DELAWARE VALLEY
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REGIONAL
PLANNING COMMISSION

Transportation Operations Master Plan

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Our logo is adapted from the official DVRPC seal, and is designed as a stylized image of the Delaware Valley. The outer ring symbolizes the region as a whole, while the diagonal bar signifies the Delaware River. The two adjoining crescents represent the Commonwealth of Pennsylvania and the State of New Jersey.

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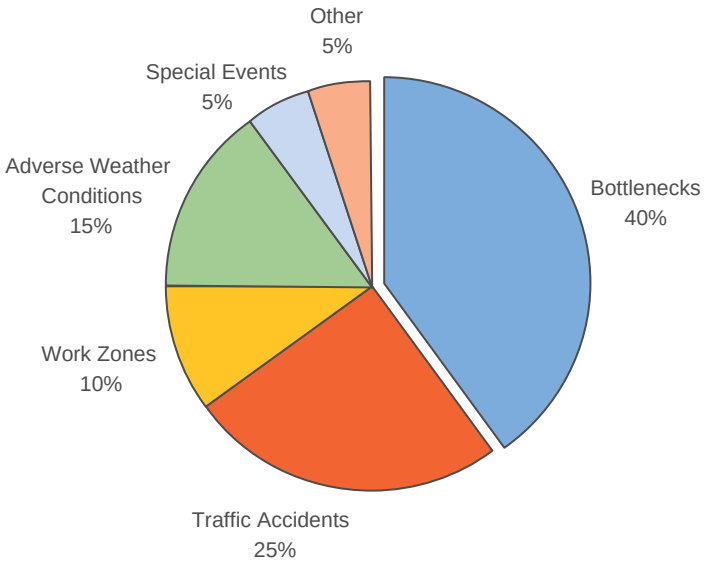
CHAPTER 1

Transportation Operations Master Plan Overview

What is Transportation Operations?

Approximately 60 percent of the traffic congestion in major urban areas (**Figure 1**), like the Philadelphia metropolitan area, is due to temporary or non-recurring conditions, such as disabled vehicles, traffic crashes, maintenance and construction activity, or adverse weather conditions. Traditional transportation improvement strategies, such as increasing highway capacity or providing alternative transportation options, are not applicable in these situations. Transportation operation strategies are targeted to mitigating non-recurring congestion. The purpose of the Transportation Operations Master Plan is to present a comprehensive long-term vision of transportation operations in the region, bridging individual agency programs to create a cohesive vision.

Figure 1: Sources of Traffic Congestion (FHWA)



Transportation operations is the application of a combination of technology, robust planning, improved preparedness, and extensive interagency and intra-agency coordination.

- **Technology** Technology is the backbone of transportation operations. It utilizes advanced technologies: computers, communications, electronics, and control systems to improve the efficiency and safety of the surface transportation system. Real-time surveillance systems monitor transportation facilities identifying unusual conditions that need immediate action, whether it is a bus running behind schedule or a crash on the Schuylkill Expressway. Technology enables transportation operations centers to impart accurate up-to-date travel information to the public, or to adjust traffic signal timings to handle a surge of traffic from a closed expressway. It enables first responders to overcome interoperability communication issues among themselves and with transportation personnel. Deploying technology also saves agencies money by automating functions like highway toll and transit fare collection.

- **Planning** When an incident temporarily closes a highway or disrupts transit service, it is already too late to plan a response. Detour routes, traffic control points, signing, and potential response resources should be identified in advance. Agency and personnel roles and responsibilities also have to be pre-defined.

- **Preparedness** This involves conducting training courses and table top exercises so that personnel can be fully prepared to respond to a highway or transit incident. It also involves pre-deploying traffic management equipment so that portable VMS or accident investigation equipment for emergency responders will arrive in a timely manner, and not have to be transported across the region. Emergency service patrols offer immediate on-scene resources to mitigate minor incidents and provide traffic support in larger ones.

- **Coordination** Operationally, the region is very fragmented, with three departments of transportation, three state police departments, multiple toll authorities and transit agencies, and hundreds of local police and fire departments. Institutional coordination, whether at the scene of an incident, between transportation operations centers, or across jurisdictions or modes, is a major undertaking. Incident command structures must be established, and situational information disseminated. On-going coordination is required to make sure everything runs smoothly, and to correct problems that periodically occur.

Benefits of transportation operations programs have been widely documented. For example, deploying emergency service patrols on expressways has reduced average duration of incidents by 33-60 percent, resulting in fewer secondary accidents and saving millions of gallons of fuel. Improving traffic signal timings by synchronization reduces travel times and delays by 5-20 percent, translating into a 10-25 percent reduction in fuel consumption. Using Automatic Vehicle Location (AVL) systems on buses has improved on-time bus performance by 12-23 percent, reducing passenger waits at bus stops.

Transportation operations has unique funding and implementation requirements. While Intelligent Transportation Systems (ITS) projects are like other major transportation capital investments, in that they can be funded through the region's Transportation Improvement Program (TIP); they are unlike highway projects in that there is substantial maintenance and operations costs associated with them. Hardware, software, and communication devices have to be continually maintained and updated to remain consistent with the latest IT technology standards. Ultimately, operations and maintenance (O&M) costs can exceed the initial capital investment.

Many transportation operations initiatives are programmatic, for example funding service contracts, vehicles and equipment, and training programs. In many instances, non-traditional transportation stakeholders like police or fire departments will be the primary beneficiary of these program. How to fund these types of programs, whether to use federal transportation monies, state funds, toll monies, or even Department of Homeland Security funding, is unclear. As transportation agencies evolve from a design-build culture to an operations culture, decisions on how to fund, operate, and maintain these types of programs need to be resolved.

Transportation Operations Master Plan Planning Process

The *Transportation Operations Master Plan* is a component of DVRPC's adopted 2035 long-range plan ***Connections: The Regional Plan for a Sustainable Future***. It was developed in cooperation with DVRPC's Transportation Operations Task Force (TOTF), which is composed of traffic, transit, and emergency management operators in the region. It is based on a number of previous planning efforts including:

- DVRPC's ITS Master Plan for the Delaware Valley: ITS Vision and Initiatives of Regional Significance, February 2006
- PennDOT's Regional Operations Plan (ROP) for PennDOT District 6-0 Region, July 2007
- NJDOT's ITS Investment Strategy: 10-Year Program, FY 07-16, March 2007
- DVRPC's ITS Regional Architecture – Version 1.0, March 2001
- DVRPC's ITS Regional Architecture – Version 2.0, 2009 (anticipated)

The **ITS Master Plan** was the first major effort that formulated a regional policy among transportation operations personnel; however, it was primarily focused on ITS technology. This Plan takes a broader view, placing greater emphasis on planning and coordination, as well as emerging ITS technologies. The **ITS Master Plan** unsuccessfully attempted to define a capital program for ITS, whereas this plan contains a 26 year financial plan for investing federal monies in transportation operations.

Four major components comprise this Plan. **Operations Goals and Objectives** outlines the major transportation operations themes for the region. **Transportation Operations Vision** establishes location and deployment level for ITS and other operations programs. **Projects and Programs** presents specific capital projects and ongoing programs. The **Financial Plan** summaries the financial investment required to implement, maintain, and operate the programs identified in the Plan.

Transportation Operations Survey

As part of the Transportation Operations Plan planning process, a survey was conducted to ascertain regional transportation priorities and to determine how effective existing programs are. Survey results were used in developing the Plan's goals and objectives, and its projects and programs. Approximately 150 responses were received from county planners, transportation operations center staff, county 9-1-1 center personnel, state police officers, local emergency responders, and others. Since members of all the region's incident management task forces were surveyed, emergency response personnel represent the largest number of the respondents. Thus, to some extent the results may emphasize their priorities.

The most significant needs identified by the survey are summarized on the next page. For each category, the needs are listed in descending order of importance. Full survey results are included in Plan Appendix A.

Most important incident management needs in the region:

- Improve interagency radio communications interoperability at scene of incident
- Enact quick clearance laws, move-over policies, and/or implement public marketing of the laws/policies
- Provide responder safety equipment (vests, cones, arrowboards, etc.)
- Provide responder safety training

Most important transportation operations planning needs in the region:

- Coordinate construction activities between agencies to avoid conflicts
- Improve traffic signal operations and management (upgrades, periodic retiming, advanced control systems, etc.)
- Manage work zones through Work Zone Management (detour routes, incident management coordination, traveler information dissemination, etc.)

Most important traveler information needs in the region:

- Deploy variable message signs
- Provide construction and maintenance alerts

Most important ITS infrastructure needs in the region:

- Expand coverage of CCTV cameras on expressways
- Construct traffic signal systems to interconnect traffic signals
- Upgrade and retime existing traffic signals
- Install CCTV and VMS devices on key arterial highways and detour routes
- Extend fiber connections from DOT's to counties, municipalities, and first responders to carry CCTV images and other traffic/incident information

Most important operations information sharing needs in the region:

- Share evacuation information
- Share video images of highways and incidents to emergency responders
- Enhance construction activity coordination

CHAPTER 2

Operations Goals and Objectives

This chapter presents the regional Transportation Operations Master Plan's goals and objectives, and the underlying strategies that support them. There are four major operational goals pertaining to incident management, traffic management, transit operations, and traveler information. Within these goals, several cross-cutting basic themes emerged. Specifically, the need to obtain real-time accurate information, the ability to share information among agencies and with the public, and the availability of appropriate resources to respond to situations.

Reduce Traffic Congestion Through Improved Incident Management

Twenty-five percent of traffic congestion in large urban areas is due to traffic incidents ranging from flat tires to overturned tractor-trailers. These unforeseen events cause havoc, making commuters late, affecting truck deliveries, and ultimately making the region less competitive economically. Hazmat spills or crashes involving fatalities can turn what might have been a minor incident into a long-term road closure lasting hours. Primary incidents can cause secondary accidents, where drivers may slam into the rear of an unanticipated queue; the secondary crash can occasionally be worse than the original incident. More effective incident management will increase survival rates for crash victims and emergency responders.

Incident management is a multi-step process involving incident detection and verification, emergency responder response, management of on-site emergency personnel, traffic management, clearance of vehicles and debris, and recovery to normal traffic flow. It involves diverse technical skills and an assortment of different organizational entities. Incident management programs have to be sensitive to all phases of incident management and the institutional relationships, many of which are outside the purview of the traditional transportation planning and funding processes.

Table 1 summarizes incident management objectives and strategies. More narrative descriptions are given below.

Improve Incident Detection and Verification

It is critical to identify incidents as rapidly as possible. The faster emergency responders are notified, the sooner they can react and save lives. Timely detection will also aid first responders to avoid ensuing traffic delays. The quicker incident information is posted on Variable Message Signs (VMS), 511 services, or traffic reports, more motorists will take alternative routes, and not get stuck in traffic.

Table 1: Transportation Operations Goal – Incident Management

Goal	Reduce Traffic Congestion Through Improved Incident Management			
Objectives	Improve Incident Detection and Verification	Improve Response Times	Improve Interagency Coordination and Cooperation	Improve Incident Clearance
Strategies	Implement and/or upgrade traffic operations centers Construct traffic surveillance systems, fill in missing gaps Share 9-1-1 and state police Computer Aided Dispatch (CAD) information with traffic operations centers	Install reference location signs Construct RIMIS data interfaces with TOC field-to-center software to collect traffic speeds Share traffic surveillance information with emergency responders Incorporate real-time traffic information into CAD systems and emergency vehicle mobile data terminals	Operate and maintain RIMIS Establish and maintain incident management task forces Create incident management response teams (IMRT) Conduct training programs, post-incident reviews Develop regional evacuation plan, and disaster response and recovery plan TOC/County 9-1-1 centers act as a communication hub for emergency/traffic text alerts	Deploy emergency service patrols Pass quick clearance legislation Develop and promote "Move It" policies, erect "Move It" signs Identify and sign pre-arranged detour routes Develop policy and procedures to modify signal timings on detour routes, upgrade traffic controllers/F2C communication systems Pre-deploy traffic control equipment Install ramp gates and barrier gates Develop tow truck incentive program

Source: DVRPC, 2009

- **Implement and/or upgrade traffic operations centers** As technology evolves, traffic operations centers routinely need to upgrade their software, equipment, and communications to stay current with the latest standards. Two major regional entities, Delaware River Port Authority and the City of Philadelphia are in various phases of implementing traffic operations centers.

- **Construct traffic surveillance systems, fill in missing gaps** Traffic surveillance systems, CCTV cameras and traffic detectors, have tended to be constructed on a random basis, as one component of larger highway construction projects. A more systematic approach to build-out ITS systems is needed, first focusing on the Interstate systems and then on state expressways. ITS practice and technology has evolved over time; gaps in early deployments need to be infilled, and equipment brought up to current standards.

- **Share 9-1-1 and state police computer aided dispatch (CAD) information with traffic operations centers** Instrumenting arterial highways for traffic surveillance is a very expensive proposition due to the magnitude of mileage involved. Obtaining incident information from 9-1-1 and state police CAD systems is a more cost efficient approach to obtaining traffic conditions on these routes.

Improve Response Times

Improving response times involves getting situational information out to pertinent organizations that need it. Emergency responders want accurate incident location information. When a traveler is involved in an incident and calls 9-1-1, precise location descriptions save responders valuable seconds and minutes of response times. Visual information about the types of vehicles involved and the severity can assist 9-1-1 centers in determining the appropriate types of equipment to dispatch. Real-time traffic information will aid in routing emergency response vehicles to the scene.

- **Install reference location signs** By installing reference location signs, such as ramp designation signs and highway mile marker signs (**Figure 2**), travelers are able to accurately communicate their incident location to 9-1-1 dispatchers.

Figure 2: Reference Location Sign Examples (NJ)

- **Construct Regional Integrated Multi-modal Information Sharing (RIMIS) system data interfaces with traffic operations centers (TOC) field-to-center software** Constructing data interfaces will enable RIMIS to acquire real-time information being transmitted between the TOC and field devices, such as travel speeds, VMS sign information, and CCTV images.
- **Share traffic surveillance information with emergency responders** County 9-1-1 centers and other emergency vehicle dispatchers require accurate information about the incident location, types of vehicles involved, crash severity, and traffic conditions to dispatch the proper equipment and expeditiously route them to the scene. Information sharing requires high-speed communication networks to transport reliable video and other information between emergency operations centers.
- **Incorporate real-time traffic information into CAD systems and emergency vehicle mobile data terminals** The more situational information first responders have prior to arriving at the scene, the better prepared they will be to handle the situation. En-route information will assist them in navigating around traffic congestion generated by the incident.

Improve Interagency Coordination and Cooperation

As previously discussed, wide varieties of personnel are involved in managing an incident, with each having their own set of priorities. Fire personnel tend to focus on rescuing people and/or dealing with Hazmat situations, police maintain traffic flow and obtain crash report information, tow truck operators may want to close lanes to upright a vehicle, and traffic operations centers want traffic lanes open as soon as possible. Consequently, under intense pressure at crash sites, conflicts occasionally occur

among emergency responders. The strategies listed below will assist in improving interdisciplinary coordination.

- **Operate and maintain RIMIS** Incident impacts can rapidly propagate beyond the incident scene and impact other parts of the transportation system. RIMIS is an information exchange network, established by DVRPC, to share situational information about incidents, construction and maintenance activity, and special events among transportation operators and with emergency responders.

- **Establish and maintain Incident Management Task Forces (IMTF)** IMTFs allow emergency responders, traffic operations personnel, and others to meet on an ongoing basis to pre-plan incident responses and improve interagency coordination. Task forces sponsor training programs, mock exercises, and hold post incident reviews.

- **Create Incident Management Response Teams (IMRT)** IMRTs are trained personnel, many with especially equipped vehicles, which enable a department of transportation to coordinate the agency's response to an incident. They are highly effective in dealing with major incidents.

- **Conduct highway incident training programs, post-incident reviews** Highway incidents represent a small percentage of overall emergency calls, and are often overlooked in first responder training courses. Highway incident training programs focus responders on special concerns associated with those types of incidents. Post-incident reviews permit emergency responders and others to review what went right and wrong during an incident to improve overall quality of future incident response. These can be done in conjunction with incident management task forces or on a stand-alone basis.

- **Develop regional evacuation plan; and disaster response and recovery plan** There are many site specific evacuation plans in the region, such as the Limerick Generating Station, chemical plants, etc. The Regional Task Force is sponsoring an effort to develop a unified regional plan for a wide-scale emergency evacuation.

- **Traffic Operations Centers/County 9-1-1 centers act as a communication hub for emergency/traffic text alerts** County 9-1-1 Centers will function as communication hubs in major emergencies, passing information between regional agencies and local police and fire departments. Operations centers are also acquiring technology to widely disseminate alerts via wireless technology, through programs such as RSAN or ReadyPA.org. Transportation agencies should participate in these types of programs.

Improve Incident Clearance

These strategies have two objectives; ensuring minor incidents do not escalate into major incidents and managing traffic when more significant incidents happen. Minor fender benders or stalled vehicles do not necessarily have to cause major bottlenecks if vehicles are moved out of the travel lanes onto the shoulder in a timely manner. Because local police and fire personnel do not typically carry control devices to manage traffic, and few entities have real-time capability to reprogram traffic signals on detour routes to handle the surge in traffic, the following strategies will help improve incident clearance.

- **Deploy emergency service patrols** Emergency service patrols are very effective in mitigating minor incidents like disabled vehicles. They are capable of providing minor repair services, such as supplying gas or charging a battery. They carry arrow boards, cones, and other warning devices for traffic control. See **Figure 3** for examples of emergency service patrol trucks in both Pennsylvania and New Jersey, respectively.

Figure 3: PennDOT and NJ DOT Emergency Service Patrol Truck Examples

Source: PennDOT

Source: NJDOT

- **Pass Quick Clearance legislation and promote its policies** Quick clearance efforts are comprised of three components: Move Over laws, Authority Removal laws, and Move It laws. To protect first responders and reduce the incidence of secondary crashes, Move Over laws require drivers approaching a scene with emergency responders present to either change lanes and/or reduce speeds. Authority Removal gives pre-designated public agencies indemnification to clear damaged or disabled vehicles and spilled cargo from the roadway. Move It laws require vehicles involved in property damage-only crashes to move out of travel lanes to a safe location where they can exchange information or wait for police. Pennsylvania has passed all three laws. New Jersey recently enacted Move Over legislation.

Figure 4: PennDOT Detour Route Sign Examples

Sources: PennDOT

- **Identify and sign pre-arranged detour routes** PennDOT has signed pre-defined detour routes for each expressway segment (**Figure 4**), and NJDOT is gradually updating its detour routes for all state roads. Detour routes need to be periodically inspected to ensure they are still viable. Trail blazer signing and other informational programs are needed to delineate the routes for motorists, especially those unfamiliar with the area. All detour routes should be incorporated into IDRuM, a web-based application developed to make detour routes more readily accessible.

- **Develop policy and procedures to modify signal timings on detour routes, upgrade traffic controllers/field-to-center communication systems** The ability to handle traffic surges from road closures or special events is an institutional and communications problem, not necessarily a technical issue. Newer signal systems have the functionality to implement multiple emergency

timings plans, and should be used. The problem is that neither the municipalities in Pennsylvania nor most counties in New Jersey actively manage their traffic signals. Having centralized regional operations centers, such as PennDOT District 6-0, implement emergency timings will require communication systems and interagency protocols.

- **Pre-deploy traffic control equipment** Police and fire personnel do not typically carry traffic control devices as standard equipment in their vehicles. Pre-stationing portable sign boards, cones, detour signs, and other traffic control equipment throughout the region will make them more accessible in emergency situations.

- **Install ramp gates and barrier gates** These types of physical improvements are intended for long-term road closures. Ramp gates prevent vehicles from entering a closed highway and getting stuck in a traffic; it negates positioning police officers and/or maintenance crews at each on-ramp. Barrier gates are moveable gates in the highway median, the barriers can be moved in an emergency to permit trapped vehicles to exit the highway.

- **Develop tow truck incentive program** Current state laws provide trucking companies, tow trucks, and other recovery operators no incentive to expeditiously remove damaged vehicles from a crash scene. One potential strategy is to assess penalties on truckers who do not arrange for removal of their truck and/or freight in a timely manner. In other areas of the country where state police or department of transportation contract towing services, incorporating incentives and penalties into tow operator contracts have proved very successful in reducing incident durations.

Reduce Traffic Congestion Through Improved Traffic Management

Improved traffic management targets both recurring and non-recurring congestion. The primary objective is to move away from a static transportation system to a more dynamic transportation system. Examples include periodically retiming isolated traffic signals, installing more closed loop signal systems that can be centrally controlled to reflect current conditions, utilizing ramp metering and variable speed limit signs to manage traffic flow on expressways, and implementing more advanced work zone traffic control measures. Another objective is to focus on corridors (not exclusively expressways) and use traveler information dissemination to influence travel patterns to cover multiple roadways, and avoid traffic bottlenecks on just one or two highways.

Table 2 summarizes traffic management objectives and strategies.

Table 2: Transportation Operations Goal – Traffic Management

Goal	Reduce Traffic Congestion Through Improved Traffic Management				
Objectives	Implement Integrated Corridor Management	Optimize Traffic Signal Operations	Improve Work Zone Management	Implement Traffic Control Programs	Improve Winter Weather Management
Strategies	Develop integrated corridor management plans, prioritize corridors TOC monitors highway system via detectors, actively manage highways with pre-arranged plans Install traffic surveillance/ traveler information systems on arterials Construct arterial management systems PennDOT should assume responsibility for emergency traffic signal operations Coordinate with local police Implement transit vehicle priority programs Install kiosks at major traffic generators, provide real-time highway and transit information Construct park and ride lots, other TDM strategies Install communications systems to interconnect signal systems, municipal TOCs, DOTs, and transit assets in the corridor	Develop traffic signal priority network, periodically update Systematically retime traffic signals on priority network Upgrade and interconnect signals on priority network Improve traffic signal maintenance Upgrade traffic operations centers/training programs Active monitoring of traffic signal systems	Upgrade traffic surveillance Install real-time traveler information systems Deploy speed monitoring systems Employ work zone warning devices Utilize traffic management & incident management committees Initiate a construction coordination program	Archive traffic data, use to develop response plans Implement a ramp metering program on expressway on-ramps Implement speed monitoring treatment on expressways and arterials, where appropriate Implement variable speed limits Implement red light running programs at intersections with high crash rates Implement congestion pricing programs, including open road tolling and variable rate parking meters Implement parking management programs at major parking facilities and Center City Implement freight management on NHS connectors Implement Commercial Vehicle Operation safety initiatives – electronic credential and truck safety inspection programs	Deploy Roadway Weather Information Systems (RWIS) Winter weather maintenance management, including tracking snow plows and spreaders, monitoring quantities being dispersed, and CAD dispatch of equipment Install automated roadway treatment systems at overpasses and bridges with icing problems Information system to disseminate road condition information to the public

Source: DVRPC, 2009

Implement Integrated Corridor Management

In general, highways do not operate in isolation; they are usually part of larger travel corridors with parallel arterials, passenger rail lines, and bus routes. From a holistic perspective, the goal is to optimize travel in the whole corridor, not just expressways. Accomplishing this requires deploying ITS resources throughout the corridor and across modes. If traffic signals are optimized, parallel arterials can help relieve overcrowded expressways. Strategically located VMS at decision points can inform motorist of travel choices; what are the travel times via expressway versus arterials, or when is the next train arriving.

