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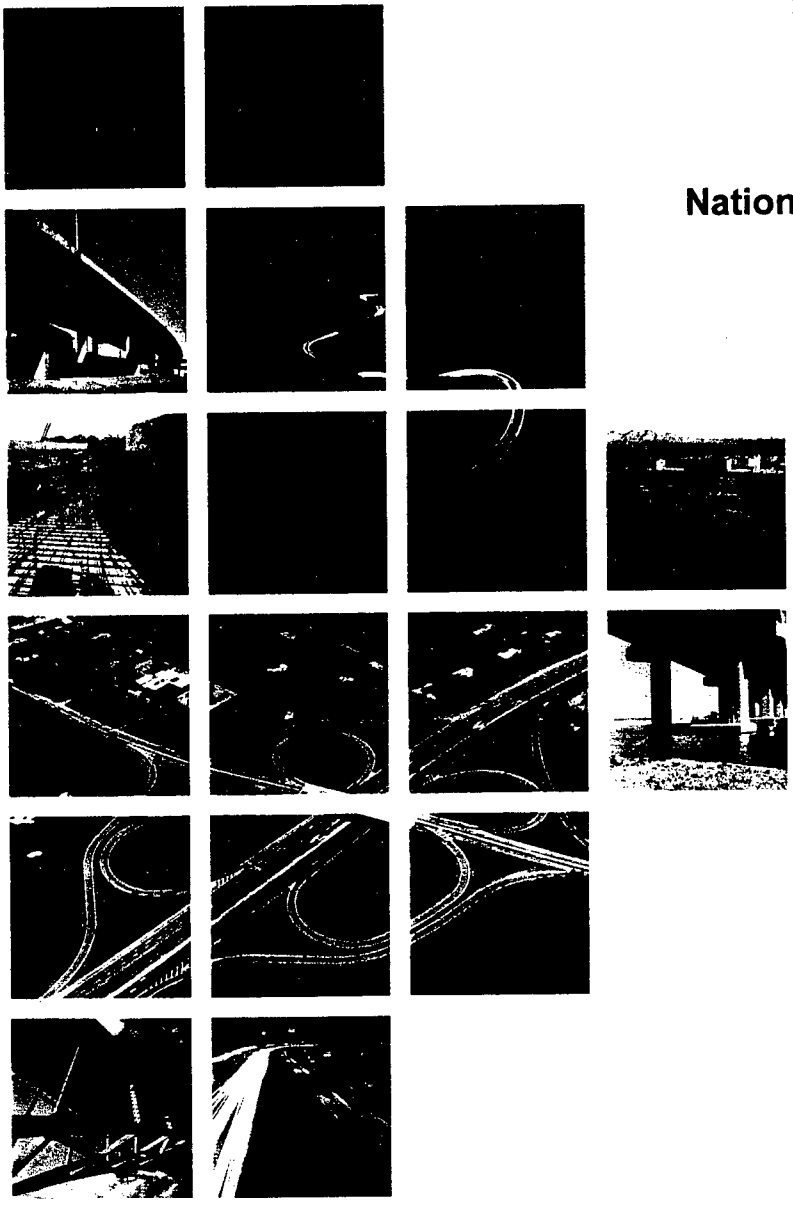

Programa Metrópolis

National Commission of the Metropolitan Area of Buenos Aires (CONAMBA)

Ministerio del Interior

Buenos Aires Traffic Management Project

Final Report

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ARGENTINA: BUENOS AIRES TRAFFIC MANAGEMENT PROJECT

RECOMMENDATIONS TO IMPROVE TRANSPORTATION MANAGEMENT IN THE CITY OF BUENOS AIRES

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RECOMMENDATIONS TO IMPROVE TRANSPORTATION MANAGEMENT IN THE CITY OF BUENOS AIRES

1. BACKGROUND

Buenos Aires, the largest and the principal urban entity in Argentina, is one of the most important metropolises in Latin America. It is the center for government, economy, commerce, finance, industry, and culture in Argentina. With a population of over eleven million (approximately one-third of the total population of Argentina) and a land area of approximately 4,500 square kilometers, it is composed of 25 municipalities in the province of Buenos Aires plus the Autonomous City of Buenos Aires.

The total population includes approximately three million living in Capital Federal, which has remained constant for over 30 years, and the remainder live in the neighboring communities of the province of Buenos Aires. A recent study conducted under the Metropolis Project predicts that the total population of Gran Buenos Aires will increase to 13 million by the end of the decade.

A review of the transportation sector shows that public transportation predominates (accounting for approximately 65% of trips), whereas private cars account for a smaller, though growing share of trips.

Mass public transportation is provided by buses (colectivos) operating on 299 routes, a 5-line subway system, one Premetro line and a 7-line commuter rail network. The city is also served by approximately 50,000 taxicabs, 15,000 limousines, approximately 1,800 unregulated buses, and an estimated 2.5 million private cars.

Private car transportation

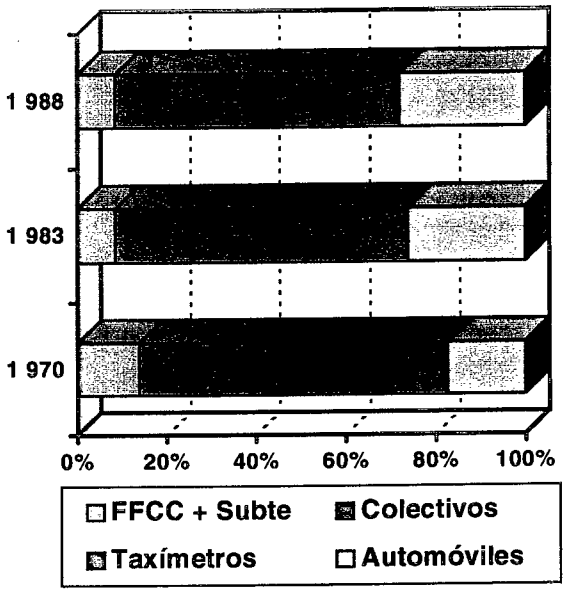
There are over 2.5 million private cars in the Region, accounting for over 35% of daily trips.

Private car growth in the last five year period has been particularly relevant, involving a transfer of users from public to private modes. Some studies estimate that from 1991 to 1995 the share of trips made by private cars grew more than 30%, principally at the expense of bus transportation.

Historical analysis of urban transportation market (%)				
Mode	**1970**	**1983**	**1988**	**1996**
Railway +subway	13.5	8.4	8.8	9.2%
Buses	59.0	54.0	53.8	46.0%
Taxicabs	7.4	8.9	9.4	9.8%
Cars	16.7	25.3	28.1	35.0%

Modal split changes

- Rail modes lost 35% of their market share in 20 years up to early 90's, but are now gradually increasing their share.
- Private car modes more than doubled their share.
- The slightly declining share of buses has continued.



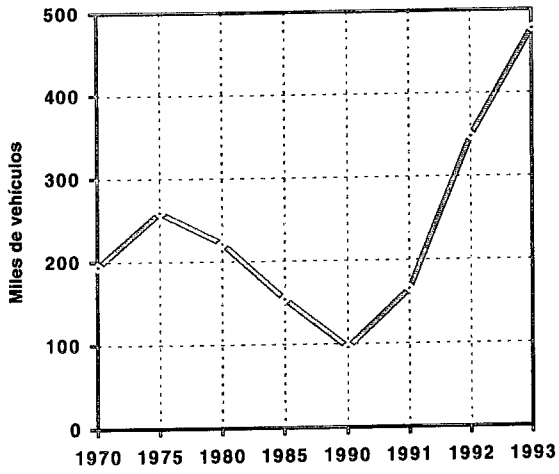
The trend beginning in the 90's indicates that car sales are likely to continue growing.

Period	*Annual Sales*
1970/1975	*194, 418*
1975/1980	*259, 782*
1980/1985	*221, 061*
1985/1990	*154, 360*

Year	*Annual Sales*
1990	*95, 887*
1991	*165, 775*
1992	*348, 363*
1993	*478, 000*

Car Sales Indicators

- Five-fold increase in sales in three years.
- Present trend likely to persist to the year 2000.



The highway network improvements, particularly in the network of Access Highways to Buenos Aires City, resulted in improved traffic operations, inducing a major shift towards individual transportation.

The following access highways will be completed before 2000:

- Acceso Norte - Av. Gral. Paz with 94.5 and 24.1 km total length, respectively.
- Acceso Oeste with 56.7 km total length.
- Autopista Ricchieri – Ezeiza - Cañuelas, with 60.1 km total length.
- Autopista Buenos Aires - La Plata, with 63.3 km total length.

When completed, these highways will simply encourage more people to use their own cars.

Surface Rail Transportation

The rail system dates back to 1857. It is wholly operated by private concession holders, although each receives State subsidies. The rail system moves close to 1.1 million passengers/day. The track layout is a radial network converging into the central area of the region. It consists of seven lines with a total length of 901 km, 164 km (18%) of which are electrified. Unfortunately, the different tracks are built at grade level, with very few sections using viaducts, embankments, or ditches, thus they significantly interfere with the urban roadway network.

The network has 268 stations and 5 terminal stations in downtown Buenos Aires or adjacent to it: Retiro (terminal station of Bme. Mitre, Gral San Martín and Gral. Belgrano Norte rail lines), Constitución (terminal station of Ferrocarril Gral. Roca), Chacarita (terminal station of Ferrocarril Urquiza), Once (terminal station of Ferrocarril Sarmiento) and Estación Buenos Aires (terminal station of Ferrocarril Gral. Belgrano Sur).

