Creating an Operations-Based Travel Forecast Tool for Small Oregon Communities

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ABSTRACT

Planning for the future by applying trend lines to historical traffic counts is a risky proposition in smaller communities experiencing growth and congestion. However, regional travel demand models are rarely available or cost effective to implement outside of larger cities. In addition, forecasts and analysis methods that do not consider intersection operations are not able to adequately consider corridor management techniques that can reduce the funding need on a state highway system. To fill this gap, DKS Associates has created a new forecasting application for small communities along major corridors that can dynamically evaluate state highway performance and be responsive to local circulation conditions. This tool is effective at forecasting and evaluating corridor improvement strategies such as couplets or alternate routes for regional facilities, and it is sensitive enough to measures impacts on all local streets and intersections within the community for a variety of local roadway improvements.

This paper describes the results of creating and applying this travel forecast tool for the small town of Sisters, OR, where seasonal recreation traffic, truck volumes, and a limited street grid create a major system bottleneck. The travel forecast tool development consisted of detailed land use forecasting, consideration of O-D patterns, and trip table estimation utilizing a simple gravity model approach. The resulting trip table was then assigned to a detailed roadway network that was created in VISUM using NAVTEQ network inputs and HCM-operations based node delays that can react to specific changes in circulation and traffic control. The forecast results were exported to Synchro for detailed analysis and simulation, which provided both a technical tool for addressing mobility and circulation throughout the system as well as a communication tool to help inform local decision makers.

INTRODUCTION

Historically, forecasting traffic growth and conducting traffic analysis in small Oregon communities that are not within the reach of a regional travel demand model has been performed by manual methods. While the manual methods are reasonable given the limited data and resources of these smaller communities, the inability of the methodology to respond to corridor management alternatives (e.g., providing alternative circulation or traffic controls) has made the manual approaches risky for communities planning to invest millions of dollars in roadway improvements. The two commonly used and approved manual methods that have been used in Oregon include:

- **Traffic Growth Trends** – This is a simple approach where historic traffic volume information is used to determine an average growth rate. The rate is then applied to existing traffic volumes to forecast out to the long-term horizon year. This methodology does not account for variations in local development that can change growth rates and trip distribution patterns.

- **Cumulative Analysis** – As a step beyond traffic growth trends, cumulative analysis follows a traditional traffic impact study approach where trips generated by future development are added to baseline volumes projected by factoring existing volumes by a background growth rate (*1*). This approach allows variation in trip distribution for future development, but it does not account for changes in the trip distribution of existing land uses.

Besides the trip distibution limitations described for both the traffic growth trend and cumulative analysis methods, neither manual methodology can account for congestion on the transportation system and its effect on traffic assignment. In congested corridors, traffic circulation patterns (particularly for local trips) can respond to congestion by avoiding major highway corridors and utilizing the surrounding local street system for circulation. The net effect of this condition can be lower future peak hour traffic volumes on a congested corridor than predicted by historic growth trends, as illustrated in Figure 1. Therefore, the manual forecast methods are only appropriate where anticipated local growth and future congestion are minimal and significant investment in roadway capacity improvements is unlikely.

