COMPREHENSIVE PLAN AMENDMENT IMPACTS ON INTERCHANGES IN OREGON

Final Report

SR 500-131

RESEARCH

Oregon Department of Transportation

COMPREHENSIVE PLAN AMENDMENT IMPACTS ON INTERCHANGES IN OREGON

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September 2005

Technical Report Documentation Page

1. Report No. OR-RD-06-07	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Comprehensive Plan Amendment Impacts on Interchanges in Oregon		5. Report Date September 2005 6. Performing Organization Code
7. Author(s) James G. Strathman, Thomas J. Kimpel, Paul Leistner, Kenneth J. Dueker Center for Urban Studies, Portland State University P.O. Box 751, Portland, OR 97207		8. Performing Organization Report No.
9. Performing Organization Name and Address Oregon Department of Transportation Research Unit 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192		10. Work Unit No. (TRAIS) 11. Contract or Grant No. SR 500-131
12. Sponsoring Agency Name and Address Oregon Department of Transportation Research Unit 200 Hawthorne SE, Suite B-240 Salem, Oregon 97301-5192		13. Type of Report and Period Covered Final Report 14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

This report examines the effects of amendments to local comprehensive plans on interchange performance on the Oregon highway system. Plan amendments over a 15-year period in Oregon, resulting in changes to industrial or commercial land use, were reviewed to identify those that occurred within one mile of an interchange. Regression analysis was then performed to estimate the impact of nearby plan amendments on subsequent interchange ADT. Plan amendments were found to have a substantial ADT effect on rural interchanges, but their incidence was very limited. In urban core areas, the estimated effect of plan amendments was negligible, possibly due to interchange congestion or effective land use planning. In urban fringe areas, plan amendments were estimated to account for about 5 percent of the subsequent interchange ADT, equivalent to about two years of the design life of these facilities. Case studies involving plan amendment activity over time near six interchanges revealed that traffic impacts were rarely identified by local planning jurisdictions and that the Oregon Department of Transportation (ODOT) was rarely involved in the review process. Recent changes in transportation planning and programming requirements will result in greater consideration of development activity in interchange areas. Interchange area management plans are now required in cases of interchange construction or improvement. Changes in the Department of Land Conservation and Development's Transportation Planning Rule also provide for direct involvement of ODOT in the review of plan amendments in interchange areas.

17. Key Words Interchange management, access management, land use, traffic impacts, transportation planning, intergovernmental coordination		18. Distribution Statement Copies available from NTIS, and online at http://www.oregon.gov//ODOT/TD/TP_RES/	
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 86	22. Price

Technical Report Form DOT F 1700.7 (8-72) Reproduction of completed page authorized Printed on recycled paper

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	millimeters squared	mm^2
ft^2	square feet	0.093	meters squared	m^2
yd^2	square yards	0.836	meters squared	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	kilometers squared	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	ml
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	meters cubed	m^3
yd^3	cubic yards	0.765	meters cubed	m^3
NOTE: Volumes greater than 1000 L shall be shown in m^3.				
		MASS		
oz	ounces	28.35	grams	g
lb	Pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
		TEMPERATURE (exact)		
°F	Fahrenheit	(F-32)/1.8	Celsius	°C

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	millimeters squared	0.0016	square inches	in^2
m^2	meters squared	10.764	square feet	ft^2
m^2	meters squared	1.196	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	kilometers squared	0.386	square miles	mi^2
		VOLUME		
ml	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	meters cubed	35.315	cubic feet	ft^3
m^3	meters cubed	1.308	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams	1.102	short tons (2000 lb)	T
		TEMPERATURE (exact)		
°C	Celsius	1.8C+32	Fahrenheit	°F

*SI is the symbol for the International System of Measurement

ACKNOWLEDGEMENTS

This project originated as a problem statement submitted by Dick Reynolds to the Oregon Department of Transportation's Research Unit. The authors thank Mr. Reynolds for his efforts in developing the research proposal, and for his input as a member of the project's Technical Advisory Committee (TAC). Comments from other TAC members, including Jerri Bohard, Mark Joerger and Anna Russo, are also gratefully acknowledged. Barnie Jones, manager of the Research Unit, provided input on the research design, statistical analysis, and interpretation of the results.

The statistical analysis itself would not have been possible without the diligent efforts of Gretchen Harvey and Todd Putnam, who compiled years of interchange traffic count data and transferred it from paper records to a digital database. Ahmed El-Geneidy and Paul Cone assisted in processing the comprehensive plan amendment data. Alan Kirk served as an effective project manager, coordinating all aspects of the research and ensuring successful completion of our work.

Finally, the authors express appreciation to the individuals (identified in the Appendix) who were interviewed for this project, whose views helped to more fully define the context of the problem taken up in this project.

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COMPREHENSIVE PLAN AMMENDMENT IMPACTS ON INTERCHANGES IN OREGON

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1.0 INTRODUCTION

Interchange design capacity decisions rely on accurate traffic projections over the expected life of the facility. These projections, however, are subject to uncertainty, especially when there is potential for substantial change in land development activity and corresponding traffic generation. Comprehensive plan amendments contribute to uncertainty in capacity design decisions in that they represent a structural change in the regulation of development activity. When plan amendments occur, traffic projections based on assumptions that current land uses will prevail in the future are undermined, and the result can be a growth of traffic beyond the projected volumes used to determine design capacity, with a consequent reduction of the effective life of the facility.

There are alternative perspectives on mitigating the effects of development-related uncertainty in interchange capacity decisions. Given that interchanges themselves often serve as a catalyst for development, a better understanding of the conditions under which development patterns are likely to change following the siting or improvement of interchanges could lead to more realistic traffic projections and capacity decisions. Alternatively, for facilities already in place, a number of policies and practices that serve to manage traffic growth associated with nearby development activity can preserve capacity. In practice, a combination of the two perspectives may provide the most effective means of mitigating uncertainty, both ensuring that interchanges actually realize their design life and that scarce resources are not wasted in producing facilities with substantial excess capacity.

This report explores the effect of comprehensive plan amendments and zoning changes on interchange traffic volumes in the Oregon highway system. The Oregon Department of Transportation (ODOT) has implemented a practice of preparing interchange area management plans (IAMPs) to bring a long-range management component to various planning efforts, as well as in connection with interchange construction or improvement on the state highway system. Plans are required by administrative rule for proposed new interchanges, as well as by Oregon Transportation Commission (OTC) conditions on interchange project programming. Generally, these plans are mutually adopted by ODOT and the local jurisdiction where the interchange is located.

The IAMPs cover various factors affecting interchange performance over time, including access management, the design of the local transportation system through which an interchange is accessed, as well as the planning regulations governing land use and development. These plans represent a departure from the traditional focus on access management by also addressing the circulation of traffic in the surrounding area and the land development process that affects traffic generation.

While it has been generally thought that comprehensive plan amendments have contributed to the growth of interchange traffic volumes on the state highway system, there has not yet been a systematic analysis of either the geographic incidence of comprehensive plan amendments or their subsequent impacts on interchange performance. Such analysis is the primary objective of this report.

1.1 ORGANIZATION OF THE REPORT

This report addresses a variety of topics associated with interchange area management on the Oregon highway system. In addition, the research approach is multi-faceted, drawing on contributions from published research on interchange management, interviews with planning professionals involved with interchange area management in Oregon, a review of the current state of the practice in Oregon, a statistical analysis of interchange traffic growth over time on the state highway system, and selected case studies that illustrate the dynamic relationship between interchange traffic and land development.

A review of literature related to interchange management issues is presented in Chapter 2. Included in the review is a summary of practices employed in selected states that are seeking to improve traffic management in interchange areas. The effect of interchange capacity change on traffic generation is also covered in the context of induced traffic.

Chapter 3 provides an overview of the policies, programs and practices related to interchange area management in Oregon. The chapter also provides a summary of several recently-adopted IAMPs.

Chapter 4 presents a synthesis of the views of the transportation and land use professionals who were interviewed for this project.

Chapter 5 describes the alternative traffic projection procedures used by ODOT in the interchange project development process.

Chapter 6 covers the project's empirical analysis, including investigation of the geographical incidence of comprehensive plan amendments in Oregon over a 15-year (1988-2002) period, as well as a statistical analysis relating traffic growth over the study period on more than 270 interchanges to comprehensive plan amendment activity and a number of other contributing factors.

Selected interchange case studies reflecting the systematic relationships identified in the statistical analysis are reported in Chapter 7.

The final chapter presents a summary of findings and recommendations for future research.

2.0 BACKGROUND AND LITERATURE REVIEW

2.1 THE INTERCHANGE MANAGEMENT PROBLEM

Interchanges are highway entry and exit points that provide access to communities and to service highway users' needs for gasoline, restaurants, and hotels. In addition, tracts of land near freeway interchanges are accessible to a wide region and have become highly desirable locations for commercial and industrial uses. The convergent land development demands of the multiple functions of serving highway users, shoppers, and employees have produced traffic volumes that have grown faster than the forecasts upon which the design of interchanges has been based, resulting in congestion and safety problems. Responding to freeway interchange congestion requires a variety of improvements, such as signalization, widening of cross roads, and new turn lanes at freeway ramps. The ability to expand interchanges is often financially constrained by intensely developed abutting property. Expansion can also be constrained in regulatory terms, when abutting land uses include ecologically sensitive land, and farm and forest lands.

In such circumstances, had transportation planners and engineers fully anticipated the access-induced traffic growth, they might have separated the highway service function by greater use of (toll road-type) service oases and rest stops along freeways, along with greater use of frontage roads, and, in select cases, advance land acquisition to accommodate interchange expansion. However, advance or excess land acquisition poses two problems. First, and foremost, there is not sufficient certainty of the traffic growth to over-ride legal constraints against excess condemnation. Second, existing land developments along cross roads makes excess land acquisition expensive and displacement contentious.

One solution would have been the avoidance of connecting interchanges to existing roads, and to connect to future roads where access could have been better managed. Awaiting the construction of these future roads, frontage roads could have been used to connect existing cross roads. Similarly, land use policies might have been shaped to temper the growth of traffic-intensive land uses near interchanges. However, local governments have often not restricted, but rather have encouraged traffic-intensive land uses near interchanges. There is a temptation for local governments to see freeway and cross road capacity as a resource that the state provides, easing their efforts to accommodate traffic growth with limited infrastructure resources.

Congestion and safety problems stem in part from rapid traffic growth in interchange areas. These problems are often exacerbated by the proximity of freeway ramps to driveways and access roads, resulting in conflicting turning movements that have to be managed by signals and access management within restricted rights-of-way (ROW).

Intense development around interchanges areas that are not sized for expansion has resulted in the need to achieve more efficient use of the current ROW. The most extreme example of this is rebuilding an overpass to serve as a gigantic intersection, called a Single-Point Urban

Interchange (SPUI). These single-point diamond interchanges allow one set of traffic signals to control all crossing movements, and the signal enables concurrent opposing left turns, which increases the capacity of the interchange. SPUIs use a compact layout requiring less right-of-way acquisition, but they require a larger bridge deck area. They are being used extensively in Minnesota in conjunction with the capacity expansion in the I-494 belt freeway corridor at Penn Ave, Lyndale Ave, and Portland Ave. In Oregon, the Market Street Interchange on I-5 in Salem is an example of a SPUI.

Whatever the option pursued to mitigate interchange area congestion, an over-arching need is to take a longer-term view of planning interchange capacity and managing interchange areas. An interchange planning process that looks ahead at least twenty years is needed. Interchange planning is not current planning; it is long-range planning that includes integrated management of land development and traffic growth. Even in circumstances where land development and traffic trends can be predicted with relative confidence, resource constraints can preclude building to meet long-range needs. Consequently, the issue is to allow for flexibility to facilitate expansion and, at the same time, to better manage traffic growth to mitigate the need for expansion. Balancing these issues over time is the essence of interchange planning and management.

2.2 INTERCHANGE MANAGEMENT THROUGH ACCESS MANAGEMENT

There is an extensive literature on access management practices. Much of this literature is focused on the technical aspects of roadway design and the regulation of traffic at specific types of locations. While the need to better integrate land use and transportation planning is increasingly noted in the access management literature, its basic orientation still tends to view the land development process as exogenous, as reflected in the following statements:

> The purpose of access management is to “provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system.” (*TRB 2003, p. 3*)
>
> “Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. It also involves the roadway design applications, such as median treatments and auxiliary lanes, and the appropriate spacing of traffic lights.” (*TRB 2003, p. 3*)

David Plazak wrote that “access management has become an increasingly important and controversial issue in many cities….across the nation.” He writes that “one of the major obstacles to the successful implementation of access management principles is the seeming disconnect between the activities of agencies responsible for administering roadways and the activities of agencies responsible for local land use planning and regulation.” (*Plazak 1998, p. 159*).

A historical tension exists between the desire of local governments and property owners to gain access to state highway facilities, and the state’s interest in maintaining the capacity and safety of the system for through traffic. Many papers and reports recognize that while state DOTs have authority to regulate direct access to state highways, local governments have the authority to regulate both the land development and transportation aspects of access management. However, local governments often approach the issue of access management on a case-by-case basis in the development approval process, which overlooks the cumulative impacts of development on interchange congestion and safety (*Williams and Forester 1996*).

Plazak (*1998*) and others stress the need for improved communication between local land use and state transportation authorities. The TRB *Access Management Manual* recommends that state transportation agencies work with local governments and encourage them to adopt local access management programs(*TRB 2003*). One approach recommended by the TRB is for local governments to adopt corridor access management plans or overlay districts, or adopt into their comprehensive plans system-wide programs that incorporate policies and planning concepts that support access management and adopt “an access management ordinance or official policy” (*TRB 2003, p. 55*).

TRB identifies the following ways to address access management in comprehensive plans:

- Adopting a section that describes the general principles and benefits of access management;
- Adopting specific goals, objectives, and policies related to access management;
- Defining a system of planned roadways classified by function and design, and access management guidelines for these types of roadways;
- Preparing a map of roadways and of identified roadway corridors that may receive special treatment or study;
- Developing land use, community design, and activity center concepts that “support access management and promote the development of unified access and circulation systems” and a response to the need for a supporting street system, especially for developing commercial and residential areas. (*TRB 2003, p. 56*)

A number of state DOTs are wrestling with efforts to better integrate state transportation system needs and local land use planning. States with statewide comprehensive land use planning systems appear to have an advantage (*Williams and Forester 1996*). In these states, local governments are required to develop comprehensive plans. State land use planning goals commonly call for coordination of land use and transportation planning. In Oregon, the adoption of the Transportation Planning Rule (TPR) by the Land Conservation and Development Commission has made such coordination a requirement. The TPR requires local transportation and land use plans to be compatible with the ODOT’s State Highway Plan. The TPR also lays out procedures for evaluating traffic impacts associated with amendments to local comprehensive plans in interchange areas, and establishes ODOT’s role in the plan amendment process.

State growth management statutes provide substantial authority to local governments in coordinating access management and land development. Such statutes support a variety of mechanisms that result in more effective access management. These include a) concurrency, which requires that that the necessary infrastructure (including transportation) be in place to accommodate new development; b) urban growth boundaries, which contain development and facilitate coordination of land use and infrastructure planning; c) impact fees, which levy marginal system infrastructure development costs on land development; and d) comprehensive plans that discourage strip commercial development and promote mixed use clustered development.

Local zoning and subdivision regulations can include a variety of provisions that serve access management objectives. These include 1) setback requirements that recognize planned/future right-of-way needs; 2) limits on the number and location of driveways per parcel; 3) driveway density limits and spacing minimums in designated corridors; 4) minimum lot sizes and frontages in designated corridors; 5) limits on lot splits and “flag lot” subdivision; 6) requiring reverse frontage service roads for subdivisions abutting major thoroughfares and interchanges; and 7) limiting driveway permits in commercially zoned corridors to promote joint and cross access to parking facilities.

With the introduction of new access requirements through changes in zoning and subdivision regulations, existing properties that are nonconforming can subsequently become subject to the new requirements under a defined set of conditions, including 1) subsequent requests for driveway permits; 2) an increase in land use intensity; 3) site improvements; or 4) increases in trip generation.

The legal authority of state and local governments to regulate access to transportation facilities has been periodically tested and interpreted in the courts. Commonly at issue are the conflicting responsibilities of government to ensure safe and efficient traffic movement, and the rights of property owners to obtain reasonable access to transportation facilities. Compensation of property owners is required when government takes property for public benefit, but reasonable regulation of access to protect public safety and welfare can be imposed without compensation. However, the regulation of access must demonstrate a “nexus” between the burden on property owners and the gain in public safety and welfare, and should be in “rough proportion” to the impacts that would have otherwise been caused by affected property (*Nollan 1987; Dolan 1994*).

More generally, Supreme Court Justice Scalia has also concluded that access management regulations contained in zoning and subdivision regulations (such as those identified above) can be employed as area-wide congestion management measures (*Pennell 1988*). Williams and Forester (*1996*) conclude that the courts have tended to be more supportive of governments’ actions in regulating access when those actions are clearly linked to transportation and land use plans.

States are gradually gaining experience with intergovernmental coordination of access management and land use planning. The experiences of Wisconsin, Florida and Texas, discussed below, provide examples of the approaches that have been reported in the literature.

2.2.1 Wisconsin

Wisconsin adopted comprehensive planning legislation in 1999. Subsequently, the Wisconsin Department of Transportation (WisDOT) created a workgroup to address transportation and land use challenges (*WisDOT 2002*). Workgroup members interviewed WisDOT district staff and developed a series of issue papers. The issue papers served as the starting point for a “template” guide and further policy development. Another recommendation was the creation of a WisDOT department-wide group -- the Land Use Roundtable -- to improve cross-divisional information sharing on land use issues.

District staff identified the need to better integrate consideration of land use issues into state transportation planning, access management and project development. They recommended the following actions:

- Coordinating access management decisions with local, regional, and state plans;
- Developing a long-term vision for access along the state highways;
- Increasing the number of corridor plans conducted;
- Improving communication and coordination between the department's planning and project development functions.

The report said that while district staff had a good understanding of the impact of local land use decisions on state facilities, they did not have adequate department support in the form of consistent policy direction, resources, training and tools. The report found that districts need to spend more time coordinating plans with local governments, but that resources to do this were limited and districts were considering cutting back on planning efforts, not increasing them.

The workgroup also prepared issue papers on the following topics: District Participation in Local Comprehensive Plans; Corridor Plans; Pre-EIS Studies; Functional Vision for Rural STHs; The Program Development and Project Planning Process; Access on Bypasses; Official Mapping of Bypasses; Land Use Relationship to Frontage Roads; Development Reviews; Transportation Impact Analysis; Land Use Related Skills, Knowledge and Training; and Metropolitan Planning Organization Plan Updates.