The technical characteristics of the network vary according to the line considered. Hence, the Sarmiento, Mitre, Roca and San Martín lines are wide gauge (1.676 m), the Urquiza line is medium gauge (1.435 m) and the Belgrano Norte and Sur are narrow gauge (1.000 m).

The Mitre, Sarmiento, Urquiza and Roca Lines (Ezeiza and Glew branches), use electric engines, while San Martín and Belgrano Norte and Sur Lines use diesel electric engines, as does the La Plata branch of Roca line.

Service frequencies vary according to the technical characteristics of the equipment involved (signaling, infrastructure, power mode, etc.), reaching 5 minutes apart during peak hours, in certain cases.

Underground rail transportation (subway)

Construction of the system started in 1913. Since 1994, the underground rail transportation system has been operated by a private concession holder. The system moves approximately 500,000 passengers a day. The rail network consists of 5 lines (4 radial and 1 circumferential lines and a grade connection, the Premetro, with 45 km total length and 77 stations.

The rolling stock, consisting of approximately 300 cars, is clearly heterogeneous as far as technical characteristics are concerned, the only common trait being the 1.435 m gauge. The cars have different clearance and platform heights. In addition, they feature three different supply systems (1100V and 1500 V aerial lines, and a third 550 V rail).

Concerning service frequencies, some lines operate units at 3-minute intervals at peak hours.

Public motor vehicle transportation

The bus system has the largest (though declining) share of public transportation traffic, moving more than 8 million passengers a day.

Operated by almost 200 private companies, the bus transportation network presents an extended territorial reach, making up an overall network of approximately 25,500 Km.

The bus fleet consists of approximately 15,000 vehicles, a majority of which are diesel-fueled units with an approximate capacity of 30 passengers seated and 50 standing. Service frequencies are generally high, with intervals between

service lower than 2 minutes in certain cases. No State subsidies whatsoever assist the motor vehicle transportation service.

Non-scheduled Transportation

The transportation supply in the region also includes taxicabs, limousines, and more informal services (charters, hired vehicles, etc.). The taxicab supply consists of approximately 50,000 units, most fueled by compressed natural gas.

Although no recent specific studies are available, estimates indicate that taxis move approximately 1 million passengers/day, which added to other non-scheduled modes total an estimated daily movement of approximately 1.7 million passengers/day.

The limousine service has shown significant growth in the last few years, from a marginal service in the past to a major service, currently moving tens of thousands of users per day. The fleet is estimated at approximately 15,000 units providing door-to-door transportation service. In Capital Federal only, more than 600 limousine services are registered.

In the case of both taxicabs and limousines, the jurisdictional authority is the relevant Municipality. Differences are observed among them concerning the rules regulating the services.

The more informal services (charters, hired vehicles, etc.) represent a novelty in the transportation supply of the region. They consist of different-sized passenger vehicles, from 50-seat buses built for long distances, down to 12-passenger mini-bus vehicles.

The vehicles serve direct routes between origin-destination pairs, with a seat reserved for each passenger, and some owners are planning to add more luxury features, such as music, air conditioning, etc. Approximately 1,800 vehicles are licensed for some 2,200 services between different origin-destination pairs.

2. *RECOMMENDED MEASURES TO IMPROVE TRANSPORTATION MANAGEMENT IN BUENOS AIRES CITY*

The Louis Berger International, Inc. - IBI Group - UBATEC Consortium has developed a series of recommendations, partly based on the Traffic Management Project proposal developed for the city of Buenos Aires, and partly on studies conducted as part of this project.

The recommendations presented below are to encourage more responsible driver behavior, and add modern management tools to the existing infrastructure to improve traffic flow. The first recommendation is to apply modern transportation management technology to the three major autopistas in Buenos Aires.

A. Implement an Intelligent Transportation System on three autopistas

The primary aim of the Intelligent Transportation System (ITS) is to improve safety and increase the efficiency of the operation of the three major autopistas in Buenos Aires. This will be accomplished through the deployment of a system of advanced transport technologies commonly referred to as an Advanced Traffic Management System (ATMS). This project addresses three areas of concern for the autopistas under study:

(1) managing of traffic,
(2) improving incident detection and response, and,
(3) improving information dissemination to the travelling public.

This last area, motorist information, is further segregated into three areas: a) an advance warning of incidents and congestion which have occurred ahead on the road, b) incident management, and c) traffic diversion around incidents. The ATMS for each autopista will be an efficient, technologically advanced system which combines the use of existing technologies that have a history of successful applications with emerging technologies (in particular sensors) that offer the prospect of improved information and operations over traditional traffic monitoring techniques. The ATMS components will be linked by an appropriate communications medium and will be managed by open architecture command and control software.

The technology employed on all three autopistas is identical, as is the basic systems architecture. However, each autopista should have a different number of sensors and variable message signs, reflecting the volume of traffic regularly experienced on each autopista.

It is the intent of each Autopista ATMS to generate revenues such that capital and annual operating costs can be retrieved within the corresponding time span. These revenues will be derived through the enforcement of select violations detected and recorded by the ATMS's sensing and recording equipment.

Central Computer System (CCS). This is the command and control center for the ATMS. It is capable of storing traffic information providing optimum traffic flows for the roadways through programmed responses to actual and projected traffic conditions. The CCS sends information and messages to the traveling motorists. The CCS captures and stores visual images of the real time flowing traffic, and registers certain types of traffic violations. The CCS is linked to and manages the operations of the three stations listed below.

Full Sensor Stations (FSS). These stations are the primary eyes of the ATMS. They collect and interpret all transit parameters that describe the dynamic flow of vehicles, they detect occurring accidents, they provide long distance visual surveillance, they measure the rate of speed and register infractors. These tasks are carried out by different devices located at the stations. The FSS is directly connected to the Central Computer System as described above. It provides traffic information as well as camera images of the flow of traffic and camera images of incidents (if they are within the scope of the camera) which are used as input for decision making concerning traffic operations, or as a basis to modify the condition of the automated operation.

Speed Enforcement Stations (SES). These stations will provide the CCS with data concerning the speed of the vehicles on the roadway. The aim of these stations is to monitor and register the license plate numbers of the vehicles that are exceeding the speed limit or of those that are driving below the permitted minimum speed.

Traveler Information Stations (TIS). These stations are the most visible ones to the travelling motorist. The main component in each station is an elevated variable sign which is lighted from the inside. The aim of this sign, which is strategically located all along the roadway, is to inform the motorists about road conditions ahead, warn motorists about congestion and accidents, present them with alternative routes or exists, warn motorists when it is necessary to reduce their speed and notify them of weather conditions.

ATMS system overview

The ATMS concept for each of these three autopistas is based upon the deployment of "wide area" traffic sensors that are able to oversee all lanes of vehicular traffic simultaneously. These sensors will be the prime data gathering devices strategically located along each of three (controlled access) toll facilities. Each of the Detection Stations will be linked to a Central Computer System (CCS) for data collection, analysis, deployment strategy, and motorist information. Motorist information concerning levels of congestion, lane closures, accidents, speed reductions, construction activity, and weather conditions will be conveyed by variable message signs that are directly linked to the CCS. The autopistas that we recommend for ATMS deployment are:

- Autopista Acceso Norte
- Autopista La Plata
- Autopista Ricchieri - Ezeiza

Each Autopista ATMS will share traffic flow and other operational data with each of its sister systems. The CCS for each Autopista, if possible, will be located within the existing right-of-way of the Autopista in proximity to a toll plaza and will utilize existing enclosed space or an expansion of existing space. The Autopista ATMS will also receive traffic count data from the toll facility Concessionaire. The major technological components of the ATMS are described in the following paragraphs. This document presented vendor materials from a variety of manufactures. Potential U.S. vendors are listed and described in Appendix I.

Major system components

Traffic sensors

The traffic sensor is the most important component in an ATMS. On a worldwide basis, knowledgeable traffic engineers have recognized that in-ground sensors of all types represent the weakest link in traffic systems and traffic control. While inductive loop detectors have been the proven and accepted detection standard globally for almost forty years, their use in large scale deployments, especially on Autopistas, suffers from two condemning faults: 1) they require pavement intrusion for installation and again for repair resulting in traffic disruption and worker exposure to traffic hazards and 2) they provide relatively little data on the dynamics of the traffic stream. Several non-intrusive detector technologies are now available, and these non-intrusive traffic sensors have now emerged, worldwide, as the most promising devices.

There are two broad categories of traffic sensors. The first category and earliest commercially available sensors of this type were based on loop emulation and/or trip wire algorithm logic. These sensors created "virtual loops" and as a result mitigated one of the two severe faults of loop detectors, i.e., pavement intrusion. More recently, the second category of traffic sensor has become commercially available, the true "wide area" vision based traffic sensor. This second category of machine vision traffic sensor utilizes individual and group vehicle tracking algorithms, thus yielding a significantly greater amount of dynamic traffic stream information. The wide area machine vision based traffic sensor responds positively to both faults associated with in-pavement point measurement devices.

The primary component of the vehicle monitoring system for each Autopista will be a Detection Station equipped with this last category of sensors. There are several important reasons why these second generation machine vision sensors are recommended for the design of the Detection Station:

- Machine vision sensors are non-intrusive. They require no disruption to traffic for installation or repair;
- Machine vision sensors are dynamic area measurement devices and, as such, can measure, in real-time, virtually all parameters of the multi-lane traffic flow on an autopista;
- Machine vision sensors provide a visual image to a (human) operator of the area that they are sensing. This affords the dual purpose of providing traffic flow data and visual surveillance images to the CCS with the same camera.
- Machine vision sensors clearly become cost competitive with traditional pavement intrusive point measurement devices such as loop detectors.