Programs that promote mode diversion will reduce traffic demand and improve highway operations. Bus priority treatment to speed bus travel times, smart bus stops displaying real-time arrival times, and parking management systems at rail stations tied into highway VMS, will collectively make transit a more competitive option.

Corridor management entails integrating state DOT highway management systems, municipal or county signal systems, and transit systems. Constructing these linkages involves surmounting both technical and institutional issues.

- **Develop integrated corridor management plans, prioritize corridors** A comprehensive vision is needed for each corridor identifying closed loop systems, CCTV and VMS locations on arterials, priority bus treatment needs, smart bus stops, and communication links to local police and municipal TOCs. With the vision in place, projects can proceed either on a corridor-wide basis or on an individual project-by-project basis.

- **TOC monitors highway system via detectors, actively manage highways with pre-arranged plans** Traffic control in corridors is currently decentralized. In New Jersey, municipalities, counties, and NJDOT operate separate signal systems. In Pennsylvania, each municipality operates its own signal system. Superimposed on top of the signals systems, is NJDOT and PennDOT's highway management systems. A centralized entity is needed to look at the big picture and develop an overall response plan for congestion and incidents. Individual department of transportation, toll or bridge authorities, counties, and/or municipalities would then manage their own assets within the encompassing vision.

Figure 5: CCTV Camera Examples – Signal (Philadelphia) and Highway (PA)

Sources: DVRPC and PennDOT, respectively

- **Install traffic surveillance/traveler information systems on arterials** To accomplish integrated corridor management, situational information for all highways, not just expressways, is needed. This involves obtaining travel speeds from road sensors or vehicle probes, and road condition information from CCTV cameras (**Figure 5**). Video imaging detection (VID) from traffic signals can also fill in gaps. Judicious placement of VMS prior to key decision points will help guide motorists.

- **Construct arterial management systems** Closed loop traffic signal systems will allow traffic engineers to dynamically change the underlying signal timing patterns to mirror changing travel demand. With multiple signal timing patterns available, a centralized computer can monitor traffic conditions and automatically select the most appropriate signal pattern for a single roadway or an entire corridor.

- **PennDOT should assume responsibility for emergency traffic signal operations** As previously mentioned, PennDOT does not own, operate, or maintain any traffic signals. In Pennsylvania, that responsibility resides with the local municipalities. In emergencies, such as traffic diversions or emergency evacuations, it would be very difficult for municipalities to implement emergency signal timing plans, and nearly impossible for adjacent municipalities in a corridor to do so in unison. In emergencies, an independent entity, such as PennDOT, who has 24/7 staffing, technical expertise, and who sees the bigger picture, needs to assume control of traffic signals across municipal boundaries. For PennDOT to assume this responsibility requires developing policy, technical, and communication protocols with local municipalities.

- **Coordinate with local police** Local police are responsible for patrolling arterial highways, their responsibilities include law enforcement, accident investigation, and staffing traffic control points during traffic diversions, maintenance or construction activities, and emergency evacuations. Presently, there are only minimal communications between local police and transportation operations personnel. There is also a disconnect between state police and local police. Effective corridor management requires more extensive information sharing and coordination between these entities.

- **Implement transit vehicle priority programs** Transit ridership is very sensitive to the relative travel time of transit to autos. Signal priority treatment enables buses to slightly extend the green time at signalized intersections so they can pass through without stopping. When signal priority treatment is installed on multiple intersections along a bus route it will shorten bus travel times, making them more competitive.

- **Install kiosks at major traffic generators, provide real-time highway and transit information** Major traffic generators such as malls and office parks are ideal locations to disseminate real-time travel information, for both traffic and transit. Programs can include installing kiosks at mall entrances or office building lobbies, sending travel alerts to major employers, or advertising construction activity in local newspapers or flyers.

- **Construct park and ride lots, other Travel Demand Management (TDM) strategies** These types of measures help support transportation operations by encouraging motorists to make fewer vehicle trips.

- **Install communications systems to interconnect signal systems, municipal TOCs, DOTs, and transit assets in the corridor** To make the above strategies work requires a backbone communications network to share traffic conditions and incident information among departments of transportation, county TOCs in New Jersey, county 9-1-1 centers, municipal police departments, and transit agencies. Having a singular backbone network would avoid duplicative cost of constructing separate communications networks to carry traffic signal timings, video images from CCTV cameras, smart bus stop information, and emergency situational information. PennDOT has started constructing such a network in Pennsylvania.

Optimize Traffic Signal Operations

Pennsylvania is one of the few states where the responsibility for operating and maintaining traffic signals on state highways resides with the municipalities, not the state department of transportation. PennDOT has regulatory approval over traffic signal design and signal timing plans; however, with over 6,000 traffic signals in PennDOT District 6-0, there is no program to systematically ensure traffic signals are properly timed. Continual changes in land use requires periodic retiming of signals to reflect current traffic patterns. While traffic signal initiatives are primarily targeted to Pennsylvania, there is still a need to retime and modernize traffic signals in New Jersey.

- **Develop traffic signal priority network, and periodically update** With over 6,000 traffic signals in PennDOT District 6-0, a signal priority network is needed to define which roads and intersections should receive preference when funding signal improvement programs. Improvements can include periodically retiming signals, signal modernization including new signal heads and controllers, and installing closed loop signal systems. Once the Pennsylvania network is completed, a similar priority network for New Jersey will be developed. DVRPC is currently developing a Strategic Corridor Investment Plan.

- **Systematically retime traffic signals on priority network** Traffic signals on the priority network should be periodically retimed to ensure the official traffic signal timing plan is optimized for current traffic conditions, and that the signal timings adhere to the official signal plan. Over time, synchronization between signals may drift, and unofficial tweaks to signal timings occasionally occur. Periodically checking signal timings will minimize these issues.

- **Upgrade and interconnect signals on priority network** Many older traffic signal systems utilize time based coordination to interconnect traffic signals. There is no central processor to dynamically manage the system, nor is there a communication network to transmit commands to individual signals or between signals. Closed loop traffic signal systems permit a central processor, though a communications network, to monitor a large group of traffic signals and implement dynamic signal timing patterns.

- **Improve traffic signal maintenance** In Pennsylvania traffic signals are maintained by the municipalities, most of whom contract out signal maintenance with private venders. The quality of maintenance can vary greatly among municipalities. PennDOT should establish minimal maintenance standards, and initiate an inspection program to make certain the public investment in signal systems is properly maintained.

- **Upgrade traffic operations centers/training programs** Computers to operate signal systems are located in municipal buildings or police departments with minimal staff trained on how to operate them. Under normal operating conditions, this is not an issue. However, personnel should be trained to implement emergency traffic signal timing programs during a traffic diversion, emergency evacuation, or similar conditions. In New Jersey, Burlington County is the only county with a traffic operations center, with dedicated staff, to operate its traffic signals.

- **Active monitoring of traffic signal systems** Advanced traffic control equipment generates a number of measures of effectiveness to measure system performance. These performance measures should be periodically reviewed to determine how signals are operating, and to identify signals that may need to be retimed.

Improve Work Zone Management

When a highway agency establishes a work zone, regardless of whether it is temporary maintenance activity or a long-term construction project, adequate precautions have to be taken to warn motorists about changes in traffic patterns and potential bottlenecks. It is vital to minimize traffic delays and protect the safety of construction workers and motorists. Work zone plans and measures should be commensurate with the size and duration of the job and traffic volumes on the affected highway. Federal work zone regulations have enshrined these principals. Emerging technology is complementing these efforts, with portable devices to issue alerts and warnings to reckless drivers. The following strategies support work zone management.

- **Upgrade traffic surveillance** Since work zones frequently close lanes and/or hinder traffic flow, it is especially important to inform motorists of unanticipated backups to reduce the potential for rear end crashes at the end of the queue. Even with adequate warnings, accidents may occur. Surveillance systems will accelerate crash detection and the dispatch of emergency response personnel.

- **Install real-time traveler information systems** It is critical to inform motorists about changes in travel patterns; which lanes are closed, is the shoulder open or closed, or is there uneven pavement. Work zone impacts on traffic can vary over the day, especially for maintenance activity. Therefore, work zone information must be accurate and reflective of current conditions (**Figure 6**).

Figure 6: Work Zone VMS Example (PA)

Source: PennDOT

- **Deploy speed monitoring systems** Portable speed monitoring devices are increasingly being deployed to help lower vehicular speeds in work zone areas. They reinforce laws lowering speed limits in work zones.

- **Employ work zone warning devices** This technology issues alerts when a vehicle gets too close or intrudes into a work zone. Drivers then have an opportunity to redirect their vehicle and avoid a crash or injury to construction workers. Workers will be warned to get out of the way of the errant vehicle.

- **Utilize traffic management and incident management committees** Planning and managing a work zone is analogous to operating an ongoing incident. Complex work zones require interdisciplinary teams of traffic engineers, traffic management center staff, incident management personnel, on-site engineers, and the contractor(s) to successfully prepare for all contingencies ranging from temporary lane closures to crashes.

- **Initiate a construction coordination program** Overlapping construction projects can have a multiplier effect on congestion. A regional approach to coordinate construction projects among highway agencies, utility departments, and local governments is needed to avoid this situation. This requires establishing a centralized construction coordination geographic database with personnel to analyze it, identifying potential conflicts, and working with the appropriate entities to resolve the conflicts.

Implement Traffic Control Programs

While traffic incidents, maintenance and construction activity, and adverse weather conditions represent 60 percent of congestion in large metropolitan areas, the remaining 40 percent is still sizeable and needs to be addressed. Many of the basic tenets of transportation operations, technology, and institutional coordination among operating agencies, can be used to mitigate traffic bottlenecks and improve highway safety.

- **Archive traffic data, use to develop response plans** Very few organizations currently archive traffic data. Archiving data, such as traffic volumes and speeds, incident information, actions taken, and even emergency service patrol logs, can assist agencies in refining their operations and prepare for reoccurrence of similar situations. Planners can use the data to feed their traffic simulation models and the Congestion Management Process (CMP).

- **Implement a ramp metering program on expressway on-ramps** Expressways can only carry approximately 2,300 vehicles per hour per lane. When this density is exceeded, traffic flow starts breaking down, causing stop and go conditions. Ramp metering, installing traffic signals on on-ramps to meter the number of merging vehicles (**Figure 7**), will ensure mainline traffic does not exceed capacity.

Figure 7: Ramp Metering Example (PA)

- **Implement speed monitoring treatment (automated speed enforcement) on expressways and arterials, where appropriate** Excessive speeding can lead to crashes. Speed monitoring programs identify excessive speeders and automatically ticket them. Keeping traffic speeds down reduces crash rates, accident severity, and resulting delays. Existing legislation may need to be modified to allow for this type of enforcement.

- **Implement variable speed limits** Speed limits are based on the 85th percentile speed of motorists under normal driving conditions. When temporary unusual conditions are present, for example a crash, maintenance or construction activity, or adverse weather conditions, traffic personnel need the ability to adjust the speed to reflect these conditions. Implementing variable speed limits may require amending state traffic regulations.

- **Implement red light running programs at intersections with high crash rates** While nominally a safety initiative, red light running programs use video technology to identify vehicles running red lights. Red light running programs discourage aggressive driving and excessive speeding, consequently reducing crash rates.

- **Implement congestion pricing programs, including open road tolling and variable rate parking meters** Many experts advocate pricing programs as a strategic tool to reduce traffic congestion, requiring motorists to pay for use of designated highway facilities during peak periods. Various demonstration projects are underway in other parts of the country; yet it is still too early to determine how effective they are and whether they would be applicable to the Delaware Valley.

- **Implement parking management programs at major parking facilities and Center City** Major attractions in Center City such as the Pennsylvania Convention Center, Independence National Historic Park, or the Avenue of the Arts are frequently inundated with motorists looking for parking, especially during events. The Sports Complex is another notorious parking situation. Parking management systems guide visitors to garages with available parking and the shortest queues, reducing the number of motorists cruising streets looking for parking.

- **Implement freight management on National Highway System (NHS) connectors** For truckers, the area between the terminal and highway is one of the most critical segments of the trip. This is where truckers are looking for route guidance, real-time traffic conditions, and instructions about approaching terminal gates. Because terminals are frequently served by rail lines, application of highway-rail crossing technology is needed on NHS connectors that serve the terminals.

- **Implement Commercial Vehicle Operation (CVO) safety initiatives – electronic credential and truck safety inspection programs** Crashes involving trucks, especially overturned trucks, tend to generate a disproportionate number of long-term lane closures. Salvage operations, removal of debris, and righting of overturned trucks require specialized crews and equipment that may take considerable time to mobilize. Implementing CVO programs to minimize less than ideal vehicles and drivers from the road will reduce the incidence of truck crashes.

Improve Winter Weather Management

Adverse weather conditions, whether it is heavy rain, snow, or icy roadways, have a detrimental impact on traffic flow and create unsafe conditions. Weather management programs have three objectives: identify hazardous roadway conditions through remote surveillance techniques, inform motorists about unsafe conditions, and provide situational information to manage field resources.

- **Deploy Roadway Weather Information Systems (RWIS)** RWIS sensors generate information about weather and roadway conditions; whether it is foggy or rainy, or whether the road is dry, icy or full of snow. Maintenance personnel use this information to determine the appropriate response plan. Traffic operations centers use RWIS generated information to trigger warnings to motorists about adverse weather conditions via VMS and/or Highway Advisory Radio (HAR).

- **Initiate winter weather maintenance management, including tracking snow plows and spreaders, monitoring quantities being dispersed, and CAD dispatch of equipment** Highway agencies are beginning to use GPS technology to track salt trucks and snow plows, keeping track on which roads have been treated, the quantity of materials used, and the condition of trucks and crews. With this information, maintenance personnel can more effectively plan and manage a response to winter weather conditions.

- **Install automated roadway treatment systems at overpasses and bridges with icing problems** Icing problems tend to repeatedly occur at the same locations, usually on bridges and other structures. Automated roadway treatment systems employ sensors and CCTV cameras to determine when icy conditions are present. Maintenance personnel can then remotely apply anti-icing solution to treat the ice.

- **Develop information system to disseminate road condition information to the public** This entails integrating data from RWIS and maintenance management systems into traveler information systems so that weather and road surface conditions automatically populates 511 and other traveler information outlets.

Provide more Options for Travelers by Providing Real-Time Information

Providing travelers with real-time travel times, incident information, and transit delay information will give them a unique opportunity to optimize their trips. With information about travel conditions, they can make intelligent decisions about routes or modes, and take mid-trip corrective actions to avoid delays. With wireless technology, the public demands and expects information on demand.

Table 3 summarizes travel information objectives and strategies.

Table 3: Transportation Operations Goal – Travel Information

Goal	Provide More Options for Travelers by Providing Real-Time Information			
Objectives	Collect Travel Condition Information	Promote Public-Private Partnerships to Disseminate Traveler Information	Enhance Agency Travel Information Programs	Enhance En-route Traveler Information
Strategies	Utilize vehicle probe and/or roadside speed detectors Catalog planned construction and maintenance activity information Obtain real-time work zone status information Obtain transit delay and service disruption information Identify special events that can disrupt traffic flow Use field sensors to collect pavement condition information Gather winter road condition information from maintenance departments	Rely upon the private sector to broadcast traveler information to the public, and offer personalized services Utilize TMAs to disseminate traveler information to their business community and local residents Disseminate agency travel information to ISPs, make use of travel information generated by ISPs (e.g., vehicle probe data) Encourage cable TV companies to broadcast agency travel information on a dedicated channel	Maintain 511 traveler information systems Coordinate 511 programs across state lines Enhance traveler information component of agency websites Provide real-time travel information and visitor services at service plazas	Expand VMS coverage to expressway access roads Place travel times on VMS Improve delineation of detour routes Emergency traveler information For special events, promote alternative routes and means of travel

Source: DVRPC, 2009

Collect Travel Condition Information

At their core, traveler information programs require high quality real-time information about the transportation system. They must be multi-dimensional and include delays, maintenance and construction activities, incidents, and other relevant information about conditions that affects travelers. The information need not be as detailed as what is used by transportation operations centers or emergency responders; however, it must be timely and accurate. Motorists sitting in traffic do not want to hear traffic is free flowing. Travel information must cover a wider number of facilities than is currently available, providing travelers a number of alternative routes. Information can be collected by public agencies, the private sector, or a combination for distribution to the public. The strategies listed on the next page further describe these efforts.

- **Utilize vehicle probe and/or roadside speed detectors** Either technology can be used to produce travel times for motorists. Vehicle probes, whether from in-vehicle GPS devices or cell phones, do not require extensive roadside infrastructure, and are therefore applicable for multiple highways in a travel corridor. Roadside speed detectors are a more mature technology; however, they require an extensive infrastructure and produce spot speeds that have to be extrapolated for longer distances.

- **Catalog planned construction and maintenance activity information** Many public agencies currently issue weekly advisories of their planned construction and maintenance activities. Creating a comprehensive list across agencies is a more difficult endeavor, because many organizations, especially utility companies and private contractors, may not disclose their activities in a timely manner.

- **Obtain real-time work zone status information** Even though maintenance and construction activity may be scheduled, that does not necessarily mean it is actually occurring. Field crews could be diverted to other jobs, or they may be waiting for supplies or a different subcontractor to arrive. Traffic impact can also vary based on different phases of a job. Although more difficult to gather, real-time work zone status information is a more accurate indictor of traffic impact than planned construct and maintenance activity.

- **Obtain transit delay and service disruption information** Transit agencies routinely issue travel alerts based on transit delays and service disruptions on their system. These alerts are triggered by major delays, and are not scaled to reflect real-time information demanded by travelers. A centralized database containing delay information across transit providers would be valuable to the public.

- **Identify special events that can disrupt traffic flow** Like planned construction and maintenance activity or transit delays, information about special events in the region (i.e. an Eagles game at the Philadelphia Sports Complex, or a concert at the Susquehanna Bank Center in Camden) exists but is scattered among different agencies. A centralized database should store information about the date of the event, the number of participants expected, the transportation facilities impacted, and its duration.

- **Use field sensors to collect pavement condition information** Adverse weather, especially snow or icy conditions, impacts travel. Motorists want information on which roads are open to traffic and their surface conditions, and if roads are snow covered, slushy, icy, or dry. RWIS stations generate this type of information, and needs to be integrated into traveler information systems.

- **Gather winter road condition information from maintenance departments** As previously discussed under winter maintenance activities, maintenance departments are gaining the ability to track road conditions. This information must be disseminated to the public.

Promote Public-Private Partnerships to Disseminate Traveler Information

Motorists are no longer content to only listen to traffic reports on KYW and other radio stations. With IT and wireless technology, the means to disseminate and customize travel information to the public has exploded. Travelers now expect to receive real-time travel condition information via multiple devices including cell phones, in-vehicle equipment, the internet, as well as traditional radio and

television. Technology companies have led the way for repackaging information available from highway agencies, collecting their own information using vehicle probes and other techniques, or a combination of approaches. Highway and transit agencies can not compete in generating content for the new technologies, nor should they divert valuable resources away from their core responsibility of traffic and incident management. The following strategies focus on how best to utilize the resources of the private sector.

- **Rely upon the private sector to broadcast traveler information to the public, and offer personalized services** The primary function of transportation operations centers is to mange their system and handle incidents and other unusual conditions. Disseminating travel information to the public is vital, but a secondary function. Public-private partnerships are a way to off-load some of the traveler information functions to entities who are more capable of distributing information to the public. With private sector resources and expertise, they can repackage and distribute information in formats that public agencies cannot currently deliver.

- **Utilize Transportation Management Agencies (TMAs) to disseminate traveler information to their business community and local residents** TMAs are public-private partnerships established to provide alternative transportation services and advocate for transportation improvements that help local residents and businesses. By way of their contacts with the business community, TMAs can efficiently disseminate information to local commuters in a target area.

- **Disseminate agency travel information to Information Service Providers (ISP), make use of travel information generated by ISPs (e.g., vehicle probe data)** Transportation agencies should routinely share travel condition information with the traffic reporting services, who in turn can more efficiently repackage the information for wide distribution. At the same time, the private sector is using more advanced technology to collect information about the transportation system, which should be made available to public agencies. An example is I-95 Corridor Coalition's Vehicle Probe Project, where its member agencies are receiving vehicle probe data by Inrix, an IT company.

- **Encourage cable TV companies to broadcast agency travel information on a dedicated channel** In many regions, cable operators have established a dedicated channel that either exclusively carries real-time transportation information, or routinely incorporates it into a 24 hour news channel. Transportation agencies should work with cable companies to establish similar channels in this region.

Enhance Agency Travel Information Programs

Relying upon the private sector to disseminate traffic information does not relieve public agencies of the responsibility for providing basic travel information to the public. Highway agencies should routinely post travel times and construction/maintenance activity notifications on the internet and their VMS. Other initiatives should include the following:

- **Maintain 511 traveler information systems** NJDOT's 511 system has been in operation since June 2008 and PennDOT plans to kick-off their system Summer 2009. Initially both systems will primarily focus on state highways. Eventually, both need to expand their coverage to transit and

other transportation services. In New Jersey, NJDOT needs to incorporate some of the more significant county roads into 511.

- **Coordinate 511 programs across modes and state lines** From an operations perspective, the DVRPC region consists of three state departments of transportation, numerous toll and bridge authorities and multiple transit agencies. The public does not differentiate between jurisdictions; they want seamless travel information on how to travel through one state, cross a bridge, and then into another state. 511 systems must be responsive to this need.

- **Enhance traveler information component of agency websites** Even with 511, agencies will still maintain websites that can impart a wider range of information currently carried by 511. It is crucial that agencies maintain these supplemental services such as planned construction activities, special event information, and alternative modes of travel.

