4.3 TOWARD DECISION SUPPORT TOOLS IN THE SHENANDOAH VALLEY

JIM GIRAYTYS, CERTIFIED CONSULTING METEOROLOGIST, WINCHESTER, VIRGINIA*
J. STEPHEN BAUSERMAN, WINCHESTER CITY COUNCIL, WINCHESTER, VIRGINIA

1.0 Introduction

The Shenandoah Valley is in the midst of dramatic change due to development. Many communities have population growths in the 3-4% per year range, with some higher. The road and highway system is facing major construction beginning with a widening of I-81 from four to possibly ten lanes. Circumferential bypasses have been built and are planned for major cities along the route. Major commercial development is occurring at each of the interchanges. Air quality has been rated by the Environmental Protection Agency in parts of the Valley to be in the lowest 20% for all counties in the US. The comprehensive plans for local jurisdictions appear inadequate to deal with the changes.

Decision support tools are needed that will meld the transportation and planning information with environmental and demographic information. This will give the local decision makers the ability to project "what if" to determine future impacts on such things as air quality, traffic patterns, land use, and taxes. At present, there is no readily available decision tool that can meld that information and project into the future for local policy makers. This paper describes an effort in the Shenandoah Valley to develop such supporting tools beginning with observations and meteorological models through to the incorporation of GIS-based information on demographics, transportation and land use patterns. The ultimate goal is to put science to work effectively for decision makers.

2.0 GEOGRAPHY AND CLIMATOLOGY

Geography makes the Shenandoah Valley (Valley) unique. The Shenandoah River flows South-North between the Blue Ridge Mountains to the East and the start of the Appalachian range to the West. (Figure 1) The northern part of the Valley lies about 80 miles to the West of the greater Washington, DC area. The Shenandoah flows into the Potomac at Harpers Ferry; made famous during the Civil War. It is one of the major river systems in the Chesapeake Bay watershed.

* Corresponding author: 301 Longview Lane, Winchester, VA 22602 <Giraytys@shentel.net>

Prevailing winds are from the south and west. Summer air quality conditions can be poor to dangerous due to the combination of the roughly north-south orientation of the mountains and the southwest prevailing wind direction. The pollutants from the Valley are trapped under the summer inversion and are not “flushed” out.

Figure 1: Shenandoah Valley, Virginia. Counties are labeled. The North and South Forks are shown converging at Front Royal in the north to form the Main Stem. Distance shown is about 110 miles along the Valley.

3.0 Sources of Air Quality Problems

The region is one of the fastest growing on the Atlantic Seaboard. Many communities have experienced a population growth of 3-4% per year for the last two decades. Frederick County has on the order of 10,000 home sites that have been zoned and available for construction.

The Valley geography and the climatology combine to make air quality a major problem. During the summer when high pressure dominates the area, pollutants are concentrated in the Valley below the inversion. According to the Environmental Protection Agency (EPA) statistics for 2000, the Winchester/Frederick County area was listed in the lowest 20% of all counties in the US for air quality. With the latest EPA 8-hour emission standards for ozone, four of the five ozone monitoring stations in the Valley

are in non-compliance. The ozone "season" runs from April to October.

Virginia Department of Environmental Quality (VDEQ) information (figure 2) shows that mobile sources (vehicles of all sorts) contribute some 78% of the Nitrogen Oxide (NOx) gases and 27% of the volatile organic compounds that contribute to ozone production. VDEQ also estimates that about 30% of the pollutants are transported into the area from the west. That includes emissions from coal fired power plants in West Virginia and points west. Seventy percent of the problem, however, is homegrown in the Valley.

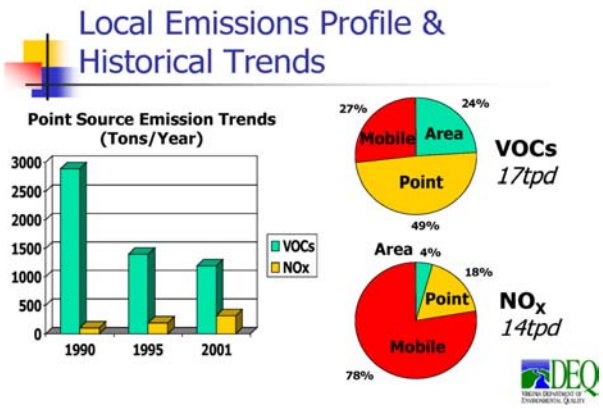

Figure 2: Emission profiles and historical trends for Frederick County, Virginia. Courtesy Virginia Department of Environmental Quality. VOCs are the larger decreasing values in the bar chart.