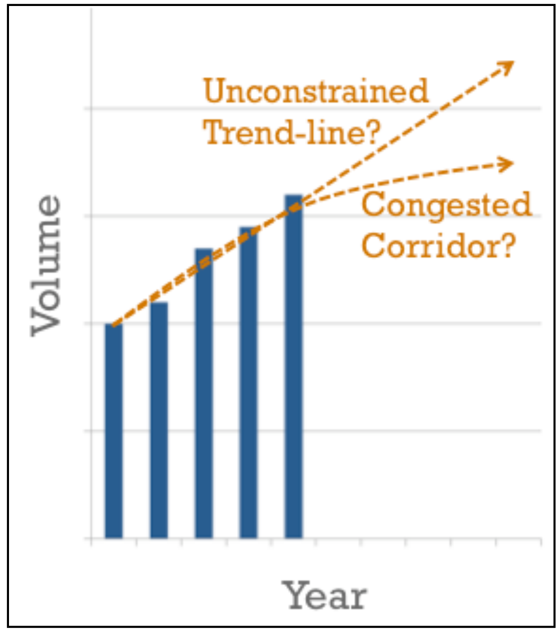

Figure 1: Manual Forecast Risk

While the commonly used manual methodologies have limitations in adjusting traffic patterns and trip distribution in response to development patterns and increased congestion, perhaps the most frustrating factor limiting their usefulness for a transportation planner is the inefficiency of adequately evaluating multiple improvement scenarios. For example, a recently completed manual cumulative analysis approach applied in Silverton, Oregon utilized a forecast area of 25 Transportation Analysis Zones (TAZs) that included trip path coding (similar to traffic impact study type analysis) in a Traffix network of approximately 1,500 unique trip paths (coded based on engineering judgment of likely route choices through the city). When the project advisory committee inquired about testing the impacts of de-coupling the downtown into a two-way street grid, the project team was unable to respond with the use of the travel forecast tool due to time and budget constraints, as a majority of the 1,500 trip paths would need to be re-estimated, re-coded, and existing traffic volumes would need to be manually adjusted.

In the fall of 2007, DKS Associates began a transportation planning study to determine the long-term solution for Highway 20 through the small town of Sisters, Oregon. Highway 20 carries a significant amount of seasonal traffic between Central Oregon and the Willamette Valley, with seasonal peak hour traffic volume fluctuations of up to 60 percent. Past studies in the community had examined couplets, bypasses, and alternate routes within the city. However, in the past 20 years, the community had been unable to develop local consensus or to agree with the Oregon Department of Transportation (ODOT) on an approach that was affordable and protected the character of the community. Efforts to provide more cost effective solutions, such as corridor management, had failed due to the inability to demonstrate that mobility could be reasonably maintained in the long-term horizon. Given this history, the DKS Associates project team decided that the development of a new travel forecast tool would be necessary to effectively evaluate corridor management (e.g., operations improvements) and test a wide range of transportation alternatives. Requirements for the travel forecast tool included the ability to:

- Evaluate corridor management solutions (including modifications to intersection geometry and traffic control)
- Integrate local circulation enhancements
- Compare corridor widening with providing a seasonal relief valve as an alternate route
- Facilitate consensus building by allowing for rapid scenario evaluation and demonstration of results

This paper describes the custom forecast tool that was developed for the Sisters, Oregon project and was approved by ODOT's Transportation Planning and Analysis Unit (TPAU) as an enhancement to the cumulative analysis approach. The components of the forecast tool development processes are summarized to explain the methodology. The results of the forecast tool, including not only calibration and performance, but also application to Sisters, OR and key project outcomes, are described. The paper also explores the application of key components of this operations-based tool as a method to develop quasi-mesoscopic focus area models within a larger metropolitan area.

METHODOLOGY OVERVIEW

Development of the forecast tool resembled a traditional four-step model approach, as shown in Figure 2. Each process step is summarized below.

