Final report of ITS Center project: Northern Shenandoah human services

A Research Project Report

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Northern Shenandoah Public Mobility Project Evaluation

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ABSTRACT

Developing new intelligent transportation systems to meet unusual challenges in rural areas where ITS implementation is limited is difficult in part because there are few similar examples to use as guides . In such situations, it is critical to conduct a thorough analysis of user needs to provide a strong foundation for the development process. This paper describes the analysis conducted to support the user needs assessment for the Northern Shenandoah Public Mobility Project in Virginia. This project, which seeks to improve the coordination of human services transportation, is unique in low-density, rural regions. The report illustrates the importance of the use of geographic information systems (GIS) in supporting the necessary analyses.

INTRODUCTION

Rural areas face transportation challenges that are quite different from the challenges faced by urban areas, but they too are looking to advanced intelligent transportation systems (ITS) technology to help. As with any ITS implementation, success depends largely upon properly understanding the problem and what ITS solutions might alleviate that problem. In other words, long before an area decides to pursue an ITS solution, it should conduct a thorough investigation into the nature of the problem, conduct an analysis of the needs, and study a wide range of alternative solutions. The following paper describes in detail how a Geographic Information System (GIS) was used to analyze a rural transportation problem in the Northern Shenandoah Valley of Virginia.

The Northern Shenandoah Valley Public Mobility Project is an ongoing effort to create a coordinated human service transportation system for the Northern Shenandoah Valley region of Virginia using advanced intelligent transportation systems technology. A sampling of the coordination elements under investigation include:

- networked computer aided dispatching;
- ride-sharing for the clients of the participating human service agencies;
- van-sharing between the agencies for on-going or event specific transportation;
- flex-routing and demand responsive transportation to maximize existing human service transportation routes.

The Public Mobility Project is a unique ITS public transportation effort in that it focuses on transportation provided by human service agencies. The primary mission of these agencies is to provide a wide range of services to special needs clients, such as the elderly, disabled, etc. Therefore, transportation is not the primary objective of the agencies. However, they must invest substantial resources toward providing transportation services in order to accomplish their goals, and they recognize the need to improve efficiency. Furthermore, this project takes place in a region that can generally be characterized as rural, although not isolated. Socially and economically, it is tied to the Washington, D.C. metropolitan area, which is located some 35 miles to the east. With the exception of Frederick County, which includes the city of Winchester, none of the counties have populations greater than 50,000.

Northwestern Community Services and the Committee for Coordinated Human Service Transportation have led this effort. The Smart Travel Laboratory of the University of Virginia's Center for Transportation Studies has provided support by analyzing the operational feasibility of ITS alternatives. The purpose of this paper is to describe the geographic information systems analysis conducted by the University of Virginia. It is intended to provide guidance and information to those considering similar projects in the future. Please note that since this analysis was completed, the project has progressed and the agencies are currently in the process of developing a computer-assisted coordination support system.

GIS ANALYSIS BACKGROUND

The purpose of the GIS analysis and report was to make observations and recommendations based on an analysis of the routes and unmet needs provided by the human service agencies participating in the Northern Shenandoah Valley Public Mobility Project. The analysis attempted to answer, from an operational standpoint, the question: can coordinated transportation work and what kinds of coordination are feasible? The sections that follow contain observations drawn from the GIS analysis and a number of static maps generated from the project to illustrate those observations. It also contains an analysis of the various alternative products of the project.

GIS is an information technology that allows for the integrated analysis of spatial and attribute data. It has proven to be valuable in varied application areas, ranging from natural resources, to community planning, to construction site analysis. In this effort, UVA utilized one of the most widely used GIS packages on the market, ESRI's ArcView.

PROJECT COMPONENTS

The GIS project that UVA prepared in developing the report consisted of several different components. First is the existing route data for human service agencies. Tuesday was chosen as a representative day and each route was represented on a map as a series of connecting line segments. Attribute data was also collected for each route segment to store the number of empty seats on the vehicle. This data was visualized based on the following scheme: a dark blue line represented the largest number of empty seats and faded to light blue as those seats were filled. Line segments with no empty seats were colored red so that they would stand out. Each agency's routes were created as a separate layer so that they could be easily made visible or invisible on the map. Second, the unmet need (spatial region) for each agency was drawn as a set of polygons on their own map layer so that they too could be easily turned on and off. Third, a layer was created that displayed all the routes color-coded by client type. Finally, a three-mile buffer was created around all the routes to demonstrate areas of the region that no agencies have the potential to service with current routes/vehicles.

