CHITTENDEN COUNTY
METROPOLITAN PLANNING ORGANIZATION

INTELLIGENT TRANSPORTATION SYSTEMS (ITS) PROJECT DEVELOPMENT

FINAL REPORT

April 4, 2002

IBI GROUP

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Executive Summary

Introduction

This document presents the methodology and recommendations of the Intelligent Transportation Systems (ITS) Project Development project prepared on behalf of the Chittenden County Metropolitan Planning Organization (CCMPO). The consultant team was lead by IBI Group in association with Robert Chamberlain, Resource Systems Group, and Dr. Adel Sadek, Department of Civil and Environmental Engineering, University of Vermont. The cooperation and support of the Vermont Agency of Transportation, the Chittenden County Transit Authority, and other local stakeholders on the Steering Committee was also important to the implementation and success of the project. The study began in June 2001 and concluded in February 2002.

The objective of this project was to translate the recommendations of the *Chittenden County ITS Strategic Deployment Plan* into specific projects that can be incorporated into the regional Transportation Improvement Program (TIP). The recommended projects take into consideration the unique attributes of Chittenden County and present an efficient, effective means of deploying ITS to achieve both early success and long-term integration with regional, state, and interstate advanced technology infrastructure. Each recommended project was described in terms of its objectives, geographic scope, lead agency, functional requirements, anticipated benefits, costs, deployment timeline, and other relevant information.

The study findings culminate with a deployment plan and schedule illustrating the recommended implementation timeline over the next 10+ years.

Work Tasks & Findings

The study consisted of four tasks, described below:

- Review of the Chittenden County ITS Strategic Deployment Plan
- Develop the Project Development Process / Sample ITS Project
- Develop the Recommended ITS Projects
- Develop Final Report

Review of Chittenden County ITS Strategic Deployment Plan

The Chittenden County ITS Strategic Deployment Plan was reviewed as part of Task 1 of the Intelligent Transportation Systems Project Development effort.

The objectives of this review were as follows:

?? To ascertain the status of ITS planning and deployment in Chittenden County, including the region's ITS needs, vision, and goals;

?? Evaluate the recommendations of the Plan as they relate to project definition and deployment, including the timeframe and prioritization of projects; and

?? Recommend modifications and amendments to the Plan to advance the ITS program from strategic planning to project deployment in a proven and cost-effective manner.

The study review highlighted the need to shift emphasis from functional requirements to a prioritized, project-driven approach that gradually phases in ITS while demonstrating benefits and ensuring short-term operability.

Project Development Process

The Transportation Improvement Program (TIP) ITS projects were developed following the recommendations of the *Strategic Plan*, but also taking into account other relevant deployment considerations such as:

?? Opportunities for phased implementation;
?? The state of technology;
?? Use of ITS technologies and equipment to achieve multiple project purposes;
?? Opportunities to leverage construction projects and external funding sources for ITS implementation;
?? Inter-project and inter-modal coordination;
?? Coordination with state, inter-state, and federal ITS initiatives;
?? Developments since the completion of the Strategic Plan;
?? Lessons learned from other regions; and
?? "Early success" opportunities that produce tangible short-term benefits.

This, with the functional framework established for the region, is necessary to transform functional elements of the ITS system into project-based deployments that could be prioritized, programmed into the TIP, funded, and implemented strategically over time. The process used to achieve this is illustrated in Figure A on the following page.