Each Wide Area Sensor will monitor an area that encompasses a width of as many as five travel lanes plus the roadway shoulder for a length of 60 to 100 meters. The ATMS system will be able to determine the following traffic flow parameters by tracking the paths of individual and multiple groups of vehicles within its wide area sensor field of view:

- individual vehicular speed
- platoon dynamics
- flow density

- volumes
- vehicle classification (five classifications to be determined)
- incident detection

There are more than 20 different manufacturers of machine-vision based traffic sensors worldwide. Appendix I presents vendor material from several representative manufacturers of these devices.

License plate reader technologies

The ATMS will also include at selected locations, high resolution digital camera(s), able to record the license plate numbers of vehicles violating certain traffic regulations. These license plate reader cameras will receive notification of a violation from either the Wide Area Sensor or from another kind of speed sensing detector. While "wet film" systems are far more common than digital camera systems, we have specified digital camera technology because of its ability to easily transmit data to a central location for processing and its compatibility with the vision-based traffic sensor technology specified for the Autopista ATMS's. An additional point of note is that digital license plate reader technology is already deployed and operating successfully in Argentina for speed violation detection.

In outlying areas where traffic volumes are relatively light, a Wide Area Sensor will not be installed. In these areas, only the violation detection portion of the detection station will be installed. A non-intrusive point measurement sensor in concert with the license plate reader will be used in these outlying areas to record traffic volumes and monitor and control speed limit violations only.

Variable message signs

The variable message signs located strategically along the Autopista will be the primary means of communication with the driver. In general, each sign will be mounted on its own overhead structure. The signs must be visible to the driver both day and night. Each variable message sign will be controlled from the CCS. Exact specifications for sign dimensions and visibility requirements will be determined prior to the preparation of the final plans and bid specifications.

Command and control logic

Very few off-the-shelf ATMS command and control software programs exist. This is so because most traffic systems require site specific and often unique functional commands. Of those software programs that do exist, few are open architecture configured such that they could readily read, and consequently utilize, the sensor input from wide area, machine vision traffic sensors. All software programs, to date, have relied upon sensor input from point measurement devices. It is imperative that the software to be deployed for each of the Autopista ATMS's be able to perform the functions stipulated and measure the parameters identified in the individual Autopista ATMS descriptions.

Telecommunication technologies

No attempt has been made to dictate the specific technology to be employed for communication among and between the various devices that make up each Autopista ATMS. Actual data transmission rates and availability of various cable and non-hardwired technologies will emerge differently for competing concessionaires depending upon system approach and data transfer requirements. It is in the best interest of the Autopistas to allow broad latitude in the selection by competing concessionaires on the subject of telecommunications alternatives. Figure 1, Telecommunication Technologies, identifies those telecommunication technologies currently deployed for ATMS's around the world and defines the capacities and attributes of the various alternative technologies.

Figure 1 Telecommunication Technologies

Means of Communication	Band Range	Repetition Distance	Transmission Rates	Voice Channels	Video Channels	Information Channels	Comments
Optic fibers SMF	< several Ghz	40-50 miles	< several Gbps	100	< 16	100	Number of channels based on multiple capacity
Optic fibers MMF	500 MHz (1)	1-12 miles	< several Gbps	100	< 16	100	Number of channels based on multiple capacity

Double pair copper cable	27 kHz	9-15 miles	< 9.6 Kbps	24	1 (2)	(3)	no video
Coaxial cable	< 300 MHz	1-3 miles	< 10 Mbps	100	< 50	(3)	Only one way communication
Cellular	30 kHz (4)	N / A	1.2 kbps (9.6 Kbps data)	1		(3)	
Terrestrial Microwave	10 MHz (4)	40-50 miles	< 40 Mbps	100	< 16	(3)	permits
Radio (800 MHz)	25 kHz	15-30 miles	< 9.6 Kbps	1		(3)	permits
Satellite	5	N / A	< 50 Mbps	100	1		Microwave from / to satellite

B. Changes in driving rules and drivers' habits

The roadway infrastructure of Buenos Aires was not the result of a planned strategy. Its development followed the development of the city. This process explains the existence of very narrow streets in downtown Buenos Aires and the absence of avenues permitting fluid communication with the different neighborhoods.

The well-known civil works to expand central avenues were completed only in the 1980's, along with urban highways on three axes:

- North: Arturo Illia urban highway.
- West: 25 de Mayo and Perito Moreno highways.
- South: La Plata - Buenos Aires and 9 de Julio Sur.

The coastal roadway connection is not yet completed, and the General Paz Avenue serves as the cross connection with above highways.

Given the history of how the transportation network developed, expanding or physically changing the network will not be an effective way to lessen the traffic problems of the city. The recommended measures therefore focus on optimizing the use of existing facilities. Accordingly, the measures below are the most significant to make the city traffic more orderly while increasing traffic safety:

- To relieve peak-load congestion, design and use reversible lanes and set aside a network of lanes exclusively for public passenger transportation and for high occupancy vehicles.

- Implement new rules for the loading/unloading of goods by ensuring the strict enforcement of current regulations. This will help prevent stoppages during peak hours.

C. Improve city traffic management

In the layout of colonial cities, no priority was given to arterial streets. In this century, some streets were enlarged into avenues, and in fact priority was given to arterial width.

However, avenues do not carry the primary traffic flow because signage, signals and modern traffic management technologies are not applied to identify a primary versus a secondary road network. A survey of population movement needs to be undertaken to identify which roads should be part of a primary network and which roads should be a secondary network.

Streets which are currently considered as primary streets feature non-uniform signaling, lighting identical to secondary streets and obsolete traffic signal coordination. Once the principal street network is determined it should be made easily recognizable by drivers. The most significant measures to be taken are:

- Signaling and network optimization: a survey should be conducted of existing traffic signals and an inventory made of the traffic control equipment needed to modernize the system.

- A signaling program needs to be designed and implemented giving priority to traffic on primary streets.

- After identifying and improving the primary network as discussed above, implement the program to optimize its use by introducing an exclusive bus and high-occupancy lane network, and reversible lanes in response to peak-load demand.

D. Increase the efficiency of taxicab service

Surveys have been concurrently conducted in downtown Buenos Aires which reveal that the taxicab share in certain streets amounts to 70% of the traffic, producing congestion and ensuing environmental pollution.

To address this traffic management problem:

- Promote the use of public transportation, including use of the subway network.

- To limit the number of taxicabs and manage their operations by promoting the use of fixed taxicab stands and radio-telephones instead of permitting slow cruising around searching for passengers.

E. Revamp parking policies

Because city growth was not planned, inadequate parking facilities were built. To address car parking problems:

- Develop a new parking policy that increases monitoring and promotes more compliance with parking rules to ensure smooth traffic flows.

- Promote the construction of new parking lots and promote use of lots.

- Pursue an active policy of removing illegally parked cars and heavy vehicles from the streets with car-towing equipment.

F. Enhance pedestrian safety

Much travel in the city is by foot. Currently the streets and sidewalks are inadequate for safe pedestrian traffic. To determine what needs to be done, pedestrian traffic flows need to be monitored, and streets with high pedestrian presence rates assessed for safety and ease of use. For example, sidewalk/pavement width ratios, sidewalk physical conditions, pedestrian islands, pedestrian crossing markings need examination. Also a study is needed of marking streets for pedestrian use only in the central area of town. Based on these studies, a pedestrian traffic plan should be developed and implemented.

3. High Priority Recommendations

The following recommendations should be implemented as soon as possible to ease the traffic problems of the city.

- Roadway infrastructure Maintenance Plan. Develop and implement a roadway maintenance plan based on the primary street network, giving priority to physical maintenance on streets with high volumes of traffic,

keeping the pavement in good condition, traffic light coordination (if necessary), adequate lighting, parking restrictions, and etc.

A pavement marking program should be rapidly implemented for the principal roadways both in Capital Federal and in the Greater Buenos Aires area, since no campaign to enforce traffic rules can begin unless markings are in place.

- Establish "pedestrian only" streets or streets for pedestrian use only during certain hours. Determine arterial streets for at least periodic exclusive pedestrian use in downtown and greater downtown (micro and macrocentro) areas in conjunction with determining an exclusive bus lane network.

- Widen targeted sidewalks In the downtown area, many sidewalks are too narrow for the high volume of pedestrians.

  On the other hand, heavy traffic flows (often dominated by buses) on narrow streets (such as Maipu, Esmeralda, Suipacha, Tucumán, Viamonte, Paraguay, etc.) make pedestrian travel dangerous. The buses should be limited to streets with exclusive bus lanes, ensuring safer pedestrian traffic. this will concentrate heavy traffic on very few streets that are set aside as the primary network.

- Change direction of traffic on "neighborhood" streets every few blocks. As a result of establishing primary and secondary networks, many streets will no longer be used for passer-by traffic but only for access to the neighborhoods in which they are located. To avoid the use of such streets by traffic that ought to be using the primary or secondary network, we recommend changing the direction of traffic every few blocks, thus interrupting continuity and diverting traffic to the primary and secondary streets.

- Establish a high-weight traffic network. Develop a network that shall be geometrically and structurally adapted to truck movements. Such development will also include a sub-network for transportation of hazardous substances.

  The current network is confusing, failing to take full advantage of the existing network of access highways to the city. Such a network should be conveniently restructured placing special emphasis on traffic concentration on the main corridors.

One of the main traffic problems in downtown Buenos Aires is that heavy trucks go through downtown to the port. To ease congestion, we recommend diverting heavy trucks to Arturo Illia and Coastal Highways until the Puerto Nuevo access exchange, near the Retiro Bus Terminal as part of the solution for the transportation of heavy loads to and from the port.