NATURE AND QUALITY OF THE DATA

Like any other analysis, this effort relied on the data that was used to support it. The data for this GIS analysis was obtained through several rounds of interviews and site visits with the participating agencies as well as mailed surveys. There was quite a bit of information available about routes that run on a more or less regular basis. Most agencies provided data for what they felt was a typical day for their vehicles. Not surprisingly, there was very little information available on demand responsive service because there was simply very little demand response service provided. Finally, the data on unmet need was general in nature but fit well into the context of the project.

The heart of the GIS project was the representation of the regular routes that the agencies run. Tuesday was chosen as a representative day and the routes were grouped into those that occur in the morning and those that occur in the afternoon. The morning and afternoon classification was quite sufficient for the purpose of identifying trends and making observations on the possibility of coordinated transportation.

GIS ANALYSIS RESULTS

The GIS analysis revealed a number of features of interest in the context of cooperative transportation efforts.

- *A significant portion of the region is accessed by the existing routes (Table 1 and Figure 1).*

This can be seen with the map buffering all the routes. The highlighted blue region spans three miles on either side of all the routes. This three mile buffer covers 65% of the total area of the planning district. If a two mile buffer is used, 53% of the planning district is covered and 34% is covered by a one mile buffer.

Table 1: Portions of total planning district land area covered by route buffers.

Total area of the Lord Fairfax Planning District: 1650 square miles.			
	Area	Percent of Total	
3 mile buffer	1070	65	
2 mile buffer	870	53	
1 mile buffer	570	34	