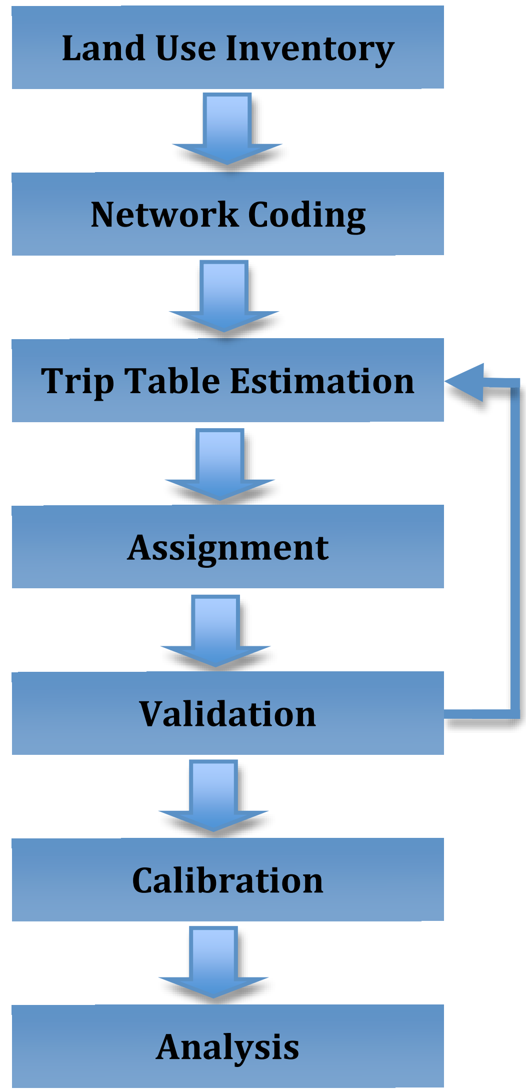

Figure 2: Forecast Tool Development Process

Land Use Inventory for the forecast area was completed at parcel level detail based on GIS data, aerial photography, and citywide Comprehensive Plan control totals. Land use growth was allocated to vacant lands in the City's urban and urban reserve areas based on zoning designations and typical densities.

Network Coding in VISUM was completed for all local, collector, and arterial streets within the forecast area. The existing roadway network (built off of NAVTEQ files) was used for configuring the model links and field surveys were used to supply traffic control information for each intersection within the model.

Trip Table Estimation was completed utilizing Origin-Destination (O-D) surveys for through traffic and a simple gravity model for internal trip distribution. Trip generation was based on representative *ITE Trip Generation Rates* for the general land use types (*2*).

Assignment of the estimated trips was completed utilizing model travel time based on link speeds and node delay calculated using *Highway Capacity Manual* (HCM) methodology (*3*).

Validation of the estimated traffic volumes was completed using screenline analysis. When needed, adjustments were made to the trip generation estimates to improve the results of the trip estimation.

Calibration of the forecast tool was completed through a regression analysis of turn movements at study intersections and flow-bundle analysis of key travel patterns through the forecast area. Minor adjustments were made to link speeds and traffic control (e.g., adjusting for delays caused by the high volumes of pedestrian crossings in downtown) to match field-observed values.

Analysis utilizing the forecast results was completed by exporting both the VISUM network and forecasted volumes into Synchro for operations analysis. Forecasted volumes were post-processed at study intersections and balanced within the Synchro network.

RESULTS

The following sections describe the results of the customized forecast tool. Calibration results and key forecast tool benefits are described to demonstrate the performance and usefulness of the tool. Application to the project in Sisters, Oregon, is summarized to demonstrate the benefit of the operations based forecasts in comparing and analyzing corridor management solutions.

Calibration

The forecast tool outputs were calibrated to peak hour conditions. Review of the VISUM model included shortest-path searches between key origins and destinations, as well as review of forecasted traffic turn movements where existing traffic volumes were available. Figure 3 shows the estimated base year forecast tool volumes compared to the existing traffic turn movement volumes. The slope of the fitted curve is 1.031, indicating that the estimated volumes are generally only 3% higher than the existing peak volumes and that the validated trip generation was reasonable. Furthermore, the R^2 value of 0.975 indicates that the estimated volumes are reasonably accurate at the turn movement level, reflecting the performance of the HCM node-delay assignment methodology.