Other recommended port-related traffic management measures include the following:

- Setting up a freight transfer yard inside the port area to allow for load transfers to continue uninterrupted without interfering with vehicle traffic on access highways.
- Setting up freight transfer yards associated with the main access highways to the city of Buenos Aires, so as not to overload them in peak-load hours.

In addition to becoming a new business in itself, the proposal to set up freight transfer yards may be a good alternative to alleviate congestion produced by heavy traffic in town, and by reducing the intimidating size of trucks in the urban area.

A project developed by the former Federal Secretariat of Transportation proposed a network of exclusive lanes within the city. In our opinion, some of the streets proposed are not suitable for such traffic. A proper study based on actual passenger traffic by bus should be conducted so that the required pavement size would be designed and provided to ensure comfortable and safe transportation, both for passengers and pedestrians.

- Establish high occupancy lanes. As mentioned earlier, this will limit the number of private cars, and ease traffic congestion.

- Develop a new parking policy. Such a policy shall charge a differential rate based on demand, encourage transfers to mass transportation modes, and institute parking restrictions or bans an primary arterial and key secondary streets.
  The parking policy must not respond to demand requirements in the area but to the surrounding roadway supply, in order for key streets not to be saturated with parked cars, impeding heavy traffic flows.

  In many districts drivers habitually park on both sides of the pavement the whole day, including avenues and the most congested corridors. In addition, the simultaneous loading and unloading of goods and passengers (particularly by taxicabs) is common, with apparently no control by the relevant authorities. The problem is not restricted to the greater downtown

area, but is observed and is even more aggravated outside that area, mainly in Barrio Norte, Palermo and Belgrano.

In the central area of town, parking rules are poorly enforced. This is in spite of the two private companies are responsible for the enforcement of parking rules. We recommend increasing the strictness with which parking rules are enforced.

No restrictive parking policy can be implemented unless it is in conjunction with a policy encouraging the use of public transportation. Accordingly, our proposal consists of gradually implementing a ban on parking on the sidewalk to the extent that public transportation mode conditions improve.

In addition, new parking time parameters should be established. At present, vehicles are allowed to park for hours in the same location, while no space is allotted for people who require short-term parking (15 to 30 minutes). So parking spaces should be metered where no parking extensions will be allowed beyond a pre-established maximum period.

In short, the proposed measures are intended to:

- Gradually limit the space allotted to parking in the central area and adjacent districts, so long as the public transportation improvements are capable of absorbing the increasing demand.

- Reduce maximum parking times in public places, precluding drivers from unlimited parking in key slots, thus leaving parking spaces for people needing parking for shorter periods.

- Implement differential parking rates, with low metering rates for parking in areas not impeding traffic flow.

Such measures must be coupled with building parking lots associated with transfer centers, or with new parking lots adjacent to access highways, and having good connections with central areas via public transportation.

- Integral traffic study for the city of Buenos Aires and the province of Buenos Aires. The lack of basic traffic flow data makes it imperative to rapidly conduct an integral traffic study to obtain enough information to: develop a medium- and long-term strategy to improve traffic conditions in the city; permit monitoring the implemented of the traffic plan; help develop a new parking policy; determine the characteristics of an accident-reduction

program; and promote training of municipal officials responsible for developing and implementing the actions resulting from the study.

- New driving program. Such programs must include not only penalties for traffic law violations but also determining long-term criteria likely to promote a system of rewards and penalties surpassing current monetary amounts. Two measures are recommended to achieve the proposed goals:

  - Develop a driver's education program, emphasizing the fines for traffic violations. Educational processes generally require long time periods for results to be appreciated. However, the program is too important to postpone because it takes a long time to show results.

  - Institute a program that revokes driving licenses for repeat offenders. Traffic law violations must be associated with a point system where the accumulation of points leads to larger fines, suspension of the driver's license, and eventual license withdrawal in the case of repeat violators.

- Adjusting light signal scheduling. Adjust signal timings to match and enhance current vehicle traffic flow, particularly at critical intersections that are part of the primary road system. Also implement time-differential programs to meet peak-load demands, including extreme adjustments when and where demand is very low (i.e., night in residential districts).

4. ENVIRONMENTAL IMPACT ASSESSMENT

The recommendations put forward in this report are listed below. These recommendations propose to initiate and/or increase use of:

- **Traffic Sensors**, i.e., equipment capable of determining individual vehicular speeds, platoon dynamics, flow densities, volumes of traffic and vehicle classifications.

- **License Plate Reader Technologies,** i.e., high resolution digital cameras capable of recording license plate numbers of vehicles to facilitate enforcement of traffic regulations

- **Variable Message Signs**, i.e., electronically controlled highway signs to alert highway users to traffic conditions.

- **Command and Control Logic,** i.e., site-specific computer programs designed to utilize traffic data to determine optimum lane utilization and

other variables to enhance traffic flow.

- **Telecommunications Technologies,** i.e., techniques and equipment to allow communication among the various devices that make up each Autopista's automated traffic management system (ATMS).

The potential environmental impacts of implementing these recommendations and the ATMS which they would comprise will be beneficial and no significant adverse environmental consequences are anticipated. No additional traffic generation is anticipated as a result of the proposed actions. The beneficial environmental consequences of the proposed actions are anticipated to include:

- **Improved Air Quality** - due to improved traffic flow, reduction of congestion and consequent reductions in fuel consumption.

- **Enhanced Traffic Safety** - due to enhanced communications and improved traffic flow.

No offsetting increases in traffic levels or other offsetting impacts to overall traffic flow are anticipated.

Recommendations following the installation of the Advanced Traffic Management Systems on the thee autopistas are:

- **More efficient use of existing road capacity** - including the use of reversible lanes, designated lanes for exclusive use by public transport, improved traffic signal coordination, stricter enforcement of loading and unloading restrictions and similar strategies.

- **Promotion of public transportation.**

- **Increasing the efficiency of taxi operations** - including limits on the number of taxis, the use of taxi stands and radio-controlled taxis, and the elimination and/or discouragement of cruising as a way of finding passengers.

- **Parking restrictions** - including a new parking policy imposing restrictions and bans on selected arterial streets and metering to limit parking to specific time periods to reduce the overall demand for parking on key roads. This would open up extra lanes during hours of peak use and reduce overall congestion. On-street parking reductions would be offset by the development of off-street parking with no net increase in the amount of available parking spaces.

The potential environmental impacts of implementing these recommendations will be beneficial and no significant adverse environmental consequences are anticipated. No additional traffic generation is anticipated as a result of the proposed actions. The environmental consequences of the proposed actions are anticipated to include:

- **Improved Air Quality** - due to improved traffic flow, reduction of congestion and consequent reductions in fuel consumption, and greater use of public transport as an alternative to private vehicular use.

- **Enhanced Traffic Safety** - due to enhanced communications and improved traffic flow.

No offsetting increases in traffic levels or other offsetting impacts to overall traffic flow are anticipated.

It should be noted that implementation of the recommendations may require more definitive environmental assessment on the basis of site-specific plans. Although, as a general rule, no increases in right-of-way (ROW) widths or overall lane capacities are anticipated, the possibility that all actions will be confined to the existing ROW's can not be assured in the absence of more detailed engineering assessments and site-specific consideration. Selective ROW increases or re-alignments may be necessary in some instances. The need for such actions can only be determined on the basis of more detailed, site-specific engineering analysis.

Construction in environmentally sensitive areas may also dictate the need for appropriate mitigating actions. Road improvement projects of the types proposed, even those contained wholly within the existing ROW's are, therefore, generally required to undertake environmental assessments which rigorously present the existing environmental conditions, complete descriptions of the proposed actions, the alternatives considered, a systematic evaluation of the potential environmental impacts on a site-specific basis and the proposed mitigating actions if required.

Issues addressed generally include restrictions to be placed on construction to minimize the potential impact to air, noise and water quality in the potentially affected area, impacts to cultural resources (e.g., due to noise and/or vibration during both the construction and operational phases of the project), and potential impacts due to relocations and alterations of existing land uses (if any). Large scale road improvement projects may necessitate the preparation of a programmatic environmental assessment of the overall project to assure initial environmental clearances, followed by more detailed project-level

environmental assessments for those portions of the overall program which are found to warrant more detailed investigation and/or the identification of mitigating actions.

Accordingly, the project proponents should be aware of the environmental documentation requirements of both Argentina and the funding/financing organization(s). Environmental considerations should be integrated as a part of the subsequent engineering and design considerations and the required environmental documentation should be undertaken at an appropriate level of specificity in tandem with more detailed engineering considerations and project design.

APPENDIX I TECHNOLOGY DEPLOYMENT REVIEW

1. Introduction

This Technology Deployment Review presents the results from a database search on the following technologies:

- License Plate Readers and Violation Enforcement Systems
- Wide Area Detection/ Tracking Systems
- Dynamic Message Signs/ Electronic Displays

◊ Part A presents vendor material on *license plate readers and violation enforcement systems* from some of the most representative manufacturers.

◊ Part B presents vendor material on *wide area detection/ tracking systems* from some of the most representative manufacturers.

◊ Part C presents vendor material on *dynamic message signs/ electronic displays* from some of the most representative manufacturers.

2. Summary Review of ATMS technologies

This section presents a brief summary review of the ATMS technologies typically applied. The tables below show the different technologies' relative advantages and disadvantages with respect to the relevant criteria.