2.2.2 Florida

The Center for Urban Transportation Research (CUTR) at the University of South Florida has done extensive work on access management in Florida. In 2000, CUTR published a report for the Florida Department of Transportation (FDOT) that describes land development and access management strategies for Florida interchange areas.

The CUTR report states that it is "essential to have regulations in place that address issues of compatibility and function" (*Land and Williams 2000, p. 6*). The report states that the separation of state and local authority makes this difficult to accomplish. "No single technique or governmental entity can achieve the desired results. Effective interchange area management requires a combination of techniques involving land use planning, zoning, subdivision regulation, signage, access management, and intergovernmental coordination" (*Land and Williams 2000, p. 6*).

The CUTR report provides suggestions (described below) for land development regulations that can facilitate planning for interchange area development and protection of interchange capacity.

<u>Subdivision Regulations</u>: Subdivision regulations can "require dedication of land for road improvements, ensure proper street layout in relation to existing or planned roadways, require

internal property access for residential development, and establish design principles and standards for lots, blocks, streets, public places, pedestrian ways, and utilities" (*Land and Williams 2000, p. 10*).

Zoning Regulations: Zoning regulations can be "applied in a variety of ways to advance interchange area access and development objectives", including:

- **"Interchange Overlay District**. Interchange zoning controls are added to the standard zoning requirements of the underlying district (commercial, residential, etc.). The property and any improvements are subject to both the standard zoning regulations and the overlay restrictions. Overlay requirements may address any issues of concern, such as driveway spacing or consolidated access roads, and are often used to implement an access management plan."

- "**Interchange Zoning District**. A separate zoning district specifically for those areas within the designated interchange area, having its own set of subdivision and development regulations."

- "**Planned Unit Development for Interchange Areas.** Larger tracts are planned and developed as a functional unit, as opposed to standard zoning, which regulates development on a lot-by-lot basis. A PUD process is oriented toward accomplishing site design that is more sensitive to the characteristics of an area. For an interchange area, they could be oriented toward accomplishing consolidated access and circulation systems. PUD controls are more flexible and are subject to a thorough investigation and review before approval is granted. Conditions for approval are specified prior to development."

- "**Special or Conditional Use Permits**. Certain conditions must be found to exist prior to granting approval, and development must be compatible with the surrounding area." (*Land and Williams 2000, p. 11*).

The CUTR report indicates that Florida has a "Development of Regional Impact" (DRI) process that allows more extensive review of "proposed development projects that, because of their size, character, or location, have impacts that extend far beyond the development site." The DRI process provides an opportunity to address "impacts on the surrounding transportation system, including interchange areas" (*Land and Williams 2000, p. 11*).

The CUTR report also recommends regulatory and non-regulatory access management measures that include:

- Alternate access roads;
- Access separation distances (spacing standards);
- Medians;
- Joint and cross access requirements;
- Improved driveway design;
- Acquisition of access rights (*Land and Williams 2000, p. 12*).

2.2.3 Texas

In contrast to Wisconsin and Florida, the Texas Department of Transportation has relied more heavily on highway design solutions in managing access to interchanges. The Texas approach is based on an extensive system of frontage roads comprising 4,500 centerline miles in 2000 (*Kockelman, et al. 2003*). Although frontage roads add to the cost of interchange projects, they provide a very effective means of managing traffic in interchange areas. Access to interchanges is directed through frontage roads, while access to frontage roads is regulated by standards limiting driveway density and spacing. Frontage roads thus facilitate local circulation and limit congestion at interchanges and the freeways they serve.

Kockelman, et al. (*2003*) investigated the effects of frontage roads on safety and interchange/freeway operations in the Austin area. They found that crash rates were substantially lower in corridors served by frontage roads, with the lowest crash rates being associated with frontage roads having the most limited access. To assess operations, they used the Federal Highway Administration's CORSIM software to estimate speed and delay for scenarios with and without frontage roads, under alternative access, residential and commercial development density and interchange spacing assumptions. Frontage roads were found to have little effect on speed and delay for various levels of residential development, but were found to produce a substantial improvement in operations in the case of commercial development, especially when interchanges were closely spaced (i.e., one mile or less). Considering the higher capital costs of designs with frontage roads, Kockelman, et al. (*2003*) concluded that this approach would likely be cost effective only in areas of high levels of commercial activity, high land value, and closely-spaced interchanges.

2.3 INDUCED TRAVEL

The consideration of induced travel responses to a change in transportation facilities can be traced to the earliest cost-benefit studies of highway improvements. The concept was further generalized in Anthony Downs' (*1962*) classic portrayal of its contribution to the "triple convergence" response of travelers to new highway capacity. More recent research has focused on estimation of the magnitude of the induced travel response to new capacity, with the work of Hanson and Huang (*1997*), focusing on traffic growth following freeway expansion in California, drawing considerable attention. Goodwin (*1996*) reviews the empirical evidence on induced travel from the literature published up to the mid-1990s.

In the late 1990s, the US EPA sponsored additional empirical research on induced travel responses to changes in highway capacity, given that emissions associated with induced travel warrant consideration as "indirect and cumulative effects" in the preparation of Environmental Impact Statements for highway projects. The findings and implications of the EPA-sponsored research are discussed in Noland and Lem (*2002*).

Several important distinctions need to be considered in interpreting traffic responses to highway capacity changes. The first is concerned with the scale of analysis, or the need to distinguish between site and system level responses. Traffic responses at the site level, or in the immediate locale of a capacity change, is usually much greater than at the system level, given that traffic tends to divert to routes where capacity improvements occur.

The second distinction is concerned with traffic changes that occur in the short run versus the long run. In the short run, induced traffic responses to capacity changes reflect the expression of latent travel demand occasioned by the reduction in the generalized cost of travel. In the longer term, the initial expression of latent demand is supplemented by changes in land development patterns that are occasioned by the improvement in accessibility associated with the change in highway capacity.

The longer-term changes in development patterns are of particular interest in the case of freeway interchanges, given that interchanges are capable of producing substantial improvements in accessibility. In this context, work by Cervero (*2003*) and Boarnet and Chalermpong (*2001*) provide good empirical examples of the role that land development plays in induced traffic responses to highway capacity changes.

Cervero observed that "the preponderance of empirical evidence to date suggests that the effects of induced demand are substantial" (*Cervero 2003, p. 145*). He also claims that "past research has come under fire on methodological grounds" and attempts to correct these errors. Cervero argues that "road improvements confer benefits in the form of higher travel speeds, and that it is changes in operating conditions that influence demand, not the physical attributes (e.g. lane miles) of a project" (*Cervero 2003, p. 146*). Cervero describes an "anatomy of induced demand" that includes short-run behavior shifts—some formerly suppressed trips are made (i.e. latent demand); "some motorists switch modes, routes, and times of travel to exploit available capacity," and longer term structural changes, in which "people and firms locate to exploit the accessibility benefits created when freeways are upgraded."

Cervero distinguishes between types of travel gains as generative and redistributive. Generative gains are truly new travel ("formerly suppressed trips, longer trips as motorists opt to travel farther because of freer flowing traffic, and modal shifts"). Redistributive gains include route and schedule changes for existing travel.

Cervero cautions that "many past empirical studies have applied simplified model structures to gauge induced demand effects." He writes that some earlier studies treated traffic increases as a direct consequence of lane-mile additions. He argues that only if "travel speeds increase and travel times fall will motorists gravitate to an improved corridor." Adding a lane in a congested urban corridor will generate trips that adding the same lane to a rural, lightly traveled road will not.

Cervero developed an empirical model that reflects four key effects:

- Effects of road improvements on travel speeds;
- Effects of road improvements and travel speeds on urban development (reflecting the knowledge that institutional delays in land development responses to new highway capacity can delay induced travel effects by up to five years);
- Effects of travel speeds and urban development on travel demand;
- Effects of travel demand and speeds on road improvements. (*Cervero 2003, p. 148*)

Cervero's 2003 study used data for 24 California freeway projects across 15 years. He found that the magnitude of induced-growth effects was generally smaller than previous research had shown. His estimated induced demand elasticity was approximately .30, indicating that a one percent increase in system highway capacity would result in a three-tenths percent increase in system traffic. He concludes that the analysis of travel impacts associated with road expansion can be enhanced by modeling that better reflects the complex dynamics of the relationship between new infrastructure, the land development process, and induced travel.

Another study by Boarnet and Chalermpong offers strong evidence that the construction of toll roads in California produced accessibility benefits that were capitalized in the housing market. The authors argue that the increase in property values is evidence of an "accessibility premium." They write that the willingness to pay for an improvement in accessibility influences both development patterns and induced travel (*Boarnet and Chalermpong 2001, p. 575*).

In contrast with other research on induced travel, a study sponsored by ODOT examined the impacts of highway capacity improvements on land uses and growth. The study found that "most highway capacity increases do not cause development to be dramatically different from local land use plan guidance, or from what would have occurred in absence of the highway improvement." (*Sanchez and Moore 2001*.)

The report cautions that because so much transportation system and land development has occurred in Oregon, it is difficult to clearly determine the extent to which land uses are responding to the development of the highway system, or the extent to which highway improvements are responding to transportations needs resulting from development and settlement patterns (*Sanchez and Moore 2001, p. 5*).

3.0 INTERCHANGE AREA MANAGEMENT IN OREGON

ODOT is responsible for the safe and efficient operation of interchanges on state highways, while local governments regulate nearby land uses which generate traffic. The OTC has endorsed actions that seek to protect the capacity of these interchanges from development beyond what is anticipated in existing zoning and comprehensive plans, which are key drivers in determining interchange design capacity. ODOT cannot regulate local land uses and development activity. Thus, the Department's approach has been to work cooperatively with local governments to manage development around interchanges.

Oregon's long established state-wide land use planning system gives ODOT transportation planners an advantage over many states by formally requiring coordination of transportation and land use planning at the local level, as well as coordination between local and state-level plans.

3.1 LAND USE AND TRANSPORTATION PLANNING AUTHORITY

Oregon state law requires every city and county to adopt a comprehensive plan and to implement zoning and land division regulations. Local comprehensive plans must implement nineteen state planning goals, including Goal 12: Transportation. ODOT has no formal role in approving local comprehensive plans; this responsibility is vested in the Department of Land Conservation and Development (DLCD).

Oregon's Transportation Planning Rule sets out administrative rules to implement Goal 12. With the exception of smaller communities, cities and counties are required to adopt Transportation System Plans (TSPs). A local TSP establishes a transportation network to serve state, regional, and local transportation needs (*Oregon Secretary of State 1995*).

The TPR was amended in April 2005 to address comprehensive plan amendments in interchange areas, which were defined to include land within a 1/2-mile radius of an interchange center point or as defined by an adopted IAMP (*Oregon Secretary of State 2005*). The new language in the TPR establishes more direct involvement of ODOT in the plan amendment process with respect to the determination of traffic impacts on interchanges. The amended TPR also clarifies the methods by which projected traffic impacts are determined, and the financial and functional means through which impacts are mitigated.

ODOT has authority to regulate access to state highway facilities through OAR Division 51: Highway Approaches, Access Control, Spacing Standards and Medians. This is ODOT's most direct authority to regulate access to highway interchanges. Division 51 encourages (but does not mandate) the development of access management plans, access management plans for interchanges, and interchange area management plans "to maintain highway performance and improve safety by improving system efficiency and management before adding capacity consistent with the 1999 Oregon Highway Plan" (*Oregon Secretary of State 2004*). Interchange area management plans are required for all new interchanges.

3.2 OREGON HIGHWAY PLAN

The 1999 Oregon Highway Plan (*ODOT 1999*) includes a number of policies and actions that relate to the planning and management of interchanges and interchange areas. The general objective of these policies is to preserve the function of interchanges in serving system-level mobility needs and to manage access associated with local traffic. Related to this objective, the Highway Plan directs ODOT to develop coordinated approaches with local governments to ensure that local comprehensive and transportation system plans are compatible with the system-level mobility goals.

Policy 3C addresses interchange access management areas and is directly relevant to the present study. Under this policy, ODOT is directed to develop interchange area management plans to protect the function of interchanges and to minimize the need for major improvements of existing interchanges. The policy calls for adherence to the Division 51 interchange access standards in new interchange construction and improvements to existing interchanges. When feasible, it encourages ODOT to purchase access rights in order to meet Division 51 standards, with primary consideration given to limiting access on crossroads for a minimum of 1,320 feet. Prior to interchange construction, any necessary improvements in the local road network in interchange areas must be identified in the local comprehensive plan along with funding commitments.

More generally, the Highway Plan's Policy 1G directs ODOT to design major improvements to limit access and protect through-traffic movement. The policy also directs ODOT to develop intergovernmental agreements to establish any necessary supporting actions that local governments must take in their comprehensive plans. When major improvements to state facilities are identified in local transportation system and comprehensive plans, ODOT support is made contingent on the existence of local plan measures that would protect the function of the facility.

The Highway Plan's Policy 1B also has relevance for interchange area traffic management. This policy directs ODOT to work with local government to limit the expansion of development along state highways by promoting compact development away from state highways and avoiding expansion of urban growth boundaries near interchanges. If such expansions occur, the Plan calls for ODOT to work with local governments to develop an interchange management plan to protect interchange operation.

3.3 ODOT BYPASS STUDY

In 2002, ODOT completed an evaluation of 16 bypass facilities on the state highway system (*ODOT 2002*). The evaluation considered changes that had occurred on and near the facilities from the time of construction to the present. Among the performance indicators studied were traffic volumes, the number of accesses, the population of adjacent communities, crash activity, and land development activity. Development was examined by comparing aerial photographs of the bypass corridors taken prior to construction with more current photos.

The evaluation concluded that bypasses were generally serving their intended purpose of diverting through-traffic from downtowns and limiting access to local traffic. Crash rates on the bypasses were found to be lower than the system-wide average. For a majority of the bypasses, average access spacing exceeded ODOT's standards. For bypasses constructed since 1980, subsequent land development activity appeared to conform to the comprehensive plans that were in place at the time of construction.

The bypass study also identified several concerns. First, there was evidence from several bypasses that development near the termini was impeding traffic flow. Second, in selected instances, there was an apparent need to seek greater access control through acquiring existing approaches as well as planning for the reservation of access in the future. Third, the report recommended greater state-local coordination of long range transportation and development planning activity in bypass corridors, including ODOT participation in the development review process.

Following the bypass study, the OTC adopted an amendment to the 1999 Highway Plan, creating a bypass policy (*OTC 2003*). The policy directs ODOT to work with local governments to plan and manage local development to preserve the effectiveness and function of bypasses. The policy defines the scope of state-local coordination to include the development and amendment of local transportation plans, zoning, subdivision regulations, access management, and bypass financing. It directs ODOT to establish joint agreements with local governments in the form of management plans addressing bypass interchanges/intersections, access, zoning, and land use. For new bypasses or alignments, management plans need to be adopted prior to construction.

Finally, the new bypass policy encourages ODOT to be proactive in its access management practices, including (on new bypasses and alignments) avoiding granting direct private property access by acquiring access rights and, when 20-year forecasts identify the need for future interchange development, advance purchase of necessary right of way and adjacent access rights.

3.4 INTERCHANGE AREA MANAGEMENT PLANS

To date, four Interchange Area Management Plans (IAMPs) have been completed for programmed interchange construction projects, and another is nearing completion. A total of 26 plans are in preparation. Two of the completed plans are for interchanges on US 26 on the west side of the Portland metropolitan area, at the intersections of Jackson School Road and Cornelius Pass Road. These projects are responding to traffic growth along US 26 and new development in the Sunset Corridor of Washington County. A third one is located in Ontario (Malheur County), and the fourth is at Rickreall (Polk County). The one nearing completion is located in Woodburn (Marion County).

- The IAMPs in Rickreall and Woodburn represent sharply contrasting circumstances in urban development: The Rickreall IAMP, addressing a new interchange at OR 22/OR 99W and OR 22/Dallas Rickreall Highway, deals with an interchange area that is relatively undeveloped, and the general objective of the IAMP is to ensure that the interchange will be protected from future development.

- The Woodburn IAMP, addressing the Woodburn interchange of I-5 and OR 214, deals with an interchange area that has experienced rapid commercial development over the past 15 years, and the general purpose of the IAMP is to manage future development in order to extend the functional life of an interchange that is programmed to be rebuilt in the near future.

3.4.1 Rickreall

The IAMP for the Rickreall interchange is presented in the *Rickreall Junction Transportation Facility Plan* (*ODOT and Polk County 2004*). Included among the major development-related elements of the plan were the following actions:

- Preservation of existing land uses in the unincorporated community of Rickreall, maintenance of Exclusive Farm Use zoning of properties adjacent to OR 22, and continued protection of resource and exception lands in the interchange area from growth-induced development from interchange construction;

- Adoption of measures that would prevent urban growth boundary expansion (by the City of Dallas, located about two miles west of Rickreall) in the vicinity of the interchange;

- Adoption of the Rickreall Junction Facility Plan in the Polk County Comprehensive and Transportation System Plans;

- Construction of a local access road parallel to OR 99W to serve local traffic circulation needs and divert local traffic from the interchange;

- Relocation of selected farm access to OR 22 and OR 99W and purchase of access control from a property on Rickreall Road to ensure that the interchange satisfies Division 51 access standards;

- Early inclusion of ODOT in the review of proposed development or redevelopment in the interchange area that would substantially increase trip generation.

Given adoption of the Rickreall Junction Facility Plan in the Polk County Comprehensive and Transportation System Plans, ODOT Region 2 decided to forgo the preparation of an intergovernmental agreement with Polk County for the adoption and implementation of the IAMP.

3.4.2 Woodburn

The Woodburn IAMP is represented in an interchange area overlay district, to be adopted by the City of Woodburn in its comprehensive plan. The primary objectives of the IAMP are two-fold: 1) to establish a “trip budget” in connection with future (20-year) development of vacant parcels in the interchange area; and 2) to limit comprehensive plan amendments and zoning changes that would increase trip generation in the interchange area.

The trip budget is applied to development of 962 vacant acres contained in four sub-areas in the vicinity of the Woodburn interchange. The sub-areas are distinguished by their comprehensive plan land use designations, covering industrial, single family and nodal medium density residential, and commercial land uses. The City of Woodburn can approve development of any parcel whose trip generation would exceed its proportional trip budget, and the proportional trip budgets for any sub-area can be exceeded as long as the overall trip budget for the overlay area is not exceeded over the 20-year period. The trip budget will be adjusted every three years, based on actual development and changes in overlay area employment. The City of Woodburn would be responsible for documenting trip generation from approved developments and changes in employment. Finally, in order to maintain a positive trip budget, the City may require transportation demand management measures as a condition of development approval.