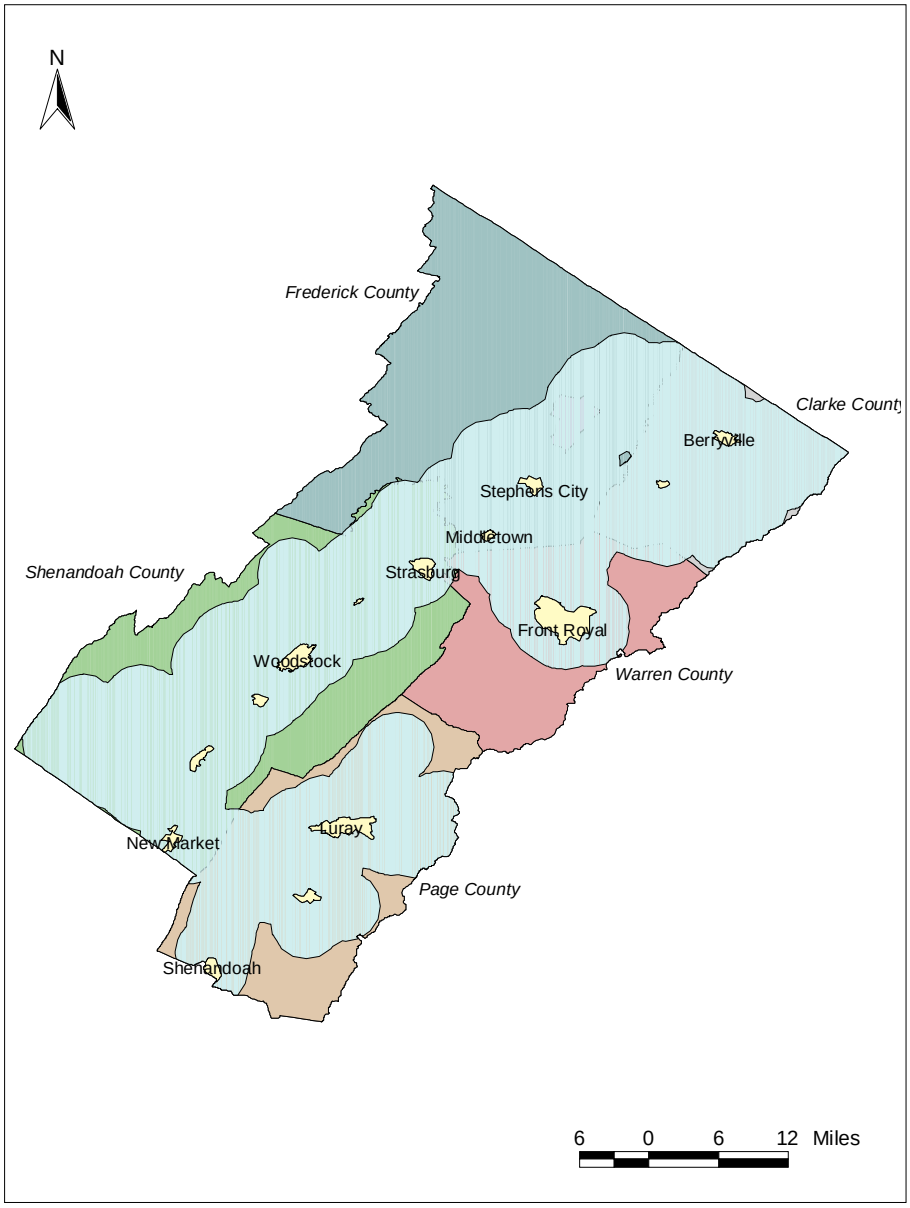

Figure 1. Three mile buffer around all the routes.

- *One way to look at the routes is to see them as connecting small towns (Figure 2).*

For instance, Northwest Community Services runs a good Winchester – Front Royal connector and Northwest Workshop runs a Winchester – Berryville connector. In fact, many towns in the planning district are connected to their neighbors in this way. This way of looking at the routes illustrates one potential method for coordinating service.

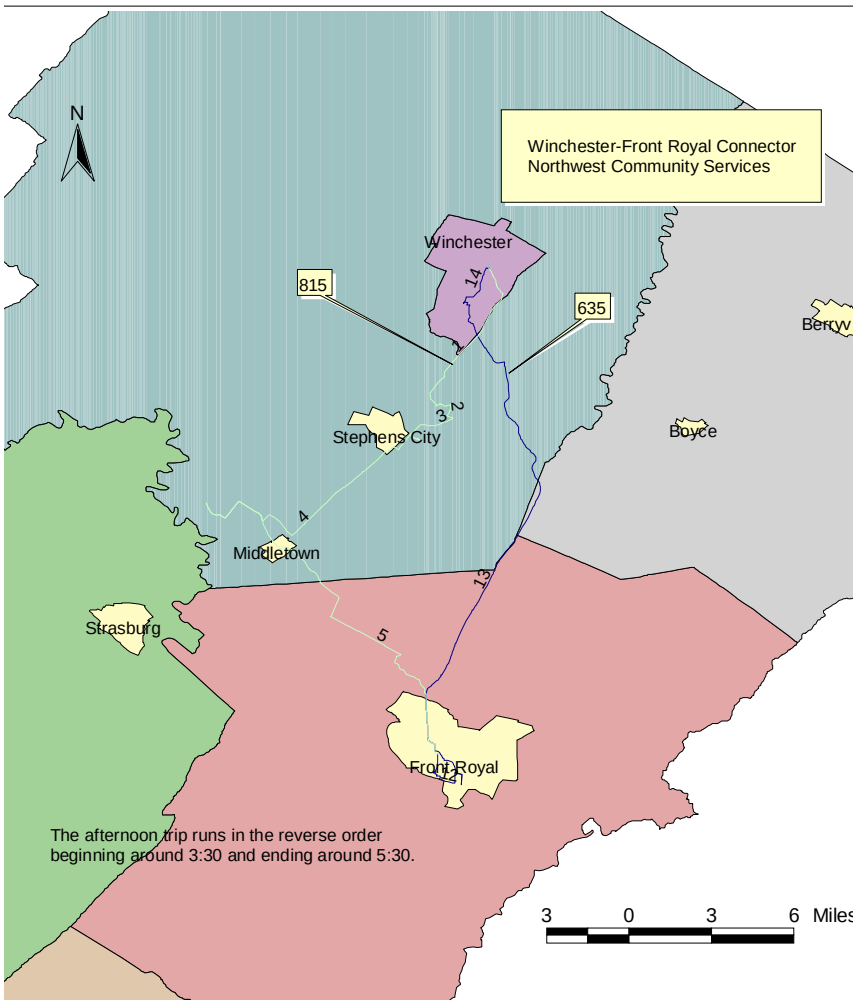

Figure 2. Route/Town Connectivity

- *Shenandoah Agency on Aging and Northwest Community Services are the two largest agencies (Figure 3).*

These are the agencies that could play the most important role in a cooperative system because they cover the most ground. The Shenandoah Area Agency on Aging has 66% of the total route segments and Northwest Community Services has 14%.

