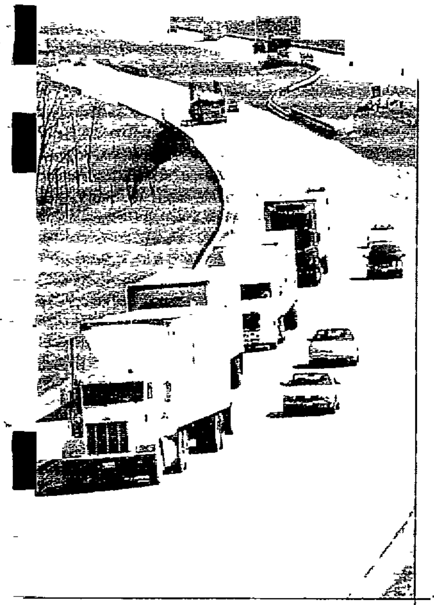

Final Report

Cleveland
Metro Area

Strategic Plan for Deployment
of Intelligent Transportation Systems
in the Interstate 71 Corridor
(Columbus to Cleveland)

Columbus
Metro Area

71 Intelligent Transportation Systems

Prepared for

Ohio Department of Transportation

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April 1998

DOT/FHWA
150309

STRATEGIC PLAN FOR DEPLOYMENT OF INTELLIGENT TRANSPORTATION SYSTEMS IN THE I-71 CORRIDOR (COLUMBUS TO CLEVELAND)

FINAL REPORT

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FOREWORD

The Intermodal Surface Transportation Efficiency Act (ISTEA} signed by the U.S. Congress in December of 199 1 called for improvements in surface transportation through technological advancements. The U.S. Department of Transportation subsequently launched the Intelligent Transportation Systems (ITS) Program, involving research. strategic planning, and operational tests of new technologies. These technologies promise to bring much needed operational improvements to the nation's transportation system, and provide a safer, more convenient, and more efficient trip experience for the traveling public.

The I-71 Corridor ITS Strategic Deployment Plan is an effort undertaken by the Ohio Department of Transportation (ODOT) to develop a strategic plan for deploying ITS technologies. The vision for this project is to identify, innovative ITS technologies to satisfy the many challenges facing the rural I-71 Corridor between Columbus and Cleveland. The focus is on incident management, traveler information, and improved trucking operations.

The Federal Highway Administration (FHWA) has developed a Planning Process to aid local/regional agencies in the development of ITS Strategic Plans. In addition, a National Program Plan for ITS has been prepared to provide a general framework to guide ITS investment decisions and promote ITS goals.

The National ITS "Early Deployment" Planning Program provides much needed assistance to state transportation agencies and MPOs for the development of local or corridor-wide long-term strategic deployment plans. This study was launched recognizing that the I-71 Corridor in Ohio is an excellent location for deployment of rural applications of ITS technologies. The I-71 Corridor between Columbus and Cleveland is shown in **Figure 1.**

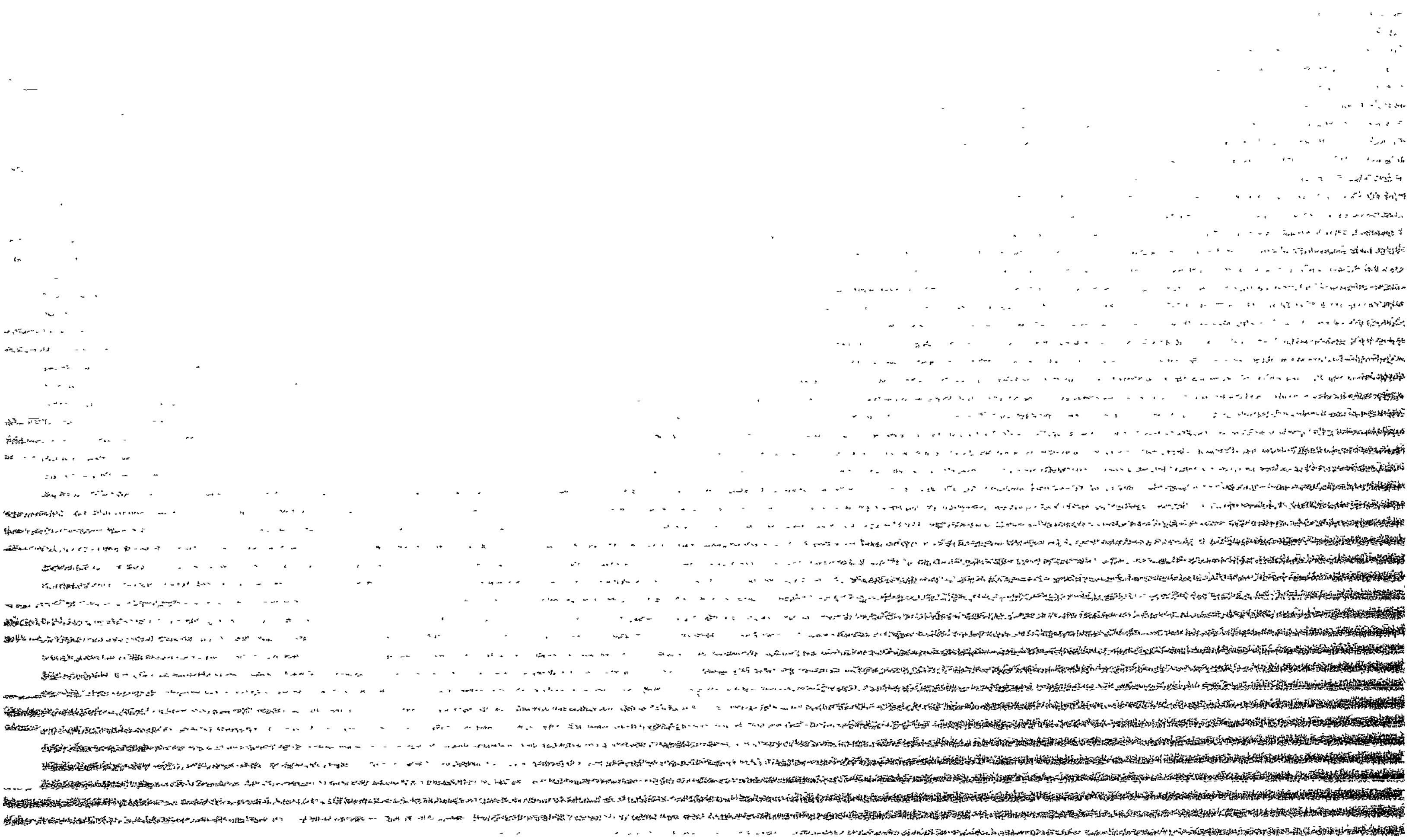
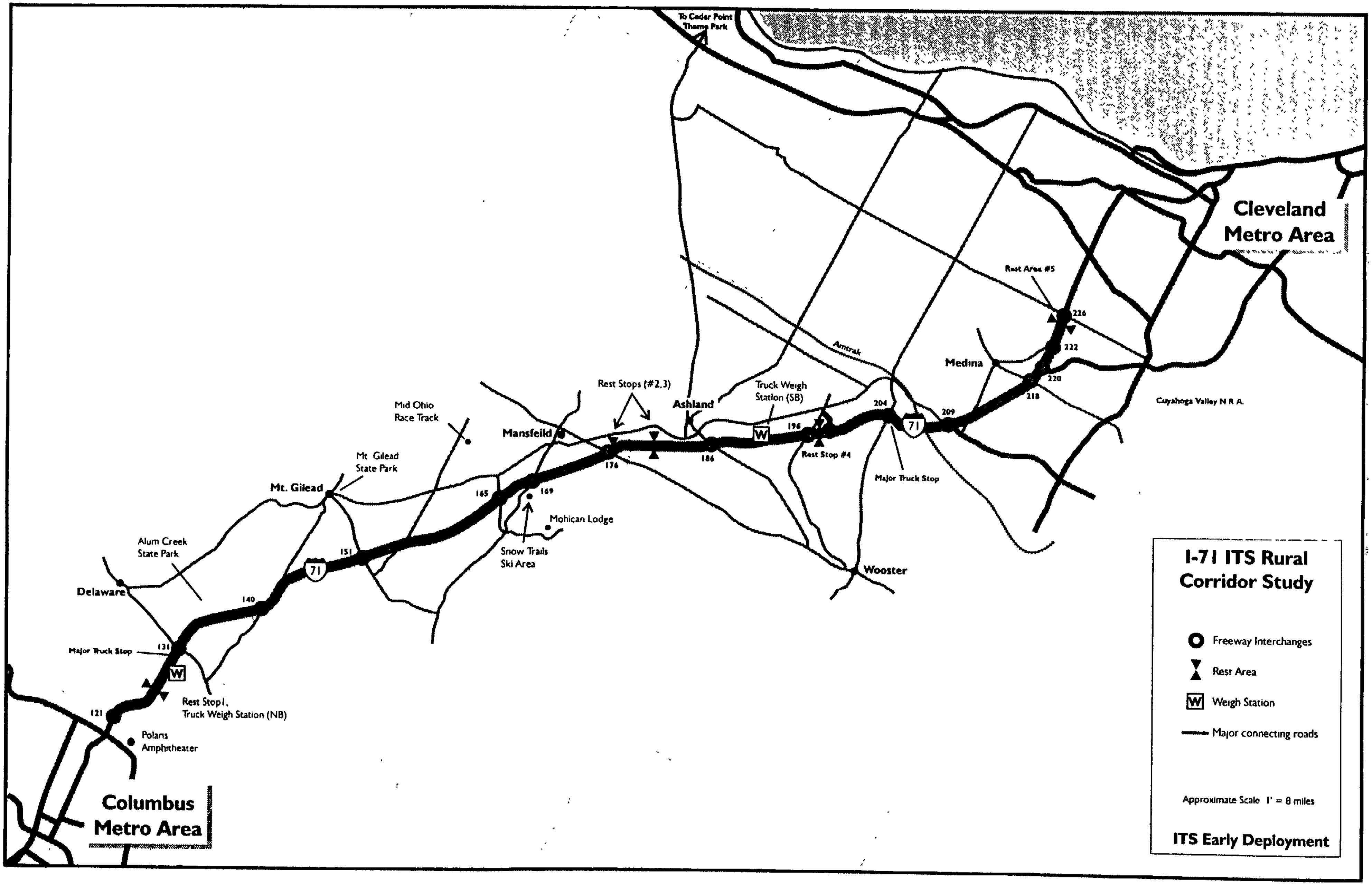


Figure 1



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This Strategic Plan will serve as a roadmap for implementing ITS technologies. It will also be an excellent summary of the overall transportation and travel-related communications needs that exist in the Corridor. To ensure that this Strategic Plan leads to rapid implementation, priority will be given to implementation of the recommendations of this study by ODOT. other state and regional agencies, local governments in the Corridor, and private sector partners.

The Strategic Plan identifies short-, medium-, and long-term initiatives. One of the project goals is to carry out the necessary groundwork for launching short-term initiatives in 1998. The National ITS planning process. depicted in **Figure 2** is consistent with the methodology used in this study.

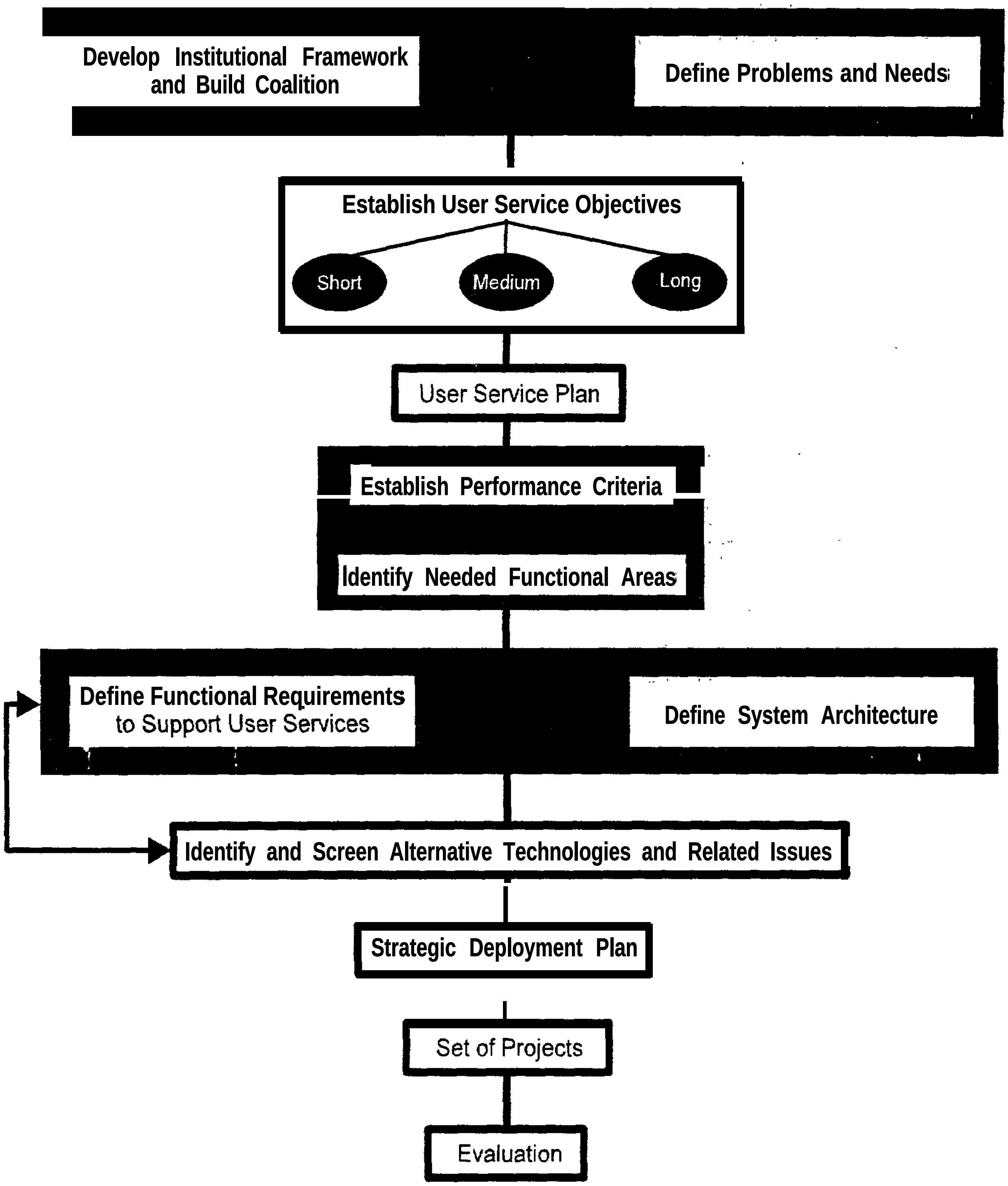


Figure 2
National ITS Planning Process

The ODOT has outlined a process that closely parallels the National ITS Program Plan and FHWA Planning Process. It has been divided into ten sequential tasks. listed in Table 1.

Table 1
I-71 Strategic Planning Study Tasks

NO.	*Task*	*Task Objective*
A	*Define Systems and Problems*	To produce a comprehensive document describing the current transportation system. along with the needs and problems in the I-71 Corridor that may be alleviated by the application of ITS technologies.
B	*Establish Institutional Framework*	To create a database of people and organizations interested in ITS solutions for the transportation problems and needs of the l-71 Corridor and form an I-71 Advisory Committee and ITS Coalition.
C	*Identify User Services*	To determine from the users of the I-7 1 Corridor which of the 29 ITS User Services are needed and when they should be provided: short-, medium-, or long-term.
D	*Establish User Service Objectives and Performance Criteria*	To formulate the objectives to be achieved by implementing identified User Services and to specify the criteria that measure the degree of success (performance) of the User Services when they are deployed.
E	*Develop an Integrated ITS User Service Plan*	To group the needed User Services into program categories, establish the interactions among the needed User Services, and categorize the User Services as having short-, medium-, or long-term potential for implementation.
F	*Identify Needed Functional Areas*	To match the needed User Services with the appropriate functional areas as defined in the National ITS Program Plan and to further define the technologies available to support the user service plan.
G	*Define the System Architecture*	To develop an open architecture meeting the needs and ITS services that is affordable, technology independent, compliant with ODOT's Statewide Communications Plan, and consistent with the national ITS architecture.
H	*Identify and Screen System Components*	To provide a physical architecture with recommended technologies based on optimization of system availability, supportability, expandability. compatibility with existing infrastructure and standards. affordability, and phased implementation capability.
I	*Develop Implementation and Operational Strategies*	To define operations and maintenance issues. identify funding options including public/private partnership opportunities, assess the benefits and costs of the recommended architecture, and determine a phased implementation plan.
J	*Develop ITS Strategic Deployment Plan*	To prepare a business plan and a plan for deployment of identified ITS elements and prepare project descriptions. estimates for deployment. funding sources. and scheduling information.

BACKGROUND

Phase One of ACCESS OHIO. the department's first major statewide planning effort, was completed in 1993. This document outlined the infrastructure of the State and identified long-term needs and goals for the "macro" system: major highway corridors, airports, water ports, and railways. The I-71 corridor project is commensurate with the goals and objectives established for the State's transportation system in ACCESS OHIO.

Several macro-level facilities were identified in ACCESS OHIO. The purpose of establishing the macro corridor system was to aid in the evaluation of the State's major transportation facilities that are critical to promote safe travel as well as economic development. All of the urban and rural Interstate facilities, including the Ohio Turnpike. were identified as macro corridors. In addition to the macro corridors, macro-level hubs and clusters were also identified. The metropolitan areas of Cleveland and Columbus both contain foreign trade zones and serve as major ports, Cleveland with its Lake Erie water port. and Columbus as an inland port. The I-71 corridor has been targeted as a macro facility in need of improvement. including many bridge structures eligible for rehabilitation or replacement.

Ohio's highway system consists of more than 113,000 miles of public roadways and more than 43,000 bridges, facilitating almost 255 million vehicle-miles of travel each day. Due to its location in the Midwest, Ohio functions as the crossroads for commerce, with several water ports, major rail systems, and important US Interstate facilities bisecting the state, both north-south and east-west. Highway preservation, maintenance, improvement, and expansion have been the mainstay of ODOT for many years. Intelligent transportation systems concepts have only just recently been seriously considered as an important element of Ohio's transportation system management efforts. Traffic control and incident management techniques utilizing advanced technologies provide a cost-effective means in gathering data to inform the travelling public (in real-time) of the current status of the highway system.

Projects utilizing ITS for traffic control, incident management, and traveler information services are currently underway in Cincinnati, Columbus, and Cleveland. ODOT worked closely with the Kentucky Transportation Cabinet. the City of Cincinnati, and the Ohio-Kentucky-Indiana Council of Governments (OKI) to develop and implement a Regional Traffic Management System (RTMS) in the Cincinnati metropolitan area using ITS. This system while not yet fully operational covers 88 miles of freeway and includes a traffic control center, loop detectors, widebeam radar detectors, video imaging. CCTV, Highway Advisory Radio, and changeable message signs. In addition. Columbus and Cleveland have initiated Early Deployment Planning for RTMS projects, which will likely be constructed in the near future. ODOT is also part of a multi-state consortium working on an ITS project for I-75 (Advantage l-75).

Problems facing I-71 provide a strong motivation for ODOT to aggressively pursue and implement ITS solutions in this corridor. A recent project construction backlog has forced ODOT to look for new and more cost-effective ways to solve our major transportation infrastructure problems. ITS provides an excellent opportunity to do just that and allows for mitigation of future problems.

The l-71 corridor between the Columbus and Cleveland metropolitan areas consists of 105 centerline miles of four-lane interstate highway through rural Ohio. The average daily traffic counts (ADT) within this corridor range from 30.000 to 50.000. 'The daily percentage of class B and C vehicles (trucks) ranges from 8% to 27% with an average of 2 1% for the corridor. This high truck percentage combined with several long grades near the middle of the corridor slows traffic on this facility.

Recurring congestion associated with weekends, holidays and special events has been experienced along the corridor. In addition, delays resulting from road construction and maintenance have also been experienced and are expected to continue with future projects. ODOT has calculated the threshold for delay as an ADT of 28,000 on a four-lane facility with one lane closed due to maintenance or construction. Currently, all of the segments in this corridor have ADTs in excess of 30.000 and it is estimated that the entire corridor will be at LOS *F* by the year 2020. Therefore, any lane closures will result in recurring congestion. With one major construction project and nine maintenance projects scheduled in this corridor over the next ten years, it is likely that delays due to construction will continue to be a major problem. Designated as a macro corridor, I-71 will receive continual rehabilitation and maintenance projects for the foreseeable future.

Non-recurring congestion resulting from accidents also presents a problem. Over a three-year period, the corridor has averaged 937 accidents per year, or 2.57 accidents per day, translating to 0.65 accidents per MVM. Of these 25 were fatal, 635 injury, and 2, I50 property damage accidents. The isolated nature of some of the areas traversed by I-7 I makes it difficult to quickly assess and respond to accidents, thus complicating the dispatching of proper emergency equipment and clearing of debris.

The I-71 corridor between Columbus and Cleveland links two of the major metropolitan areas in Ohio. Although traffic and congestion management systems are not in place for this corridor, both cities are now in the process of developing an RTMS program. ODOT is working in cooperation with the Northeast Ohio Areawide Coordinating Agency (NOACA) in the initial stages of developing an RTMS system in the Cleveland region, which consists of 223 miles of interstate highway and includes approximately 50 municipalities. The Columbus system, which will cover 102 miles of freeway, is in the final design stage and will use many of the same elements as the Cincinnati system. A rural corridor traffic management system providing integration of the urban regional traffic management systems in Columbus and Cleveland could address several operational issues associated with I-71.

There may be opportunities to utilize infrastructure components established for other projects. The Advantage I-75 project will outfit the vehicles of several companies operating in Ohio with GPS-based equipment. which could also be exploited for traffic and travel data collection in the I-71 corridor. ODOT's Bureau of Travel & Tourism has also recently expressed an interest in placing kiosks at major tourist information centers throughout the state. This effort could represent part of the delivery system for ATIS in this corridor.

Air quality is yet another issue facing this corridor, since Medina and Delaware counties currently have non-attainment status for air quality. Moreover. population growth in communities along the corridors can be expected to have a commensurate impact on air quality. More efficient use of the freeway in this area will reduce air pollution, and help affected regions achieve attainment status.

In summary, the I-71 Corridor faces many challenges which make it ideal for an ITS project. I-71 is the primary link between two major cities and carries a large amount of commercial truck traffic. Recurring congestion during seasonal travel and maintenance and rehabilitation will continue to be a problem unless the physical capacity of I-71 is increased and/or the management of this freeway is facilitated through ITS. Furthermore, significant congestion problems arise as a result of accidents. Although this corridor is not "desolate" in the sense of I-70 in rural Colorado, there is still a need to improve timely and adequate response to injury, property damage, and hazardous accidents in section of the corridor which are not proximate to a community.

Traditionally, Ohio has dealt with congestion by adding lanes. For planning purposes it is estimated that rural interstate widening costs approximately $1 million to $3 million per mile of added lane in each direction. Implementation of ITS technologies fall under the lower range of this cost in urban areas, and even lower in rural areas. and is therefore a cost-competitive alternative for increased highway capacity and safety.

CHAPTER 1.0

1.0 EXISTING TRANSPORTATION SYSTEM, PROBLEMS, AND OPPORTUNITIES

Task A Overview

The objective of this task was to define and characterize the I-71 transportation system and its problems. Identification of the system attributes enabled us to pinpoint the needs and opportunities to satisfy them with deployment of advanced technologies. Technology exists, or is rapidly emerging, to implement a wide range of programs which will make the transport of people and goods safer and more efficient, less impacting on air quality and the environment, and more accommodating to the transportation needs of a heavily traveled rural corridor.

In this first task, we documented the existing system and gaps in current or planned transportation and traveler information services and facilities. We then evaluated the effectiveness of the current infrastructure. Key activities carried out for this task include:

- Inventory of existing transportation infrastructure, including ITS technologies.
- Identification of planned improvements to the Corridor from the *ACCESS OHIO* documents and the State's current multi-year TIP.
- Collection and analyze traffic and accident data.
- Analysis of traffic projections for the Corridor.
- Solicitation input regarding the needs from the stakeholders.
- Identification of needs and problems which ITS technologies may serve to resolve.
- Assessment of currently in-place or planned technology deployments along the Corridor.
- Identification of opportunities to incorporate ITS elements in scheduled transportation improvements.
- Development of vision with the stakeholders of the ultimate intelligent transportation system in the Corridor.

Description of Existing Transportation System

Interstate 71 is over 300 miles in length, extending from I-90 near Downtown Cleveland, Ohio to I-65 in Louisville, Kentucky. Within Ohio, l-71 connects the state's three largest metropolitan areas — Cincinnati, Columbus, and Cleveland — and as such, is one of Ohio's most critical transportation corridors for both commercial and non-commercial traffic.

The limits of this ITS corridor plan are from MP 121 (Polaris Interchange) in Delaware County to MP 226 (SR 303 Interchange) in Medina County. The study section carries between 28,000 and

57,000 vehicles per day, with truck percentages ranging from 10% to 27%. Permanent count station data show that traffic volumes can fluctuate dramatically from week to week, particularly during weekends and on holidays. In addition, the corridor is often subject to inclement weather during the winter months, with major areas of concern within the higher altitude section of I-71 near Mansfield, and the section of I-7 1 approaching the Cleveland area. The heavy truck traffic, fluctuating traffic patterns, and hazardous weather issues present potential opportunities for improving transportation needs with ITS technologies.

The data collection effort of this task has resulted in a compilation of corridor problems and concerns, which are presented in the following sections.

Inventory of Transportation Infrastructure

The following sections describe the deployed and planned transportation facilities along I-71. The information presented is based on conversations with local, regional, and State employees, as well as on various reports provided by ODOT.

The inventory includes weigh stations, vehicle count stations, variable message signs, weather and road condition stations, and detection systems. A summary of the locations of these elements is presented in **Figure 1.0-l.** These elements are briefly discussed in the following sections.

Weigh Stations

Currently, two weigh stations are located on I-71 within the study area. The first station, which provides one facility for northbound traffic and one facility for southbound traffic, is located approximately four miles north of US 250, near the center of the study area. A northbound only weigh station facility is located near the southern project terminus, approximately four miles south of US 36.

A Weigh-In-Motion (WIM) station, which is not yet fully operational, is located just north of SR 36. At the present time, ODOT uses data from this station mainly for vehicle classification, and as a check on truck weights during periods of time when the station is closed.

As part of the "Advantage I-75" project, a fully operational WIM station has been recently installed on I-75 near Toledo, Ohio. This WIM facility has proven to be valuable both in reducing delay for trucks and improving safety for motorists.

Vehicle Count Stations

ODOT's Office of Technical Services monitors a nehvork of Automated Traffic Recorders (ATR) at approximately 90 locations statewide, including one on I-71 within the study area. The ATR is located near mile marker 142 in Morrow County, approximately 2 miles north of SR 61. Information gathered from this station is discussed in a subsequent section of this report.

Variable Message *Signs*

Although ODOT operates a number of Variable Message Signs (VMS), no permanent VMS has been established in the I-7 1 study area. However, VMS is an integral part of the recently constructed ARTIMIS freeway management project in the Cincinnati, Ohio area. In addition, the Cities of Columbus and Cleveland will be implementing Regional Traffic Management Systems, which will also feature VMS technologies. Certainly, Ohio drivers can be expected to become very familiar with the operation of VMSs in the near future, particularly within the State's urban centers.

In addition to the major city projects, ODOT District 5 is currently conducting a demonstration of VMS on I-70 near Zanesville. The results of VMS test projects around the country suggest that the implementation of permanent, strategically located VMSs can be useful to alert drivers to accidents ahead, to warn of dangerous weather conditions, and/or to inform drivers of alternate routes for incident management.

Weather and Road Conditions

ODOT currently provides roadway sensors on key highways in ODOT District 6, including one station on I-71 at US 36. Although these sensors are capable of measuring a full spectrum of atmospheric and pavement conditions including precipitation, visibility, freeze point, chemical content on the pavement, temperature, dew point, wind speed/direction, and road temperature, ODOT uses these data primarily for the assessment of snow removal performance measures. However, the same data could be used to advise motorists of roadway conditions.

It should be noted that both District 6 and District 3 are presently considering adding several more stations along I-71. If installed as planned, ODOT would have weather station coverage of the entire corridor.

Summary

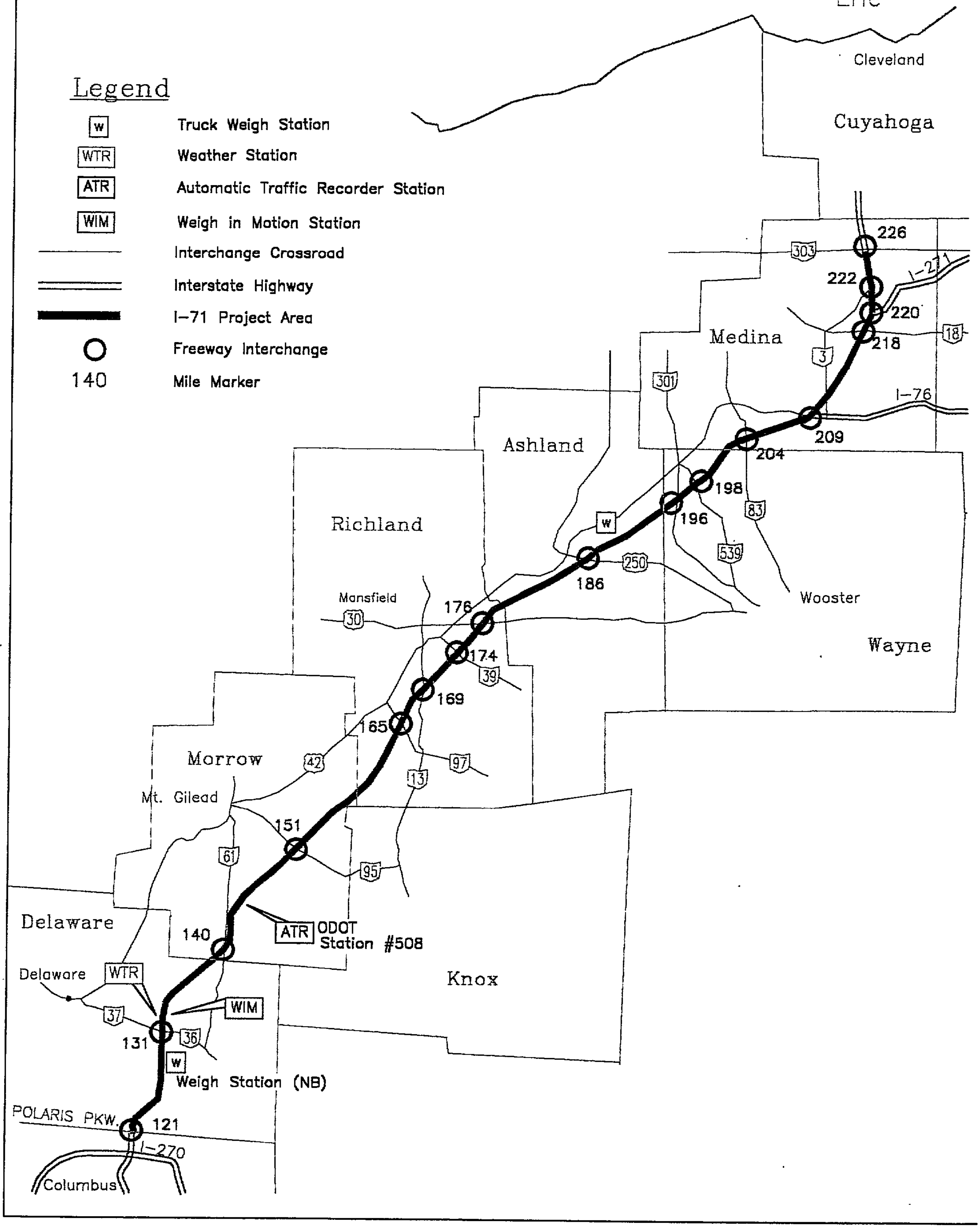
The inventory of the deployed ITS-related technology indicates that I-71 currently incorporates the following ITS-type facilities:

- One ATR count station
- One Weigh-in-Motion Station (not fully operational)
- One weather and roadway condition sensor station, with five or six stations possibly to be added in the near future.

In summary, several ITS-related systems have been initiated within the corridor. These systems are not integrated. however, and are not used to transmit information to drivers. Certainly, more ATR and weather stations will be required to achieve corridor-wide data coverage.

Figure 1.0-1

Inventory of Existing ITS Elements

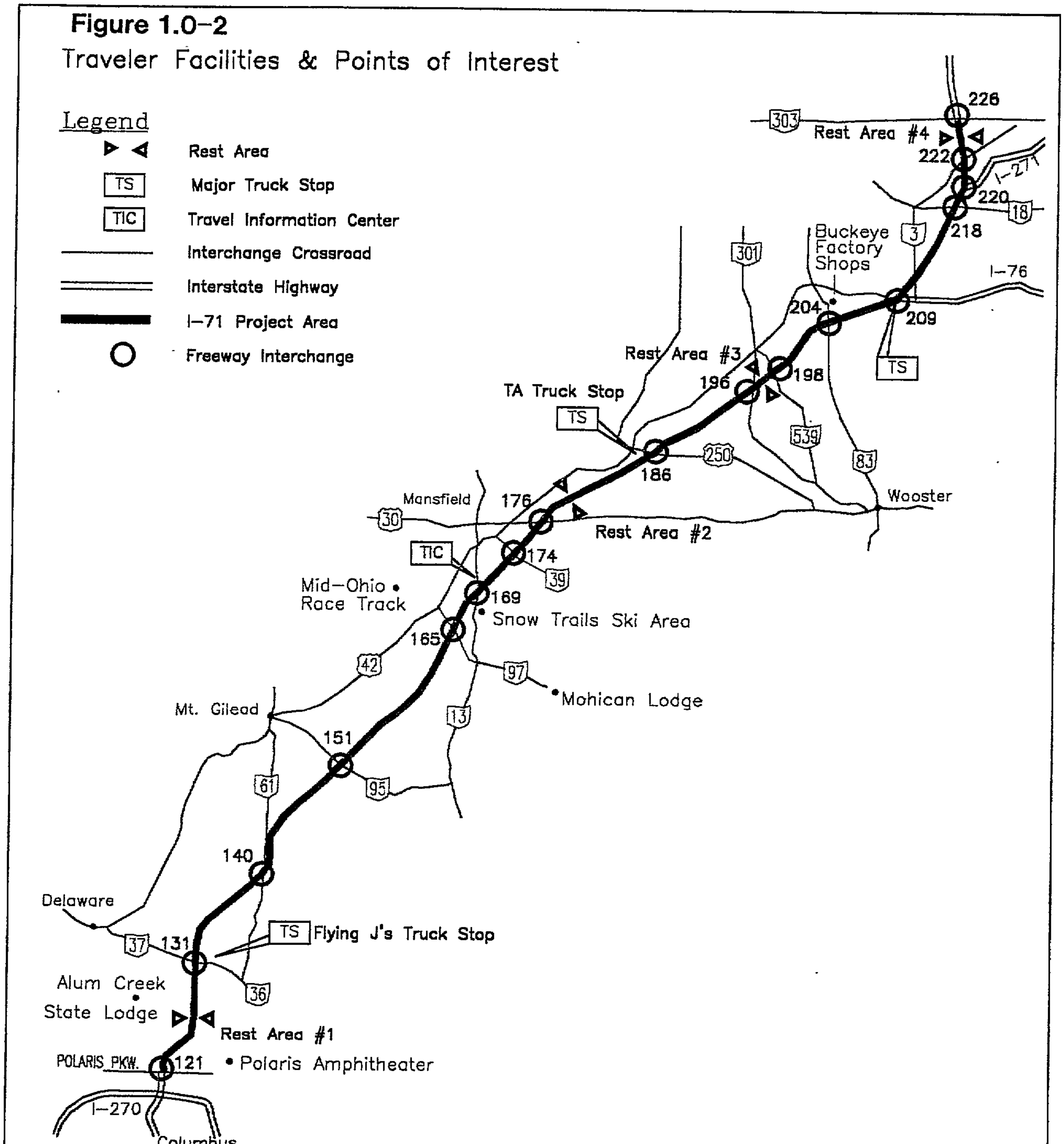


Traveler Facilities and Services

Traveler services on I-71 are limited to rest areas and truck stops, with a total of four rest areas, and two major truck stops. Traveler brochures and tourism information are available at most rest areas. In addition, a seasonal travel information center (open 6/1—9/30) is located in Richland County, at the interchange. The locations of these facilities, as well as the major attractions along the corridor, are shown below in **Figure 1.0-2**.