Comprehensive plan amendments in the interchange overlay area would be subject to several limitations: 1) amendments that would increase commercial land area in the overlay area would be prohibited; and 2) amendments that would allow land uses generating trips in excess of the overlay area trip budget would be prohibited.

4.0 STAFF INTERVIEWS

As part of the review of ODOT policies and practices related to interchange area management, interviews were conducted with staff from ODOT transportation planning, DLCD and Oregon Department of Justice. A list of interviewees is reported in the Appendix.

Staff sent a strong general message that proactive planning by ODOT and collaboration with local government officials and planners are the best ways to ensure that development associated with comprehensive plan amendments does not compromise interchange performance. In the context of this general message, staff identified a number of more specific issues, problems, and opportunities.

4.1 PROACTIVE VERSUS REACTIVE PLANNING

Some staff observed that planning at ODOT has become more reactive and less proactive. ODOT has shifted from preparing corridor plans to focusing on specific locations or highway segments, to produce specific facility-level plans in concert with project development. They noted that funding for planning has diminished at the same time that the OTC and the Land Conservation and Development Commission (LCDC) are pressing ODOT to become more involved in working with local governments to better manage land use and development near state facilities.

Staff claimed that the best opportunity to negotiate land use measures is in a broader planning process—such as a Transportation System Plan (TSP)—that looks, in an integrated way, at a community's transportation system. If a TSP is adequately prepared, it will anticipate that a new interchange will be needed 10 years from now. Without a good TSP, ODOT's role is confined to the tail end of the process, in its authority to allow or not allow property owners to gain access to a state facility.

Staff emphasized that it is important to be proactive in preparing TSPs and IAMPs, as much in advance of project development as possible. When planning occurs in close concert with project development, the pressure is then on to get the project designed and built. This situation has improved in recent years, and planners are now included on most project development teams. The recent staff report on interchange management (*ODOT 2004c*) reinforces the importance of getting in front of the problem. The report identifies 65 interchanges on the state highway system that are either operating at capacity or face obsolescence in the near future. At the date of the report (May 2004), four IAMPs had either been completed or adopted by the OTC, and another 23 plans were in progress. The remaining 38 interchanges were considered "of highest concern," and had not yet been addressed.

The substantial effort involved in preparing the IAMPs exceeds ODOT staff resources. Thus, the Department has been directed to contract out IAMP work for some projects. When the preparation of plans is contracted out, it is important to recognize that the oversight of plan development, as well as the future implementation, monitoring and maintenance of plans will require substantial ODOT staff resources. Also, planning often requires time spent building collaborative relationships with local staff and officials, and these relationships will need to be developed and maintained by ODOT staff irregardless of who actually prepares the plans.

4.2 COMPREHENSIVE PLANNING

Local comprehensive plans are the most effective means to control development around highway interchanges. However, ODOT has no formal role in the preparation of local comprehensive plans. ODOT staff have the same right that any citizen or organization has to comment on proposed comprehensive plan changes and to appeal proposed changes to the Land Use Board of Appeals (LUBA).

All Oregon cities and counties currently have adopted comprehensive plans. Opportunities for ODOT involvement arise when a local government amends its comprehensive plan or during periodic review of the plan. At the region level, ODOT planners try to track proposed changes and comment when the changes pose potential adverse impacts on state transportation facilities. A major problem is the up-zoning of agricultural, residential or multifamily land to allow large commercial development near an interchange.

Staff report that the best strategy is to get local governments to formalize transportation planning efforts by adopting a TSP into their local comprehensive plan, and for ODOT to adopt this work as a formal Facilities Plan. This establishes a greater sense of commitment and elevates the perception of the level of process a local government will feel it needs to pursue to change elements of the agreement in the future. Placing the TSP in the local comprehensive plan also gives ODOT the opportunity to formally appeal a local government's decision that contradicts the agreement.

4.3 TRAFFIC IMPACT STUDIES

A major problem affecting the design life of interchanges is the up-zoning of nearby land to allow large commercial and industrial developments. TSPs require a traffic impact study to determine whether a change would have a "significant impact" on the highway system. ODOT does not undertake the traffic impact study. Rather, local governments require developers to do the study. There is a concern that these studies have tended to understate the subsequent traffic impacts of new development. This issue is presently being examined in another project sponsored by the ODOT Research Unit. ODOT has no formal standards for these studies. Standards for the studies only exist if they are defined in a local TSP. Even if a "significant impact" is found, the U.S. Supreme Court *Dolan* decision may severely limit how much ODOT can require a developer to pay for transportation improvements to accommodate the additional traffic generated by the development.

4.4 UGB EXPANSION

ODOT does not have a formal role in local deliberations over whether and where to expand an urban growth boundary (UGB). ODOT can only attempt to persuade local governments, until a specific development proposal is on the table. Interchange operations and safety can potentially be compromised by development following nearby UGB expansions and associated rezoning. Thus, one person suggested that local governments should be required to negotiate an IAMP with ODOT for UGB expansions near state highway interchanges.

4.5 OTC PROJECT REVIEW AND FUNDING

One of the persons interviewed suggested that the OTC's Statewide Transportation Improvement Program (STIP) guidelines could be amended to require more upfront planning before a project is funded. Step 13: Project Readiness Matrix is one likely place to do this. The TPR could also be amended to clarify which assumptions and criteria should be used to determine which projects get funded.

4.6 TRAFFIC FORECASTING

A number of staff raised concerns about traffic forecasting. They believe that the forecasts used to determine interchange design capacity do not adequately anticipate the full build-out potential in interchange areas. (Note: Chapter 5 describes the traffic forecasting procedures employed by ODOT) One reason given is that local zoning designations are often very general, allowing for a wide range of development activity and possible traffic impacts. Some planners believe the forecasts rely too much on averages. Alternatively, some staff say that to design interchanges for the maximum possible build-out would be prohibitively expensive. More specific zoning regulations, overlay zones, or trip allocation ordinances can help remedy this problem.

4.7 STAFF RESOURCES

It does not appear that ODOT or local governments have the capacity to engage in more in-depth planning. ODOT planning capacity is already stretched thin. Working with local governments to limit land uses around interchanges requires substantial staff time. It also requires staff with the necessary planning and negotiation skills. No matter what regulatory and planning tools are available, ODOT and local governments will need sufficient staff time and resources to make it work. Many local governments do not have the staff resources to be involved with in-depth transportation planning processes. They often do not see this as a priority until they have a transportation problem, at which point it is too late. In many cases, ODOT staff may need to be prepared to carry most of the load on these planning projects.

4.8 POLICYMAKER SUPPORT

Staff noted that politics sometimes trumps careful planning and established policy. Agreements with local governments can often be reached at the staff level. It is more difficult to get agreement and support from local elected officials, ODOT officials, or state legislators. It is important for staff to know that when they work out an agreement, local and state officials will subsequently support it. This concern is not unique to interchange area management nor to Oregon. For example, a national survey by the Urban Transportation Monitor (*1995*) found that 63 percent of 350 responding city traffic engineers had encountered “political restraints” in their efforts to implement access management programs.

4.9 REGULATION

A number of staff cautioned against adopting a new layer of regulation. They said the solution lies in working with local governments to develop plans within the existing regulatory and policy framework that fit the unique needs of each community and ODOT.

4.10 SUCCESS MEASUREMENT

Staff were concerned that little review is done to evaluate the effectiveness of ODOT planning efforts, but they also noted that it is difficult to define clear evaluation criteria for planning activities. If it is not possible to define clear, measurable evaluation criteria, ex-post case studies could be done to assess the aspects of the process that turned out to be effective and those that did not contribute to the planning objectives.

4.11 ACCESS MANAGEMENT

Access management is the most direct authority ODOT has to control traffic impacts from development. The standards adopted in the Division 51 rules define more restrictive criteria for the access permitting process. Nevertheless, previously-approved permits are “grandfathered” under the new regulations. Consequently, most interchanges in the state highway system do not meet current access management standards. In the 1999 Oregon Highway Plan, “Actions Related to Interchange Access Management Areas” (Policy 3C) encourages the purchase of access rights “as opportunities arise” in order to bring interchanges into compliance with the Division 51 standards.

Property owners can obtain approach permits when it can be demonstrated that no reasonable access alternative exists, resulting in a de facto violation of the Division 51 access standards. Staff said that the way to minimize the incidence of such cases is to negotiate good TSPs that will ensure an effective local street circulation system and ensure that alternative routes other than the state highway exist.

4.12 TRIP CAPS

In preserving interchange capacity, one option is to negotiate trip cap or allocation limit agreements with local governments. This approach has been used elsewhere in the country but is fairly new to Oregon. ODOT planners work with local staff and officials to identify the amount of capacity at an interchange available to serve local development. Future developments can only move forward if the interchange has the available capacity to serve them. This allows local government to manage land development, but also preserves the function of the interchange. The Woodburn IAMP employs this approach at the area level.

4.13 ACQUISITION OF DEVELOPMENT RIGHTS

Some staff suggested that ODOT could be more aggressive in acquiring excess land or development rights to help limit development near an interchange. However, the Attorney General's office has advised that ODOT has limited ability to use this tool and must establish a clear connection to facility protection needs (*ODOT 2004c*). ODOT does have authority to purchase access rights, which can effectively achieve the same end as the purchase of development rights. Also, TSPs can identify future right of way needs. These needs can be reflected in zoning setback requirements, thus reducing future right of way acquisition costs.

5.0 ODOT'S TRAFFIC PROJECTION PROCEDURES

Since 1997, ODOT's Transportation Planning Analysis Unit (TPAU) has made 20 year projections of design hour volumes (DHV) for the traffic count locations (currently numbering 4,654) covered in the Traffic Volume Tables (TVTs). These projections are updated annually and are reported in the Future Volumes Tables (*ODOT 2004a*). The DHV projections contribute to transportation needs assessment on the state highway system and the preparation of the STIP. For projects in the STIP, base DHV projections are subsequently refined in the project development process, and are used to determine facility design capacity.

Three alternative methods are employed in making base DHV projections, with the choice of method depending on the traffic count location and consideration of local land development circumstances. The methods are 1) Historical Trend; 2) Cumulative; and 3) Urban Transportation Demand Model. The methods are described in the *TPAU Training Manual* (*ODOT 2001*).

The historical trend method is generally employed in projecting DHV for non-metropolitan count locations and other locations where substantial traffic growth is not anticipated. The trend method estimates historical DHV growth rates using a linear regression. Data for the regression are drawn from the DHV time series of actual traffic counts (recovered every three years) from the Traffic Volume Tables, and commonly includes 10 or more time/data points. In addition to the 20 year DHV projections, the Future Volumes Table reports the regression R-Square value when this method is employed. The R-Square values generally exceed .70, indicating that a linear trend explains a substantial share of the historic annual variation in DHV. Low R-square values are typically associated with lower volume count locations.

Some judgment can be involved in making historical trend projections. For example, projections for rural locations that have experienced a downward DHV trend are projected to assume a zero (rather than negative) growth rate.

The cumulative method is used for traffic count locations in or near smaller urban areas. This method is a hybrid approach, using historical trend estimates supplemented by DHV estimates associated with projected land use changes. Projected land use changes can include pending developments, as well as future build-out of vacant land based on current zoning and observed development densities. In selected instances, changes in zoning and development densities are reflected in the cumulative method forecasts, based on recent development patterns. The DHV projections may also be adjusted to reflect facility design capacity constraints. Considerable staff time can be involved in making projections with the cumulative method. Thus, this approach is generally limited to project development applications.

DHV projections from urban transportation demand models are made for traffic count locations in Oregon's larger metropolitan areas. These models are maintained by metropolitan planning organizations (MPOs) under federal mandate to support the urban transportation planning process. TPAU has also developed transportation demand models for smaller urban areas (e.g., Brookings, Newberg, Redmond, Woodburn) to support their TSPs. These models employ a 4-step process (trip generation, destination choice, mode choice, and network assignment) in projecting traffic volumes, based on exogenously-determined land use projections. The land use projections, in turn, are driven by forecasted changes in population, households, and employment.

In the most recent Future Volumes Table, published in August 2004, DHV projections for 3,399 count locations employed the historical trend method, while urban transportation demand models were used in projections for the remaining 1,255 count locations.

In addition to their use in monitoring transportation system performance and identifying needed improvements, DHV projections support design capacity decisions in the project development process. In interchange project development, for example, the projection starts with a determination of base DHV totals, which involves the manual collection of 14-16 hour intersection turning movement truck classification counts taken at intersections in the study area. The manually-collected data are then seasonally adjusted to produce a base DHV estimate. One of the projection methods described above is then used to forecast future DHV, which is then used in determining the design capacity of the interchange.

A variety of factors can complicate the DHV forecast in the project development process. The geographic extent of the area considered in the projection can be affected by the types and densities of development that may occur over the life of the facility. While estimates of traffic linked to build-out and zoning changes can be incorporated in the projection, actual trip generation can vary substantially, even within a given zoning classification. Also, the time and cost of producing DHV projections are treated as elements of the project development process. Motivations to achieve timely project delivery, coupled with limited project funds, can constrain efforts to develop project-specific traffic forecasts. In some cases, limited project funds can result in design capacity decisions in which the projected design life of a facility falls below the 20 year standard.

None of the traffic projection methods explicitly considers induced traffic growth associated with facility development. In urban transportation demand models, this would require an iterative approach, with a feedback loop from the network assignment step to the land use component. In the cumulative method, induced growth effects could be captured through the assumptions made about projected build-out and zoning in the traffic shed. The empirical evidence in Oregon that could be drawn on to support treatment of induced growth impacts, however, is mixed (*Sanchez and Moore 2000*), although the ambiguity of these findings may be a reflection of the disparate system improvements and circumstances studied.

ODOT is deeply involved in developing the next generation of integrated transportation and land use models, which incorporate the feedback effects mentioned above. The first prototype statewide model was used to assess induced development and traffic associated with a Newberg-Dundee bypass (*ODOT 2004b*). In this assessment, the bypass was projected to enhance the accessibility of McMinnville (located 12 miles west of Dundee), leading to greater development there and lead to an increase in trips in the Highway 99W/18 corridor to and from the Portland metropolitan area. However, the model projected negligible changes in development and traffic in the immediate Newberg area.

6.0 ANALYSIS OF THE EFFECTS OF PLAN AMENDMENTS ON INTERCHANGE TRAFFIC

In this chapter we document the temporal and geographic incidence of comprehensive plan amendments, and statistically analyze the relationship between plan amendments and interchange traffic volume. With respect to plan amendments, our focus is on changes in designated land use where the subject area is reclassified to either industrial or commercial land use. With respect to geographic incidence, our interest relates to the proximity of comprehensive plan amendments to interchanges on the state highway system. In this study, we define an amendment to be proximate if it is located within one mile of an interchange. Lastly, the time frame of the analysis is determined by data availability. The DLCD has maintained a fairly consistent record of comprehensive plan amendments in the state from 1987 to the present. Annual traffic count data for interchanges has been maintained by ODOT over a longer period, with the most recent report covering 2002 at the time of data collection for this study. Thus, the time period of the study is 1987-2002.

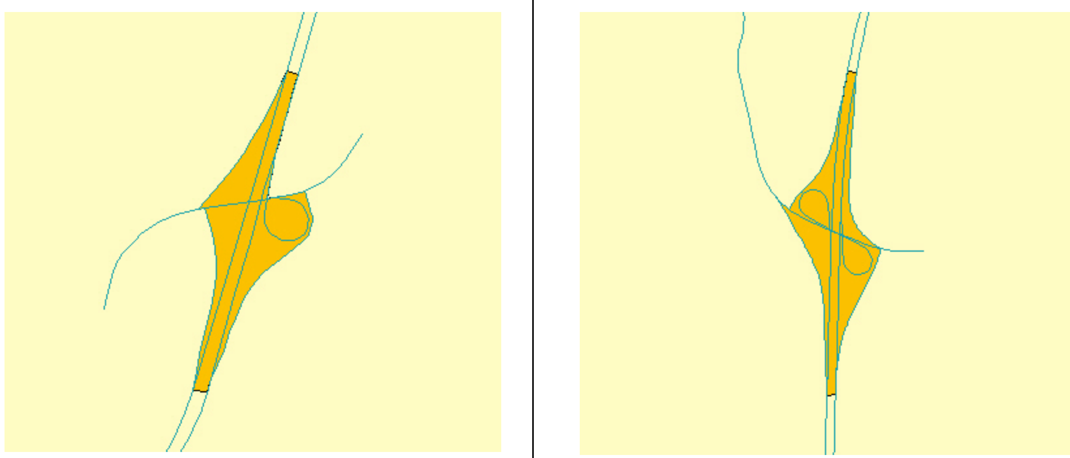
6.1 INCIDENCE OF PLAN AMENDMENT ACTIVITY

The examination of the incidence of comprehensive plan amendment activity begins with the selection of grade-separated interchanges on the state highway system. Excluded from the analysis are rest area exits, and recently-constructed interchanges for which traffic count data does not exist prior to 2002. In a few selected instances, multiple interchanges that were treated as single entities in the *Transportation Volume Tables* were split. In other instances where freeways intersected, the *Transportation Volume Tables* sometimes assigned the same interchange to both freeways, and in these cases the assignment to the freeway with the greater through traffic volume was retained. The resulting set of ten highways and 273 interchanges is presented in Table 6.1.

Table 6.1: Study highways and interchanges

Highway Name	Route Numbers	Interchanges
Pacific Hwy.	I-5, ORE99, ORE138	116
Columbia River Hwy	I-84, US30, US395, US730	100
Sunset Hwy.	US26, ORE47	13
Stadium Freeway Hwy.	I-405, US30	4
East Portland Fwy.	I-205, ORE213	15
Beltline Hwy.	ORE69	6
McNary Hwy.	I-82	3
Beaverton-Tigard	ORE217	9
Eugene Springfield Hwy.	I-105, ORE126	7
Total		**273**

The next step involved the use of GIS to create a one-mile buffer around each interchange to represent a traffic impact zone, where comprehensive plan amendments and subsequent development could be expected to have direct consequences on interchange performance. A polygon was first created that encompassed the interchange. The centroid of the polygon was then determined and a one-mile radius buffer around that centroid was created (see Figure 6.1).



Hwy. 1- Exit 286 (I-5 & Stafford Rd.) | Hwy. 64- Exit 11 (I-205 & Gladstone.)

Figure 6.1: Interchange polygons

The locations of interchanges in the study varied considerably with respect to level of urbanization. Three categories were thus defined to distinguish locational status in relation to urban growth boundaries. The first category – rural – included interchanges whose one-mile buffer lay entirely outside a UGB. The second category – urban – included interchanges whose buffer lay entirely inside a UGB. The final category – urban fringe – included interchanges whose buffer crossed a UGB and included both urban and rural land. Table 6.2 shows the resulting breakdown and the associated data records covering the 15-year time frame of the study. About 23 percent of the interchanges and data records fell into the urban category, while urban fringe interchanges accounted for 39 percent and rural interchanges accounted for 38 percent of the observations.