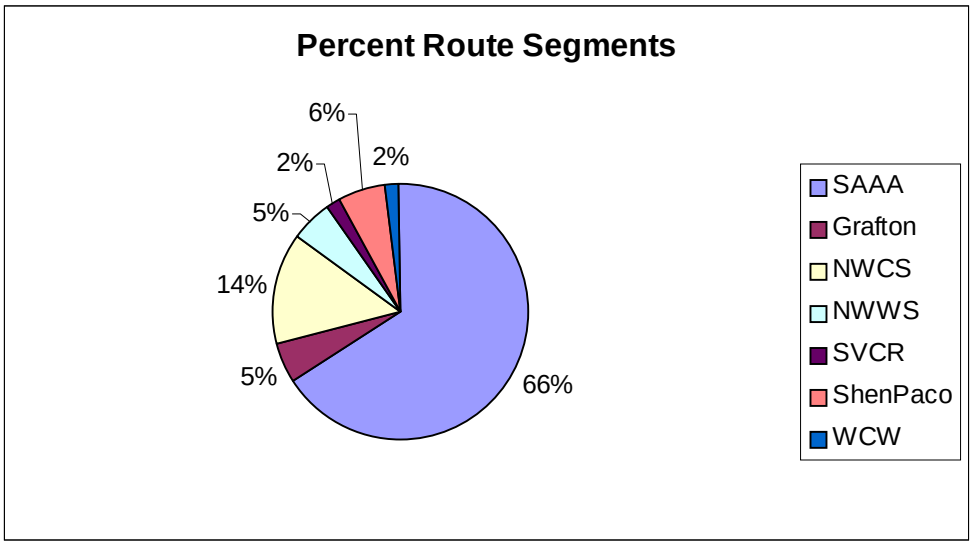

Figure 3. Agency Shares of Route Segments

- *There are many empty seats on the majority of the routes (Figure 4).*

A graduated color scale was used to highlight where each agency has empty seats on their routes. On the typical Tuesday morning, only 12 of 262 route segments are filled (5%). Northwest Community Services, Shenandoah Area Agency on Aging, Shen-Paco Industries, and Northwest Workshop all stop at individual residences or group homes and pick up one or two people at a time to take to some destination. Their vehicles are then full only from the last stop to the destination – they have empty seats available on every other route segment. Grafton, Warren County Workshop, and Shenandoah Valley Community Residence transport all of their clients from a single pick up point to another destination, but do not always fill up their vehicles. These are the empty seats that could be filled by another client in a rideshare situation.