- **Provide real-time travel information and visitor services at service plazas** Out of town travelers approaching the region have special needs which may not be fully served by 511. Kiosks with real-time travel visual information and visitor services, such as information about tourist attractions, hotels and restaurants, or truck repair services, can bridge this information gap. It can supplement static traveler information currently available. Regional toll roads, such as the Atlantic City Expressway, New Jersey Turnpike, and the Pennsylvania Turnpike, are ideal location for these services.

Enhance En route Traveler Information

Conditions will frequently change while the traveler is en route. En route traveler information gives travelers a dynamic opportunity to change routes based on the latest travel conditions.

- **Expand VMS coverage to expressway access roads** NJDOT and PennDOT have made a sizeable investment in VMS on the region's expressway system to warn motorists about anticipated delays. Unfortunately, there is no mechanism to warn motorists about the same condition before they enter the highway and are trapped in traffic. VMS should be placed at decision points on the arterial system just prior to expressway on-ramps.

- **Place travel times on VMS** Commuters or others who routinely travel on highways have an approximate idea on how long a trip should take. By providing motorists travel time information, especially for alternative routes, drivers can make an educated decision on their best travel options.

- **Improve delineation of detour routes** Both NJDOT and PennDOT have official detour routes for their highways. These highways were chosen because of their capacities, and lack of clearance and height/weight restrictions. Without adequate signing delineating the route, they may not be used by motorists.

- **Provide emergency traveler information** In emergency situations, such as evacuations associated with flooding, Hazmat situations, or terrorist attacks, the public will need information on which transportation facilities are open, shelter locations, or even how to contact loved ones. Agencies ranging from American Red Cross to county Emergency Management Agencies will be issuing various alerts and warnings. A unified public information program is needed to avoid conflicting messages and to provide the public with consistent and accurate information on how to safely evacuate.

- **For special events, promote alternative routes and means of travel** Special events, like those at the Sports Complex, Pennsylvania Convention Center, or the Ben Franklin Parkway, are infamous for the hordes of people they attract and the traffic jams they create. Better marketing of transit, alternative parking lots, or even alternative access routes and can help relieve traffic congestion, speeding access, and egress to/from these events.

Improve Delivery of Transit Services

Unlike highway agencies, transit agencies historically performed transportation operations on an ongoing basis. They manage transit fleets and take corrective actions when vehicles breakdown or are delayed. They adjust schedules for special events and handle incidents on their property. Instead of primarily focusing on the operations side of transit, the main emphasis of this transit goal will be the technology component. For years, transit agencies used technology to manage their rail systems, controlling signals, and power systems. Modern Supervisory Control and Data Acquisition (SCADA) systems gives operations center staff a more comprehensive picture of all elements of rail systems, automatically monitoring various system elements and issuing alerts when problems are detected. Installing on-board sensors in rail vehicles and buses complements SCADA systems and will lead to improved vehicle diagnostics; reducing the incidence of breakdowns and equipment failures. Computer aided dispatch (CAD) systems are used to monitor bus movements, to identify when buses are behind schedule and to alert operations center personnel that corrective action needs to be taken. Surveillance and traveler information systems similar to those used for highways can make transit stations safer and impart real-time traveler information to passengers.

Table 4 summarizes transit management objectives and strategies.

Implement Technologies to Control and Operate Transit Systems

Like highway agencies, transit agencies need situational information about their assets in order to manage their system. This need cuts across all modes of transit, buses, rail lines, and even fixed assets like stations and maintenance facilities. Unlike highways agencies, transit agencies also need command and control systems to dispatch buses, operate rail signal systems, and monitor individual transit vehicles. SCADA systems, used in settings ranging from chemical plants to power pants, provide the basic technology to make transit operate efficiently.

- **Upgrade PATCO and NJ Transit South operations centers, including computer-aided bus dispatching, and signal and power systems for rail** In the last ten years, SEPTA has totally rebuilt their operations center and its component systems with state-of-the-art technology. Installing new SCADA systems at PATCO Center Tower and New Jersey Transit Bus Operations South will improve service reliability on those transit properties.

- **Place GPS on buses and rail vehicles to monitor their location** Equipping transit vehicles with GPS gives transit agencies greater control to monitor their transit fleet.

- **Install on-board transit vehicles diagnostic monitoring systems** Nothing infuriates a transit passenger like getting stuck on a broken transit vehicle and waiting for assistance. On-board

diagnostics can identify potential mechanical problems before they fail, improving overall transit reliability.

Table 4: Transportation Operations Goal – Transit Services

Goal	Improve Delivery of Transit Services			
Objectives	Implement Technologies to Control and Operate Transit Systems	Upgrade Transit Information Systems	Improve Fare Collection	Improve Transit Security and Passenger Safety
Strategies	Upgrade PATCO and NJ Transit South operations centers, including computer-aided bus dispatching, and signal and power systems for rail Place GPS on buses and rail vehicles to monitor their location Install on-board transit vehicles diagnostic monitoring systems Provide signal priority for transit vehicles	Provide transit information in 511 systems Provide personalized trip information for transit users Install electronic real-time "next bus/train" information at bus stops/train stations Install kiosks at major traffic generators with real-time transit information and route planning capabilities Install advanced parking management systems at rail stations	Deploy smart card technology Coordinate smart cards among transit agencies Install new fare collection equipment Employ passenger count technology	Install surveillance systems and panic alarms in public areas Install PA systems and digital message signs to communicate information to passengers Upgrade surveillance of storage yards, maintenance facilities, and rail infrastructure Implement communications network to support surveillance

Source: DVRPC, 2009

- **Provide signal priority for transit vehicles** Transit ridership is very sensitive to the relative travel time of transit to autos. Signal priority treatment enables buses to slightly extend the green time at intersections so they can pass through without stopping. When signal priority treatment is installed on multiple intersections along a bus route it will shorten bus travel times, making them more competitive.

Upgrade Transit Information Systems

Transit information systems have two functions: give basic transit information to the occasional user or a potential first time user; and provide accurate real-time pre-trip and en route information to all transit riders. Occasional users need to know what transit options exist, which lines to take, and frequency of service. All passengers want to know about delays and when the next transit vehicle is arriving. Transit operations centers routinely collect this information via SCADA systems; the information must get out to the public.

- **Provide transit information in 511 systems** The initial 511 rollouts by NJDOT and PennDOT do not provide transit information, there are just links to transit operators. Transit information should be phased into 511.

- **Provide personalized trip information for transit users** Unlike cars where you can drive point-to-point, transit trips frequently involve taking multiple buses and/or trains. Therefore, personalized trip planning is an important marketing tool for transit agencies.

- **Install electronic real-time "next bus/train" information at bus stops/train stations** PATCO and New Jersey Transit provide train arrival information in their stations. SEPTA provides similar information for Regional Rail in Center City Stations; however for other SEPTA assets there is no real-time information. SEPTA is beginning to roll out real-time arrival information in other stations, but it needs to be expanded system-wide. Smart bus stops consist of an LED screen indicating next bus arrival times. Because of long headways between buses, especially at outlying bus stops, smart bus stops are urgently needed in this region.

- **Install kiosks at major traffic generators with real-time transit information and route planning capabilities** One tool to encourage transit ridership is greater dissemination of transit information at major traffic generators, such as shopping malls and office buildings. Providing transit information, especially route planning capabilities, will reinforce the concept of transit as a viable option.

- **Install advanced parking management systems at rail stations** At many transit stations parking is at a premium. Instead of having commuters waste time looking for a parking space, parking management systems can inform passengers about parking availability and even guide them to the section of the lot where spaces are available. Parking management systems also assist transit agencies in optimizing parking utilization, by monitoring parking usage and facilitating different mixes of reserved and unreserved parking.

Improve Fare Collection

Traditional fare collection systems are both costly and inefficient. There are considerable direct and indirect costs associated with maintaining fare collection equipment and performing backroom bookkeeping. They are inefficient in that passengers either have to feed cash, tokens, or transit passes into fare machines, hindering the flow of passengers onto a bus or station. New smart card technology mitigates many of these concerns. Backroom functions can be outsourced to banks or other financial institutions; passengers can increase the value of their smart card using credit cards or making electronic payments, thus minimizing paperwork. Smart cards, especially those employing contactless technology, are easier to process, speeding the flow of passengers. Contactless fare collection, while it has a higher initial cost, is relatively maintenance free. PATCO's Freedom Card is an excellent example of how smart card technology can work.

- **Deploy smart card technology** PATCO is using its Freedom Card at all stations and parking lots. SEPTA is funding a smart card project. New Jersey Transit is studying fare technology options.

- **Coordinate smart cards among transit agencies** As transit agencies switch over to smart cards, provisions should be made so passengers can use the same media across systems, making transfer among systems seamless.

- **Install new fare collection equipment** A decision on employing smart card technology will result in a sizeable initial investment in new fare collection equipment.

- **Employ passenger count technology** Accurate passenger count information lays the foundation for transit service planning. While transit agencies might have information on passengers entering transit vehicles because of the fares they pay; there is a dearth of information on when they exit. Use of transit passes and free transfers compound the passenger count issues because there is no paper trail associated with them. Emerging technology will be able to eventually supply this data.

Improve Transit Security and Passenger Safety

The public generally perceives transit systems as having a higher crime rate than the surrounding area. Consequently, transit agencies place great emphasis on creating a safe and secure environment for their customers. ITS technology, such as video surveillance, alarms, detectors, and other devices monitor transit properties, and two-way communication systems enable direct communications with transit passengers during emergency situations. Terrorist attacks in other countries have shown transit systems are a prime target. Consequently, this has necessitated securing elements of the transit system that would never have been a concern before.

- **Install surveillance systems and panic alarms in public areas** CCTV cameras, emergency phones, and panic detectors can help create a secure environment in transit stations and park and ride lots, giving passengers a greater sense of safety. Many transit operators are even installing surveillance systems on transit vehicles.
- **Install public address systems to communicate information to passengers** When an incident does occur, the victim and other passengers want to know law enforcement is aware of the situation and a response is underway. Two-way communication systems will facilitate this.
- **Upgrade surveillance of storage yards, maintenance facilities, and rail infrastructure** Surveillance and detector systems are needed to secure transit support facilities and its basic infrastructure, by discouraging intrusions by unauthorized personnel and/or detecting them as they occur.
- **Implement communications network to support surveillance** Transporting video, detector data, and two-way communications back to a centralized operations center requires constructing a secure high bandwidth communications network.

Performance Measures

This section presents performance measures to gauge how effective the region has been in meeting the goals and objectives presented in this Plan. There are two types of performance measures: performance-based measures and activity-based measures. The former generally measures the outcome of implementing transportation operations programs; examples include measuring travel times, travel time reliability, or incident duration. The latter measures how successful agencies were in implementing operations programs, for example the number of expressway ramps that have ramp metering, emergency service patrol hours of service, or how many traffic signals were retimed each year.

Performance based measures also require the collection and analysis of a significant amount of data. Much of the data is either not currently being collected or is not readily available for analysis.

Ideally, the Plan should recommend a mix of both types of measures, with the primary emphasis on performance-based measures. Unfortunately, the region is not yet ready to begin a performance-based measure program. Large chunks of the Plan advocate new programs, such as arterial management, systematic signal retiming, construction coordination, or bus priority treatment. At this point, it is more crucial to measure how successful the region has been in implementing these programs than to assess their outcome in reducing congestion or improving incident management.

For more mature programs, like deploying ITS infrastructure on expressways, the availability of data to measure their success is somewhat haphazard. For example, Traffic.com and PennDOT roadside sensors generate substantial travel speed information in Pennsylvania; however, there is a dearth of travel speed information in New Jersey. Through their SWIFT system, NJDOT has an extensive database documenting their response to incidents; since PennDOT manually logs incident information, only limited information is available. Given the lack of uniform performance data, this Plan will recommend a limited number of simplistic performance-based measures. Specifics as to how to collect and analyze the data will need to be developed.

Incident Management

- Number of expressway miles where ITS deployment meets the mainline criteria as defined by the **2035 ITS Infrastructure Vision**
- Number of expressway miles with emergency service patrol coverage
- Hours of emergency service patrol by expressway miles
- Number of incidents recorded by RIMIS
- Number of municipalities PennDOT has agreements with to mange traffic signals in emergencies

Traffic Management

- Number of corridors with Integrated Corridor Management plans
- Number of CCTV cameras and VMS on arterials
- Number of traffic signals retimed each year
- Number of traffic signal upgraded and placed on signal systems each year
- Implementation of a regional construction coordination program

Traveler Information

- Incorporation of real-time transit information into 511 systems

- Total annual 511 calls
- Total annual 511 website visitors
- Number of VMS posting travel times

Transit Management

- Replacement of PATCO and New Jersey Transit operations centers
- Number of traffic signals offering bus priority treatment
- Number of bus stops offering real-time bus arrival information
- Number of Smart Stations
- Percent of SEPTA fare collection devices using Smartcard technology

Performance-Based Measures

- Average incident duration on expressways
- Average travel time between pre-defined origin-destination pairs for AM, midday, and PM peak periods
- Estimated travel time savings from retiming traffic signals

Transportation Operations Vision

The previous chapter set forth the transportation operations goals and objectives for the region. This chapter will present the transportation operations vision. It describes where basic ITS infrastructure should be constructed, emergency service patrols deployed, and where incident management task forces are warranted.

In the 2006 **ITS Master Plan**, transportation operations elements were characterized as existing, programmed, or future activity. This depiction did not accurately reflect their status. While deploying 1-2 CCTV cameras on a highway or operating peak hour emergency service patrol may constitute an existing service, its benefits were marginal. Consequently, the plan misrepresented the level of ITS deployment, implying greater coverage than what actually existed. Therefore, this Plan takes a different approach by specifying coverage levels to match road conditions. For example, should there be full CCTV coverage of an entire roadway, or should it be limited to key interchanges? Should emergency service patrols operate 8, 16, or 24 hours per day? By taking this approach, deficiencies in existing deployments can be identified and programmed for rectification.

The Plan establishes a regional vision, including deployment criteria. By projecting out to Year 2035, it takes a very ambitious view of operations. Individual agencies with tight budgets, short-term timeframes, and their own implementation policies, may not be totally in sync with all elements of the plan. However, over the next 26 years, most, if not, all elements of the vision will be implemented.

ITS Infrastructure

The **2035 ITS Infrastructure Vision** for the region is presented in **Figure 8**. The map establishes different levels of ITS infrastructure deployment for various ITS elements including CCTV cameras, VMS, incident detection, travel time detectors, and traffic signals. Level of coverage is associated with the location and function of the road. For example, different deployment levels are established for urban versus more rural expressways, and for major arterials that carry substantial traffic versus secondary arterials that support emergency operations. As a planning document, the ITS Infrastructure Vision establishes high-level regional goals. Individual agency policies may vary from these goals. As a point of reference, existing ITS coverage is documented in **Appendix B**.

Primary Coverage

This category covers the majority of expressways in the region. As high volume, multi-lane limited access highways that are prone to congestion and frequent crashes, they merit a major investment in ITS infrastructure.

- **Full CCTV camera coverage** Due to high volumes associated with this class of roads, full wall-to-wall video coverage is required to manage traffic, and locate and mitigate incidents.
- **VMS on mainline and select crossroads** VMS are needed between all interchanges to inform motorists about downstream road conditions. During normal operating conditions, VMS can post travel time information. Where feasible, VMS are required on the crossroads to intercept motorists prior to them entering a congested highway and becoming trapped in traffic.
- **Incident detection** Incident detectors will speedup incident detection by automatically sensing changes in traffic speeds and generating alerts to the operators. Using SCADA technology, information from incident detectors can automatically redirect CCTV cameras to the general vicinity of the incident. It avoids the need for operators to view hundreds of cameras to identify incidents.
- **Travel time detectors** Travel time detectors will feed 511 and other traveler information media with real-time travel conditions. VMS will display travel times at key locations, giving motorists an indicator of the level of congestion. Travel time detectors look at much longer highway segments than incident detectors, and therefore are not as sensitive to changes in highway conditions picked up by them, nor will they detect the location of the incident.

Secondary Coverage

Two types of roads fall in this category. The first group consists of expressways at the periphery of the region where traffic volumes and number of incidents do not justify the same level of ITS coverage as expressways in the region's core. Examples include the Pennsylvania Turnpike west of the Downingtown Interchange in Pennsylvania, and NJ 55 south of US 322 in New Jersey. The second class includes arterials that are almost an extension of adjacent expressways and/or arterials with controlled access. Examples include US 202 in King of Prussia, PA 100 in Exton, and the US 202 Parkway.

- **Limited CCTV camera coverage on expressways** For expressways in this category, CCTV coverage should be limited to interchange areas, high accident locations, and other sensitive areas. There is no need for wall-to-wall CCTV camera coverage.
- **Full CCTV camera coverage on arterials** CCTV camera coverage on these arterials should be far more extensive than other arterials due to their location and potential impact on the region's highway network. Full CCTV coverage is recommended.
- **VMS** Deploy VMS at key decision points. For expressways at major interchanges, and on arterials at multiple locations.

Figure 8

TRANSPORTATION OPERATIONS MASTER PLAN

2035 ITS INFRASTRUCTURE VISION

MINIMUM REQUIREMENTS

PRIMARY COVERAGE
- Full CCTV Coverage
- VMS on Mainline, Select Crossroads
- Incident Detection
- Travel Time Detectors

SECONDARY COVERAGE
- Limited CCTV Coverage on Expressways, Mainly at Interchanges
- Full CCTV Coverage on Arterials
- VMS
- Travel Time Detectors
- All signals Part of Signal Systems
- Signals Operated by PennDOT (In PA)

TERTIARY COVERAGE
- CCTV at Major Intersections
- VMS at Decision Points
- Travel Time Detectors
- All Signals Part of Signal Systems
- Signals Operated by PennDOT (In PA)

EMERGENCY ROUTES
- Limited CCTV Coverage
- Limited VMS
- Signals Operated by PennDOT (In PA) in Emergency Situations

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DELAWARE VALLEY dvrpc REGIONAL PLANNING COMMISSION

UPDATED: July 2009

- **Travel time detectors** To incorporate traffic conditions on these roads into 511, travel time detectors are needed.
- **All traffic signals to be part of a signal system** All traffic signals on these highways should be integrated into traffic signal systems.
- **Signals to be operated by PennDOT** These arterials have regional significance, and as such their signal systems should be operated by PennDOT on a 24/7 basis.

Tertiary Coverage

This category represents the key arterials in the region, most of which are on the National Highway System (NHS). As the class of roads that carry the largest share of traffic after the expressways, a moderate investment in ITS infrastructure is required to ensure they operate properly. NJDOT has already deployed CCTV cameras, VMS, and closed loop traffic signal systems on many roads of this type. ITS deployment on arterials in Pennsylvania has been limited to traffic signal systems. It should be noted that tertiary coverage in Philadelphia is greater than shown on Figure 1 due to mapping constraints.

- **CCTV cameras at major intersections** Most highways in this category are sluggish, but free flowing, with only sporadic bottlenecks. Bottlenecks are typically situated at expressway interchanges, shopping malls, business parks, and major intersections. Focusing CCTV cameras at these locations can enable traffic operators to monitor the situation and take corrective actions.
- **VMS at major intersections** Deploying VMS at select major intersections on arterials will enable traffic operations centers to positively guide motorists to avoid congested highways.
- **Travel time detectors** Traffic conditions on these roads should be available via 511 and other traveler information services. Use of vehicle probe detectors should generate sufficient information about traffic conditions.
- **All traffic signals to be part of a signal system** All traffic signals should be part of a signal system. This will enable adaptive traffic signal control, dynamically changing traffic signal timings to reflect current traffic conditions which can be fed into these systems.
- **Signals to be operated by PennDOT** In Pennsylvania, PennDOT should be responsible for operating traffic signals on these roads on a 24/7 basis. Because of the significance of these roads to the regional transportation network, signal operations need to be centralized, and not left to individual municipalities who passively operate them. This will necessitate major policy changes by PennDOT District 6-0 and PennDOT Central Office in Harrisburg.

Emergency Routes

This category of roads represents official PennDOT detour routes, unofficial detour routes, and regional emergency evacuation routes. Minimal ITS infrastructure is needed to support these highways, generally limited to major decision points and major intersections. While recognizing their importance, NJDOT did not elect to designate emergency routes due to their inability to fund ITS on them.

- **Limited CCTV camera coverage** Potential bottlenecks on emergency routes should be monitored via CCTV cameras.
- **Limited VMS** VMS are needed at decision points to guide motorists along detour routes, and/or to inform them which roads are open to traffic.
- **Traffic signals to be operated by PennDOT in emergency situations** PennDOT staff should have the authority and capability to implement pre-planed emergency traffic signal timings in emergency situations to handle the anticipated surge in traffic. During normal operating conditions, traffic signal operations would revert to the municipality.

Emergency Service Patrols

Emergency service patrols are currently deployed in the region and are considered a valuable incident management resource. **Figure 9** depicts the coverage area and hours of service for emergency service patrols. With the exception of toll roads, the current maximum hours of operation is only 16 hours weekdays, generally limited to I-295 in New Jersey and I-76 and I-95 in Philadelphia. NJDOT operates limited weekend service during summer months for shore traffic. Staffing level will vary during the day. For off-peak hours, especially overnight and on weekends, reduced staffing levels will be needed to reflect lower demand for service and the larger patrol areas a vehicle can cover. To reach the levels shown on Figure 9, a gradual ramp-up of service will be required, and may take years to accomplish. NJDOT and PennDOT have taken different approaches to operating their service patrols. NJDOT owns their tow trucks and staffs them with state employees, whereas PennDOT contracts out trucks and personnel. Each approach has proven very successful.

Full Coverage

Full coverage represents 24/7 coverage on the region's interstates, toll roads, and toll bridges. Non-interstates that fall under this category include sections of NJ 55, and NJ 90 in New Jersey; and US 1 Freeway in Pennsylvania.

There is currently 16-hour weekday coverage on I-95, I-195, I-295, and NJ 42 in New Jersey. In Pennsylvania, there is presently 16-hour weekday coverage on I-76, I-95, I-676, and US 1 Freeway; and 8-hour weekday coverage on sections on I-476 and I-76 outside Philadelphia.