Table 6.2: Composition of study sample

Interchange Type	Number of Interchanges	Number of Interchange-Years
Rural	103	1,537
Urban Fringe	107	1,586
Urban	63	932
Total	273	4,055

As one would expect, interchange traffic volume was much greater on urban interchanges than it was on urban fringe and rural interchanges. Table 6.3 presents the composite (sum over all ramps) average daily traffic (ADT) for the three categories for the beginning and end years of the study period, as well as the associated average annual percentage rate (AAR) of increase over the time period.

The annual growth rate of traffic on urban interchanges (1.82%) was the smallest of the three categories, followed by rural (2.38%) and urban fringe (2.74%) interchanges. The traffic growth differences between urban and urban fringe interchanges likely reflect both urban development and facility congestion effects. The pace of development (and corresponding traffic generation) tended to be greater at the fringe than at the urban core, and urban core interchanges were more likely to be subject to ramp metering than interchanges at the urban fringe. Finally, it is noteworthy that traffic growth on urban and rural interchanges was less than the growth of bi-directional through traffic, while urban fringe interchange traffic growth was nearly equivalent to through traffic growth.

Table 6.3: Growth in traffic volume by interchange type, 1988-2002

Category	Average ADT, 1988	Average ADT, 2002	AAR (%) 1988-2002
Interchange Type			
- All Interchanges	13,266	18,086	2.24
- Rural Interchanges	1,971	2,740	2.38
- Urban Fringe Interchanges	11,798	17,230	2.74
- Urban Interchanges	34,681	44,615	1.82
Through Traffic	17,698	25,820	2.73

The next step in the analysis involved the review of comprehensive plan amendments wherein a designated land use was changed to either commercial or industrial activity. The DLCD maintains these records for all of Oregon's municipalities and counties in support of their comprehensive plan acknowledgement process. The locations of amendments meeting the defined land use change were reviewed to determine whether they resided inside an interchange buffer area. The outcome of this process is summarized in Table 6.4.

A total of 1,565 amendments to commercial or industrial use occurred between 1987 and 2001 in which a location could be determined. (The location of an additional 39 amendments could not be determined). Nearly 29 percent (448) of these amendments were located within an interchange buffer area. Information on the size of the amended area was also recovered, and about 22 percent of the total amended acreage was found to be located within an interchange buffer area. Thus, given the relative incidence of amendments, those that occurred inside interchange buffers tended to involve slightly smaller acreages on average than those that occurred outside the buffers.

Table 6.4: Location of comprehensive plan amendments, 1987-2001

Location	Number of Amendments	Percent	Area (acres) of Amendments	Percent
Inside Interchange Buffers	448	28.6	8,461	22.2
Outside Interchange Buffers	1,117	71.4	29,680	77.8
Total	1,565	100.0	38,141	100.0

The trend in plan amendments occurring inside the interchange buffers is shown in Figure 6.2. It is apparent that there is a general decline in both the frequency and size of amendments between 1987 and 2001, although both trends are subject to considerable variation. Trend regressions indicate that the frequency of amendments declined at a 5.7% annual rate (R^2 = .55), while the associated acreage declined at an 8.5% annual rate (R^2 = .16).

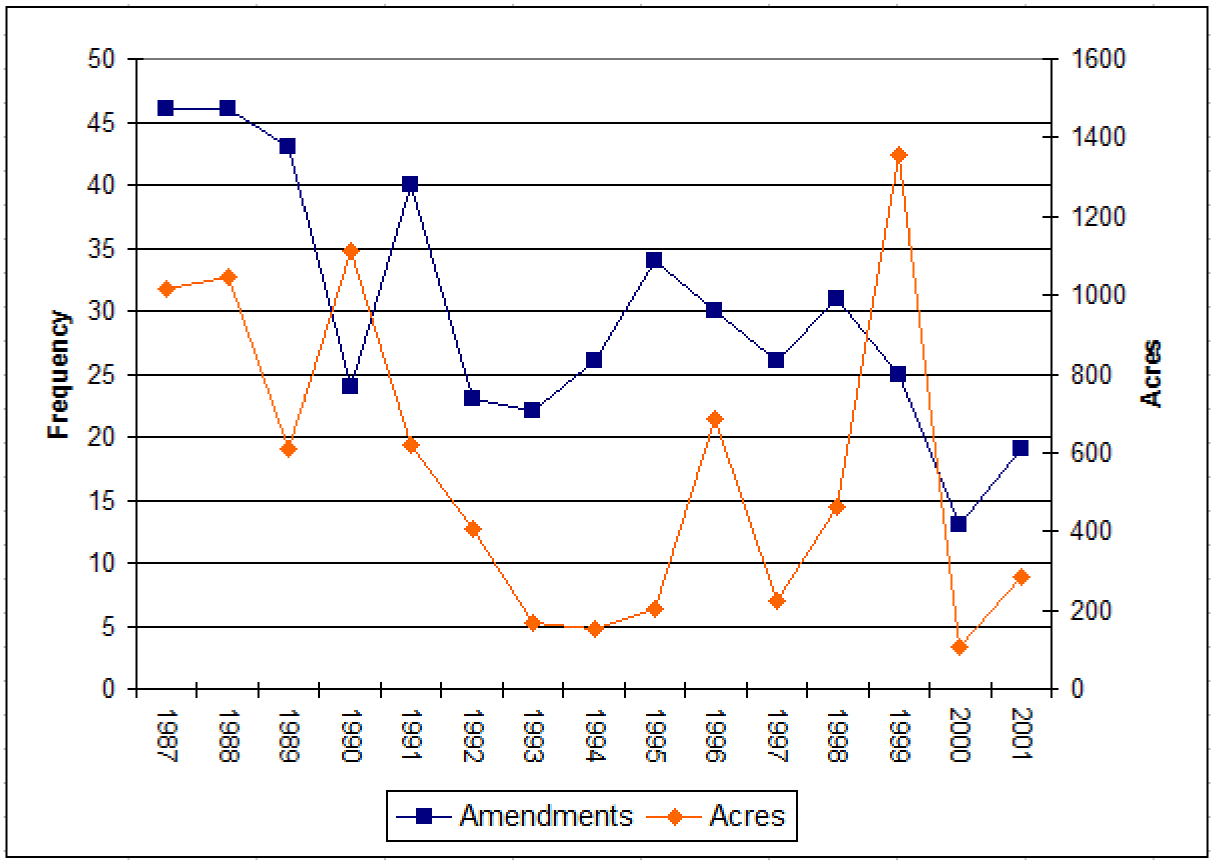


Figure 6.2: Trends in plan amendment activity inside interchange buffers

The incidence of plan amendments varied considerably across the interchange categories (see Figure 6.3). Overall, about 55 percent of the study interchanges experienced no plan amendments between 1987 and 2001. The incidence was smallest for rural interchanges, where 93 of 103 interchanges (90.3%) did not contain an amendment within their one-mile buffer areas.

In the urban fringe category, 41 of 107 interchanges (38.3%) did not contain an amendment within their buffers, while in the urban category, 15 of 63 interchanges (23.4%) did not contain an amendment. Seventy-nine interchanges (8 rural, 43 urban fringe and 28 urban), about 29 percent of those in the study, contained one to three amendments. The remaining 45 interchanges (about 16% of the total) experienced more that three amendments, up to a maximum of 17 amendments in the cases of one urban and one urban fringe interchange.

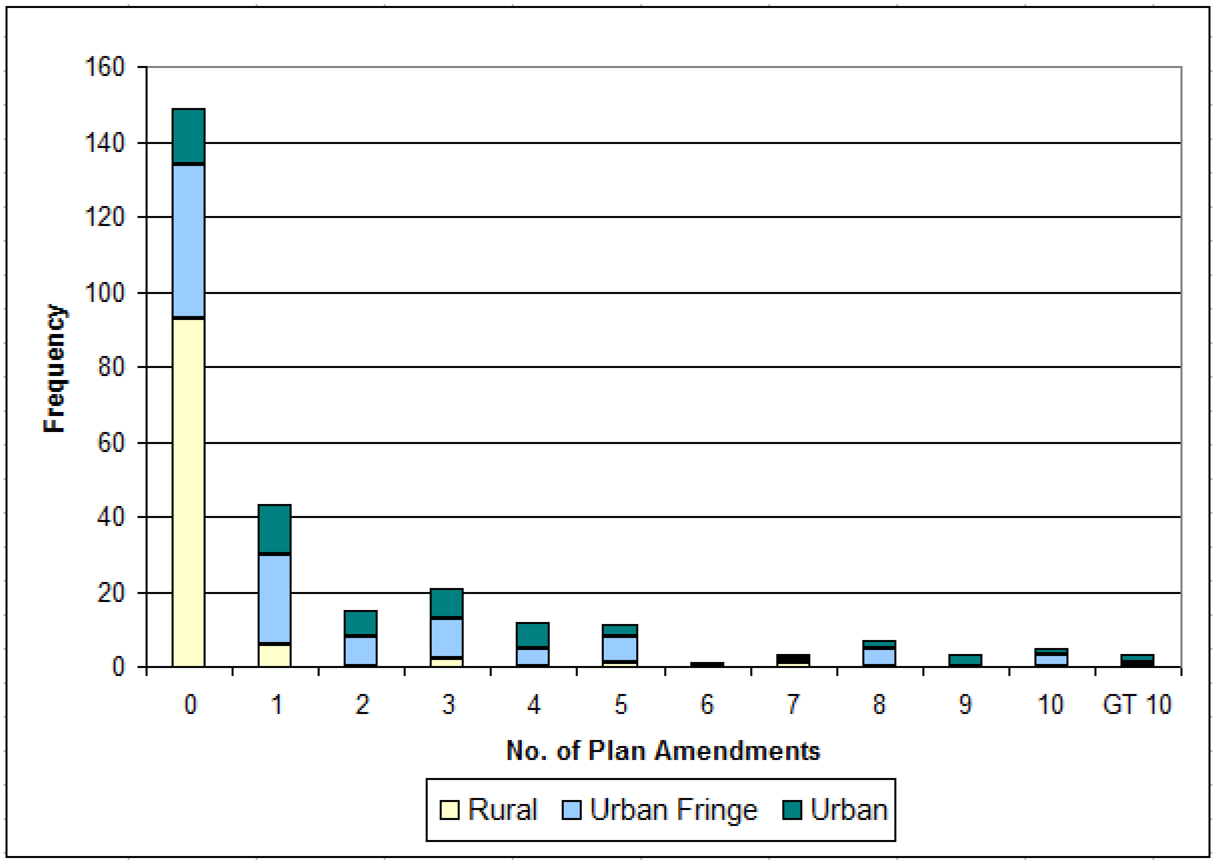


Figure 6.3: Frequency distribution of plan amendments in interchange areas

The geography of plan amendment activity in interchange areas is shown in Figure 6.4. Plan amendments are clearly clustered around metropolitan areas along the I-5 corridor (including Medford, Grants Pass, Roseburg, Eugene, Salem, and Portland). The less urbanized I-84 corridor shows less plan amendment activity, with much smaller concentrations around Hood River, Pendleton, Baker City, and Ontario.

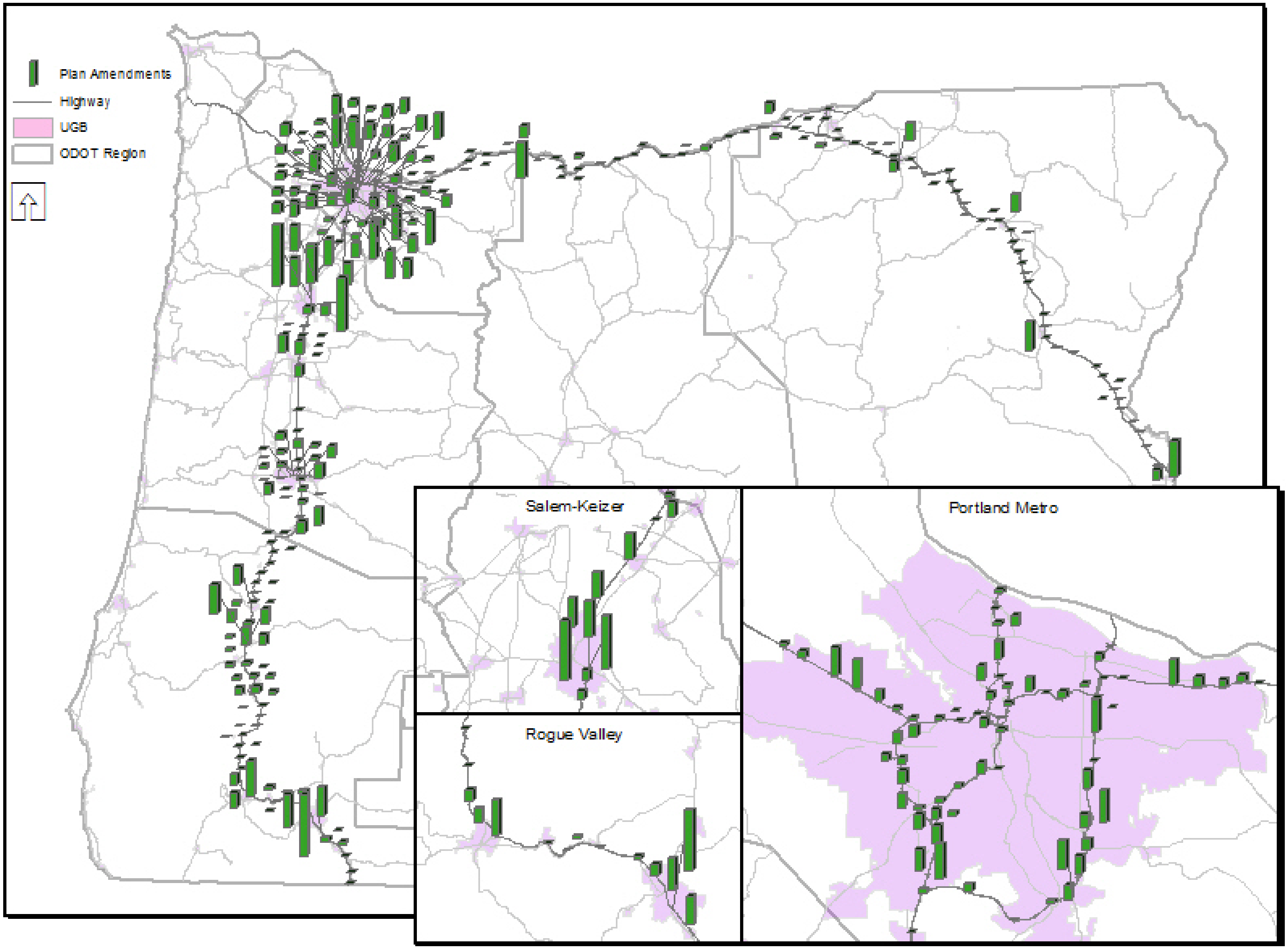


Figure 6.4: Geography of interchange area plan amendments

The map inset in Figure 6.4 provides a closer look at the geographic distribution of amendments in the Portland, Salem-Keizer, and Rogue Valley metropolitan areas. It is interesting to see that amendment activity within these urban areas tends to be greater near their peripheries. For example, in the Portland metropolitan area, interchange areas along the Sunset Corridor of US 26, along the Southeast I-205 corridor, and the I-5 corridor south of the OR 217 interchange generally have a higher incidence of amendments than do interchange areas in the central Portland area. Thus, one can reasonably posit that there is a general correspondence between the geographic incidence of plan amendments and development activity in interchange areas at both the state level and within metropolitan areas.

Another way of examining the incidence of comprehensive plan amendments in interchange areas is to graph their mean cumulative frequency by interchange category (see Figure 6.5). Thus, for example, we see that urban interchanges, on average, had experienced 3.2 amendments by the end of the study period, as compared to 2.2 amendments for urban fringe interchanges, and .2 amendments for rural interchanges.

We can also determine the median time point, or the year at which half of the cumulative amendment activity had occurred for each interchange category. For rural interchanges, the median year was 1991, or the fifth year in the study period. For urban interchanges, the median year was also 1991, while for urban fringe interchanges, the median year was 1994. Two of these time junctures occurred before 1994, the median study year, indicating that rural and urban interchanges witnessed relatively more plan amendment activity earlier in the study period, while urban fringe interchanges witnessed relatively more activity later in the period.

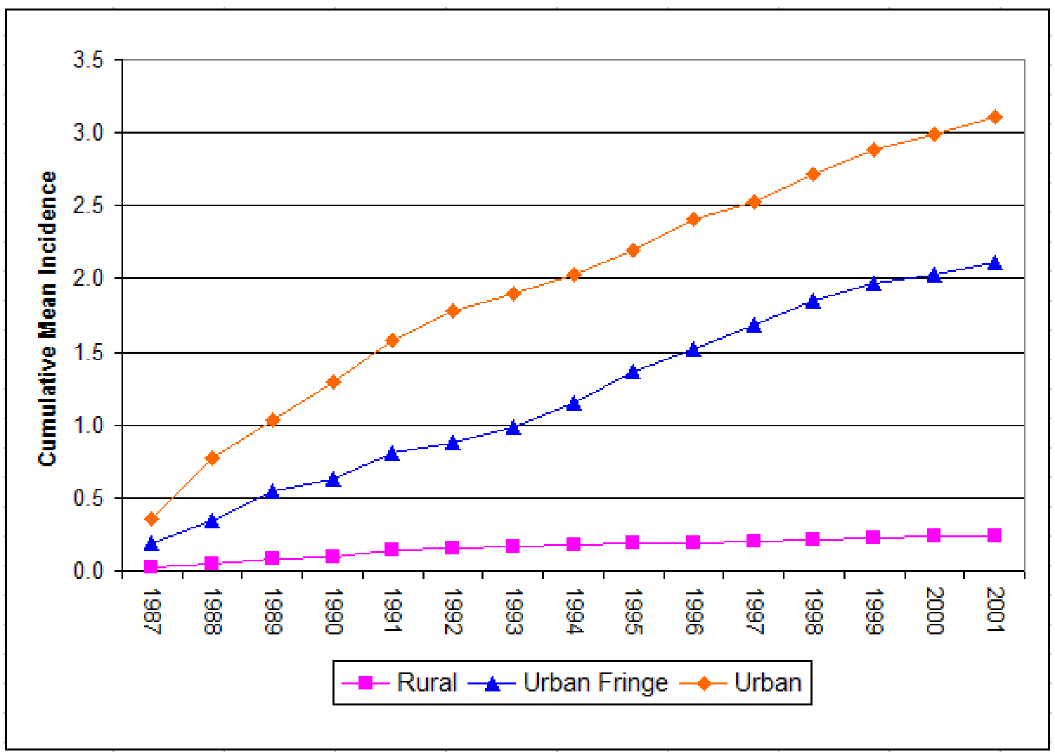


Figure 6.5: Cumulative mean incidence of comprehensive plan amendments in interchange areas, 1987-2002

With respect to the geographic incidence of comprehensive plan amendments, a central question is whether the likelihood of amendments occurring inside interchange buffers is greater than the likelihood of them occurring outside the buffers. This likelihood can be represented by a location quotient, which is a measure of relative geographic incidence (*Isard 1960*). In this application, the location quotient would generally be measured as follows:

$$LQ = \frac{\text{No. of Amendments Inside Interchange Buffers / Total Buffer Area}}{\text{No. of Amendments Outside Interchange Buffers / Total Area Outside Buffers}} \qquad \textbf{(6-1)}$$

When the location quotient value is equal to one, this indicates that plan amendments are as likely to occur inside interchange buffers as they are outside, while values greater than one indicate a relatively greater likelihood of occurring inside. A value of two, for example, would indicate than plan amendments are twice as likely to occur inside an interchange buffer.