Figure 1.0-2

Traveler Facilities & Points of Interest



Comprehensive pre-trip traveler information is also available through the Internet or through the Ohio Office of Tourism. The available facilities and services are discussed in more detail in the following subsections.

Rest Areas and Truck Stops

Within the 105-mile study segment, I-71 provides 4 stops-which is by far the heaviest concentration of rest stops within the State. The typical rest area along I-71 is equipped with rest rooms, telephones, and vending machines. At most locations, open spaces and picnic facilities are also available. The corridor also provides two major truck stops: Flying J's Plaza, located at US 36 (milepost 13 1), and Flying J's Plaza, located at the I-76/US 224 interchange (milepost 209). .

In spite of the frequency of rest stops, the rest stop areas are frequently overcrowded. In many instances, especially late at night, the truck traffic overflows from the parking area to the on and off-interstate ramps.

Traveler and Tourism Information

The study area provides a wide variety of seasonal and year-around attractions which affect traffic levels on I-71. In the summer months, Polaris Amphitheater, Alum Creek State Lodge, Mohican Lodge, and Mid-Ohio Raceway are major traffic generators. In the winter months, the Snow Trails Ski Area attracts significant traffic.

Currently, travelers have a very limited set of information sources. Weather and incident/detour information is available en-route via a network of CB radios (used primarily by truck operators), and Iocal radio broadcasts. Corridor travelers frequently stress the need for better and clearer information on local attractions, lodging, restaurants, and other services along I-71.

Due to the limitations on en-route information, it is extremely important for Ohio tourism to provide a comprehensive source of pre-trip information. Presently, a wealth of information on Ohio Tourism can be found on the Internet or through the Ohio Office of Tourism and Travel.

There are several Internet Web sites currently providing visitor-oriented information for attractions along the study area. These sites are maintained by a variety of sources, both public and private.. For example, the Mid-Ohio Sports Car Course Web site, which provides a listing of schedules, ticket information, and directions to the venue, is shown in below.

Welcome to the Most Competitive Road Racing Facility in the U.S.

MID-OHIO SPORTS CAR COURSE

Events
Tickets
Food & Lodging
Driving School
Merchandise

Web sites for cities along the corridor, such as Wooster, shown below, also provide information on local attractions. In addition, these sites often provide information regarding transportation, population communications, etc. to attract prospective businesses and residents to the area.

WOOSTER AREA

CHAMBER OF COMMERCE

The State provides a toll free number (l-800-BUCKEYE) to allow tourists to contact travel counselors through the Ohio Office of Tourism and Travel. The Office maintains a database of more than 10,000 attractions, events, hotels, campgrounds, and other tourism-related items. Through this service, the counselors can provide a packet of maps, brochures, and travel guides to prospective travelers free of charge.

Currently, no information kiosks or radio-based traveler information stations, such as Highway Advisory Radio, are provided in the corridor. According to ODOT sources, there are no plans for implementing such services in the corridor.

Roadway Characteristics

I-71 is one of seven major interstate facilities in Ohio, (I-70, I-75, I-76, I-77, I-80, and I-90 being the other six). Interstate 7 1 runs northeast/southwest through the State, connecting Cincinnati, Columbus, and Cleveland, Ohio's three largest cities. Through these metropolitan areas, I-71 is a multi-lane, high-volume freeway with frequent interchanges, including severaf complex, multi-level interchanges. Between these major cities, however, I-71 is primarily a four-lane rural interstate, with a moderate to high percentage of truck traffic.

Within the study segment, I-71 is predominantly a four-lane, rural freeway, with interchange spacing typically ranging from 2- 10 miles. The study segment passes through two ODOT Districts and six Ohio counties, as summarized in **Table 1.0-l.**

Table 1.0-l
Summary of I-71 Miles (By County and ODOT District)

		Total Miles	
ODOT District	OHIO COUNTY	COUNTY	**DISTRICT**
6	Delaware	16.25	36.18
	Morrow	19.93	
3	Richland	20.64	67.90
	Ashland	16.14	
	Wayne	07.10	
	Medina	24.02	

I-7 1 provides level terrain though most of the study area. However, in the higher altitude section near Mansfield, I-71 becomes a rolling contour with relatively steep grades. These grades, in combination with the heavy truck traffic, can cause significantly slower travel speeds, increase congestion, and contribute to safety problems within the section.

Maintenance Activities

Maintenance of I-71 is the responsibility of the ODOT Districts. The main office for District 6 is located in the City of Delaware. The main office for District 3 is located in the City of Ashland.

The Districts are responsible for maintenance of the section of I-71 within that District's jurisdiction. The maintenance includes snow & ice removal, minor repairs (pot hole and crack repair), and overlay /resurfacing projects. The statewide activities on I-71 are also coordinated through ODOT's Central Office.

The districts are also responsible for incident management of the freeways within its jurisdiction. For routine accidents, the Districts respond with the necessary crews to close lanes (if necessary), remove the wreckage, and sweep the debris from the road. In extreme circumstances, (e.g. hazardous waste spills, pile-up accidents, or fatal accidents), the district will, at the direction of the Highway Patrol, provide and install drums and barricades to close the freeway. If necessary, the District will also establish and sign an appropriate detour route around the closed freeway section.

Traveling Conditions on I-71

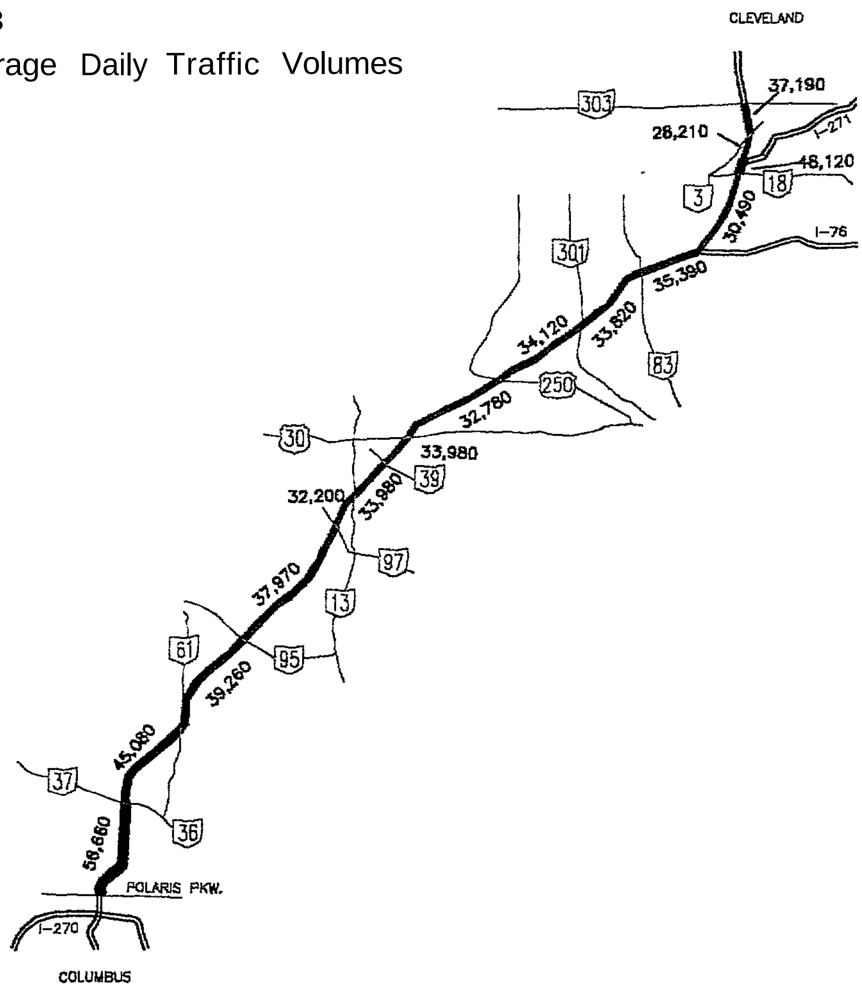
Traveling conditions on I-71 have been assessed from both a qualitative and quantitative standpoint. The information gathered during visits to various sites along the corridor and interviews with I-71 stakeholders have been analyzed to qualify travel conditions from an anecdotal level. These issues are discussed in a subsequent section of the report.

In addition, analyses of existing & projected traffic volumes and traffic accident records have been conducted to assess the corridor's traffic flow and safety. The results of these analyses are discussed in the following subsections.

Existing and Projected Traffic Volumes

ODOT maintains an extensive database for traffic volumes on all State and Federal highways within Ohio. For purposes of this study, existing traffic volumes were based primarily on data published by ODOT in "Traffic Survey Report." The Western Half report, which includes Delaware and Morrow Counties, summarizes 1992's average daily traffic volumes (ADTs). The Eastern Half report, which covers the remainder of the corridor, summarizes ADTs for the year 1994. The existing traffic volumes for the corridor, as extracted from these reports, are summarized in **Figure 1.0-3.**

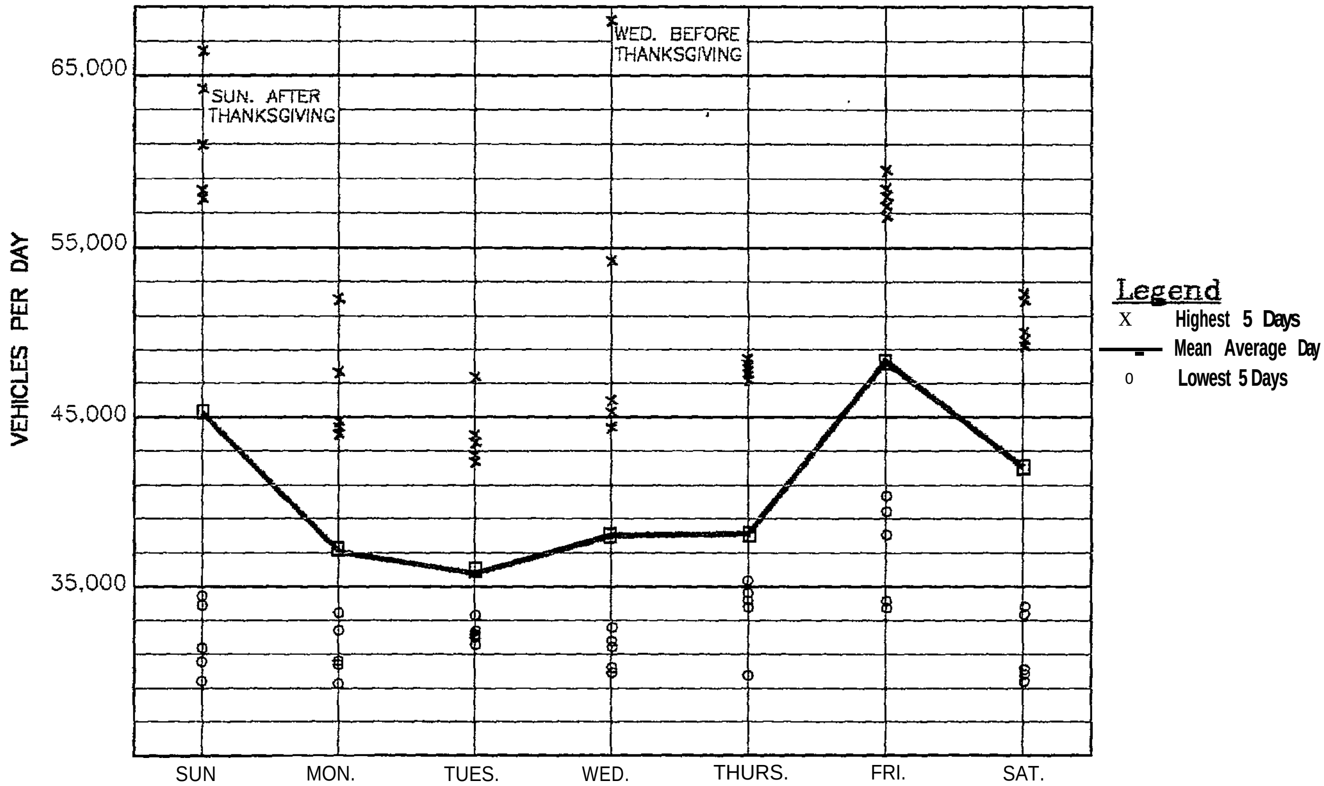
Figure 1.0-3
Existing Average Daily Traffic Volumes



In addition to the "Traffic Survey Report", ODOT also operates and maintains an Automatic Traffic Recorder (ATR) station on I-71 in Morrow County. Data from this station were supplied for the entire year of 1996, broken down by hour-of-day, day-of-week, and month-of-year. These data show that traffic volumes on I-71 can fluctuate dramatically from week to week, particularly on weekends and near holidays. For illustrative purposes, the top five and bottom five daily traffic volumes were plotted for each day of the week and compared with the average traffic for each day, as shown below in Figure 1.0-4.

Figure 1.0-4

1996 DAILY TRAFFIC VARIATIONS
(From ATR Station #508)

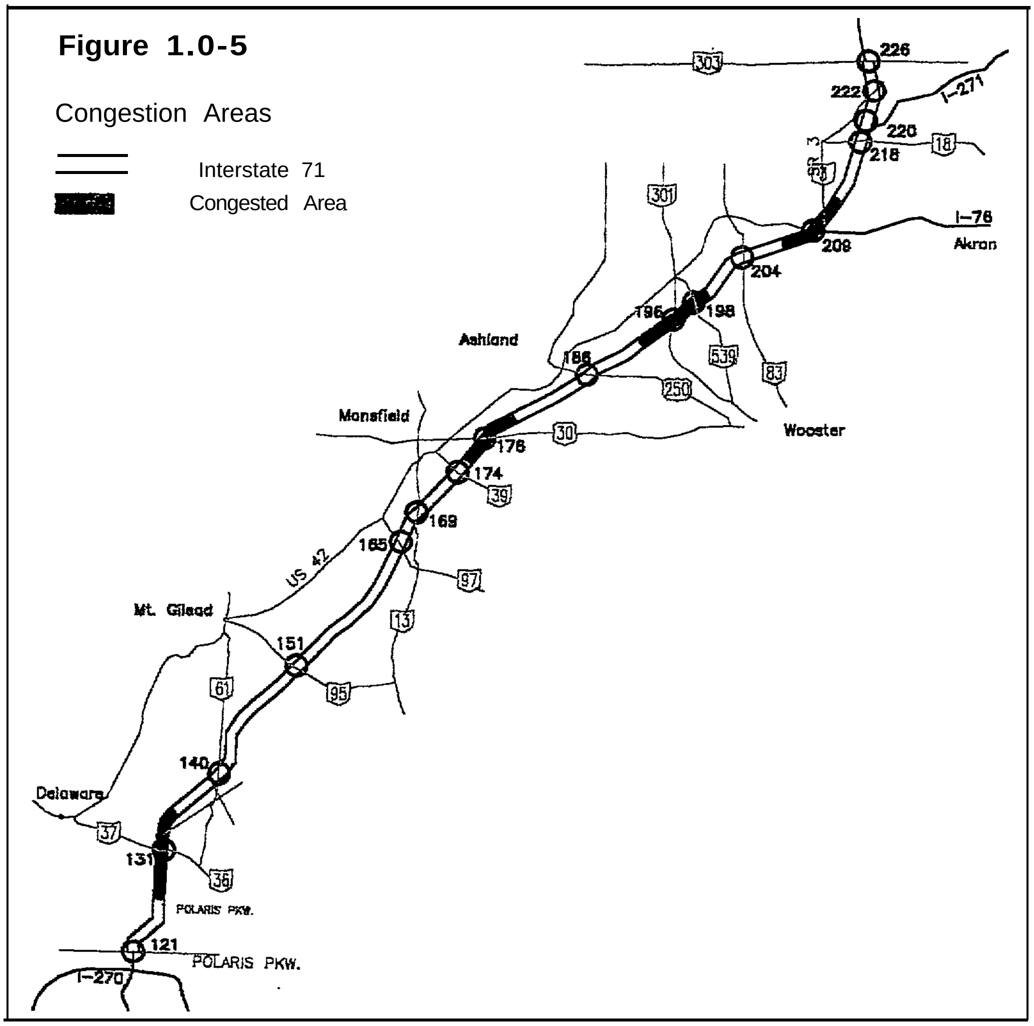


From these data, the following traffic patterns are evident:

- The highest traffic volumes typically occur on Fridays, with peak traffic occurring in the early evening hours (4-7 PM).
- The greatest traffic volume fluctuations occur on Sundays, which is also the second heaviest day.
- Traffic volumes on weekdays (Monday through Thursday, excluding holidays) are steady and relatively consistent.
- Peak annual activity occurs on the Wednesday before Thanksgiving and the Sunday after Thanksgiving, with traffic volumes almost 80% higher than average conditions.

On the Wednesday before Thanksgiving of 1996, 330O northbound vehicles passed ATR Station #508 from 4 to 5 PM. This volume of 1650 vehicles per lane represents the virtual capacity of the two-lane northbound Interstate facility. It should be noted, however, that traffic volumes on the segment south of the ATR station (from Polaris to US 36) are typically about 40% higher than the segment from SR 61 to SR 95 (where the ATR is located). Therefore, it is likely that capacity restraints in the southern project section served to meter northbound traffic through the ATR section.

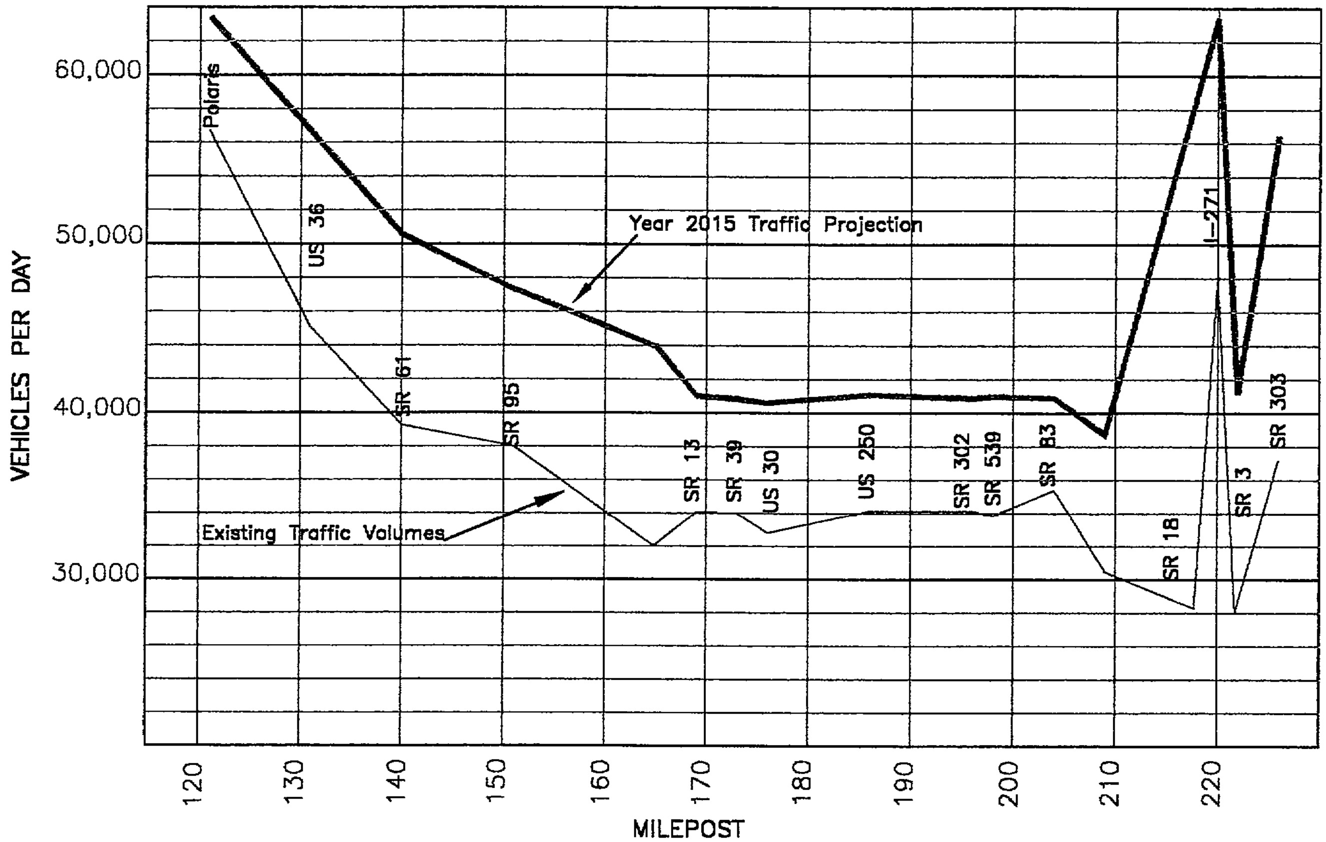
The ability of a highway to accommodate traffic demand is generally based on assessments of operations during the thirtieth highest hour of the year, commonly referred to as the design hour. According to the ATR data, approximately 2500 vehicles traveled I-71 during the design hour--which represents a fair, but acceptable, level of service for mainline travel. However, this relatively high mainline volume can result in congestion near the freeway exit and entrance ramps, particularly at high-volume on-ramps. An illustration of the areas along the corridor where congestion, back-ups, and sudden stops are common during peak time periods is illustrated below in Figure 1.0-5.



Traffic volume projections for the year 2015 were developed for the corridor as part of the ACCESS OHIO project. These projections for the corridor, as compared with the existing ADTs, are summarized in **Figure 1.0-6.**

Figure 1.0-6

EXISTING AND PROJECTED TRAFFIC VOLUMES
(Average Annual Daily Traffic Volumes vs. Milepost)



If the corridor traffic volumes grow as predicted, the level of service on the Interstate can be expected to deteriorate steadily over the next two decades. In short, the existing four-lane facility is not capable of accommodating the expected traffic volumes at an acceptable level of service. Without major corridor improvements and/or interstate widening, traffic growth can be expected to increase local congestion, cause higher accident rates, impact air quality, and increase the need for traveler services in the corridor.

Accidents on I-71

Trips along rural highways are typically taken at relatively high speeds and for long distances. For these reasons, rural highways can often present unique safety problems for drivers and responsible agencies. However, the accident data for rural areas indicates that safety on rural highways is continually improving. In 1981 there were 50,800 traffic deaths nationwide, with 31,700 (62%) of those occurring in rural areas. By the year 1990, the total traffic deaths in rural areas dropped to 44,475 and the percentage of the total fatalities in rural areas dropped to 56.9%.

Traffic accident data for the I-71 corridor were obtained through the Ohio Department of Public Safety, for the calendar years 1995 and 1996. The traffic data were analyzed to identify crash statistics, high accident locations, and common contributing factors within the study area.

The accident data show that 2,247 accidents occurred on I-71 within the study area, from January 1994 through December 1995. Of these, 496 accidents involved personal injury, including 54 serious injuries. In addition, 11 accidents were fatal, resulting in 14 total deaths. The overall accident statistics for the corridor, broken down in 10-mile increments and compared overall with the statewide averages, are summarized below in **Table 1.0-2.**

Table 1.0-2
Summary of Corridor-Wide Accident Data

	Total Acc.	Vehicle Type			Animal Acc.	Road/Weather				Fatal Acc	Injury Acc.	ADT	Acc. Rate
MP		Car	Truck	Other		Dry	Wet	S/I	FG				
121	244	297	75	11	56	179	21	16	1	1	46	56.6	0.60
131	192	215	51	4	44	117	18	43	2	0	47	45.1	0.58
141	199	207	46	2	59	130	27	24	2	1	44	39.3	0.69
151	207	231	46	4	56	152	25	19	2	2	45	38.0	0.74
161	263	286	79	11	55	148	35	54	3	0	61	35.0	1.03
171	274	266	106	7	54	164	38	50	3	1	56	33.9	1.11
181	158	166	46	2	42	105	24	18	2	1	31	33.0	0.66
191	196	190	72	3	34	118	18	36	3	2	41	34.0	0.80
201	204	203	76	2	27	115	21	38	0	2	52	34.0	0.82
211	198	225	34	3	33	111	23	44	1	1	51	32.0	0.84
216	112	141	20	0	20	68	11	20	0	0	22	32.0	0.96
Total	2247	2427	651	49	480	1407	261	362	19	11	496	-	-
Percentage of Total					21%	63%	12%	16%	8%	0.5%	22%	-	-
Statewide Average					15%	78%	14%	6%	1%	0.5%	33%	-	0.5

Notes:

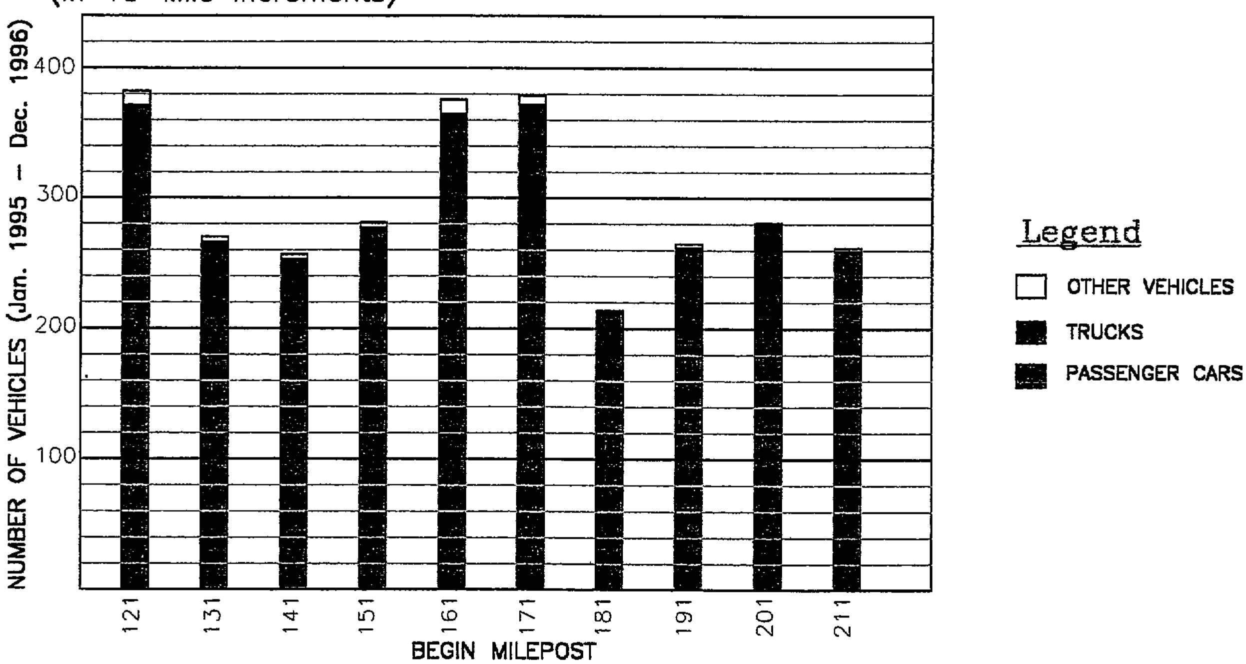
MP = Begin Mile Post (10-mile Increments)
S/I = Snow and Ice
Fat. Acc. = Fatal Accidents
Injury Acc. = Injury Accidents

Animal Acc. = Animal Action Accident
ADT = Average Daily Traffic (in thousands)
Acc. Rate = Accident Rate
(Accidents per Mil. Veh.) Miles)

The accident rate for a rural freeway is typically about 0.5 accidents per million vehicle-miles traveled. As shown in the Table above, ever y segment of the study area exhibits an accident rate above the State average. In particular, the section of I-71 from mile marker 161 to 181 (near Mansfield) has an accident rate that is well above the overall average for the corridor, and is more than twice the statewide average. As stated previously, this section has rolling terrain and steep grades. This topography, combined with the heavy truck traffic and propensity for inclimate weather, is creating serious safety concerns. A summary of the number (and type) of vehicles involved in accidents, broken down in 10-mile increments, is summarized below in **Figure 1.0-7**.

Figure 1.0-7

TOTAL VEHICLES INVOLVED IN TRAFFIC ACCIDENTS
(In 10-Mile Increments)



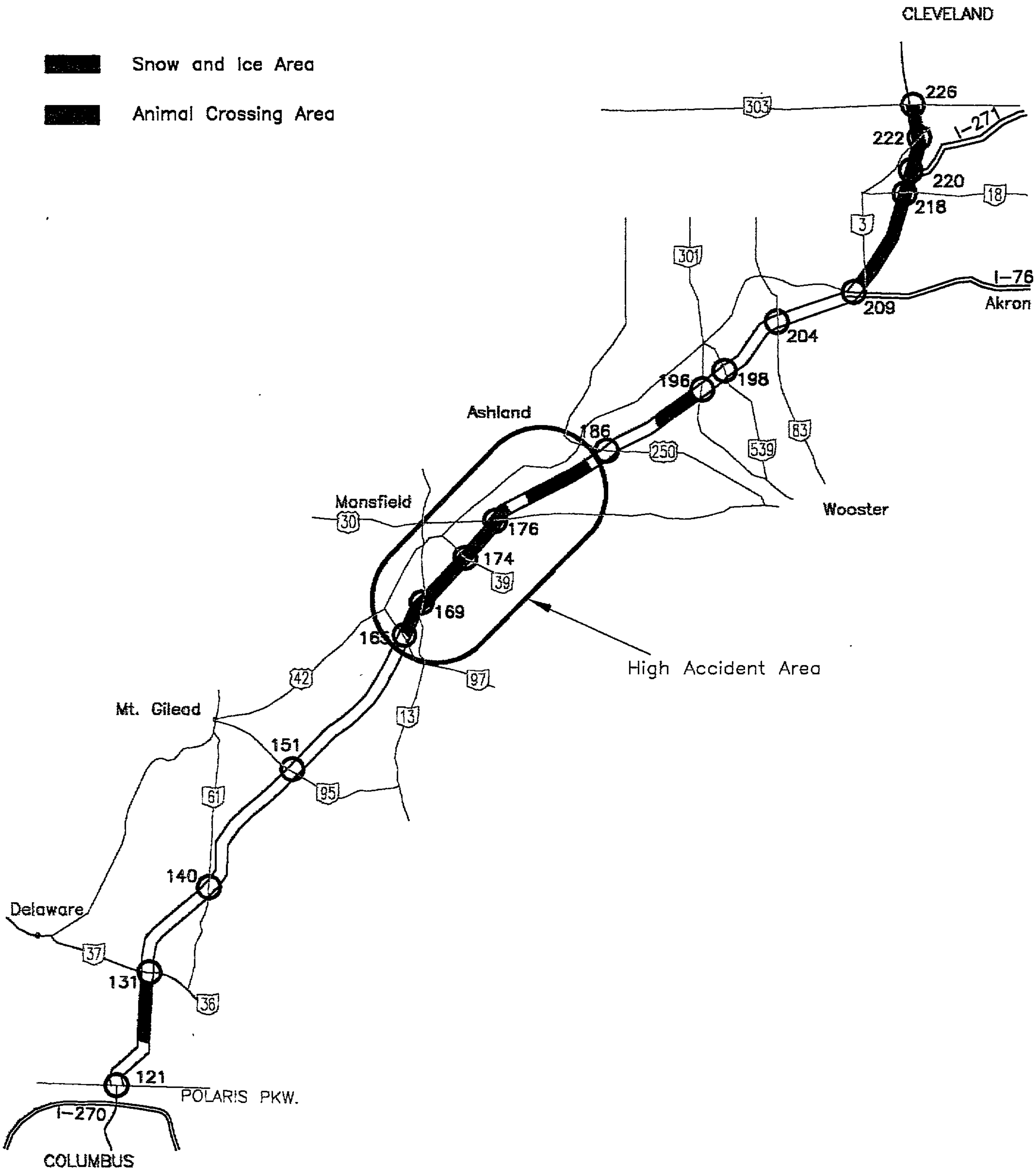
Based on the accident data, the safety deficiencies can be grouped into two categories: Weather (Snow/Ice and Fog) and Animal Crossing. The areas with particular accident problems are highlighted in **Figure 1.0-8** and discussed below.

Overall, 15% of the total accidents occurred in snow and ice conditions, as compared with the statewide average of approximately 6%. However, in the higher altitude section on I-71 near Mansfield and the northern project section near Medina, accidents occurred under snow and ice conditions nearly 20% of the time (which is over three times the statewide average). The accident rate for Fog accidents was also much higher than the State average; however, these accidents were not concentrated in one section of the corridor.

According to statewide accident summaries, approximately 15% of accidents in rural areas can be attributed to animal actions. The accident data for the study area show 480 of the 2247 accidents (21%) involved conflicts with animals on the freeway. The three sections of I-71 identified on the map shown above illustrate areas where animal crossings, particularly deer, are frequent—leading to an unusually high concentration of animal related accidents.

Figure 1.0-8

Summary of Corridor Safety Problems



Summary of Problems and Concerns within the Corridor

The I-71 Corridor presently accommodates the existing traffic levels at an acceptable level of service during the majority of time periods. The traffic volumes can, however, vary dramatically from week to week, particularly during weekend evenings and days near holidays. This variability often results in unexpected congestion and delays for motorists, and creates a significant safety concern.

Although the overall accident rate on I-71 is within acceptable limits for most of the corridor, several safety problems are evident. Snow and ice accidents in the section of the corridor near Mansfield, and in the northern project limits near Medina, are significantly higher than the statewide average. In addition. the corridor has an unusually high percentage of animal related accidents.

Planned improvements to the Corridor

The need for additional geometric improvements along the study section of I-71 has been well documented in the past. The ACCESS OHIO report concluded that approximately 300 miles of rural interstate highway in Ohio would need to be widened within the next 30 years in order to maintain the existing level of service. The report also states that over 80 miles of I-71 within the study area will require widening, at an estimated cost of more than 300 million dollars.

ODOT has also recognized the need for improvements to f-7 1. According to the State's Draft *Major/New Construction Program,* several f-71 widening projects have been ranked in the State's top 1 00 projects (ranked in order of priority).