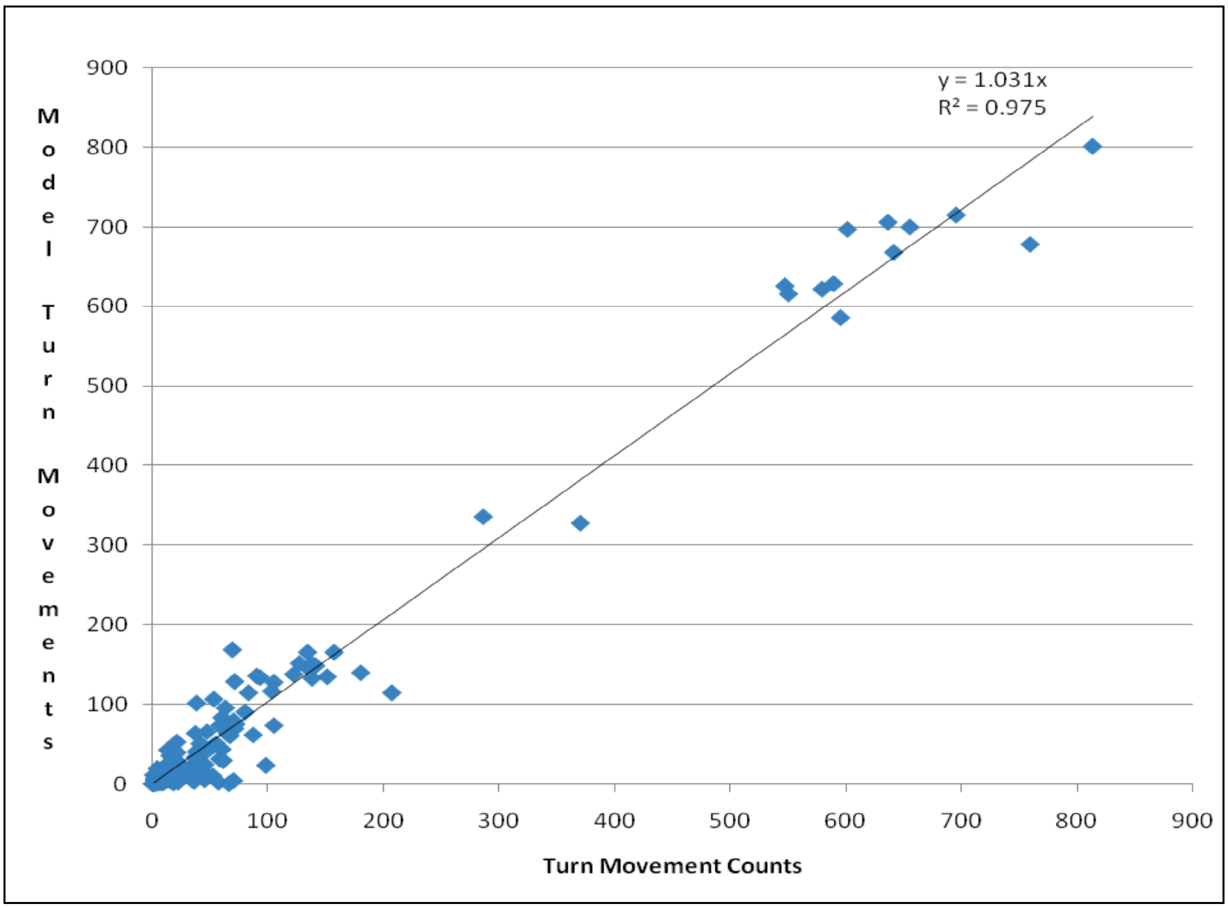

Figure 3: Estimated Traffic Volumes vs. Manual Turn Movement Counts

Key Forecast Tool Benefits

The custom forecast tool represents every street in the city, not just the major streets as in travel demand models, and more importantly, it accounts for the differences in driver delays associated with intersection operations. In addition, the enhanced version of the cumulative analysis methodology allows existing trips to be reassigned on the roadway network in response to changes in congestion, land use, or route choices. This means that the tool has the ability to rapidly forecast and graphically display changes in traffic patterns caused by anything from converting to a one-way couplet in a downtown to changing a signalized left-turn from permitted to protected phasing.

Two key graphical outputs of the travel forecast tool are citywide volume to capacity (v/c) ratio plots and network volume difference plots, which are shown in Figure 4 and Figure 5, respectively. The v/c ratio plot shows significantly more data than a traditional travel demand model link v/c plot, as the travel forecast tool is able to show estimated intersection HCM operations level of service (LOS) results at every intersection within the forecast area. Intersection operations data is a powerful tool to identify bottlenecks in the forecast area, indicating capacity issue areas that may not have been captured by traditional analysis of select study intersections. The volume-difference plots, which show local street level of detail, are powerful in demonstrating to both technical and non-technical decision makers the traffic diversion that can result from roadway network alternatives.