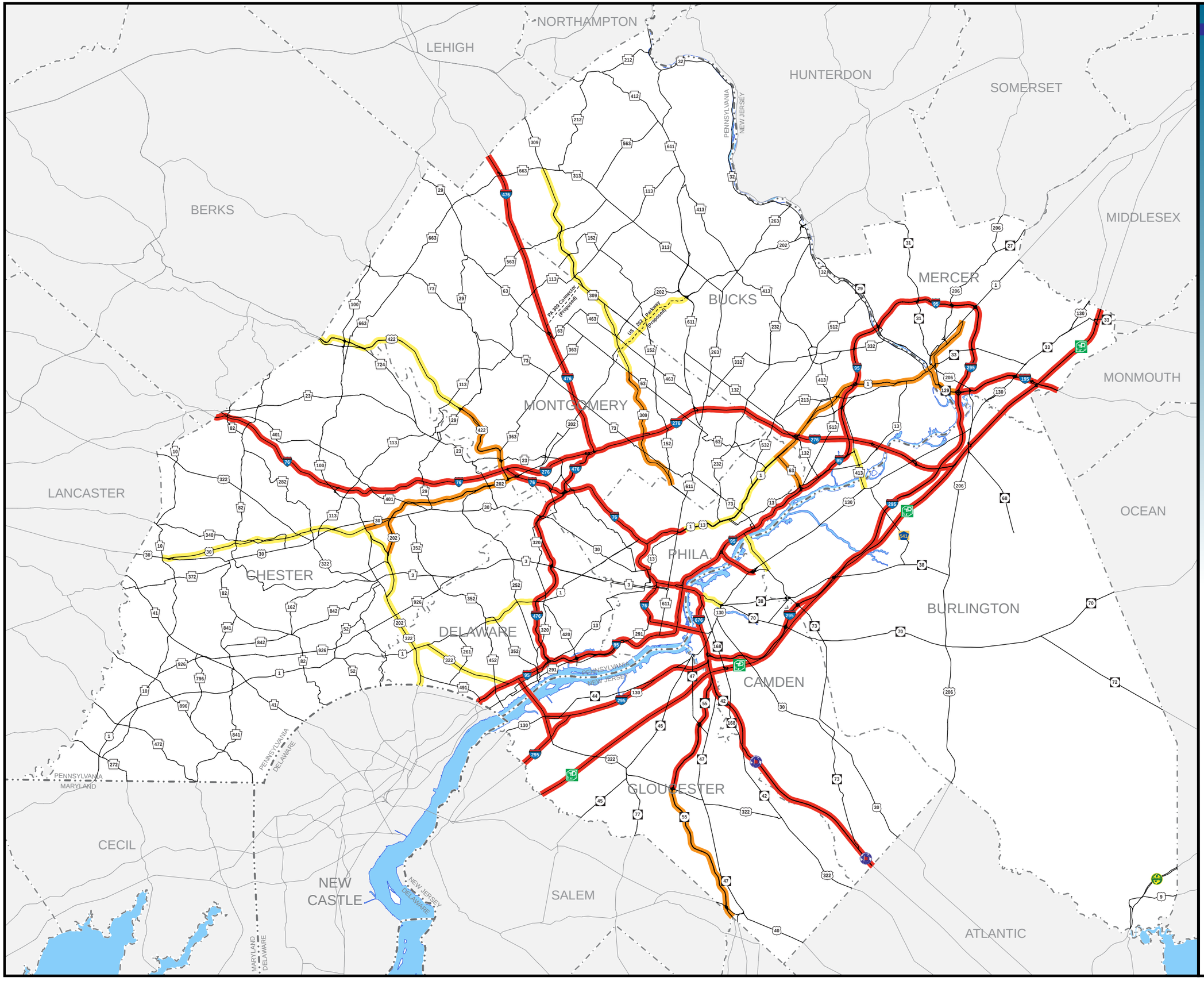
Limited Coverage

Limited coverage represents 16-hour weekday coverage for most of the remaining expressway network. Highways that fall under this category include sections of US 1, NJ 55, and NJ 129 in New Jersey; and portions of US 1, US 202, US 422, and PA 309 in Pennsylvania. Limited weekend coverage is possible depending upon circumstances. For example, NJ 55 will likely have weekend service during the summer for shore traffic.

Figure 9

TRANSPORTATION OPERATIONS MASTER PLAN

2035 EMERGENCY SERVICE PATROL (ESP) VISION



FULL COVERAGE

LIMITED COVERAGE

PEAK HOUR COVERAGE

NOTE: Staffing levels will vary throughout the day to reflect ESP demand

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Peak Hour Coverage

Peak hour coverage represents eight-hour weekday coverage, four hours in the morning and four hours in the evening, on the remaining expressways and a select number of arterials. Expressways that fall under this category are generally situated at the periphery of the region, such as US 30 and US 422. The arterials include US 1 in Philadelphia, US 322, and US 202.

Incident Management Task Forces

Incident management task forces allow local police, fire, and EMS to work with county 9-1-1 centers, state police, department of transportation staff, and the towing community to resolve incident management coordination issues. The first task force in the region was the I-76/I-476 Crossroads Incident Management Task Force in Pennsylvania, followed by the NJ 42/55/, I-76/676/295 Incident Management Task Force in New Jersey. Currently there are seven task forces in existence in the region.

Figure 10 shows the locations of existing, developing, and proposed incident management task forces. Experience has repeatedly demonstrated that local buy-in is the key to making a successful task force. Thus, unlike ITS infrastructure or emergency service patrols, the linkage between listing a task force in the Plan and making it work is a lot more tenuous. In some instances it may take years to develop a task force. Yet, in other instances, a construction project or major incident may jump start the process. Under these circumstances, the list of task forces and geographic limits, as shown on Figure 10, are very flexible, and will likely change as local conditions warrant.

Existing Task Forces

Seven incident management task forces currently exist in the region. Four of them are managed by DVRPC and two by the Greater Valley Forge TMA (GVF Transportation). However, GVF Transportation's task forces have a broader coalition building and/or construction coordination focus, and incident management is just one of many issues they address.

- **NJ 42/55, I-76/676/295 Incident Management Task Force** Located in Camden and Gloucester counties, managed by DVRPC.
- **Philadelphia Incident Management Task Force** Located in Philadelphia, managed by DVRPC. Initial focus is on the reconstruction of I-95, it will eventually expand citywide.
- **PA 309 Corridor Coalition** Located in Montgomery County, managed by GVF Transportation. The primary focus is on the PA 309 reconstruction project.
- **US 422 Corridor Coalition** Located primarily in Montgomery County, managed by GVF Transportation. While its primary focus is on mitigating traffic issues in the corridor, GVF Transportation has advanced incident management in the corridor.
- **I-76/I-476 Crossroads Incident Management Task Force** Located in Delaware, Chester, and Montgomery counties, managed by DVRPC.

- **Delaware County Incident Management Task Force** Located in Delaware County, managed by DVRPC. It is the newest task force, initially focusing on I-95 and the lower portion of I-476, but will eventually expand countywide.
- **PA 41 and Delaware** Located in Chester County and the State of Delaware. It was established by DelDOT to deal with cross-state traffic issues, it meets on an as-needed basis.

Task Forces in Development

Four incident management task forces are either in the preliminary stages of development and/or local stakeholders are advocating its need. The latter is the first step in originating a task force.

- **I-295/NJ Turnpike Camden and Burlington Counties** As one of the two major travel corridors in South Jersey, NJDOT is interested in creating an incident management task force for this segment of I-295.
- **I-95 Bucks County** Bucks County TMA is working with the Pennsylvania Turnpike Commission to establish an incident management task force as part of the Pennsylvania Turnpike/I-95 Interchange Project.
- **PA Turnpike Northeast Extension** The Pennsylvania Turnpike Commission is considering creating a task force as part of the I-476/Northeast Extension Widening Project.
- **US 202 Great Valley** Work zone management planning for US 202 reconstruction can potentially lead to an incident management task force.

Potential Task Forces

Ten potential incident management task forces are proposed in the Plan. They focus on the major travel corridors in the region, eventually completing coverage of all the expressways. It is foreseeable that some of the proposed areas will be absorbed into existing task forces, or combined among themselves, to avoid overlap or duplication. Local stakeholders will determine boundaries as part of the start-up process.

- **I-295/New Jersey Turnpike South**
- **I-95/I-195/I-295 Mercer County**
- **US 1 Mercer County**
- **Upper PA 309**
- **US 202 Bucks and Montgomery counties**
- **Delaware County Incident Management Task Force Expansion**
- **Pennsylvania Turnpike Main Line**

Figure 10

TRANSPORTATION OPERATIONS MASTER PLAN

INCIDENT MANAGEMENT TASK FORCES

- EXISTING TASK FORCE
  - 1 NJ 42 / 55, I-76 / 676 / 295
  - 2 PHILADELPHIA INCIDENT MANAGEMENT TASK FORCE
  - 3 PA 309 SOUTH
  - 4 US 422
  - 5 I-76 / I-476 CROSSROADS
  - 6 DELAWARE COUNTY TASK FORCE
  - 7 PA 41 / DELAWARE
- TASK FORCE IN DEVELOPMENT
  - 1 I-295 / NJ TURNPIKE CAMDEN & BURLINGTON COUNTIES
  - 2 I-95 BUCKS COUNTY
  - 3 PA TURNPIKE NORTHEAST EXTENTION
  - 4 US 202 GREAT VALLEY
- POTENTIAL TASK FORCE
  - 1 I-295 / NJ TURNPIKE SOUTH
  - 2 I-95 / I-195 / I-295 MERCER COUNTY
  - 3 US 1 MERCER COUNTY
  - 4 UPPER PA 309
  - 5 US 202 BUCKS & MONTGOMERY COUNTIES
  - 6 DELAWARE CO. TASK FORCE EXPANSION
  - 7 PA TURNPIKE MAIN LINE
  - 8 US 202 / PA 100 WEST CHESTER
  - 9 US 30 BYPASS
  - 10 US 1 CHESTER COUNTY
  - 11 PA 41 EXPANSION
  - 12 PA 100 CHESTER & MONTGOMERY COUNTIES

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- **US 202/PA 100/West Chester Area**
- **US 30 Bypass**
- **US 1 Chester County**
- **PA 41 Expansion**
- **PA 100 Chester & Montgomery Counties**

Integrated Corridor Management

Integrated Corridor Management (ICM) optimizes travel in a corridor by coordinating traffic on expressways and arterials, as well as between highways and transit modes. It is accomplished by integrating expressway management systems, municipal and county traffic signal systems, and transit bus and rail systems. Traffic signal timings across the corridor can be adjusted to implement traffic management strategies. Travelers will get consistent information on the best travel choices, whether it is taking an expressway, using arterials, or taking transit. **Figure 11** displays potential corridors for ICM treatment.

I-76 in Montgomery County is the prototype ICM corridor in the region. Montgomery County has taken the leadership role working with PennDOT, SEPTA, Philadelphia Streets Department, and local municipalities to develop a Transportation Systems Management (TSM) Plan for the corridor. Projects developed from the TSM Plan include constructing a closed loop traffic signal system; installing CCTV cameras, VMS, and detectors on PA 23; developing agreements with local municipalities for PennDOT to assume control of traffic signals in emergencies; constructing of E-ZPass readers on I-76 to gather travel time information; and constructing a fiber communications link between PennDOT and SEPTA. Installing kiosks at the King of Prussia Mall Transit Center is a future project awaiting funding.

As a large metropolitan area with well-defined highway and multi-modal corridors, ICM is an excellent approach to corridor management. However, the concept of ICM has not spread as rapidly as anticipated due to the number of local stakeholders and the long gestation period to develop and implement projects. As elements of the I-76 TSM Project come to fruition, it can serve as a model for others to emulate.

Regional Communications Network

In emergency situations, regional entities need to share situational information and coordinate their responses. The goal is to create a virtual operations center during these situations, where entities can share information and discuss a unified response without having to physically send representatives to each other's operations centers. Situational traffic information will primarily come from RIMIS and emergency management situational information via Knowledge Center software. Agencies also want to share video feeds of the incident and the general highway conditions. Response planning will be conducted utilizing live video conferencing and Smart Board technology.

The need for a regional communications effort has been reinforced by regional emergency evacuation planning efforts.

Making this concept work will necessitate the construction of a regional communications network. Due to bandwidth needs, and security and redundancy concerns, a private virtual network is envisioned. It is anticipated the network will be constructed through a combination of agency owned fiber resources and leased fiber. New technologies may eventually supplement or replace them.

The proposed Regional Communications Network is shown on **Figure 12**. Rather than displaying an actual network, it shows which agencies will become nodes on it. Both NJDOT and PennDOT have made extensive efforts to build out their networks. In New Jersey, many of the state entities are already interconnected. In Pennsylvania, PennDOT has fiber links to many county 9-1-1/emergency management agencies. The map does not show which municipalities may eventually be on the network.

Transportation Entities

The following types of transportation organizations are envisioned to be part of the network:

- **State DOTs** This includes NJDOT, PennDOT, and Delaware Department of Transportation.
- **Bridge and toll authorities** This the Atlantic City Expressway, New Jersey Turnpike, the Pennsylvania Turnpike, and the various Delaware River crossing bridge authorities.
- **Transit agencies** New Jersey Transit, PATCO, and SEPTA.

9-1-1/Emergency Management Agencies

County 9-1-1 public safety centers include public call takers and local police, fire, and medical service dispatchers. Except for a few isolated municipalities, all call taking and dispatching goes through county 9-1-1 centers. County emergency management agencies are responsible for coordinating incidents, like Hazmat situations, floods, and severe weather, which impacts more than one municipality. Transportation is a critical component in emergency management. In fact, it is one of 15 supporting functions defined in the National Response Framework (NRF). Constructing the regional communications network will enable better integration between transportation agencies and 9-1-1/emergency management agencies.

Separate links will be needed with Philadelphia Police Dispatch, the Fire Department Communications Center, and Philadelphia Office of Emergency Management.

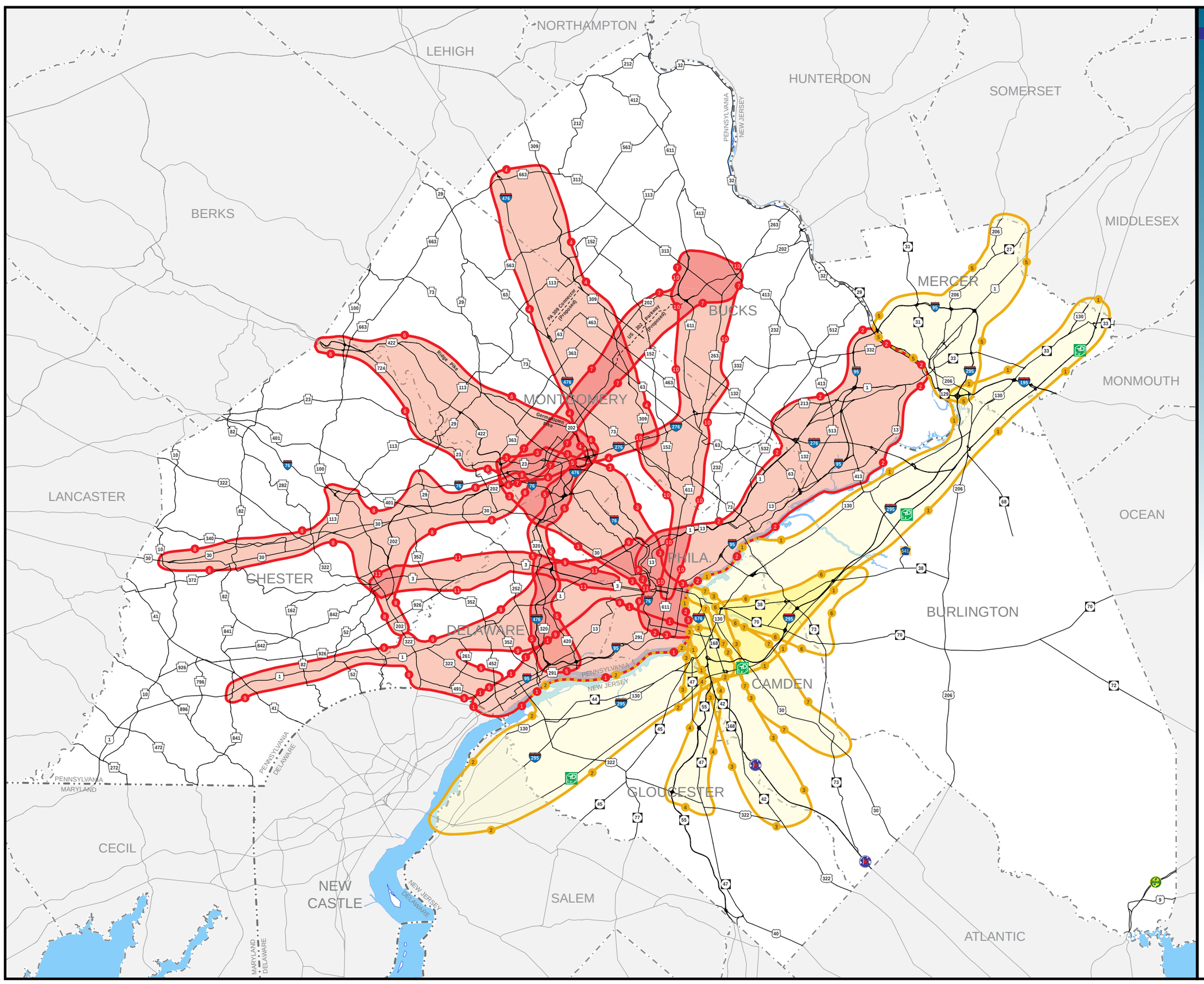
State Police

Communication linkages are required to different state police stations or barracks, as well as dispatch and intelligence centers. These locations are shown on Figure 12.

Figure 11

TRANSPORTATION OPERATIONS MASTER PLAN

2035 INTEGRATED CORRIDOR MANAGEMENT (ICM) PLAN



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1. I-95 SOUTH
2. I-95 / US 1 / NORTH
3. I-76 & I-676
4. PA Turnpike NE Extension / PA 309
5. I-476 SOUTH
6. US 422
7. US 202 NORTH
8. US 202 / US 322 / US 30 / PA 100
9. US 1 SOUTH
10. PA 611
11. PA 3

ICM Corridor

ICM Corridor Overlap

NEW JERSEY

1. I-295 / NJ Turnpike NORTH / US 130
2. I-295 / NJ Turnpike SOUTH / US 130
3. AC Expressway / NJ 42
4. NJ 41 / NJ 47 / NJ 55
5. I-95 / I-295 / US 1
6. NJ 38 / NJ 70
7. US 30

ICM Corridor

ICM Corridor Overlap

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Figure 12

TRANSPORTATION OPERATIONS MASTER PLAN

2035 REGIONAL COMMUNICATIONS NETWORK

TRANSPORTATION COMMUNICATIONS

1. NJDOT Statewide Traffic Management Center / NJTA TMC
2. NJDOT Traffic Operations - South
3. PennDOT District 6-0 Traffic Management Center
4. City of Philadelphia (Proposed)
5. Delaware River Port Authority (DRPA) TMC (Proposed)
6. Delaware River Bay Authority (DRBA)
7. Burlington County Bridge Commission (BCBC) (Potential)
8. Delaware River Joint Toll Bridge Commission (DRJTBC) (Potential)
9. South Jersey Transportation Authority (SJTA)
10. Pennsylvania Turnpike Commission (PTC) Operations Control Center
11. Burlington County TMC
12. Philadelphia Sports Complex (Proposed)
13. Southeastern Pennsylvania Transit Authority (SEPTA)
14. NJ Transit Bus Operations - South
15. **PATCO Center Tower**
16. DelDOT TMC
17. PennDOT District 5-0 Traffic Management Center
18. PennDOT District 4-0 Traffic Management Center
19. PennDOT District 8-0 Traffic Management Center

EMERGENCY COMMUNICATIONS: NEW JERSEY

911/EMA Centers

1. Burlington County
2. Camden County
3. Gloucester County
4. Mercer County

State Police

5. ROIC
6. Bellmawr
7. Bordentown
8. Hamilton NJSP / NJDOT / DEP Joint Communications Center

EMERGENCY COMMUNICATIONS: PENNSYLVANIA

911/EMA Centers

1. Bucks County
2. Chester County
3. Delaware County
4. Montgomery County
5. Philadelphia Police Dispatch
6. Philadelphia OEM / Fire Comm. Center
7. Philadelphia Fusion Center (Proposed)

State Police

8. Norristown Consolidated Dispatch Center
9. Philadelphia
10. Media
11. Skippack
12. Trevose
13. Avondale
14. Embreeville
15. Troop T Substation

Note: Select municipalities not shown

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Projects and Programs

Previous chapters presented the transportation operations vision and its supporting strategies. This chapter organizes them into a comprehensive list of projects and programs for the region to advance. It will retain the same general outline as the regional goals and objectives, namely incident management, traffic management, traveler information, and transit management. Since this is a long-range plan, the projects are more programmatic in nature because it is impossible to spell out every specific project over the next 26 years. For each program, there is a brief description, a list of priority projects, lead agency(s), and its priority versus other operations programs. **Table 5** summarizes the programs and their priorities. At the end of this chapter is an **Action Plan**, summarizing short-term high priority projects.

ITS Infrastructure Programs

Since the need to implement basic ITS infrastructure cuts across all operational goals, ITS infrastructure has been elevated to its own programmatic category. ITS infrastructure is also an enabling program; without having ITS infrastructure in place, other programs can not advance.

ITS Infrastructure on Expressways

This program involves constructing, or infilling, basic ITS infrastructure on the region's expressways to the levels established in the **2035 ITS Infrastructure Vision**. On the region's core expressways, this involves full CCTV camera coverage, VMS between all interchanges, and incident and travel time detectors. On secondary expressways, CCTV coverage will be targeted to interchange areas and VMS limited to major decision points. Building ITS infrastructure also involves constructing the underlying communications network for field-to-center communications. All of Pennsylvania's priority projects are funded through the federal program titled *American Recovery and Reinvestment Act of 2009* (Economic Stimulus Package).