In the present case, the location quotient could be distorted by the small number of rural plan amendments in relation to the very large rural area of Oregon. Thus, the location quotient is calculated for the urban and urban fringe interchanges, and is amended as follows:

$$ALQ = \frac{\text{Amendments Inside Urban \& Fringe Buffers / Total Urban Buffer Area}}{\text{Amendments Outside Urban \& Fringe Buffers / Net Total Urban Area}} \qquad \textbf{(6-2)}$$

In this case, urban buffer area is defined as the area lying inside a UGB, while the net total urban area is defined as the total area in Oregon within all UGBs less the urban area contained in the urban and fringe interchange buffers. In excluding rural interchanges, we assume that the percentage of rural plan amendments located outside interchange buffers is equal to the overall percentage for all interchanges. Given the small number of plan amendments inside rural interchange buffers, the sensitivity of the amended location quotient to this assumption is very weak. We also assume that all amendments occurring outside urban and fringe interchange buffers are still located inside a UGB. The value of the location quotient will be depressed by the extent to which this assumption is violated, making it a fairly conservative estimate of relative geographic incidence. The resulting location quotient value is as follows:

$$ALQ = \frac{\text{424 Amendments / 199,104 Acres}}{\text{1093 Amendments / 618,383 Acres}} \qquad \textbf{(6-3)}$$

$$ALQ = 1.25$$

Thus, it can be concluded that comprehensive plan amendments in urban areas are about 25 percent more likely to occur in interchange areas than elsewhere.

6.2 STATISTICAL ANALYSIS

In this section, a statistical analysis of interchange performance over a 15-year period (1988-2002) in relation to comprehensive plan amendments is presented. The analysis estimated traffic volumes on interchanges as influenced by throughput volumes, the functional classification of intersecting routes, selected locational characteristics, a proxy for growth (and traffic generation) in the wider area, and the incidence of comprehensive plan amendments in interchange areas. The primary purpose of the statistical analysis was to isolate the effects of plan amendment activity from a variety of other factors that potentially affect interchange traffic volumes.

The relationship to be estimated takes the following general form:

$$IADT_{it} = f(CPNO_{it}, RAMPS_{it}, DIST_{it}, TADT_{it}, IRCLS_{it}, APOT_{it}) \qquad \textbf{(6-4)}$$

where

- i = interchange (= 1, … 273);
- t = year (= 1988, … 2002);
- $IADT$ = interchange ADT;
- $CPNO$ = the cumulative number of plan amendments;
- $RAMPS$ = the number of ramps comprising the interchange;
- $DIST$ = the distance between interchanges;
- $TADT$ = throughput ADT;
- $IRCLS$ = intersecting route functional classification;
- $APOT$ = population potential of the interchange travel shed.

ODOT's *Transportation Volume Tables* provided the data for the interchange and throughput ADT variables. Between 1982 and 1992, ADT on highways and interchanges was counted on a two-year cycle. In 1993, point traffic counts went to a three-year cycle. Estimates of ADT are made in the intervening years, based on factors such as automatic traffic recorder data and ramp meter data in urban areas. When actual counts take place, they are conducted mid-week over a 48-hour period.

Throughput ADT (TADT) represents the average daily traffic volumes recorded on the highway of interest between interchanges. This measure is the average of the bi-directional traffic volumes associated with an interchange in a given year.

The RAMPS variable is a count of the total number of on and off ramps associated with an interchange. A higher value for RAMPS indicates a more complex interchange, as is the case with paired interchanges or the intersection of two freeways.

The CPNO variable measures the cumulative number of comprehensive plan amendments that have been adopted within the interchange buffer area. Each increment in the value of this variable occurs in the year following adoption, under the assumption that the subsequent year represents the earliest opportunity to observe a change in interchange ADT associated with traffic from plan amendment-related development. For example, a plan amendment adopted in 1987 is given a value of one in 1988 and every year thereafter. For a second amendment occurring in 1990, the value of the variable would increase to two in 1991 and subsequent years.

IRCLS is a set of dummy variables representing the functional classification of the intersecting route at each interchange. It would have been useful to have traffic volume data for intersecting routes, but consistent traffic count data over the study period were not available for county and local roads. Thus, a set of dummy variables is used to designate the following categories: interstate highways; U.S. highways; state highways; and county or local roads.

The population potential variable (APOT) reflects the general level and growth of trip making in the larger travel shed served by an interchange beyond the buffer area. It is a gravity-like formulation based jointly on interchange access and population size, and has long been used to represent spatial interaction in travel research (*Isard 1960*). The following equation was used to calculate population potential for an interchange in a given year.

$$IPOPP_{it} = \sum_{j} \frac{POP_{jt}}{d_{ij}^{\alpha}} \quad \textbf{(6-5)}$$

where

IPOPP = population potential;
i = interchange (=1, …273);
t = time period (=1988, …2002);
j = incorporated place;
POP = incorporated place population;
d = distance (in feet); and
α = distance decay parameter

Annual population estimates for Oregon municipalities were obtained from the Center for Population Research at Portland State University. Distances from interchanges to nearby places were calculated using a GIS. Both the maximum perimeter distance and the distance decay parameters were set according to whether a given interchange was located in an urban or rural area. The perimeter distance for interchanges located within Metropolitan Statistical Areas (as defined by the 2000 Census) was set at 5 miles. For rural interchanges, the perimeter distance was set at 20 miles. A distance decay value (α) of 2.0 was set for urban areas, and a value of 1.5 for rural areas. The reason for the larger value for urban interchanges is that one would expect a greater rate of distance decay in urban areas, given that area speeds are generally slower and interchanges are more closely spaced.

The DIST variable measures the average distance between a given interchange and the interchange that precedes and follows it. Controlling for other determinants of interchange ADT, it is expected that interchanges that are more separated will experience greater traffic volumes. This variable was calculated using a GIS based on the following equation:

$$DIST_i = \frac{(DIST_{i-1} + DIST_{i+1})}{2} \quad \textbf{(6-6)}$$

Descriptive statistics for these variables across rural, urban fringe and urban interchange categories are presented in Table 6.5. Average interchange spacing clearly differs by level of urbanization, at nearly 4 miles between rural interchanges, 2.5 miles between urban fringe interchanges, and 1.3 miles between urban interchanges.

Table 6.5: Means and standard deviations of interchange model variables

Variable	Rural Interchanges	Urban Fringe Interchanges	Urban Interchanges
Distance Between Interchanges (miles)	3.94	2.48	1.27
Standard deviation	(1.91)	(1.52)	(.58)
Population Potential	.00018	.033	.245
Standard deviation	(.0014)	(.075)	(.440)
Intersecting Route Class. (0, 1)			
- Interstate Highway	.010	.028	.113
Standard deviation	(.098)	(.166)	(.316)
- U.S. Highway	.078	.180	.086
Standard deviation	(.268)	(.384)	(.280)
- State Highway	.166	.277	.258
Standard deviation	(.372)	(.448)	(.438)
Number of Interchange Ramps	3.66	4.17	4.35
Standard deviation	(.87)	(1.21)	(1.46)
Through ADT (vehicles)	8,448.2	18,645.0	51,100.0
Standard deviation	(6,259.0)	(15,271.0)	(17,051.0)
Through ADT^2 (vehicles)	110.5E+06	580.7E+06	290.2E+07
Standard deviation	(204.6E+06)	(975.5E+06)	(286.0E+07)
Comp. Plan Amendment-Years	.159	1.206	1.908
Standard deviation	(.776)	(2.07)	(2.77)
Interchange ADT (vehicles)	2,323.6	14,534.0	40,517.0
Standard deviation	(3,717.5)	(15,652.0)	(30,733.0)
Sample Size	1,537	1,586	932

The mean population potential associated with urban interchanges is more than seven times the corresponding value for urban fringe interchanges, and more than a thousand times greater than the value for rural interchanges. The low population potential linked to rural interchanges reflects the relatively small number of municipalities outside Oregon's major urban areas.

With respect to the functional classification of intersecting routes, freeway-interstate connections range from about 11 percent for urban to about 1 percent for rural interchanges. US highway intersections are most prevalent at urban fringe interchanges (18%), and occur at less than half that average frequency at urban and rural interchanges. State highway intersections occur at more than 25% of urban and urban fringe interchanges and at about 17% of rural interchanges. The remaining interchanges intersect with county and local roads, which account for about 75% of rural interchanges and more than half of the urban and urban fringe interchanges.

The mean incidence of comprehensive plan amendments over the study period ranges from a high of 2.0 for urban interchanges to a low of .2 for rural interchanges. Categorical differences in interchange and throughput ADT were discussed earlier.

Interchange ADT models for the three categories were estimated by ordinary least-squares regression. A number of issues were addressed in the estimation process. The first issue concerned non-linear transformations of the variables in the specification. A number of alternatives were explored, including semi-log, log-log, and exponential transformations. However, none of the transformations produced an improvement in the fit of the model over a linear-in-variables specification, with the exception of the singular addition of a quadratic term for the through ADT variable. The resulting specification also provides for more direct interpretation of the parameter estimates.

The second issue related to the validity of the assumption maintained to this point that the effects of the various determinants of interchange ADT would differ across rural, urban fringe, and urban interchanges. This assumption can be evaluated by the Chow test (*Pindyck and Rubinfeld 1998*), which tests for parameter equivalence across sub-models. This test was performed and the hypothesis of parameter equivalence was rejected at the .001 level. Thus the effects of the independent variables on interchange ADT can be posited to differ by interchange category.

The third issue related to the possibility of serial correlation, given the existence of temporal observations in the sample. A Durbin-Watson test revealed significant serial correlation, and the Cochrane-Orcutt estimation procedure (*Pindyck and Rubinfeld 1998*) was thus used to correct the problem.

The fourth issue related to the state highway intersecting route dummy variable, which was nearly co-linear with the US highway dummy in several submodels. It was thus deleted, and the reference case for interpreting the coefficients of the remaining interstate and US highway dummies became the composite of state, county and local roads.

The last issue concerned the treatment of comprehensive plan amendments in the model. Data was available on both the number of amendments and their geographic size. However, models estimated using an amendment size variable, both independently and in combination with the number of amendments, revealed that the size of amendments did not have a significant effect on interchange ADT. This could be a consequence of the considerable variation in the size of amendments in the study. For example, when a substantial area is amended to industrial or commercial use, it may take many years for full build-out to occur, whereas in the case of smaller-size amendments, build-out is more likely to occur in the near term. Smaller amendment areas may also be subject to denser development than larger areas, with corresponding implications for trip generation. Given the lack of statistical significance associated with the size of comprehensive plan amendments, the estimation process incorporated only the number of plan amendments.

Regression results for the rural, urban fringe and urban interchange ADT models are presented in Table 6.6. Overall, the models fit the data fairly well, explaining between 60 and 80 percent of the variation in interchange ADT. Most of the parameter estimates are also significant, with t-statistics exceeding the .05 critical value of 1.96.

Spacing was estimated to have a significant positive effect on rural interchange ADT, with a one-mile increment estimated to result in a 223-vehicle increase in ADT. In contrast, a one-mile increment in urban fringe interchange spacing was estimated to lower ADT by about 790 vehicles, likely reflecting the transition from urban to exurban conditions. Urban interchange ADT was not found to be significantly influenced by changes in spacing.

Increases in population potential were estimated to have a positive effect on interchange ADT across all categories. Evaluated at the mean population potential values, the estimated marginal interchange ADT effect is 168 vehicles for rural, 653 vehicles for urban fringe, and 2,130 vehicles for urban interchanges, respectively.

Relative to the reference case of state, county, and local intersecting roads, a freeway intersection with an interstate highway is estimated to produce an increment of about 6,250 vehicles on rural, 11,250 vehicles on urban fringe, and 34,570 vehicles on urban interchanges. The ADT increment associated with a US highway intersection is substantially smaller, estimated at about 2,270 vehicles on rural, 805 vehicles on urban fringe, and 8,690 vehicles on urban interchanges.

Table 6.6: Parameter estimates for the interchange models*

Variable	**Rural Interchanges**	**Urban Fringe Interchanges**	**Urban Interchanges**
Distance Between Interchanges (miles)	223.0	-790.9	553.1
t-statistic	(6.7)	(-6.4)	(.4)
Population Potential	9.35E+05	19,690.0	8,679.5
t-statistic	(20.0)	(7.8)	(5.3)
Intersecting Route Class. (0, 1)			
- Interstate Highway	6,249.2	11,252.0	34,568.0
t-statistic	(10.5)	(9.7)	(12.6)
- U.S. Highway	2,267.5	805.0	8,689.9
t-statistic	(10.1)	(1.7)	(3.5)
Number of Interchange Ramps	543.0	4,724.1	9,747.1
t-statistic	(7.4)	(29.3)	(18.7)
Through ADT (vehicles)	.25	.24	.42
t-statistic	(8.5)	(5.8)	(5.4)
Through ADT^2 (vehicles)	-.000002	.000006	-.000001
t-statistic	(-2.4)	(8.9)	(-3.2)
Comp. Plan Amendment-Years	1,887.7	615.2	25.6
t-statistic	(21.5)	(6.9)	(.8)
Intercept	-3,088.4	-12,890.0	-26,601.0
t-statistic	(-9.8)	(-15.7)	(-6.0)
Adjusted R^2	.63	.79	.59
Standard Error of Estimate	2,265.1	7,103.9	19,605.0
Durbin-Watson Statistic	1.98	1.99	2.0
Sample Size	1,537	1,586	932

* t-statistics are reported in parentheses. Those greater than 1.96 are significant at the p = .05 level

As would be expected, given the definition of interchange ADT, additional ramps are estimated to contribute to increases in total interchange traffic. On a per-ramp basis, the estimated ADT increment is about 540 vehicles on rural, 4,720 vehicles on urban fringe, and 9,750 vehicles on urban interchanges.

Interchange ADT is estimated to be positively affected by changes in through traffic volume. In this case, through traffic is represented by both linear and quadratic terms in the regressions. In circumstances where the linear term is positive and the quadratic term is negative (as is the case for rural and urban interchanges), this indicates that interchange ADT increases at a decreasing rate with the growth of through traffic. When both terms are positive (as they are for urban fringe interchanges), this indicates that interchange ADT increases at an increasing rate (i.e., exponentially) with the growth of through traffic. The combined marginal effects of the linear and quadratic terms can be derived at the mean through traffic values for the three interchange categories. In this case, the estimated marginal interchange ADT effect associated with through traffic is .228 for rural, .348 for urban fringe, and .344 for urban interchanges. In other words, a 10-vehicle increase in through traffic ADT is estimate to result in a 2.3 vehicle increase in rural interchange ADT, a 3.5-vehicle increase in urban fringe interchange ADT, and a 3.4-vehicle increase in urban interchange ADT.

The final term in the regressions relates to the effects of comprehensive plan amendments on interchange ADT. In this case, an amendment is estimated to result in a subsequent, sustained 1,890-vehicle increase in rural interchange ADT and a 615-vehicle increase in urban fringe interchange ADT. The estimated plan amendment effect on urban interchange ADT is quite small and not significant.

Given the limited number of plan amendments near rural interchanges, the substantial estimated traffic impact may reflect specialized traffic-serving or traffic-intensive development. This possibility will be subsequently addressed in case studies.

Interpreting the negligible impact of plan amendments near urban interchanges is complicated by competing possibilities. One possible explanation is that a number of plan amendments in the Portland area, where a majority of the urban interchanges are located, have sought to intensify commercial and mixed-used development in town centers and corridors served by bus transit, and in light rail station areas. These town centers, corridors, and station areas also tend to be fairly proximate to interchanges. It may be that the incremental trips resulting from the intensified development have been effectively served by transit and other alternative modes, with little vehicular impact on interchanges.

An alternative interpretation is that with many urban interchanges already experiencing congestion, additional development is simply contributing to latent interchange traffic demand, with the consequence being a diversion of traffic to less congested alternative routes and auto trips that are rescheduled to less congested periods or foregone altogether, reflecting Down's (*1962*) triple convergence principle. If this interpretation is valid, it would complicate future design capacity decisions relating to urban interchange construction or improvement in terms of accounting for non-trivial induced demand effects.

One way of summarizing the system-level interchange ADT effects of comprehensive plan amendments is to jointly consider their estimated marginal effects and their incidence in relation to the mean interchange ADT, as expressed in the following equation:

Impact (%) = (Marginal Effect * Mean Incidence / Mean Interchange ADT) * 100 **(6-7)**

As Table 6.7 shows, in circumstances where the estimated marginal effect of plan amendments is quite large and the incidence of amendments is fairly limited, as is the case for rural interchanges, the resulting ADT impact per interchange in that category is substantially reduced. The alternative also holds where the incidence of amendments is much greater and the marginal effect is very small, as is the case for urban interchanges.

Table 6.7: Systematic plan amendment impacts on interchange traffic volume

Interchange Category	Marginal Effect	Mean Incidence	Mean IADT	Impact per Interchange ADT	(%)
Rural	1,887.7	0.159	2,324	300.1	12.91
Urban Fringe	615.7	1.206	14,534	742.5	5.11
Urban	25.6	1.980	40,517	50.7	0.13

The resulting ADT impact of plan amendments per rural interchange is about 300 vehicles, which represents nearly 13 percent of average interchange ADT. This is a fairly substantial impact in percentage terms, equivalent to over five years of the historic ADT growth in that interchange category. However, nearly all of these rural facilities are diamond interchanges, and given their low mean ADT, it may be more relevant to relate the nominal impact (i.e., 300 ADT) to their design capacity.