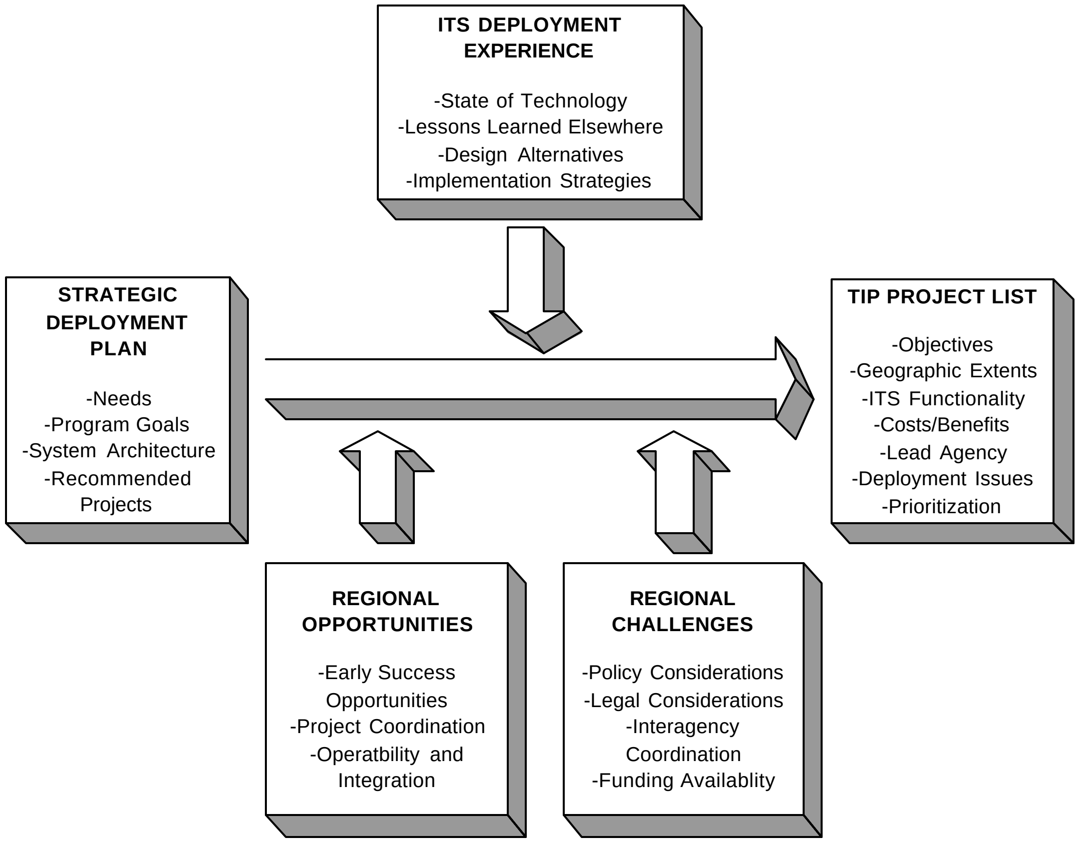

Figure A: Project Development Process

The outcome of the project development process was a set of project descriptions that sufficiently portrayed the nature and objectives of ITS projects for the Chittenden County region. The descriptions for each project contained the following information that outlined the important parameters of the project:

?? Project Description and Objectives
?? ITS Functional Areas
?? Geographic Extent
?? Estimated Cost
?? Anticipated Benefits
?? Lead Agency
?? Other Key Participants
?? Deployment Considerations
?? Deployment and Phasing
?? Funding Opportunities
?? Prioritization

When applicable, project benefits were analyzed using the Federal Highway Administration's ITS Deployment Analysis System (IDAS). IDAS is a sketch-planning tool for estimating the benefits and costs of ITS deployment, operating as a post-processor to traditional planning models. It can be applied where network models are available for existing traffic conditions, as well as specific information about the type and location of ITS information to be deployed. For projects analyzed through IDAS, a benefit/cost (b/c) ration has been provided.

A sample project (Shelburne Road Smart Corridor) was developed for the Steering Committee as an example and their feedback was instrumental in developing all project descriptions.

Project Descriptions

The following are short descriptions of the twelve recommended ITS projects. The projects are discussed in greater detail in Chapter 4 and Appendix A in the main body of the Final Report.

ITS-001: U.S. Route 7-Shelburne Road Smart Corridor

The Route 7-Shelburne Road Smart Corridor project is envisioned as a corridor traffic management system for one of the County's most important and congested arterials.

The Smart Corridor project could be implemented at reduced cost, and could provide the added benefit of mitigating the negative short-term traffic impacts of the construction period. The Smart Corridor is capable of operating initially as a freestanding traffic management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center. Traffic flow and traffic management options would be greatly enhanced by integrating key Route 7 signals in the southern part of the City of Burlington (just north of the reconstruction project boundary) in subsequent phases (this is proposed in the Shelburne Road Northern Extension Project).