- ◊ Table 1-1: Telecommunications technologies
- ◊ Table 1-2: Vehicle detection and monitoring technologies
- ◊ Table 1-3: Callbox technologies
- ◊ Table 1-4a: Information dissemination technologies
- ◊ Table 1-4b: Dynamic message signs/ electronic displays
- ◊ Table 1-5: Traffic control system technologies
- ◊ Table 1-6: Traffic control center system technologies

Table 1.1 Summary Review of Telecommunication Technologies

TELECOMMUNICATIONS TECHNOLOGIES			
TECHNOLOGY	**METHOD OF OPERATION**	**ADVANTAGES**	**DISADVANTAGES**
Fiber Optics	uses modulated light from laser diode through glass fiber	very high bandwidth, long transmission distances (SMFO) excess bandwidth can be sold immune to electromagnetic interference (EMI)	high capital cost for cabling and equipment requires specialized installation and test equipment and technicians
Leased Land Lines	Lease communications services from existing provider (e.g. telephone, cable company); contract for bandwidth requirements	low capital costs rapid service installation • service provider maintains	• high variable costs • quality dependent on provider • limited flexibility • poor long term option
Twisted Pair Cable	Data communications use various types of modems and physical interface standards (e.g. DSL, V.34, RS-422, 485, 232)	• large installed base (e.g. existing telephone wire in buildings) • new technologies (e.g. DSL) offer increasing bandwidth, transmission distances	• high capital cost for installation of cabling
Coaxial Cable	Data communications use cable modems	• high bandwidth data (digital) • supports analog video • new cable modems offer increasing bandwidth	• high capital cost for installation of cabling • specialized installation and test equipment and technicians required

		• good EMI immunity with properly installed connectors	
Packet Radio	Packetized data communications on radio frequency pairs (tx/rx) in various bands (HF to microwave) using various modulation techniques (e.g. FSK)	• relatively low capital costs • well suited to short message transmissions	• unsuitable for voice communications and long file transfers (low guaranteed bit rate) • data rate depends on base band
Microwave	Operates in 928 MHz to 40 GHz band on frequency pairs (tx/rx), line-of-sight; various modulation techniques used (e.g. ASK, PSK, FSK, QPSK)	• high bandwidth; suitable for trunk communications (multiple channels) • digital and analog (full motion video) transmission	• relatively high cost • requires line-of-sight communications path • may require FCC license • required antenna installations often difficult
Spread Spectrum Radio	Signal bandwidth spread over multiple frequencies (sequentially or hopped) for transmission of packetized data, signal recombined at receiving station	• relatively high bandwidth • low transmitter power • good EMI immunity • avoids land-line issues	• new technology risks • unlicensed band may result in interference problems • requires antennae, specialized equipment and line-of-sight

TELECOMMUNICATIONS TECHNOLOGIES (cont.)			
Satellite	Ground stations transmit to geosynchronous or low-earth-orbit satellites (uplink) for relay broadcast to receivers (downlink)	• cost of circuits independent of length • cost effective for long-haul circuits • downlink signals received over wide area • uplink signals originate over wide area • flexibility for "quick setup" or mobile applications • new services expected near-term (e.g. Iridium, Globalstar)	• costs depend on bandwidth requirements (channel allocation) • not proven cost effective for local communications
Broadcast Systems	Various techniques including standard AM radio (HAR), FM-subcarrier, TV vertical blanking interval, and digital radio broadcasting	• effective means for broadcast of traveler information relevant to local area (transmission range) • AM-radio receivers (for HAR) widely deployed (car radios)	• older technologies (e.g. AM-radio HAR) have low data rates, poor signal quality • new technologies (e.g. digital radio) requires substantial capital outlays for broadcast equipment

Table 1.2 Summary Review of Vehicle Detection and Monitoring Technologies

VEHICLE DETECTION AND MONITORING TECHNOLOGIES			
DETECTION TECHNOLOGY	**METHOD OF OPERATION**	**ADVANTAGES**	**DISADVANTAGES**
Self-Tuning Inductive Loop	Generates electromagnetic field which is disturbed as vehicle passes over	• Most commonly used typed of detector. • Relatively easy to install. • Size and shape of detection zone can be customized. • Good presence detection.	• Relocation requires installation of new loop. • Can be expensive if installed in small numbers. • Occasionally require manual retuning.
Magnetic Probe	Vehicle passage over detector disturbs Earth's magnetic field.	• Low maintenance • Simple	• Cannot measure most traffic parameters.
Sensing Cable	Vehicle wheels compress piezo-electric cable which generates electrical signal	• Well defined detection zone	• Cannot measure most traffic parameters • Measures axles, not vehicles
Loop Mat	Same as conventional inductive loops	• Easy to install	• Designed for temporary use only-unsuitable for long term use.
Infrared	Overhead transmitter/receiver notes vehicle passage by change in signal reflection	• Does not require Pavement-mounted sensors	• Sensitive to ambient light conditions and Pavement color • Sensitive to weather and atmospheric conditions

Ultrasonic-Continuous Wave	Operates on Doppler principle for reflected waves	• Direct speed measurement • Does not require Pavement mounted sensors	• Cannot detect presence. • Accuracy problems during congestion. • Sensitive to environmental conditions.
Ultrasonic-Pulsed	Emits bursts of energy. Detection is based on reflections arriving within a certain period of time	• Can be used where Pavement is unstable. • Can classify vehicle height • Does not require Pavement-mounted sensors	• Conical detection zone may result in inaccuracies. • Accuracy problems during congestion. • Sensitive to environmental conditions.
Microwave	Operates on Doppler principle for reflected microwaves.	• Direct speed measurement • Does not require Pavement-mounted sensors	• Performance may be impacted by other nearby microwave transmissions. • Cannot detect presence. • Accuracy problems during congestion.
Solid State Closed Circuit TV	Provide oversight of roadway at specific locations. Technology uses a semiconduct or to convert image into signal	• PTZ controllers allow manipulation of camera for various views of the roadway • Low maintenance • Shock and vibration proof	• High level of calibration for PTZ

Table 1.3 Summary Review of Motorist Call Box Technologies

CALL BOX TECHNOLOGIES			
TECHNOLOGY	**COMMUNICATION INFRASTRUCTURE**	**ADVANTAGES**	**DISADVANTAGES**
Motorist Call Box System	**Land Line**	• full duplex voice • moderate operating cost	• cable installation can be disruptive • communications cable subject to breakage • cable maintenance can be costly
Motorist Call Box System	**Cellular Telephone Network**	• full duplex voice • easy to install	• potentially high communications charges • poor connections in cellular "dead zones"
Motorist Call Box System	**FM Radio Code Transmitter**	• easy to install • low operating cost	• higher potential for false alarms • reduced functionality

Table 1.4a Summary Review of Information Dissemination Technologies

INFORMATION DISSEMINATION			
TECHNOLOGY	**METHOD OF OPERATION**	**ADVANTAGES**	**DISADVANTAGES**
Changeable/ Variable Message Signs	Over-roadway signs which are capable of displaying either pre-programmed messages or newly created messages. Used for driver advisories of either current roadway conditions or scheduled events.	• disseminate current roadway conditions to all motorists in specified areas • provides a means for traffic control for police and emergency crews to implement an incident response plan	• does not allow for pre-trip planning
In-vehicle Display	In-vehicle navigation and route guidance systems provide motorists with real-time roadway conditions and alternate route guidance	• route guidance for congestion avoidance • provides real-time driver advisories about traffic conditions, incidents, transit schedules and other mode options	• does not supply information to all motorists
Highway Advisory Radio	Employ radio transmitters at selected locations in a freeway corridor to provide en-	• disseminate information to all motorists • low cost	• must be updated frequently for accurate data dissemination • interference in densely

	route traffic and road condition information to motorists		
Radio, Television, Kiosk, and Internet	Use media and other service providers to disseminate information to the public. Provide roadway conditions, transit schedules, and other traveler information.	• disseminate information to a wide range of the traveling public via radio and television • allows for pre-trip planning	• Kiosk and Internet services only distribute information to specific users

Table 1.4b Summary Review of Dynamic Message Signs/ Electronic Displays

TYPE	ADVANTAGES	DISADVANTAGES	EXAMPLE SUPPLIERS
Flip Disk	Low power requirements Low capital cost	Moving parts Poor nighttime visibility Disks fade and require replacement	ADDCO, Winkomatics
Shuttered **Fiber-Optic**	Multiple colors easily implemented Good visual impact	Moving parts High cost Bulb maintenance Minimum replacement of a 3-module unit when required	Fortran, Lake Technologies, Telespot
LED	Multiple colors possible Fully solid state Low power requirements Good visual impact	Degradation of intensity over a period of 10 years	Ledstar, Econolite, ADDCO, Daktronics
Hybrid Fibre Optic/ Flip Disk	Excellent visibility under all Lighting conditions Display possible during power Failure	Moving parts High cost Bulb maintenance Disks fade and require replacement	Telespot, Matrix Media, ADDCO
Hybrid LED/ Flip Disk	Multiple colors possible Display possible during power Failure Lower maintenance costs Compared with hybrid fiber/disk	Disks fade and require replacement Reduced visibility when backlit by sunlight	Matrix Media, ADDCO

Table 1.5 Summary Review of Traffic Control System Technologies

TRAFFIC CONTROL SYSTEMS			
TECHNOLOGY	**METHOD OF OPERATION**	**ADVANTAGES**	**DISADVANTAGES**
Traffic Signal Control	Use one or more computers to coordinate and manage traffic signals	• Real-time traffic adaptive systems allow for optimization of signals throughout the roadway network • Signal pre-emption for police and transit for rapid response and schedule adherence	• Generic signal system types do not provide for dynamic network impacts such as incidents • Lack of capability among neighboring jurisdictions prevents unified signalization and fluctuates traffic flow through the system
Ramp Metering	Control the rate and amount of traffic entering the freeway system through the use of signals	• reduce turbulence due to excess demand and/or geometric bottlenecking • improve travel time and corridor traffic management	• metering on ramps may cause excess queuing and vehicles backing up onto arterial roadway

Table 1.6 Summary Review of Traffic Control Center System Technologies

TRAFFIC CONTROL CENTER SYSTEMS	
TECHNOLOGY	**DESCRIPTION**
Head-End Hardware	3 fundamental subsystems: • a computer for processing and recording data received from field • communications system for transmitting and receiving data and commands • display systems • provide an integrated advanced traffic management system • allow for coordinated response among various agencies
Head-End Software	Processes raw traffic data in order to determine roadway conditions and signal traffic operators of advisory conditions • automatic incident detection and alarm • coordinated traffic signal control • generate automatic incident response plans • optimization of detection rate and false alarm rate ongoing

List of Representative Vendors and Costing Information

The next three parts cover, by category, a few selected vendors of the specified technologies which are believed to provide the equipment of primary interest to the ATMS project:

- License Plate Readers and Violation Enforcement Systems
- Wide Area Detection/ Tracking Systems
- Dynamic Message Signs/ Electronic Displays

PART A: LICENSE PLATE READERS AND VIOLATION ENFORCEMENT SYSTEMS

The following vendors were identified in the database search as relevant suppliers of license plate readers and vehicle enforcement systems.