In the decade of the 1990s, industry in the northern Shenandoah Valley reduced emissions by 2/3rds while emissions from mobile sources increased by three times. The industrial emissions are still significant, but the source that must be dealt with is vehicles.

Interstate 81 runs the length of the valley. I-81 is carrying 280% of design capacity for trucks and 64% of capacity for other vehicles. The volume for vehicles, especially trucks, is projected by the Virginia Department of Transport (VDOT) to double by 2012, and by one international construction company to triple by 2021. I-81 has become the east coast highway of choice for moving freight north and south. Trucks on I-81 are of primary concern for air quality.

Federal standards for new truck engines are projected to reduce emission by 50% when the fleet has been retrofitted. Low sulfur fuels will further reduce emissions. Estimates vary on the lifetimes of current engines from 5-20 years. In addition, I-81 has been designated as a North American Free Trading Act (NAFTA) highway that will allow foreign trucks to use it without meeting the EPA standards for clean truck engines. At best, the improvements in truck engine emissions will balance the expected increase in volume of trucks using I-81 by 2012. By 2021, the emissions will be twice that of today.

While I-81 is the "900 pound gorilla" in terms of transportation impact on air quality, the local development is a major contributor. Land use planning assumes that each new residence produces from 6-10 vehicle trips per day. That projects to some 60,000 to 100,000 new vehicle trips per day from the 10,000 or so houses on the books to be build in Frederick County alone. Frederick County is not unique in the Valley.

4.0 Localities Take Action

Since the data from the ozone monitoring gauge for Winchester/Frederick County does not meet the EPA standards, some local action was required by the Clean Air Act to bring the readings back into compliance. One choice was to let EPA specify the actions required. The alternative was to enter into an Early Action Compact (EAC) with EPA and VDEQ. The EAC is intended to develop a localized Early Action Plan to return to compliance with the EPA 8-hour standard for ozone. Winchester /Frederick County chose to sign the Early Action Compact.

The two governments are currently developing a joint plan to comply with EPA ozone emission standards. The governments have assigned to their joint Economic Development Commission, working with the Northern Shenandoah Valley Regional Commission, and other stakeholders, the task of developing a voluntary program that will be submitted to EPA for approval in early 2004. The work has been organized through an Air Improvement Task Force. (Both authors are members of the Task Force.)

The EAC requires the plan to be approved by the two jurisdictions by the end of 2004 and to take effect on January 1, 2005. Compliance must be reached by December 31. 2007. Compliance means that the average of the fourth highest reading each year over those three years must be below the standard of 85 parts per billion of ozone. In addition, the plan must provide for remaining in compliance until at least 2012. That means the plan must not only deal with the current situation, but must project changes out for at least the better part of a decade.

5.0 EMERGING ISSUES

A number of issues are emerging as the Task Force grapples with developing the plan. These are generally in three groups:

- Strategies available for implementation in 2-3 years,
- Verification, and
- Long Term Compliance.

Available Strategies

The Virginia constitution severely limits the ability of local jurisdictions to take action that has not been agreed at the state level. The "Dillon" rule excludes most of the local regulatory actions on industry, development, and commerce that have a potential for significant reductions in either or both VOCs and NOx. Voluntary strategies, of course, are always possible.

Verification

Verification means the ability to determine not only that the actions in general have been effective, but that specific actions have been effective. If business, local governments and the citizens are asked to make changes in their activities, there has to be some way to show that their specific changes are worth the effort.

At the moment, it is not possible to verify the effectiveness of particular strategies. Even in the aggregate, verification is difficult at best as there is only one ozone gauge in the five or six county area around Winchester. That gauge was established by EPA some 20 years ago in a relatively rural area to the north of the greater Winchester area so that it was downwind of the then major sources of pollution. That ozone gauge is now located in the midst of intensive industrial development. The readings no longer represent the general conditions throughout the region. Strategies that might be adopted to improve the general air quality cannot be verified one way or another based on that one gauge.

Long Term Compliance

Long term compliance means that there has to be some way to make informed decisions on how the economy of the Valley develops over periods of a decade or more. Those decisions have to be regional in nature because the primary source for ozone producing emissions, vehicles, is regional. As just one example, major east-west road connectors to Washington, DC converge on the Winchester/Frederick County area and I-81. These include Interstate 66 and routes 50 and 7. Because of the major road system, this area has been targeted as a desirable location for major warehouse and redistribution centers. In turn, that increases the volume of trucks in the area.

6.0 DECISION SUPPORT TOOLS LACKING

A systematic valley-wide approach to managing the air quality is not now possible. The data from the monitoring gauges are useful only to indicate that there is a severe problem. The existing gauges are too few and do not represent the highly varying situations in specific localities.