ITS-002: U.S. Route 7 – Shelburne Road Smart Corridor Northern Extension

The section of Route 7 south of Burlington, also known as Shelburne Road, is a principle arterial in the region. This project will build upon that initial Shelburne Road Smart Corridor deployment and will continue the technology deployment to the portion of the corridor north of the reconstruction project, from I-189 to Downtown Burlington encompassing nine signalized intersections. This project will therefore extend signal coordination and other ATMS functionality ensuring that the benefits gained through the initial deployment are continued along the road. This project will

Table A: Recommended ITS Projects

Project Title	ITS Project No.	Estimated Cost	Deployment Schedule	Lead Agency
U.S. Route 7 – Shelburne Road Smart Corridor	ITS-001	Phase I: $207k Phase II: $653k	Phase I and II: Short-Term Phase III: Long-Term	VTrans
U.S. Route 7 – Shelburne Road Smart Corridor Northern Extension	ITS-002	Phase I: $566k Phase II: $50k Phase III: $24k	Medium Term – build on success of initial Shelburne Road project	VTrans
Interstate 89/189 ATMS	ITS-003	Phase I: $735k Phase II: $46k Phase III: $55k	Phase I and II: Short-Term	VTrans
Chittenden County Urban Traffic Management System	ITS-004	Phase I: $483k Phase II: $366k	Medium Term – Phase 1: 3 years, Phase 2: 4 years	CCMPO / VTrans
Circumferential Highway ATMS	ITS-005	Phase I: $458k Phase II: $24k	Phase I and II: Medium-Term	VTrans
Southern Connector ATMS	ITS-006	Phase I: $484k Phase II: $24k	*Medium* Phase I in Concert with road construction	City of Burlington
Traffic Management Information Center (TMIC) Enhancements	ITS-007	$364k	Medium Term (5 years) to coordinate individual projects	VTrans
Transit Automatic Vehicle Location (AVL)	ITS-008	Phase I: $271k Phase II: $260k	Phase I - High priority project for regional transit Phase II – medium term (3 years) Phase III – Long Term (6 years)	CCTA /SSTA
Integrated Fare Management	ITS-009	Phase I: $75k Phase II: $229k Phase III: $1,686k	Medium priority to take advantage of current investments being made by CCTA (5-1 0 years)	CCTA
Transit Traveler Information System	ITS-010	Phase I: $91k Phase II: $84k Phase III: $222k	Phase I- Near Term Phase II- in concert with broad AVL deployment (3 years) Phase III- Long term (> 5 years)	CCTA
Regional Traveler and Tourism Information System	ITS-011	Phase I: Web $210k Phase II: Kiosks $231k	Medium-Term (Within 5 years) to build on momentum created by initial projects	Vtrans
U.S. Route 15 ITS Improvements	ITS-012	Phase I: $342k Phase II: $216k Phase III: $24k	Medium Term	Vtrans

also ensure that conditions are not worsened at the boundary between the instrumented and non-instrumented sections due to improvement on the south section. The full benefits of signal coordination and preemption can only be realized through this geographic extension.

ITS-003: Interstate 89/189 ATMS

The section of I-89 from Exit 12 (VT 2A) to Exit 16 (U.S.7) I-89 and the I-189 spur to Shelburne Road are principal urbanized freeways in the region. There is a need to detect and respond effectively to incidents and address recurring congestion hotspots at exits 12, 14, 15 and 16. In addition, traffic congestion on Route 7-Shelburne Road creates delays for general motorists and emergency vehicles alike. This project will provide freeway monitoring and control for these sections of roadway and provide for integration with the Shelburne Road Smart Corridor project.

ITS-004: Chittenden County Urban Traffic Management System

There are a number of congestion hotspots within Chittenden County that can benefit from closer monitoring and intersection control. This project will provide monitoring and signal coordination for these key hotspots including, but not limited to: downtown Burlington and its key radial corridors (U.S. 2, U.S. 7, VT 15) and South Burlington, Winooski, Colchester and Essex Junction.

ITS-005: Circumferential Highway ATMS

The Circumferential Highway ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed.