Presently, ODOT operates under a I.5 billion annual operating budget, of which about 700-800 million comprises the vast cost of maintaining the existing highway network. Although Ohio ranks 35th among the states in land surface area, Ohio has:

- The 10th largest roadway system in the nation
- The 4th largest interstate highway system in the nation
- The 2nd largest inventory of bridges in the nation
- The 5th highest traffic volume in the nation

With over half of its budget going to maintenance, and another 450 Million for operations and other costs, ODOT is presently left with only about 300 Million annually for new construction. However, after 1998, the department will no longer be able to finance major new construction projects through Issue 2 bonding authority. Consequently. available funding for new construction is expected to diminish annually until the year 2002. when the funding will become negligible.

At the present time, ODOT has over 200 projects programmed (and prioritized) at a cost of over 5.6 billion dollars. Assuming ODOT could commit 150 million annually to these projects, it will take the department over 50 years to build the 201 major/new projects, even *if a newproject were not added to list for the next half-century.*

Although several I-71 projects have been identified. none of these projects have been ranked within the State's top-50 priority list. Consequently, unless major changes are made in funding, it is unlikely that the widening of I-71 can be accomplished within the next 30 years. Therefore, as traffic grows on I-71, it will become even more critical to maximize freeway capacity, through application of ITS technologies.

Opportunities for Deployment of ITS Services Along Rural I-71

For this task, several activities were carried out. including: an inventory of existing infrastructure and planned improvements; collection and analyses of accident data. traffic data, and traffic projections; and initial identification of problem areas. The project team has also assessed the in-place or planned technology deployments along the Corridor. Several problem areas in the I-71 Corridor between Columbus and Cleveland have been identified, including frequent delays resulting from:

- High truck percentages and long grades
- Road construction and maintenance
- Incidents/accidents
- Winter weather conditions

There are segments particularly susceptible to ice and/or snow. Air quality is a continuing concern in the corridor, as Medina and Delaware counties currently have non-attainment status. Furthermore, there is a need for more readily available and more timely pre-trip and en-route traveler information detailing nearby services, attractions, and road/traffic conditions.

One opportunity for implementing ITS technologies is a rural corridor Traffic Management System (TMS). This TMS would integrate the urban traffic management centers currently being developed in Columbus and Cleveland, and could include technologies such as:

En-Route Traveler Information
- Variable message signs
- Highway Advisory Radio
- Traveler Advisory Radio

Pre-Trip Traveler Information
- Traveler information kiosks
- Web page
- Road Weather Information Systems
- Highway Closure and road restriction systems

Incident Management
- Improved communications/coordination between agencies
- Traffic monitoring of key locations [e.g.. Closed Circuit Television (CCTV)]
- MAYDAY services

Commercial Vehicle Operations
- electronic clearance for trucks with proper credentials

Data Collection Techniques
- Loops, video imaging, CCTV, widebeam radar,
- Global Positioning System (GPS) receivers on trucks, serving as probes

Six User Services have been initially identified by the ODOT as having the highest potential for deployment in the I-71 Corridor:

- En-Route Driver Information
- Traveler Services Information
- Incident Management
- Pre-Trip Travel Information
- Commercial Vehicle Electronic Clearance
- Commercial Fleet Management (Freight Mobility)

This assessment of I-71 transportation problems and opportunities has been used as the technical background for the development of user needs in Task 3.

CHAPTER 2.0

2.0 INSTITUTIONAL FRAMEWORK

The objectives of Task B have been to identify and create a database of people and organizations interested in Intelligent Transportation Systems (ITS) solutions for the transportation needs of the I-71 Corridor; to form an I-71 ITS Advisory Committee and Coalition; and to keep these groups up-to-date and involved through meetings and the I-71 ITS newsletter.

Methodology and Key Task B Activities

This task has involved the development of the institutional framework necessary to guide the consultant through the strategic planning process and carry its recommendations to deployment. The key to carrying any plan into the implementation stages is the involvement of a strong coalition of people who will "buy in" and promote the recommendations of the plan. The solid institutional framework developed in this task will very important to the long-term success of ITS deployment in the corridor.

Public involvement has also been important in identifying public perceptions of the I-71 Corridor. The institutional framework and public involvement program set out to answer three main questions:

1. What do local residents and highway users see as the biggest transportation problems/issues in the corridor between Columbus and Cleveland?

2. What suggestions to local residents and users have for solving these problems, and for addressing the issues they see as being more important?

3. To what extent do local residents and highway users see information-based and technological applications as solutions that will improve the corridor's quality and accessibility?

Key Task B activities have included:

- Formation of the Advisory Committee
- Development of the I-71 ITS Coalition and database
- ITS Partnering Workshop to educate stakeholders about ITS and the strategic planning process
- Development of vision and mission statements for the l-71 ITS Program
- Development of first edition of ITS project newsletter

Advisory Committee and Coalition

To establish the necessary institutional framework for the project, the first step was to work with the Ohio Department of Transportation (ODOT) to develop the Advisory Committee. The Coalition was created by developing a database of people from the following corridor organizations:

- Mayors and City Council members
- County commissioners and engineers for each of the counties along the corridor
- Key city staff (i.e. city engineers. planners, public works/transportation directors)
- Township trustees
- Major employers in the corridor
- Chambers of Commerce and Convention Bureaus
- AAA, UPS, US Postal Service, Federal Express. bus and tour companies, etc. that are regular users of the corridor
- Ohio State Highway Patrol (SHP)
- Emergency response such as Ohio Association of EMS
- ODOT (Central Office staff plus Districts 3. 6, and 12)
- Radio and television stations in the corridor
- Department of Development and Office of Travel and Tourism
- Key railroad representatives, particularly AMTRAK (crosses the northern part of the corridor)
- Recreational facility contacts in the area
- Major private and public tourist attractions
- Agricultural interests, such as Ohio Farm Bureau Federation
  Metropolitan Planning Organizations in the corridor

The Advisory Committee was developed in the beginning stages of the project. It comprises representatives from the following organizations:

- ODOT Central Office: Traffic Engineering, Policy, Communications, Technical Services
- ODOT Districts 3, 6, and 12
- Federal Highway Administration (FHWA)
- Ohio Department of Development
- Ohio Department of Agriculture
- Ohio State Highway Patrol
- Mid-Ohio Regional Planning Council (MORPC)
- Northeast Ohio Areawide Coordinating Agency (NOACA)
- Eastern Ohio Development and Transportation Agency (EDATA)
- Richland County Planning and Engineering Departments
- Morrow County Planning Department
- Medina County Commissioner
- Morrow County Commissioner
- Brunswick Area Chamber of Commerce
- Mansfield-Richland Area Chamber of Commerce
- Medina Area Chamber of Commerce
- City of Ashland
- City of Mansfield
- City of Mt. Vernon
- City of Brunswick
- LifeFlight. MetroHealth Medical Center
- Kokosing Construction Company
- Scenic Ohio
- The Gorman-Rupp Company
- University of Akron Civil Engineering Department

The complete list of Advisory Committee members is included in the appendix to this chapter. A complete list of ITS Coalition members (including Advisory Committee) is also included in the appendix, along with addresses. phone/fax, email etc.

Vision and Mission Statements

The vision for ITS on Ohio's I-71 Corridor. Columbus to Cleveland: To develop a comprehensive program for deploying advanced technologies on the Interstate corridor in order to provide specific short-term and long-term improvements to the quantity and quality of [tourism, travel, and traffic] information available to visitors and residents, to improve safety, to reduce periodic congestion, and to serve as a model for ITS deployment in other rural areas of the state and nation.

The Advisory Committee's specific mission includes the following tasks:

- Review project progress.
- Review project deliverables, such as project technical memoranda.
- Participate in the project workshops and advisory committee meetings
- Provide input and guidance
- Assist in encouraging their respective community, business, and agency leaders in participation in learning about ITS technologies.

The vision and mission statement for the I-71 Ohio ITS Program is based on USDOT ITS Program Goals, which are shown in **Table 2.0-l.**

Table 2.0-l
ITS Program Goals

1.	Widespread implementation of intelligent vehicle-highway systems to enhance the efficiency and safety of the Federal-aid highway system, and to serve as an alternative to additional capacity of the Federal-aid highway system.
2.	Enhance, though more efficient use of the Federal-aid highway system, the efforts of several states to attain air quality goals established pursuant to the Clean Air Act.
3.	Enhance safe and efficient operation of the Nation's highway system, particularly system aspects that will increase safety. Identify system aspects that may degrade safety.
4.	Develop and promote and intelligent transportation system (ITS), and an ITS industry in the United States.
5.	Reduce social, economic, and environmental costs associated with traffic congestion.
6.	Enhance U.S. industrial and economic competitiveness and productivity.
7.	Develop a technology base for intelligent vehicle-highway systems and establish the capability to perform demonstration experiments, using existing national laboratory capabilities, where appropriate.
	Facilitate the transfer of transportation technology from national laboratories to the private sector.

Source: Implementation of the National Intelligent Transportation System Program, 1994-1995 Report to Congress, USDOT, FHWA, ITS Joint Program Office, Washington, DC.

CHAPTER 3.0

3.0 ITS USER SERVICES

Methodology and Key Task C Activities

Key activities accomplished as a part of Task C have included the following:

- Developing an interview form to identify needed User Services
- Providing the media with information on the project
- Conducting interviews at rest stops along the corridor (actually restaurants at selected locations)
- Conducting interviews at truck stops along the corridor
- Conducting focus group meetings (July 23-25 at Medina, Ashland, and Delaware)
- Conducting follow-up telephone interviews with I-71 Corridor users identified as key organizations during the focus groups and/or individual interviews
- Preparing a matrix of identified needs and ITS User Services
- Identifying existing transportation-related services being provided
- Preparing a short list of ITS User Services
- Categorizing the needed User Services into short-, medium-, and long-term time frames

Information on corridor problems and/or concerns is in the process of being obtained through the Advisory Committee and a series of surveys, Focus Group meetings, and interviews involving those who use the I-7 1 Corridor. The raw data assembled from these sources have been refined and matched to appropriate ITS User Services. The ITS National Program Plan has categorized ITS components into 30 User Services. These are grouped into seven categories:

- Travel and Transportation Management
- Travel Demand Management
- Public Transportation Management
- Electronic Payment
- Commercial Vehicle Operations
- Emergency Management
- Advanced Vehicle Safety Systems

Within each of these groups are one or several individual "User Services." These User Services are listed below. In interpreting the following User Service list, the services identified with a ([1]) have been identified initially by the Ohio DOT as the User Services having the highest potential for deployment in the 1-71 Corridor. These User Services were used as a starting point, but there was also a thorough assessment of needs as identified by all stakeholders.

The services identified by a ([2]) in the list are the User Services that require a reduced level of attention by state and local agencies since their deployment will be primarily at the national level and promulgated by the motor vehicle industry. They have therefore been given somewhat less attention in this planning study, but are nevertheless included in this preliminary draft.
User service categories and individual User Services are shown below.

Travel and Transportation Management

- En Route Driver Information [1]
- Route Guidance
- Traveler Services Information [1]
- Emissions Testing and Mitigation
- Incident Management
- Traffic Control

Travel Demand Management

- Pre-Trip Travel Information[1]
- Ride Matching and Reservation
- Demand Management and Operations

Public Transportation Management

- En-Route Transit Information
- Public Transportation Management
- Personalized Public Transit
- Public Travel Security

Electronic Payment Services (single user service)

Commercial Vehicle Operafions

- Commercial Vehicle Electronic Clearance[1]
- Automated Roadside Safety Inspection
- On-Board Safety Monitoring
- Hazardous Material Incident Notification
- Commercial Vehicle Administrative Processes
- Commercial Fleet Management (Freight Mobility) [1]

Emergency Management

- Emergency Vehicle Management
- Emergency Notification and Personal Security
- Highway-Railroad Grade Crossing Improvements

Advanced Vehicle Safety Systems

- Longitudinal Collision Avoidance[2]
- Lateral Collision Avoidance[2]
- Intersection Collision Avoidance
- Vision Enhancement for Crash Avoidance
- Safety Readiness[2]
- Pre-Crash Restraint Deployment
- Automated Vehicle Operation

After a thorough review of the data to be collected in the remainder of this task (from truckers, citizens involved in the focus groups.% and other travelers on the corridor) the final set of User Services will be selected an incorporated into the integrated user services plan in Task E.

Needs Identification

Information on the problems, concerns and other issues in the I-71 Corridor were assembled from the following sources:

- Previous studies and data (from Task 1 review and analysis)
- Advisory Committee survey
- Traveler interviews at rest stops (restaurants) along the corridor
- Trucker interviews at truck stops along the corridor
- Focus group meetings

The following paragraphs summarize the key elements of the needs identification data collection efforts.

Advisory Committee Surveys

The Advisory Committee survey was distributed at the group's first two meetings on May 28 and July 23, 1997 to approximately 32 participants. A total of 19 completed surveys were returned. Following is a summary of the responses:

I. ***What part of the Interstate 71 do you or those you represent use most frequently or ate most familiar with***? The responses reflect very diverse experiences. Approximately two-thirds of the respondents indicated that they travel the entire corridor from Cleveland to Columbus with some frequency. Seven respondents identified specific areas of travel, with emphasis on the northern part of the corridor – from Mansfield to Cleveland.

2. ***What do you see as the biggest transportation problems/issues in the corridor between Columbus and Cleveland?*** Again, the responses reflect a variety of experiences, with emphasis on the following problems:

- High traffic volumes -greater than capacity.
- Congestion at selected locations, particularly near exits, such as:

  — Polaris exit north of Columbus
  — Rt. 10 in Cuyahoga County
  — US 36 (Delaware)
  — Exit 226 – north to Cleveland and south to Exit 2 18
  — Exits 169. 165 and 131. and MP 161
  — From Belleville exit (97) to Ashland (SR 250)

- Long delays due to construction and lane closings.
- Long grade areas resulting in traffic congestion (due to trucks).
- Too much truck traffic. particularly at night.

- Different speed limits for cars and trucks.
- No advance notice for incidents: inability to take alternative routes.

3. ***Do you have any ideas for solutions or ways to address these problems, especially information-based and technological applications*?** Numerous solutions were suggested for these problems. Listed in the order of their frequency, these suggestions are:

- Provide motorists with advance notice of incidents, with directions to exits and alternative routes. Notification can either be through variable message signs or on-board notification systems.

- Develop early warning devices about changing road conditions.

- Deliver traffic and weather information through existing communication channels (including media) in the short term, and through investments in traffic management technologies in the long term.

- Build a third lane along the entire corridor. or at least for trucks in grade areas.

- Use alternate route applications during construction activities through variable message signs.

- Develop high speed rail alternatives; encourage the use of rail for passenger and freight transportation.

4. ***Which of the following conditions ate problems on the I- 71 corridor?***

	Yes	Maybe	Comment
Fog	45%	20%	Rt. 97 exit
Snow	50%	30%	Exit 176 and MP 161-171
Ice	50%	30%	MP 210-226, MP 161-171, Exit I76
High winds	0%	55%	
Construction	55%	30%	Rt. 97, Rt. 39, Rt. 13
Wildlife cross	20%	35%	MP 149-151
Accidents	30%	25%	

5. ***Can you offer any ideas for solutions to any or all of the problems you identified above (especially infotmaiion-based and technological applications)?*** Suggestions for solving these problems include:

- The entire corridor would benefit from a third lane – or a limitation on heavy truck traffic.
- Reduce traffic levels through the use of bullet trains and/or alternative routes.
- Work on construction during off-peak hours.
- Establish active fog alert signing – something that can detect atmospheric conditions and provide advance warning.
- Provide freeway surveillance and advanced warning systems in high accident areas.

6. ***Are intermodal connections adequate-and should they be improved?*** There appears to be a broad consensus that existing intermodal connections are not adequate. This view is most pronounced as it relates to truck and railroad transportation – and to the connection between passenger trains and buses.

7. ***Do any opportunities exist for cooperative ventures between transportation modes along the I-71 Corridor (between Cleveland and Columbus), particularly with information-based and technology applications***? Only a few participants responded to this question. One suggested that the completion of Rt. 29 will improve railroad and highway connections. Others suggested that a rail right-of-way for passenger trains should be set aside along the corridor.

8. ***Are there transportation-related problems at/near tourist attractions within the corridor (or neat the corridor)? Please describe and give locations such as Mid-Ohio Raceway, Mohican State Park, Polaris, Cedar Point and the like.*** While most respondents do not see serious problems here, several people point to Polaris, the Mid-Ohio Raceway, and snow resorts as potential problems. Clearly, Polaris is an emerging problem that respondents think needs to be addressed.

9. ***I. there a need for additional information for tourists within the corridor? What and where?*** Responses suggest that there is little consensus here. Some participants say "NO" – emphatically. They believe that most major attractions are well-signed.

   Others report that improved signage is needed at most exists near tourist attractions. Where possible, technology-based message boards are favored by these respondents.

   Acknowledging that tourist information centers already exists, some respondents suggest a need for radio and smart-car technology to provide information to travelers. Again, where signage is needed, most respondents prefer "active" signs.

10. ***Do conflicts between truck and automobile traffic in the corridor cause significant problems? What and where?*** Several responses merit attention here:

- Yes, along the entire corridor. Truck lanes may be desirable on steeper grades.
- Yes, slow speeds and traffic congestion are common in Richland and Ashland counties, particularly where there are long grades.
- The Advantage 75 initiative should be considered on l-71.
- Speed limits for trucks and cars should be the same – 65 miles per hour.
- Consideration should be given to the use of truck-based smart vehicles.

3.2.2 Traveler Surveys

Traveler interviews were carried out at rest stops (restaurants) in the l-71 Corridor. These stops include the following sites:

- Cracker Barrel, Milepost I69 (Mansfield)
- Cracker Barrel. Milepost 218 (Medina)

Approximately 203 travelers were surveyed on-site. The form used in conducting the traveler interviews is included in the Appendix to Chapter 3. The completed interview responses were divided into three groups for analysis: travelers who use I-71 [anywhere between Columbus and Cleveland] more than once per week, travelers who use I-71 one to four times per month, and those who use it less than once per month. Responses were tabulated in each of the three groups, and percentages figured. A heavier weight for consideration was placed on the responses from the first group. Problems identified by the travelers along with percentages, are shown in **Table 3.0-1.**

Table 3.2.2-1 shows that the highest percentage response is represented by the many (39 %) I-71 frequent private vehicle travelers that did not mention any problems with the Corridor between Columbus and Cleveland. The next highest percentages for this group are: construction zones (21 %), lack of maintenance (17 %), truck-related (13 %). and ramps/bridges problems (13 %). Lack of maintenance, truck-related problems, and general capacity problems were mentioned most in less frequent traveler surveys.

Table 3.0-l
Problems Identified by Private Vehicle Travelers

	Frequency of Travel on I-71		
	> once per week	1 to 4 times per month	< once per month
Identified Problems	**Percent identifying problem**		
None identified	39	41	40
Lack of maintenance	17	26	19
Construction zones	21	3	11
Differential speed limits	4		5
Accidents	9	9	
Too strict enforcement	4	3	2
General congestion (over capacity)		20	10
Wide load/heavy machinery transport	4		
Signs		3	8
Uneducated or inattentive drivers		9	6
Ramps/bridges	13	3	
Truck-related	13	26	15

Table 3.0-2 represents the results of the surveyed travelers' suggestions for improving problems on I-71. This shows an extremely high number of interviewees (56 %) that did not suggest a solution. The next highest percentage among the most frequent travelers is three lanes in each direction, for all or part of the segment (17%). and the addition of a truck lane for all or part of the segment (9 %). Less frequent travelers most often suggested three lanes, better/more signs, and a truck lane to solve problems in the Corridor.

Table 3.0-2 Suggested Solutions Identified by Private Vehicle Travelers			
	Frequency of Travel on I-71		
	> once per week	1 to 4 times per month	< once per month
Suggested Solution	Percent identifying solution		
None mentioned	56	65	54
Better maintenance	4	3	2
Project scheduling	4	-	-
Construction at night	4	-	-
Uniform speed limit	4		
Uniform 65 mph	4		3
Restrictions on oversized loads	4		
More enforcement		3	2
3 lanes	17	22	8
Truck lane	9	3	5
Trucks drive at night		3	
Better/more signs		9	6
High-speed rail		3	2
Driver education	-	3	-
More interchanges	4	-	-
Aesthetic improvement	-	3	-

3.2.3 Trucker Surveys

Personal interviews were conducted on-site at 3 truck stops in the I-71 Corridor. The survey form used for trucker interviews is included in the Appendix to Chapter 3. The three sites include the following:

- Flying J Plaza, Milepost 13 1 (Delaware/Sunbury, US 36/SR 37)
- Duke Plaza, Milepost 15 1 (Mt. Gilead/Fredricktown, SR 95)
- Travel Centers of America (TA), Milepost 209 (Lodi, I-76 E, US 224)

A total of 181 truck operators participated in the study. including 99 at the Flying J, 26 at Duke, and 56 at TA. The information solicited in the trucker interview, as in the traveler interview, included problems and solutions in the l-71 Corridor. In addition, the truckers were asked what types of communications devices they use in their vehicles. All of those interviewed use Citizens Band (CB) radios, 77 % use AM or FM radios, 29 % use cellular phones, 11 % use laptop/computers, 0.5 % use televisions, and 0.5 % use satellite connections.

Like the private vehicle traveler responses. the trucker problem/solution responses were grouped into three categories according to frequency of travel on I-71 [anywhere between Columbus and Cleveland]. **Table 3.0-3** presents the problems shared by truckers. The problems most often mentioned by the most frequent l-71 travelers include differential speed limits between trucks and other vehicles (47 %), general congestion due to over-capacity (35 %), construction zones (26 %), and uneducated/inattentive drivers (25 %). Differential speed limits and general congestion due to over-capacity are problems most often mentioned by truckers who travel on this section of l-71 less frequently.

Table 3.0-3 Problems Identified by Truck Travelers			
	Frequency of Travel on 1-71		
	> once a week	1 to 4 times per month	<once a month
Identified Problems	**Percent identifying problem**		
None identified	14	13	24
Lack of maintenance	15	3	7
Construction zones	26	20	7
Differential speed limits	47	43	38
Accidents	7	4	
Too strict enforcement	13	20	3
General congestion (over capacity)	35	33	28
Wide load/heavy machinery transport	4		7
Signs		1	3
Uneducated or inattentive drivers	25	9	3
Ramps/bridges	1		-
Weather-related	10	3	
Over-crowded weigh stations	6	6	3
Crime in rest areas	7	I	-
Truck stop/rest area parking capacity		15	10

Table 3.0-4 presents the solutions that were suggested by the interviewed truckers. In all three groups of truckers, the solutions mentioned most include: uniform speed limit, three lanes each direction in whole or part, and increased truck speed limit.

Table 3.0-4 Suggested Solutions Identified by Truck Travelers			
	Frequency of Traveler on I-71		
	> once a week	1 to 4 times per month	< once a month
Suggested Solution	**Percent identifying solution**		
None mentioned	21	39	34
Better maintenance	8	5	7
Construction at night	3	-	-
Uniform speed limit	28	20	24
Increased truck speed limit	18	20	21
Better incident management	-	-	3
Reduced enforcement	7	10	3
3 lanes	25	15	17
Truck lane	3	3	-
Alternate route	1	1	-
Pull-off areas	-	1	-
Better/more signs	-	1	3
Variable message signs	-	-	7
Real-time radio reports	1	-	-
Electronic clearance/weigh-in-motion	6	4	3
Driver education	6	3	3
Require CDL for RVs	1	-	-
Improve interchanges	1	-	-
Increase capacity at rest areas	-	8	10

Focus Group Meetings

Focus groups are a qualitative research method in which a small group of participants – usually 8 to 12 -are encouraged to talk about a subject under the direction of a facilitator. In a focus group, people with selected characteristics come together for an in-depth discussion of their opinions, behaviors, motivations and/or decision criteria. Focus groups offer an unstructured research environment – an opportunity for follow-up questions and probing.

Focus groups are characterized by predetermined discussion topics and an open-ended flow of ideas. Focus group protocols consist of a set of primary questions and a set of secondary questions designed to get others in the group to either confirm or disagree with the first respondent's answers.

Participants were identified and recruited through a series of procedures designed to produce diverse groups of stakeholders. First, potential participants were identified by reviewing membership lists of key constituent groups (e.g., focal chambers of commerce, public officials, transportation industry representatives). Members of the Advisory Committee were also consulted, and several of them made helpful suggestions.

Over a period of two weeks in early July, telephone contact was made with more than 60 people, whose interest and willingness to participate was determined. In the end, approximately 15 people were invited to participate in each focus group, with the objective being to recruit between 7 and IO participants for each session.

Three focus groups were conducted on July 23-25, 1997, at the following locations:

* July 23 Rustic Hills Country Club (Medina), 8 participants
* July 24 Richard County Area Chamber of Commerce (Mansfield), 7 participants
* July 25 Delaware Area Chamber of Commerce (Delaware), 8 participants

At feast 10 individuals agreed to participate in each focus group, but five of these people did not show up for the sessions. Ultimately, the focus group participants were drawn from the following sectors:

• Public officials (7)	1	Elected official
	2	Career administrators
	2	Public engineers
	2	Regional planners
• Business (14)		Real estate
	2	Public utilities
	2	Construction
	2	Retail
	2	Small business
	2	Transportation
	3	Manufacturing
• Human service (2)		Health administrator
		Alcohol/drug addiction services administrator

For these three focus groups, the protocol consisted of a set of questions that paralleled the advisory group survey. Yet, given the dynamics of the focus group process, we were able to probe beyond the initial set of questions. The following are results of the focus groups:

1. ***There is a clear consensus thai I-71 is a vital resource to the area, but participants disagree on the corridor's quality and accessibility.*** Participants in these three focus groups agree on one thing: the I-71 corridor is a vital economic resource for the communities it touches. Designed as a connector between Cleveland and Columbus, I-71 is now seen as a critical asset for communities along the corridor. It is seen as a source of their economic growth and prosperity – and that expansion is recognized as a major contributor to the problems that presently beset the corridor (e.g.. high levels of truck traffic, congestion, and safety issues).

   However, there is disagreement on the quality. convenience and safety of the interstate highway. While many participants are quick to point to the problems, others believe that I-71 compares favorably to similar facilities.

2. ***To the extent that participants perceive that I- 71 has problems, there is substantial agreement about what those problems are.*** Participants in the three focus groups identified the following problems:

- The corridor's capacity is not sufficient to meet the current demand. Congestion is seen as a serious problem – particularly at major exits and at long, steep grades. Polaris is perceived to be a particular problem, and the connectors to Cleveland and Columbus (at the ends of the corridor) are believed to be serious problems.

- Long delays due to construction and lane closings are believed to be a real problem – and a surprisingly large number of people know that construction projects will be the norm during the next eight years.

- The different speed limits for cars and trucks is seen as a serious problem. Most respondents want to see this change -that is, the same speed limit for all vehicles.

- Respondents believe that there are serious design flaws, such as:

  — Poor quality of roadway construction and maintenance
  — Entrances and exits are too short. which results in traffic congestion
  — 1-271's connection to 1-71 does not permit traffic to go northward
  — The interchange that connects I-71 to 1-76 is hazardous
  — Travelers cannot see across bridges over the highway

- Most participants agree that alternative routes are not available when backups occur along the corridor. In fact. several people believe that ODOT has allowed a once-superior highway to decline in recent years. No land has been procured in the past 30 years, they say. Exits have not been modernized. and maintenance has not been sufficient.

- Consistent with the responses to the advisory group survey, most participants do not see weather conditions to be a serious problem.

3. ***Safety concerns dominate the thinking of most highway travelers.*** As participants talked about highway conditions. it became clear that safety is their primary concern. In their words:

- "Road surfaces need to be better maintained. They're not safe now."

- "The lighting at rest stops is inadequate. I won't stop there, particularly with the large number of trucks that often clog the rest stop entrances and exits."

- "Trucks and automobiles should have separate rest stops."

- "Differential speed limits for cars and trucks are not safe. Everyone should have the same speed limit – 65 mph."

- "Back-ups on the highway are a regular occurrence. It scares me to drive on I-71."

- "Patrol stations are located inappropriately, and the police create accidents when responding to calls." (The point here is that accidents occur when the police spend too much time handling an incident.)

- "I-71 won't be safe until there are three lanes from Cincinnati to Cleveland – sometimes a 4th lane on steep grades."

4. ***There is not a clear consensus on the solutions to these problems.*** Participants were quick to suggest solutions, but only a few of these solutions drew enthusiastic support from other participants. Significantly, even fewer of the preferred solutions related to information-based and technological applications. For example:

- Calls for a third lane – either along the entire corridor or at specific locations – is a popular solution. It is probably THE most widely supported solution.

- Off-peak times should be used for construction activities, whenever possible. Work at night and 24 hours a day. Always maintain two lanes of traffic during construction.

- Interrnodal solutions – and recommendations for the development of alternative modes of transportation (e.g., rail) are the source of considerable interest. Yet, most participants do not believe that they are feasible, or that they offer any substantial relief for 1-71's congestion problems.

- The most popular ITS solutions are:

  — Provide motorists with advance notice of incidents using variable message signs, with directions to exits and alternative routes.

  — Develop early warning devices to alert travelers to changing road conditions – or to incidents ahead.

- It should be noted that participants are not particularly enthusiastic about on-board communications systems (i.e. computers and "smart" vehicles). They see these devices as possible long-term solutions. but they do not expect them to have a significant impact in the near-term.

5. ***Participants do not believe that the Ohio Department of Transportation (ODOT) has been particularly responsive to the needs of local communities, nor do they think it has been sensitive to I-71's unintended consequences for communities.*** Some specific concerns are:

- The location of weigh stations results in the diversion of truck traffic through'communities – causing local congestion and road damage.

- The construction materials currently being used by ODOT are widely seen as being "inferior." And, with these paving materials, the need for more frequent maintenance is a fairly widespread concern.

6. ***Individual participants are interested in a number of specific actions, although some of them drew more group support than others.*** These are:

- Advantage 75 is a good idea, particularly for long-haulers. There is considerable interest in this initiative.

- Use the latest technology to determine safe speeds for automobiles and trucks and communicate changeable speed limits to travelers.

- Develop an alternative mode of transportation in the median since ODOT owns the land.

- Encourage car-pooling.

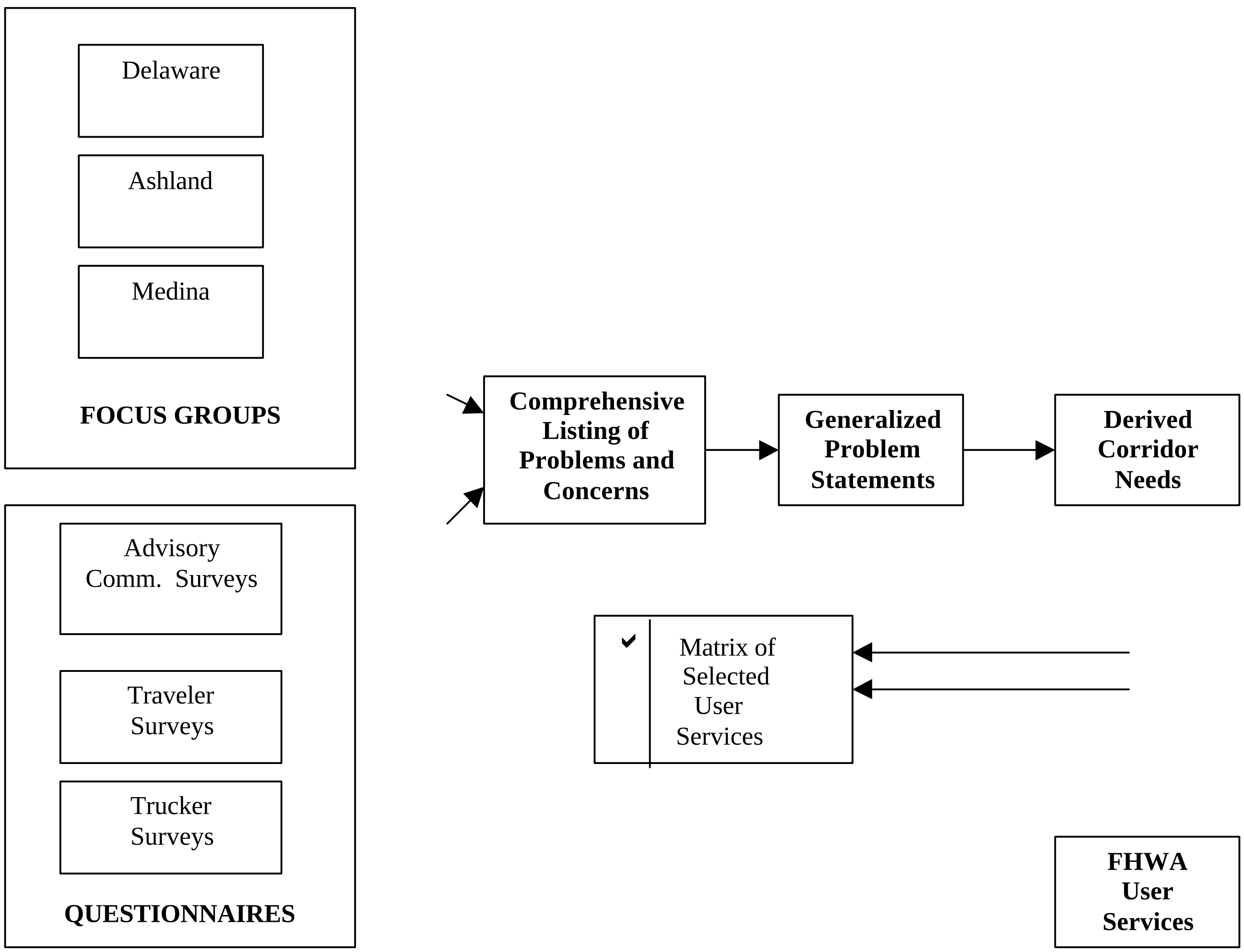
Comparing ITS User Services to Identified Needs in the I-71 Corridor

A five-step process will be used to refine the original statements of problems and concerns and to identify appropriate User Services for I-71. Figure 3.0-I illustrates this process in a graphical format for the first set of needs supplied by the Advisory Committee. First, the original statements of problems and concerns from all data collection efforts in this task were assembled into a comprehensive list of over 300 records. Next. this list of original. "raw" statements was reduced and refined, through grouping of similar statements, into more descriptive, general problem categories.

This data reduction step also eliminated those problem statements not directly related to transportation or ITS from this corridor need assessment and User Services selection process, by placing them in a separate category of *Additional Information.* Examples of the generalized problem categories include: "snow/ice on road" and "driver fatigue."

The generalized problem categories were then used to arrive at specific corridor needs. For example, using a set of needs that are likely needs in any part of the country with severe winter weather, one derived corridor problem or need statement could be "accidents caused by drivers unaccustomed to local winter driving conditions." This derived need might be derived from such "raw data" statements as: (1) early weather warning and driving conditions information to travelers, (2) need to provide drivers with information relative to safe stopping distances based on conditions. Some of the needs have ITS solutions, some do not.

Finally, the specific corridor needs were refined and linked to appropriate User Services. **Table 3.0-5** is a matrix that summarizes the matching of need statements to User Services.