- **NJ Priority Projects:** I-295 (Creek Road to I-195), NJ 42 Expressway, NJ 55 (US 322 to NJ 42)
- **PA Priority Projects:** I-95 Delaware County (Delaware State Line to the Airport), I-95 Bucks County (PA 132 to New Jersey), US 1 Bucks County (I-95 to New Jersey), PA 63 (I-95 to US 1)
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** High

Table 5: Transportation Program Priorities

Category	Program	Priority
ITS Infrastructure	ITS Infrastructure on Expressways	High
	ITS Infrastructure at Select Expressway Crossroads	Medium
	Philadelphia ITS Infrastructure	Medium
	DRPA ITS Infrastructure	Medium
	Road Weather Information Systems	Low
	Roadway Treatment Systems	Low
Traffic Management Centers	DOT Traffic Operations Center Support	High
	DRPA Traffic Operations Center	High
	Philadelphia Traffic Operations Center	High
	New Jersey County Traffic Operations Centers	Low
Incident Management	Emergency Service Patrols	High
	RIMIS	High
	Incident Management Task Forces	High
	Incident Management Grant Initiative	High
	Arterial Traffic Management	High
	PennDOT Manages Traffic Signals in Emergencies	High
	Tow Truck Incentive Programs	Medium
	“Move It/Move Over/Quick Clearance” Public Education Program	Medium
	Detour Route Initiatives	Medium
	Emergency Communications Network	Medium
	Crash Investigation Equipment	Low
	Emergency Evacuation Plan	Low
	On-Ramp Gates and Median Barrier Gates	Low
	Share Computer-Aided Dispatch Information	Low
Traffic Management	Traffic Signal Retiming Program	High
	Traffic Signal Moderization and Interconnection	High
	PennDOT Operates Traffic Signals	High
	Construction Coordination	High
	Archive Traffic Data	Medium
	Traffic Signal Maintenance Program	Medium
	PennDOT Traffic Signal Monitoring Program	Medium
	Integrated Corridor Management Initiatives	Medium
	Work Zone Traffic Management Initiatives	Medium
	Ramp Metering	Medium
	Variable Speed Limits	Medium
	Freight Initiatives	Low

Source: DVRPC, 2009

Table 5: Transportation Program Priorities (Continued)

Category	Program	Priority
Traveler Information	511 and Traveler Information Websites	High
	Place Travel Times on VMS	High
	Continue Public-Private Partnerships	High
	Centralize Construction, Maintenance, and Special Events Info	Medium
	Travel Information at Service Plazes and Visitor Centers	Low
Transit Management	PATCO Operations Center	High
	New Jersey Transit Bus Operations South	High
	Smart Bus Stops and Stations	High
	Bus Priority Treatment	High
	Fare Collections Systems/Smart Card Technology	High
	Passenger Surveliance and Safety Systems	High
	Security Systems	High

Source: DVRPC, 2009

ITS Infrastructure at Select Expressway Crossroads

The ITS Infrastructure Vision calls for constructing VMS at select expressways crossroads to warn motorists about congestion or incident conditions prior to them entering the highway. Because this aspect of ITS infrastructure is not as high of a priority as deploying ITS on expressway mainlines, it was separated out into a separate program. Identification of which interchanges will receive VMS on their approach roads requires further study.

- **NJ Priority Projects:** I-95/I-295 (I-195 to Pennsylvania State Line), I-295 (I-76 to Creek Road)
- **PA Priority:** I-76 (US 1 to Pennsylvania Turnpike), I-95 (I-676 to PA 132), US 202 (PA 252 to I-76), US 422 (US 202 to PA 29)
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** Medium

Philadelphia ITS Infrastructure

The City of Philadelphia plans to deploy CCTV cameras, VMS, and travel time detectors on major arterials in the city. The impetus for the program is two-fold. First, to actively manage traffic on the City's arterials utilizing signal systems, cameras, and other field devices. Second, to manage traffic diversions during the I-95 Reconstruction Project. The City, PennDOT, and DVRPC are currently working together to develop a master plan for this program.

- **Priority Project:** Conduct study to develop ITS Master Plan
- **Lead Entities:** Philadelphia Streets Department, PennDOT
- **Program Priority:** Medium

DRPA ITS Infrastructure

This project will complete the installation of ITS infrastructure on DRPA's four bridges. It includes constructing additional CCTV cameras, VMS, travel time detectors, and infrastructure sensors. Funding for this project will largely come from DRPA toll revenues, with additional FHWA financial support.

- **Priority Projects:** None
- **Lead Entities:** DRPA
- **Program Priority:** Medium

RWIS Systems

This program will continue deployment of Road Weather Information Systems to monitor roadway conditions though out the entire region. RWIS devices measure ambient weather and road surface conditions and transmit the data back to traffic management centers and maintenance operations. Although NJDOT and PennDOT have deployed a number of RWIS systems, existing coverage is very limited, not providing sufficient roadway conditions information. This program will fill in gaps in RWIS coverage.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT
- **Priority:** Low

Roadway Treatment Systems

This program will install devices to spray anti-icing chemicals at locations that have icing problems. Further study is required to identify potential locations and appropriate technology.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT
- **Priority:** Low

Traffic Management Centers

Traffic management centers is another category of programs which cut across all the transportation operations goals and like ITS infrastructure is the first step towards implementing more advanced programs.

DOT Traffic Operations Center Support

This program will assist the departments of transportation to operate and maintain their traffic operations centers, NJDOT's Statewide Traffic Operations Center, NJDOT Traffic Operations – South, and PennDOT District 6-0's Traffic Management Center. Federal funding will support equipment and software upgrades and operations center enhancements. It should not pay for operations center personnel.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT
- **Priority:** High

DRPA Traffic Operations Center

DRPA is planning a centralized traffic operations center to manage traffic on its four Delaware River crossings. CCTV cameras, VMS, traffic detectors, and other devices will be managed from the new center. It will also give regional agencies a centralized point of contact in lieu of contacting DRPA police officers at each bridge. This project will fund the federal share of the operations center.

- **Priority Projects:** None
- **Lead Entity:** DRPA
- **Program Priority:** High

City of Philadelphia Traffic Operations Center

One-quarter of the traffic signals in Pennsylvania, over 3,200 signals, are located in the City of Philadelphia. This project will allow Philadelphia to construct a traffic operations center to manage traffic signals on its traffic signal system. Ultimately, the City also intends to construct and operate CCTV cameras, VMS, and travel time detectors. Philadelphia is receiving funding for an interim center as part of the I-95 Reconstruction Project. Initially it will operate during peak hours, with PennDOT managing traffic signals during off-peak hours. A permanent traffic operations center will probably be co-located in the City's proposed fusion center.

- **Priority Projects:** None
- **Lead Entity:** Philadelphia Streets Department
- **Program Priority:** High

New Jersey County Traffic Operations Centers

This program will construct county traffic operations centers in New Jersey. The centers will allow the counties to actively monitor and manage traffic signals on their signal systems. Burlington County's traffic operations center is the prototype for the other counties. Camden County does not currently operate any of its signals; it has relegated that responsibility to its municipalities. Therefore, for Camden County this is a more problematic initiative.

- **Priority Projects:** None
- **Lead Entities:** Camden, Gloucester, and Mercer Counties
- **Program Priority:** Low

Incident Management Programs

There are approximately 15 programs recommended in the Plan dealing with various aspects of incident management. The largest cost item is emergency service patrols. Some programs, like RIMIS and the emergency communications network, focus on improving interagency information sharing. Others like on-ramp gates or detour route signage are on-street projects to manage traffic. While others, like incident management task forces and tow truck incentive programs address institutional issues.

Emergency Service Patrols

Emergency service patrols are one of the most effective incident management tools. This project will incrementally increase service patrol coverage until the ultimate vision presented on the **2035 Emergency Service Patrol Vision** is achieved. Expanding service hours will not require a commensurate increase in cost since the number of patrol vehicles on the road will vary during the day to reflect traffic conditions.

- **NJ Priority Projects:** Increase coverage hours on I-76, I-295 (from I-76 to Creek Road), and NJ 42 to 24/5.
- **PA Priority Projects:** Increase coverage on all Interstates to 16/5. This requires extending patrol coverage to I-95 in Bucks County.
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** High

RIMIS

RIMIS will provide situational information about traffic and transit conditions to traffic management centers, transit agencies, county 9-1-1/emergency management centers, and the state police. RIMIS

should be operational within the next 6-8 months. This program will pay for RIMIS's operations and maintenance, and for data interfaces so that RIMIS can collect information from agency legacy systems.

- **Priority Projects:** Implement RIMIS, construct RIMIS-PennDOT District 6-0 Traffic Management Center data interface.
- **Lead Entities:** DVRPC
- **Program Priority:** High

Incident Management Task Forces

Maintain existing incident management task forces; initiate new task forces, as needed, to provide coverage as depicted in the **2035 Incident Management Task Force Vision**. Among other benefits, task forces will address interagency cooperation issues, provide training focused on highway incident management, and conduct post-incident reviews.

- **NJ Priority Projects:** I-295/NJ Turnpike Camden and Burlington counties, I-95/I-195/I-295 Mercer County
- **PA Priority Projects:** I-95 Bucks County, US 202 Great Valley, US 202/PA 100 West Chester
- **Lead Entities:** DVRPC, GVF Transportation, TBD
- **Program Priority:** High

Incident Management Grant Initiative

This new program would issue small-scale grants, $70,000 per year in total, to local responders and County 9-1-1 centers to purchase equipment for highway incident management. Eligible projects include traffic control equipment, detour route and reference location sign implementation, communications equipment for interagency operability, traffic signal power interrupt devices, and training courses. This will be a competitive program that would be structured in a way to foster greater interagency cooperation.

- **Priority Projects:** None
- **Lead Entities:** DVRPC
- **Program Priority:** High

Arterial Management

Arterial management programs serve a dual purpose. Under normal traffic conditions, arterial management forms the backbone of integrated corridor management. It supplements signal systems by installing CCTV cameras and VMS to more actively manage the arterial network, reducing delays

and increasing overall corridor throughput. During expressway closures and other emergencies, it will enable NJDOT and PennDOT to manage traffic on detour and emergency evacuation routes. NJDOT already has arterial management programs in place on sections of US 1, NJ 38, NJ 70, and NJ 73; PennDOT is nearing completion of its first project on PA 23.

- **NJ Priority Projects:** US 130, NJ 168
- **PA Priority Projects:** US 1 (Roosevelt Boulevard), US 13 (Frankford Avenue), PA 23 (Conshohocken State Road)
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** High

PennDOT Manages Traffic Signals in Emergencies

There are two programs in the Plan that advance some form of PennDOT operations of traffic signals. This program is the first step in that direction, with PennDOT assuming control of traffic signals during emergencies. It allows operators in PennDOT's Traffic Management Center to implement pre-planned emergency signal timing plans to handle the surge of traffic during a detour, special event, or an emergency evacuation. It replies upon other Plan programs, to construct signal systems and the underlying communications network that enable this functionality.

- **Priority Project:** Conshohocken State Road (PA 23) as part of the I-76 TSM Project
- **Lead Entities:** PennDOT
- **Program Priority:** High

Tow Truck Incentive Program

This program would restructure laws regarding recovery and removal of vehicles in New Jersey and Pennsylvania. It will permit either the state police or department of transportation to assess a penalty should a trucking company not have a salvage crew and tow truck on-site and complete removal/salvage operations within an allotted time. It will reduce incident duration by minimizing the wait time for a contracted towing and recovery crew to show up on scene.

- **Priority Project:** Conduct a tow truck incentive demonstration project
- **Lead Entities:** TBD
- **Program Priority:** Medium

"Move It/Move Over/Quick Clearance" Public Education Program

Quick Clearance public education can take two forms. First, erecting signs on highways informing motorists to move disabled vehicles or vehicles involved in a minor accident off the highway.

PennDOT plans to start installing “Fender Bender” signs on I-76, I-476, and US 422. Second, periodically employing public service radio announcements and/or paid advertising to reach a wider audience. This program envisions utilizing both approaches with the departments of transportation responsible for the former and a regional entity, like DVRPC, coordinating the latter.

- **Priority Project:** Construct Fender Bender signs
- **Lead Entities:** NJDOT, PennDOT, DVRPC
- **Program Priority:** Medium

Detour Route Initiatives

Both NJDOT and PennDOT have official detour routes for their highways. However, motorists and many public agencies are not aware of the routes. This program will increase awareness through several initiatives. It will erect detour signs delineating the routes for motorists. PennDOT already has accomplished this; NJDOT has yet to install any signs. DVRPC has developed IDRuM (www.idrum.us), an interactive web browser program that graphically displays all the detour routes for seven of the region’s nine counties. While emergency response personnel use IDRuM, the information is not getting out to the public. Linking IDRuM to traffic reporting services and agency 511 systems/traveler information websites will generate wider knowledge about the detour routes. Establishing official detour routes and signing them will not insure they will succeed. New operating procedures for local police and department of transportation personnel are needed to ensure the detour routes are ready for the surge in traffic, traffic control points are staffed, and emergency traveler information is provided to motorists in an expeditious manner.

- **Priority Projects:** Erect detour route signs, complete and maintain IDRuM
- **Lead Entities:** NJDOT, PennDOT, DVRPC
- **Program Priority:** Medium

Emergency Communications Network

In an emergency or large-scale special event, transportation, law enforcement, and emergency management agencies need to communicate situational and command information with each other. Situational information will come from two sources, traffic information via RIMIS and emergency management information via Knowledge Center. The long-term vision is to utilize video conferencing and Smart Board technology for command decision-making. The vital nature of these communications requires a secure redundant broadband network. This network can be built upon the fiber network many agencies are building to operate signal systems. This program will fund the “last mile” cost associated with running fiber cable from the signal network to law enforcement or emergency management agencies. It would also cover equipment for video conferencing and Smart Board Technology to be installed in traffic operations centers. The program is eligible for Department of Homeland Security funding.

- **Priority Projects:** Build connections to County 9-1-1/Emergency Management Centers
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** Medium

Crash Investigation Equipment

This program will enable state police departments to purchase additional crash investigation equipment. Pre-deploying crash investigation equipment throughout the region will reduce incident duration by speeding up equipment arrival to the scene of a major crash. This program will also train additional police officers to use the equipment, so police do not have to wait for the arrival of a trained crash investigator.

- **Priority Projects:** None
- **Lead Entities:** New Jersey State Police, Pennsylvania State Police
- **Program Priority:** Low

Emergency Evacuation Plan

Several emergency evacuation planning efforts are underway in the region. They range from all hazard plans to incident specific plans, such as a hurricane at the Jersey Shore. Completion of the plans is just the first step. Table top exercises to test the plans need to be conducted, traffic control equipment stored for emergency use, and mutual aid agreements developed to share resources during the evacuation. Detailed protocols to support various aspects of the plans also have to be formulated.

- **Priority Projects:** None
- **Lead Entities:** Various
- **Program Priority:** Low

On-Ramp Gates and Median Barrier Gates

Construct gates at expressway on-ramps to prevent vehicles from entering a closed highway. Construct median barrier gates to facilitate removal of vehicles trapped on an expressway. It is recommended demonstration projects be implemented to develop procedures for their use and to test their effectiveness.

- **Priority Project:** None
- **Lead Entities:** NJDOT, PennDOT, FHWA
- **Program Priority:** Low

Share Computer-Aided Dispatch Information

This program will allow departments of transportation to obtain state police and county 9-1-1 computer-aided dispatch information pertaining to expressways, detour routes, and other transportation facilities. Transportation agencies will use CAD data to supplement their situational information, especially on detour routes that are not monitored. Criminal and other sensitive information will have to be filtered out of the data. Due to the innovative nature of the project, and the hesitation of law enforcement agencies to divulge this type of information, an appropriate approach on how to advance this program needs to be developed.

- **Priority Projects:** None
- **Lead Entities:** TBD
- **Program Priority:** Low

Traffic Management Programs

Traffic management programs address a wide range of categories including traffic signals, work zones, capacity enhancements, and intermodal transportation.

Traffic Signal Retiming Program

Generally, once a traffic signal is constructed, its signal timing plan is rarely adjusted to reflect changes in traffic conditions. While there may be occasional adjustments in response to citizen complaints; more typically, new development, changes in land uses, and drifts in time based coordination timings result in signals that are not fully optimized. This program represents a systematic approach to periodically retime traffic signals on a five-year basis. Signal retiming entails extensive data collection, field studies, and using signal optimization software. For traffic signals on signal systems, measures of effectiveness captured by the signal system can assist in determining when optimization is required and reduce data collection requirements.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, New Jersey counties, PennDOT, Philadelphia Streets Department
- **Program Priority:** High

Traffic Signal Modernization and Interconnect Program

This program will systematically upgrade traffic signals, incorporating them into signal systems. It will replace outdated traffic signal controllers, construct fiber communications, and install the necessary software. Signal heads and other equipment would be replaced as needed. DVRPC is developing a Regional Strategic Corridor Investment Plan that will identify key corridors for signal upgrade and

system integration. While the program is predominately targeted to traffic signals in Pennsylvania, it is also applicable for NJDOT and county traffic signals in New Jersey.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, New Jersey counties, PennDOT, City of Philadelphia, DVRPC
- **Program Priority:** High

PennDOT Operates Traffic Signals

This program will assist PennDOT in assuming responsibility for operating traffic signals on key interregional arterials identified in the **2035 ITS Infrastructure Vision**. These arterials carry a disproportionate share of traffic on the arterial highway network. Most of the traffic signals on these arterials are already part of municipally operated signal systems. This project will fund the necessary integration at PennDOT, purchasing the requisite equipment and software for signal operations. This is the second of two PennDOT traffic signal programs. The first would enable PennDOT to operate traffic signals on detour routes in emergencies; it is a precursor to this project.

- **Priority Projects:** None
- **Lead Entities:** PennDOT
- **Program Priority:** High

Construction Coordination

While many entities issue construction alerts about impending construction or maintenance activity, there is no overall program to ensure construction projects do not conflict; having concurrent projects on adjacent roads. With the implementation of RIMIS, agencies will have a common regional database to input future maintenance and construction activity. With some minor enhancements, RIMIS will gain the functionality to geographically plot future construction events by date and time periods. DVRPC staff will need to work with agencies to develop procedures and resolve interagency conflicts that may occasionally occur.

- **Priority Project:** Modify RIMIS software to graphically display future construction projects by date and time.
- **Lead Entities:** DVRPC
- **Program Priority:** High

Archive Traffic Data

Data archiving will store traffic information, incident information, and agency actions in a user friendly format that can readily be accessed for future analysis. Much of the data generated by ITS devices, whether from roadside sensors or traffic signal equipment, is either not retained or is retained in a

format that is not very usable. Information needs be stored at two levels, at the agencies and at a regional entity like DVRPC. Agencies will need to agree upon a regional architecture to archive data.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, New Jersey counties, PennDOT, DVRPC
- **Program Priority:** Medium

Traffic Signal Maintenance Program

In Pennsylvania, the municipalities are responsible for maintenance of traffic signals. With the exception of Philadelphia, most municipalities contract signal maintenance to outside vendors. Consequently, the quality of routine signal maintenance and responsiveness for emergency signal repairs is haphazard; a function of the service contract and maintenance company. Development of uniform maintenance contract standards would assure traffic signals are properly maintained. While this program is targeted to Pennsylvania, it is also applicable to New Jersey where the counties do not have a uniform signal maintenance program.

- **Priority Projects:** None
- **Lead Entities:** PennDOT
- **Program Priority:** Medium

PennDOT Traffic Signal Monitoring Program

This program complements PennDOT operation of traffic signals by providing the communications links and hardware for them to monitor traffic signals operated by the municipalities. By monitoring these signals, PennDOT can make certain the signal timings are in compliance with the official signal timing plan. It will also permit PennDOT Traffic Management Center personnel to determine when signal timings are not optimized, triggering a signal optimization project.

- **Priority Projects:** None
- **Lead Entities:** PennDOT
- **Program Priority:** Medium

Integrated Corridor Management Initiatives

The I-76 TSM project is the prototype integrated corridor management program. What made it very successful was the initial planning undertaken, working with the municipalities and PennDOT to identify parallel highways, potential signal systems, arterial management systems, transit initiatives, and inter-jurisdictional signal coordination projects. Instead of advocating specific projects to advance, integrated corridor management should initially focus on developing strategic plans for

major corridors, identifying ITS projects and institutional solutions. Projects can then advance under other Plan programs like traffic signal modernization, arterial traffic management, or incident management task forces. Potential corridors for analysis are displayed in the **2035 Integrated Corridor Management Plan**.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT, DVRPC
- **Program Priority:** Medium

Work Zone Traffic Management Initiatives

Departments of transportation and other highway operators routinely develop maintenance of traffic plans for construction projects and maintenance activities. Work zone traffic management elevates the level of planning and resources for projects that impact expressways and high volume arterials. Depending upon the type of facility, duration of project, and impact on traffic, work zone initiatives may lead to formation of work zone management teams, pre-deployment of permanent or temporary CCTV cameras and speed detectors, and installation of warning devices and intrusion sensors. Since many of these techniques are relatively new to highway designers and their consultants, an education effort is required to train personnel.

- **Priority Projects:** Hold work zone traffic management workshops and training programs, form work zone management teams
- **Lead Entities:** NJDOT, PennDOT, FHWA
- **Program Priority:** Medium

Ramp Metering

Ramp metering regulates the flow of traffic onto an expressway at a rate that will not be disruptive to mainline traffic flow. While ramp metering is a proven technology, the difficulty in implementing it in the region has been the prevalence of substandard ramps. Many highways were designed in the 1950's; consequently, the ramps have insufficient storage capacity and/or deficient acceleration lanes for vehicles stopped at a ramp signal. In Pennsylvania, ramp meters are in place at several I-476 interchanges. PennDOT wants to construct ramp metering on sections of I-95 (Bucks County), US 30 Bypass, US 422, and PA 309. NJDOT also expressed a strong interest in implementing ramp metering on I-295 and other highways in South Jersey. A study is needed to identify locations conducive for ramp metering, and to identify those ramps that can meet the criteria with minor to moderate geometric upgrades.

- **Priority Project:** Conduct ramp metering study
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** Medium

Variable Speed Limits

Variable speed limits is an approach to safely slow traffic when an event such as an incident or a maintenance crew is causing traffic backups. It minimizes high-speed rear end collisions caused by unexpected traffic queues. This program will involve constructing dynamic message signs after each on-ramp informing motorists of the appropriate speed limit. For long expressway segments, intermediate variable speed limit signs may be appropriate, to account for situations that occur between the interchanges. Procedures to determine how to establish the appropriate safe speed and then to incrementally sign it so as to gradually reduce vehicle speeds, need to be developed. New Jersey and Pennsylvania may need special legislation to modify traffic regulations to make variable speed limits enforceable.

- **New Jersey Priority Project:** I-295
- **Pennsylvania Priority Projects:** I-76, I-95
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** Medium

Freight Initiatives

DVRPC's Goods Movement Committee has identified several areas where ITS can assist freight operations. Intermodal connectors, local roadways between freight terminals and the expressway system, are frequently populated with rail lines feeding the terminals. Upgrading highway-rail intersections with new technology will increase safety and improve signal operations. Providing truck drivers with real-time traffic information, not only for major highways but also for the intermodal connectors is also a priority identified by the committee. To avoid long queues at entrance gates, many ports throughout the country have implemented appointment calendars, requiring truckers to sign-up in advance for slots at the terminal. Metering the number of trucks entering the port, increases the port's efficiency to load or unload containers, and gets trucks out faster.

- **Priority Projects:** None
- **Lead Entities:** TBD
- **Program Priority:** Low

Traveler Information

Traveler information programs will continue to advance initiatives like 511 and place travel times on VMS, as well as continue public-private partnerships. The private sector has greater technical and financial resources to disseminate traveler information than the public sector. Agencies have come to rely upon the private sector as an indispensable partner in disseminating traveler information. Transit specific traveler information programs are discussed in the next section, under transit management.