ITS-006: Southern Connector ATMS

The Southern Connector ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed. The Southern Connector runs parallel to Route 7 and it will therefore be important to provide good information on travel conditions on the two instrumented roadways.

ITS-007: Traffic Management Information Center (TMIC) Enhancements

This project will consolidate and upgrade the central control software and hardware systems of previous advanced traffic management system deployments. The discrete desktop control systems from the individual projects will be integrated into a single regional traffic management system, operated from a shared central software platform. Advanced algorithms for response plans, signal coordination and emergency vehicle preemption will be implemented on the central system. The system will provide a central repository for regional data for use by other systems, including the traveler information system.

ITS-008: Transit Automatic Vehicle Location (AVL)

Automatic Vehicle Location (AVL) uses a vehicle mounted device which communicates the locations of the vehicle to a control center in real-time. The control center can then use this data to display the location of vehicles on a map for dispatcher use. The information can also be used to calculate schedule adherence; calculate headways; provide information to riders on route status and predicted arrival times; and for real-time assignment and routing functions in a paratransit system or deviated fixed route system. The data generated can also be used to calculate vehicular travel times for road sections for use in monitoring travel conditions and providing accurate traveler information. This system therefore can provide a particularly useful function by filling in gaps in regional travel time data from buses in non-instrumented, less urban areas.

ITS-009: Integrated Fare Management

This project will develop an integrated fare medium, such as a smart card, that will build on the existing magnetic card deployment to support bus, rail, parking, ferry applications, and possibly other retail/service locations in the region. The information stored and collected through this type of smart card could also provide valuable service and fare planning information to the region's transit providers. The fare medium would likely include a prepaid balance that would be decremented as the device is used to pay for services and/or purchases. The medium will support transfers, intermodal discounts and periodic passes.

ITS-010: Transit Traveler Information System

The transit traveler information system will provide travelers with access to real-time updates and transit planning capabilities when planning their trips or while en-route. A variety of dissemination media will be available including web, telephone, kiosks and specialized displays at bus stop locations. The system will disseminate both static data for planning purposes and real-time data for providing updates to travelers. This traveler information system will be combined with the regional traveler and tourist information system and with TRIO (TRaveler Information Online).

ITS-011: Regional Traveler and Tourism Information System

The regional traveler and tourist information system is a centralized system that consolidates and distributes static and real-time traveler, weather, and tourist information for transportation agencies and the general public. It will also form the regional data interface with the multi-state TRIO initiative.

ITS-012: U.S. Route 15 ITS Improvements

The Route 15 corridor is currently undergoing a multimodal alternatives analysis to improve capacity, travel options, and safety. This project will provide emergency vehicle preemption, and traffic monitoring/control instrumentation to support emergency vehicle operations, regional traffic management, signal coordination, and transportation planning.

Deployment

Figures B and C on the following pages illustrate the Deployment Plan and Schedule, respectively, for ITS projects in Chittenden County.

ITS Project Deployment Plan

The deployment plan, Figure B, designates projects as short term, medium term, or long term, and illustrates the interdependencies among them. The lead agency, project budget, and duration are also indicated for each. Note that short-term projects are either those with unique, time-dependent deployment opportunities and/or are "Early Success" projects that can deliver tangible benefits as freestanding deployments. Longer-term projects integrate the short-term projects into consolidated, regional systems that leverage existing deployments and enhance the traffic management, transit management, and traveler information capabilities of the regional ITS infrastructure.

Project Schedule

The schedule shown in Figure C shows a proposed deployment timeframe for each phase of the 12 projects. The duration for Design/Procurement and Implementation, in months, is also listed. Dynamic conditions such as funding availability, emerging project coordination opportunities, new technologies, and/or changing needs may influence the actual project deployment schedule.

Next Steps

The *ITS Strategic Plan* and the project list developed in this study are evolving documents that present an outlook and strategy for ITS deployment in Chittenden County. As such, they need to be updated as Chittenden County's transportation needs change and as technology changes. It is recommended that the *ITS Strategic Plan* and the project list be reassessed at regular and frequent intervals.