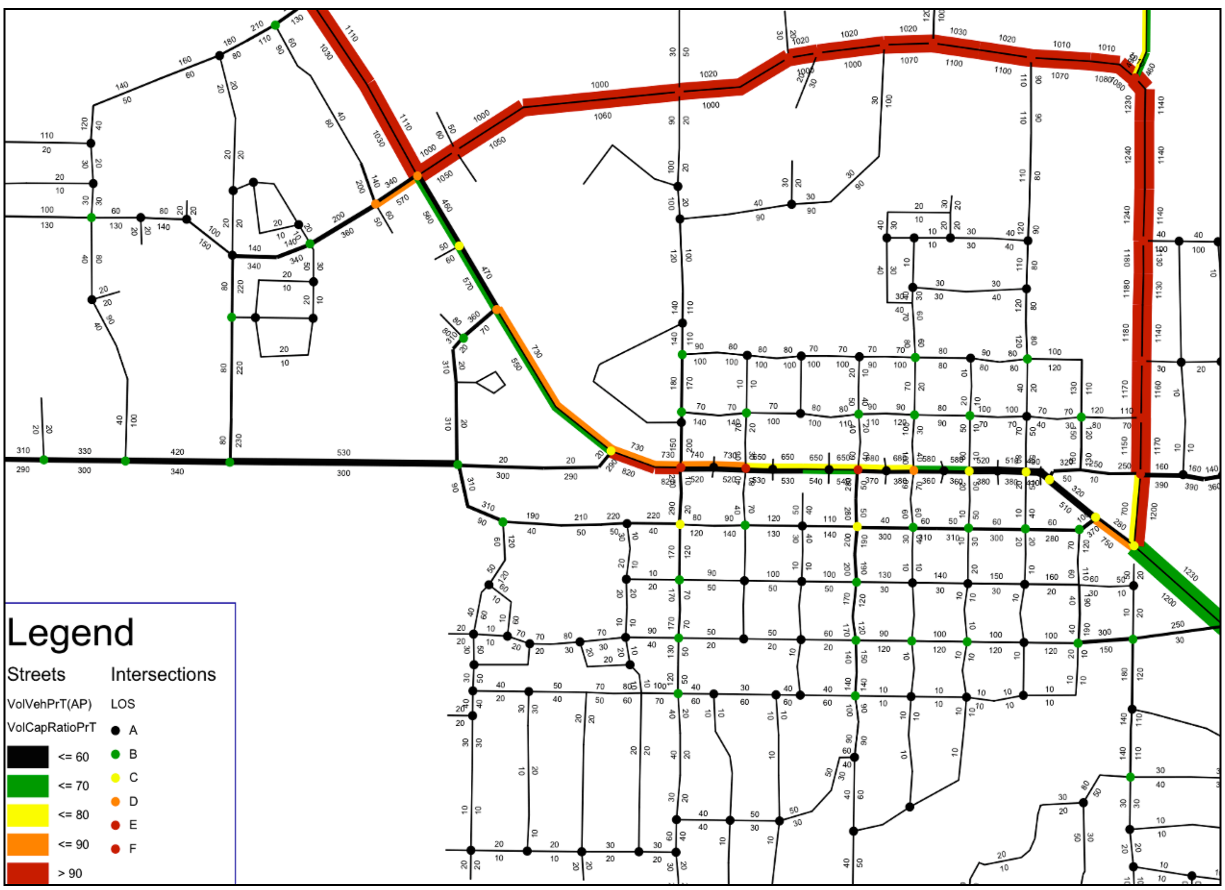

Figure 4: Forecast Tool Volume and Network Operations Plot

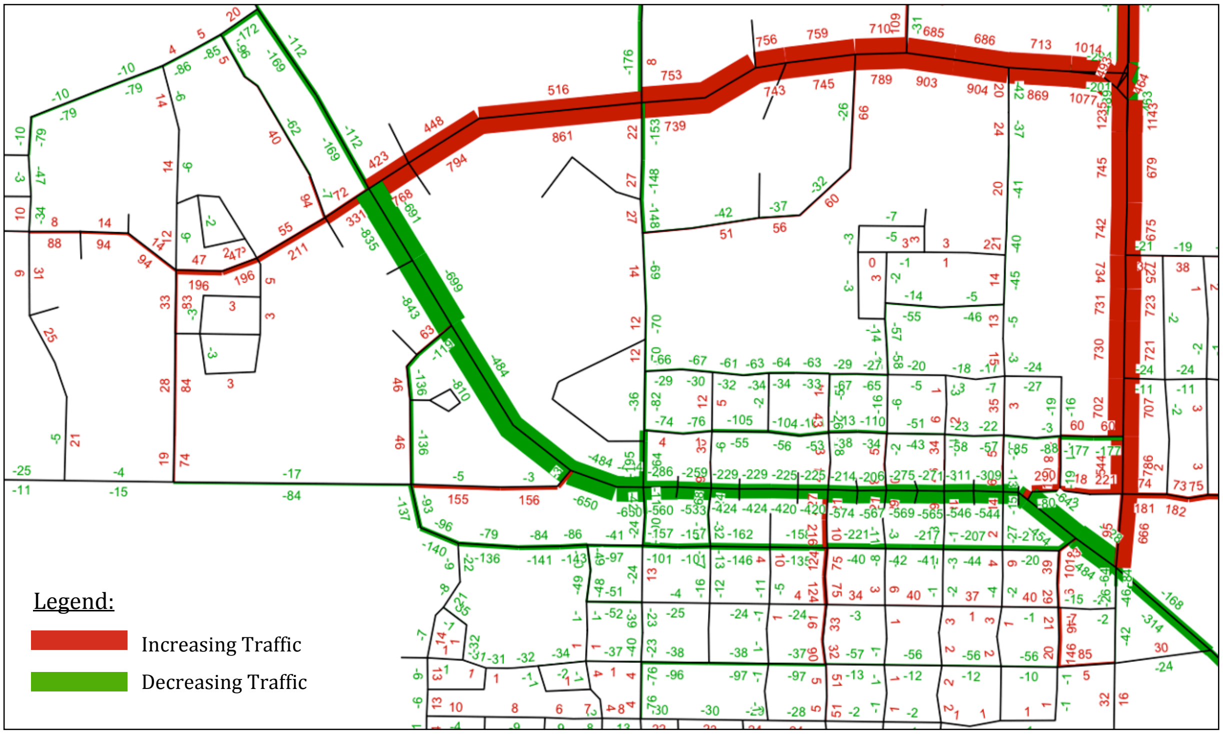

Figure 5: Forecast Tool Scenario Volume Difference Plot

Another key benefit of the traffic forecasting tool is the ability to quickly translate raw travel forecasts into a citywide operations model, which is illustrated in Figure 6. Besides automating conversion to a robust operations tool that can evaluate traffic flow throughout the model area, the operations model can also be used to display simulation of traffic flow throughout the community. Such simulation has been found to be an invaluable tool for effectively communicating with the public and elected officials.