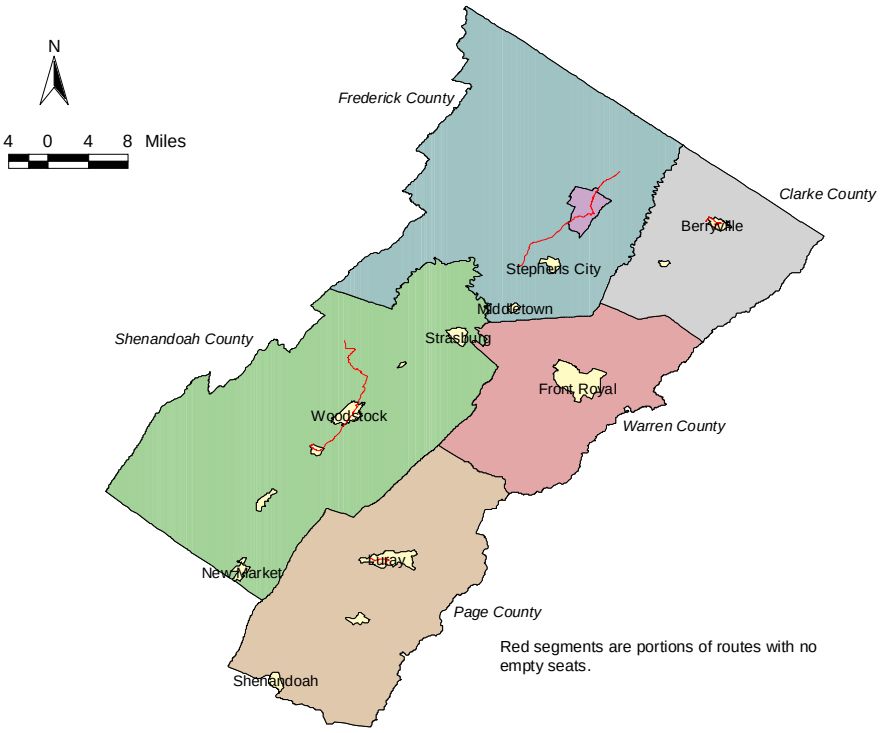

Figure 4. Empty Seats

ANALYSIS OF ALTERNATIVES

Each of the alternative system approaches described in the introduction section will be addressed below. In the broadest possible terms, the data suggests that the availability of empty seats is not a problem. Making it easy to find those empty seats would need to be part of the job of a system that facilitates cooperative transportation efforts. Secondly, if no new routes are created, there will still be areas of need that cannot be reached.

- *Van Sharing*

Van sharing has been a very unpopular idea thus far among the participating agencies. However, the morning and afternoon schedule does indicate that there is likely significant vehicle down time. From conversations with all of the agencies, it seems that there is seldom a driver available during that vehicle down time, though. Some agencies only hire drivers part time (Northwest Community Services). Other agencies have other responsibilities for their drivers during vehicle idle time. For instance, Shen-Paco and Warren County Workshop drivers are also work supervisors, Grafton drivers help in the school, and Shenandoah Area Agency on Aging uses their drivers during midday down time to deliver meals to home bound seniors. Vehicles also seem to be available during the evening and weekend hours, though many are used for sporadic outings and chores.

- *Ride Sharing (Route Optimization)*

Ride sharing might be considered "route optimization" which could either be approached at a system wide level or on a smaller scale to meet specific objectives. In either case, agencies would cooperate on some of their regular route service by giving rides to clients from another agency while that other agency gives rides to some of their clients. Goals might be to reduce total route time and distance while giving more people an opportunity to participate in programs. Looking at the ArcView project, there is considerable overlap in where routes are run. It remains a question whether there is sufficient overlap in times and direction for a large-scale optimization effort to be effective. However, a major optimization of routes would change dramatically the way that agencies handle their transportation and would likely be unpopular for that reason. On a small scale, agencies could look for specific situations in which they could cooperate in order to reach previously unmet need. For example, Figures 5 shows how Northwest Community Services pass through areas of need identified by the Frederick Department of Social Services. In fact, 67% of the areas of unmet need fall within three miles of an existing route, indicating that at some level route optimization could be quite effective.