- Alphatech
- Computer Recognition Systems
- Monitron International
- Racal Messenger
- Serco/ Visual Image Dynamics
- Perceptics

Technical Usage of LPR and VES

Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas:

- Speed Violation Enforcement
- Toll Violation Enforcement
- High Occupancy Vehicle/ Diamond Lane Enforcement
- Border Inspection Control
- Rental Car Inventory and Lot Control
- Facility Access Control
- Parking Lot Fraud and Theft Control

General Information

Most LPR/ VES systems are based on two or more check points along a road stretch. Depending on the desired functionality of these systems one cannot generalize the equipment layout. Mobile systems may offer feasible alternatives but fixed installation are usually less expensive.

General Cost Information

LPR/ VES Equipment	$50,000 per lane (plus installation of cameras)

Transmission Media	$5 per meter of fiberoptic cable $6 per meter of copper cable $24 per meter of conduit
Operation **(Assume operational 24 hrs per day)**	0.48 kWh per day (camera w/ heater) 0.50 kWh per day (processor)
Maintenance	5% of capital cost per year

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Alphatech, Inc.***
Alphatech was founded in 1979 and has been working closely with clients such as: Naval Air Command, Naval Research Board, US Army Strategic Defense Command, Boeing, Texas Instrument and Raytheon.. Their LPR equipment has not yet become widely deployed in the USA for ATMS usage.	
Automatic LPR Automatic LPR Violation Enforcement Systems (VES) Violation Enforcement Systems (VES)	• Car rental garage in Manhattan, New York, USA SCOPE: License Plate Reader controls at exit from garage **=> *Hertz Corporation*** • Parking garage at major research center in Santa Barbara, California, USA SCOPE: License Plate Reader controls at entrance/ exit from garage **=> *Hughes Santa Barbara Research Center*** • Violation Enforcement System of Electronic Toll Collection SCOPE: Violation Enforcement System for 14 lanes in Metro-Dade County, Miami, USA **=> *Venetian & Rickenbacker Causeways*** • Violation Enforcement System of Electronic Toll Collection SCOPE: Violation Enforcement System for 115 lanes on 10 Bridges and tunnels in New York City **=> *Metropolitan Transportation Authority Bridges and Tunnels***
Technology Usage	Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control

Equipment Vendor and Vendor Contact	***Imaging Systems Division of Alphatech, Inc.*** **Dick Butt** (Sales Manager) Phone: 617.273.3388 ext. 231 fax: 617.273.9345
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

The image processor can handle up to 24 camera set-ups. Please note that the license plate reader system specified below can operate 24 hours a day with black and white cameras, but not with color cameras alone (i.e. the color camera option would need black and white cameras for night operations).

Description	**Unit Price (B&W)**	**Unit Price (Color)**
Image Processor	$14,000	$14,000
Frame Grabber (2070 standards)	$1,300	$1,700
Analog Camera (with enclosure)	$1,420	$1,550
Pedestal and Brackets	$175	$175
Light and Filter	$690	$690

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Computer Recognition Systems, Inc.***
Computer Recognition Systems was founded in 1979 and claim to have developed the first real time license plate reader. Systems provided by the firm are known in over 15 countries on five continents.	
LPR Violation Enforcement Systems (VES)	No information available on deployment sites
Technology Usage	License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control
Equipment Vendor and Vendor Contact	***Computer Recognition Systems, Inc.*** Salvatore D'Agostino (President) Phone: (617) 491-7665 fax: 617.491.7753
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements ·	

Description	**Unit Price**
License Plate Reader (4 camera capacity)	$35,000

Camera (Fixed, B&W; color has been used in some cases)	$2,300 + installation

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Monitron International***
Monitron International is a supplier of a wide range of urban traffic and highway monitoring products.	
LPR Violation Enforcement Systems (VES)	No information available on deployment sites.
Technology Usage	Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control
Equipment Vendor and Vendor Contact	***Monitron International*** Helene Richmond (Sales Coordinator) phone: +44+01562 825556 fax: +44+01562 822250
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**NOT AVAILABLE**
Special Features/Requirements	(Monitron International is ISO 9001 certified)

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Racal Messenger***
Racal Messenger is a supplier automatic license plate recognition systems.	
LPR Violation Enforcement Systems (VES)	No information available on deployment sites.
Technology Usage	Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control
Equipment Vendor and Vendor Contact	***Racal Messenger*** John Keehart (Sales Engineer) phone: (954) 846-4839 fax: (954)846-5527
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**NOT AVAILABLE**
Special Features/Requirements	

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Serco/ Visual Dynamics***	
Serco/ Visual Dynamics is a supplier of a several image processing software and equipment..		
LPR Violation Enforcement Systems (VES)	No information available on deployment sites.	
Technology Usage	Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control	
Equipment Vendor and Vendor Contact	***Serco/ Visual Dynamics*** Dave Dallas (Sales Engineer) phone: +44+01275793150 fax: +44+0127534003	***Serco/ Visual Dynamics*** Trevor Platt (Director) phone: +44+01275793110 fax: +44+01287610360
Equipment Cut-sheets/ Technical Information	**ATTACHED**	
Equipment Cost Data	**SEE BELOW**	
Special Features/Requirements		

Serco's number plate recognition system would cost in the order of **$40,000 - $48,000 per lane** to implement (including camera). Please keep in mind that most speed enforcement systems are based on two check points, i.e. the actual cost would double per lane. Additional cost considerations need to be give to the transmission medium. This capital cost estimate was based on a mobile system which could be operated from a vehicle. Fixed installations are typically less expensive.

Technology: License Plate Readers and Violation Enforcement Systems	***Vendor: Perceptics Corporation***	
Perceptics is a well recognized company on the market for automatic license plate readers with over 15 years of experience. Currently their LPR technology is deployed at over 175 locations world wide		
Automatic LPR Automatic LPR Violation Enforcement Systems (VES) Violation Enforcement Systems (VES)	• Customs 2000 SCOPE: Customs control CONTRACT VALUE: $6,000,000 **=> *Revenue Canada Customs and Excise*** • Customs Service SCOPE: Customs control CONTRACT VALUE: $10,000,000 **=> *Revenue Canada Customs and Excise*** • SafetyNet SCOPE: Customs control CONTRACT VALUE: $1,000,000 **=> *State Police and State DOT's/ FHWA*** • Dulles Toll Road SCOPE: Toll Road Enforcement CONTRACT VALUE: unknown **=> *Virginia Department of Transportation***	
Technology Usage	Automatic License Plate Reader and Violation Enforcement Systems can be used in the following areas: • Toll Violation Enforcement • High Occupancy Vehicle/ Diamond Lane Enforcement • Border Inspection Control • Rental Car Inventory and Lot Control • Facility Access Control • Parking Lot Fraud and Theft Control	
Equipment Vendor and Vendor Contact	***Perceptics Corporation*** **Terry G. Gibson** (Sales and Marketing Manager) phone: 615.966.9200 fax: 615.966.9330	***Perceptics Corporation*** **Tim Bates** (Sales and Marketing Manager) phone: (423) 966-9200 fax: 615.966.9330

Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

Description	**Unit Price**
License Plate Reader (complete with integral pulsed IR illuminator)	$35,000
Video Buffer Set (Transmitter/ Receiver)	$3,500
Vehicle Sensor (complete)	$895

Wide Area Detection/ Tracking System

The vendors below were identified in the database search as relevant suppliers of cameras for surveillance and complete wide area detection/ tracking systems.

Cameras only:

- Cohu
- Pearpoint

Wide area detection/ tracking systems:

- Autoscope
- Peek Traffic
- Traffic Analysis System

Technical Usage of Surveillance and Wide area detection/ tracking systems

Machine Vision Detection/ Tracking can be used in the following areas:

- Incident Detection
- Incident Analysis
- Intersection Detection
- Freeway Detection/ Management
- Ramp Metering
- Vehicle Counting
- Vehicle Classification
- Traffic Data Collection
- Turning Movement Analysis
- "Wrong Way" - Detection
- Enforcement
- Queue Length Analysis

General Information

The surveillance and wide area detection/ tracking systems consist of cameras connected to an image processor. Various vendors' systems typically handle from two to eight cameras per processor. For most technical applications monochromatic cameras are used for enforcement purposes while color cameras are used for surveillance. Depending on the application objectives, various cameras and camera deployment configurations may be considered.