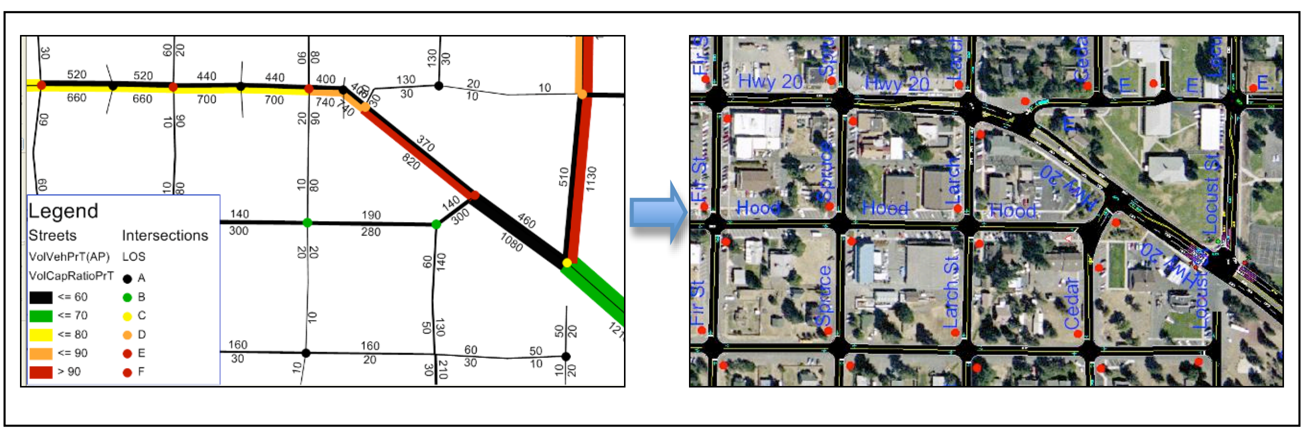

Figure 6: Conversion of VISUM Forecast Tool to Synchro/SimTraffic Operations Analysis

Application to Sisters, OR

Application of the forecast tool in the Sisters, Oregon, both assisted in the development of and allowed the demonstration of the benefit of an innovative corridor management solution for Highway 20, including a seasonal alternate route. The Highway 20 solution was approved by the community and ODOT and will save over $100 million compared to a traditional bypass ($40 million compared to approximately $150 million or more). In addition, the solution was viewed as a solution to protect the character and livability of the community. Several keys of the enhanced forecast tool that helped achieve these outcomes include:

- The long-term (20-year) forecasts for Highway 20 were able to reflect local traffic diverting from the highway corridor to avoid future congestion. The resulting traffic forecasts, as shown in Figure 7, were approximately 50 percent less than a traffic growth trend analysis would have estimated due to utilization of a parallel local street grid system for local traffic, which allowed a corridor management approach to be implemented for Highway 20 instead of a bypass solution.

- The Synchro/SimTraffic operations tool developed for the entire forecast area was utilized to demonstrate to both the local community and ODOT staff that vehicle operations through the Highway 20 corridor (including vehicle queuing) would meet applicable mobility standards and not gridlock during peak periods.

- The visual tools provided by the SimTraffic models were key to presenting the plan alternatives to the public and elected officials so they could easily understand the changes in traffic flow and the components of the Highway 20 improvements. This understanding of the corridor management approach led to consensus within the community for the first time in over 20 years.

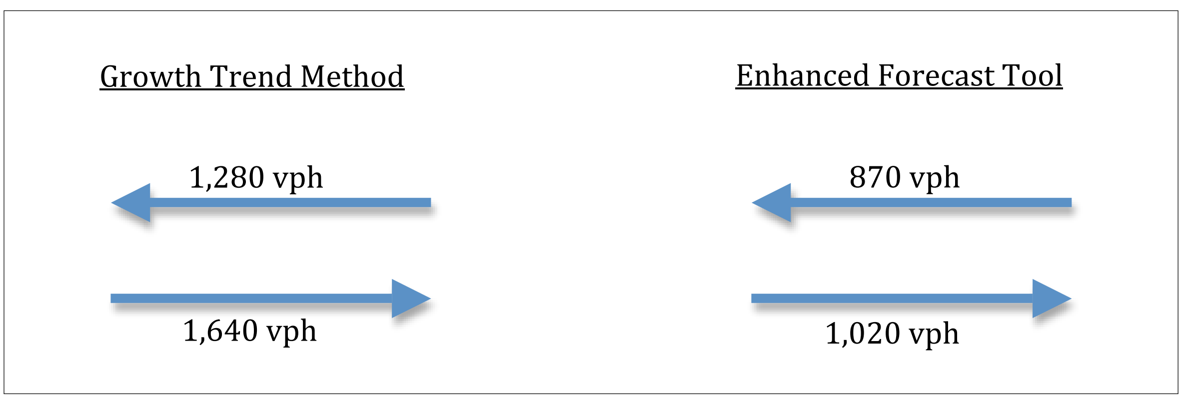

Figure 7: Highway 20 Long-Term Forecasts with Traffic Growth Trends vs. Forecast Tool

APPLICATION TO LARGER URBAN AREAS

The outcome of the Sisters, Oregon project points to the importance of considering detailed roadway networks and intersection operations in the development and analysis of corridor management solutions. While there are a growing number of mesoscopic forecasting tools designed for this purpose, DKS Associates has found that components of the operations-based forecast tool can be readily applied for refining traffic assignments within the boundary of a regional travel demand model that has been developed in a VISUM software platform.