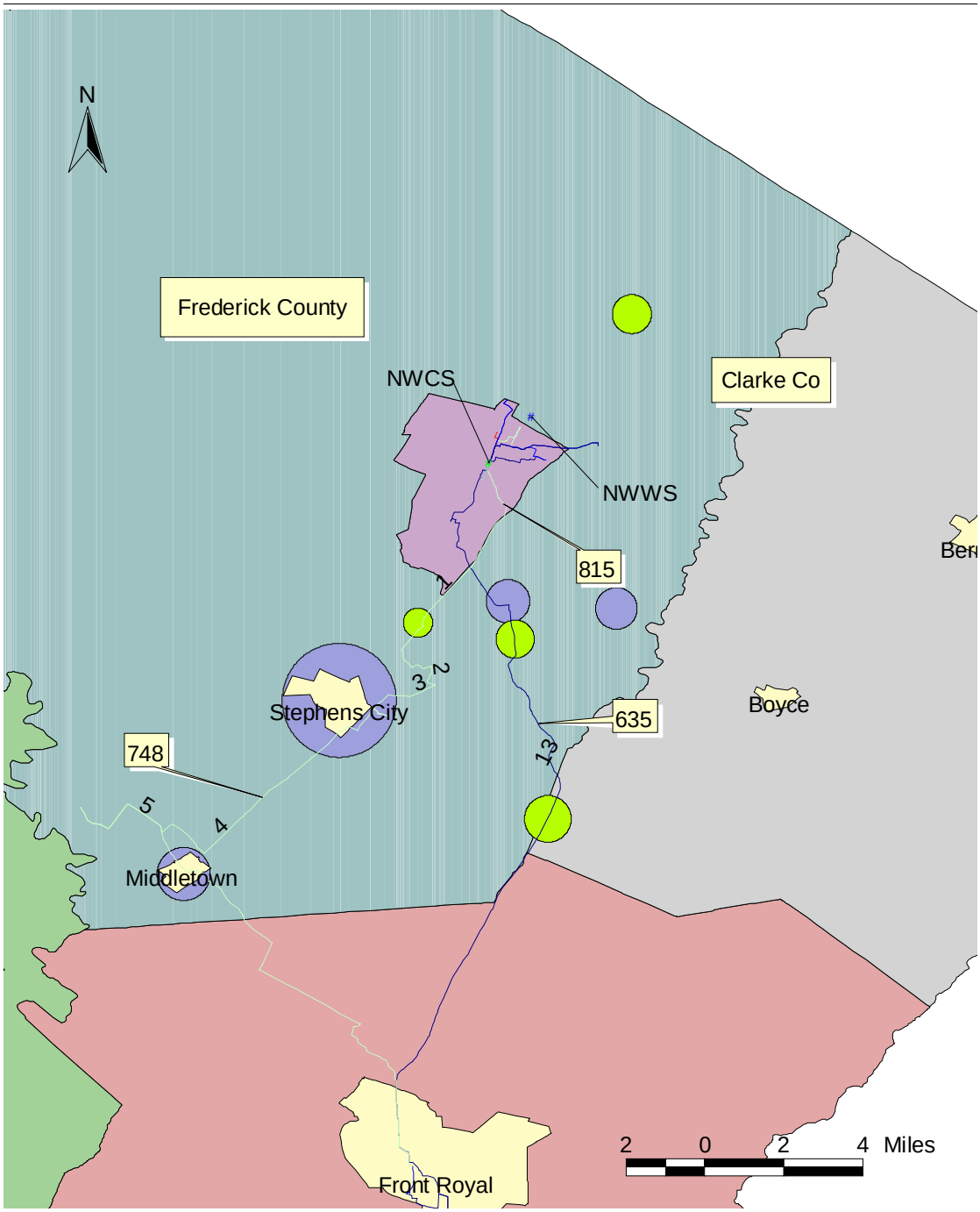

Figure 5. Unmet need of the Frederick Department of Social Services and the routes of Northwest Community Services.

- *Flex Routing and Demand Responsive Transportation*

Flex routing and demand responsive transportation are perhaps the most feasible of the above ideas. The fact that so much of the planning district is covered by the routes is certainly

encouraging, even if the times that vehicles travel each route are limited. Given the degree of variability inherent to many of the routes, a demand responsive system would likely work best for clients who have some flexibility in their trips. This specifically indicates that people who need transportation to and from a job on a regular basis may have difficulty with the options available, whereas those who need a ride periodically to a medical appointment or shopping center might have more success. Agencies could provide morning trips out with a return in the afternoon. These routes could be viewed as connecting towns with departure and arrival times in each town. Note, however, that the nature of many of the routes is to stay within a fairly limited area. Though a demand response client may be able to go between a few towns within their county, they may not be able to go to the far side of the planning district. It would probably not be practical to attempt to arrange transfer trips.

- *Computer Aided Dispatching*

Finally, the dispatching issue is essentially a question of communication. Though it is not geographic in nature, some information on current dispatching procedures did come up in the course of gathering route data. Almost all the agencies accomplish their dispatching through informal means. Those with regular routes only have to keep track of daily variability, which is often best accomplished by having the driver or someone close to the driver in the organization handle minor route changes. For example, Shenandoah Area Agency on Aging has each of the six senior centers do their own dispatching. Shen-Paco's dispatching is very informal and changes are made by calling an administrator in the office. By a conservative count, perhaps 18 dispatch locations are involved.

Whatever the product of this effort is, it is sure to rely heavily on clear communication so the effective use of communication tools will play an important role. Given the relatively small number of participating agencies and the relative scarcity of resources (time and money), the product should be kept fairly simple. However, there is a significant amount of complexity to the issues at hand. An effective way to tackle that complexity would be to develop a system that allows dispatchers to quickly view some generalized options and then contact the other dispatchers in question. In other words, the system would provide general information then get the right people talking to each other in order to work out all the necessary details. This approach would deal effectively with daily variability and other tricky factors such as client compatibility by letting the people involved make those decisions based on a first hand knowledge of the factors involved. The decentralized nature of dispatching would be one of the challenges to overcome in such a system.

CONCLUSION

As described in this paper, experience in the Northern Shenandoah Mobility Project indicates that GIS is an effective tool to use in identifying the need for, and requirements for, ITS solutions for public transportation challenges in rural regions. It is recommended that a rigorous needs assessment, using tools such as GIS, be conducted to support the development of unique ITS systems.