511 and Traveler Information Websites

NJDOT's 511 program began operations in early 2008, and PennDOT's program will go online Summer 2009. Like traffic operations centers, 511 interactive voice response (IVR) systems and websites require ongoing support to maintain software and equipment, and update to the newest IT standards. NJDOT has expanded its 511 database to incorporate other agencies such as DRPA and the South Jersey Transportation Authority. Other entities such as transit, county roads and the Burlington County Bridge Commission are still missing. Similarly, PennDOT will eventually have to capture local traveler and transit information from the Philadelphia Streets Department, SEPTA, and other local entities.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** High

Place Travel Times on VMS

FHWA guidance encourages the posting of travel times on VMS, when they are not displaying incident information. Blank VMS are a transportation investment that is not being fully utilized. In areas that experience congestion or where traffic conditions are unreliable, it is encouraged that travel time messages be the default information provided to motorists. This requires installation of travel time detectors, typically E-ZPass readers in this region, and converting the raw data into origin-destination travel times. This is an ongoing program, retrofitting legacy systems and incorporating travel time technology into new ITS deployments.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT
- **Program Priority:** High

Continue Public-Private Partnerships

Traveler information partnerships are a two-way street. Giving travel and incident information to traffic reporting services and other information service providers is an inexpensive way for the public sector to disseminate their traffic information to the public. At the same time, the private sector is investing in state of the art technologies, such as GPS based vehicle probes, to capture travel speeds on a wide range of highways, not just expressways. As this technology matures, it may become more cost effective to purchase travel time information from the private sector than to deploy agency owned assets.

- **Priority Projects:** None
- **Lead Entities:** NJDOT, PennDOT, toll and bridge authorities

- **Program Priority:** High

Centralize Construction, Maintenance, and Special Events Information

Special events, maintenance, and construction activity are large contributors to non-recurring traffic congestion. Information about special events and maintenance and construction activity is scattered among the operating agencies; information about utility work is largely nonexistent. A centralized repository can address this problem; reducing the time and resources agencies dedicate to collect this information, and providing a single database for information service providers to utilize. Utilizing RIMIS as the central repository might be a potential solution.

- **Priority Projects:** None
- **Lead Entities:** TBD
- **Program Priority:** Medium

Travel Information at Service Plazas and Visitor Centers

Placing traveler information kiosks in turnpike plazas, visitor centers, shopping malls, and other similar venues supplements other traveler information programs. Information should cover all modes of transportation, not just highways.

- **Priority Projects:** None
- **Lead Entities:** New Jersey Turnpike Authority, Pennsylvania Turnpike Commission, PennDOT
- **Program Priority:** Low

Transit Management

Transit management programs include upgrading transit management centers, traveler information and fare collection systems, and implementing security technology. The programs listed below represent distinct projects that transit agencies typically implement. There is also a broader range of ITS technology routinely incorporated into transit projects. New buses and rail vehicles, for example, typically come with diagnostic sensors and passenger information displays. Because these technologies are normally incorporated in larger projects, there is no need for specific programs to implement them.

PATCO Operations Center

PATCO plans to replace its operations center, Center Tower, with a new larger facility utilizing SCADA technology. Center Tower is PATCO's original operations center. The proposed SCADA system will operate PATCO's power, signal, traveler information, and safety and security systems.

- **Priority Project:** None
- **Lead Entities:** PATCO
- **Program Priority:** High

New Jersey Transit Bus Operations South Operations Center

New Jersey Transit Bus Operations South is responsible for dispatching all buses in South Jersey. Its current technology is not suitable for implementing many of the Plan's more innovative transit management and traveler information programs. Unlike PATCO's Center Tower, the new bus operations center does not require constructing a new building; instead, the project involves new workstations, CAD technology, and systems integration.

- **Priority Project:** None
- **Lead Entities:** New Jersey Transit
- **Program Priority:** High

Smart Bus Stops and Stations

Smart bus stops and stations give real-time arrival information to waiting passengers. For buses, it involves equipping them with GPS systems, installing small display panels in bus shelters, and creating a communications link between the transit operations center and the bus stops. In Pennsylvania, SEPTA's bus fleet is mostly GPS equipped; PennDOT has offered SEPTA use of its fiber network. New Jersey does not have as much infrastructure in place. SEPTA has an ongoing program to upgrade traveler information equipment in its stations; beginning in Center City and extending outwards on both rail stations and regional rail lines. PATCO has upgraded traveler information systems in all its stations, and currently provides real-time traveler information.

- **Priority Project:** Conduct demonstration project for smart bus stops
- **Lead Entities:** New Jersey Transit, SEPTA
- **Program Priority:** High

Bus Priority Treatment

Bus priority treatment permits buses approaching an intersection to extend green times by a few seconds, allowing them to clear the intersection and not get stopped at the traffic signal. There are several technologies available to accomplish bus priority treatment. A demonstration project is needed to evaluate the alternative technologies.

- **Priority Project:** Conduct demonstration project
- **Lead Entities:** New Jersey Transit, SEPTA

- **Program Priority:** High

Fare Collection Systems/Smart Card Technology

PATCO's Freedom Card is the first use of Smartcard technology in the region. SEPTA has a study underway to evaluate Smartcard technology, and has programmed funds to implement its results. New Jersey Transit is more focused on implementing a new fare medium in North Jersey. After the technology has been selected and rolled out in North Jersey, it is anticipated New Jersey Transit will implement it in South Jersey.

- **Priority Project:** Deploy a SEPTA Smartcard
- **Lead Entities:** New Jersey Transit, SEPTA
- **Program Priority:** High

Passenger Surveillance and Safety Systems

This program will install CCTV cameras, emergency telephones, and panic buttons, in train stations, parking lots, and at bus stops to create a safer environment for transit passengers. Security systems also include technology capable of automatically monitoring data feeds from all the surveillance equipment. Also included in this category are two-way public address systems, interoperability radio communications so local emergency responders can communicate with transit police officers, smoke detectors, and other safety devices.

- **Priority Project:** None
- **Lead Entities:** New Jersey Transit, PATCO, SEPTA
- **Program Priority:** High

Security Systems

Security systems protect the assets of the transit operator and involve anti-terrorism surveillance. While they have two separate focuses, there is a large overlap between the two. This program will extend passenger security systems to protect critical infrastructure, transit repair shops and yards, and other sensitive areas. It involves installing intrusion detection systems, CCTV cameras, radiological and biological detectors, and fire/smoke systems. This is predominately a Department of Homeland Security initiative.

- **Priority Project:** None
- **Lead Entities:** New Jersey Transit, PATCO, SEPTA
- **Program Priority:** High

Action Plan

This section summarizes the high priority projects that constitute a short-term **Action Plan** for transportation operations. Projects outside local regional control, such as implement 511 programs, are not included in the plan.

ITS Infrastructure Projects

- I-295 Burlington County (Creek Road to I-195)
- NJ 42 Expressway
- NJ 55 (US 322 to NJ 42)
- I-95 Delaware County (Delaware State Line to Philadelphia International Airport)
- I-95 Bucks County (PA 132 to New Jersey State Line)
- US 1 Bucks County (I-95 to New Jersey State Line)
- PA 63 (I-95 to US 1)

Traffic Management Centers

- DOT Traffic Operations Center Support
- Construct DRPA Traffic Operations Center
- Construct Philadelphia Traffic Operations Center

Incident Management

- New Jersey Emergency Service Patrols — Increase hours on I-76, I-295 (I-76 to Creek Road), and on NJ 42
- Pennsylvania Emergency Service Patrols — Initiate coverage on I-95 Bucks County, increase hours to 16/5 on all Interstates
- RIMIS — Implement RIMIS, construct RIMIS-PennDOT District 6-0 data interface
- New Jersey Incident Management Task Forces — I-295/NJ Turnpike Camden and Burlington counties, I-95/I-195/I-295 Mercer County
- Pennsylvania Incident Management Task Forces — I-95 Bucks County, US 202 Great Valley, US 202/PA 100 West Chester
- Implement an Incident Management Grant Initiative Program
- New Jersey Arterial Management — US 130, NJ 168

- Pennsylvania Arterial Management — US 1 (Roosevelt Boulevard), PA 23 (Conshohocken State Road)
- PennDOT Manages Traffic Signals in Emergencies

Traffic Management

- Implement Traffic Signal retiming Program
- Implement Signal Modernization Program
- Implement Construction Coordination Program

Traveler Information

- Place Travel Times on VMS
- Implement and Upgrade 511 and Traveler Information Websites
- Add Transit Information to 511 and Traveler Information Websites
- Continue Public-Private Partnerships

Transit Management

- Construct New PATCO Operations Center
- Construct New Jersey Transit Bus Operations Center South
- Conduct Smart Bus Stop Demonstration Project
- Conduct Bus Priority Treatment Demonstration Project
- Deploy SEPTA Smartcard
- Passenger Surveillance and Safety Systems
- Security Systems

Financial Plan

This chapter presents a financial analysis of how much it will cost to build out, operate, and maintain the transportation operations vision presented in the Plan. As a Metropolitan Planning Organization (MPO), DVRPC's primary focus is on the allocation of federal highway and transit funds. Federal planning regulations require MPOs, such as DVRPC, to perform a financial analysis of their long-range plan, to project funding needs and revenues. As the first comprehensive financial analysis of regional transportation operations, this effort will begin to frame the long-term financial commitment required to fund transportation operations.

Toll roads, bridge authorities, counties, and municipalities all directly or indirectly contribute substantial resources to support operations; whether it is funding traffic signal maintenance or paying municipal fire departments to respond to vehicle crashes. This funding is largely unquantifiable and excluded from the analysis.

There is a significant recurring cost associated with operating and maintaining ITS systems. Software needs constant updating, new device drivers are always being developed, and IT technology is continuously evolving. Without a commitment to update software and equipment to the latest standards, they rapidly become outdated and obsolete. CCTV cameras, VMS, and other ITS equipment have a relatively short life span as compared to a highway or bridge; they require periodic replacement. Communications costs are integral to operating ITS equipment. Whether leasing bandwidth from commercial communication providers or engaging service contracts to maintain agency owned communication assets, it requires funding. Agencies cannot financially bear the full cost of operations and maintenance with their own resources. Therefore, they frequently seek federal funds if they are eligible. Agencies are obviously responsible for personnel and other minor costs. On the other hand, big ticket items such as replacing VMS or major software upgrades are more problematic. In funding ITS with federal monies, there is an implied commitment to operate and maintain the investment in these deployments with federal funds.

The traditional transportation federal funding and spending model does not match how transportation operations functions. Many operations programs are not capital projects, but rather involve purchasing equipment and services; and in many instances, they are targeted to non-traditional stakeholders. DVRPC's Transportation Improvement Program (TIP) already funds service contacts for emergency service patrols. Municipalities and counties have made a significant investment of their own in their traffic signals. Without federal money, these signals will not be retimed or modernized on a systematic basis. Using federal funds for incident management training courses or to purchase traffic control equipment for emergency responders will have a beneficial impact on traffic operations. To achieve the goals and objectives outlined in the Plan will necessitate a more liberal

interpretation of the types of projects eligible for TIP funding. Specific eligibility and cost sharing guidelines will have to be developed.

Methodology

Cost projections in the Plan represent order of magnitude costs in 2009 dollars. A bottom-up analysis was conducted to estimate costs. Where specific information was available, it was used. However, for most plan elements, gross assumptions on deployment level, location, and phasing were made with limited agency input. Costs were derived from a combination of agency input and unit costs from national deployment statistics. While the cost estimate for specific elements are less precise, it is believed the overall cost represents a reasonable estimate of funding transportation operations between 2010 and 2035. Therefore, while there is a substantial technical underpinning to this analysis, only the overall results are shown in this document.

This financial plan was developed in close coordination with DVRPC's long-range plan, ***Connections***. Results of this analysis directly fed into ***Connections*** Transportation Operations financial needs assessment. The long-range plan, in turn, allocated funding among broad categories of capital investment based on financial constraints. For consistency with ***Connections***, the financial plan was divided into three time periods: 2010-2015, 2016-2025, and 2026-2035. The major discrepancy between the two financial plans is that this analysis used 2009 dollars, whereas the long-range plan adjusted needs and revenues for inflation.

Financial Plan Project Assumptions - Highways

For those cost elements associated with the **Transportation Vision** presented in Chapter 3, the vision maps were used as the basis to identify specific projects, which were then spread out over the three time periods. For other plan elements, the analysis tends to be more high-level. While agency input framed the process, DVRPC was responsible for specific assumptions.

Below are some of the major assumptions used to define scope of projects for cost estimating purposes:

- **ITS infrastructure (Pennsylvania)** Using the ITS Infrastructure map as a guide, the first priority in Pennsylvania is to complete ITS deployment on the Interstate system; this includes infilling ITS devices on I-95 in Center City and on I-476; and on adjoining highways such as US 322, PA 63, and US 1 in Bucks County. The next priority is to infill ITS on the non-Interstate expressways; extending ITS deployments on highways such as US 422 west of PA 29 and US 1 Media Bypass; and begin deploying ITS devices at select Interstate crossroads. The last priority is to deploy ITS on lower priority expressways such as US 1 in Chester County and PA 309 in Bucks County, and continuing to deploy ITS at select expressway crossroads.
- **ITS infrastructure (New Jersey)** The highest priority in New Jersey is to deploy ITS on I-295 in Burlington County and between I-76 and US 130 in Gloucester County, and on NJ 42. The next priority includes I-676, US 1 Freeway, NJ 29 between I-95 and US 1, and NJ 55 north of US 322. The last priority includes deployment on the southern portion of NJ 55, US 130 between I-295

and the Commodore Barry Bridge, and initial deployment of ITS at select expressway crossroads.

- **Emergency service patrols (Pennsylvania)** Interstates: 16-hour weekday coverage 2010-2015, 24-hour weekday coverage 2016-2025, and 24/7 coverage 2026-2035. Non-interstates: retain existing coverage 2010-2015, 8-hour weekday coverage 2016-2025 and 16 hour weekday coverage 2026-2035. Expressways that will ultimately have only peak-period coverage would not receive funding until 2026-2035.

- **Emergency service patrols (New Jersey)** Service patrols presently operate 16/5 with limited weekend service. To achieve 24/7 operations requires a 50 percent increase in service. It was assumed half the increase would occur during the 2016-2025 time period and the remainder in the 2026-2035 time period. No assumptions were made with respect to specific facilities.

- **Pennsylvania traffic signals** For the four suburban counties in Pennsylvania, it is assumed 350 signals will initially be retimed each year, gradually tapering to 200 per year during the 2026-2035 time period. On a five-year schedule, approximately half the signals in these counties would be retimed. As traffic signal systems and their underlying communications are built-out, PennDOT envisions gaining the capability of monitoring the signals and adjusting signal timing plans from their offices, without the need for extensive studies or field work, eventually reducing the number of signals to be retimed each year. It is also assumed 150 signals per year will be modernized. This total represents a balance in the enormous costs associated with upgrading traffic signals and the goal of eventually replacing outdated traffic signal equipment.

- **Philadelphia traffic signals and ITS devices** The City of Philadelphia provided an estimate of the number of CCTV cameras, VMS, and speed detectors they plan to deploy. For traffic signal systems, DVRPC identified major travel corridors within the city, and then estimated the number of signals in these corridors on existing systems. It was assumed the remaining signals in these corridors will eventually be included in systems.

- **Arterial management (New Jersey)** NJDOT has installed closed loop traffic signal systems, CCTV cameras, and VMS on US 1, US 30, NJ 38, NJ 70, and NJ 73. For this analysis, it is assumed that over time these systems would be extended outwards. For example, on NJ 38, ITS will be deployed to US 206 from I-295. Other major state highways without arterial management systems, such as US 130, US 206, and NJ 41, will also receive ITS deployments.

- **New Jersey county traffic signal systems** Burlington County was used as the prototype for estimating attributes associated with constructing and operating a centralized county traffic signal system. There are currently 250 county owned traffic signals, of which 150 are on the County's signal system. It took Burlington County 15 years to construct their system. The Plan assumes for each financial time period one of the other South Jersey counties will begin constructing a signal system; however, due to the 15-year timeframe involved, costs for each county will have to be spread out among two time periods. It was also assumed the magnitude of signals to be modernized and retimed would be similar to Burlington County's mix.

Financial Plan Cost Assumptions – Highways

Unit cost information used to estimate deployment costs primarily came from the agencies. Where information was unavailable, or needed to be supplemented, USDOT's Research and Innovative

Technology Administration (RITA) ITS cost database was used. RITA maintains an extensive database of unit costs for a wide range of ITS deployments, based on national deployment statistics.

Below are examples of the cost assumptions used:

- **Expressway deployments** It costs PennDOT approximately $1 million per mile to deploy ITS on its expressways, inclusive of CCTV cameras, VMS, detectors, and fiber communications. In New Jersey, wherever NJDOT has already installed fiber on an expressway, the unit deployment cost was appropriately discounted.
- **Emergency service patrols** Based on PennDOT's current contract, it costs approximately $100 per hour to operate an emergency service patrol vehicle. Service patrol costs are based on the hours of service and number of patrol vehicles. The former was determined as per the emergency service patrol vision; the latter was obtained from PennDOT. In addition to these costs, tow trucks need to be replaced on a 3-year cycle, at $85,000 per vehicle. In New Jersey, NJDOT provided a statewide emergency service patrol cost, which was then prorated to the DVRPC region.
- **Traffic signals** A unit cost of $3,500 per signal is used for signal retiming programs, and $50,000 per signal for traffic signal modernization and upgrade programs. The latter cost includes signal controllers and supporting communication systems.
- **Traffic management centers** The annual cost to operate and maintain traffic management centers was obtained from PennDOT. NJDOT felt comfortable using the same unit cost in New Jersey. Burlington County supplied the cost to construct county traffic operations centers.
- **DRPA** DRPA provided costs to deploy ITS on it's four bridges and to construct a centralized traffic operations center. Discussions were held with them to split the cost into toll revenue and federal funding. The federal share was then equally split between New Jersey and Pennsylvania.

Financial Plan Project and Cost Assumptions – Transit

Financial projects and costs for transit operations were directly obtained from New Jersey Transit and SEPTA. There was no need to perform any independent cost analysis.

Transportation Operations Financing Needs

Table 6 summarizes highway operations funding needs for New Jersey and Pennsylvania. Costs are aggregated into five categories, ITS Infrastructure, Traffic Management Centers, Incident Management, Traffic Management, and Traffic Signals. Total highway operations needs in 2009 dollars are projected to be $407 million in New Jersey and $1,022 million in Pennsylvania. Pennsylvania is anticipated to have a more expensive program than New Jersey due to a larger network of expressways and traffic signals.

Table 6: Highway Operations Cost Estimate Summary (2009-2035)

	New Jersey		Pennsylvania	
Category	Cost	Percent	Cost	Percent
ITS Infrastructure	$116,620,000	28.6%	$459,450,000	45.0%
Traffic Mgmt. Centers	$24,570,000	6.0%	$24,930,000	2.4%
Incident Management	$181,330,000	44.6%	$197,120,000	19.3%
Traffic Management	$20,310,000	5.0%	$31,410,000	3.1%
Traffic Signals	$64,200,000	15.8%	$308,700,000	30.2%
TOTAL	**$407,030,000**	**100.0%**	**$1,021,610,000**	**100.0%**

Source: DVRPC, 2009

In New Jersey, incident management represents 45 percent of the operations costs, ITS infrastructure 30 percent, and traffic signals represent 15 percent. Incident management costs are largely attributable to emergency service patrols. In Pennsylvania, ITS infrastructure accounts for 45 percent of the cost, traffic signals 30 percent, and incident management represents 19 percent. In both states, traffic management is almost incidental when compared to the larger, more costly programs.

Transit operations related projects and programs are projected to cost approximately $79.3 million in New Jersey and $391.5 million in Pennsylvania (**Table 9**). Again, Pennsylvania has a more extensive network of rail and buses than South Jersey, resulting in a more ambitious program.

Highway Operations Costs – New Jersey

Below is a detailed analysis of highway operations costs that are summarized in **Table 7**. Some details cited are generalized from supporting spreadsheets, not shown, used to calculate overall costs.

- **Operations and maintenance costs** Operations and maintenance costs represent 66 percent, or $267 million, of the overall transportation operations program. However, at $145 million, emergency service patrols account for 53 percent of the operations and maintenance budget. More traditional maintenance activities, such as software replacement or communications costs, constitute less that 40 percent of operations and maintenance costs.
- **Emergency service patrols** At $145 million, emergency service patrols represent the largest cost component of the plan for New Jersey. Its annual cost will grow to $6.5 million from the current $4.3 million per year.
- **Expressway ITS infrastructure** Constructing and infilling ITS infrastructure on expressways, at $104 million, is the second most costly component of New Jersey's costs in the Plan.
- **DRPA** About $9 million will be spent to fund ITS on DRPA bridges. This represents New Jersey's share of the non-toll revenue needed to construct, operate, and maintain ITS equipment on the four bridges.

- **Traffic management centers** $800,000 each year has been set aside to help support operation of NJDOT's Statewide Traffic Management Center and Traffic Operations - South. $2.7 million has been allocated to construct county traffic management centers in Camden, Gloucester, and Mercer counties.
- **Arterial management** This component will provide for construction of signal systems, and extending CCTV camera and VMS sign coverage on state highways that do not currently have such systems.
- **County signal systems** This category consists of two separate county traffic signal projects. The larger program, estimated at $36 million, will fund signal systems on county roads in Camden, Gloucester, and Mercer counties. Another $28 million is budgeted to fund an ongoing traffic signal retiming program for all four South Jersey counties.

Highway Operations Costs – Pennsylvania

Below is a detailed analysis of highway operations costs that are summarized in **Table 8**. Some details cited are generalized from supporting spreadsheets, not shown, used to calculate overall costs.