General Cost Information

Equipment	$35,000 per lane (plus installation of cameras)
Software	$10,000 per system
Transmission Media	$5 per meter of fiberoptic cable $6 per meter of copper cable

	$24 per meter of conduit
Operation (Assume operational 24 hrs per day)	0.48 kWh per day (camera w/ heater) 0.50 kWh per day (processor)
Maintenance	5%-10% of capital cost per year (plus software customizing)

PART B: WIDE AREA DETECTION/TRACKING SYSTEMS

Technology: LPR and Surveillance Cameras	***Vendor: Cohu, Inc.***	
CCTV	• Most major "Smart Corridor" Projects in North America	
Technology Usage	Machine Vision Detection/ Tracking can be used in the following areas: • Incident Detection • Incident Analysis • Intersection Detection • Freeway Detection/ Management • Ramp Metering • Vehicle Counting • Vehicle Classification • Traffic Data Collection • Turning Movement Analysis • "Wrong Way" – Detection • Enforcement • Queue Length Analysis	
Equipment Vendor and Vendor Contact	***Cohu, Electronics Division.*** Curt Duplack (Traffic Surveillance) Phone: 619.277.6700 fax: 619.277.0221	***Cohu, Electronics Division.*** Joe Barrett (Sales Engineer) phone: (603) 430-2806
Equipment Cut-sheets/ Technical Information	**ATTACHED**	
Equipment Cost Data	**SEE BELOW**	
Special Features/Requirements		

COHU Monochrome cam

Description	**Price**
Monochrome cam, 25mm lens/ Hsg	$2,300
Camera mount	$100

COHU Color cam with 10:1 zoom

Description	Price
Color cam, 10:1 zoom lens, ID gen, environmental enclosure	$5,000
Camera multi-conductor cable (50ft)	$800
Medium duty pan/ tilt	$2,000
Pan/ Tilt cable	$300
Camera/ Pan/ Tilt – controller	$1,700

Technology: LPR and Surveillance Cameras	***Vendor: Pearpoint.***
LPR and CCTV	No information available on deployment sites
Technology Usage	Machine Vision Detection/ Tracking can be used in the following areas: • Incident Detection • Incident Analysis • Intersection Detection • Freeway Detection/ Management • Ramp Metering • Vehicle Counting • Vehicle Classification • Traffic Data Collection • Turning Movement Analysis • "Wrong Way" – Detection • Enforcement • Queue Length Analysis
Equipment Vendor and Vendor Contact	***Pearpoint*** James M. Kennedy Sales Engineer Phone: (619) 343-7350
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

PEARPOINT Monochrome cam

Description	**Unit Price**
Monochrome Camera (w/o lens)	$3,740
Controller (capacity for 32 cameras)	$1,850
Lighthead Illuminator	$1,600
Cable; Junction box – Camera	$480 ($48 per meter)

(max 10 meter)	
Cable; Junction box – Controller (max 3 meter)	$144 ($48 per meter)
Cable; Junction box – Mains	$19 per meter
Camera/ Pan/ Tilt – controller	$1,700

PEARPOINT Monochrome/ Color cam

Description	**Unit Price**
Monochrome/ Color Camera (w/o lens)	$5,497
Controller (capacity for 32 cameras)	$1,850
Lighthead Illuminator	$1,600
Cable; Junction box – Camera (max 10 meter)	$480 ($48 per meter)
Cable; Junction box – Controller (max 3 meter)	$144 ($48 per meter)
Cable; Junction box – Mains	$19 per meter
Camera/ Pan/ Tilt – controller	$1,700

This company is currently penetrating new markets with their number plate capturing cameras, including the ITS market in USA, with a new license plate recognition technology based pulsed IR (which reduces the effect of car headlights and ensures that readings of not only clean number plates can be taken). As a result their cameras have been more than marginally more expensive, but cost is expected to be cut substantially in the near future (according to vendor).

Description	**Unit Price**
Number Plate Capture Camera (complete with integral pulsed IR illuminator)	$9,892
Camera Control Unit	$1,382
Camera cable	$35 per meter
Terminated and potted connectors	$350 per pair

<table>
<tr><td>Technology: Traffic Management Video Systems</td><td colspan="3">Vendor: Autoscope/ Econolite/ Image Sensing Systems.</td></tr>
<tr><td colspan="4">Autoscope/ Econolite/ Image Sensing Systems are the suppliers of the AutoScope System</td></tr>
<tr><td>CCTV & VIP</td><td colspan="3">• Atlanta Advanced Traffic Management Project
Atlanta, Georgia, USA
SCOPE: Largest ATMS in the world (317 image sensors)
=> Georgia Department of Transportation
• Michigan's FAST - TRAC program
Oakland County, Michigan, USA
SCOPE: Largest machine vision based vehicle detection for adaptive intersection control
=> Michigan Department of Transportation
• Gowanus/ Prospect Expressway
New York City, New York, USA
SCOPE: Automatic Incident Detection System
=> New York State Department of Transportation</td></tr>
<tr><td>Technology Usage</td><td colspan="3">Machine Vision Detection/ Tracking can be used in the following areas:
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• Incident Analysis
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• Vehicle Counting
• Vehicle Classification
• Traffic Data Collection
• Turning Movement Analysis
• "Wrong Way" – Detection
• Enforcement
• Queue Length Analysis</td></tr>
<tr><td>Equipment Vendor and Vendor Contact</td><td>Autoscope
Lisa R.Dumke (Director Global Sales)
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fax: 612.603.7795</td><td>Econoloite
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Paul A. Misticawi (
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Brad Boyle
Phone :(612) 603-7747
James W. Welch:
Phone: (612) 603-7700</td></tr>
</table>

EquipmentCut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

The "Autoscope Video Vehicle Detection System" has been field deployed for 8 years. Currently there are about 1,500 units in operation through out the world. Recent and significant installations in the USA include 57 units in Atlanta (Georgia DOT) and 250 units in Oakland County (Michigan DOT). The budgetary quotation below includes most hardware items for an "Autoscope Video Vehicle Detection System" as well as a "developers solution kit" for incident management applications. Please note that the current configuration of the system does not allow for speed violation enforcement.

Description	**Unit Price**	
Processor (4 camera capacity)	$17,000	$18,200
Camera (Fixed/ B&W; 1 camera ⇔ 8 lanes)	$2,685	$2,685
Supervisor cable (connects processor with PC)	$350	$350
Digitizer Card (supports real-time image transfer and overlay)	$945	$945
Incident Detection Software Kit (interface software; one time licensing)		$11,000

Technology: Traffic Management Video Systems	***Vendor: Peek Traffic.***
Peek Traffic is the supplier of the VideoTrack System	
Video Tracking Systems	• Smart Call-Box Projects, San Diego, USA **=>*U.S. Commlink (partner on project)*** • Speed, Occupancy and Headway Systems on Route 18, Middlesex County, New Jersey, USA => Farradyne ***(partner on project)***
Technology Usage	Machine Vision Detection/ Tracking can be used in the following areas:

	• Incident Detection • Incident Analysis • Intersection Detection • Freeway Detection/ Management • Ramp Metering • Vehicle Counting • Vehicle Classification • Traffic Data Collection • Turning Movement Analysis • "Wrong Way" – Detection • Enforcement • Queue Length Analysis	
Equipment Vendor and Vendor Contact	***Peak Traffic Inc.*** Ian Cardozo (Director) Phone: (813) 366.8770 fax: (813) 365.0837	***Peak Traffic Inc.*** W.H. Sowell: phone: (904) 562-2253 Scott Meyerhoff phone: (904) 562-2253
Equipment Cut-sheets/ Technical Information	**ATTACHED**	
Equipment Cost Data	**SEE BELOW**	
Special Features/Requirements	• Shadow Removal • Image Stabilization • Field of View Realignment • Specialized Video Compression Techniques allows for viewing of video images on a standard notebook format transmitted over regular media including telephone lines.	

The "VideoTrack System" has been proven in the field world wide since 1995. The most recent achievement as a supplier of wide area video track and detection system was to get awarded a five year contract by the State of Utah for supplying the Utah ATMS video detection equipment, by itself a major part of the planning efforts for the 2002 Winter Olympics.

A complete system would cost in the order of **$25,000 to $35,000** depending on the options. The are 32 detection zones per camera and the processors have either a 4 or 8 camera capability.

Description	**Unit Price**

Processor (4 camera capability)	$16,000
Processor (8 camera capability)	$22,000
Camera (Burle/ Philips make)	$1,382

Technology: Traffic Management Video Systems	***Vendor: Computer Recognition Systems, Inc.***
Computer Recognition Systems is the supplier of Traffic Analysis System (TAS/ TAS 2)	
TAS	No information on deployment sites available
Technology Usage	Machine Vision Dectection/ Tracking can be used in the following areas: • Incident Detection • Incident Analysis • Intersection Dectection • Freeway Detection/ Management • Ramp Metering • Vehicle Counting • Vehicle Classification • Traffic Data Collection • Turning Movement Analysis • "Wrong Way" – Detection • Enforcement • Queue Length Analysis
Equipment Vendor and Vendor Contact	***Computer Recognition Systems, Inc.*** Salvatore D'Agostino (President) Phone: (617) 491-7665 fax: 617.491.7753
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

The Traffic Analysis System (TAS/ TAS2) costs approximately **$50,000** ((1-2 lanes) includes software, cable, single camera) or **$100,000** ((2-4 lanes) includes software, cable, double cameras).