The ADT impact of plan amendments on urban fringe interchanges is more than twice that of rural facilities, but given that the traffic these facilities accommodate is more than six times the rural amount, the impact in percentage terms is much smaller. Nevertheless, at more than 5 percent of mean interchange ADT, the impact of amendments is equivalent to just under two years of historic growth of urban fringe interchange traffic.

Finally, for urban interchanges, the impact of amendments is negligible in both ADT and percentage terms, representing just over one month of historic traffic growth on those facilities.

7.0 CASE STUDIES

Six of the study interchanges were selected for a more detailed examination of the comprehensive plan amendment process. The objective in selecting interchanges was to reflect circumstances that were generally represented in the models that were estimated in the previous section. Given that comprehensive plan amendments were not found to have a significant effect on urban interchange traffic, the selection was limited to two rural and four urban fringe interchanges. While the interchanges that were selected had experienced more than the mean number of amendments, they were not among the "most active" of those in the study. Information supporting the case studies is primarily drawn from DLCD files on the plan amendments. The case studies were designed to yield the following information:

- The interchange ADT trend over the study period;
- The year of adoption, location, and size of each amendment;
- The change in land use associated with the amendment;
- Whether the amendment defined to relate to Statewide Planning Goal 12 – Transportation;
- The number of amendments located within 1/2 mile of an interchange (which, with recent amendments to the TPR, would have triggered a more careful review of interchange traffic impacts);
- The number of amendments located within 1/4 mile of an interchange (which, with the recent implementation of Division 51 access management standards, might have triggered reappraisal of grandfathered approaches);
- References to potential traffic impacts in written comments by local jurisdictions, ODOT, or other entities; and
- References to anticipated development linked to the plan amendment.

Several issues should be recognized at the outset of the case study analysis. First, the DLCD files include a "Notice of Adoption" form that is filled out by local jurisdictions. This form lists the Statewide Planning Goals potentially relevant to the amendment, State agencies potentially affected by the amendment, and parties that have been involved in the process or have requested notification. Local jurisdictions are expected to recognize relevant Oregon Statewide Planning Goals and follow guidelines defined by Oregon Administrative Rules in their review of comprehensive plan amendments. It is their responsibility to identify interested or affected parties, determine which Statewide Planning Goals that relate to an amendment, and to assess the potential consequences of plan amendments for local and state transportation facilities.

Second, after local comprehensive plans have been updated and acknowledged by the DLCD, the files associated with prior individual plan amendments are removed from the DLCD archives. Thus, in such cases, there was no recorded plan amendment information to draw from in the case studies. When this occurred, it was indicated in the comment field in the summary information tables by the statement "No DLCD file."

Finally, maps showing the approximate locations of the amendments, and graphs showing interchange ADT trends and the timing of amendments are provided for each case study interchange. The designated timing of the amendments in the graphs corresponds to the convention employed in the statistical analysis, in which implementation is defined as the year following adoption.

Six interchanges were selected for case study examination, as follows:

- I-5, Exit 24 (Phoenix);
- I-5, Exit 55 (East Grants Pass);
- I-5, Exit 119 (Coos Bay/Roseburg Highway);
- I-5, Exit 260 (Chemawa Road);
- I-5, Exit 263 (Brooks);
- US 26, Exit 57 (North Plains).

7.1 I-5, EXIT 24 (PHOENIX)

Traffic volume on the I-5 Phoenix interchange increased from 11,700 to 16,580 ADT between 1988 and 2002, or at an annual rate of 2.35 percent (see Figure 7.1). This rate of increase is somewhat lower than the 2.74 percent average for all urban fringe interchanges reported in Table 3. DLCD records indicate that eight amendments occurred over the study period. Files were available for seven of the eight, all related to the City of Phoenix. The file for a 1987 amendment by Jackson County was not available, most likely as a result of a subsequent plan update. Four of the eight actions related to property located within 1/4 mile of the interchange. The actions in 1987 and 1998 involved annexations totaling approximately 25 acres to the City of Phoenix (see Table 7.1).

Goal 12 was identified as being potentially affected by the 1988 amendment covering property at the intersection of North Phoenix and Fern Valley Roads. ODOT was also identified in this case as a state agency with a potential interest in the case. However, the DLCD file contained no materials covering assessment of expected traffic impacts of the amendment, or reference to ODOT comment.

No other action for this interchange was identified as related to Goal 12. In two other cases, ODOT was identified as an interested state agency. Both cases (in 1987 and 1988) involved land that fronted the Pacific Highway (OR 99). The file from the 1987 case indicated that ODOT participated in the amendment process, while the 1988 case file provided no evidence of ODOT comment.

Evidence of a finding of significant traffic impacts was identified in a single case, involving a 1998 annexation of 13 acres and zoning change by the City of Phoenix. The Annexation Agreement in the DLCD file indicates that future development would be tied to a required traffic study to assess the adequacy of capacity in the interchange area, and implementation of mitigation measures to address traffic impacts.

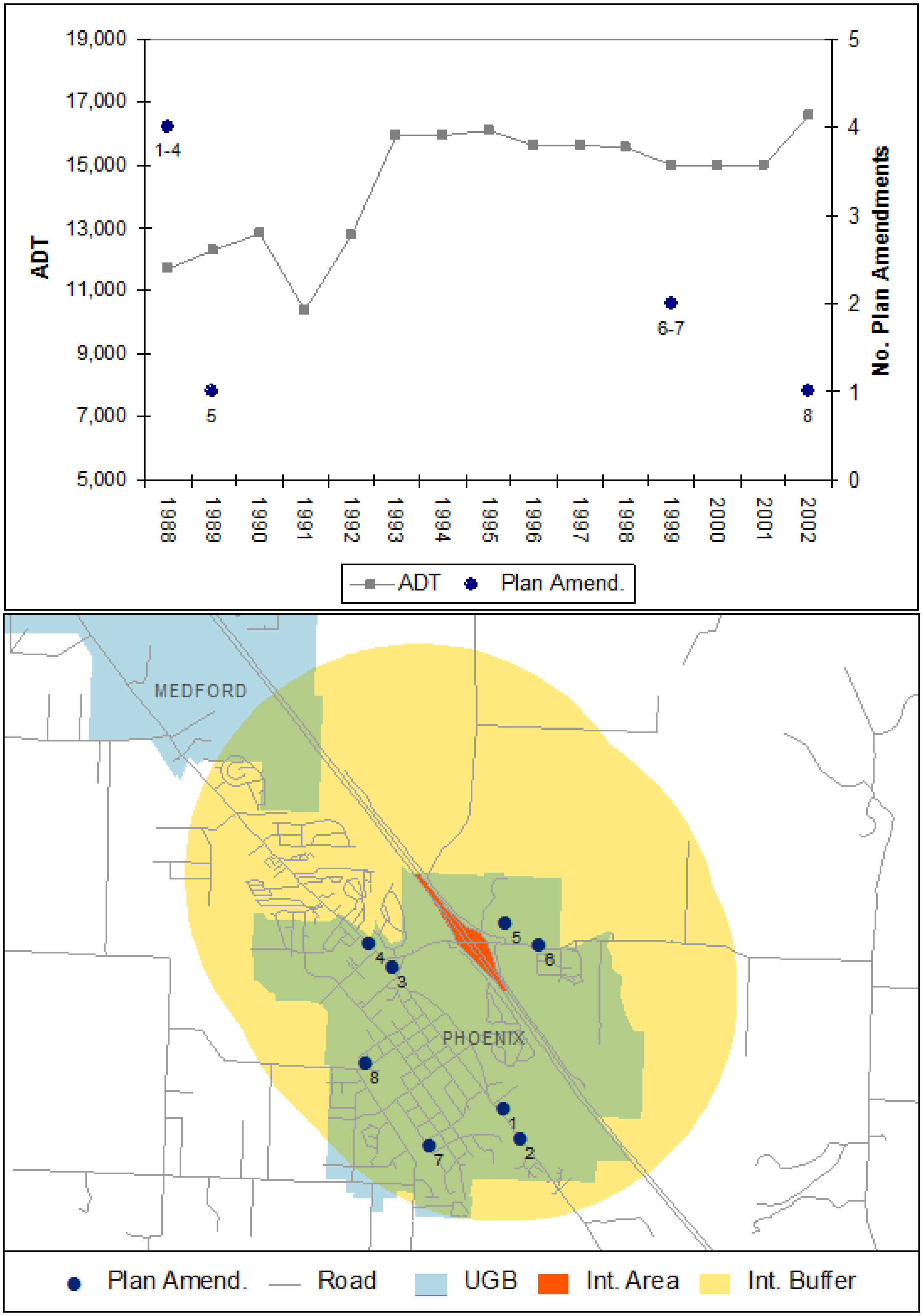


Figure 7.1: I-5, Exit 24 (Phoenix)

Table 7.1: I-5, Exit 24 (Phoenix) – Summary information from DLCD files

Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1987	East of N.W. corner of Hiram Colver Land Claim #43 (City of Phoenix)	11.5	Change to C-1 (Gen. Commercial); annex 11.5 acres to City of Phoenix.	No	Yes/No	Direct frontage on Hwy 99. Intent to construct 55-unit mobile home park and reserve frontage for future commercial development. ODOT "participated in local revision."
1987	No. location given (City of Phoenix)	30.0	Adopted Commercial Highway District for parcels along Hwy 99	No	No/No	Zoning change to allow heavy commercial and auto uses not allowed under C-1 and C-t zoning. Located within 1/4 mi. of interchange.
1987	(Jackson Co.)	19.3	Change to Commercial			No DLCD file. Located within 1/4 mi. of interchange.
1988	South Hwy 99 area (City of Phoenix)	65.0	Change from Gen. Comm. – Light Ind. to Comm. Highway	No	Yes/No	Allows Highway Commercial development along Hwy 99 frontage, and reserves rear portion for Light Mfg., Storage, Comm.-related Industrial.
1988	N. Phoenix Rd/Fern Valley Rd (City of Phoenix)	4.6	Change from Light Ind. to Gen. Commercial	Yes	Yes/No	DLCD file contains no materials. Located within 1/4 mi. of interchange.
1998	3850 Fern Valley Rd (City of Phoenix)	13.34	Change 1/2 of parcel from Fam. Res. To Comm-Hwy; annex 13.34 acres.	No	No/No	Zoning change. Annexation Agreement states: "A traffic study shall be required at the time of development of any portion of this property to determine the traffic impacts and to identify traffic mitigation measures. The timing of development will be directly tied to the determination that there is adequate capacity in the interchange area …" Located within 1/4 mi. of interchange.
1998	N. side of W. 1st St. adj. to CO&PRR (City of Phoenix)	2.55	Change zoning from Industrial to Mixed Use	No	No/No	Purpose of the zoning change was to facilitate a 13-unit condominium/commercial/industrial development project.
2001	601 5th St. & 415 N. "C" St (City of Phoenix)	0.43	Change zoning from R-1, SFR to L-1, Light Industrial	No	No/No	Zoning change to conform to comprehensive plan designation. DLCD file contains no materials.

7.2 I-5, EXIT 55 (EAST GRANTS PASS)

Traffic volume on the I-5 East Grants Pass interchange increased from 11,750 to 23,410 ADT between 1988 and 2002, representing an annual rate of increase of 4.70 percent (see Figure 7.2). This rate of traffic growth is about seventy percent greater than the average among urban fringe interchanges. DLCD records indicate that 10 comprehensive plan amendments occurred over the study period. Five of the 10 amendments occurred within the City of Grants Pass. The files for these amendments were not in the DLCD archives, indicating that the City had subsequently updated its comprehensive plan. The remaining five amendments were under the jurisdiction of Josephine County, and files covering each action were available. One of the amendments related to land located within 1/4 mile of the interchange, and two additional amendments were located with 1/2 mile.

A review of the DLCD files on the five Josephine County amendments found reference to a Goal 12 effect in one case, involving a 1992 amendment of an 18-acre parcel to allow for an expansion of an adjacent industrial business. ODOT was identified as having a potential interest in this case, as well as in a 1989 amendment involving a change from commercial to industrial use. The files contain no documentation of ODOT comment or participation in either case.

Only one case, involving a change from residential to commercial use in 1997, provided evidence of a possible adverse traffic impact, based on citizen comment. However, in its endorsement of the amendment, the County Commission concluded that the change would have no significant impact. The actions are summarized in Table 7.2.

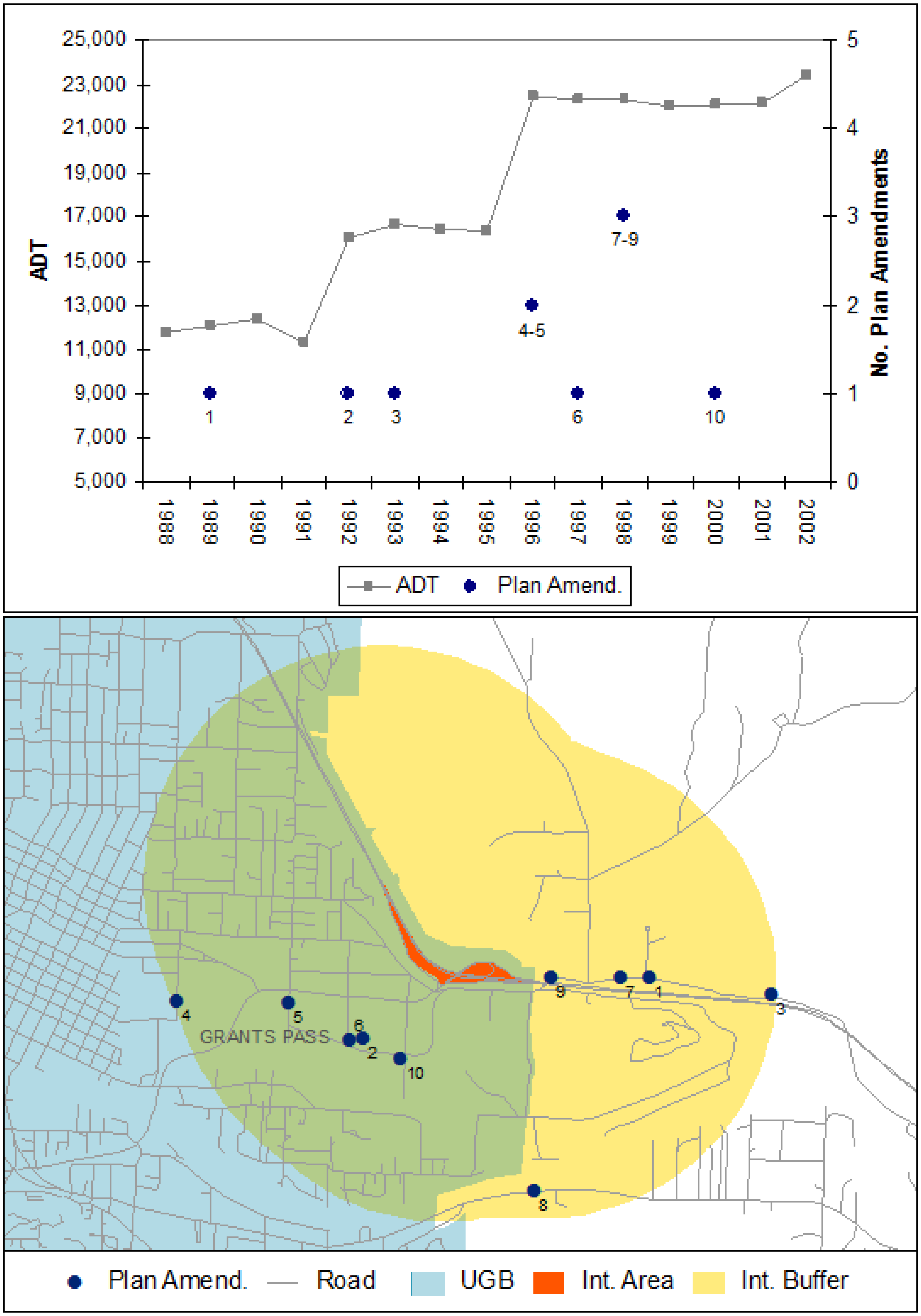


Figure 7.2: I-5, Exit 55 (East Grants Pass)

Table 7.2: I-5, Exit 55 (East Grants Pass) – Summary information from DLCD files

Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1989	3033 Foothill Blvd. (Josephine Co.)	3.03	Change from Commercial to Industrial Use	No	Yes/No	Site served as a truck terminal for previous 13 years. Staff report notes proximity of site to interchange; no discussion of traffic impacts.
1991	(C. of Grants Pass)	2.98	Change to Commercial			No DLCD file.
1992	3390, 3450, 3470 Foothill Blvd. (Josephine Co.)	18.26	Change from Residential to Industrial	Yes	Yes/No	Planning Comm. states that the purpose is to allow for expansion of existing use on adjacent property. No discussion of traffic impacts.
1995	(C. of Grants Pass)	2.47	Change to Commercial			No DLCD file.
1995	(C. of Grants Pass)	6.48	Change to Commercial			No DLCD file.
1996	(C. of Grants Pass)	1.38	Change to Commercial			No DLCD file.
1997	2910 Foothill Blvd. (Josephine Co.)	0.90	Change to Industrial	No	No/No	DLCD file only contains copies of adoption notice and local ordinance. Amendment located within 1/2 mi. of interchange.
1997	2455 Rogue River Highway (Josephine Co.)	0.37	Change from Residential to Commercial	No	No/No	DLCD file notes opposition from one person concerned about traffic impacts and inconsistent zoning. Commission concludes change will have no significant traffic impact.
1998	2520 Foothill Blvd. (Josephine Co.)	3.26	Change from Residential to Industrial	No	No/No	Notice notes that nearby “urban uses” include oil depot, auto body shop, mini-warehouses, small businesses, and auto repair shop. Amendment located within 1/4 mi. of interchange.
1999	(C. of Grants Pass)	3.98	Change to Commercial			No DLCD file. Amendment located within 1/2 mi. of interchange.

7.3 I-5, EXIT 119 (COOS BAY/ROSEBURG HIGHWAY)

Exit 119 on I-5 is classified as a rural interchange, although there is substantial exurban residential, industrial, and commercial development in its vicinity. Traffic volume on this interchange increased from 12,220 to 18,930 ADT between 1988 and 2002, with a considerable amount of the increase occurring between 1995 and 1996 (see Figure 7.3). The annual rate of growth over the period was 2.96 percent, or about 25 percent greater than the average annual rate among rural interchanges in the study. There were five amendments adopted during the study period, and DLCD files were obtained for two, with both occurring in 2000. One of the five amendments was located within 1/4 mile of the interchange, and two others were located with 1/2 mile.