- **Operation and maintenance costs** At $480 million, operation and maintenance activities represent 47 percent of the overall transportation operations costs. Not all of the costs are attributable to typical maintenance type activities. Emergency service patrols at $164 million and traffic signal retiming programs at $32 million make up 41 percent of the operations and maintenance costs in Pennsylvania.
- **Expressway ITS infrastructure** This item represents the largest cost component, at $400 million. Slightly over half the cost is associated with building out or infilling ITS infrastructure including CCTV cameras, VMS, incident and travel time detectors, and fiber communications networks. With $73 million earmarked to ITS, the Economic Stimulus Package will fund a sizeable share of the ITS infrastructure build-out. The other half of ITS infrastructure costs are associated with operations and maintenance; service contracts and replacement costs.
- **Road treatment systems** This program has a relatively high maintenance cost due to replacement of anti-icing materials.
- **DRPA bridges** The cost for DRPA represents Pennsylvania's portion of non-toll revenue to support construction and maintenance of ITS infrastructure on its four bridges.
- **Traffic management centers** $1.25 million is allocated toward construction of DRPA and Philadelphia's traffic operations centers. $6 million per year is set aside for support of PennDOT, Philadelphia, and DRPA traffic operations centers.
- **Emergency service patrols** $164 million is set aside for emergency service patrols in Pennsylvania. Annual costs gradually increase to $8 million per year from $4 million per year as patrol coverage and service hours increase. Emergency service patrols account for one-third of the operations and maintenance costs.
- **RIMIS** RIMIS is funded at $8 million, including service contracts, data interfaces, and software enhancements.

- **Incident management task forces and equipment** Over $4 million is budgeted for more general incident management programs including incident management task forces, an incident management grant initiative, advertising quick clearance policies, and purchasing accident investigation equipment.

- **Traffic management** Traffic management constitutes only 3 percent of the highway operations budget. The most costly item under traffic management is variable speed limit signs.

- **Traffic signals** The financial plan allocates 30 percent of the overall budget, $308 million, to traffic signal related programs. Traffic signal modernization including new signal systems is projected to cost $240 million, with about $190 million of that spent in the suburban counties. Even though there is a comparable number of traffic signals in Philadelphia and the four suburban counties, the majority of signals in Philadelphia do not warrant signal system treatment. Traffic signal retiming programs, in both the city and suburbs, will cost $32 million. PennDOT programs to centralize traffic signal control at their Regional Traffic Management Center represent the remaining signal funding.

Table 7: New Jersey Highway Operations Cost Estimate

Category	Element	2010-2015		2016-2025		2026-2035	
		Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M
ITS Infrastructure	Expressways	$15,160,000	$2,280,000	$23,750,000	$13,520,000	$23,660,000	$25,370,000
	RWIS Systems	$150,000	$20,000	$200,000	$120,000	$150,000	$210,000
	Road Treatment Systems	$600,000	$150,000	$600,000	$750,000	$0	$1,000,000
	DRPA Bridges	$2,500,000	$220,000	$1,000,000	$1,750,000	$1,000,000	$2,450,000
	Subtotal	**$18,410,000**	**$2,670,000**	**$25,550,000**	**$16,140,000**	**$24,810,000**	**$29,030,000**
Traffic Management Centers	NJDOT TOCs	$0	$4,800,000	$0	$8,000,000	$0	$8,000,000
	DRPA TOC	$500,000	$80,000	$0	$250,000	$0	$250,000
	County TOCs	$500,000	$200,000	$500,000	$400,000	$500,000	$600,000
	Subtotal	**$1,000,000**	**$5,080,000**	**$500,000**	**$8,650,000**	**$500,000**	**$8,850,000**
Incident Management	Emergency Service Patrols	$0	$26,000,000	$0	$54,200,000	$0	$65,000,000
	RIMIS	$750,000	$690,000	$1,900,000	$820,000	$1,030,000	$820,000
	Task Forces, Equipment	$60,000	$410,000	$60,000	$710,000	$60,000	$710,000
	Arterial Management	$4,530,000	$680,000	$5,670,000	$3,680,000	$6,770,000	$6,790,000
	Subtotal	**$5,340,000**	**$27,780,000**	**$7,630,000**	**$59,410,000**	**$7,860,000**	**$73,320,000**
Traffic Management	Ramp Metering	$1,050,000	$160,000	$1,450,000	$890,000	$500,000	$1,370,000
	Variable Speed Limits	$1,750,000	$260,000	$2,900,000	$1,600,000	$3,650,000	$3,240,000
	Parking Management	$0	$0	$850,000	$210,000	$0	$430,000
	Subtotal	**$2,800,000**	**$420,000**	**$5,200,000**	**$2,700,000**	**$4,150,000**	**$5,040,000**
Traffic Signals	County Signal Systems	$6,250,000	$0	$16,250,000	$0	$13,500,000	$0
	County Retiming/Upgrades	$0	$3,900,000	$0	$11,000,000	$0	$13,300,000
	Subtotal	**$6,250,000**	**$3,900,000**	**$16,250,000**	**$11,000,000**	**$13,500,000**	**$13,300,000**
TOTAL		**$33,800,000**	**$39,850,000**	**$55,130,000**	**$97,900,000**	**$50,820,000**	**$129,540,000**

Source: DVRPC, 2009

Table 8: Pennsylvania Highway Operations Cost Estimate

Category	Element	2010-2015		2016-2025		2026-2035	
		Capital Cost	O&M	Capital Cost	O&M	Capital Cost	O&M
ITS Infrastructure	Expressways	$82,300,000	$12,350,000	$85,450,000	$62,510,000	$54,200,000	$97,420,000
	RWIS Systems	$260,000	$40,000	$340,000	$220,000	$130,000	$330,000
	Road Treatment Systems	$0	$0	$3,000,000	$2,500,000	$9,000,000	$10,000,000
	City of Philadelphia	$5,700,000	$850,000	$9,200,000	$5,150,000	$1,700,000	$7,880,000
	DRPA Bridges	$2,500,000	$220,000	$1,000,000	$1,750,000	$1,000,000	$2,450.000
	Subtotal	**$90,760,000**	**$13,460,000**	**$98,990,000**	**$72,130,000**	**$66,030,000**	**$118,080,000**
Traffic Management Centers	PennDOT District 6-0	$0	$4,800,000	$0	$8,000,000	$0	$8,000,000
	City of Philadelphia TOC	$750,000	$300,000	$0	$1,000,000	$0	$1,000,000
	DRPA TOC	$500,000	$80,000	$0	$250,000	$0	$250,000
	Subtotal	**$1,250,000**	**$5,180,000**	**$0**	**$9,250,000**	**$0**	**$9,250,000**
Incident Management	Emergency Service Patrols	$0	$26,020,000	$0	$56,740,000	$0	$80,780,000
	RIMIS	$870,000	$1,410,000	$1,470,000	$1,670,000	$740,000	$1,680,000
	Task Forces, Equipment	$350,000	$610,000	$540,000	$1,030,000	$640,000	$1,030,000
	Emg. Comm. Network	$190,000	$30,000	$160,000	$130,000	$530,000	$300,000
	Arterial Management	$3,220,000	$480,000	$4,140,000	$2,650,000	$4,830,000	$4,890,000
	Subtotal	**$4,630,000**	**$28,550,000**	**$6,310,000**	**$62,220,000**	**$6,740,000**	**$88,680,000**
Traffic Management	Ramp Metering	$450,000	$30,000	$1,300,000	$430,000	$850,000	$960,000
	Variable Speed Limits	$1,750,000	$260,0 00	$6,150,000	$2,410,000	$4,350,000	$5,020,000
	Parking Management	$1,100,000	$300,000	$1,800,000	$1,750,000	$0	$2,500,000
	Subtotal	**$3,300,000**	**$590,000**	**$9,250,000**	**$4,590,000**	**$5,200,000**	**$8,480,000**
Traffic Signals	Signal Retiming/Upgrades	$45,150,000	$7,540,000	$75,150,000	$10,810,000	$75,150,000	$7,290,000
	Signal Communications	$3,000,000	$450,000	$3,750,000	$2,440,000	$3,000,000	$4,130,000
	Philadelphia Traffic Signals	$16,950,000	$5,880,000	$19,950,000	$10,790,000	$7,550,000	$9,720,000
	Subtotal	**$65,100,000**	**$13,870,000**	**$98,850,000**	**$24,040,000**	**$85,700,000**	**$21,140,000**
TOTAL		**$165,040,000**	**$61,640,000**	**$213,400,000**	**$172,230,000**	**$163,670,000**	**$245,630,000**

Source: DVRPC, 2009

Transit Operations

Transit operations costs, as summarized in **Table 9**, were directly obtained from the transit agencies, and are thus not as detailed as the highway costs projected by DVRPC. New Jersey Transit, and to a lesser extent SEPTA, tended to group ITS operational improvements into a generic category called Information Technology Systems (ITS). This category encompasses a wide range of projects from SCADA systems used to dispatch and monitor buses and rail, to passenger count systems used for planning purposes. SEPTA plans major investments in a new fare collection system, costing $84 million, and real-time traveler information programs, at $67 million.

In addition to the direct operational costs listed in the table, there are significant indirect costs associated with other transit initiatives. Both transit agencies are planning significant investments in new and rehabilitated transit vehicles, new rail lines, and security systems. ITS technology is an unquantifiable cost component of these projects.

Table 9: Transit Operations Cost Estimate

Element	New Jersey Transit			SEPTA		
	2010-2015	2016-2025	2026-2035	2010-2015	2016-2025	2026-2035
Information Technology (ITS)	$18,000,000	$30,000,000	$30,000,000	$62,700,000	$36,900,000	$36,900,000
Real-Time Information	$0	$0	$0	$52,900,000	$14,000,000	$0
Traffic Signal Preemption	$0	$0	$0	$8,900,000	$8,100,000	$9,600,000
Smart Stations	$0	$0	$0	$30,800,000	$21,000,000	$26,100,000
Fare Modernization	$300,000	$500,000	$500,000	$83,600,000	$0	$0
TOTAL	**$18,300,000**	**$30,500,000**	**$30,500,000**	**$238,900,000**	**$80,000,000**	**$72,600,000**

Source: DVRPC, 2009

Funding Allocation

As part of the ***Connections*** planning effort, an extensive financial analysis was conducted to estimate transportation funding needs and potential revenues. Because federal regulations require an MPO's long-range transportation plan to be fiscally constrained, the allocation of monies cannot exceed total revenues.

The ***Connections*** analysis was a cooperative effort between the state departments of transportation, local transit agencies, federal funding agencies, and county planners. Preparation of revenue estimates involved reviewing historical data and trends, statewide financial guidance documents, previous Statewide Transportation Improvement Programs (STIP), FHWA SAFETEA-LU planning guidance, and other relevant documents. Funding needs were derived from agency capital programs, asset management systems, cost estimates of projects of regional significance, spending trends, and agency cost estimates. All revenue and needs were adjusted for inflation. An annual inflation rate of 4 percent was used. To be consistent with the Plan, ***Connections*** needs and revenues were converted back to 2009 dollars. However, there are still minor discrepancies between the plans due to project timing assumptions and how to account for the Economic Stimulus Package.

Transportation funding needs of the long-range plan were divided into seven highway and six transit program areas, one of which represents operations. All program areas were then further divided into subcategories to better characterize transportation needs. It is important to note the transit agencies define operations more broadly, and include such items as doubling tracks and sidings, which is outside the scope of this Plan. An initial allocation of highway and transit revenue was based on percentage of need. Actual percent allocations for each category were then determined by DVRPC in cooperation with its planning partners.

Resulting funding needs and allocations for highways from ***Connections*** are presented in **Table 10** and **Table 11**.

Table 10: Connections Financial Plan Needs and Allocation – New Jersey Highways

Category	Needs (in millions)*		Allocation (in millions)*	
	Dollars	% of Need	Allocated Dollars	% of Allocation
Highway Reconstruction, Resurfacing, Restoration	$3,768.5	30.4%	$2,559.6	31.0%
Bridge Replacement/Restoration	$4,636.6	38.7%	$3,098.8	37.6%
Safety Improvements	$1,203.4	10.0%	$998.3	12.1%
Transportation Operations	$407.0	3.5%	$247.8	3.0%
New Capacity	$1,381.4	11.3%	$986.5	11.9%
Bike/Pedestrian	$453.5	4.1%	$119.6	1.4%
Other	$237.1	2.0%	$247.8	3.0%
TOTAL	**$12,088.1**	**100.0%**	**$8,258.4**	**100%**

* In 2009 dollars (*Connections* uses inflation adjusted dollars)
Source: DVRPC, 2009

As might be anticipated, bridge and highway reconstruction/resurfacing projects are the greatest regional highway needs, representing over 70 percent of the projected highway expenditures in both states. Highway operations only account for 3.5 percent of New Jersey's needs and 4.8 percent of Pennsylvania's needs. Since regional needs far exceed potential revenues, funding had to be re-allocated in a manner to reflect regional priorities and uncertainty in cost estimates. In re-allocating funds, operations in New Jersey did not fare as well as it did in Pennsylvania. The net result is that operations will receive $247.8 million in New Jersey, which is 61 percent of the estimated need. In Pennsylvania it will receive $669.8 million, or 66 percent.

Due to the urgency of bridge repairs, it is recognized that bridges will receive a disproportionate funding for years 2010-2015. Many of the other funding needs identified for the time period will have to be deferred to a later date. However, over the 26-year time period in ***Connections***, it is assumed the allocation percentage among program areas will be maintained. As has previously been stated, the federal Economic Stimulus Package will make a significant down payment, $73 million, toward building ITS infrastructure in Pennsylvania.

Table 11: Connections Financial Plan Needs and Allocation – Pennsylvania Highways

Category	Needs (in millions)*		Allocation (in millions)*	
	Dollars	% of Need	Allocated Dollars	% of Allocation
Highway Reconstruction, Resurfacing, Restoration	$5,291.1	24.6%	$3,886.9	30.6%
Bridge Replacement/Restoration	$11,563.5	53.9%	$5,191.9	40.8%
Safety Improvements	$1,244.5	5.8%	$1,093.0	8.6%
Transportation Operations	$1,021.6	4.8%	$669.8	5.3%
New Capacity	$1,627.2	7.6%	$1,466.2	11.5%
Bike/Pedestrian	$480.8	2.2%	$221.5	1.7%
Other	$243.4	1.1%	$192.1	1.5%
TOTAL	**$21,472.0**	**100.0%**	**$12,721.4**	**100%**

* In 2009 dollars (*Connections* uses inflation adjusted dollars)
Source: DVRPC, 2009

Transit needs and funding allocations from ***Connections*** are presented in **Table 12** and **Table 13**.

Transit vehicle rehabilitation and restoration are the most costly program area in both states, representing 38 percent of the total transit needs. New rail and BRT starts are the next most costly need in New Jersey, with rail infrastructure rehabilitation and restoration the second most costly program in Pennsylvania. Transportation operations represent only 1.1 percent of the total transit needs in New Jersey and 4.5 percent in Pennsylvania. While this program area includes projects outside the scope of the Plan, the vast majority of operations funding needs submitted by transit agencies focus on information technology, real-time information, fare modernization, and smart stations. Transit operations programs fare very well in the allocation process, with New Jersey funding 76 percent of their projected needs, and Pennsylvania funding 99 percent.

The Plan will not attempt to bridge the gap between transportation operations needs and potential funding. By establishing transportation operations priorities, regional planners will have sufficient guidance to decide which projects and programs to advance.

Table 12: Connections Financial Plan Needs and Allocation – New Jersey Transit

Category	Needs (in millions)*		Allocation (in millions)*	
	Dollars	% of Need	Allocated Dollars	% of Allocation
Rail Infrastructure Rehabilitation, Restoration	$438.3	6.1%	$392.0	7.5%
Vehicle Rehabilitation, Restoration	$2,807.7	38.9%	$2,430.5	46.5%
Station Enhancements	$528.8	7.3%	$522.7	10.0%
System/Operational Improvements	$79.3	1.1%	$78.4	1.5%
New Capacity	$2,591.6	35.9%	$1,306.7	25.0%
Other	$769.8	10.7%	$496.6	9.5%
TOTAL	**$7,215.4**	**100.0%**	**$5,226.9**	**100%**

* In 2009 dollars (*Connections* uses inflation adjusted dollars)
Source: DVRPC, 2009

Table 13: Connections Financial Plan Needs and Allocation – Pennsylvania Transit

Category	Needs (in millions)*		Allocation (in millions)*	
	Dollars	% of Need	Allocated Dollars	% of Allocation
Rail Infrastructure Rehabilitation, Restoration	$3,724.9	23.4%	$2,198.2	22.0%
Vehicle Rehabilitation, Restoration	$6,128.6	38.5%	$3,796.8	38.0%
Station Enhancements	$2,834.4	17.8%	$1,498.7	15.0%
System/Operational Improvements	$714.7	4.5%	$699.4	7.0%
New Capacity	$1,489.9	9.4%	$799.3	8.0%
Other	$1,013.5	6.4%	$999.2	10.0%
TOTAL	**$15,904.8**	**100.0%**	**$9,991.7**	**100%**

* In 2009 dollars (*Connections* uses inflation adjusted dollars)
Source: DVRPC, 2009

APPENDIX A

Transportation Operations Survey Results

A survey was conducted by DVRPC to gauge transportation operations needs in the region. This survey, titled **Transportation Operations in the DVRPC Region** was disseminated in January and February of 2009 to various members of the transportation operations community including incident management task forces, departments of transportation, transit agencies, toll authorities, and transportation management associations. Over 160 unique responses to the survey were recorded out of an estimated 500 surveys that were distributed. For a survey of this size, a 30 percent response rate is excellent. Approximately, 65 percent of the survey responders answered from a Pennsylvania perspective, 29 percent from a New Jersey perspective, and 6 percent answered the survey from both perspectives. **Table 14** further details the composition of survey responses, by asking if they are a member of a particular group. It is important to note that survey respondents could choose more than one group. For example, they could be a member of an incident management task force, as well as a first responder.

Table 14: Survey Results: Respondents Membership

Survey Respondents Membership	Number of Responses
NJ 42/55, I-76/676/295 Incident Management Task Force Member	46
I-76/476 Incident Management Task Force Member	38
US 422 Corridor Coalition Member	37
Transportation Operations Task Force Member	27
PA 309 Corridor Coalition Member	15
I-95 Philadelphia Incident Management Task Force Member	13
Delaware County Incident Management Task Force Member	13
Other	13

Source: DVRPC, 2009

Table 15 lists employment categories of those responding to the survey. A survey respondent could choose more than one category of employment. Forty-three percent of survey respondents described their employment as a first responder, working in the fire, police, EMS or towing industry, for example. Due to a high number of first responders answering the survey, overall results could be interpreted as slightly skewed to their needs. The “Other” category is the second most popular answer, and included employment categories such as municipal public works staff and transportation consultants.

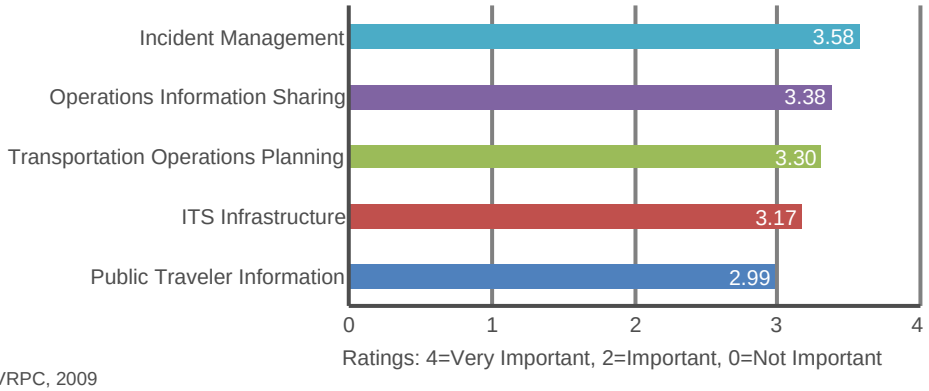
Table 15: Survey Results: Respondents Employment

Survey Respondents Employment	Number of Responses
First Responder (Fire, Police, EMS, Towing, etc)	69
Other	33
County 9-1-1/EOC/EMA Staff	15
PennDOT Staff	13
County Planning Staff	11
Transportation Management Association (TMA) Staff	11
NJDOT Staff	8
DRPA Staff	4
SEPTA Staff	3
FHWA Staff	2
PA Turnpike Staff	2
NJ Transit Staff	1

Source: DVRPC, 2009

As seen in **Figure 13**, "Incident Management" needs ranked highest when asked to rate five general programs with respect to improving overall traffic operations on the highway system in the region. Each general program was then explored further in subsequent questions.

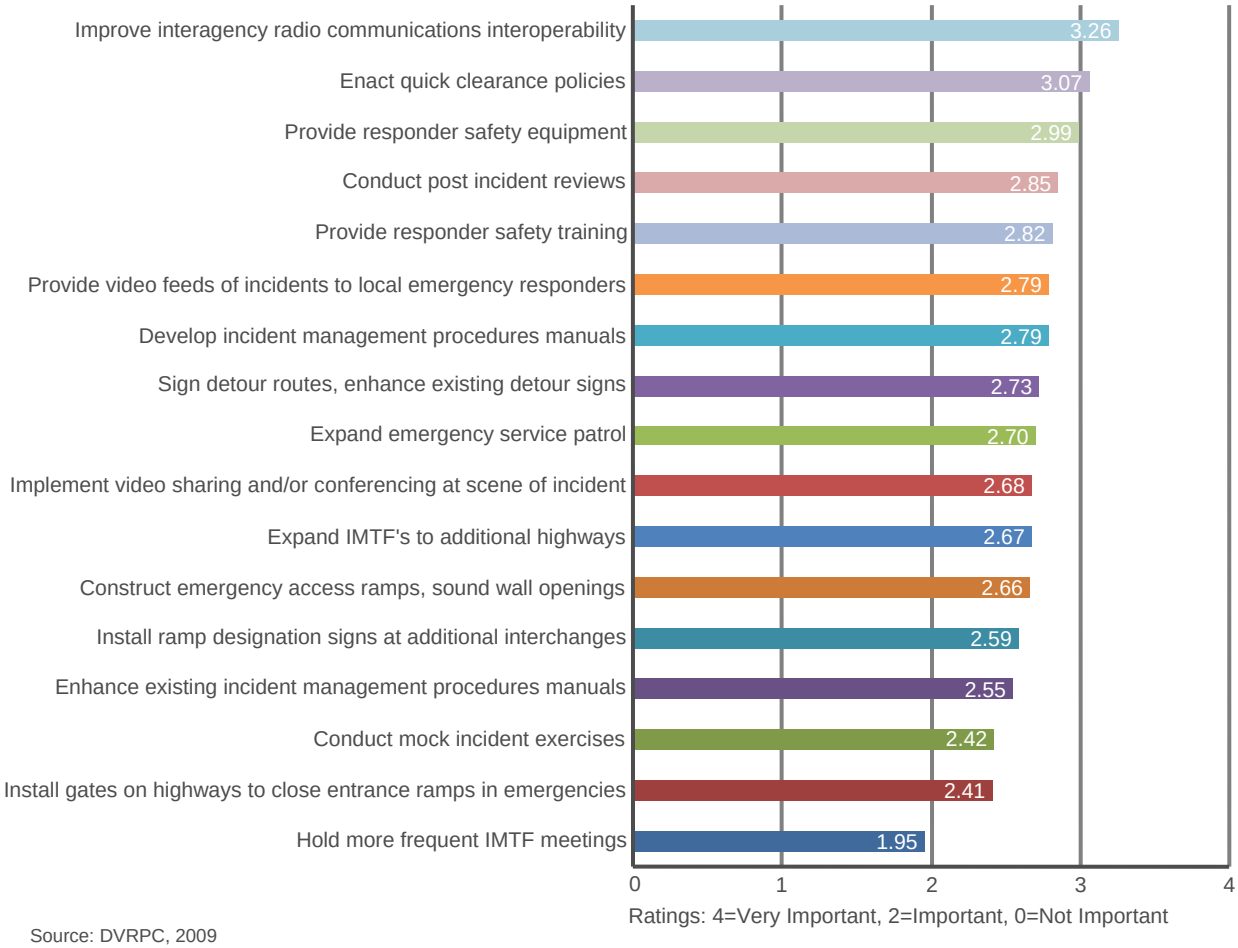
Figure 13: Survey Results: Overall Needs to Improve Traffic Operations in the Region



Source: DVRPC, 2009

When asked to rate the importance of seventeen different incident management needs, survey respondents chose "Improve Interagency Radio Communications Interoperability" as their top need, as depicted in **Figure 14**. Due to the high number of first responders answering the survey, it is understandable that having improved communications at the scene of an incident is a top priority. "Enact Quick Clearance Policies" also ranked high for this question, supporting the regional goal of instituting these types of legislation. The least ranked is "Holding More Incident Management Task Force Meetings," which supports our current practice of holding quarterly IMTF meetings.