Valley-specific forecast models of the atmosphere and the air pollution sources provide only gross estimates. Further, air quality models, economic models, and land use models cannot now be integrated to give the planners and policy makers a comprehensive tool to understand the potential impact of their decisions. Decision support tools are essential if long-term strategies are to be developed that avoid air pollution crises and the imposition of unforeseen and possibly unnecessary future economic burdens and restrictions.

Discussions with VDEQ indicate a lack of funding and manpower to undertake such a broadly based, long-term effort that will (1) improve the data availability; (2) develop the integrated models that link air quality to economic development decisions; and (3) provide the jurisdictions with effective decision support tools. It will do little good to establish a network of air monitors and systematically collect data if those data cannot be analyzed in a timely and meaningful manner. Information collected from a wide range of sources must be integrated to provide a clear picture of the impact air quality has on the economic development of the valley.

Performing analysis with software calibrated to the valley would allow us to fully understand what does and does not cause or influence air pollution in our area. Analyses results would show how much control local communities may, or may not, have over pollution sources, as well as the projected impact government actions might have on pollution. Most importantly, we would have the capability to integrate all of the information relating to air quality and economic development to understand how to craft long range plans that had a regional focus versus that of a single local government.

One of the most effective ways to review monitoring data, perform analyses, and model different scenarios through computer simulations would be to develop collaborative partnerships

with the various colleges and universities situated in or near the valley, as well as with governmental organizations, private companies and citizen groups. To develop the needed capabilities, strategic investments would be required on the part of the Commonwealth, I-81 Corridor States, and the Federal Government.

7.0 SHENANDOAH VALLEY AIR QUALITY PROGRAM

A Shenandoah Valley Air Quality Program (SHENAIR) is being proposed. The goals for SHENAIR are to:

- Improve regional air quality,
- Provide a scientific basis for decision makers,
- Entrain stakeholders in a regional effort,
- Provide the observational data, and models needed to integrate science with economics, and
- Develop a virtual laboratory of collaborating educational institutions (collaboratory) for developing integrated recommendations on science, economics and policy.

The SHENAIR foci shown in figure 3 are to provide a base of knowledge, develop the policy and decision support tools, and outreach. This latter includes educating professionals who can make the decision support systems work for the decision makers.

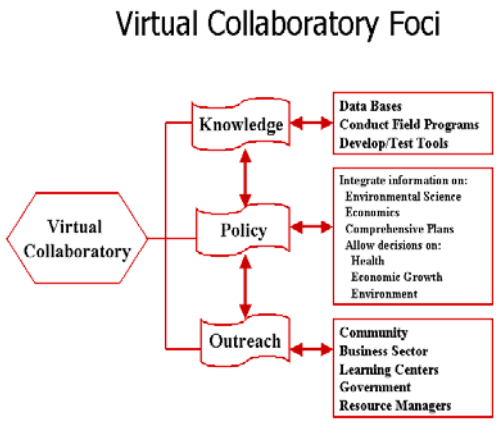

Figure 3: Foci for SHENAIR and the Virtual Collaboratory.

The bottom line is that unless we have a good knowledge of the atmosphere and sources of pollutants, and can couple that knowledge with societal impacts, economics, comprehensive planning, and engineering skills, we will not be able to manage our impact on the environment, development or health.

8.0 SHENAIR STRATEGY

The first part of the strategy is to obtain stakeholder "think-in". "Buy-in" is the classic first step. Before people can commit to, or buy into a program, however, they have to understand what it is and how it fits with their issues. That is the "think-in" stage.

A supporting infrastructure must be built. That infrastructure has to provide the scientific, political and demographic understanding of the issues. In turn, knowledge bases have to be located and compiled where they exist and generated where they do not. A well-organized Geographical Information System (GIS) users group exists, as do a wide range of GIS-related data bases. Education and training programs need to be established and/or expanded. Much of the intellectual infrastructure exists in the Valley with universities, community colleges and strong environmental groups.

In some instances, physical facilities need to be constructed. A good environmental observing and monitoring network is one that is lacking and needs to be built. An optical backbone communications network exists in the Valley as do several T3 lines to support high speed internet access. These need to be linked to the observing and monitoring systems. Important elements of the needed SHENAIR infrastructure are there. Significant gaps need to be filled and a functioning system built.