I-71 USER INPUT

Figure 3.0-1
Identification of Needs and User Services

Table 3.0-5
Summary of Corridor Needs and Matched User Services

Corridor Need ID #	Corridor Needs		Travel & Transportation Managment						Travel Demand Management			Public Transportation Operations					Commercial Vehicle Operations						Emergency Management			Advanced Vehicle Control and Safety Systems							
		Non ITS-need	En-route driver information	Route guidance	Traveler services information	Traffic control	Incident management	Emissions testing and mitigation	Demand management and operations	Pre-trip travel information (includes kiosks)	Ride matching and reservations	Public transportation managment	En-route transit information	Personalized public transit	Public travel security	Electronic payment services	Commercial vehicle electronic clearance	Automated roadside safety inspection	On-board safety monitoring	Commercial vehicle administrative process	Hazardous materials incident response	Freight mobility	Emergency notification and personal security	Emergency vehicle management	Highway-rail grade crossing improvements	Longitudinal collision avoidance	Lateral collision avoidance	Intersection collision avoidance	Vision enhancement for crash avoidance	Safety readiness	Pre-crash restraint deployment	Automated vehicle operation	
1	Make public more aware of construction		X							X																							
2	In-vehicle information		X	X	X																												
3	Electronic maps in vehicles		X	X																													
4	Announcements to long-distance commuters								X	X																							
5	Travel-time information		X							X																							
6	More/better signs for tourists	X																															
7	Kiosks with real-time information				X					X																							
8	Pre-trip congestion information				X					X																							
9	Electronic yellow pages at stops and en-route		X		X																												
10	Travel information via rental cars in Cleveland and Columbus		X		X																												
11	Enhancement/expansion of 1-800-BUCKEYE				X					X																							
12	Easily accessible visitor information				X					X																							
13	Real-time weather information		X							X																							
14	Variable message signs		X	X																													
15	Central clearinghouse for roadway condition information		X							X																							
16	Early warning of reduced visibility		X							X																							
17	Real-time radio traffic reports									X																							
18	24-hour traveler information availability		X		X					X																							
19	Inform public on how to access information		X		X					X																							
20	Provide information on Ohio tourist sites to I-71 travelers		X		X					X																							
21	Safety and capacity improvements at US 30 interchange																											X					X
22	More emergency roadside assistance						X																X										
23	Improve safety for construction workers																																X
24	Safety/human factors public awareness of in-vehicle devices																													X			
25	Information on availability of cellular coverage		X		X					X																							
26	Improve safety at rest areas						X																										X
27	Include advanced technology in driver education																													X			
28	Require Type C license for RVs	X																															
29	Reduce or eliminate speed limit differential																															X	
30	Provide more enforcement																																X
31	Remove safety hazard at I-76 & SR 218 interchanges with I-71																											X					X
32	Monitor and detect driver fatigue and vehicle condition																													X			
33	Advance notice of animal crossings																																X
34	Emergency detection in remote areas						X																X										
35	Improved incident/emergency management						X																X										
36	HAZMAT notification and emergency management infrastructure																				X												
37	Improved inter- and intra-agency communications systems																																X
38	Improved bandwidth/increased no. of channels on communications infrastructure						X																X										
39	Improved safety MP 161 to 181						X																X										X
40	Improved wireless communications infrastructure						X																X										
41	Alternative to cellular						X																X										
42	Improved interchange operations																											X					
43	Better road maintenance	X																															
44	Three lanes each direction, esp. on long grades	X																															
45	Added truck lane	X																															
46	Nighttime construction	X																															
47	Better manage wide load/heavy machinery transport		X				X															X											

Table 3.0-6

Summary of Corridor Needs and Matched User Services

Corridor Need ID #	Corridor Needs	Non ITS-need	Travel & Transportation Managment						Travel Demand Management			Public Transportation Operations					Commercial Vehicle Operations						Emergency Management			Advanced Vehicle Control and Safety Systems							
			En-route driver information	Route guidance	Traveler services information	Traffic control	Incident management	Emissions testing and mitigation	Demand management and operations	Pre-trip travel information (includes kiosks)	Ride matching and reservations	Public transportation managment	En-route transit information	Personalized public transit	Public travel security	Electronic payment services	Commercial vehicle electronic clearance	Automated roadside safety inspection	On-board safety monitoring	Commercial vehicle administrative process	Hazardous materials incident response	Freight mobility	Emergency notification and personal security	Emergency vehicle management	Highway-rail grade crossing improvements	Longitudinal collision avoidance	Lateral collision avoidance	Intersection collision avoidance	Vision enhancement for crash avoidance	Safety readiness	Pre-crash restraint deployment	Automated vehicle operation	[illegible]
48	Better project scheduling	x																															
49	Encourage truck travel at night	x																															
50	Reduce congestion at I-76 interchange																											x					x
51	Improved design at I-271 to allow north/south travel	x																															
52	Separate operation for trucks/RVs and other vehicles at rest areas	x																															
53	Congestion relief in communities from I-71		x	x						x																							
54	Congestion relief near weigh stations and on diversion routes																x					x											
55	Improved work zone safety																																x
56	Region-wide communications infrastructure																																x
57	Increased awareness of available rail and air schedules at Cleveland and Columbus				x							x																					
58	Real-time information on other options for travel				x							x																					
59	Better access to central cities				x							x																					
60	Integrate traffic information for connecting surface streets, other freeways, and I-71		x							x																							x
61	Advise travelers of alternate routes		x	x						x																							
62	Improve access to recreational opportunities				x							x																					
63	Better access to Snow Trails ski area				x							x																					
64	Develop high speed rail				x							x													x								x
65	Advantage I-75 needed immediately on I-71																x					x											
66	Add transponders on trucks																x					x											
68	Provide real-time traffic information		x																														
69	Increase parking capacity at truck stops and rest areas		x		x												x																
71	Relief for over-crowding at weigh stations		x																														
72	Increase truck speed limit to 65 mph	x																															

Identification of User Service Deployment Time Frames

The National ITS Program Plan defines anticipated deployment of ITS based upon the following schedule:

Term	Time-Frame	Envisioned ITS Deployment
Short	1997-1999	Travel Information/Fleet Management
Medium	2000-2005	Transportation Management
Long	Beyond 2005	Enhanced Vehicles

The National Plan defines the beginning of the short-term time frame (1997) to coincide with the reauthorization of ISTEA. Considering the typical planning, design, and implementation schedules of transportation projects, the short term encompasses a relatively brief time frame (three years). This schedule reflects the desire by FHWA to implement, as quickly as possible, visible and effective ITS projects that will stimulate public support for the funding levels required to implement the future medium- and long-term deployment programs.

Summary

As components of this work task, inputs were assembled from the Advisory Committee and other users of 1-71, problems and concerns of the stakeholders were refined into corridor needs, appropriate ITS User Services were selected to address the needs, and appropriate time frames of ITS implementation were determined.

The original statements of stakeholder problems and concerns have been translated into corridor needs using a process of categorization and generalization. The time frames of User Service deployment were selected based on the anticipated schedule for addressing the corridor need with which a given User Service is associated. Additional discussion of system objectives and deployment time frames are better addressed later in this report.

CHAPTER 4.0

4.0 USER SERVICE OBJECTIVES AND PERFORMANCE CRITERIA

Methodology and Key Task D Activities

The purpose of Task D is to state the objectives to be achieved by implementing the User Services identified in Task C of this Strategic Plan and to specify the criteria to be used to measure the degree of success (performance) of the User Services when they are deployed.

Key activities for Task D have included:

- Establish objectives of each User Service identified in Task C.
- List quantitative measures of performance for each User Service.
- List qualitative performance criteria for each User Service.

This work task has established corridor-wide and project-specific objectives based on the corridor needs developed in Task C and determines alternative performance criteria to measure the relative effectiveness of the User Services assigned to each need to achieve these objectives. An example of the formulation of objectives and performance criteria for a sample need is summarized below:

Need:	To avoid motorists unexpectedly encountering icy roads
System objective:	Improve safety
User Services:	Pre-trip travel information En-route driver information
Project-level objective:	Warn travelers of icing conditions soon enough for traveler to change plans or driving behaviors
Performance criteria:	Accident rates Emergency service call-outs Rating based on survey of system users
Time frame:	Short term

Performance measures or criteria, described in subsequent sections of this report, were then developed in order to quantitatively or qualitatively assess the effectiveness of the matched User Services in achieving the project-level objective. It should be noted that the time frame listed represents the anticipated timing of the initial User Service deployed to satisfy a need. Therefore, the time frame is need-based, not user service-based.

Performance Measures

A number of alternative indicators of effective eness. referred to as performance measures. are available to assess the degree to which the selected User Services achieve each specific goal. Performance measures can be grouped into quantitative or qualitative categories and consist of a wide range of transportation-related. environmental. and other indices. The following paragraphs summarize the identification and assessment of alternative performance criteria.

Candidate performance measures were identified based on a review of several sources, including:

- DOT's National Program Plan for ITS
- DOT's Advanced Public Transportation Systems: Evaluation Guidelines
- *ITS Architecture* reports
- ITS-America *Proceedings*
- Professional literature search
- Previous Kimley-Horn ITS Corridor studies
- Evaluation of specific objectives in the l-71 corridor

A total of 79 unduplicated performance measures were assembled during the course of this research. Although an even larger number of the measures were found to be applicable to urban conditions, the performance measures in these lists were found to be applicable to the typically rural character of I-71. A number of alternative performance measures were found to be applicable to more than one system objective.

Review of the candidate performance measures resulted in the selection of 16 measures, including three qualitative measures and 16 quantitative measures. These recommended performance measures are shown in **Table 4.0-l.** It should be noted that the generalized measures listed in this table are assumed to incorporate more detailed breakdown of the information each provides. For example. the accident rate performance measure is assumed to provide accident rates for alternative roadway and environmental conditions. in addition to the rate for each segment of highway, and at each interchange.

Prioritization of User Services

Although the User Services associated with each corridor need have been assigned a deployment time frame as described in Chapter 3. the relative prioritization of each User Service within each time frame was not established. In order to address this consideration. each ITS-related corridor need and its associated User Service(s) and system objective was grouped based on its anticipated deployment time frame. Within each time frame. the individual corridor needs and associated User Services and objectives was qualitatively evaluated based on the following criteria relating to the User Services:

- Does it improve safety?
- Does it facilitate localized or regional economic benefits?
- Does it alleviate congestion?
- Is the overall benefit applicable to the entire I-71 corridor?

Table 4.0-l
Recommended Performance Measures

QUALITATIVE	QUANTITATIVE
Accurate incident detection	Accident rate
Conformance/response to messages	Emergency response time
Level of Service (LOS)	Emergency service call-outs
(3 subtotal)	Hazardous material spills
	Number of communications channels
	Number of hours in which information is available
	Number of visitor centers with traveler information kiosks
	Person-hours of delay
	Tow truck service calls
	Truck/fixed object collisions
	Weather station coverage
	CVO operations and impacts (by-pass capability)
	Wireless communications coverage
	(13 subtotal)

Tables 4.0-2 through 4.0-7 show the needs, matched User Services, User Service objective(s), and system objective(s) for each need. Each table addresses a different program area, including the following:

1. Tourism and Travel Information
2. Traveler Safety and Security
3. Emergency Services
4. Infrastructure Operations and Maintenance
5. Public Traveler/Mobility Services
6. Commercial Vehicle Operations

The User Service objective focuses on the specific goal of the User Service(s) in addressing the particular need. The system objective is a more broad, or system-wide goal that several User Services would work toward accomplishing. For example, the need for variable message signs relates to the en-route and route guidance User Services. The User Service objectives is to disseminate accurate, timely information. The broad objective is to improve information coverage.

Table 4.0-2

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives - Tourism and Travel Information

Need No.	Need Description	User Services	User Service Objective	System Objective
1.1	Make public more aware of construction	En-route Pre-trip	Disseminate/provide access to accurate. timely information	Reduce congestion and improve air quality
1.2	In-vehicle information	En-route Route guidance Traveler Services Info	Disseminate accurate, timely information	Reduce congestion and improve air quality Improve safety and security
1.3	Electronic maps in vehicles	Route-guidance En-route	Improve traffic flow and reduce unnecessary travel	Reduce congestion and improve air quality Improve safety and security
1.4	Announcements to long-distance commuters	Pre-trip	Provide interactive access to real-time traffic/travel info .	Reduce congestion and improve air quality
1.5	Travel-time information	Pre-trip En-route	Increase consumer awareness of travel options	Reduce congestion and improve air quality
1.6	More/better signs for tourists	Non-ITS		
1.7	Kiosks with real-time information	Traveler services info Pre-trip	Increase consumer awareness of travel options	Improve information coverage
1.8	Pre-trip congestion information	Pre-trip Traveler services info	Increase consumer awareness of travel options	Improve information coverage
1.9	Electronic yellow pages at stops and en-route	En-route Traveler services info	Provide increased access to travel services info	Improve information coverage
1.10	Travel information via rental cars in Cleveland and Columbus	Traveler services info En-route	Increase consumer awareness of travel options	Improve information coverage
1.11	Enhancement/expansion of 1-800-BUCKEYE	Traveler services info Pre-trip	Increase tourist information and consumer awareness of travel options	Increase tourism
1.12	Easily accessible visitor information	Traveler services info Pre-trip	Increase tourist information and consumer awareness of travel options	Increase tourism
1.13	Real-time weather information	Pre-trip En-route	Disseminate/provide access to accurate, timely information	Improve safety and security
1.14	Variable message signs	En-route Route guidance	Disseminate accurate. timely information	Improve information coverage

1.15	Central clearinghouse for roadway condition information	Pre-trip En-route	Disseminate/provide access to accurate, timely information	Reduce congestion and improve air quality
1.16	Early warning of reduced visibility	Pre-trip En-route	Disseminate/provide access to accurate, timely information	Improve safety and security
1.17	Real-time radio traffic reports	Pre-trip En-route	Disseminate accurate, timely information	Improve information Coverage
1.18	24-hour traveler information availability	Pre-trip En-route Traveler services info	Disseminate accurate, timely information	Improve information coverage
1.19	Inform public on how to access information	Pre-trip En-route Traveler services info	Disseminate accurate, timely information	Improve information coverage Increase tourism
1.20	Provide information on Ohio tourist sites to I-71 travelers	Pre-trip En-route Traveler services info	Disseminate accurate, timely information	Improve information Coverage Increase tourism

Table 4.0-3

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives – Traveler Safety and Security

Need No.	Need Description	User Services	User Service Objective	System Objective
2.1	Safety and capacity improvements at US 30 interchange	Intersection collision avoidance Other safety-related services	Advanced warning to drivers	Improve safety and security
2.2	More emergency roadside assistance	Incident management Emergency notification and personal security	Reduce response time	Improve safety and security
2.3	Improve safety for construction workers	Other safety-related services	Reduce construction worker injuries and fatalities	Improve safety and security
2.4	Safety/human factors public awareness of in-vehicle devices	Safety readiness	Better driver training	Improve safety and security
2.5	Information on availability of cellular coverage	Traveler services information Pre-trip information En-route information	Disseminate accurate and up-to-date information	Improve safety and security
2.6	Improve safety at rest areas	Other safety-related services Incident management	Reduce response time	Improve safety and security
2.7	Include advanced technology in driver education	Safety readiness	Better driver training	Improve safety and security
2.8	Require Type C license for RVs	Non-ITS		
2.9	Reduce or eliminate speed limit differential	Automated Highway System	Reduce accidents between trucks and other vehicles	Improve safety and security
2.10	Provide more enforcement	Other safety-related services	Reduce accidents	Improve safety and security
2.11	Remove safety hazard at I-76 & SR 218 interchanges with I-71	Intersection collision avoidance Other safety-related services	Advanced warning to drivers	Improve safety and security
2.12	Monitor and detect driver fatigue and vehicle condition	Safety readiness	Driver notification/warning and enforcement	Improve safety and security
2.13	Advance notice of animal crossings	Other safety-related services	Driver notification/warning	Improve safety and security

Table 4.0-4

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives – Emergency Services

Need No.	Need Description	User Services	User Service Objective	System Objective
3.1	Emergency detection in remote areas	Incident management Emergency notification and personal security	Quick detection and Response to incidents	Reduce congestion and improve air quality Improve safety and security
3.2	Improved incident/ Emergency management	Incident management Emergency notification and personal security	Quick detection and response to incidents	Reduce congestion and improve air quality Improve safety and security
3.3	HAZMAT notification and emergency management infrastructure	HAZMAT incident response	Quick detection and response to incidents	Reduce congestion and improve air quality Improve safety and security
3.4	Improved inter- and intra-agency communications systems	Interagency coordination	Quick detection and response to incidents	Reduce congestion and improve air quality Improve safety and security
3.5	Improved bandwidth/increased no. of channels on communications infrastructure	Incident management Emergency notification and personal security	Quick detection and response to incidents	Improve safety and security

Table 4.0-5

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives - Infrastructure Operations and Maintenance

Need No.	Need Description	User Services	User Service Objective	System Objective
4.1	Improved safety MP 161 to 181	Incident management Emergency notification and personal security Other safety-related services	Advanced warning to drivers	Improve safety and security
4.2	Improved wireless communications infrastructure	Incident management Emergency notification and personal security	Receive and disseminate accurate and up-to-date info	Reduce congestion and improve air quality Improve safety and security
4.3	Alternative to cellular	Incident management Emergency notification and personal security	Receive and disseminate accurate and up-to-date info	. Reduce congestion and improve air quality Improve safety and security
4.4	Improved interchange operations	Intersection collision avoidance	Provide automated traffic control measures at interchanges	Reduce congestion and improve air quality Improve safety and security
4.5	Better road maintenance	Non-ITS		
4.6	Three-lanes each direction, esp. on long grades	Non-ITS		
4.7	Added truck lane	Non-ITS		
4.8	Nighttime construction	Non-ITS		
4.9	Better manage wide load/ heavy machinery transport	Fleet management En-route Incident management	Better decisions about vehicle routing and scheduling	Reduce congestion and improve air quality Improve safety and security
4.10	Better project scheduling	Non-ITS		
4.11	Encourage truck travel at night	Non-ITS		
4.12	Reduce congestion at I-76 interchange	Intersection collision avoidance Other safety-related services	Provide automated traffic control measures at interchanges	Reduce congestion and improve air quality Improve safety and security
4.13	Improved design at l-271 to allow north/south travel	Non-ITS		
4.14	Separate operation for trucks/ RV's and other vehicles at rest areas	Non-ITS		
4.15	Congestion relief in communities from I-71	Route guidance En-route Pre-trip	Disseminate accurate and up-to-date info	Reduce congestion and improve air quality Improve safety and security
4.16	Congestion relief near weigh stations and on diversion routes	Fleet management Electronic clearance	Better decisions about vehicle routing and scheduling	Reduce congestion and improve air quality Improve safety and security
4.17	Improved work zone safety	Other safety-related services	Reduce incidents in work zones	Improve safety and security
4.18	Region-wide communications infrastructure	Interagency coordination	Expand I-71 ITS comm. backbone to connect ATMS in Cleveland and Columbus	Reduce congestion and improve air quality Improve safety and security

Table 4.0-6

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives Public Traveler/ Mobility Services

Need No.	Need Description	User Services	User Service Objective	System Objective
5.1	Increased awareness of available rail/air schedules at Cleveland and Columbus	Traveler services info Public transportation management	Promote multimodal travel	Reduce congestion and improve air quality
5.2	Real-time information on other options for travel	Traveler services info Public transportation management	Promote multimodal travel	Reduce congestion and improve air quality
5.3	Better access to central cities	Traveler services info Public transportation management	Promote multimodal travel	Reduce congestion and improve air quality
5.4	Integrate traffic information for connecting surface streets, other freeways, and I-71	Interagency coordination En-route Pre-trip	Increase coverage of accurate. real-time information on traffic and alternate modes	Reduce congestion and improve air quality
5.5	Advise travelers of alternate routes	Route guidance En-route Pre-trip	Disseminate accurate, real-time traffic information	Reduce congestion and improve air quality
5.6	Improve access to recreational opportunities	Traveler services info Public transportation management	Promote multimodal travel	Reduce congestion and improve air quality
5.7	Better access to Snow Trails ski area	Traveler services info Public transportation management	Promote multimodal travel	Reduce congestion and improve air quality
5.8	Develop high speed rail	Traveler services info Public transportation management Rail-highway grade crossing	Promote multimodal travel	Reduce congestion and improve air quality Improve safety and security

Table 4.0-7

Summary of Corridor Needs, Specific Objectives, User Services, Performance Criteria, and System Objectives - Commercial Vehicle Operations

Need No.	Need Description	User Services	User Service Objective	System Objective
6.1	Advantage I-75 needed immediately on I-71	Electronic clearance Fleet management	Better decisions about vehicle routing and scheduling	Increase commercial vehicle productivity Reduce congestion and improve air quality
6.2	Add transponders on trucks	Electronic clearance Fleet management	Bypass of weigh stations	Increase commercial vehicle productivity
6.3	Provide real-time traffic information	En-route	Better decisions about vehicle routing and scheduling	increase commercial vehicle productivity
6.4	Increase parking capacity at truck stops and rest areas	En-route Traveler services info	Better utilization of parking areas (parking management)	Increase commercial vehicle productivity Improve safety and security
6.5	Relief for over-crowding at weigh stations	En-route Electronic clearance	Better decisions about vehicle routing and scheduling	Increase commercial vehicle productivity Improve safety and security
6.6	Increase truck speed limit to 65 mph	Non-ITS		

CHAPTER 5.0

5.0 INTEGRATED USER SERVICES

The objectives of Task E were to group the needed User Services into program categories, establish the interactions among needed User Services. and categorize the User Services as having short-, medium-, or long-term potential for implementation.

Methodology and Key Task E Activities

The area of emphasis for this ITS Strategic Plan is a comprehensive assessment of the immediate and long-range ITS deployment opportunities in this rural, high-use corridor. The needs are based on the broad-based assessment and input from approximately 300 stakeholders (I-71 ITS Coalition) plus approximately 400 travelers and truckers that were included in user interviews.

Primary input for this User Services Plan comes from documentation shown in the previous four chapters, the review and comments received at two Advisory Committee meetings, the traveler and trucker surveys, and the results of three focus groups. As a summary of the following detailed User Services plan, two elements have been identified as priority user service categories which need more attention than others: (1) an enhanced Incident Management System and (2) a corridor-wide Advanced Traveler and Tourist Information System (ATIS).

The ATIS-related User Services contained in this plan will build on several components already in place or under development. In addition to these two high priority User Services, this plan will incorporate other User Services that will address other corridor needs.

One criterion for the inclusion of User Services in this plan is that each must respond to an identified need for the Corridor or a significant portion of it. This plan is designed to inform and educate both the public and transportation professionals in order to gain the support of the ITS Coalition and other decision-makers for ITS projects. At the same time, it is designed to fit into the format of USDOT funding guidelines for ITS deployment.

This Integrated User Services Plan addresses goals of the I-71 ITS program by combining User Services into a framework that can be readily designed and deployed as specific, cost-effective projects. (Actual projects were identified in Task J and are described in Chapter 10.) In Task E, User Services addressed relate to real and urgent needs to solve the immediate and emerging problems associated with high-use tourist seasons and high-volume commercial traffic in the I-71 Corridor.

The activities accomplished as part of Task E include the following:

- Summarize the work effort and results from Tasks A through E.
- Illustrate how the overall vision of the Ohio Department of Transportation, the project Advisory Committee. and local communities along the I-71 corridor between Columbus and Cleveland can be met through implementing ITS.
- Identify institutional issues and potential barriers to the successful deployment of ITS in the 1-71 Corridor.

- Group the needed User Services into Critical Program Areas.
- Establish the interactions among needed User Services.
- Categorize the User Services as having short-, medium-, or long-term potential for implementation.

User Service Categories

As the delineation of a national rural ITS program has evolved during the course of this study, the concept of Critical Program Areas has been raised by the National Architecture team, and program descriptions by the FHWA have used the concept of Critical Program Areas rather than the original set of "bundles" that were described in earlier versions of the *National ITS Program Plan.* A comparison of the rural Critical Program Areas and the urban user service groups (or "bundles") is related in **Table 5.0-l.** As a result of the evaluations and analyses described in section 5.1.2 and the further development of objectives, the FHWA Critical Program Areas and User Services presented in **Table 5.0-2** are recommended as best representing the focus of ITS Early Deployment initiatives in the rural I-71 Corridor in Ohio.

Table 5.0-l
Relationship of User Services Categories and Critical Program Areas

User Service Groups	Critical Program Areas
Travel & Transportation Management	Travel Safety and Security
Travel Demand Management	Tourism and Travel Information
Public Transportation Management	Public Traveler/Mobility Services
Electronic Payment Services	Fleet Operations & Management
Commercial Vehicle Operations	Commercial Vehicle Operations
Emergency Management	Emergency Services
Advanced Vehicle Control and Safety Systems	Infrastructure Operations & Maintenance

No specific needs were identified in the Fleet Operations and Management Critical Program Area, so it is not addressed in the User Services Plan: however, it has been incorporated into the Chapter 8 Architecture Plan to accommodate fleet operations in future years.

Table 5.0-3 is a matrix relating again the needs that were identified in previous tasks. At the August 8, 1997 Advisory Committee meeting. this list of needs was reviewed and revised (as shown herein), and priorities for potential deployment were identified by time frame. Needs are grouped in Table 5.0-3 based on the Critical Program Areas identified in Table 5.0-2.

Table 5.0-2
User Services Based on Needs in the Ohio I-71 Corridor

Major Critical Program Areas (Specific to Ohio I-71 Corridor, and included in the draft ***ITS Rural Program Plan.*** September 1996)	**Specific ITS User Services** (Specific to 1-71. but also included in ITS ***National Program Plan and National Architecture,*** as amended)
Traveler Safety and Security	Rail-Highway Grade Crossings Other Safety-Related Services Intersection Collision Avoidance Automated Highway System Safety Readiness
Tourism and Travel Information	Pre-Trip Travel Information En-Route Driver Information Route Guidance Traveler Services Information
Public Traveler/Mobility Services	Public Transportation Management
Commercial Vehicle Operations	Commercial Vehicle Electronic Clearance Fleet Management (Mobility)
Emergency Services	Emergency Notification & Personal Security Emergency Vehicle Management HAZMAT Incident Notification
Infrastructure Operations and Maintenance	Incident Management Interagency Communication

Table 5.0-3
Compilation of Needs Critical Program Area

Critical Program Areas	Specific Needs Identified on I-71 Corridor (no priority)
Tourism and Travel Information	1.1 Make traveling public more aware of upcoming construction and to take alternate routes if possible 1.2 In-vehicle information Electronic maps in cars 1.3 Announcements to commuters who work outside resident counties 1.5 Travel time information 1.6 More/better signs for tourists 1.7 Kiosks with real-time information 1.8 Pre-trip congestion information 1.9 Electronic yellow pages at stops and en-route 1.10 Travel information via rental cars in Cleveland and Columbus 1.11 Enhancement/expansion of 1-800-BUCKEYE 1.12 Easily accessible visitor information 1.13 Real-time weather condition information exchange 1.14 Variable message signs 1.15 Centralize and inform public as to where roadway condition information is available 1.16 Early warning of reduced visibility ahead 1.17 Real-time radio traffic reports 1.18 24-hour traveler information availability 1.19 Inform public on how to access information 1.20 Provide information on Ohio tourist sites to l-71 travelers
Traveler Safety and Security	2.1 Safety and capacity improvements at US 30 interchange 2.2 More emergency roadside assistance 2.3 Improve safety for construction workers 2.4 safety/human factors - public awareness of in-vehicle devices 2.5 Inform motorists where cellular coverage is available 2.6 Improve safety at rest areas 2.7 Driver education, include advanced technology in 2.8 Require Type C license for RVs 2.9 Reduce or eliminate speed differential between trucks and other vehicles 2.10 More enforcement 2.11 Remove safety hazard at SR 218 (Medina) and I-76 interchanges with I-71 2.12 Monitor and detect driver fatigue and vehicle condition 2.13 Advance notice of animal crossings
Emergency Services	3.1 Means to detect emergencies in remote areas 3.2 Improve incident/emergency management 3.3 HAZMAT notification and emergency management infrastructure 3.4 Improve inter- and intra-agency communications systems 3.5 Improve bandwidth/increased number of channels on communications infrastructure

Infrastructure Operations and Maintenance	4.1 Improve safety from MP 161 to MP 181 4.2 Improve wireless communications infrastructure 4.3 Provide alternative to cellular. 4.4 Improve interchange operations 4.5 Better road maintenance 4.6 Three lanes each direction. at least along long grades 4.7 Add truck lane 4.8 Construction at night 4.9 Better manage wide-load/heavy. machinery transport 4.10 Better project scheduling 4.11 Encourage trucks to travel at night 4. I2 Reduce congestion at I-76 interchange 4.13 Improve design at I-271 to allow north/south travel 4.14 Separate operation at rest areas for trucks, RVs, and other vehicles 4.15 Congestion relief in local communities as a result of I-71 traffic (i.e. Lexington) 4.16 Truckers exiting I-71 and traveling in local communities to avoid weigh stations - congestion/roadway destruction (i.e. Delaware) 4.17 Improved work zone safety 4.18 Region-wide communications infrastructure
Public Traveler/ Mobility Services	5.1 Increased traveler awareness of available rail and air at Columbus and Cleveland 5.2 Real-time information to make travelers aware of other options for travel 5.3 Better access to central cities 5.4 Integrate traffic information for connecting surface arterials and freeways with I-71 5.5 Advise travelers about alternate routes 5.6 Improve access to recreational opportunities 5.7 Better access to Snow Trails ski area 5.8 Develop high-speed rail
Commercial Vehicle Operations	6.1 Advantage I-75 needed immediately (weigh-in-motion and electronic clearance) 6.2 Add transponders on trucks 6.3 Real-time traffic information 6.4 Increase parking capacity at truck stops and rest areas 6.5 Relief of over-crowded weigh stations 6.6 Increase truck speed limit to 65 mph

Prioritization of Critical Program Areas

Although the User Services associated with each corridor need have been assigned a deployment time frame as described in Chapter 3, the relative prioritization of each user service within each time frame was not established. In order to address this consideration. each ITS-related corridor need and its associated User Service(s) and system objective was grouped based on its anticipated deployment time frame. Within each time frame. the individual corridor needs and associated User Services and objectives were qualitatively evaluated based on criteria relating to the seven Critical Program Areas.

Critical Program Areas. in priority. order as determined by a survey of the Project Advisory Committee on July 23. 1997. are:

1. Traveler Safety and Security
2. Tourism and Travel Information
3. Commercial Vehicle Operations
4. Emergency Services
5. Infrastructure Operations and Maintenance
6. Public Traveler/Mobility Services

The seventh ITS program area. Fleet Operations and Maintenance. which applies to public agency or private vehicle fleets such as delivery services. municipal governments, etc., has been omitted from this priority listing since no specific needs have been identified in the I-71 Corridor.

The Advisory Committee was asked to rank the ITS program areas in priority order by listing their top three areas in terms of what they saw as critical needs. A detailed explanation of what is involved in the program area was given, with a general discussion of what some reasonable criteria to consider in listing the top three areas, such as:

- Is it likely to improve safety?
- Would it facilitate localized or regional economic benefits?
- Would it alleviate congestion?
- Is the overall benefit applicable to the entire I-71 corridor?

Table 5.0-4 summarizes the listing of apparent priority needs within each program area. A suggested time frame for deploying ITS technologies that would meet the needs implied is shown in this table, plus the apparent barriers to implementation of each measure: financial, technical and/or institutional.

Table 5.0-4
Summary of Ranked Needs, Potential Time Frames, and Constraints on Deployment

Corridor Needs	Time Frame	Constraints
First Priority: Traveler Safety and Security		
2.1 Safety and capacity improvements at US 30 interchange	Long	Financial
2.2 More emergency roadside assistance	Short	Institutional
2.3 Improve safety for construction workers	Short	None
2.4 Safety/human factors - public awareness of in-vehicle devices	Medium	Institutional
2.5 Inform motorists where cellular coverage is available	Short	None
2.6 Improve safety at rest areas	Medium	Institutional
2.7 Driver education, include advanced technology in	Medium	Institutional
2.8 Require Type C license for RVs	Non-ITS	-----_
2.9 Reduce or eliminate speed differential between trucks and other vehicles	Long	Institutional
2.10 More enforcement	Short	Financial
2.11 Remove safety hazard at SR 218 and I-76 interchanges with 1-71	Non-ITS	------
2.12 Monitor and detect driver fatigue and vehicle condition	Long	Technical
2.13 Advance notice of animal crossings	Long	Technical
Second Priority: Tourism and Travel Information		
1.1 Make traveling public more aware of upcoming construction and take alternate routes if possible	Short	None
1.2 In-vehicle information	Long	Technical
1.3 Electronic maps in cars	Long	Technical
1.4 Announcements to commuters who work outside resident counties	Medium	Institutional
1.5 Travel time information	Long	Institutional
1.6 More/better signs for tourists	Non-ITS	----------
1.7 Kiosks with real-time information	Medium	Technical
1.8 Pre-trip congestion information	Long	Institutional
1.9 Electronic yellow pages at stops and en-route	Medium/long	Technical
1.10 Travel information via rental cars in Cleveland and Columbus	Short	Institutional
1.11 Enhancement/expansion of 1-800-BUCKEYE	Short	Financial
1.12 Easily accessible visitor information	Medium	Technical
1.13 Real-time weather condition information exchange	Medium	Technical
1.14 Variable message signs	Medium	Financial
1.15 Centralize and inform public as to where roadway condition information is available	Medium	Institutional
1.16 Early warning of reduced visibility ahead	Long	Financial
1.17 Real-time radio traffic reports	Long	Institutional
1.18 24-hour traveler information availability	Medium	Financial
1.19 Inform public on how to access information	Short	Institutional
1.20 Provide information on Ohio tourist sites to I-71 travelers	Short	None

Third Priority: Emergency Services, Infrastructure Operations and Management, Commercial Vehicle Operation		
3.1 Means to detect emergencies in remote areas	Short	Institutional
3.2 Improve incident/emergency management	Medium	Institutional
3.3 HAZMAT notification and emergency management infrastructure	Long	Financial
3.4 Improve inter- and intra-agency communications systems	Medium	Institutional
3.5 Improve bandwidth/increase number of channels on communications infrastructure	Short	Financial
4.1 Improve safety from MP 161 to MP 181	Long	Financial
4.2 Improve wireless communications infrastructure	Medium	Financial
4.3 Provide alternative to cellular	Medium	Technical
4.4 Improve interchange operations	Long	Financial
4.5 Better road maintenance	Non-ITS	------
4.6 Three lanes each direction, at least along long grades	Non-ITS	------
4.7 Add truck lane	Non-ITS	------
4.8 Construction at night	Non-ITS	------
4.9 Better manage wide-load/heavy machinery transport	Long	Institutional
4.10 Better project scheduling	Non-ITS	------
4.11 Encourage trucks to travel at night	Non-ITS	-------
4.12 Reduce congestion at I-76 interchange	Medium	Financial
4.13 Improve design at I-271 to allow north/south travel	Non-ITS	------
4.14 Separate operation at rest areas for trucks, RVs, and other vehicles	Non-ITS	------
4.15 Congestion relief in local communities as a result of I-71 traffic (i.e. Lexington)	Medium	Financial
4.16 Truckers exiting I-71 and traveling in local communities to avoid weigh stations - congestion/roadway destruction (i.e. Delaware)	Medium	Institutional
4.17 Improved work zone safety	Short	Financial
4. 18 Region-wide communications infrastructure	Short	Institutional
6.1 Advantage I-75 needed immediately (weigh-in-motion and electronic clearance)	Short	None
6.2 Add transponders on trucks	Short	None
6.3 Real-time traffic information	Long	Financial
6.4 Increase parking capacity at truck stops and rest areas	Medium	Financial
6.5 Relief of over-crowded weigh stations	Medium	Financial
6.6 Increase truck speed limit to 65 mph	Non-ITS	-------
Fourth Priority: Public Traveler/Mobility Services		
5.1 Increased awareness of available rail and air at Columbus and Cleveland	Long	Financial
5.2 Real-time information to make travelers aware of other options for travel	Long	Financial
5.3 Better access to central cities	Long	Financial
5.4 Integrate traffic information for connecting surface arterials and freeways with I-71	Long	Institutional
5.5 Advise travelers about alternate routes	Long	Institutional
5.6 Improve access to recreational opportunities	Long	Financial
5.7 Better access to Snow Trails ski area	Long	Financial
5.8 Develop high-speed rail	Long	Financial

CHAPTER 6.0

6.0 FUNCTIONAL REQUIREMENTS

The objectives of Task F have been (1) to identify the ITS functional areas to support the selected Critical Program Areas identified in Task E, (2) to relate functions to system architecture, and (3) to produce a mapping of needed Critical Program Areas compared with functional requirements.