Figure 8 illustrates how a simplified version of the operations forecast tool has been applied within the Portland, Oregon metropolitan area for sub-area plans, coridor studies, and circulation studies. As shown, the steps of developing land use inventories, estimating trip tables, and validating forecasts are not required if a regional travel demand model is available as a resource. For these applications, a focus model can be created by extracting a trip table from the regional model and applying it to a detailed network that intergrates the operations-based node delays and trip assignment. While not a complete mesoscopic modeling approach with feedback to the regional model 4-step process, this method is a valuable aid to refining trip assignment as a post-processing tool. This approach has been applied to evaluate local transportation system issues, such as:

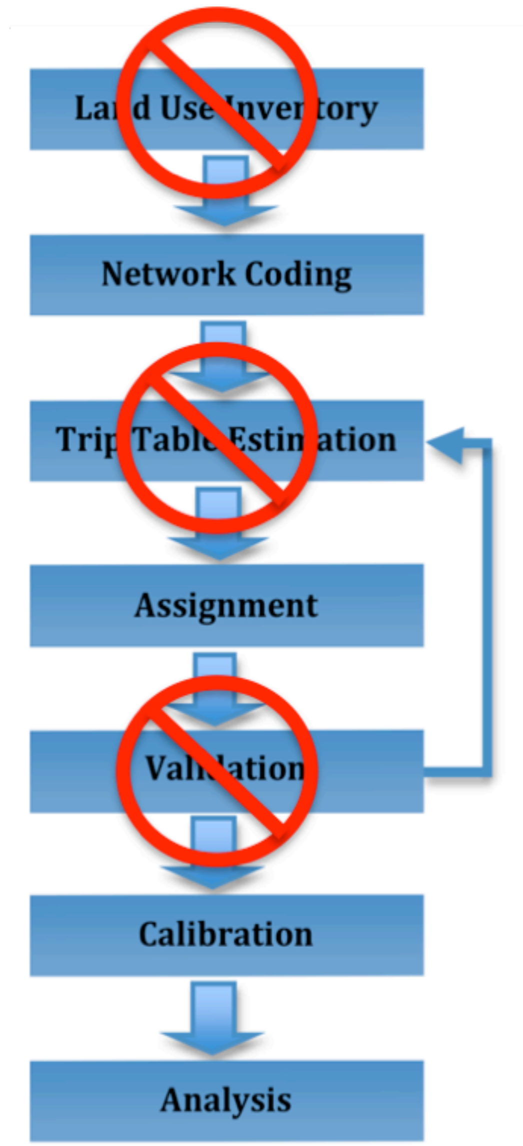

Figure 8: Focus Model Process

- Neighborhood traffic impacts from various levels of connectivity to new development
- Traffic circulation benefits from improving a street grid in a congested area
- Traffic diversion from improving intersection control or restricting turn movements

CONCLUSIONS

This paper described the creation of a custom forecast tool that was developed as an automated enhancement to a manual cumulative analysis approach. The custom forecast tool represents every street in the forecast area, not just the major streets as in travel demand models, and more importantly, it accounts for the differences in driver delays associated with intersection operations. In addition, the forecast tool allows existing trips to be reassigned on the roadway network in response to changes in congestion, land use, or route choices. This means that it has the ability to rapidly forecast and graphically display changes in traffic patterns caused by anything from converting to a one-way couplet in a downtown to changing a signalized left-turn from permitted to protected phasing. In particular, it allows effective evaluation of corridor management alternatives to minimize spending on increasing roadway capacities in a financially constrained environment.

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