SHENAIR will be based on a virtual collaboratory. The virtual collaboratory would integrate the capabilities of the universities, colleges, environmental groups, private sector, and governmental (local, state and federal) facilities to address well defined goals and objectives. Each of the stakeholders would have both an input into defining those goals and objectives, and a vested interest in making SHENAIR work. The capabilities of the internet, distance learning, and shared data bases across the Valley would meld those stakeholders into the virtual collaboratory. The concept of how SHENAIR and the virtual collaboratory would develop the decision support tools is shown in figure 4.

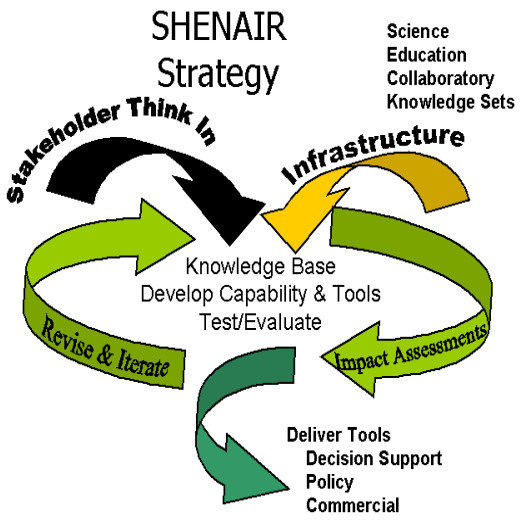

Figure 4: SHENAIR process for developing, testing and delivering decision support tools for both public and private sectors.

9.0 BASE EXISTS FOR SHENAIR

SHENAIR will require the integration of science, engineering and policy studies. While such integration is a relatively new concept, some of the institutions in the Valley already have major elements in place. James Madison University (Harrisonburg, VA), for example, has an undergraduate college of Integrated Science and Applied Technology where those concepts are brought together. The Virginia Military Institute (Lexington, VA) has for many years sponsored week long environmental programs that bring people from a range of scientific disciplines in contact with policy makers. Shenandoah University (SU) School of Journalism (Winchester, VA) is a very strong supporter of GIS. SU also hosts the Marsh Institute, a public policy forum. Lord Fairfax Community College (near Winchester) has won recognition and awards in the state as a leader in data base integration and visualization tools.

Environmental groups like the Caanan Valley Institute sponsor major programs in the Valley. Industry supports the Pure Water Forum 2000 that brings all stakeholders together to deal with water issues. The Northern Shenandoah Valley Regional Commission addresses a wide range of scientific, engineering and policy issues. Just one of the many active citizen groups, Friends of the Shenandoah, have some 100 people who take water quality samples every two weeks on the Shenandoah river. Their data is of the highest standard and accepted by VDEQ and others. Those we have mentioned above are primarily in the northern half of the Valley. Important capabilities like these exist throughout the southern part of the Valley as well.

10.0 MAKING SHENAIR A REALITY

Mass et al (2003) describe a regional modeling and prediction capability for the Pacific Northwest. In creating the Northwest Modeling Consortium, Mass and his associates started with regional user needs to develop the specific products that would be provided.

We start at the same place, user needs, develop the scientific capability to deliver products for real time use and strategic planning, then put heavy emphasis on integrating the scientific information with policy decisions to create decision support tools. In a real sense SHENAIR aspirations are a close relative to what Mass and associates are doing in the Pacific Northwest.

The first steps at making SHENAIR a reality are aimed at stakeholder "think-in" for five groupings: (1) local government, (2) educational institutions, (3) business, (4) environmental institutes and (5) citizen organizations. As of finalizing this paper (November 2003) the authors have begun the process of involving the local and state governments. These include Boards of Supervisors, City Councils, regional commissions, and state officers. Discussions with the other three groups are being scheduled.

The "buy-in" phase will begin in early 2004. The objective is to have sufficient funding to complete the design and organizational structure by the end of 2004. That will give the virtual institute shape so that funding can be sought for the implementation of the "hard" infrastructure in late 2004 and 2005.

SHENAIR will be able to build on the broadly based and well-formed foundation of capable people and organizations throughout the Valley. The bottom line, however, will be the ability to deliver effective decision support tools, and most importantly, the trained professionals who can make those tools work for the decision makers.

REFERENCE

Mass, C. F., M. Albright, D. Ovens, R. Steed, M. MacIver, E. Grimit, T. Eckel, B. Lamb, J. Vaughan, K. Westrick, P. Storck, B. Colman, C. Hill, N. Maykut, M. Gilroy. S. A. Ferguson, J. Yetter, J. M. Sierchio, C. Bowman, R. Stender, R. Wilson and W. Brown, 2003: Regional Environmental Prediction over the Pacific Northwest. *Bull. Amer. Meteor. Soc.*, **84**, 1353-1366.