Key activities completed as a part of this task include:

- Identifying the functional areas that will be required in the I-71 Corridor
- Developing a set of matrices matching functional areas with Critical Program Areas
- Identifying specific delivery systems to address the needed Critical Program Areas, including functions that are provided by existing systems
- Reviewing and obtaining input from the Advisory Committee

Functional Areas

The FHWA has recognized seven basic functional areas that support ITS Program Areas. Each function is achieved through the application of several technologies that perform one or more of the following system functions:

- Surveillance: Collection and analysis of speed, volume, densities, travel time, queue length, position, classification, weather, hazardous material, and other information for use in providing needed user services

- Data Processing: Management integration and quality control of all data and algorithms pertaining to ITS

- Communications: Transmission (by wirelines and/or wireless) of voice, data, and video information to and from vehicles and travelers, and system infrastructure

- In-Vehicle Sensors: Monitoring of vehicles, drivers, and the external environment that might affect vehicle operations or driver performance

- Control Strategies: Strategies implemented to help smooth traffic flow, reduce congestion, and ensure traveler safety

- Traveler Interface: Means by which a user interacts with information sources

- Navigation/Guidance: Systems to assist travelers in route planning; position identification, route following, and finding directions when lost

Mapping Functional Areas to Critical Program Areas

Each of the User Services relating to the Critical Program Areas identified as particularly relevant to the rural I-71 Corridor was matched with the functional areas described above. Functional areas are consistent with the descriptions in the FHWA *National ITS Program Plan.* **Table 6.0-1** presents the matching of each of the User Services with functional areas that will be required for implementation.

Table 6.0-l
ITS User Services Mapped to Functional Areas

User Services	Functional Areas						
	Surveillance	Data/Voice Communi-cations	Traveler Interface	Control Strategies	Navigation Guidance	Data Processing In-vehicle Sensors	In-vehicle Sensors
Incident Management	X	X		X	X	X	
En-Route Driver Information	X	X	X		X	**X**	X
Route Guidance	X	X	X		X	X	
Pre-Trip Travel information	X	X	X		X	X	
Traveler Services Information	X	X	X			X	
Emergency Notification & Personal Security		X	X			X	X
Emergency Vehicle Management		x .	X	X	X	X	X
Rail-Highway Grade Crossing	X	X	X	X		X	
Other Safety-Related Services	X	X	X		X	X	X
Commercial Vehicle Operations	X	X	X		X	X	X

CHAPTER 7.0

7.0 SYSTEM ARCHITECTURE

This chapter describes the activities and findings of Task G. The goal of Task G was to develop an open architecture meeting the needs and ITS services of the I-7 1 corridor.

Methodology and Key Task G Activities

All activities carried out in developing an ITS architecture for the I-71 Corridor have been based upon and consistent with the work done to develop the National ITS Architecture by Lockheed-Martin Federal Systems and Rockwell International. Kimley-Horn has been involved in the National Architecture program as a reviewer and through collaborative efforts on local architecture development in other parts of the county.

Key activities carried out as part of Task G include the following:

- Decompose functional requirements and map them into a functional architecture.

- Define the functional architecture based on: FHWA National Architecture, IEEE/TRB ITS Communications Workshops, proven deployed architectures in other locations, and NCHRP ITS Communications Study 3-51.

- Develop candidate interconnecting communications links for information flow between functions.

- Evaluate candidate architectures based on evaluation criteria established from stakeholder objectives, modularity, expandability, compatibility with plans and standards.

- Document results in a technical memorandum (this chapter).

The needs for the I-71 Corridor, identified in Task C (Chapter 3), represent a subset of the overall User Services defined in the National Program Plan for ITS. The I-71 Corridor functional requirements define what functions must be performed to satisfy the needs. These functions are further partitioned to the elements of the architecture which must perform the functions.

A system architecture is a framework based on user requirements for system design. It is not a system design, but a structure upon which to design systems. An architecture defines the-following items:

- functions (e.g., gather traffic information, provide traffic information to travelers) that must be performed to implement a specific user requirement
- physical entities or subsystems where these functions reside (e.g.. a vehicle or kiosk)
- interfaces/information flows between the physical subsystems
- communications requirements for the information flows

Functional Requirements

The functional requirements for the l-71 Corridor Architecture were derived from the I-71 Corridor needs that were identified in this study. In order to assure consistency with the ITS National Architecture (INA), each user need was mapped to its closest equivalent User Service Requirement.

Using the full set of Process Specifications developed for the INA, a subset of process and capability descriptions was tailored to meet the specific I-7 I Corridor needs. In most cases this was a fairly straight-forward selection process. In many cases, however. some wording changes for specificity and clarification were necessary. Each resulting process was then collected and grouped by the specified Critical Program Areas. Further editing was applied to improve readability and cohesiveness.

This process results in a set of concise functional requirements specific to meeting the 1-71 Corridor Needs, while at the same time consistent with elements of the INA.

General Description of ITS Architecture

Basic Elements - Transportation Layer

The I-71 Corridor ITS Architecture provides a common structure for the design of Intelligent Transportation Systems. The purpose of the architecture is to define the framework around which multiple design approaches can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common foundation. Most ITS architectures that have been developed to date are for urban or metropolitan areas. There are many ways that the architecture for a rural corridor is similar. There are other ways, particularly in the degree to which freeway management systems are deployed (minor, not at all), that make the requirements in rural areas different.

The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement a given User Service, the physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle), the interfaces/information flows between the physical subsystems, and the communications requirements for the information flows (e.g., wireline or wireless). The architecture is comprised of two technical layers, the Transportation Layer and the Communications Layer. which must operated in the context of the Institutional Layer.

The basic elements of the Transportation Layer are ***Critical Program Areas, subsystems, technology packages,*** and ***market packages.*** The Critical Program Area is the set of subsystems, technology packages. and market packages that are required to provide some portion of User Service or need. The subsystem is the highest level building block of the architecture. It represents a set of transportation functions (or processes) which are likely to be collected together under one physical agency. jurisdiction. or physical location (eg. within a vehicle).
The interfaces between subsystems represent key communication link which will be defined by the architecture. The information contained in these key interfaces is defined by dataflows. Subsystems are further subdivided into technology. packages. which represent the lowest level of functionality in the architecture.

Subsystems

Subsystems identified in the National ITS Architecture that have been identified for short-term deployment in the I-71 ITS architecture include the following. This list includes those Subsystems that are recommended to be deployed in the short-term as well as those subsystems that should be incorporated in the long-term build-out of the system:

- **Traveler Subsystems:**
  - Personal Information Access
  - Remote Traveler Support

- **Center Subsystems:**
  - ITS Planning and Nehvork Performance Monitoring
  - Traffic Management
  - Information Service Provider
  - Emergency Management
  - Fleet Management
  - Transit Management

- **Roadside Subsystems:**
  - Roadway
  - Parking Management

- **Vehicle Subsystems:**
  - Personal (or Basic) Vehicle
  - Commercial Vehicle
  - Emergency Vehicle
  - Transit Vehicle

Market Packages

To provide a direct link between the "user side" of ITS — Critical Program Areas and User Services — and the ITS architecture, the concept of ***market packages*** has been developed. Market packages that are identified in the National Architecture and also suggested as applicable to the I-71 rural corridor are as follows. These market packages are listed in a very general order in which they would be implemented, recognizing that many will be deployed concurrently. This list contains market packages that may be deployed in the short-run as well as those that may be deployed further in the future:

<u>Short-Term Market Packages</u>

- Traveler Security
- Traffic Information Dissemination
- Incident Management
- Emergency Response
- Broadcast Traveler Information
- Interactive Traveler Information

- Freight Management
- Driver Safety Management
- CVO Fleet Administration
- Electronic Clearance
- Weigh-in-Motion
- In-Vehicle Signing
- ITS Planning/Performance Evaluation

Market Packages Added in the Mid-Term:

- MayDay Support
- Yellow Pages/Reservations
- Nehvork Surveillance
- Parking Management
- Freeway Operations

Market Packages Added in the Long-Term:

- ISP-based Route Guidance
- Dynamic Route Guidance
- Autonomous Route Guidance
- Automated Highway System
- Driver Safety Monitoring
- Traffic information Management
- HAZMAT Management
- Multimodal Coordination
- Integrated Transportation Management
- Transit Fixed-Route Operations (High Speed Rail)

Short-Term Architecture - Transportation Elements

The Short-Term I-71 Corridor ITS Architecture provides the functionality to satisfy the needs identified for the short term (with the exceptions as noted below). The table on the following page summarizes the short-term user needs (from Chapter 5) and maps these needs to Critical Program Areas (CPAs) and Market Packages.

Each *Market Package* consists of several *subsystems, technology packages* within the subsystems. and *data flows* which define information that goes from one subsystem to another. Subsystems are divided into four categories: Centers. Roadside. Vehicles. and Traveler subsystems.

Table 7.0-l
Short-Term User Needs Mapped to Critical Program Areas and Market Packages

Critical Program Areas	Needs	Market Packages
Traveler Safety and Security	2.2 More emergency roadside assistance 2.3 Improve safety for construction workers 2.5 Inform motorists where cellular coverage is available 2.10 More enforcement	Traveler Security Broadcast Traveler Information Emergency Response
Tourism and Travel Information	1.1 Make traveling public more aware of construction and take alternate routes 1.10 Travel information via rental cars in Cleveland and Columbus 1.11 Enhancement/expansion of I-800-BUCKEYE 1.19 Inform public on how to access information 1.20 Provide information on Ohio tourist sites to I-71 travelers	Broadcast Traveler Information Interactive Traveler Information Traffic Information Dissemination In-vehicle Information
Emergency Services	3.1 Means to detect emergencies in remote areas 3.5 Improve bandwidth/increase number of channels on communications infrastructure	Incident Management Emergency Response
Infrastructure Operations and Management	4.17 Improve work zone safety 4.18 Region-wide communications infrastructure	Traffic Information Dissemination ITS Planning Performance Evaluation
Commercial Vehicle Operations	6.1 Weigh-in-Motion and electronic clearance needed immediately (Advantage CVO) 6.2 Add transponders on trucks	Fleet Administration Electronic Clearance Weigh-in-Motion Freight Management

Example of Market Package Interconnect Diagrams

The following example of one of the major ATIS components - the Broadcast Traveler Information Market Package — is shown here as an example of the manner in which the pieces of the architecture are constructed. In the three tables that map the CPAs to the needs and the corresponding Market Packages, approximately 30 of the INA (ITS National Architecture) Market Packages are suggested as relevant to the I-71 Corridor.

The Broadcast Traveler Information Market Package provides the user with a basic set of Advanced Traveler Information System (ATIS) services. It involves the collection of traffic conditions. advisories, general public transportation and parking information, and the near real time dissemination of this information over a wide area through existing infrastructures and low-cost user equipment (e.g.. FM subcarrier. cellular data broadcast). Different from the market package Traffic Information Dissemination. which provides the more basic HAR and VMS information capabilities. this package provides the more sophisticated digital broadcast service.

There are two basic types of information provided: (1) static traveler information such as locations, schedules and fees for attractions, events, etc., and (2) real- (or near real) time data on the transportation system. Successful deployment of the second type of data on the transportation system. Successful deployment of the second type of data relies on availability of real-time transportation data from the Traffic Management Subsystem (TMS) or Transit Management Subsystem (TRMS). **Figure 7.01** illustrates Broadcast Traveler Information market package.

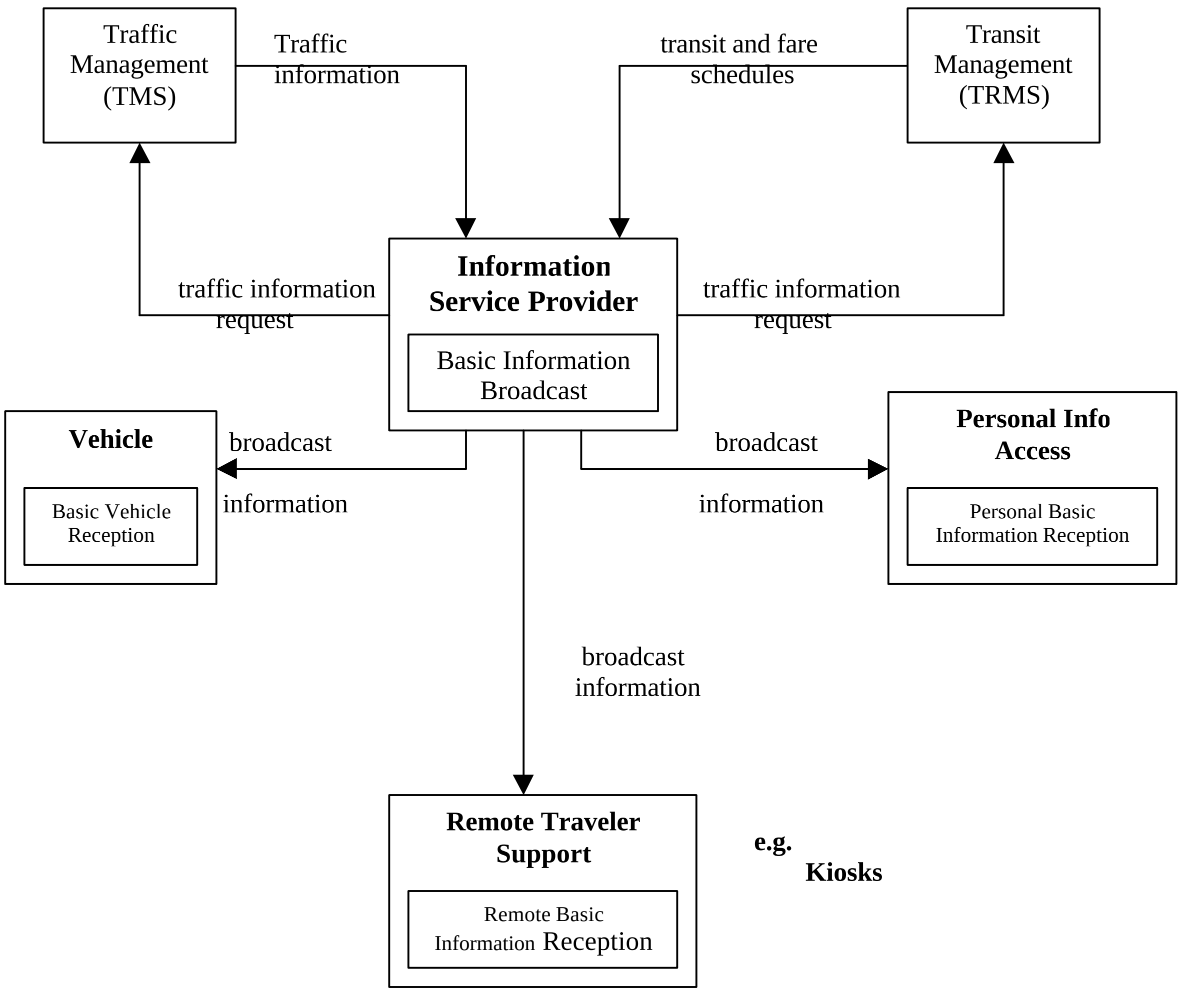


Figure 7.0-1
Broadcast Traveler Information Market Package

Mid-Term Architecture

The Mid-Term I-71 Corridor ITS Architecture provides the functionality to satisfy the user needs defined for the mid term. **Table 7..0-2** lists the Critical Program Areas (CPAs), mid-term user needs (from Chapter 5) and market packages required for mid-term deployment. The CPAs are listed in priority order.

Table 7.0-2 Mid-Term Needs Mapped to Critical Program Areas and Market Packages (in priority order)

Critical Program Areas	Needs	Market Packages
Traveler Safety and Security	2.4 Safety/human factors- public awareness of in-vehicle devices 2.6 Improve safety at rest areas 2.7 Driver education, including advanced technologies	In-vehicle signing Broadcast Traveler Information ITS Planning MayDay Support
Tourism and Travel Information	1.4 Announcements to commuters who work outside resident counties 1.7 Kiosks 1.8 Pre-trip congestion information 1.9 Electronic yellow pages at stops 1.12 Easily accessible visitor information 1.13 Real-time weather information exchange 1.14 Variable message signs 1.15 Centralize and inform public as to where to find roadway condition info. 1.18 Twenty-four hour traveler information availability	Interactive Traveler Information Yellow Pages and Reservations Broadcast Traveler Information Traffic Information Dissemination
Emergency Services	3.2 Improve incident/emergency management 3.4 Improve inter- and intra-agency communications systems	Emergency Response MayDay Support Incident Management
Infrastructure Operations and Management	4.2 Improve wireless communications infrastructure 4.3 Provide alternative to cellular 4.12 Reduce congestion at 1-76 interchange 4.15 Congestion relief in local communities from 1-71 traffic 4.16 Truckers exiting l-71 and traveling in local communities	Network Surveillance Traffic Information Dissemination Incident Management Freeway Operations
Commercial Vehicle Operations	6.4 Increase parking capacity and safety at truck stops and rest stops 6.5 Relief of overcrowded weigh stations	Network Surveillance Parking Management Traveler Security

Long-Term Architecture

The Long-Term I-71 Corridor ITS Architecture provides the functionality to satisfy the needs identified for the long term. **Table 7.0-3** lists the Critical Program Areas (CPAs), long-term user needs (from Chapter 5), and market packages required for long-term deployment.

Table 7.03
Long-Term User Needs Mapped to Critical Program Areas and Market Packages

Critical Program Areas	Needs	Market Packages
Traveler Safety and Security	2.9 Reduce or eliminate speed differential 2.12 Monitor and detect driver fatigue and vehicle condition 2.13 Advance notice - vehicle crossings	Driver Safety Monitoring Intersection Safety Warning/Collision Avoidance Automated Highway System
'ravel Information	1.3 Electronic maps in cars 1.8 Pre-trip congestion information 1.9 Electronic yellow pages a stops and en-route 1.16 Early warning of reduced visibility 1.17 Real-time radio traffic reports	Autonomous Route Guidance Yellow Pages & Reservations Driver Visibility Enhancement Traffic Information Management
Emergency Services	3.3 HAZMAT notification & emergency management infrastructure	HAZMAT Management
Infrastructure Operations and Management	4.1 Improve safety from MP 161 to 181 4.4 Improve interchange operations	Driver Visibility Enhancement Intersection Collision Avoidance Freeway Operations
Commercial Vehicle Operations	5.3 Real-time traffic information 6.5 Relief of overcrowded weigh stations	Traffic Information Management Parking Management Traffic Information Dissemination
Public Traveler/ Mobility Services	5.1 Increased traveler awareness of available rail/air in major cities 5.2 Real-time info to make travelers aware of other travel options 5.3 Better access to central cities 5.4 Integrate traffic info for connecting arterials & freeways with I-71 5.5 Advise travelers about alt. routes 5.6 Improve access to recreational opportunities 5.7 Better access to Snow Trails area 5.8 Develop high-speed rail	Multimodal Coordination Integrated Transportation Management Transit Fixed-route Operations Dynamic Route Guidance

Communications Elements

There are four basic communication media types to support the communications requirements between the subsystems defined for ITS. They are *wireline* (fixed-to-fixed), *wide-area wireless* (fixed-to-mobile), *dedicated short-range communications* (fixed-to-mobile), and *vehicle-to-vehicle* (mobile-to-mobile). For the I-71 Corridor Long-Term Architecture, the top-level interconnect diagram is shown in **Figure 7.0-2.** The center subsystems and roadside subsystems interconnect using wireline communications. The vehicle Subsystems receive information via wireless (primarily broadcast wireless in the short-term architecture). The traveler subsystems initially will connect to the centers via wireline communications. but the possibility exists for some of the devices represented by the personal information access subsystem to connect via two-way wireless. This long-term interconnect diagram builds on the communications links necessary for deployment of the more basic ITS functions in the short to mid-term system.

The long-term interconnect diagram is shown here; the only difference between this build-out of the system and the short-term components is that the short-term contains fewer subsystems,

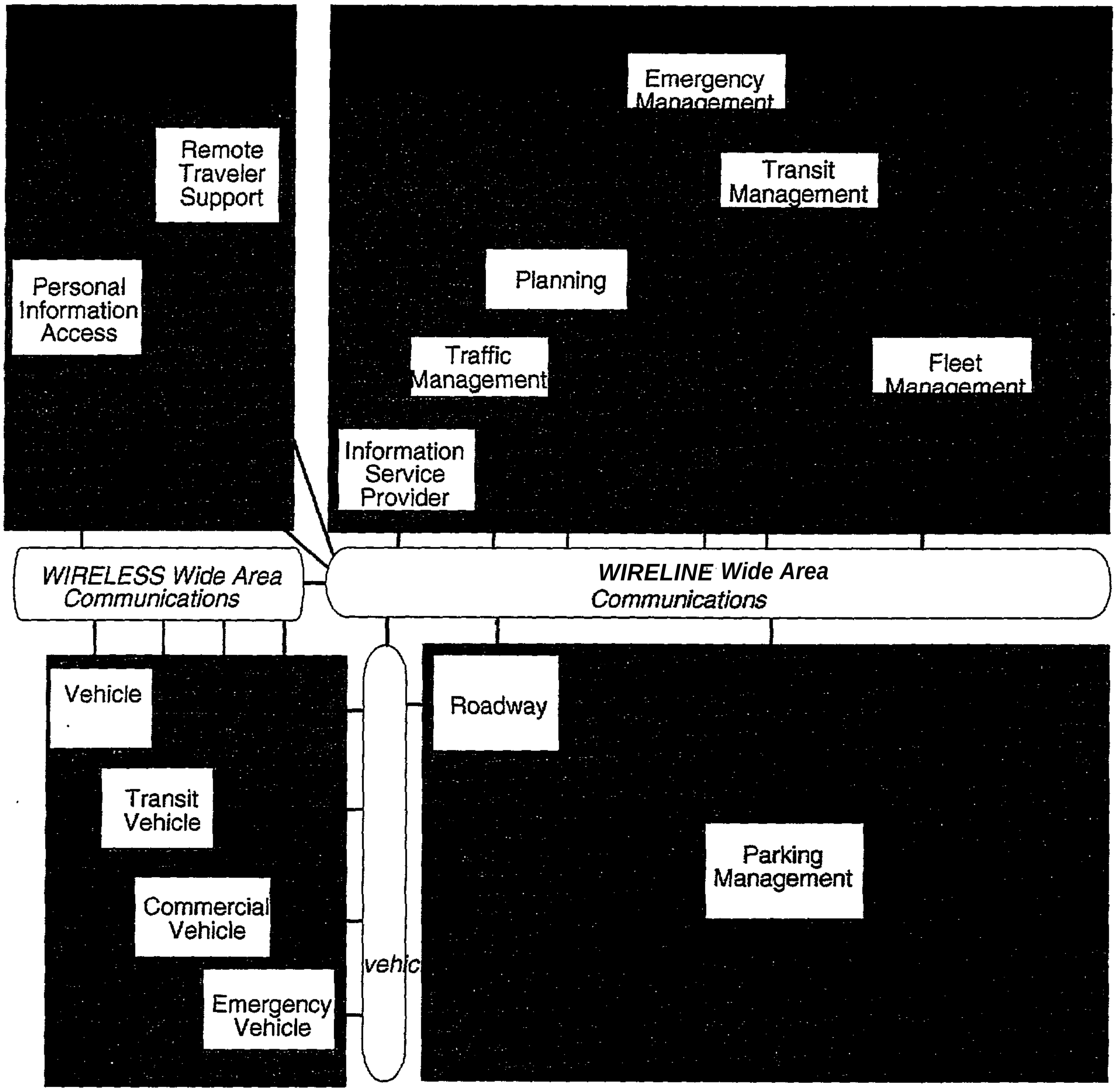


Figure 7.0-Z
Long-Term I-71 Architecture Interconnect Diagram

CHAPTER 8.0

8.0 SYSTEM COMPONENT OPTIONS

This chapter describes the methodology and activities of Task H of the *1-71 Corridor ITS Strategic Deployment Plan* between Cleveland and Columbus. The objective of Task H has been to provide a physical architecture with recommended technologies based on optimization of system availability, supportability, expandability, compatibility with existing infrastructure standards, affordability, and phased implementation potential.

Methodology and Key Task H Activities

The focus of Task F was to choose the FHWA functional areas and requirements that best support the local User Services and were considered essential to meeting the short-, medium-, and long-term needs of transportation stakeholders in the I-71 Corridor. A system architecture was defined in Task G. Key task activities have included the following:

- Compile candidate technology matrix for all functional requirements.
- Analyze existing infrastructure, define usability and interface requirements.
- Define privatized infrastructure and interfaces.
- Establish the evaluation criteria based on Tasks D and E inputs and experience with ITS needs.
- Analyze the trade off of technology against requirements using established evaluation factors.
- Select highest ranking candidates and physically configure the system.
- Show phasing of architecture deployment
- Prepare cost for hours.
- Prepare Chapter 8 (this chapter).

The purpose of the assessment has been to identify, describe, and compare the principal relevant technologies currently available which will be needed to support the I-71Corridor ITS Architecture defined in Task G. A brief comparative analysis of the most prominent of these technologies is provided to assist in determining the appropriate selection of specific technologies for each function. Technologies are included that will meet the long-term ITS deployment needs of the Corridor. However, the focus of this assessment is on those technologies that are candidates for implementing an Advanced Traveler and Tourist Information System (ATIS), a corridor-wide Incident Management System, and enhanced Commercial Vehicle Operations (CVO).

Technology Candidate Analysis

This section provides an overview and analysis of technology candidates in the following areas:

1. Communications
2. Traffic Surveillance
3. Advanced Traveler and Tourist Information Systems (ATIS)
4. Traffic Signal Control
5. Navigation, Route Guidance, and Mayday
6. Incident and Environmental Condition Detection
7. Vehicle Safety.

Communications

The communication system requires a physical path through which the various devices communicate with one another. The major portion of the communication system for the I-71 ITS System will be the communication path from the control center to the field. This path may be composed of one or more of a variety of transmission media. The transmission media generally recommended in such systems include fiber optic cable, radio, or microwave transmission. There are a variety of communications requirements for the architecture including:

- Infrastructure-to-Infrastructure
  - Network backbone supporting communications with field devices and between operations centers
  - Interconnect links to the backbone

- Infrastructure-to-Vehicle
  - One-way to the vehicle
  - Two-way to/from the vehicle

Within each of the communications categories reviewed. recommendations are made for technology implementation within the system architecture.

Key Factors in Evaluating Communications Technology

Important factors to be considered in selecting a technology for the system architecture include:

- Nationally recognized, approved standards compliant with International Standards Organization's seven-layer architecture (not considered open architecture if technology does not meet this criteria).

- Supported by commercial industry (if the standard is not supported by competitive technology, it presents risks in technology cost and future supportability).

- Availability of the technology with fault tolerance and a standard network management protocol (if not available. presents reliability and maintainability risk).

- Ability to modularly expand as bandwidth requirements and interface requirements expand (if not expandable. the technology presents cost and obsolescence risks).

- Compatibility with multimedia which requires synchronous or isochronous capability (if not compatible. special overlay links are required for voice and video, and the system will be subject to obsolescence as technology rapidly transitions into complete multimedia).

- Field equipment should be compatible with outdoor environment (if not compatible, problems will include: cost to place in an environment-controlled enclosure, reliability dependent on air conditioner reliability. reliability of semiconductor greatly impeded by temperature overstressing).

Communications Backbone Technology

The recommended architecture for rhe I-71 Corridor ITS System is a Synchronous Optical Network (SONET) architecture which conforms to Bellcore GR-253-CORE *SONET Transport Systems: Common Generic Criteria,* American National Standards Institute (ANSI) T1.105-1991, *American National Standards for Telecommunications. Digital Hierarchy: Supplement for Optical interface Protocol and Format Specifications,* and ANSI T1.102-1989, *American National Standards for Telecommunications, Digital Hierarchy: Electrical Interfaces.*

An add/drop capability in accordance with Bellcore TR-NWT-000496 should be included for each communications hub supporting ITS functions. Fault tolerance through use of line-switched or path-switched technology should be used. Physical optical ring diversity is recommended for the highest reliability. Inter-networking ring technology may also be used to support reliability and modular network expansion.

Particularly important for rural corridors, SONET allows a variety of build-out options including use of SONET digital microwave links and use of ISDN, DS-1, and DS-3 circuits. Without a detailed design, it is difficult to determine the exact amount of bandwidth required for the network. An OC- 12 SONET network would accommodate the basic communications requirements facilitating center-to-center backup and peer-to-peer sharing of compressed digital video: however, OC- 12 would not facilitate significant bandwidth for expan sion. An OC-24 network would accommodate spare bandwidth for growth.

SONET and ATM are the technologies receiving the highest evaluation. Since SONET is inherently compatible with ATM, a combination of the technology is recommended. Where wireless voice or data communication is permitted (such as for law enforcement or emergency services), this service would be provided. as determined to be permissible and useful during the detailed design. Policy may dictate that only dispatchers use wireless frequencies associated with law enforcement and emergency service vehicles. It is recommended that a coordination link be established (to the extent allowable) to provide on-scene feedback for incident clearance prediction. This recommendation should be coordinated with Incident Management plans in the corridor.

Traffic Surveillance

Of all the technologies reviewed in this project, traffic surveillance technologies have the longest history of application in advanced transportation. being introduced as early as the 1950's. Surveillance technologies include:

Inductive Loop Detectors: Detect passage. presence. occupancy. and queue length. Inductive loop technology is based on the interaction between the magnetic field produced by the conducting loop and the effects on this magnetic field when the vehicle passes over it.

Video Imaging Systems: Use a real-time video camera and a microcomputer with applications software to detect vehicles. With the proper software. video image detectors can determine passage, presence, occupancy. speed. volume. and queue length.

Closed Circuit Television: Supports functions such as current congestion assessment; potential congestion assessment; surveillance of visitor centers, shopping areas, rest stops, truck stops, universities, community colleges, convention center parking, parks, parking lots, etc.; incident detection and/or confirmation, evaluation, and site management; hazard detection and determination; verification of messages on variable message signs; queue build-up behind incidents with assessment of congestion clearance time; and security of deployed equipment.

Microwave and Radar Sensors: Have been developed and are deployed in ITS systems. Reliability problems exist with radio frequency (RF) sensors related to RF interference, multipath, and impact of weather conditions on RF signals.

Laser Sensors: Operated as radar (or laser integrated radar - LIDAR) comprise a reasonably new technology. Having a much more narrow beam, LIDAR is less susceptible to interference; however, multipath can be a problem, as well as signal transmission deterioration during heavy rain.

Infrared (JR) **Sensors:** An emerging option; however. reliability of these sensors has not proven to exceed that of loops. IR sensors do not have to be embedded in the pavement.

Acoustical Sensors: Has excellent performance compared with loop sensors. ITS tests have proven that they operate on highways and within traffic grids. Experimental tests indicate that the sensor has the potential to: classify a vehicle. determine velocity, provide a vehicle weight estimate. and provide an indication of unsafe tires.

Advanced Traveler and Tourist Information System (ATIS)

ATIS services are categorized by the location of the traveler that they serve:

- Travelers in private vehicles
- Travelers at home, hotel, or office (pre-trip)
- Travelers on public transportation vehicle
- Commercial driver in vehicle
- Commercial/transit operations out of vehicle

Evaluation ranking of in-vehicle ATIS devices is as follows. listed from most effective to least effective.

- En-route guidance and passenger information system. supported by radio digital data service

- Variable Message Signs. supported by direct interconnect with the ATIS center and TOCs

- Broadcast radio, supported by ATIS communications links to public media for traffic status

- Cellular telephone and the emerging DCS technology, supported by the cellular telephone traveler information service interfaced with the system's ATIS service link

- Toll tags with alarms and displays (Type 3), supported by direct links to ITS

- Public cellular digital, supported by digital links to cellular interfaced with the ITS ATIS center for support

- Paging service traveler information supported by available service link from ATIS

Technology recommended at this time for the I-71 Corridor includes all but paging, toll tags, and a public cellular system. The recommended technologies will aid in congestion relief for special events such as those that will be held at various places along the corridor and in Cleveland or Columbus. Paging is not recommended due to the limited information available to the traveler. The public cellular system is already being used on an informal basis. At times, cellular phones are over-used by travelers in reporting accidents on high-volume roads. Cases are documented where too many calls have overloaded the cellular network. For this reason a publicly-funded cellular service is not recommended. **Table 8.0-l** summarizes ATIS technology, in two categories:

Privatized services
- broadcast radio
- RDDS
- kiosks
- vehicle dispatching centers (CVO and perhaps transit such as charter buses)

Public services
- VMS
- AHAR/TAR

Table 8.0-1
ATIS Technology Summary

Technology Recommended	Device	Device Finance	Communications Link	Communication Link Operations Finance
Broadcast Radio Terminal	Standard radio	User	Broadcast radio station and HAR	Radio station and jurisdictions for HAR
Broadcast Radio FM Subband Digital	FM radio with subband modification (Delco)	User	Broadcast radio station	Radio station and ITS Project
Broadcast TV	Standard TV set: home/office and portable	User	Broadcast TV Station	TV station
Cable TV (CATV)	TV with CATV adapter	User	CATV	CATV station or public channel, if available
Interactive CATV	TV with interactive CATV adapter	User	CATV	CATV station and/or hotel
Variable Message and Pathfinder Electronic Signs	Electronic signs	Jurisdictions	ITS system link	ITS project
Kiosk Terminals	Kiosk terminals	Private and Jurisdiction	Private links to terminal, private terminals, & public link to public-supported terminals	Private funding for private links, public funding for public link
RF Tag Link (ETTM)	Toll tag in-vehicle/ Type III. with display	User	RF tag link	ITS project (experimental limited basis)
CVO Dispatching System	Integrated real-time traffic conditions	User	Data link from ITS system	Users: CVO and transit
Dial-Up Digital Service: PDA and Computer Support	PDA with modem and computer with modem	User	Regular telephone/dial-up direct or via cellular telephone	Users pay via software charge; privatized ATIS with yellow page advertisers providing funding
Dial-Up Voice Service	Autovoice via standard telephone or cellular telephone	User	Regular telephone or cellular	Cellular telephone private service or privatized ATIS service funded by yellow page advertisers

Radio digital data service should be implemented by partnering with FM stations with the widest broadcast coverage. The RDDS link information should be planned to be created by the ITS system and supplied to the radio station. Radio stations broadcast public service information regularly. This is perhaps the most important ATIS service that is emerging nationwide,

A partnership with an area major cellular service company and security monitoring service is recommended to support automated emergency notification systems. MayDay™ is a highly visible ITS service to users. particularly in rural areas. Deployment encourages tax payers' support for ITS projects.