PART C: DYNAMIC MESSAGE SIGNS/ELECTRONIC DISPLAYS

Dynamic Message Signs/ Electronic Displays

The following vendors were identified in the database search as relevant suppliers of dynamic message signs/ electronic displays:

- American Electronic Sign
- American Signal Company
- Dactronics
- Dambach
- Fiberoptic Display Systems
- Infocite Group
- Skyline Products
- Tele-Spot

Technical Usage of dynamic message signs/ electronic displays

Dynamic Message Signs/ Electronic Displays can be used in the following areas:

- Freeway Traffic Management Systems
- Reversible Lane Systems
- Tunnel Systems
- Toll Road Systems
- Mass Transit Systems
- Parking Systems
- Signage Systems
- Warning Systems

General Cost Information

TYPE	TYPICAL COST
Flip Disk	$70,000
Shuttered Fiberoptic	$108,000
LED	$85,000
Hybrid Flip Disk/ Fiberoptic	$108,000
Hybrid Flip Disk/ LED	$85,000

Installation (Assume existing sign support structure)	80 labor hours in the field
Operation (Assume operational 24 hrs per day and 3 lines of 21 18 inch (460 mm) characters illuminated 40% of the time (70 Watts per character LED signs))	42 kWh per day

Maintenance (Including periodic maintenance and replacement of filters and replacement of failed character boards)	5%-10% of capital cost per year

Technology: Electronic Display Systems	***Vendor: American Signal Company***
PVMS	PVMS are being used extensively across the globe, especially for construction mitigation
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems
Equipment Vendor and Vendor Contact	***American Signal Company*** Stephen P. Hart: Phone: (770) 458-7278
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	PVMS can be run on solar power or diesel

American signal company provides a large family of message signs. Their signs allow for remote operation and powered by solar and/ or power. Their selection of PVMS range from **$5,000** to **$23,000**.

Technology: Electronic Display Systems	***Vendor: American Electronic Sign Company***
	No information on deployment sites available.
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***American Electronic Sign Company*** Daniel W. Skites: Phone: (509) 928-2296
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**NOT AVAILABLE**
Special Features/Requirements	

Technology: Electronic Display Systems	***Vendor: Daktronics***
	For deployment sites see section below
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning System Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***Daktronics*** Tom Becker: Phone: (605) 697-4300
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

Daktronics display technologies include monochrome incandescent (SunSpot), LED (Infoline), reflected light (glow cube) and incandescent color (Starbust). Recent installations include projects by Connecticut DOT, Virginia DOT, New Jersey Highway Authority, New Jersey DOT, Sweden National Road Administration, Washington State DOT, and special event clients such as 1994 Winter Games in Lillehammer, Norway.

VMS Model/ Types	**Character**	**Unit Price**

	Height	
Light Emitting Diode 2 x 12	18	$45,000
Light Emitting Diode 3 x 18	18	$120,000
Glow Cube Reflective Display 2 x 12	18	$35,000
Glow Cube Reflective Display 3 x 18	18	$90,000

Technology: Electronic Display Systems	***Vendor: Dambach***
	No information on deployment sites available.
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***Dambach*** John Cunningham: Phone: (401) 658-1954
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

Dambach have been one of the major electronic message sign providers for the past twenty years. Today they are strong in three segments of the market internationally, namely fully variable message signs, lane control signs and old small prism technology. They currently have an installment record of more than 700 systems.

VMS Model/ Type	**Character Height**	**Unit Price**
Lane Control Sign	n/ a	$800 - $2,500

3 x 15 alphanumeric	12"	$70,000 -$80,000
3 x 18 alphanumeric	18"	$90,000
2 x 20 alphanumeric	18"	$70,000
3 lines continuous matrix	18"	$90,000
Full graphic display based on 3 x 18	18"	$140,000

Technology: Electronic Display Systems	***Vendor: Fiberoptic Display Systems Inc.***
Fiberoptic VMS Fiberoptic VMS Fiberoptic VMS Fiberoptic VMS	• I-20 Technology Demonstration Project Phoenix, Arizona, USA **=> *Arizona Department of Transportation*** **CONTACT:** Dan Powell at 602.255.7190 • Mass Turnpike Prudential Tunnel Emergency Signing Boston, Massachusetts, USA **=> *Massachusetts Turnpike Authority*** **CONTACT:** Al Abdella 617.894.0175 • Mass Turnpike Callahan Tunnel Airport Signing Boston, Massachusetts, USA **=> *Massachusetts Turnpike Authority*** **CONTACT:** Al Abdella 617.894.0175 • San Antolio Sysytem San Antolio, Texas, USA **=>*Texas Department of Transportation*** **CONTACT:** Patrick Irwin at 210.731.5249 • Route 16 Hood Canal/ Tacoma Narrows Project Tacoma, Washington, USA **=> *Washington State Department of Transportation*** **CONTACT:** Richard Swanson at 206.357.2633
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	**Fiberoptic Displays** Gary H. Geissler (Marketing Manager) Phone: 401.232.3370 fax: 401.232.7130

Equipment Cut-sheets/ Technical Information	**Fiberoptic VMS** Fiberoptic technology provides for: • Excellent Legibility
Equipment Cost Data	Partially provided
Special Features/Requirements	• "No-tools" modular design (i.e. simple maintenance) • Low power requirements (Fiberoptic Display Systems are ISO 9001 certified).

Fiberoptic Display is a vendor of several electronic signs ranging from small blackout signs, traffic signs and lane control signals to large overhead full message variable message signs. Their traffic signs start around **$3,000** while their large 3 x 18 with 18" height character cantilever signs cost between **$80,000 and $100,000.**

Technology: Electronic Display Systems	***Vendor: F-P Electronics/ Mark IV Industries***
	For deployment sites see section below.
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***F-P Electronics/ Mark IV Industries*** Colin McGregor (905) 624-3020 Greg Bartlett: (905) 624-3020
Equipment Cut-sheets/ Technical Information	**ATTACHED**
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	

F-P Electronics/ Mark IV Industries has been one of the pioneering firms in supplying electromagnetic flip disc displays. Today the company also provides emissive display technologies such as LED/ Disk hybrid and Fiberoptic/ Disc Hybrid: The company supplied the VMS in the INFORM project in the State of New York. In the recent past they provided 105 PTD on the Maine Turnpike. The cost range of their dynamic signs is **$50,000 - $120,000 per sign**, with a typical 3 x 18" fiberoptic sign with 18 characters per line.

Technology: Electronic Display Systems	***Vendor: Infocite Group Inc.***
LED VMS LED VMS LED VMS	• Boston Central Artery/ Tunnel Integrated Project Control System Boston, Massachusetts, USA **=> *Massachusetts Highway Department*** • Milwaukee-area Freeway Traffic Management System Milwaukee, Wisconsin, USA **=> *Wisconsin Department of Transportation*** • Montreal Advanced Traffic Management Systems Project Montreal, Quebec, Canada **=> *Quebec Department of Transportation***
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***Infocite Group Inc.*** Daniel Chevalier (President) Phone: 514.978.1230 fax: 514.978.8811
Equipment Cut-sheets/ Technical Information	**LED VMS** LED technology provides for: • Optimal Legibility
Equipment Cost Data	Pending
Special Features/Require	• "No-tools" modular design/ No moving parts (i.e. simple maintenance)

ments	• Low power requirements • Need to assess NTCIP compliance (Infocite Group Inc. is currently undergoing ISO 9001 certification).

Technology: Electronic Display Systems	***Vendor: Skyline Products Inc.***
Flip Disk Internally-Illuminated Rotary Displays Externally-Illuminated Rotary Displays LED VMS	• Major Highway CMS/ VMS System Colorado Colorado, USA **=> *Colorado Department of Transportation*** **CONTACT:** Ed Fink at 303.757.9371 • Major Highway CMS/ VMS System Minneapolis - St. Paul Area, Duluth, Rochester Minneapolis, USA **=> *Minnesota Department of Transportation*** **CONTACT:** Jerry Christensen at 612.341.7296 • Major Highway CMS/ VMS System I-45 Houston Texas, USA **=> *Texas Department of Transportation*** **CONTACT:** John Hemme at 713.802.5836 • Major Highway CMS/ VMS System Lawrence Expressway, San Tomas Expressway, Santa Clara County California, USA **=> *Santa Clara County Road and Airport Department*** **CONTACT:** Tong Hong at 408.321.7136
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems Equipment include Changeable Message Signs/ Variable Message Signs, Lane Use Signals, Variable Speed Limit Signs, Blank-out Signs, Traffic Signal Heads and Portable Variable Message Signs.
Equipment Vendor and Vendor Contact	***SKYLINE Products, Inc.*** Chip Stadjuhar (General Manager) Phone:719.392.9046 fax: 719.392.3839

Equipment Cut-sheets Technical Information	**Flip Disc VMS** Flip Disc technology provides for: • Good legibility during day/ Fair legibility during night **Rotary Display VMS** Rotary Display provides for: • Very Good- Excellent legibility day and night **LED VMS** LED technology provides for: • Optimal Legibility
Equipment Cost Data	NOT AVAILABLE
Special Features/Requirements	

Technology: Electronic Display Systems	***Vendor: Tele-Spot.***
VMS	• New York Triborough Bridge and Tunnel *SCOPE:* 38 VMS • Province of British Colombia *SCOPE:* 59 VMS • Washington State *SCOPE:* 19 VMS
Technology Usage	Electronic Displays can be used in the following areas: • Freeway Traffic Management Systems • Reversible Lane Systems • Tunnel Systems • Toll Road Systems • Mass Transit Systems • Parking Systems • Signage Systems • Warning Systems
Equipment Vendor and Vendor Contact	***Tele-Spot*** Barbara Norton Phone:203.964.0575 fax: 203.964.1677
Equipment Cut-sheets Technical Information	**Fiberoptic VMS** Fiberoptic technology provides for: • Excellent Legibility
Equipment Cost Data	**SEE BELOW**
Special Features/Requirements	• "No-tools" modular design (i.e. simple maintenance) • Low power requirements (Fiberoptic Display Systems are ISO 9001 certified).

Tele-Spot's over-the-road signs cost between **$25,000 and $40,000** depending on the number and size of the characters.