantly, estimates of the demand for land should be based on the same population and economic forecasts as the estimates used in the transportation plans.

Guiding principle 14: The plan should achieve internal consistency (between facts, goals, analyses, and policies), horizontal consistency (between the plan and plans of neighboring jurisdictions), vertical consistency (between the locality and state and federal plans and mandates), and consistency in implementation (between plan policies and implementation mechanisms such as land use regulations and building codes).

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