Navigation, Route Guidance, and MayDay

Navigation Technology

Navigation technologies include: Global Positioning Systems (GPS), Differential GPS, dead reckoning/GPS update, dead reckoning/sign-post update. inertial, time difference of arrival, direction finding (DF)/cross correlation, map matching, and cellular telephone. GPS and DF using dead reckoning are considered to be superior technologies for navigational purposes. Differential GPS is preferred over standard GPS since it is far superior in accuracy.

Route **Guidance**

Route Guidance technology is basically associated with vehicles. The functions of the route guidance system are:

- Receive navigation subsystem input.
- Locate vehicles on the GIS database of the road infrastructure.
- Determine progress along the planned route.
- Display alerts to the driver of upcoming intersections with cues to proceed ahead or turn.
- Display alerts to the driver about an upcoming hazard.

Automated Emergency Notification System

This service is an ITS function that provides positive messaging of an accident or need for assistance from the vehicle to a center which is responsible for responding to the emergency. Emergency roadside telephones are a form of "mayday" calls that require a driver to walk (up to 1/3 mile) to the telephone and report the emergency. Of course in the case of a serious accident, the driver (or his passenger) could not walk to an emergency telephone. Wired and cellular emergency telephones are typically deployed along highways and are now emerging in tourist areas and on college campuses. MayDay™ is a registered trademark for one provider of such a service. 1996 Lincoln Continentals and 1997 Cadillac automobiles include the service, and it will be provided with increasing frequency on autos in the future. These will be initially offered as options but with time will be standard equipment on some models.

Another form of automated emergency notification service (AENS) uses cellular telephones to report an accident and request emergency service. Many cellular telephone companies are providing speed-dial emergency reporting and dispatch service coordination for their customers. Again, use of this function requires the driver (or a passenger) to be able to make the call for help.

The concept which is arising in ITS is for real-time reporting of an accident to emergency services centers and/or to a traffic operations center. The concept is to integrate safety sensor and associated alarm signals with automated reporting system much like a home security system with remote monitoring.

The recommendation for the 1-71 Corridor is to include real-time automated emergency notification monitoring as a privatized service. This service may be offered by an established security service, or in the future by a regional ATIS center. A communications link should be provided with a SONET network for coordinating emergency services and managing incident clearance.

Incident/Environmental Condition Detection

Many of the basic traffic surveillance sensors also support incident/environmental condition detection. These include:

- CCTV
- Driver surveillance
- ODOT reports on construction/maintenance

In addition, there are a number of other sensors which may be deployed to support hazardous conditions detection and reporting:

- Wind velocity/direction, temperature, precipitation, and barometric pressure
- IR and imbedded moisture/temperature sensors
- Water level sensors
- Radar
- Visibility sensors
- Hazardous agent detectors

Other sensors are used in support of environmental protection including ozone level sensors and pollution sensors. Generalty, pollution sensors are deployed by the Environmental Protection Agency and support smog/ozone alerts and execution of discount fares on public transportation. Another technology that senses hazardous materials is receiving interest in the ITS community. Since only Class I hazardous material must be reported fortransit through an area, Class III and Class II are not reported. This means jurisdictions are not aware that certain hazardous chemicals and biological agents may be present.

Using the commercial vehicle RF tag reader strategically deployed on main commercial corridors. the presence of a vehicle with any hazardous material (Class I to III) may be detected upon entering and exiting the jurisdiction. This provides a “potential hazards warning” to the jurisdiction. If the vehicle is involved in an accident. the jurisdiction is then better prepared to quickly and effectively deal with the clean-up. As in-vehicle safety sensors emerge and MayDay reporting capability is facilitated by vehicular technology. a near instantaneous knowledge of an accident with injury. fire. or potential fire (gas leak) will be available to the jurisdiction. This, too is a form of incident/environmental condition detection.

Warnings to the driver are accomplished in a number of ways:

- Portable signs, including Variable Message Signs
- Fixed and flip disc signs
- Highway advisory radio (HAR) -- AM
- Traveler advisory radio (TAR) -- FM
- Variable message signs
- In-vehicle route guidance systems
- Special low-powered hazards beacon

There are various types of hazard reporting and analysis technology The main hazards to consider are:

- Road debris
- Road construction and repair
- Vehicle accidents (normal)
- Vehicle accidents with fire and fuel spills
- Hazardous material accidents
- Visibility sensor (fog)

Many of the basic traffic surveillance sensors also support incident/environmental condition detection. These include the tested sensors in **Table 8.0-2.**

Table 8.0-2
Common Sensors Used for Incident Detection and Environmental Conditions

Sensor	Hazardous Conditions Sensor	Comment
CCTV	Weather, debris in roadway, flooding, chemical spill, accident, etc.	Significantly valuable, all around sensor
Incident Detection	Point on corridor with abnormal traffic problem	
Individual Drivers (driver surveillance)	Any hazardous condition seen by a driver and reported via cellular telephone. mobile radio. CB. or police network	Needs a simple, quick call, no cost communications channel to be effective
ODOT reports on construction and maintenance	Obstruction of lanes	Common practice

Vehicle Safety

Vehicle safety sensors are beyond the scope of this project. However, some of the technologies that are evolving in the automotive industry involve the following.

In-vehicle MayDay Systems:

- Impact sensors (associated with air bag release)
- Under-hood fire detection sensor
- Under-hood trunk-area gas leak sensor

Other Personal Vehicle Safety Systems:

- Collision warning
- Over speed limit
  - — Speed limit for corridor transferred via infrastructure-to-vehicle data link.
  - — Vehicle information system advises driver of speed violation.
- Night vision enhancement

CVO Safety Systems:

- "Air break pressure loss" warning
- "Steep hill ahead" warning
  - — Through hazards warning link from infrastructure-to-vehicle route guidance and driver information system.

CHAPTER 9.0

9.0 IMPLEMENTATION AND OPERATIONAL STRATEGIES

The objectives of Task I have been to define operations and maintenance issues; identify funding options, including public/private partnership opportunities; assess the benefits and costs of the recommended architecture; and develop a phased implementation plan.

Methodology and Key Task I Activities

The approach used in determining operations and maintenance issues has been to obtain information from potential equipment manufacturers and operating agencies on the staffing, equipment, and budgets needed to operate the type of ITS system conceptualized for the I-71 Corridor. This information was supplemented with input from the ODOT.

The benefits and associated cost savings have been estimated using before-and-after evaluations that have been performed for similar installations.

The project phasing has been determined based on logical phasing steps and geographical gaps in the systems where the needs are greatest.

Funding options were determined through discussions with the local FHWA office in Columbus, the Regional FHWA office, through Committees and various contacts at ITS-America, and with ODOT personnel.

Key activities carried out during Task I include:

- Identify the basic requirements of a Corridor Traffic Management Center.
- Estimate life cycle costs and benefits in terms of cost savings.
- Establish project phasing, management, and business plans.
- Identify procurement resources and funding options.
- Identify opportunities for public-public and public-private partnerships.
- Identify any legal issues related to selected ITS strategies.
- Prepare Chapter 9, "Implementation and Operational Strategies."
- Exchange data among the Columbus and Cleveland Regional Traffic Management Systems, State Highway Patrol Communications Center, Statewide Emergency Management Center, and local Emergency Management System.

Management and Operation Summary

The strategic plan recommended in Chapter 10 for the I-71 Corridor is based on a common architecture, but leaves individual stakeholders free to pursue an integrated set of smaller, incremental projects, to achieve the required ITS services and recommended system architecture. Individual stakeholders that will lead deployment efforts include ODOT, local governments, travel and tourist industry, trucking companies. State Highway Patrol, travel information providers, and others.

It is imperative that this loose coalition of stakeholders be kept together and expanded through a permanent I-71 ITS Advisory Committee. It vsould also be helpful for this group to become involved with the ITS-Ohio chapter, in order to stay abreast of new technologies as they are developed and deployed in rural corridors in other states.

The recommendations contained in this section are for the ultimate build-out of ITS components in the I-71 Corridor. They should not be construed to imply that all of these components apply to projects that are recommended for short-term deployment based on short-term needs. This management and operations plan includes the following recommendations:

- Adoption of the common architecture outlined in Chapter 7 supporting incremental build-out of ITS capabilities and services.

- Field infrastructure upgrades to support needed sensor information to determine weather information on the Corridor, plus rapid detection and response to incidents.

- I-71 ITS System integrated with the TOCs in Columbus and Cleveland, to control response to incidents on the freeway and other state highways, assist local jurisdictions in emergency response, and be a sub-regional clearinghouse for traveler information.

- Implementation of a communications infrastructure, including upgrades to the current communications backbone to support (1) interoperability between Columbus and Cleveland TOCs and (2) improvements in traveler information support to the traveler and tourist information system, commercial vehicle management, public transportation, and other components. Development of a detailed communications plan for the I-71 Corridor based on the Statewide Communications protocol is recommended.

Business Plan for Deployment

The objective of preparing a business plan and management structure is to establish a framework for policy, process and action between the public and private jurisdictions involved. By establishing a management structure, the interest and involvement of the Advisory Committee in I-71 Corridor will continue. This interest must continue for deployment to become a reality.

Plan Oversight: I-71 ITS Advisory Committee

During the development of the strategic plan, the Advisory Committee met regularly to receive updates on the status of the plan development, offer their input, and review the deliverables from the study. The interaction of this group has brought about a strengthening of the coalition of public and private agencies active in the l-71 Corridor. The Advisory Committee consists of the following agencies representing the stakeholders in an advanced transportation system for l-71

- ODOT Central Office: Traffic Engineering. Policy, Communications, Technical Services
- ODOT Districts 3, 6, and 12
- Federal Highway Administration (FHWA)
- Ohio Department of Development
- Ohio Department of Agriculture
- Ohio State Highway Patrol
- Mid-Ohio Regional Planning Council (MORPC)
- Northeast Ohio Areawide Coordinating Agency (NOACA)
- Eastern Ohio Development and Transportation Agency (EDATA)
- Richland County Planning and Engineering Departments
- Morrow County Planning Department
- Medina and Morrow County Commissioners
- Medina, Mansfield-Richland, and Brunswick Area Chambers of Commerce
- Cities of Ashland, Mansfield, Mt. Vernon, and Brunswick
- LifeFlight, MetroHealth Medical Center
- Kokosing Construction Company
- Scenic Ohio
- The Gorman-Rupp Company
- University of Akron Civil Engineering Department

From this Advisory Committee it is recommended that ODOT appoint an Executive Committee to function as the oversight and policy guidance body of the deployment plan. A chairperson who is enthusiastic and interested in developing an integrated, multimodal approach to the I-71 Corridor's ITS solutions should be appointed, preferably come from the private sector.

The Advisory Committee's future function is to continue supporting and assuring that the jointly developed strategic ITS plan for I-71 is meeting the needs of the economy of Ohio as well as travelers through, and visitors to, the region. The Advisory Committee must continue for ITS to succeed in the I-71 Corridor in Ohio.

Another future function of the Advisory Committee will be to review new technologies and new concepts, as they become available, and to determine if modifications are necessary in the Strategic Plan. The Advisory Committee should work directly with ODOT and other state and federal agencies in order to respond to questions and/or issues that may arise dealing with the direction, funding, administration, deployment. and operations and maintenance of ITS projects as they come on-line.

It is recommended that an Executive Committee of the Advisory Committee be established to keep the organization going, consider the option of filing for non-profit status, and serve as the policy/guidance body for I-71 ITS deployment.

I-71 ITS Management Team

The management structure is a significant element of any corridor-wide plan. A management team, made up of dynamic individuals from the Advisory Committee, needs to be created to serve as the foundation for project implementation. As the Strategic Plan is developed into specific tactical plans, funding is secured, and implementation proceeds, a flexible approach should be maintained by the management team.

Opportunities may become evident at any time for earlier implementation of projects than suggested in this document. These windows of opportunity may present themselves in the form of alternative funding sources. local improvements. private initiatives, or higher priorities being assigned by state, federal, or local governments, or by the private sector. As these "earlier-than-early deployment" opportunities arise, the management team's task will be to review the Strategic Plan. in close cooperation with the remainder of the Advisory Committee, and to set new strategies and priorities.

Management Structure for Operations and Maintenance

It would be easy to identify the management structure for operating and maintaining any intelligent infrastructure deployed in the I-71 Corridor as a responsibility of the three ODOT district offices in the region. These units will of course be involved, and for a major part of the infrastructure recommended, it will in fact be left up to the District Engineers. Within each of these districts, an individual with some background in communications systems, or at a minimum traffic systems, needs to be identified under each of the District Traffic Operation Engineers. This individual should be at a fairly high level in the organization, and should have at least five years experience with ODOT or similar type experience in another state or local transportation department.

The identification of an individual, the preparation of a job description, and the recruiting or promotion within the organization to fill this demanding job is not the only action that needs to be taken. First, there are a number of market packages (and thus, projects) that will be the responsibility of some government agency or private sector company. A review of the input of the Advisory Committee in working with the consulting team to identify appropriate responsibilities and involvement by various organizations is shown in **Table 9.0-l.**

Table 9.0-l
Advisory Committee Organizations with Responsibility for ITS Deployment

Market Packages for Deployment	Responsible Organizations and Potential Partners
Travel Information Dissemination	ODOT/FHWA* information Service Providers (i.e. Internet. radio, TV, cable) Local governments State Highway Patrol (SHP)
Incident Management	SHP* Emergency Medical Services (EMS) ODOT/FHWA Corridor attractions Local governments Tow truck industry
Interactive Travel Information	Local governments (municipal, county)* Tourist industry (AAA. etc.)* Traffic information providers* Ohio Office of Tourism ADOT/FHWA National Weather Service (NWS) SHP Transit services Trucking companies Corridor attractions
Broadcast Traveler Information	ODOT/ FHWA *Federal Communications Commission Local governments (FCC) NWS Transit services SHP Tourist industry All broadcast media Traffic information providers Corridor attractions ITS equipment vendors
Traveler Security	SHP* Private security companies ODOT/FHWA Local governments All media
HAZMAT Management	SHP* Trucking companies ODOT/FHWA Railroads HAZMAT teams
Emergency Response	SHP* all media Local governments ITS equipment vendors ODOT/FHWA towing industry cellular industry
MayDay Support	SHP* cellular industry ODOT/FHWA ITS equipment vendors all media FCC
ITS Planning	ODOT/FHWA* local SHP
Traffic Network Performance Monitoring and Evaluation	ODOT* SHP local governments Ohio State University
Traffic Surveillance	ODOT/FHWA* Transit services (bus, tour bus, shuttle) SHP Trucking companies local governments Traffic information providers
Fleet Administration	ODOT* Tour bus companies Trucking companies Traffic information providers
In-Vehicle Signing	ODOT/FHWA* ITS equipment vendors Vehicle manufacturers* Traffic information providers
Intermodal Traveler Fare Management	Local governments Transit services*
Multimodal Coordination	ODOT Division of Multi-Modal Planning and Programs* Local governments Transit services Railroads Tour bus companies

* lead agency

Summary of Implementation and Operations Plan

Table 9.0-2 presents the proposed management structure for project implementation. It shows project areas and the jurisdictions that would be responsible for deploying projects in those areas.

Potential Barriers to Successful Deployment

Table 9.0-3 summarizes the potential barriers that might interfere with a successful deployment plan and continuing operation and maintenance of the l-71 ITS Corridor. In addition to these specific potential barriers (which may not materialize, but are possible). there are a number of over-arching barriers that could be a factor in any ITS deployment. These over-arching barriers include:

- lack of national, regional and statewide public involvement, education and training in ITS
- possibility of negative press
- attempting to accomplish too much too soon (better to take an incremental approach)
- inability to sell the overall program and attract private capital needed to make it work
- lack of sufficient perseverance and/or continuity of leadership of the I-71 ITS Corridor Advisory Committee

To forestall and/or overcome, if necessary, these potential barriers. it will be imperative for the I-71 Corridor Advisory Committee to maintain interest and continuing involvement in the deployment process. As with all transportation improvement programs, it would be advantageous for ITS deployment to be integrated with the overall STIP process.

Table 9.0-2
Strategic Plan – General Description of Deployment Program Areas by Units Responsible

	Areas of ITS Deployment												
Responsible Jurisdictional Area	ITS Planning	Performance Monitoring & Evaluation	Variable Message Signs	Road Weather Info Systems	Kiosks	Broadcast Traveler Info	Web Page	1-800-BUCKEYE	Truck Parking Management	Advantage CVO Program	Emergency Notification System	Incident Management	Freeway Service Patrols
ODOT Central Office	✔	✔	✔	✔	✔		✔		✔	✔	✔	✔	✔
ODOT District Offices													
3	✔	✔	✔								✔	✔	✔
6	✔	✔	✔								✔	✔	✔
12	✔	✔	✔								✔	✔	✔
ODOD					✔	✔	✔	✔					
Cities	✔						✔	✔					
Counties	✔			✔				✔					
SHP	✔			✔		✔			✔	✔	✔	✔	✔
EMS				✔		✔				✔	✔	✔	✔
OH Office of Travel & Tourism					✔	✔		✔	✔				
Traffic Info Providers			✔	✔	✔	✔	✔						
Travel Industry			✔	✔	✔			✔					
Trucking Industry			✔	✔					✔	✔			
Private Sector	✔				✔								
University		✔											

Table 9.0-3
Potential Barriers to Successful ITS Deployment

Core Features	Potential Barriers to Success
District TOCs, Freeway Service Patrols	Competition for other funding priorities.
	Insufficient short-term "work" to justify full-time TOC managers.
Traveler Information Kiosks	Failure to obtain services of experienced traveler information kiosk vendor to set up and manage the program.
	Lack of sufficient private support through advertisements.
	Failure to select a partnership with a well-defined plan for partnership continuity, and continued O&M funding.
GPS-based AVL (ODOT, SHP vehicles, commercial vehicles)	Inadequate funding for project.
Incident Management Program	Lack of sufficient funding to capitalize on current initiatives within each district and complete the formation of an interagency team that will uniformly adopt ATIS technologies deployed for incident management.
Truck Parking Management	Shortage of funds to commit to the project; long-term budgeting cycle of the Federal government.
	Lack of support from other Coalition members.

CHAPTER 10.0

10.0 STRATEGIC DEPLOYMENT PLAN

This chapter describes the activities and findings of Task J and some remaining activities completed as part of Task I. The objectives of Task J have been:

- To prepare a business plan and plan for deployment of the ITS elements identified to provide the needed User Services on I-71.
- To prepare project descriptions, estimates for deployment, funding sources, and scheduling information.
- To develop an evaluation plan for determining the effectiveness of the I-71 ITS Program projects.

Also documented in this chapter are several key activities carried out as a part of Task I (not reported in Chapter 9), including the following:

- Identify requirements for operations and maintenance of the Rural I-71 Corridor ITS Communications Center.
- Estimate life cycle costs.
- Estimate benefits in terms of cost savings.

Technology Deployment by Phase

This section presents the technologies and projects recommended for deployment in the rural I-71 Corridor. These projects, based on the recommended market packages presented in Chapter 7, were recommended to, and approved by, the I-71 ITS Corridor Advisory Committee at its meeting in Ashland on December 10, 1997.

Figure 10.0-l illustrates recommended projects and a phasing scheme for their implementation. The following subsections break the projects down by phase, with Phase 1 corresponding with the short-term time frame (immediate through 1999), Phase 2 with the mid-term time frame (2000 through 2004), and Phase 3 with the long-term time frame (2005 and beyond).

Figure 10.0-1

Project Deployment by Phase

Kimley-Horn and Associates, Inc.

Project Name	Number	Phase 1 (short term)		Phase 2 (mid term)					Phase 3 (long term)			
		Jan 1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 4
Program Management												
ITS Planning/STIP Updates	C-1											
Performance Monitoring and Evaluation	C-2											
System Manager	C-3											
Incident Management												
Engineering, Plans, Specifications and Estimates (part)	C-5											
Freeway Service Patrols	D-1											
Rest Area Surveillance	D-2											
Incident Detection	D-3											
Coordinated Response System	D-4											
MAYDAY Support	C-15											
Construction Mangement/Changable Message Signs	D-5											
Traveler Information												
Engineering, Plans, Specifications and Estimates (part)	C-5											
Broadcast Information	O-1											
1-800-BUCKEYE	O-2											
Web Page	C-9											
RWIS Information	C-10											
Traveler Information Kiosks	O-3											
In-Vehicle Information	O-4											
Variable Message Signs	O-6											
Commercial Vehicle Operations												
ADVANTAGE Program	C-11											
Parking Management	C-12											
Weigh-in-Motion	C-13											
Oversized Vehicle Management	C-14											
HAZMAT Management	D-7											
Communications System												
Region-wide ITS Communications Deployment Plan	C-4											
Engineering, Plans, Specifications and Estimates (part)	C-5											
Communications Center	C-6											
Communications Backbone and Network Integration Project	C-7											
Connection of Cleveland and Columbus Networks	C-8											

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Projects starting in Phase 1   Projects starting in Phase 2   Phase 3

Corridor ITS Project Summary

To meet the needs of the Corridor. the high-level architecture shown in Figure 10.0-2 was developed. This high-level architecture focuses on the basic elements. The system consists of a communications network, a corridor ITS communications center. various field elements. information dissemination elements, operators, and travelers. In addition. each geographical area utilizes a variation of these elements.

The common relationship between elements and areas includes travelers, the communications network, and information. The information is used to provide services to the operators and travelers for the corridor. The type of services provided include control of the system. traveler information, control of resources, and emergency management. Operators in the Columbus Regional Traffic Management Centers (RTMCs) will be able to monitor sensor information from the southern and/or northern segments of the I-71 Corridor. Travelers will receive warnings and advisories (on incidents, road conditions, weather, parking availability, tourist attractions, etc.) at critical locations from VMS and broadcast media. Travelers receive advanced warnings and advisories from VMS, in-vehicle information systems, parking status signs (for truckers at selected truck stops), highway advisory radio (HAR). and kiosks.

Traveler information is originally provided from sensor element data, verified in the RTMCs, and processed via the I-71 Corridor Communications Center. This ability to collect information and disseminate it to travelers is provided through the communications network. The communications network is proposed to be a hybrid of subsystems that takes advantage of existing communications and adds capability to provide a complete network. It is recommended that the communications network consist of SONET fiber and microwave for the corridor, spread spectrum for field devices to main trunk links (where a land-line is not easily installed), and public telephone linking the rural I-71 system to the Columbus (and later Cleveland) RTMC. A more detailed analysis of the communications infrastructure is needed to provide specific system design recommendations.

Corridor ITS projects to implement this architecture are listed and summarized in Tables 10.0-2 through 10.0-4. Project title, area affected, and a brief description are provided. Projects have been placed in the following order: ODOT corridor-wide projects, ODOT District projects, and projects to be developed and deployed by others. The 26 projects recommended for deployment in the corridor are shown by scheduled deployment time in **Figure 10.0-3.**

Figure 10.0-Z

i-71 High Level ITS Architecture, Columbus to Cleveland

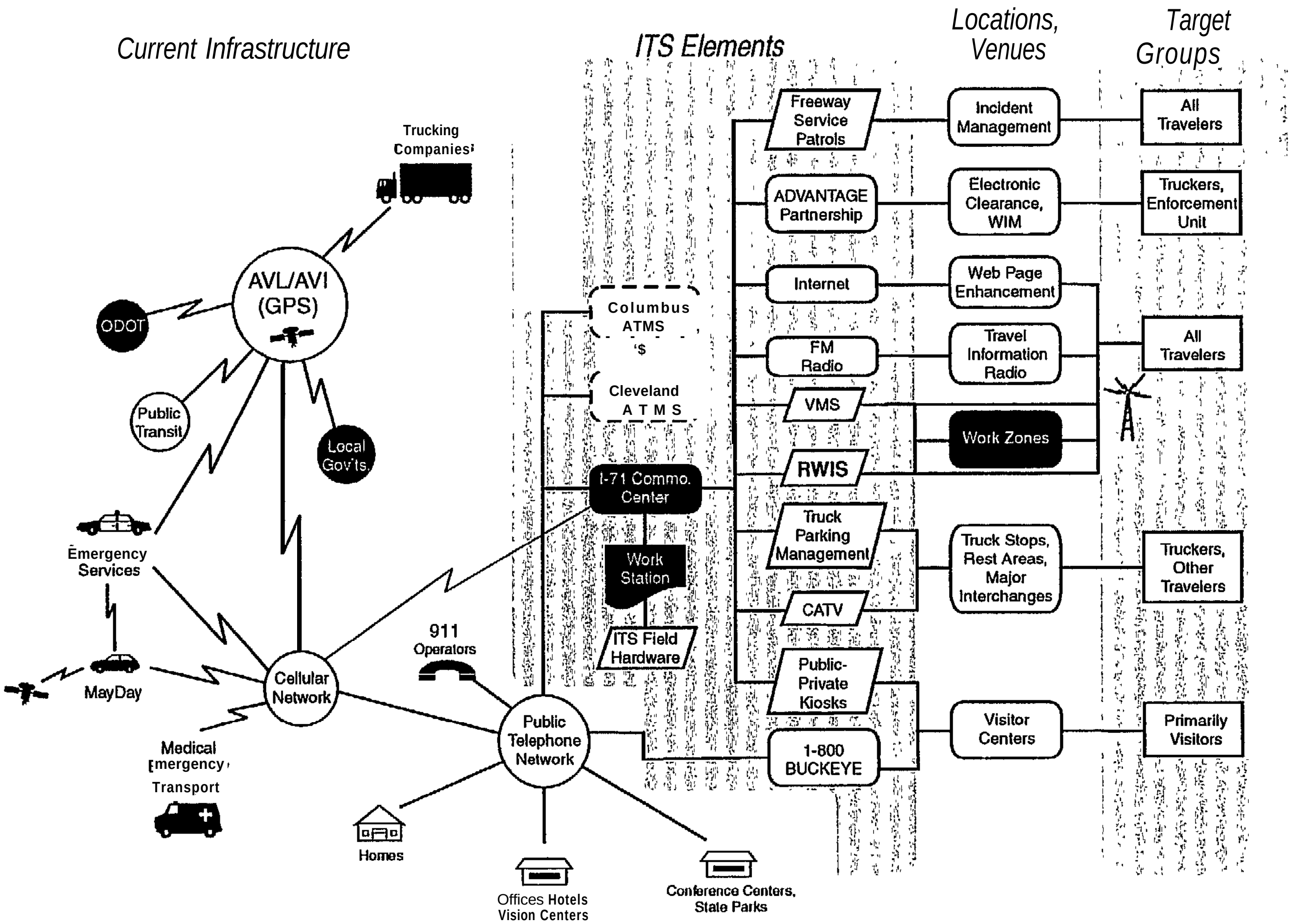

Table 10.0-l
Ohio I-71 Corridor-wide ITS Project Summary (Columbus to Cleveland)

Project No./Title	Agency/Area	Project Summary Description
C-l. Ohio I-71 Corridor ITS Planning, STIP Integration	ODOT Central Office	Continues and provides a charter for a working Advisory Committee to support developm of the I-7 1 intelligent corridor system, and to coordinate the deployment of ITS projects. This activity should include an outside steering committee made up of other state agencies, local governments and MPOs, and private industry in the corridor . An ODOT management team should be part of the overall advisory committee, and the review team for input on the other ITS projects (equipment purchases, communications designs, etc.) that require coordination. This committee may also be requested to coordinate funding requests in the STIP process for ITS projects. This body should remain intact throughout the ITS implementation phase (1998-2008).
C-2. Performance Monitoring and Evaluation System	ODOT Central Office	A database must be created in order to evaluate before and after ITS is deployed. Evaluation will be on safety, traffic congestion, information services, and transportation system performance.
C-3. Corridor System Manager Project	ODOT Central Office	This is the project that ensures that all projects work together and fit the architecture It identifies the scope of all ITS projects on the corridor, what ITS field devices will be deployed, and how they are to be integrated. The ITS System Manager (ISM) will be responsible to see that other contractors comply with overall system requirements.
C-4. Corridor Wide ITS Communications Deployment Plan	ODOT Central Office	This project is needed to develop the communications system data base and a consistent, achievable plan for integrating the I-71 ITS architecture, communications center, and ITS field components with current and planned communication networks, both wireless and wireline . The project will develop communications requirements, acquisition options, cost analysis, and a cost-benefit analysis. Also included will be a review of existing telecommunications infrastructure that will support ITS deployment, and a comparative analysis of single-purpose or shared resource options.
C-5. Communications Engineering; Plans, Specifications and Estimates (PS&E)	ODOT Central Office	This project could be carried out by the system manager as part of the integration of field components with existing and planned communications systems, or by third party contract.

Table 10.0-1, continued
Ohio 1-71 Corridor-wide ITS Project Summary

Project No./Title	Agency/Area	Project Summary Description
C-6. I-71 Corridor ITS Communications Center (CICC)	ODOT Central Office	This project will develop the communications hub for the corridor-wide advanced traveler information system (ATIS). It will be designed to provide a critical communications link and to integrate all corridor ATMS (i.e. traffic management) infrastructure into either the Columbus or Cleveland RTMC. It will function as an interim Traffic Management Center (TMC) for the corridor north of the Columbus RTMC zone of control. The communications center will link the corridor's ATIS componen ts with the corridor's communications infrastructure "backbone." Existing field devices that are part of the corridor communications network (Project C-7) will also be integrated as part of this project.
C-7.Communication Backbone and Network Integration Project	ODOT Central Office	This project will integrate all appropriate I-71 Corridor ITS field devices into the communications network. This should be done as an extension of the Columbus RTMS Project.
C-8 . Connection of Columbus and Cleveland RTMS Networks	Districts 6, 12, and central office	This project will integrate all appropriate I-71 communications center and ITS infrastructure in the corridor into the Coumbus RTMC (from MP 121 to approximately MP 176). It connects the rural corridor components into the Cleveland RTMC from MP 176 to MP 226. It also links the two systems currently being deployed in the two metropolitan areas with the overall corridor communications infrastructure. Part of this project will be the installation of workstations at the Ohio DOT Districts 6 and 12, and State Highway Patrol outposts along the corridor.
C-9. Enhanced ODOT Web Pager Traveler Information	ODOT Central Office	This project will build on ODOT's award-winning web page and provide information on the I-71 IICS that will provide travel and traffic information to residents and visitors in homes, hotels, and high-use venues throughout the corridor.
C-10. Road Weather information System (RWIS) Extension	ODOT Central Office	This project will install RWIS sites along I-71 at 5-7 mile intervals and integrate the RWIS sites to the corridor communications network and the CICC. Road and bridge ice sensors are to be included as appropriate.
C-11 .ADVANTAGE CVO (Commercial Vehicle Operations) Partnership Extension	ODOT Central Office	This project will extend the commercial vehicle electronic weigh station clearance project that is already under development on the l-75 Corridor to the 1-71 Corridor. This project is recommended for the entire corridor from Cleveland to Cincinnati. Two weigh stations in each direction on the corridor between 12 MP 121 and MP 276 would be involved.

Table 10.0-1, continued
Ohio I-71 Corridor-Wide ITS Project Summary

Project No./Title	Agency/Area	Project Summary Description
C-12. l-71 Truck Stop Parking Management System	ODOT Central Office	This project will be to develop a system that detects parking conditions at selected truck stops and provides travelers information via VMS. HAR. kiosks. and parking availability signs along 71. This will include integrating the information into the communications infrastructure and into the RTMCs in Columbus and Cleveland (in the event that Cleveland proceeds with its RTMC).
C- 13 .Weigh-in-Motion (WIM)	ODOT Central Office	This project would extend the WIM program to other weigh stations on the corridor between MP 12 1 and MP 226. Overweight vehicle data would be automatically transmitted to the Oversized Vehicle Management System, Project C-14.
C- 14. Oversized Vehicle Management System	ODOT Central Office	This project will implement new overheight detection systems on all low bridges in the corridor. It will provide notification to travelers in the area of "over load vehicle ahead." It will include integration of existing height and weight sensor systems into the infrastructure (most likely the RTMCs). It will also provide notification to travelers of oversized vehicle(s) in the immediate area.
C-l5. MAYDAY support	ODOT Central office; Emergency Service Providers	Support for MAYDAY and other similar automatic emergency notification devices is the focus of this project. Such devices will increasingly be included in personal vehicles in the future (as it is at present in a few models) Infrastructure needed by the state and emergency response agencies will provide an interface. with private security monitoring services (such as Westinghouse), for monitoring cellular alarms, and for reporting emergency response calls to the State Highway Patrol and (if needed) to the appropriate county emergency management agency.

Table 10.0-2
I-71 Projects Managed by the ODOT Districts

Project No./Title	Agency/Area	Project Summary Description
D- 1. Freeway Service Patrols	Districts 3, 6, and 12	ODOT maintenance vehicles are currently being deployed in District 12 for motorist assistance. It is recommended that they also be deployed in other high-use sections of the interstate This would apply particularly to the section between MP 12 1 and MP 131 in District 6, between MP 165 and 176 in District 3, and extending south from MP 226 in District 12 to MP 209.
D-2. Rest Area Surveillance	Districts 3, 6, and 12	At each rest area maintained by ODOT, it is recommended to increase traveler security that the current interior video surveillance will be augmented by monitored high-mount aerial surveillance cameras.
D-3. Incident Detection	Districts 3. 6, and 12	In the short term, it is recommended that ODOT maintenance vehicles be used as incident reporters (as they are at present), that Freeway Service Patrols be the second stage in the short term. The project will eventually include the installation of loop detectors in the corridor.
D-4. Coordinated Response System	Districts 3,6, and 12	This project is designed to coordinate incident management and resources utilized in the corridor to respond to accidents and other incidents. In the long term, this system will share data with Columbus & Cleveland RTMCs, State Highway Patrol communications network, and county emergency management responders.
D-5. Variable Message Sign (VMS) Deployment	ODOT Districts 3,6 and 12; support from Central Office	This project will add 15 permanently-mounted, overhead VMS signs to provide messages for weather, road conditions, fog, truck parking management, and recommended travel advisories. Integration of the new VMSs into the communications infrastructure will be part of this project. Existing VMS will be integrated as part of the Corridor Communications Network Project.
D-6. Construction Management/ Changeable Message Signs (CMS)	Districts 3,6, and 12	Although not as effective as permanently-mounted VMS, CMS does have a place if used appropriately. One feature is NOT to use more than two alternating messages at a time, and no more than two lines per message. To augment the permanent VMS installations, it is recommended that portable, Changeable Message Signs (CMS) be deployed on a consistent basis in all construction zones as reconstruction takes place. These installations should be used in conjunction with portable Highway Advisory Radios (HAR) to increase effectiveness.
D-7. HAZMAT Management	Districts 3, 6. and 12	RF tag readers will be deployed at Weigh Stations in order to electronically detect HAZMAT loads on commercial vehicles.