Goal 12 was identified as affected by both of the amendments, and ODOT was identified as a state agency with potential interests in both cases as well (see Table 7.3). In the first amendment, involving a change from residential to industrial use on a 15-acre parcel, ODOT submitted written opposition. The agencies opposition was based on concerns about already existing congestion and potential safety problems on the south-bound off-ramp of the interchange. At that time, the ramp was already operating at LOS-F during weekday peak hours, and ODOT stated that additional industrial development following the amendment would worsen the situation. In response, the Douglas County Planning Commission concluded that since the ramp was already performing at LOS-F, adoption of the amendment would thus not lead to a change in performance. The County also concluded that the change in use would take advantage of recent improvements to the local transportation system.

The second amendment in 2000 involved an expansion of the Urban Unincorporated Boundary to include a 2-acre site, and a change from agricultural to commercial/industrial use. Although ODOT was identified as an interested state agency in this amendment, the DLCD file contains no reference to agency input.

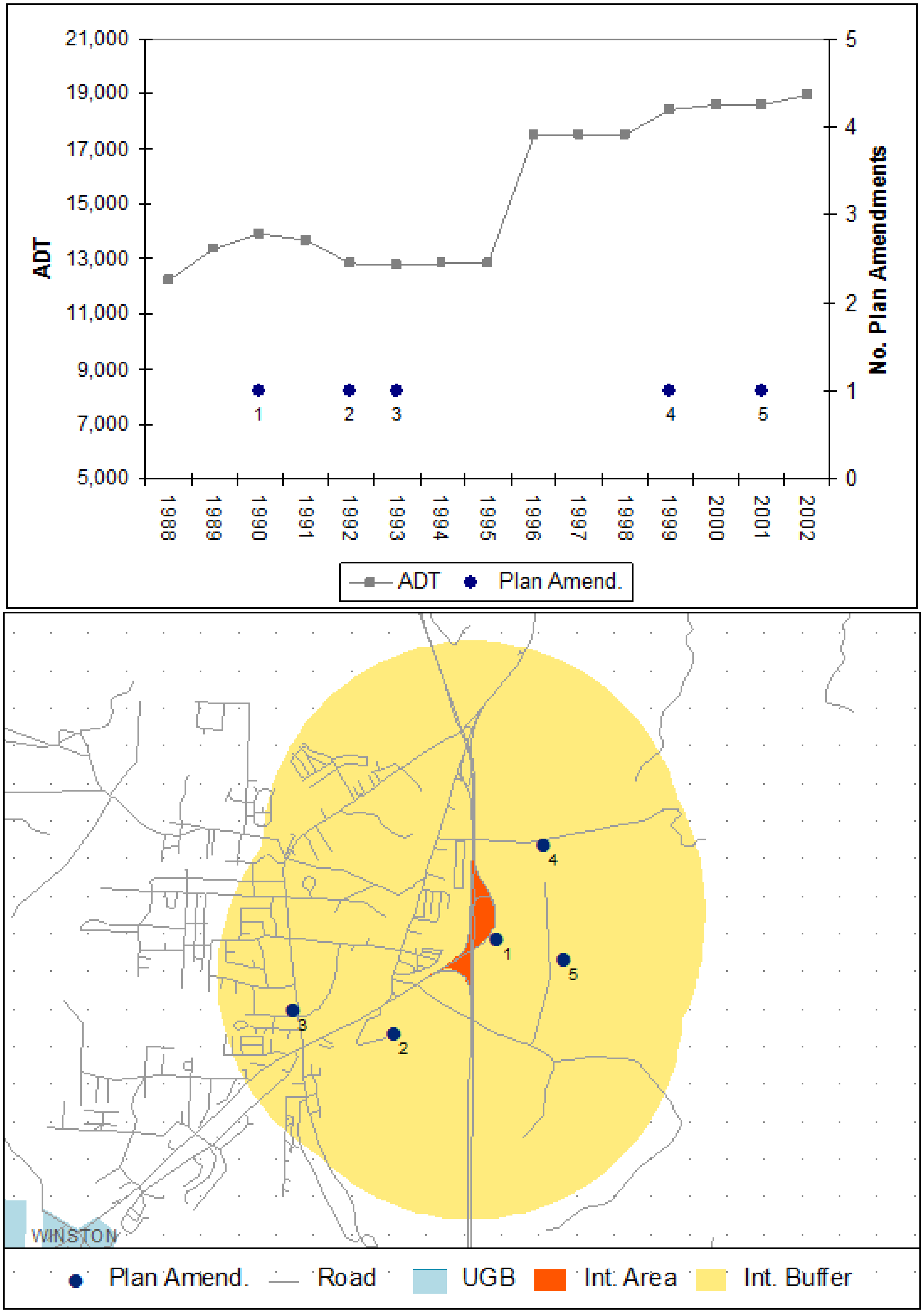


Figure 7.3: I-5, Exit 119 (Coos Bay/ Roseburg Highway)

Table 7.3: I-5, Exit 119 (Coos Bay/Roseburg Hwy) – Summary information from DLCD files

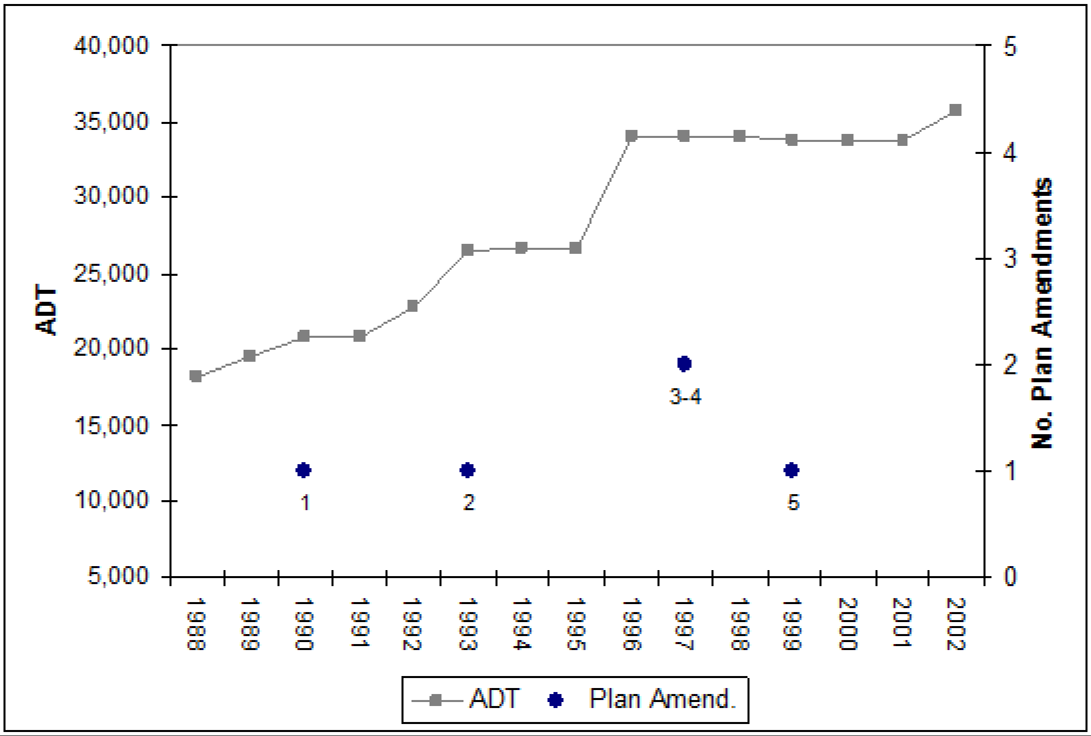
Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1989	(Douglas Co.)	64.89	Change to Industrial			No DLCD file. Located within 1/4 mi. of interchange.
1991	(Douglas Co.)	0.22	Change to Commercial			No DLCD file.
1992	(Douglas Co.)	0.47	Change to Commercial			No DLCD file. Amendment is located within 1/4 mi. of interchange.
2000	Speedway Rd. (Douglas Co.)	15.07	Change from Residential to Industrial	Yes	Yes/Yes	ODOT submits written opposition, noting that exit off-ramp is operating at LOS-F during the evening peak hour, and that additional development would worsen safety & congestion problems. County Planning Commission notes that amendment would take advantage of local system improvements, and that the change would not worsen an already unacceptable LOS. Amendment is located within 1/2 mile of interchange.
2000	E. side of Ingram Dr. (Douglas Co.)	2.00	Expand Urban Unincorporated Boundary to include site; change from Agricultural to Commercial/Industrial	Yes	Yes/No	Purpose of amendment is to allow development of a deli/espresso outlet to serve people now working nearby and expected from future commercial and industrial development in the area. Amendment is located within 1/2 mi. of interchange.

7.4 I-5, EXIT 260 (CHEMAWA ROAD)

Traffic volume on the Chemawa Road Exit of I-5 increased from 18,200 to 35,770 ADT between 1988 and 2002, with the substantial volume at the end of the period being more characteristic of an urban than an urban fringe interchange. The annual rate of increase during the period was 4.61 percent, nearly 70 percent greater than the average annual growth rate among urban fringe interchanges. Five comprehensive plan amendments were adopted during the study period, involving three jurisdictions: the Cities of Keizer and Salem, and Marion County (Figure 7.4). DLCD amendment files were found for two of the amendments, the first involving the City of Keizer in 1996, and the second involving the City of Salem in 1997. Both amendments covered relatively large areas: 30 acres in the first case, and nearly 52 acres in the second (see Table 7.4). Two of the amendments were located within 1/4 mile of the interchange, and none of the remaining three was located within 1/2 mile.

The stated purpose of the plan amendment adopted by the City of Keizer, involving a change in use on 25 of the 30 acres from general industrial to civic, was to allow the development of a minor league baseball stadium. An effect on Goal 12 was recognized, as was ODOT's potential interest in the case. The DLCD file contains materials indicating the agency's serious concerns about traffic impacts related to the amendment, and the failure of the City to adequately evaluate consequences for the area transportation system. Beyond undertaking traffic impact studies for the stadium and remain areas, ODOT recommended that mitigation measures be implemented by the City, including preparing an event traffic management plan.

The amendment adopted by the City of Salem in 1997 involved one block along Chemawa Road and several properties on Portland Road (or OR 99E). Land use on the Chemawa Road block was changed from developing residential and community service-education to industrial, while the properties along Portland Road were changed from developing residential to commercial use. DLCD file materials indicate the City Salem received a Transportation Growth Management (TGM) grant for ODOT and DLCD to undertake a transportation/land use study of the interchange, with the study area defined to include the jurisdictions of Salem, Keizer, and Marion County. File materials also indicate that this study was completed in 1995.



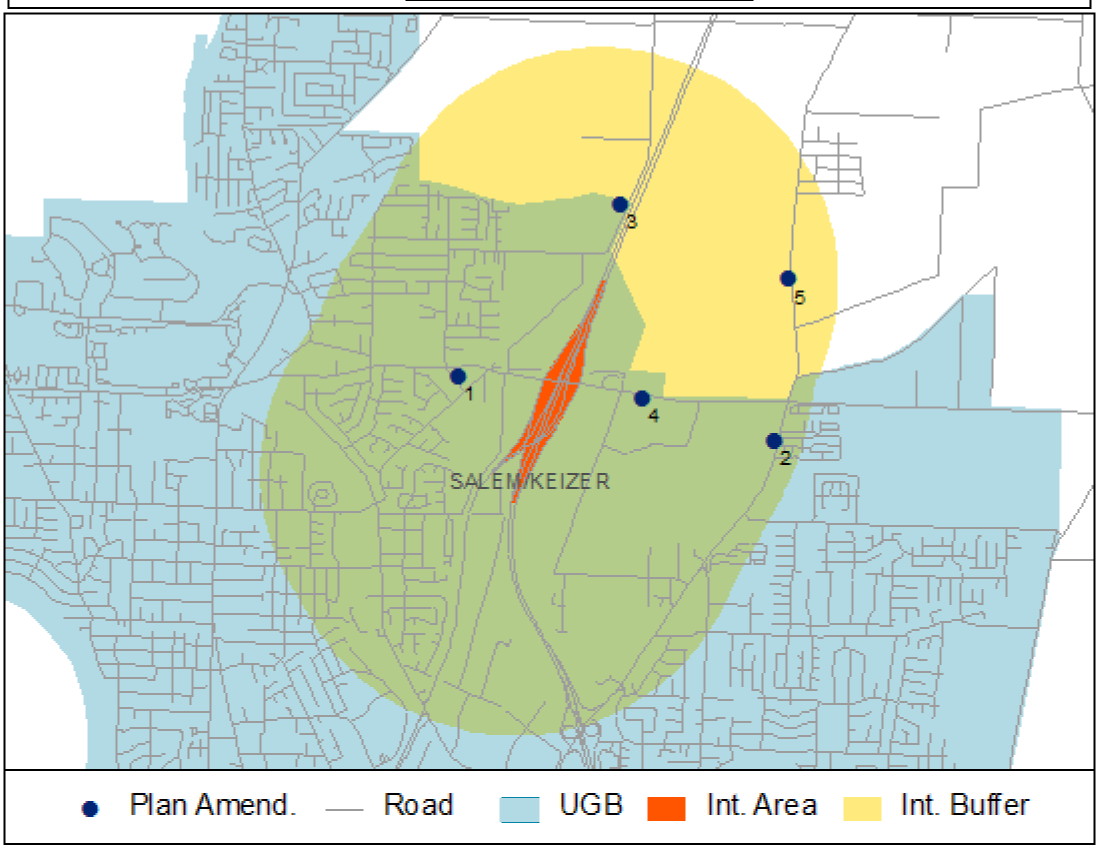


Figure 7.4: I-5, Exit 260 (Chemawa Road)

Table 7.4: I-5, Exit 260 (Chemawa Rd.) – Summary information from DLCD files

Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1990	(Marion Co.)	2.72	Change to Commercial			No DLCD file. Located within 1/4 mi. of interchange.
1992	(City of Salem)	9.00	Change to Commercial			No DLCD file.
1996	Radiant Dr. (City of Keizer)	30.0	Change from General Industrial to Civic on 25 acres	Yes	Yes/Yes	Purpose of the change is to allow development of a baseball stadium and commercial development. ODOT notes its concerns about the City "…proceeding with a plan amendment that may adversely affect area transportation facilities without fully evaluating its impacts…" ODOT recommends limiting amendment to the stadium area; conducting traffic impact analysis of remaining area; undertaking traffic study for stadium to identify mitigation measures; preparing event traffic management plan for stadium. Located within 1/4 mi. of interchange.
1997	3100 Blk Chemawa Rd; 5343, 5455 Portland Rd. NE (City of Salem)	51.73	Ch. from Developing Resident. & Comm. Serv.-Ed. to Indust. (3100), and from Devel. Resid. to Commercial (5343 & 5455)	Yes	Yes/Yes	City receives TGM grant to conduct a land use & transportation study of the interchange, covering 3 jurisdictions (Salem, Keizer, Marion Co.). Located within 1/4 mi. of interchange.
1999	(Marion Co.)	8.00	Change to Industrial			No DLCD file.

7.5 I-5, EXIT 263 (BROOKS)

This interchange is located about 3/4 west of the unincorporated community of Brooks (see Figure 7.5). OR 99E runs through the community, parallel to I-5. Traffic volume on the interchange increased from 8,000 to 21,760 between 1988 and 2002. The annual rate of increase in interchange ADT over the period was 6.90 percent, the largest of the case study interchanges and nearly three times the average among rural interchanges. Figure 7.5 shows fairly rapid growth of interchange ADT between 1988 and 1992, the same period when the seven amendments in the study area were adopted, and then a sharp increase between 1998 and 1999. Two of the amendments were located with 1/4 mile of the interchange, and no others were located with 1/2 mile.

The Brooks interchange provides the most complete documentary record of comprehensive plan amendments among the case studies. DLCD files were found for all of the seven amendments. In five of the seven amendments, the designated land use was changed from rural residential to industrial or commercial (see Table 7.5). Land use in another amendment was changed from primary agricultural to industrial, while the final amendment involved a change from public to industrial use. All of the amendments related to fairly small land parcels, generally less than two acres. The anticipated development following the amendments is also well documented, generally involving expansion of adjacent businesses.

None of the seven amendments identify either Goal 12-related effects or ODOT as an interested state agency. This may be a result of the relatively small land areas involved, and it also may reflect the adoption of the amendments in the earlier part of the study period. The DLCD file materials contain two references to potential traffic impacts. The first reference involves the 1987 amendment, in which the local school district expressed concern about traffic impacts on a nearby elementary school. In the second case, involving a property adjacent to OR 99E, the Marion County Board of Commissioners conditioned approval of the amendment on the receipt of an access permit from ODOT.