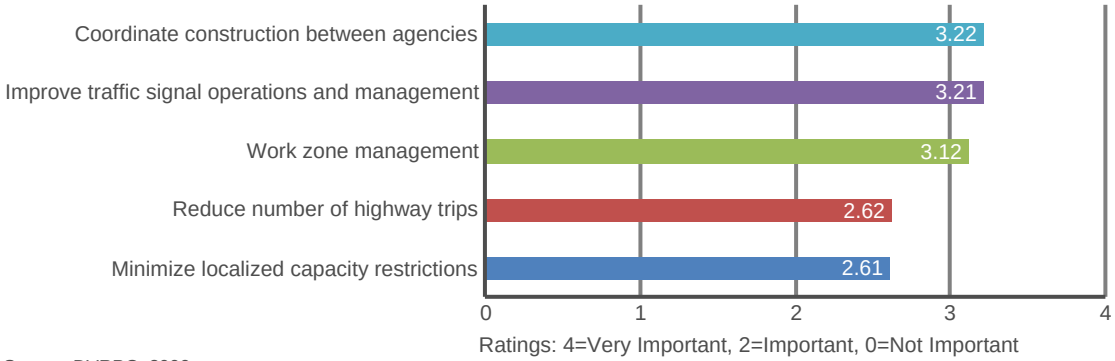
Figure 14: Survey Results: Incident Management Needs



Source: DVRPC, 2009

The next question asked survey respondents to rank their transportation operations planning needs relating to short and long-term goals with respect to the region. As shown in **Figure 15**, survey respondents selected “Coordinate Construction Between Agencies” as their top priority, with “Improve Traffic Signal Operations and Management” nearly tying for the top need. “Work Zone Management” ranked a close third. Both construction and work zone management planning priorities illustrate the need from survey respondents for more of that type of information and coordination within and between agencies.

Figure 15: Survey Results: Transportation Operations Planning Needs

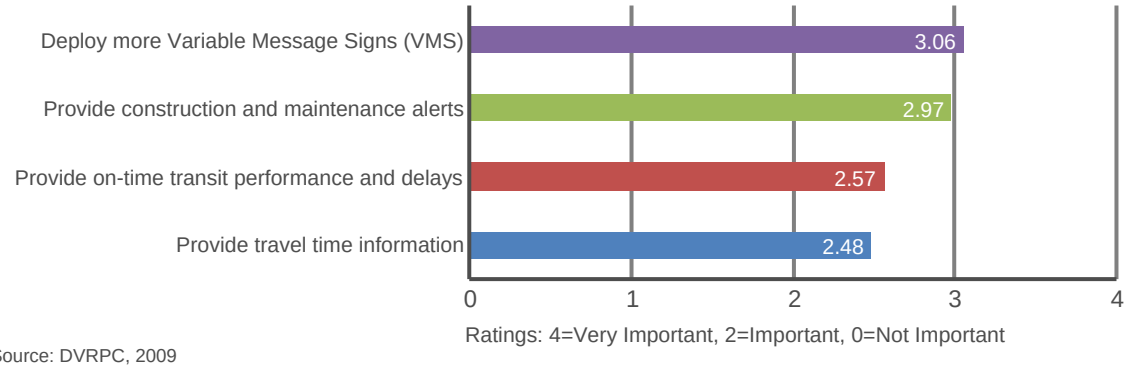


Source: DVRPC, 2009

Two questions in the survey related to operations and management of traffic signal systems. Ninety-three percent of the survey responders answering from a Pennsylvania perspective agree that PennDOT should operate and manage select traffic signals during emergency situations. NJDOT currently operates and manages traffic signals on select corridors. Ninety-five percent of the survey responders answering from a New Jersey perspective acknowledged that NJDOT should expand their current program to include other corridors.

With respect to public traveler information needs, **Figure 16** shows that "Deploy more VMS" and "Provide Construction and Maintenance Alerts" are top priorities with survey responders. These two needs can work in conjunction with each other.

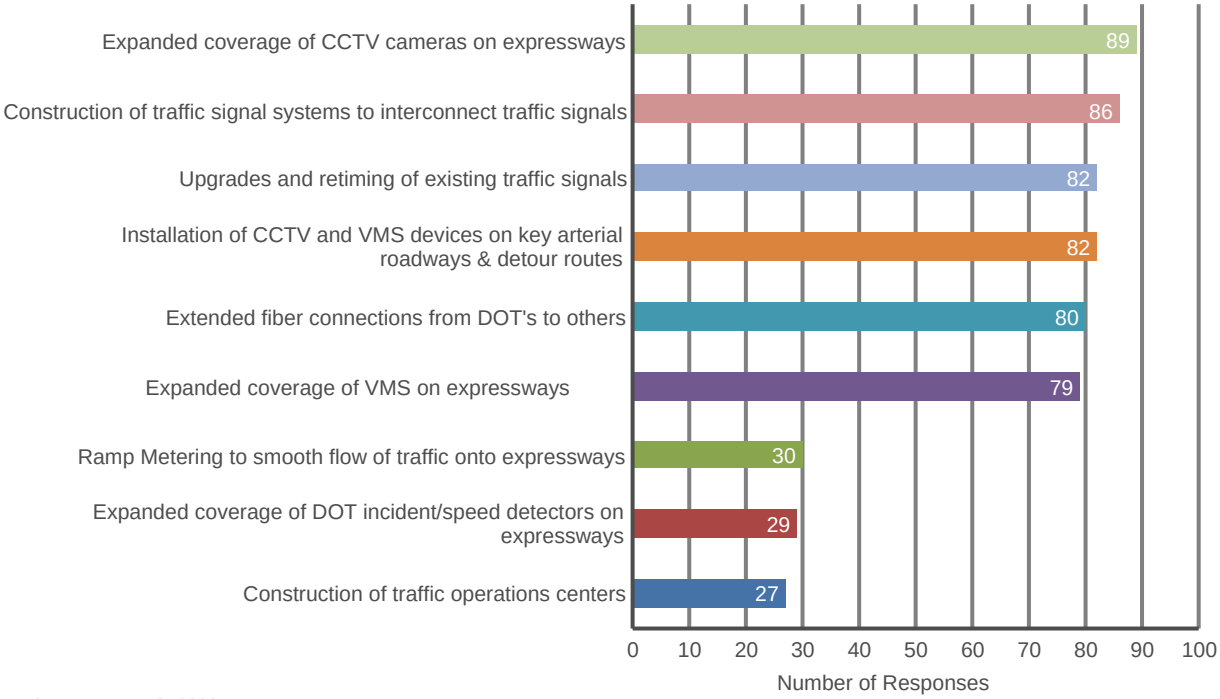
Figure 16: Survey Results: Public Traveler Information Needs



Source: DVRPC, 2009

When asked to choose their opinion of the four most critical ITS infrastructure improvements needed in the region, survey respondents selected "Expand Coverage of CCTV Cameras on Expressways" as their top priority. **Figure 17** shows the number of survey responses chosen for each need. "Traffic Signal System Interconnection" ranked a close second, further supporting the need for these types of projects in the region.

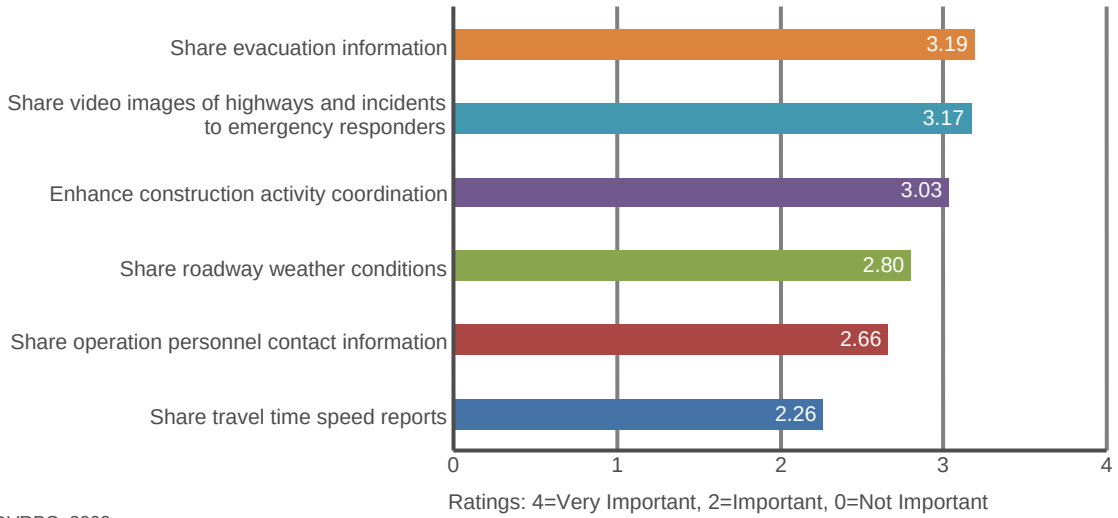
Figure 17: Survey Results: ITS Infrastructure Improvement Needs



Source: DVRPC, 2009

Operations information sharing needs were assessed by the survey responders and the results are shown in **Figure 18**. "Sharing Evacuation Information" between agencies and the public, and "Sharing Video Images of Highways and Incidents with Emergency Responders" both ranked the highest. "Sharing Travel Time Speed Reports" was not rated as a top need, possibly because there is already a current FHWA proposal to implement real-time information programs for reporting traffic and travel conditions along all Interstate highways within two years.

Figure 18: Survey Results: Operations Information Sharing Needs



Source: DVRPC, 2009

APPENDIX B

Existing ITS Deployment

The **2035 ITS Infrastructure Vision** map established minimum requirements for deploying ITS infrastructure in the region, it does not document existing ITS deployment. To provide policymakers a better perspective of where there are gaps in existing coverage that need infill, or which highways lack ITS altogether, the following tables document existing ITS deployment levels in the region. **Tables 16-23** are reflective of the deployment criteria set forth on the vision map.

Table 16: Primary Coverage – Pennsylvania

Highway	CCTV Coverage	VMS On Mainline	VMS On Cross Streets	Incident Detection	Travel Time Detectors
I-76 (Passyunk Ave. to I-476)	●	◘	○	●	●
I-76 (I-476 to PA Turnpike)	●	◘	○	○	●
I-95 (DE Line to Island Ave)	○	○	○	○	○
I-95 (Island Ave. to Vine St.)	◘	◘	○	○	○
I-95 (Vine St. to PA 132)	●	◘	○	◘	◘
I-95 (PA 132 to US 1)	○	◘	○	○	○
I-95 (US 1 to NJ Line)	○	◘	○	○	○
I-476 (I-95 to US 30)	◘	◘	○	○	○
I-476 (US 30 to PA Turnpike)	●	◘	○	○	○
I-676 (I-76 to I-95)	●	◘	○	○	○
US 1 (PA 896 to PA 52)	○	○	○	○	○
US 1 (PA 352 to I-476)	○	○	○	○	○
US 1 (I-76 to 9th Street)	●	◘	○	○	○
US 1 (PA 132 to NJ Line)	○	◘	○	○	○
US 30 (US 30 Bus. to US 322)	○	○	○	○	○
US 30 (US 322 to US 202)	●	◘	○	○	○
PA 63 (I-95 to US 1)	◘	◘	○	○	○
PA 100 (US 202 to Pottstown Pk)	●	◘	○	○	○
US 202 (US 322 to I-76)	●	◘	○	○	○
PA 291 (I-95 to I-76)	●	◘	○	●	●
PA 309 (Cheltenham Ave to PA 63)	●	◘	○	○	○
US 322 (I-95 Cherry Tree Rd)	○	○	○	○	○
PA 309 (County Line Rd to Bethlehem Pike)	○	○	○	○	○
US 422 (US 202 to PA 29)	●	◘	○	○	○
US 422 (PA 29 to Berks Co Line)	○	○	○	○	○
PA Turnpike/I-76 (Downingtown –Valley Forge)	◘	◘	○	○	●
PA Turnpike/I-276 (Valley Forge – Philadelphia)	◘	◘	○	○	●
PA Turnpike/I-276 (Philadelphia – NJ Turnpike)	◘	○	○	○	●
PA Turnpike/I-476 (I-276 – Lansdale)	○	◘	○	○	●

○ No ITS Assets Deployed ◘ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 17: Primary Coverage – New Jersey

Highway	CCTV Coverage	VMS On Mainline	VMD On Cross Streets	Incident Detection	Travel Time Detectors
I-76 (Walt Whitman Br to I-295)	◐	○	○	○	○
I-95 (PA Line to I-295)	◐	◐	○	○	○
I-195 (I-295 to NJ Turnpike)	◐	◐	○	○	○
I-295 (Salem Co Line to US 130)	○	○	○	○	○
I-295 (US 130 to I-76)	○	◐	○	○	●
I-295 (I-76 to Creek Rd)	●	◐	○	○	○
I-295 (Creek Rd to I-195)	○	◐	○	○	○
I-295 (I-195 to I-95)	◐	◐	○	○	○
I-676 (I-76 to Ben Franklin Br)	○	○	○	○	○
US 1 Freeway (PA Line to US 1 Bus)	○	○	○	○	○
NJ 29 (US 1 to I-295)	◐	◐	○	○	○
NJ 42 (I-295 to AC Exp)	◐	◐	○	○	○
NJ 55 (US 322 to NJ 42)	○	◐	○	○	○
NJ 90 (PA Line to NJ 73)	○	○	○	○	○
Atlantic City Exp (NJ 42 to Atlantic Co Line)	○	◐	○	○	○
NJ Turnpike (Salem Line to Middlesex Line)	◐	◐	○	○	○

○ No ITS Assets Deployed ◐ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 18: Primary Coverage – Delaware River Bridges

Highway	CCTV Coverage	VMS On Mainline	Incident Detection	Travel Time Detectors
Commodore Barry Bridge	●	○	○	○
Walt Whitman Bridge	●	○	○	○
Ben Franklin Bridge	●	○	○	○
Betsy Ross Bridge	●	○	○	○
Tacony-Palymra Bridge	○	○	○	○
Trenton-Morrisville Bridge	○	○	○	○
Scudder Falls Bridge	○	○	○	○

○ No ITS Assets Deployed ◐ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 19: Secondary Coverage – Pennsylvania

Highway	CCTV at Expressway Interchanges	CCTV at Arterial Intersections	VMS Coverage	Travel Time Detectors	Signal Systems	PennDOT Operates Signals
US 1/City Line Ave (PA 23 to I-76)	n/a	○	○	○	◐	○
US 202 (DE Line to Matlack St)	n/a	◐	◐	○	◐	○
US 202 Parkway (PA 63 to Doylestown Byp)	n/a	○	○	○	○	○
PA 100 (PA 100 Exp to I-76)	n/a	○	○	○	◐	○
PA 309 (PA 63 to County Line Rd)	n/a	○	○	○	◐	○
Doylestown Bypass (PA 611 & US 202)	○	n/a	○	○	n/a	n/a
Newtown Byp (I-95 to PA 413)	n/a	○	○	○	◐	○
PA Turnpike/I-76 (Downingtown to Morgantown)	○	n/a	○	◐	n/a	n/a
PA Turnpike/I-476 (Quakertown to Lehigh Valley)	○	n/a	○	◐	n/a	n/a

○ No ITS Assets Deployed ◐ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 20: Secondary Coverage – New Jersey and Delaware River Bridges

Highway	CCTV at Expressway Interchanges	CCTV at Arterial Intersections	VMS Coverage	Travel Time Detectors	Signal Systems
US 30 (I-676 to US 130)	n/a	◐	◐	○	n/a
Atlantic City Expressway	◐	n/a	○	○	n/a
I-295 (Gloucester)	○	n/a	◐	◐	n/a
NJ 55 (Southern Section)	○	n/a	◐	○	n/a
New Jersey Turnpike (Salem to Middlesex)	○	n/a	◐	◐	n/a
I-195 (NJ Turnpike to Monmouth Line)	○	n/a	○	○	n/a
NJ Turnpike Ext (PA TPK to NJ TPK)	○	n/a	◐	◐	n/a
Hightstown Bypass	○	n/a	○	○	n/a
Burlington Bristol Bridge (US 130 to US 13)	○	○	○	○	○
Tacony Palmyra Bridge (US 130 to I-95)	○	○	○	○	○

○ No ITS Assets Deployed ◐ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 21: Tertiary Coverage – Pennsylvania

Highway	CCTV Coverage	VMS Coverage	Travel Time Detectors	Signal Systems	PennDOT Operates Signals
US 1 (MD Line to PA 896)	○	○	○	○	○
US 1 (PA 52 to US 202)	○	○	○	○	○
US 1 (US 202 to PA 352)	○	○	○	◐	○
US 1 (I-476 to PA 23)	○	○	○	◐	○
US 1/Roosevelt Blvd (9th St to PA 132)	○	○	○	◐	○
US 13 (US 1 to Linden Ave)	◐	◐	○	◐	○
US 13 (Linden Ave to US 1)	○	○	○	◐	○
US 30 (Exton Byp to US 1)	○	○	○	◐	○
US 202 (Main St to PA 63)	○	○	○	◐	○
US 202 (PA 309 to PA 611 Byp)	○	○	○	◐	○
US 322 (Cherry Tree Rd to US 1)	○	○	○	○	○
PA 3 (US 202 to I-76)	○	○	○	◐	○
PA 29 (US 30 to Ridge Pike)	○	○	○	◐	○
PA 100 (PA Turnpike to US 422)	○	○	○	◐	○
PA 309 (Sellersville Byp to Lehigh Line)	○	○	○	◐	○
PA 611 (Bucks Co.)	○	○	○	◐	○
PA 611 (Montgomery)	○	○	○	◐	○
PA 611 (Philadelphia)	○	○	○	●	○
PA 724/PA 23 (PA 724/PA 100 Int to PA 23/US 422 Int)	○	○	○	◐	○
Cheltenham Ave (PA 309 to PA 611)	○	○	○	◐	○
Delaware Avenue/Columbus Blvd (Philadelphia)	○	○	○	◐	○
Germantown Pike (I-476 to US 202)	○	○	○	◐	○
Kelly Drive (Philadelphia)	○	○	○	○	○
Oregon Avenue (Philadelphia)	○	○	○	◐	○
Ridge Pike (US 422 to Kelly Dr)	○	○	○	◐	○
Sumneytown Pike/Norristown Road (PA Tpke to PA 309)	○	○	○	◐	○
West River Drive	○	○	○	○	○

○ No ITS Assets Deployed ◐ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 22: Tertiary Coverage – New Jersey

Highway	CCTV Coverage	VMS Coverage	Travel Time Detectors	Signal Systems
US 1 Bus (US 1 Freeway to US 1)	○	○	○	●
US 1 (US 1 Freeway to Middlesex Line)	●	●	○	●
US 30 (US 130 to CR 712)	◘	○	○	◘
US 130 (I-76 to Middlesex Line)	○	○	○	○
US 322 (US 130 to NJ 55)	○	○	○	○
NJ 70 (Radnor Blvd to US 206)	○	○	○	○
NJ 73 (US 130 to US 30)	●	◘	○	●
NJ 73 (US 30 to AC Exp)	○	○	○	○
NJ 168 (NJ 42 to US 130)	○	○	○	○
NJ 130 (NJ 38 to US 30)	◘	◘	○	○
CR 541 (US 130 to NJ 38)	●	○	○	●

○ No ITS Assets Deployed ◘ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

Table 23: Emergency Routes – Pennsylvania

Highway	Limited CCTV Coverage	Limited VMS Coverage	PennDOT Operates Traffic Signals in Emergencies
US 30	○	○	○
PA 10	○	○	○
PA 23 (I-76 to US 1)	●	●	●
PA 23 (Berks Line to I-76)	○	○	○
PA 41	○	○	○
PA 52	○	○	○
PA 73 (PA 100 to PA 663)	○	○	○
PA 100 (US 422 to PA 73)	○	○	○
PA 132	○	○	○
PA 291	○	○	○
PA 313	○	○	○
PA 320	○	○	○
PA 413	○	○	○
PA 452	○	○	○
PA 663	○	○	○
PA 724 (PA 100 to Berks Line)	○	○	○
Bridge St (Montgomery Co/Chester Co to PA 724)	○	○	○
Germantown Pike (US 202 to Ridge Pike)	○	○	○
Township Line Rd/Main Street/Bridge St (Ridge Pk to PA 724)	○	○	○

○ No ITS Assets Deployed ◘ Partial Deployment ● Full Deployment n/a Not Applicable
Source: DVRPC, 2009

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Key Words:	Transportation operations, Intelligent Transportation Systems (ITS), incident management, traffic management, traveler information, transit management, traffic signals, financial plan
Abstract:	This document outlines a long-range vision of transportation operations for the DVRPC region. It presents transportation operations goals, objectives, and operational strategies to achieve them. An operations vision establishes a plan of where ITS infrastructure, emergency service patrols, and incident management task forces, should be deployed in the region. A series of plans and programs are identified to accomplish the regional goals and vision. Lastly, a financial analysis was conducted to estimate the costs to construct, operate, and maintain these projects.

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Transportation Operations Master Plan

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