Table 10.0-3
I-71 Projects Managed by Other Partners

Project No./Title	Agency/Area	Project Summary Description
0- 1. Broadcast Traveler Information	Ohio Department of Development	At least two FM radio stations will be fitted with RDBS transmitting equipment to accommodate transmittal of emergency broadcasts of major incidents on the corridor,
O-2. 1-800-BUCKEYE	Ohio Department of Development; AAA - Ohio	To supplement the telephone response "hot line" operated by the Department of Defense in Ohio, a special trip routing response feature will be designed to send preferred routing plans through AAA to patrons.
O-3. Traveler Information Kiosks	Ohio Department of Development; Local governments	Local travel destinations such as Mohican State Park and Lodge, Mid-Ohio Raceway, the Polaris Amphitheater, and more remote destinations such as the R&R Hall of Fame in Cleveland, Cedar Point, and the' State Capitol and the German District in Columbus could be participants in a public-private venture to provide kiosks at visitor centers and welcome centers entering the state. A pilot project is recommended at the Welcome Center on I-7 1 north of the Kentucky state line.
O-4. In-Vehicle Information Systems	Ohio Department of Development; Rental car agencies; AAA	In-vehicle GPS receivers and trip routing guides are being incorporated into Hertz and Avis rental cars now in approximately a dozen major markets in the country. Within the next two years such systems will be introduced in the Columbus and Cleveland markets. To access destinations in corridor towns such as Mansfield, Ashland, Mt. Vernon, etc., a public-private partnership could be formed to provide additional data for the database that **is** normally confined to the major market areas. This database could also be integrated into other commercial systems like AAA's Trip Finder software.

Figure 10.0-3

Project Deployment by Organization Responsible

Kimley-Horn and Associates, Inc.

PROJECT NAME	NUMBER	Phase 1 (short term)		Phase 2 (mid term)					Phase 3 (long term)			
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008 →
Program Management												
ITS Planning/STIP Updates	C-1											
Performance Monitoring and Evaluation	C-2											
System Manager	C-3											
Incident Management												
Engineering, Plans, Specifications and Estimates (part)	C-5											
Freeway Service Patrols	D-1			3 6 12								
Rest Area Surveillance	D-2						3 6 12					
Incident Detection	D-3								3 6 12			
Coordinated Response System	D-4			3 6 12								
MAYDAY Support	C-15											
Construction Mangement/Changable Message Signs	D-5								3 6 12			
Traveler Information												
Engineering, Plans, Specifications and Estimates (part)	C-5											
Broadcast Information	O-1											
1-800-BUCKEYE	O-2											
Web Page	C-9											
RWIS Information	C-10											
Traveler Information Kiosks	O-3											
In-Vehicle Information	O-4											
Variable Message Signs	D-6					6 12						
Commercial Vehicle Operations												
ADVANTAGE Program	C-11											
Parking Management	C-12											
Weigh-in-Motion	C-13											
Oversized Vehicle Management	C-14											
HAZMAT Management	D-7									3 6 12		
Communications System												
Region-wide ITS Communications Deployment Plan	C-4											
Engineering, Plans, Specifications and Estimates (part)	C-5											
Communications Center	C-6											
Communications Backbone and Network Integration Project	C-7											
Connection of Cleveland and Columbus Networks	C-8										District 6 and 12	

ODOT Central Office | ODOT Districts | Others

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Estimated Cost Summary

Table 10.0-4 is a summary of the each project total capital cost estimates. The estimates include base system, options and maintenance where appropriate. Details are provided in the respective sections. **Table 10.0-5** is a summary of individual project O&M (operation and maintenance) costs. These are rough order of magnitude (ROM) estimates to be used for-long range planning. The following projects are shown as annual budget estimates for operating costs only:

- Project C- 1: ITS planning, STIP updates
- Project C-2: Performance Monitoring and Evaluation
- Project C-3: System Manager

All other projects are shown as a combination of initial construction/ installation (capital) costs plus an annual O&M or project operating budget. The following projects are shown as a capital or one-time expenditure only, and without a continuing operating budget:

- Project C-4: Region-wide ITS Communications Plan
- Project C-5: Engineering Plans, Specifications and Estimates (PS&E)
- Project O-2: Enhancement of 1-800-BUCKEYE information system

Table 10.0-4
Summary of Project Capital Cost Estimates

Project Number	Project Name	Ohio DOT Central Office	Districts 3,6,12	Other ITS Partners	Corridor Wide
C-l	ITS Planning, STIP Updates	_____			
c-2	Performance Monitoring & Evaluation	_____			
c-3	System Manager	_____			
C-4	Region-wide ITS Communications Plan	2 19,400			
c-5	Engineering Plans, Specs & Estimates .	582,400			
C-6	Communications Center	1,507,500			
c-7	Communications Backbone and Network Integration	4.094,600			
C-8	Connection of Cleveland and Columbus Networks	968,500			
c-9	Enhanced Web Page	6,000			
c-10	RWIS Information	959,400			
C-l 1	ADVANTAGE CVO Partnership	220,000			

Table 10.0-4, continued
Summary of Project Capital Cost Estimates

Project Number	Project Name	Ohio DOT Central Office	Districts 3,6,12	Other ITS Partners	Corridor Wide
C-12	Truck Parking Management	1,570,600			
C-13	Weigh-in-Motion	450,000			
C-14	Oversized Vehicle Management	630,000			
C-15	MAYDAY Support	I09,000			
	SUBTOTAL, CENTRAL OFFICE	**11,317,400**			
D-l	Freeway Service Patrols		187,000		
D-2	Rest Area Surveillance		241,200		
D-3	Incident Detection		712,000		
D-4	Coordinated Response System		535,000		
D-5	Construction Management		841,000		
D-6	Variable Message Signs		4,33 1,300		,
D-7	HAZMAT Management		621,400		
	SUBTOTAL, DISTRICTS		7,468,900		
O-1	Broadcast Information			350,000	
O-2	l-800 BUCKEYE Enhancement			10,000	
O-3	Traveler Information Kiosks			584,300	
O-4	In-vehicle Information			350,000	
	SUBTOTAL, OTHERS			**1,269,300**	20,055,600

Table 10.0-5
Summary of Annual Project Operations & Maintenance Cost Estimates

Project Number	Project Name	Ohio DOT Central Office	Districts 3,6, & 12	Other ITS Partners	Corridor Wide
C-l	ITS Planning, STIP Updates	113,000			
C-2	Performance Monitoring & Evaluation	84,000			
C-3	System Manager	457,300			
C-4	Region-wide ITS Communications Plan	———			
C-5	Engineering Plans, Specs & Estimates	———			
C-6	Communications Center	170,000			
C-7	Communications Backbone and Network Integration	120.000			
C-8	Connection of Cleveland and Columbus Networks	15,000			
C-9	Enhanced Web Page	1,500			
C-10	RWIS Information	140,000			
C-l1	ADVANTAGE CVO Partnership	10,000			
C-12	Truck Parking Management	125,000			
C-13	Weigh-in-Motion	5,000			
C-14	Oversized Vehicle Management	8,000			
C-15	MAYDAY Support	5,000			
	SUBTOTAL, CENTRAL OFFICE	**1,253,800**			
D-l	Freeway Service Patrols		820,000		
D-2	Rest Area Surveillance		60,000		
D-3	Incident Detection		50,000		
D-4	Coordinated Response System		150,000		
D-5	Construction Management		140.000		

Table 10.0-5, continued
Summary of Annual Project Operations & Maintenance Cost Estimates

Project Number	Project Name	Ohio DOT Central Office	Districts 3,6, & 12	Other ITS Partners	Corridor-Wide
D-6	Variable Message Signs		300,000		
D-7	HAZMAT Management		12,000		
	SUBTOTAL, DISTRICT PROJECTS		1,532,000		
O-1	Broadcast Information			50,000	
O-2	I-SOO-BUCKEYE Enhancement			———	
O-3	Traveler Information Kiosks			45,000	
O-4	In-Vehicle Information			10,000	
	SUBTOTAL, OTHER ORGANIZATIONS			105,000	
	TOTAL, ALL PROJECTS				$ 2,890,800

Evaluation Plan for the I-71 ITS Intelligent Corridor System

This section describes the plan for evaluating the effectiveness of ITS technologies deployed in the I-71 Corridor. The evaluation plan will be carried out during the coming years as ITS technologies are deployed. A specific project (C-2) is recommended and described previously in this chapter. The evaluation plan outlined in this section should be used as the basis for an RFP or Scope of Services to secure an evaluation agency. This should be one of the first deployment steps taken, and should be undertaken as soon as practical in order to develop baseline performance measures beginning in the summer of 1998.

User Service Objectives and Performance Measures

A list of system objectives was compiled in Task D using the needs and issues identified in Tasks A and C. These system objectives are:

- Improve safety and security
- Reduce congestion and improve air quality
- Improve information coverage
- Increase tourism
- Increase commercial vehicle productivity
- Ensure that responsible agencies and offices cooperate effectively

Based on these objectives, a set of 79 candidate performance criteria was assembled in Task D, of which 16 were originally selected (approximately 20 percent of all criteria evaluated). The final criteria, incorporating both.quantitative and qualitative measures. were selected for the purposes of evaluating the effectiveness of the selected User Services in meeting the specific objective of each need.

Measures for Assessing Effectiveness

Availability of traveler information is a performance measure that has been added in this chapter (making 17 candidate performance measures), as the ATIS component has become a more important overall element in the I-71 ITS Program through progression of the study.

The 17 performance measures have been further reviewed for selection and future use in evaluating deployed I-71 ITS projects. Final selection of performance measures was guided by the following considerations:

- Performance measures should be used that are associated with a large number of corridor ITS projects rather than just one or two. Use of a performance measure that contributes to evaluating only one or two projects is an inefficient use of evaluation resources.
- Performance measures should be used that provide the best chance of detecting an improvement. A performance measure that is relatively insensitive to changes will not be effective in demonstrating the value of ITS projects.
- Performance measure information must be readily available and easily measured. Performance measures with existing available data are preferable. If so, the cost of collecting data will be minimized.

These observations suggested that there was a smaller number of performance measures that could be very effectively used to evaluate the success of ITS projects in the rural I-71 Corridor. The performance measures recommended in this chapter could be very effective because each one could potentially be used to measure the effectiveness of multiple ITS projects and could also measure whether a large number of corridor needs had been met. The performance measures that were selected based on these guidelines include:

Qualitative Measures	**Quantitative Measures**
Availability of Traveler Information	Accident Rate
Conformance/Response to Messages	Person-Hours of Delay
Level of Service (LOS)	Emergency Response Time
	Emergency Service Call-Outs
	Tow Truck Service Calls
	CVO Operations and Impacts (by-pass capability)

This evaluation plan has been designed to use these nine performance measures, which are recommended as the most effective in detecting improvements. most easily measured, and most applicable to the projects.

Collection of Baseline Data

Baseline data will serve as the frame of reference by which changes in performance will be measured. At present, very little ITS technology is deployed in the l-71 Corridor. However, it is anticipated that improvements to the existing technologies will continue to be made and that additional ITS projects will be deployed within the coming year. Therefore, baseline data in the following categories should be collected in mid- 1998:

- Accident/traffic/roadway data
  - (1) accident data for I-7 l by year for 1995, 1996, and 1997, including total number of accidents, number of accidents involving trucks, and number of accidents involving wet or icy pavement and (2) total number accidents per mile (by year) on other Ohio rural interstate mileage 1995-1997
  - (1) total and truck traffic counts/VMT data for I-7 1 and (2) total traffic count/VMT data for other Ohio rural interstate mileage in 1995-97 (by year)
  - Starting and ending mileposts for segments of I-7 I subject to congestion and with steep grade

- Delay data
  - Current travel time during weekday am and pm peak periods to traverse (1) entire I-7l Corridor from Columbus to Cleveland and (2) specific high-volume and congested segments along the Corridor

- Emergency and towing data
  - Daily telephone logs and vehicle operating logs from emergency responder dispatchers (two or three counties in corridor) for typical one-month period (April or October) in 1995, 1996, and 1997
  - Agencies and private providers of emergency services within I-71 Corridor
  - Number of emergency service call-outs in 1996 for roadway-related emergencies on I-71
  - Private providers and government agencies that provide tow truck service in I-7l Corridor
  - Number of tow truck service calls in 1996 in I-71 Corridor

- CVO data
  - Count number of trucks that bypass permanent weigh scales on the corridor

- Traveler information data (qualitative)
  - (1) number of traveler kiosks currently deployed in the corridor, (2) amount of information available on kiosks and web pages (number of pages, quantity and quality of information)
  - Current geographic coverage of the Road Weather Information System (data collection stations)
  - Design and administer questionnaire survey to assess usage of current sources of traveler information

- No baseline data collection recommended for conformance/response to messages and level of service

Plan for Analysis and Interpretation of Data

Subsequent data should be collected after initial ITS projects have been deployed and been in operation for at least a few months. Since some performance measures are based upon annual counts of information, complete impacts may not be obvious until one year following implementation. Continuing evaluation can be done at annual intervals. Data collected each year can be compared with prior years to assess changes in performance.

CHAPTER 11.0

11.O COST-BENEFIT ANALYSIS

The purpose of this cost-benefit analysis has been to show, as accurately as possible, how the costs associated with ITS project deployment in the I-71 Corridor compare with the resulting benefits. Three scenarios were analyzed to determine the range of Present Worth (PW) cost-benefit ratios for the rural I-71 ITS Program:

- Scenario 1: Assumes that all Phase 1 projects are deployed, with no Phase 2 or 3 project deployment. Phase 1 projects include those scheduled to begin in 1998-99 (short term).
- Scenario 2: Assumes that all Phase 1 and Phase 2 projects are implemented, with no Phase 3 deployment. Phase 2 projects include those scheduled to begin in 2000-04 (mid term).
- Scenario 3: Assumes that all Phase 1,2, and 3 projects are deployed. Phase 3 projects include those scheduled to begin in 2005-beyond (long term).

In Present Worth calculations, the interest rate was assumed to be five percent. However, a sensitivity analysis was performed in Scenario 3, using interest rates of three and four percent for comparison of PW benefit/cost ratios.

Cost Elements

In this analysis, capital and operational costs for each recommended project were estimated (see Chapter 10, Sections 6 and 7), based on a twenty-year horizon. Operating costs were assumed to commence after the first year of deployment. Maintenance was taken as 7% of al1 project capital costs, also assumed to begin after the first year. Contingency was estimated at 21% of all project capital costs. Engineering costs have been included in project capital costs. Although the costs have not been actually calculated in this chapter, they are presented in detail in the Appendix to this chapter. The Present Worth (PW) of the total estimated cost for each scenario is:

- Scenario 1: PW (i=5%) of total Phase 1 deployment costs = $ 16.0 million
- Scenario 2: PW (i=5%) of total Phase 1 and 2 deployment costs = $32.9 million
- Scenario 3: PW (i=5%) of total Phase 1, 2, and 3 deployment costs = $34.7 million
  PW (i=3%) of total Phase 1, 2, and 3 deployment costs = $40.5 million
  PW (i=4%) of total Phase 1, 2, and 3 deployment costs = $37.4 million

Benefit Elements

The principal benefit elements analyzed were accident reduction and travel time savings. Also, a general category of operational benefits (as a result of reduced accidents and travel time) was used. Benefits, once estimated, were converted into 1997 dollar amounts. The following subsections describe each of these elements. Benefit calculations are shown in the Appendix to this chapter. The present worth of the total estimated benefit for each scenario is:

- Scenario 1: PW (i=5%) of total Phase 1 deployment benefits = $104.6 million
- Scenario 2: PW (i=5%) of total Phase 1 and 2 deployment benefits = $184.9 million
- Scenario 3: PW (i=5%) of total Phase 1. 2, and 3 deployment benefits = $256.7 million
  PW (i=3%) of total Phase 1, 2, and 3 deployment benefits = $320.5 million
  PW (i=4%) of total Phase 1, 2, and 3 deployment benefits = $286.4 million

Accident Reduction

For accident reduction, there were several parameters to quantify:

- Average cost per accident is $14,500, based on 1993 US Statistics of 11 million crashes at a total expenditure of $167.3 billion. *(Traffic Safety Facts* 1994, NHTSA)
- Total accidents per year is 1125 on I-71 Corridor between Columbus and Cleveland based on 1994- 1995 Statistics (See Chapter 1).
- Scenario 1 assumes a 4% reduction in total accidents per year, based on the benefits of Phase 1 projects only throughout the twenty-year period.
- Scenario 2 assumes a 4% reduction in accidents per year as a result of Phase 1 deployment (through 2002, allowing extra time for Phase 1 benefits to be realized), and a 8% reduction in accidents as a result of Phases 1 and 2 project deployment (through 2008).
- Scenario 3 assumes a 4% reduction per year through 2002, a 8% reduction per year through 2008, and a 15% reduction in total accidents per year as a result of the combined Phases I, 2, and 3 projects.

The accident reduction percentages assumed in the three scenarios are conservative estimates, since reported ITS safety benefits indicate a 15-62% reduction in accident rates under freeway management ("Assessment of Benefits - Results from the Field," *Proceedings of the 1996 Annual Meeting of ITS America,* Shank and Roberts).

Accident reduction calculations are shown in the Appendix to this chapter.

Travel Time Savings

For travel time savings, the following items were used:

- Average trip traversing the I-71 Corridor between Columbus and Cleveland is 53 miles, based on the following assumptions:
  - 95% of trucks, or 20% of total traffic, travel entire 105 miles (based on 21% trucks)
  - 10% of total traffic travels 80 miles
  - 10% of total traffic travels 60 miles
  - 25% of total traffic travels 40 miles
  - 35% of total traffic travels 20 miles

- Average travel time to traverse 53 miles is 0.85 hours. based on 65 mph for personally-owned vehicles (POV) (79% of traffic) and 55 mph for commercial vehicles (21% of traffic).

- Average 1995 ADT for 17 interchanges is 35,000 vehicles per day (vpd) [see Chapter 1].

- Average 2015 ADT for 17 interchanges is 44,000 vpd [see Chapter 1]

- Average ADT for next 20 years is 39,500 vpd.

- Assuming one person per vehicle, number of hours spent traveling on I-71 between Columbus and Cleveland is 12.232.590 per year.

- Average wage rate is $16.25 per hour, based on the following:

  - 1988 wages (State of Ohio) is $10.33 per hour, based on average annual pay of $21,500 (U.S. Labor Statistics) and 2080 working hours per year.
  - 2% increase per year for 10 years
  - $30 hourly travel value for commercial drivers
  - 79% POV and 21% trucks

- During years when only Phase 1 benefits would be realized (all 20 years in Scenario 1), a 4% reduction in travel time was estimated.

- During years when benefits from both Phases I and 2 would be realized (after 2002), an 8% reduction in travel time was estimated.

- During years when benefits from all of Phases 1,2, and 3 would be realized (after 2008), a 15% reduction in travel time was estimated.

The percentage reductions in travel time are conservative estimates, since reported travel time benefits indicate 20-48% improvements under freeway management systems, 20% improvement with in-vehicle navigation systems, and 10-42% improvements in travel time under incident management systems ("Assessment of Benefits - Results from the Field," *Proceedings of the 1996 Annual Meeting of ITS America*, Shank & Roberts).

Travel time savings calculations area shown in the Appendix to this chapter.

Operational Benefits

A 10% adjustment was added to basic travel time savings to account for the operational benefits that come as a result of reduced accidents and travel time, and all the items not included in the travel time calculation. Justification for this factor is based on the following:

- Wage rate was taken to be static over the 20-year horizon, with no adjustment for inflation.
- Fuel consumption benefits attributable to the reduction in stops and in travel time were not included.
- Air quality benefits, as a result of decreased travel time and less congestion, were not quantified.

Operational benefits calculations are shown in the Appendix to this chapter.

Cost-Benefit Ratios

The cost-benefit ratio is a number which represents the value of a project in terms of costs and benefits. The ratio itself is the present worth of the total benefit realized as a result of the project's deployment divided by the present worth of the actual costs associated with that project's deployment. In this case, the total benefit and cost of ITS projects deployed in three different scenarios have been estimated. If the cost-benefit ratio is less than one, then the project's benefits are not as great as its costs. If the cost-benefit ratio is greater than one, then the costs are outweighed by the benefits.

There were three scenarios analyzed, as indicated at the beginning of this section:

- Scenario 1, which includes costs and benefits as if only Phase 1 recommended projects were deployed.
- Scenario 2 which includes costs and benefits as if Phases 1 and 2 recommended projects were deployed (and not Phase 3).
- Scenario 3, which includes costs and benefits as if all Phases of projects were deployed (full build-out).

Scenario 1

In Scenario 1, the following projects would be implemented during the twenty-year horizon (deployment in 1998-200 1):

- O-2) 1-800-BUCKEYE enhancement
- C-9) ODOT Web Page enhancement
- C-l 1) ADVANTAGE CVO Program extension to I-71
- C-13) Weigh-in-Motion (WIM)
- O-4) In-vehicle information
- D-l) Freeway Service Patrols
- O-1) Broadcast Information
- C-6) I-71 Corridor Communications Center
- C-10) Road Weather Information System (RWIS)

Table 11.0-l shows the cost-benefit analysis over the 20 year period for Scenario 1. The total cost is estimated at $23,957,630. The Present Worth (PW) of this amount is $ 15,990,3 16. The total estimated benefit is $ 169,178,423, with a PW of $ $104,636,290. Based on these figures, the PW benefit-cost ratio for Scenario 1 is 6.54. Detailed computations are shown in a spreadsheet in the Appendix.

Table 11.0-l
Cost-Benefit Analysis, Scenario 1

Total Capital Cost	$ 3,397,000
Total Operational Cost	$ 19,265,000
Total Maintenance Cost	$ 582,260
Total Contingency	$ 713,370
TOTAL ESTIMATED COST	$ 23,957,630
PW OF TOTAL COST (i=5%)	$ 15,990,316
Total Accident Reduction	$ 15,496,875
Total Travel Time Savings	$ 188,840,601
Total Operational Benefits	$ 37,768,120
TOTAL ESTIMATED BENEFIT	$ 169,178,423
PW OF TOTAL BENEFIT (i=5%)	$ 104,636,290
PW Benefit-Cost Ratio (i=5%)	**6.54**

Scenario 2

In Scenario 2, the following projects would be implemented during the twenty-year time frame, in addition to Scenario 1 projects:

- D-4) Coordinated Response System
- C-7) Corridor communications backbone and network integration
- C-15) May Day support
- D-6) Variable message signs
- D-2) Rest area surveillance
- O-3) Kiosks
- D-3) Incident detection
- D-5) Changeable message signs
- C-12) Commercial Vehicle Parking Management System

Table 11.0-2 shows the Scenario 2 cost-benefit analysis for the twenty-year period. The total cost of Scenario 2 deployment is estimated at $ 53,835,288. The PW of this amount is $ 36,640,317. The total benefit is estimated at $ 310.160,459 with a PW of $ 184,896,145. The PW benefit-cost ratio of Scenario 2 is 5.15. Detailed computations are shown in a spreadsheet in the Appendix to this chapter.

Table 11.0-2
Cost-Benefit Analysis, Scenario 2

Total Capital Cost	$ 16.729.600
Total Operational Cost	$31,440,000
Total Maintenance Cost	$ 2,152,472
Total Contingency	$3,513,216
TOTAL ESTIMATED COST	$53,835,288
PW OF TOTAL COST (i=5%)	$36,640,317
Total Accident Reduction	$ 29,362,500
Total Travel Time Savings	$ 357.803.244
Total Operational Benefits	$ 71,560,649
TOTAL ESTIMATED BENEFIT	$ 310,160,459
PW OF TOTAL BENEFIT (i=5%)	$ 184,896,145
PW Benefit-Cost Ratio (i=5%)	5.05

11.3.3 Scenario 3

Projects added in Scenario 3 include the following:

- C-14) Oversized vehicle management
- D-7) HAZMAT vehicle management
- C-8) Communications connection

Table 11.0-3 shows the Scenario 3 cost-benefit analysis for the twenty-year period. The total cost of Scenario 3 deployment is estimated at $ 54.831,868. The PW of this amount is $ 37,089,229. The total benefit is estimated at $458,19 1,577, with a PW of $ 256,667,978. Based on these figures, the PW benefit-cost ratio of Scenario 3 is 6.92. Detailed computations are shown in a spreadsheet in the Appendix to this chapter.

Table 11.0-3
Cost-Benefit Analysis, Scenario 3

Total Capital Cost	$ 17,049,600
Total Operational Cost	$32,005,000
Total Maintenance Cost	$2.196.852
Total Contingency	$3,580,416
TOTAL ESTIMATED COST	$54,83 1,868
PW OF TOTAL COST (i=5%)	**$37,089,229**
Total Accident Reduction	$47,306,250
Total Travel Time Savings	$576,460,782
Total Operational Benefits	$ 115,292,156
TOTAL ESTIMATED BENEFIT	$458,191,577
PW OF TOTAL BENEFIT (i=5%)	$256,667,978
PW Benefit/Cost Ratio (i=5%)	6.92

As indicated previously in this chapter, a sensitivity analysis was performed in Scenario 3 using alternate interest rates of three and four percent to compare with the PW benefit/cost ratio using five percent. **Table 11.0-4** shows this comparison.

Table 11 .O-4
Sensitivity Analysis: Scenario 3 Interest Rates

PW Benefit/Cost Ratio (i=3%)	**7.46**
PW Benefit/Cost Ratio (i=4%)	**7.19**
PW Benefit/Cost Ratio (i=5%)	**6.92**

According to the sensitivity analysis, the PW benefit/cost ratio goes up with decreasing interest rates. The five percent interest rate factor gives a more conservative, but still viable, benefit-cost ratio.

Rate-of-Return Analysis

Using the ODOT software package "Economic Analysis of Highway Capacity Projects," (Bureau of Planning, 1992), a rate-of-return was made based on the cost and benefit database contained in the Appendix. The analysis showed a design year rate-of-return of 24 percent. Input data for the analysis includes a 20-year design life. 3-year design period, 5-percent inflation rate, and 1O-percent discount rate. Total design year user benefits and project obligation costs by county for the I-71 ITS program is shown in Table **11.0-5.**

Table 1 1.0-5
Costs and Benefits by County
(in $ thousands)

County	Section (approx.)	Project Obligation cost	Design Year User Benefits	Opening Year User Benefits	Design Year Rate-of-Return
Medina	MP202-226	4,93 5	18,899	8,206	24
Wayne	MP195-202	1,449	5,556	2,418	24
Ashland	MP178-195	3,486	13,355	5,808	24
Richland	MP158-178	4,095	15,761	6,857	24
Morrow	MP139-158	3,969	15,014	6,530	24
Delaware	MP121-139	3,727	11,720	5,096	24
Total Project	**MPl21-226**	**21,661**	80,305	**34,915**	24

Details of these calculations, including annual and total (20 year) benefits for each county, are contained in the Appendix to this chapter.

CHAPTER 12.0

12.0 I-71 COMMUNICATIOS ALTERNATIVES

In the I-71 corridor, several ITS technologies are envisioned for use. To accommodate these technologies, a reliable communications network will need to be in place. The following subsections include a discussion of I-71 data types, data capacity requirements, and three communications system alternatives for the rural I-711TS Program: fiber optic cable, wireless with limited fiber optic cable, and cellular phone/purchased telecommunications services.

I-71 ITS Data Types

The data requirements of the hardware to be used fall into four categories: serial data, high-bandwidth network data, video, and kiosk.

Devices using ***serial data*** include:

- Detector stations
- Weather stations
- Variable message signs
- Weigh stations
- Truck Stop Parking Management System (PMS) field detectors
- Closed Circuit Television (CCTV) control

These devices typically communicate using a standard serial data format such EIA-232, EIA-422, or EIA-485. The data rate of these devices range from 1,200 bits per second (bps) to 100,000 bps.

A common configuration for an ITS application is to interconnect a series of similar devices along a single "multi-drop" communications channel. A computer located at an operations center interrogates each device on regular intervals. Also, each device transmits field data back to the central computer. The term multi-drop is used because multiple devices are connected along the same communications channel. Thus, a communications channel comprised of two optical fibers or a radio frequency could allow the central computer to communicate with multiple devices along that single channel.

High-bandwidth network data is what is commonly used in office network computing arrangements. These formats include Ethernet protocol specified at the 10 megabits per second (mbps) and 100 mbps rates, Token Ring specified at 16 mbps, and Fiber Distributed Data Interface (FDDI) specified at 100 mbps. Also emerging are gigabit Ethernet (1000 mbps), and Asynchronous Transfer Mode (ATM) which is a scaleable technology capable of operating at both 155 mbps and 622 mbps. In ITS applications, high-bandwidth network data needs include: exchanging data between computers within a traffic operations center, exchanging data between an operations center and a satellite office, and exchanging data between traffic operation center computer networks or with other agency networks.

The two primary methods of transmitting ***video*** are analog transmission and digital transmission. Analog transmission transmits full-motion, high-quality video using a single optical fiber. Using frequency division multiplexing techniques. multiple video signals can be aggregated onto a single fiber and then dis-aggregated at a central location. Analog transmission provides for high quality video, but usually requires a separate video sub-network. Also, the point-to-point nature of analog transmission makes their networks grow in complexity as the number of viewing ends increase.

Using digital transmission, the video signal is digitized and compressed. The amount of compression dictates the required data rate at which the video must be transmitted. A minimum "surveillance" grade image may be compressed for transmission at a rate as low as 128 kilobytes per second (kbps). Acceptable quality, full-motion video requires minimum data rates in the 3 to 6 mbps range depending on the type of compression being used. The disadvantage of digital video is that high-quality video requires a large amount of network bandwidth. In addition, the current cost of equipment required to compress digital can be costly (several thousand dollars per end). The primary advantage of digital video is that it can be integrated into a network data as opposed to requiring a separate video sub-network. Integrating video into the data stream also lends itself to developing an "open system" as opposed to a proprietary system. Also, digital video can be switched to multiple locations more simply than analog video, requiring a network of switches and cabling.

Providing data to the information ***kiosk*** is special in that the flow of data is primarily one way; from a data source to the kiosk. This type of data can be provided in a manner requiring a high data transfer rate or a low data transfer rate. A high data transfer rate kiosk would require the transmission of system graphics and video images in real-time to the kiosk. In essence, each kiosk would be a client to an information server distributing real-time graphic and text-based information. The primary advantage of this approach is that kiosk graphics could be changes modified from a central location and the real-time video could be transmitted to kiosks.

A low data rate kiosk would have its primary graphic screens resident at the kiosk and would be supplied only with update data in real-time. For instance, a map of the corridor would be resident in the kiosk unit while the status of each road would be updated in real-time from the operations center. Such, a kiosk would be analogous to the World Wide Web Home Pages many DOTs currently have which display transportation conditions.

I-71 ITS Data Capacity Requirements

As part of this study, a cursory estimate of the data capacity required for the proposed ITS architecture proposed for this corridor has been developed. **Table 12.0-l** shows anticipated data loads of the ITS field hardware envisioned for use in this corridor. Planning-level recommendations present a system composed of the elements listed in Table 12.2.0-l. The aggregate quantities of these items and their corresponding data needs are shown in **Table 12.0-2.**

Table 12.0-l
Device Data Requirements

Device	Data Category	Data Rate Requirement (Kilobits per second)
Detection Station	Serial	1
Weather Station	Serial	10
Weigh Station	Serial	50
Truck Stop PMS Detectors	Serial	1
Variable Message Signs	Serial	10
CCTV Control	Serial	10
Inter TOG/Agency Network Comm.	High Bandwidth Network	10,000
Video (Digital)	Video	3,000
Kiosk (Graphics resident at Central)	Kiosk	500
Kiosk (Graphics resident at Kiosk)	Kiosk	10

Table 12.0-2
Aggregate Device Quantities and Data Needs

Device	Proposed Quantity	Data Capacity Requirement (Kilobytes per second)
Detection Station	60	60
Weather Station	6	60
Weigh Station	2	100
Truck Stop PMS Detectors (assume maximum of 10 detector stations per truck stop)	20	20
Variable Message Signs	15	150
CCTV Control	4	40
Inter TOG/Agency Network Communications	I	10,000
Video (Digital)	4	12,000
Kiosk (Graphics resident at Central)	3	1500
TOTAL		23,930

Evident in Table 12.0-2 are the impacts of video communications and data network communications on the capacity requirements of the system. This assessment incorporates the following assumptions:

- Each Truck Stop Parking Management System will contain a maximum of ten detection stations.
- Each Weigh Station will require at least five dedicated serial channels.
- All devices are being routed to a single, central location.
- Each rest area will have only one CCTV camera. transmitting high-quality, compressed digital video.

Alternative 1: Fiber Optic Cable Along Entire Corridor

This scenario can be described as a corridor with single mode fiber optic cable installed from end-to-end. SONET hubs would be placed along the fiber run to aggregate branch circuits from field devices onto SONET backbone fibers. The branch circuits would consist of fiber optic links using serial data to most field hardware and fiber optic links to rest areas for video. A dedicated, hard wire connection and dial-up connection are both explored for communication to kiosks. By using the SONET node architecture, the ability to distribute video and to interface with other data networks can be accomplished at node locations.

Installation

Conduit would be installed in the less rural portions of the system between mileposts 121 and 13 1 near Columbus and between mileposts 209 and 226 near Cleveland. Direct buried fiber would be installed between mile posts 13 1 and 209. Where field devices are located on the opposite side of the freeway, conduit would need to installed across the right-of-way.

In addition to the backbone, fiber optic cable for the local communications channels would need to be routed from the SONET nodes to the field equipment. Field device equipment cabinets will need to have fiber optic termination facilities as well as fiber optic transceivers to convert the field device electronic signals to optical signals and vice-versa.

In this alternative, a preliminary plan breaks the corridor into four sections each with a SONET node. **Table 12.03** shows the milepost boundaries of each section along with the number of communications channels required for each section. It is assumed that each video channel will require one fiber. All other channels will require two fibers.

Table 12.0-3
Alternative 1 Communication Sections

Section Number	Mileposts	Serial Channels	Video Channels	Kiosk Channels	Network Data Channels	Fibers Required
1	121-144.9	4	1		1	7
2	144.9-171.7	6	2		1	16
3	171.7-200.5	3		2	1	12
4	200.5-228.6	10	1		1	23

Table 12.0-3 was developed using the assumption that a maximum of ten detector stations will be on a channel and that a network data channel will be distributed along the backbone.

In this configuration, the number of required fibers would be brought to a SONET node in that section where the channels would then be multiplexed onto the SONET backbone. A folded ring architecture requiring two fibers would then be used to transport the multiplexed data between SONET nodes. A 36-fiber cable has been assumed to be used in the corridor. This would allow for a 50% spare capacity of the highest count link.

SONET Data Rate

The SONET specification is a scaleable technology allowing data capacities from 50 mbps to 1000 mbps. Given the results of the needs analysis, a selection of SONET capacity at the OC-1 rate (5 l mbps) or OC-3 rate (155 mbps) would be recommended. Although the OC-I rate would accommodate the corridor's initial needs, equipment at least at the OC-3 rate is recommended because it allows for future expansion (including video) and a larger number of vendors supplying equipment at the OC-3 level.

Advantages and Disadvantages

Use of an all-fiber, SONET architecture has the following advantages:

- Use of open standard SONET protocol
- SONET allows the introduction of new protocols into existing hub
- Low noise, high quality, dependable communications
- Network capable of high quality video transmission
- Ability to add high data rate communications to backbone such as operation center to operation center networking
- Highly expandable

The primary disadvantage of the SONET fiber optic communications system is its high cost relative to non-hardwire alternatives.