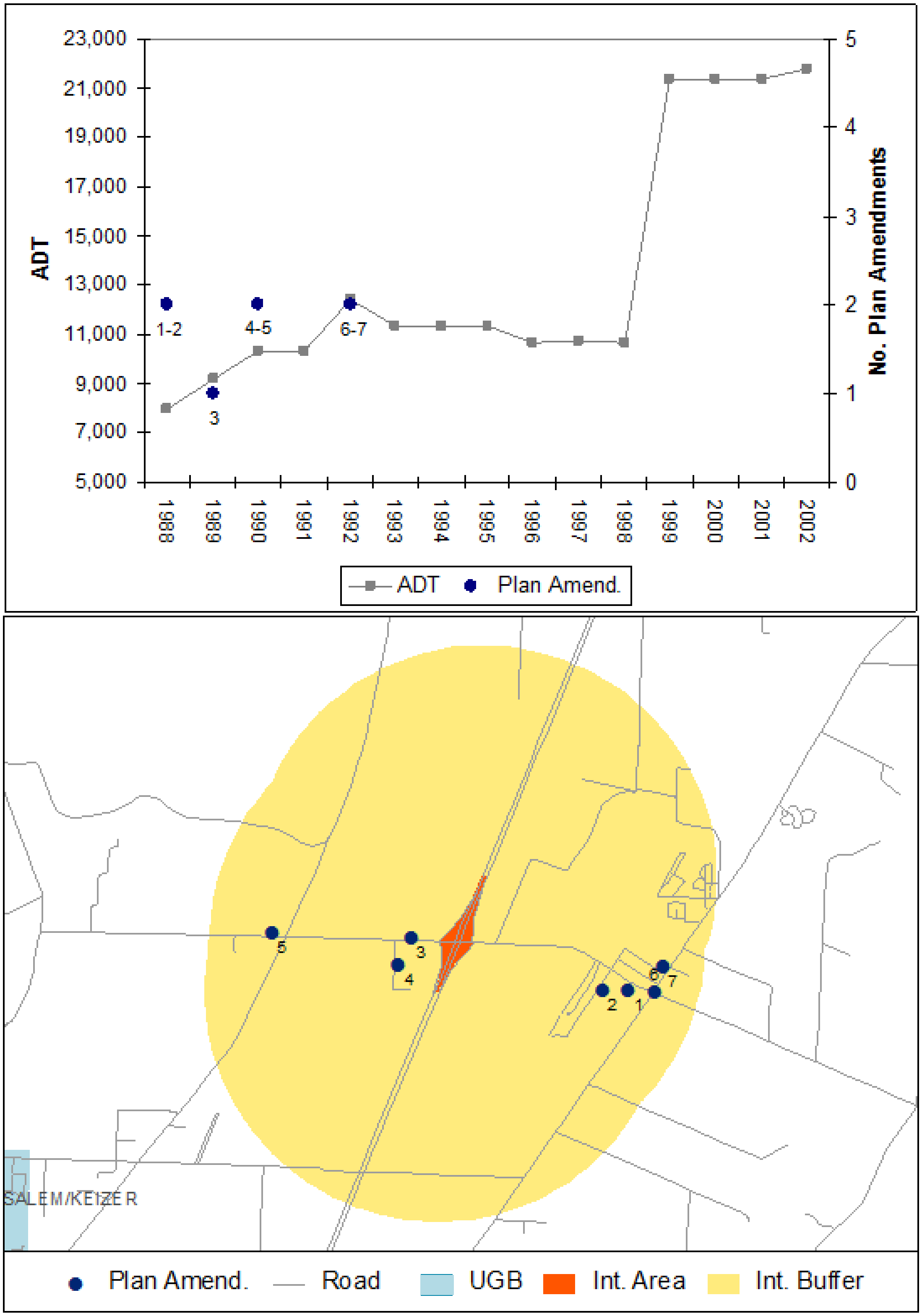


Figure 7.5: I-5, Exit 263 (Brooks)

Table 7.5: I-5, Exit 263 (Brooks) – Summary information from DLCD files

Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1987	S. end of Monterey Ave. (Marion Co.)	1.63	Change from Rural Residential to Industrial	No Notice of Adopt.	No Notice of Adoption	Purpose is to allow construction of an equipment and storage building; remainder of property to be sold to dairy business. School district expresses concern about traffic impacts on nearby school.
1988	8960 Pueblo Ave. NE (Marion Co.)	0.40	Change from Rural Residential to Industrial	No	No/No	No documents in DLCD file covering analysis of the amendment.
1990	4400 Blk Brooklake Rd. (Marion Co.)	1.50	Change from Rural Res. to Commercial	No	No/No	Purpose is to allow construction of auto repair facility. Remaining land available for other commercial development. Located within 1/4 mi. of interchange.
1990	8811 Huff Ave. (Marion Co.)	1.00	Change from Public to Industrial	No	No/No	Purpose is to allow expansion of a firm that manufactures baseball/softball pitching machines. Located within 1/4 mi. of interchange.
1990	3501 Brooklake Rd. (Marion Co.)	4.58	Change from Primary Agricultural to Indust.	No	No/No	Purpose is to allow operation of an existing heavy construction business, including warehousing, storage, and parking. County concluded that the use would not generate intensive traffic or spur further development.
1991	Hwy 99E/Brooklake Rd. (Marion Co.)	1.26	Change from Rural Res. To Commercial	No	No/No	Purpose is to allow expansion of an adjacent building materials & supply store. County conditions approval on receipt of access to Hwy 99.
1991	5030 Rockdale Ave. (Marion Co.)	0.94	Change from Rural Res. & Commercial to Industrial	No	No/No	Purpose is to allow for expansion of an adjacent industrial use. Co. Commission concludes that "facilities are adequate."

7.6 US 26, EXIT 57 (NORTH PLAINS)

This interchange located just south of the City of North Plains, nearly abutting the city's UGB. Traffic volume on the interchange increased from 11,330 to 21,720 ADT between 1988 and 2002 (see Figure 7.6). The annual rate of increase in interchange ADT, 4.44 percent, was about 60 percent greater than the average rate of increase among urban fringe interchanges. Two upward ADT trend shifts are evident, the first beginning in 1992 and the second beginning in 1996. Both shifts follow the adoption of comprehensive plan amendments.

There were five comprehensive plan amendments in the study area over the time period. Three of the amendments were located within 1/4 mile of the interchange, and neither of the remaining two was within 1/2 mile. DLCD files were found for the three most recently adopted amendments. The file for the first, adopted in 1991 included only the Notice of Adoption and a map showing the location of the amendment within the city of North Plains (see Table 7.6). The second amendment is associated with the annexation of nearly 75 acres abutting N.W. Union Road on the northwest edge of the city. City staff analysis of the amendment concluded that the local transportation system could adequately accommodate any additional traffic resulting from subsequent development. The final amendment, adopted in 1996, involved a change in use from rural commercial/agricultural/ forest to rural industrial. This amendment recognized a potential Goal-12 impact and also identified ODOT as an interested state agency. The file, however, contains no material related to assessment of traffic impacts, nor does it contain any reference to comments from ODOT.

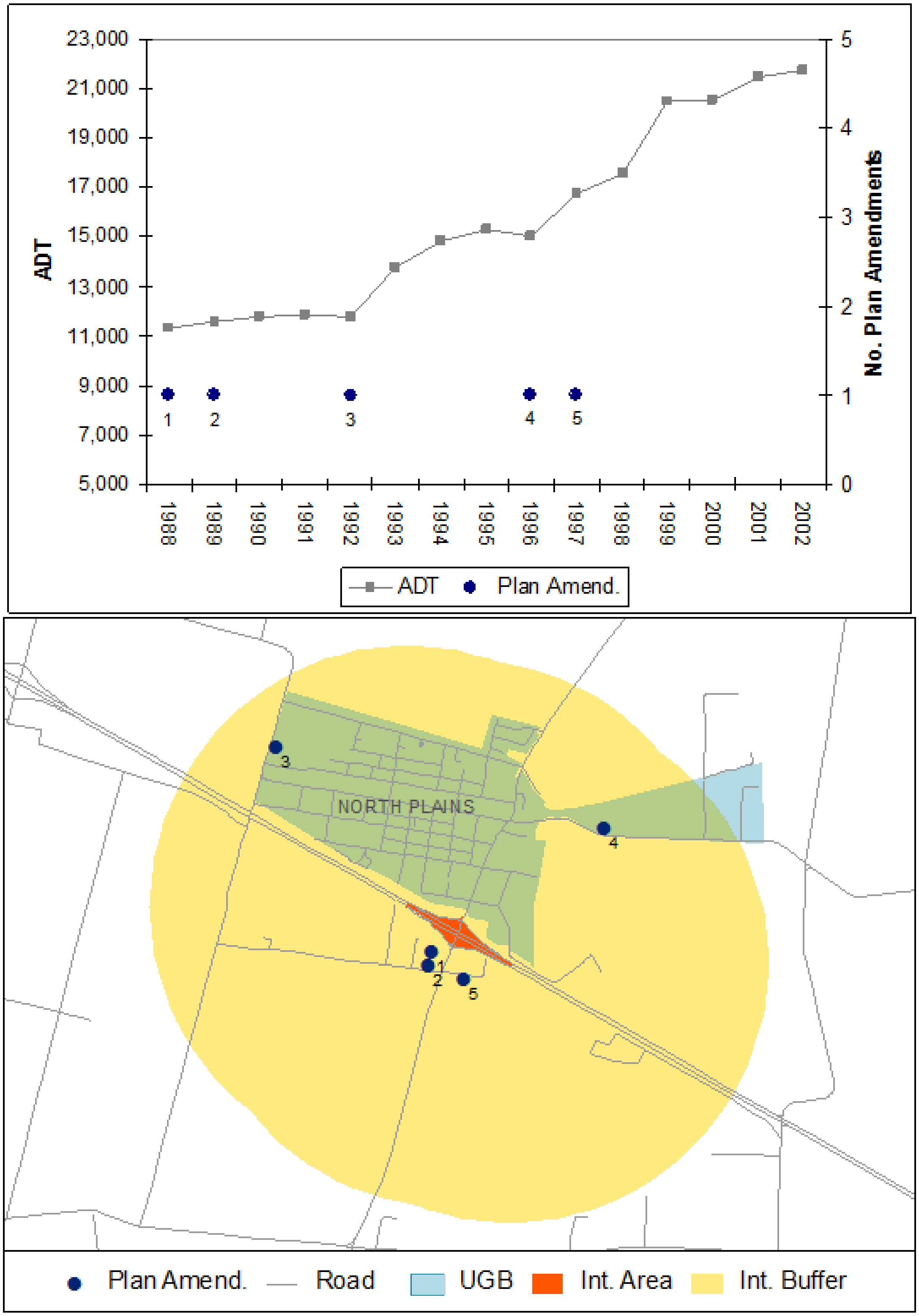


Figure 7.6: US 26, Exit 57 (North Plains)

Table 7.6: US 26, Exit 57: (North Plains) – Summary information from DLCD files

Year Adopted	Location (Jurisdiction)	Size (acres)	Amendment	Goal 12 Impact?	ODOT Notice/ Comment?	Comments
1987	(Washington Co.)	0.70	Change to Industrial			No DLCD file. Located within 1/4 mi. of interchange.
1988	(Washington Co.)	0.80	Change to Industrial			No DLCD file. Located within 1/4 mi. of interchange.
1991	Gordon Rd/Wascoe Ave. (City of North Plains)	10.60	Low Density Residential to Industrial	No	No/No	File includes map only; no other documents.
1995	N. and abutting N. W. Union Rd. (City of North Plains)	74.71	Change from Wash. Co. Future Development 10 to City General Industrial; annex 74.71 acres to City.	No	No/No	City staff conclude that N.W. Union Rd and other existing roads are adequate to handle the impact of the change. No future improvements needed. No reference to state facilities.
1996	31345 N.W. Beach Rd. (Washington Co.)	4.05	Change from Rural Commercial/Agricultur-al/Forest-5 to Rural Industrial.	Yes	Yes/No	No analysis of the impacts of the amendment are contained in the file. File contains no comments on transportation impacts from ODOT or other agencies. Located within 1/4 mi. of interchange.

7.7 CASE STUDY DISCUSSION

The interchange case studies provide more detailed documentation of the consideration of interchange traffic impacts associated with comprehensive plan amendments. Among the issues covered in the cases studies were the extent to which Goal-12 related impacts were identified in assessing amendments, whether ODOT was identified as an interested state agency, whether ODOT commented on amendments, the identification of traffic impacts requiring some form of mitigation, and the location of amendments in relation to recently-revised access management and Transportation Planning Rule regulations pertaining to interchange areas.

The incidence of consideration of these issues is summarized in Table 7.7. First, of the 40 adopted amendments or zoning changes located within one mile of the six interchanges examined in the case studies, 26 (65%) were documented by files in the DLCD archives. As noted before, lack of documentation for the remaining 14 amendments is likely to be the result of comprehensive plan updates, at which point DLCD files on prior plan amendments are removed.

Among the 26 amendment files examined in the case studies, seven (27%) contained a reference to Goal-12, and ten (38%) identified ODOT as a state agency with a potential interest. In turn, file materials indicate that ODOT provided input to the amendment process through written comments or direct participation in four (15%) instances. In the end, the need for mitigative action was documented in only three (12%) instances.

Table 7.7: Case study summary indicators

Summary Indicator	Incidence
Number of Plan Amendments	40
Number of DLCD Files Located	26
Goal-12 References	7
ODOT Interest identified	10
ODOT Participation/Comments	4
Negative Traffic Impacts Recognized	3
Amendments Within 1/4 Mile	14
Amendments Within 1/2 Mile	17

The recent revisions in access management standards and amendments to the Transportation Planning Rule would likely have had a substantial effect on the evaluation of traffic impacts associated with the amendments examined in the case studies. Given that fourteen (54%) of the amendments studied were located within 1/4 mile of an interchange, development activity following the change in land use would have provided an opportunity to re-examine access that had previously been granted. With respect to the seventeen amendments (65%) located within 1/2 mile of an interchange, the new language in the Transportation Planning Rule would have required a more rigorous evaluation of traffic impacts by local governments, more careful consideration of mitigation options, identification of financing plans, and a final determination by ODOT of traffic impacts. This final provision represents a noteworthy shift from ODOT's prior role as an "interested state agency."

In reviewing the case study materials, it would be hard to escape the conclusion that interchange traffic impacts were rarely given serious consideration in evaluating comprehensive plan amendments. The record associated with the late-1990s amendments in the vicinity of the I-5 Chemawa Road interchange represents more of an exception to the overall pattern than evidence of an evolving practice. In this respect, the case studies offer a clear reinforcement of the findings of the earlier statistical analysis in this report. In other words, had the plan amendment process involved more rigorous evaluation, the likelihood of the statistical analysis finding a significant effect of plan amendment incidence on interchange ADT would have been greatly reduced.

8.0 CONCLUSIONS

In this report we have examined the effects of comprehensive plan amendments on interchange performance on the Oregon highway system. Our examination has included a review of literature related to interchange and access management, induced traffic, and the experiences of other states. The review also covered ODOT policies and practices related to the subject of land development in interchange areas, including the recent practice of preparing interchange area management plans, jointly adopted by ODOT and local governments, in connection with interchange construction or improvement. The agency's traffic forecasting procedures were also reviewed with respect to their treatment of the structural changes that plan amendments represent in the regulation of development.

Drawing on historical data, we documented the temporal and geographic incidence of plan amendment activity in Oregon, observing a 25 percent greater likelihood of plan amendments occurring near interchanges than elsewhere in urban areas. We estimated ADT models for rural, urban fringe, and urban interchanges, and found that plan amendments account for a significant (though not necessarily substantial) share of interchange traffic volume in the cases of rural and urban fringe facilities. The absence of significant plan amendment effects on urban interchange traffic can potentially be ascribed to either effective land use planning or a growth in latent demand, or a combination of the two.

The estimated ADT impacts of comprehensive plan amendments on rural and urban fringe interchanges were calculated to be equivalent to about five and two years of historic traffic growth on these facilities, respectively. Given annualized capital cost figures for typical facilities in these two categories, it would be possible to further calculate the monetary costs associated with the related reduction in the design life of these facilities.

Six case studies were also undertaken. The case studies served to translate the more abstract statistical analysis of comprehensive plan amendments and interchange traffic into a more direct picture of the planning processes as they occurred over time at selected interchanges, including the consideration of interchange traffic consequences in these processes. The case studies provide fairly compelling evidence that traffic impacts on interchanges were rarely given serious consideration in local evaluations of plan amendments. Moreover, there is also very limited evidence of active ODOT participation in the plan amendment process. The historic lack of attention to interchange traffic impacts by local governments and ODOT may be explained by the piecemeal nature of the process. Seen independently, the traffic impacts of given plan amendments may have been considered too marginal to be of much concern. However, cumulative traffic impacts over a number of amendments grew to represent a non-trivial threat to interchange operation in selected instances. Lessons have clearly been learned from these experiences, as evidenced by the recent amendments to the TPR and OHP, as well as revisions of ODOT's access management standards.

As with many research endeavors, our findings provide insights to some questions that, in turn, lead to the identification of other issues that may deserve future investigation. First, although we have documented the geographic incidence of comprehensive plan amendment activity, our work has not contributed to a greater understanding of why this activity occurs where it does, recognizing that amendments were entirely absent in the vicinity of more than half of the interchanges studied and varied considerably in both size and frequency among the remainder.

From a statistical perspective, investigating this question would entail moving plan amendments from the right hand to the left hand side of the regressions, and then identifying a new set of factors representing key determinants of the land use regulation and development processes. It is possible that the resulting specification would include some of the same variables employed in this study, recognizing that traffic and population accessibility can also drive the land development process, especially in the commercial market. Statistically, this suggests that a simultaneous equations approach, wherein plan amendment/development and interchange performance are jointly determined, may provide a more comprehensive treatment of these two processes.

Second, given that plan amendment activity has been found to affect interchange traffic, a basic rationale for preparing interchange area management plans has been empirically validated. These agreements can be seen as a mechanism for ensuring that interchanges achieve their design life and are not prematurely compromised by traffic from unanticipated development. The agreements also act to reduce the uncertainty associated with the traffic forecasting process that supports the determination of interchange design capacity. Reduced uncertainty is likely to lead to more efficient use of resources when interchange design capacity corresponds more closely to future traffic growth.

In contrast, there have been recent developments in Oregon that may lead to a more uncertain future for coordinated management of development in interchange areas. In November 2004, Oregon voters passed Measure 37, which requires governments to compensate current landowners for losses in value attributable to regulations implemented during their tenure of ownership. Given a valid claim, if compensation is not provided, an owner's property can be exempted from the pertinent regulation. Both the access and zoning provisions contained in IAMPs could face challenges from Measure 37 claims that may ultimately be tested in the courts, not unlike previous legal challenges related to property rights discussed in this report. While earlier court rulings have upheld the state's authority to manage transportation facilities to preserve safety and mitigate congestion, the limits of this authority have been subject to challenge and judicial review in increasingly complex circumstances.

Although the agreements supporting the interchange area management plans do not contain language pertaining to amendment of IAMPs, their 20-year time horizon points to the possibility that changing conditions could warrant re-negotiation. In her review of agreements between state DOTs and local governments related to corridor management plans, Williams (*2004, p. 27*) concludes that the most effective agreements are sustained by a recognition of the need "… to make compromises from time to time to keep an agreement alive." Oftentimes, compromise or change in such agreements raises more fundamental questions related to financing and cost responsibility.

Presently, with most of the IAMPs in Oregon still in the process of preparation, there is no compelling reason to take up questions of re-negotiation and financing. In the future, however, consideration of mechanisms that will create a revenue stream to fund infrastructure expansion in interchange areas may be needed. Given the differing development circumstances prevailing in rural, urban fringe, and urban settings, a portfolio of alternative mechanisms would likely be needed. Included among these alternatives would be impact fees, which would be more applicable to new interchanges before development occurs, and creation of local improvement districts, which would be more applicable to existing interchanges where development has already occurred and more development is expected.

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APPENDIX

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PERSONS INTERVIEWED

Jerri Bohard, ODOT, Planning Section Manager

Terry Cole, ODOT, Special Projects Coordinator, Region 2

Bob Cortright, DCLD, Transportation Planning Coordinator

Bonnie Heitsch, DOJ, Assistant Attorney General (formerly ODOT, Environmental Section).

Dick Reynolds, ODOT, Planning and Implementation Unit

Anna Russo, ODOT, Planning and Implementation Unit Manager

Peter Schuytema, ODOT, Transportation Planning Analysis Unit