Costs

Table 12.0-4 lists the unit costs that have been used for this cost estimate. Cost information for this assessment has been gathered largely from National Cooperative Highway Research Program (NCHRP) Project 3-51 report entitled: *Communication Mediums for Signal, ITS, and Freeway Surveillance System,* June, 1996.

Table 12.0-4
Alternative 1 Unit Costs

Item	Units	Unit Costs (dollars)
2" conduit (installed at ends of system)	Linear Foot	8.50
2" conduit (installed across freeway via directional boar)	Linear Foot	40.00
36 fiber cable for backbone installed in conduit	Linear Foot	2.50
36 fiber cable for backbone (direct buried)	Linear Foot	3.00
6-fiber Single Mode fiber installed aerially (for kiosks)	Linear Foot	1.85
SONET Nodes	Each	30,000.00
CCTV Compression/Decompression Equipment	Each End	10,000.00
CCTV Fiber Optic Transceivers	Each End	1,750.00
Fiber Optic Data Transceivers	Each	1,250.00

For Alternative 1, the Table 12.0-5 shows the estimated quantities and total costs for an all- fiber communications system.

Table 12.0-5
Alternative 1 Quantities and Total Costs

Item	Units	Quantity	Unit Costs (Dollars)	Total Costs (Dollars)
2" Conduit (installed at ends of system)	Linear Feet	163,680	8.50	1,391,280.00
2" Conduit (installed across fwy via directional boar)	Linear Feet	4,000	40.00	
36-fiber cable for backbone installed in conduit	Linear Feet	163,680	2.50	409,200.00
36-fiber cable for backbone (direct buried)	Linear Feet	401,280	3.00	1,203,840.00
6-fiber Single Mode installed aerially (kiosks assumed to be 5 miles from hwy)	Linear Feet	52,800	1.85	97,680.00
SONET Nodes (1 per section + 1 at Operations Center)	Each	5	30,000.00	150,000.00
CCTV Compression/ Decompression Equipment	Each End	8	10,000.00	80,000.00
CCTV Fiber Optic Transceivers	Each End	8	1,750.00	14,000.00
Fiber Optic Data Transceivers	Each	107	1250.00	133,750.00
Alternative Total				**3,639,750.00**

Alternative 2: Wireless with Limited Fiber Optic Communications

Alternative 2 would be comprised of a mostly wireless system with the exception of the 10 southernmost miles which would utilize fiber optic cable. In the proposed layout, the majority of the backbone would consist of a wireless SONET system. The SONET equipment would be mounted on existing State Highway Patrol (SHP) radio towers and co-located on cellular phone towers. Local circuits for serial field devices would use radio frequency (RF) technology. Video links would be accomplished via microwave links between a rest area and the nearest wireless SONET node. For both the RF and microwave links, repeater points may be required to achieve a line of sight transmission. Kiosks would utilize a low bandwidth configuration (primary graphics will reside at the kiosk) with dial-up links.

Installation

Fiber optic cable in conduit would be installed between mileposts 121 and 131 near Columbus. Wireless SONET nodes would be installed on existing towers. This would require the installation of multiple antennas atop the towers. The antennas would include the wireless SONET antennas as well as the RF and microwave antennas. The signals received by these antennas would be transmitted to a wireless SONET chassis at the base of the tower. The non-SONET data would then be multiplexed and transmitted over the SONET backbone.

The serial field devices such as detector stations and weather stations would operate in a multi-drop fashion with a single RF channel being used to communicate with up to ten devices. An antenna would need to be installed at each location. A line of site would be required between antennas on a multi-drop channel including the antenna at the SONET node site. In addition, repeater antennas may need to be installed to insure line of sight transmission between devices. This analysis has assumed that repeater antennas are installed at overpass and interchange locations in addition to serial field device locations.

The microwave links would also require a line of site between antennas. To account for terrain and assuming the antenna mounting height at the rest areas will be relatively low (no tower will be installed), it has been estimated that three microwave links will be required to transport the video signal from the rest area to the wireless SONET node.

Wireless SONET equipment is generally rated to have a transmission distance of up to 25 miles given a line of site. A cursory assessment of the topology of the corridor shows it to be relatively flat along most stretches. Thus, it is reasonable to assume that a combination of SHP antennas in combination with co-location of equipment on cellular phone towers would provide adequate antenna spacing for the SONET nodes. Given a coverage area of approximately 100 miles (milepost 13 1 to milepost 229) and a maximum transmission distance of 25 miles, four nodes could cover the area. However, an assumption of six nodes is being used to accommodate potential line of site issues. SONET equipment at the OC-3 data rate is recommended for use.

It must be emphasized that a thorough site line survey and frequency availability survey must be conducted along the corridor to insure proper operation of the wireless equipment. Moreover, it should be noted that wireless design is complex and involves many variables, including: the use of licensed or unlicensed bandwidths, licensing coordination and fees, environmental conditions, and line of sight considerations. The equipment selected to **develop** cost estimates for this report represents those technologies which would be reasonably applicable for use in this corridor. **Table 12.0-6** shows the frequency band and licensing requirements for the equipment selected for analysis in the **report.**

Table 12.0-6
Wireless Equipment Frequency Band and Licensing Requirements

Item	Selected Frequency Band	Licensing Requirements
Wireless SONET	**6** GHz	Required
Microwave for Video	18 GHz	Required
RF for Serial Devices	902-928 MHz (Spread Spectrum Radio)	Not Required

Advantages and Disadvantages

The advantages of using a wireless communications system include:

- Use of open standard SONET protocol
- SONET allows the introduction of new protocols into existing hub
- Lower costs than all-fiber solution (assuming no tower construction)
- Modular and expandable

The disadvantages of the wireless system include:

- Co-location adds complexity to system with regards to system maintenance and expansion.
- Video quality may be deceased using microwave links.
- No video or graphics can be transmitted to kiosks (all graphics reside at kiosk).

Costs

Table 12.0-7 lists the unit costs that have been used for this cost estimate. Cost information for this assessment has been gathered largely from National Cooperative Highway Research Program (NCHRP) Project 3-51 report entitled: *Communication Mediums for Signal, ITS, and Freeway Surveillance System,* June, 1996.

Table 12.0-7
Alternative 2 Unit Costs

Item	Units	Unit Costs (dollars)
2" Conduit (installed at southern end of system)	Linear Foot	8.50
2" Conduit (installed across freeway via directional Boar)	Linear Foot	40.00
36 fiber cable for backbone installed in conduit	Linear Foot	2.50
Kiosk Dial - Up costs[1]	Each	13,000.00
Wireless SONET Nodes	Each	265,000.00
Serial Radios	Each Location	6,000.00
CCTV Microwave Equipment	Each Link	30,000.00
CCTV Compression/Decompression Equipment	Each End	10,000.00
CCTV Fiber Optic Transceivers	Each End	1,750.00
Fiber Optic Data Transceivers	Each	1,250.00

1 The Kiosk dial-up charge has assumed toll and service charges having a net present value of $12,500 over a twenty year project life using a discount rate of 5%. Modem and service initiation fees of $500 have been assumed. This assumes an average $O.O2/minute toll charge, twice hourly data updates requiring two minutes each to transmit.

For Alternative **2, Table 12.0-S** shows the estimated quantities and total costs for a primarily wireless communications system.

Table 12.0-S
Alternative 2 Quantities and Total Costs

Item	Units	Quantity	Unit Costs (dollars)	Total Costs (dollars)
2" conduit (installed at southern end of system)	Linear Foot	58,080	8.50	493,680.00
36-fiber cable for backbone installed in conduit	Linear Foot	58,080	2.50	145,200.00
Kiosk	Each	2	13,000.00	26,000.00
Wireless SONET nodes	Each	6	265,000.00	1,590,000.00
Serial radios	Each Location	150	3,000.00	450,000.00
CCTV fiber optic transceivers	Each End	2	1,750.00	3,500.00
CCTV compression/ decompression equipmt	Each End	8	10,000.00	80,000.00
CCTV microwave equipment	Each Link	9	30,000.00	600,000.00
Fiber optic data transceivers	Each	19	1250.00	23,750.00
Alternative Total				**3,412,130.00**

Alternative 3: Cellular Phone/Purchased Telecommunications Services

This scenario assumes that no agency-owned communications equipment will be installed in the system. Communication with serial field devices would be via cellular phone drops. Video from the rest area would transmit medium-quality video using a single, leased T-l line and video compression for each location. A leased T- 1 line would also be used to connect the Columbus operations center with the Cleveland operations center. Kiosks would have their graphics resident locally and be updated with traffic information via dial-up links. It is assumed that the cellular phone air time would be paid for via the ODOT's right-of-way agreement with cellular telephone providers. The scenario assumes an all-fiber solution for the southernmost 10 miles of the system.

The system presented would have a central computer poll the detector station, weather station, and weigh station serial devices on a periodic basis via bank phone lines over standard modems located at the operations center. Messages to variable message signs would be sent from the operations center either by automated central computer routines or by operator intervention.

The system presented shows an elementary **layout** based upon commonly available services. Several new wireless and **video services are emerging:** however. the market is still sorting out the next wave of wireless technologies.

Installation

The serial data would use currently available digital cellular phone service. This would require the installation of a cellular modem at the field device. This service currently supports rates up to 9,600 bps. The serial network would be arranged in a star configuration with each field device communicating directly with the central system on a dial-up basis. The primary capital cost would be for modems on the central end and on the field device end. In addition, toll charges and monthly service charges would be incurred for the phone lines installed at the central. It has been assumed that the field data would need to be updated relatively frequently (on average once every ten minutes). **Table 12.0-9** shows the anticipated quantities of serial devices and the anticipated polling rate.

Table 12.0-9
Quantity of Serial Devices

Device	**Proposed Quantity**	**Estimated Call Duration** (min)	**Primary Origin of Call**
Detection station	49	**1.5**	Operations Center
Weather station	5	1.5	Operations Center
Weigh station	1	3	Operations Center
Truck stop PMS detectors (assume max of 10 detector stations per truck stop)	**10**	1.5	Operations Center
Variable message signs	13	3	Operations Center

Based on the number of devices, the duration of each device interrogation, the primary origin of the call, and the desired update interval, an estimate of the number phone lines required at the operations center can be developed.

Table 12.0-10 shows an estimate of the number of outside lines required for communication with serial devices.

Table 12.0-10
Number of Outside Phone Lines at Operations Center

Devices	**Number Required**
Detectors, weather stations, weigh station	10
VMS	1
Kiosk	1
Spare	2
Incoming (for device alarms. device testing, etc.)	**2**
Total	**16**

To communicate with the rest area CCTV units, a leased T-l telephone line would be used. This type of line supports data rates of 1.5 mbps. Moderate-quality video along with CCTV control would be transmitted over these lines.

To communicate with the future Cleveland operations center, a leased T- 1 line is proposed to make the network connection. The anticipated number of leased T-l lines required is shown in **Table 12.0-11.**

Table 12.0-11
Number of Leased T-l Lines

Purpose	**Number Required**
Rest Area CCTV	3
Network Connection to Cleveland Operations Center	1
Total	4

Advantages and Disadvantages

The advantages of the cellular phone and purchased telecommunications services system are its low cost and minimal construction requirements. These advantages give it the potential to lead to more rapid implementation.

Disadvantages include the following:

- Lease charges are subject to fluctuation.
- Decreased real-time field data acquisition, with slower system response and data dissemination.
- Decreased video quality compared with both fiber and microwave.
- No video or graphics can be transmitted to kiosks (all kiosk graphics reside at kiosk).
- System susceptible to error and downtime of switched and cellular public telephone networks.

Costs

Table 12.0-12 lists the unit costs that have been used for this cost estimate. Cost information for this assessment has been gathered largely from National Cooperative Highway Research Program (NCHRP) Project 3-5 1 report entitled: *Communication Mediums for Signal, ITS, and Freeway Survelillance System,* June, 1996.

Table 12.0-12
Alternative 3 Unit Costs

Item	Units	Unit Costs (dollars)
2" Conduit (installed at southern end of system)	Linear Foot	8.50
2" Conduit (installed across freeway via directional Boar)	Linear Foot	40.00
36-fiber cable for backbone installed in conduit	Linear Foot	2.50
Kiosk dial-up costs[1]	Each	13.000.00
Leased T-1 charges[2]	Each Line	374,500.00
Operation center phone charges[3]	Each Line	6,000.00
CCTV compression/decompression equipment	Each End	13.250.00
CCTV fiber optic transceivers	Each End	11750.00
Fiber optic data transceivers	Each	1,250.00

1 The Kiosk dial-up charge has assumed toll and service charges having a net present cost of $12,500 over a twenty year project life using a discount rate of 5%. Modem and service initiation fees of $500 have been assumed. This assumes an average $O.O2/minute toll charge, twice hourly data updates requiring two minutes each to transmit.

2 The T-1 line lease charges have been estimated at $3,000/mo. Using a project life of twenty years and a discount rate of 5% yields a net present cost of about $373,000 per line. End equipment would total about $1,500 per line. It should be noted that T-1 rates vary widely based upon availability of the service and demand.

3 The operations center phone charges has been assumed to be as the Kiosk charges. The modem and initiation fees for the operations is assumed to be about $750 due to the cost of cellular modems on the field device end and cellular compatible modems on the operations center end.

For Alternative **3, Table 12.0-13** shows the estimated quantities and total costs for a cellular/purchased service solution.

Table 12.0-13
Alternative 3 Quantities and Total Costs

Item	Units	Quantity	Unit Costs (dollars)	Total Costs (dollars)
2" conduit (installed at southern end of system)	Linear Foot	58,080	8.50	493,680.OO
36-fiber cable for backbone installed in conduit	Linear Foot	58,080	2.50	145,200.OO
Kiosk Dial -up costs 1	Each	2	13,000.00	26,000.00
Leased T-I charges2	Each Line	3	3 74,500.00	1,123,500.00
Operation center phone charges3	Each Line	16	13,250.00	2 12,000.00
CCTV compression/ decompression equipment	Each End	8	10,000.00	80,000.00
CCTV fiber optic transceivers -	Each End	2	1,750.00	3,500.00
Fiber optic data transceivers	Each	19	1,250.00	23,750.OO
Alternative Total				**2,107,630.00**

The major costs in this scenario are the video to the kiosks and the fiber optic portion of the system in the Columbus area. Excluding these components, the estimated project cost is $238,000.00 over a twenty year project life.

APPENDICES

Appendices

Appendix to Chapter 2

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Mong Mr. Dean President	Designed Metal Products, Inc.	P.O. Box 1588 119 Elm Street Mansfield, OH	44901-	Phone: Fax: Email:
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Appendix to Chapter 11

Accident Reduction Calculations

accidents Jan 94-Dec 95	2247	(ODOT)
per year	1125	
US accidents- 1993	11000000	(Traffic Safety Facts 1994, NHTSA)
US cost for accidents	1.673E+11	(Traffic Safety Facts 1994, NHTSA)
est avg cost per accident	14500	

Degree of deployment by phase	# saved/yr	$ saved/yr of phase	2 0 0 2 3	2008 6	2017 9	totals (in 20-yr per)	$ value of benefit
Phase 1 (assume 4%*)	45	$652,500	135	270	405	810	$11,745,000
Phase 2 (assume 8%')	90	$1,305,000	135	540	810	1485	$21,532,500
Phase 3 (assume 15%')	169	$2,446,875	135	540	1519	2194	$31,809,375

The year 2002 represents the last year in which benefits from Phase 1 projects (only) are assessed (allowing time for the benefits of short-term deployment to be realized).

Phase 2 benefits are accounted for between the years 2003 and 2008, and Phase 3 benefits are accounted for during the remainder of the 20-year horizon. These considerations allow a more conservative approach in calculating benefits.

Phase 1 percentage accident reduction is applied to all 18 years in Scenario 1 (after first 2 yrs), which assumes that no Phase 2 or 3 projects would be deployed. Therefore, for Scenario 1, there are 45 less accidents per year, at $14,500 per accident.

In Scenario 2, Phases 1 and 2 projects would be deployed. Here, Phase 1 percentage accident reduction applies only to years 2000.01, and 02. Then Phase 2 percentage reduction (9O/yr) is applied to the remainder of the 20 years.

In Scenario 3, all three phases would be deployed. Phase 1 percentage reduction applies through 2002, Phase 2 reduction appies through 2008, and Phase 3 reduction (169/yr) applies to the remainder of the 20 years.

1 These are conservative estimates, since reported ITS safety benefits indicate a 1562% reduction in accident rates under freeway management ("Assessment of Benefits - Results from the Field," Proceedings of the *7996 Annual Meeting of* ITS America, Shank and Roberts.)

Travel time savings calculations

1988 wages, Ohio	$10.33 per hour	
@ 2% increase/yr	$12.59 (personal veh)	0.79 percent of total volume
	$30.00 (truckers)	0.21 percent of total volume
Avg. tt value	$16.25 per hour	

@ 55 mph and 105 miles, avg travel time to traverse corridor = 1.62 hours personal veh
@ 65 mph and 105 miles, avg travel time to traverse corridor = 1.91 hours trucks

(0.79'1.62) + (0.21*1.91) = 1.6809 hrs avg travel time for 105 mi

Assuming 95% of trucks go entire 105 miles, 20% of total traffic goes entire 105 miles
10% of total traffic goes 80 miles
10% of total traffic goes 60 miles
25% of total traffic goes 40 miles
35% of total traffic goes 20 miles
(0.2 *105) + (0.1*80) + (0.1*60) + (0.35 *20) = **53 miles**
Therefore, each vehicle travels an avg of 53 miles/trip: 53/105= 0.504762
0.848454 hrs/veh to travel 53 mi

Avg ADT for 17 interchanges = 35000 (1995)
Avg ADT for 17 interchanges = 44000 (2015)
Say Avg ADT for next 20 yrs = 39500
Assuming 1 person/veh, (0.848 hr/veh)*(39500 veh/day)*(365days/yr) = 12232590 hrs/yr

Degree of deploymt by phase	time saved/yr of phase (hr)	$ saved/yr of phase	2002 3	2008 6	2017 9	total time savings (in 20-yr per)	$ value of benefit
Phase 1 (assume 4%)	489304	$7,951,183	1467911	2935822	4403732	8807465	$143,121,299
Phase 2 (assume 8%)	978607	$15,902,367	1467911	5871643	8807465	16147018	$262,389,048
Phase 3 (assume 15%)	1834868	$29,816,937	1467911	5871643	16513996	23853550	$387,620,185

The year 2002 represents the last year in which benefits from Phase 1 projects (only) are assessed (allowing time for the benefits of short-term deployment to be realized).
Phase 2 benefits are accounted for between the years 2003 and 2008, and Phase 3 benefits are accounted for during the remainder of the 20-year horizon. These considerations allow a more conservative approach in calculating benefits.

Phase 1 percentage of travel time savings is applied to all 18 years in Scenario 1 (after first 2 yrs), which assumes that no Phase 2 or 3 projects would be deployed. Therefore, for Scenario 1, time is reduced by 489304 hours per year, at $14,500 per accident.
In Scenario 2. Phases 1 and 2 projects would be deployed. Here, Phase 1 percentage time savings applies only to years 2000.01, and 02. Then Phase 2 percentage savings is applied to the remainder of the 20 years.
In Scenario 3, all three phases would be deployed. Phase 1 percentage savings applies through 2002, Phase 2 savings apples through 2008. and Phase 3 savings applies to the remainder of the 20 years.

* These are conservative estimates, since reported ITS travel time benefits indicate 20-48% improvements under freeway mangement systems, 20% improvement with in-vehicle navigation systems, and 10-42% improvements in travel time under incident management systems. ("Assessment of Benefits - Results from the Field," *Proceedings of the Annual Meeting of ITS Amercia,* Shank and Roberts.)

Itemized Benefit and Cost Elements. Scenario 1 (Phase 1 only)	0 1998	1 1999	2 2000	3 2001	4 2002	5 2003	6 2004	7 2005	8 2006	9 2007	10 2008	11 2009	12 2010	13 2011	14 2012	15 2013	16 2014	17 2015	18 2016	19 2017	totals
O 2) 1 800 BUCKEYE	$10 000																				$10,000
C 9) Web Page	$8 000																				$8,000
C 11) ADVANTAGE	$133 000	$67 000																			$200,000
C 13) WIM	$450,000																				$450,000
O 4) In vehicle info		$250,000																			$250 000
D-1) FSP		$187 000																			$187,000
O 1) Broadcast info		$175,000	$175,000																		$350,000
C-6) CCIC		$374,000	$667,000	$165,000																	$1,206,000
C-10) RWIS		$198 000	$360 000	$180 000																	$738,000
TOTAL CAPITAL COSTS	$599 000	$1 251 000	$1,202 000	$345,000																	$3,397,000
Operating Costs		$15,000	$505 000	$1,065 000	$1 105 000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$1,105,000	$19,265,000
Maintenance @ 7%		$87 570	$84,140	$24,150	$24 150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$24,150	$582,260
Contingency @ 21%	$125,790	$262,710	$252,420	$72,450																	$713,370
SUM OF COSTS	$724 790	$1 616 280	$2,043,560	$1,506,600	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$1,129,150	$23,957,830
PW OF COSTS I=5%	$724,790	$1 539,314	$1,853,569	$1,301 458	$928,954	$884,719	$842,589	$802,466	$764,253	$727,860	$693,200	$660,191	$628,753	$598,812	$570,297	$543,140	$517,277	$492,644	$469,185	$446,843	$15,990,316
Accident reduction savings			$652,500	$652 500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$652,500	$11,745,000
Travel time savings			$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$7,951,183	$143,121,294
Operational benefits @ 10% of tt			$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$795,118	$14,312,129
SUM OF BENEFITS			$9,398,801	$9,398,801	$9,398,801	$9,398 801	$9,398 801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$9,398,801	$169,178,423
PW OF BENEFITS, I=5%			$8,524,990	$8,119,038	$7,732,417	$7,364 207	$7,013,530	$6,679,553	$6,361,479	$6,058,551	$5,770,049	$5,495,284	$5,233,604	$4,984,385	$4,747,033	$4,520,984	$4,305,699	$4,100,666	$3,905,396	$3,719,425	$104,636,290
PW B/C ratio, I=5%	**6.54**																				
B/C ratio	**7.06**																				

Itemized Benefit and Cost Elements: Scenario 2 (Phases 1 and 2 only)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	sum
O 2) 1 800 BUCKEYE	$10 000																				$10,000
C 9) Web Page	$6 000																				$6,000
C 11) ADVANTAGE	$133 000	$67 000																			$200,000
C 13) WIM	$450 000																				$450,000
O 4) In vehicle info		$250,000																			$250,000
D-1) FSP		$187,000																			$187,000
O-1) Broadcast info		$175 000	$175 000																		$350,000
C-6) CCIC		$374,000	$667 000	$165 000																	$1,206,000
C-10) RWIS		$198 000	$360 000	$180,000																	$738,000
D 4) CRS			$300 000	$235,000																	$535,000
C 7) Backbone & Network				$2,047,300	$2 047,300																$4 094 600
C 15) MayDay					$85,000																$85,000
D-6) VMS					$2 000,000	$1,980,000															$3 980 000
D 2) Rest area surveillance						$201,000															$201,000
O 3) Kiosks						$300 000	$150,000														$450,000
D 3) Incident detection							$667,000	$667,000	$666 000												$2,000,000
D 5) CMS							$255,000	$255,000	$255,000												$765,000
C 12) Parking management							$407,000	$407,000	$408,000												$1,222,000
TOTAL CAPITAL COSTS	$599 000	$1 251,000	$1,502 000	$2,627,300	$4,132,300	$2 481,000	$1 479,000	$1,329,000	$1,329,000												$16,729,600
Operating Costs		$15 000	$505 000	$1,215,000	$1,235,000	$1,540,000	$1,645,000	$1,945,000	$1,945,000	$1,945,000	$1,945,000	$1,945,000	$1,945,000	$1,945 000	$1,945,000	$1,945 000	$1,945,000	$1,945,000	$1,945,000	$1,945,000	$31,440,000
Maintenance @ 7%		$87,570	$105 140	$183 911	$289,261	$173,670	$103,530	$93,030	$93 030	$93,030	$93,030	$93,030	$93,030	$93,030	$93,030	$93 030	$93,030	$93,030	$93,030	$93,030	$2,152,472
Contingency @ 21%	$125 790	$262,710	$315 420	$551,733	$867,783	$521,010	$310,590	$279,090	$279,090												$3,513 216
SUM OF COSTS	$724,790	$1 616 280	$2,427 560	$4,577 944	$6,524,344	$4 715,680	$3,538,120	$3,646,120	$3,646,120	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$2,038,030	$53,835,288
PW OF COSTS, i=5%	$724 790	$1 539,314	$2,201,868	$3,954,600	$5,367,594	$3,694,659	$2,640,200	$2,591,229	$2,467,838	$1,313,732	$1,251,174	$1,191,594	$1,134,851	$1,080,811	$1,029,344	$980,327	$933,645	$889,166	$846,844	$806,518	$38,640,317
Accident reduction savings			$652 500	$652,500	$652,500	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305 000	$1,305,000	$21,632,500
Travel time savings			$7,951 183	$7,951,183	$7,951,183	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$262,389 054
Operational benefits @ 10% of tt			$795,118	$795,118	$795,118	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$26,238 905
SUM OF BENEFITS			$9,398 801	$9,398,801	$9 398,801	$18 797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18 797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$310,160,459
PW OF BENEFITS, i=5%			$8,524 990	$8,119,038	$7,732,417	$14,728,414	$14,027,061	$13,359,106	$12,722,958	$12,117,103	$11,540,098	$10,990,570	$10,467,209	$9,968,771	$9,494,067	$9,041,969	$8,611,399	$8,201,332	$7,810,793	$7,438,850	$184,896,146
PW B/C ratio, i=5%	5.05																				
B/C ratio	5.76																				

Itemized Benefit and Cost Elements: Scenario 3 (Phases 1, 2, and 3)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	sum
O 2) 1 800 BUCKEYE	$10 000																				$10,000
C 9) Web Page	$6 000																				$6,000
C-11) ADVANTAGE	$133 000	$67,000																			$200,000
C 13) WIM	$450 000																				$450,000
O-4) In vehicle info		$250 000																			$250,000
D 1) FSP		$187,000																			$187,000
O-1) Broadcast info		$175,000	$175,000																		$350,000
C-6) CCIC		$374 000	$667,000	$165,000																	$1,206,000
C 10) RWIS		$198,000	$360,000	$180,000																	$738,000
D-4) CRS			$300,000	$235,000																	$535,000
C 7) Backbone & Network				$2 047,300	$2,047,300																$4,094,600
C 15) MayDay					$85,000																$85,000
D-6) VMS					$2,000,000	$1,980,000															$3,980,000
D 2) Rest area surveillance						$201,000															$201,000
O 3) Kiosks						$300,000	$150,000														$450,000
D 3) Incident detection							$198,000	$198,000	$197,000												$593,000
D 5) CMS							$255,000	$255,000	$255,000												$765,000
C 12) Parking management							$407,000	$407,000	$408,000												$1,222,000
C 14) Oversized vehicles									$300,000	$204,000											$504,000
D 7) HAZMAT vehicles									$300,000	$178,000											$478,000
C 8) Communications connection										$400,000	$345,000										$745,000
TOTAL CAPITAL COSTS	$599 000	$1 251 000	$1,502,000	$2,627,300	$4,132,300	$2,481,000	$1 010 000	$860,000	$1,460,000	$782,000	$345,000										$17,049,600
Operating Costs		$15,000	$505,000	$1,215,000	$1,235,000	$1,540,000	$1 645 000	$1,960,000	$1,960,000	$1,960,000	$1,995,000	$1,995,000	$1,995 000	$1,995,000	$1,995 000	$1,995,000	$1,995,000	$1,995,000	$1,995,000	$1,995,000	$32,005,000
Maintenance @ 7%		$87,570	$105,140	$183,911	$289,261	$173,670	$70,700	$60,200	$102,200	$102,200	$102,200	$102,200	$102,200	$102 200	$102 200	$102,200	$102,200	$102,200	$102,200	$102,200	$2,196,852
Contingency @ 21%	$125 790	$262 710	$315,420	$551,733	$867,783	$521,010	$212,100	$180,600	$306,600	$164,220	$72,450										$3,580,416
SUM OF COSTS	$724,790	$1 616,280	$2,427,560	$4,577,944	$6,524,344	$4,715,680	$2,937,800	$3,060,800	$3,826,800	$3,028,420	$2,514,650	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$2,097,200	$54,831,868
PW OF COSTS, I=5%	$724 790	$1 539 314	$2,201,868	$3,954,600	$5,367,594	$3,694,859	$2,192,232	$2,176,253	$2,591,483	$1,952,147	$1,543,777	$1,226,189	$1,167,799	$1,112,190	$1,059,229	$1,008,789	$960,751	$915,001	$871,430	$829,933	$37,089,229
PW OF COSTS, I=3%	$724 790	$1,569 204	$2,288,208	$4,189,467	$5,796,795	$4,067,787	$2,460,361	$2,488,710	$3,022,490	$2,321,032	$1,871,136	$1,515,062	$1,470,934	$1,428 091	$1,386,496	$1,346,113	$1,306,906	$1,268,840	$1,231,884	$1,196,004	$42,950,311
PW OF COSTS, I=4%	$724 790	$1,554,115	$2,244,416	$4,069,776	$5 577,037	$3,875,945	$2,321,786	$2,325,956	$2,797,667	$2,127,728	$1,698,607	$1,362,301	$1,309,905	$1,259 524	$1,211,081	$1,164,501	$1,119,712	$1,076,646	$1,035,237	$995,420	$39,852,350
Accident reduction savings			$652,500	$652,500	$652,500	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$1,305,000	$2,446,875	$2,446,875	$2,446,875	$2,446,875	$2,446,875	$2,446,875	$2,446,875	$2,446,875	$2,446 875	$31,809,375
Travel time savings			$7,951,183	$7,951,183	$7,951,183	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$15,902,367	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$29,816,937	$387,620,184
Operational benefits @ 10% of tt			$795,118	$795,118	$795,118	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$1,590,237	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$2,981,694	$38,762 018
SUM OF BENEFITS			$9,398,801	$9,398,801	$9,398,801	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$18,797,604	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$35,245,506	$458,191,577
PW OF BENEFITS, I=5%			$8,524,990	$8,119,038	$7,732,417	$14,726,414	$14,027,061	$13,359,106	$12,722,958	$12,117,103	$11,640,098	$20,607,317	$19,626,016	$18,691,444	$17,801,375	$16,953,691	$16,146,372	$15,377,497	$14,645,236	$13,947,843	$258,887,878
PW OF BENEFITS, I=3%			$8,859,272	$8,601,235	$8,350,713	$16,214,978	$15,742,697	$15,284,172	$14,839,002	$14,406,798	$13,987,183	$25,462,103	$24,720,489	$24,000,474	$23,301,431	$22,622,749	$21,963,834	$21,324,111	$20,703,020	$20,100,019	$320,484,280
PW OF BENEFITS, I=4%			$8,689,720	$8,355,500	$8,034,135	$15,450,260	$14,856,019	$14,284,634	$13,735,225	$13,206,947	$12,698,988	$22,894,608	$22,014,239	$21,167,537	$20,353,401	$19,570,578	$18,817,864	$18,094,100	$17,398,173	$16,729,012	$286,351,140
PW B/C ratio, I=5%	6.92																				
PW B/C ratio, I=3%	7.46																				
PW B/C ratio, I=4%	7.19																				
B/C ratio	8.36																				

INPUT DATA FOR RATE-OF-RETURN ANALYSIS

		Costs and Benefits in $ thousands ($000)		
County/Code	**Section**	**cost**	**Null Condition Benefits**	**Improved Condition Benefits**
Medina/I71ITSM	MP202-226	4,700	2,140 8,025	857 1,605
Wayne/I71ITSA	MP195-202	1,380	630 2,358	252 472
Ashland/I71ITSS	MP178-195	3,320	1,513 5,667	605 1,133
Richland/I71ITSR	MP158-178	3,900	1,786 6,688	714 1,338
Morrow/I71ITSO	MP139-158	3,780	1,701 6,371	680 1,274
Delaware/I71ITSD	MP121-139	3,550	1,607 6,019	643 1,204
Total Project	**MP121-226**	20,630	9,400 35,200	3,760 7,040

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BENEFIT-COST

MED-71-MP202-226
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 4,700,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.83
Opening Year Benefit/Cost	1.66

Total

Design Year User Benefits	$	18,898,700
Opening Year User Benefits	$	8,206,538
Project Obligation Cost	$	4,935,000

Annual

Design Year User Benefits		2,219,834
Opening Year User Benefits	$	963,937
Project Obligation Cost	$	579,663

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BENEFIT-COST

WAY-71-MP195-202
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 1,380,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.83
Opening Year Benefit/Cost	1.67

Total

Design Year User Benefits		5,556,581
Opening Year User Benefits		2,417,827
Project Obligation Cost	I	1,449,000

Annual

Design Year User Benefits	$	652,674
Opening Year User Benefits	$	283,997
Project Obligation Cost	$	170,199

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BENEFIT-COST

ASH-71-MP178-195
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 3,320,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.83
Opening Year Benefit/Cost	1.67

Total

Design Year User Benefits	$	13,355,066
Opening Year User Benefits	$	5,807,900
Project Obligation Cost	$	3,486,000

Annual

Design Year User Benefits	$	1,568,681
Opening Year User Benefits	$	682,194
Project Obligation Cost	$	409,464

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BENEFIT-COST

RIC-71-MP158-178
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 3,900,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.85
Opening Year Benefit/Cost	1.67

Total

Design Year User Benefits	$	15,761,144
Opening Year User Benefits	$	6,856,905
Project Obligation Cost	$	4,095,000

Annual

Design Year User Benefits	$	1,851,298
Opening Year User Benefits	$	805,409
Project Obligation Cost	$	480,997

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BENEFIT-COST

MOR-71-MP139-158
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 3,780,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.78
Opening Year Benefit/Cost	1.65

Total

Design Year User Benefits	$	15,014,486
Opening Year User Benefits	$	6,530,690
Project Obligation Cost	$	3,969,000

Annual

Design Year User Benefits	$	1,763,596
Opening Year User Benefits	$	767,092
Project Obligation Cost	$	466,197

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BENEFIT-COST

DEL-71-MP121-139
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 3,550,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.80
Opening Year Benefit/Cost	1.65

Total

Design Year User Benefits	$	14,181,578
Opening Year User Benefits	$	6,166,098
Project Obligation Cost	$	3,727,500

Annual

Design Year User Benefits	$	1,665,763
Opening Year User Benefits	$	724,268
Project Obligation Cost	$	437,831

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BENEFIT-COST

Ohio-71-MP121-226
Interstate 71 ITS
20 Yr Design Life
10 % Discount Rate
$ 20,630,000 Project Cost

Design Year Rate of Return	24%
Design Year Benefit/Cost	3.83
Opening Year Benefit/Cost	1.67

Total

Design Year User Benefits	$	82,948,688
Opening Year User Benefits	$	36,075,504
Project Obligation Cost	$	21,661,500

Annual

Design Year User Benefits	$	9,743,121
Opening Year User Benefits	$	4,237,415
Project Obligation Cost	$	2‘544,352