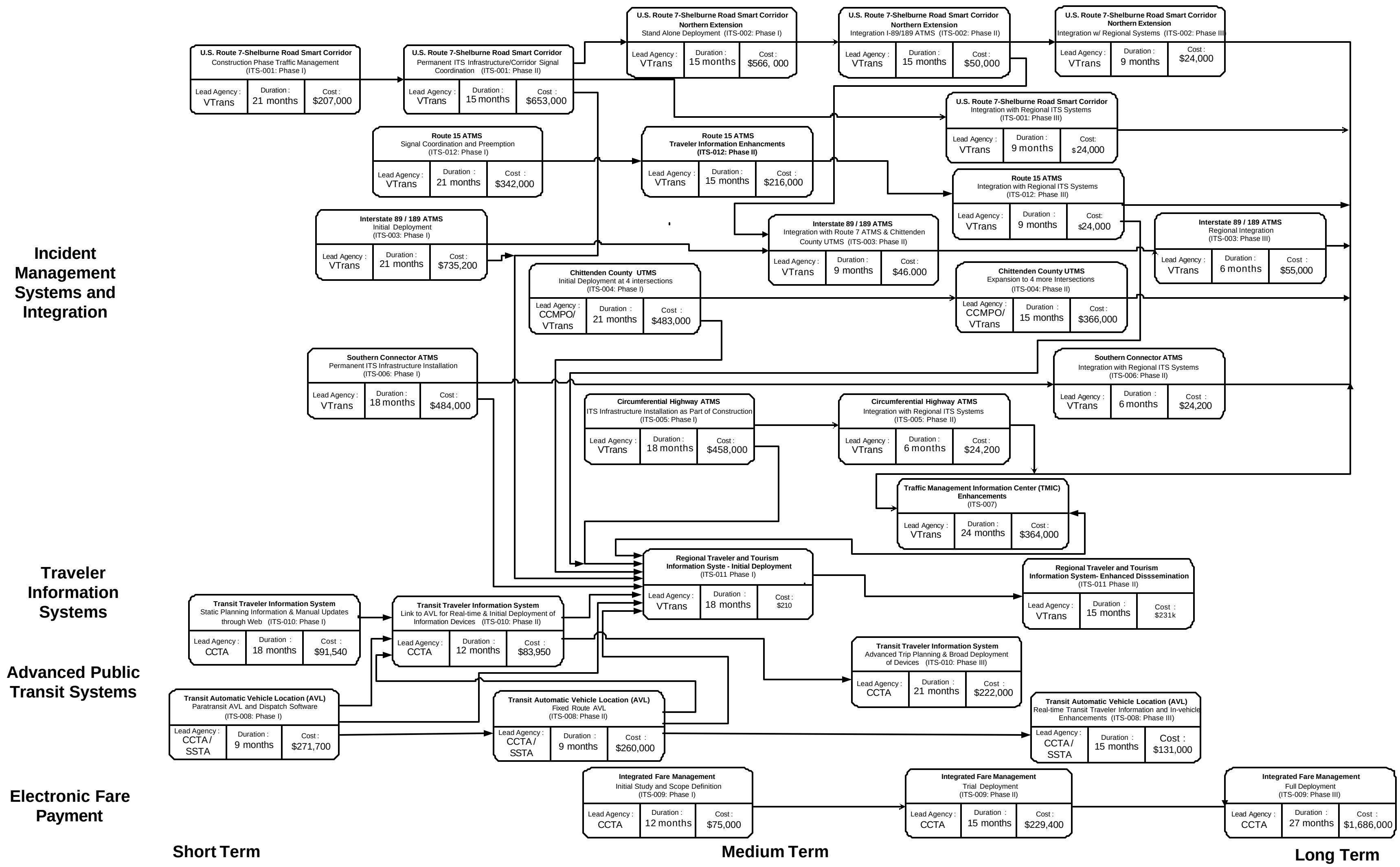

Figure B: Chittenden County ITS Project Deployment Plan

	Project Number	Design and Procure Duration	Implementation Duration	Total Duration
U.S. Route 7-Shelburne Road Smart Corridor	ITS-001			
Phase I: Construction Phase Traffic Management		9	12	21
Phase II: Permanent ITS Infrastructure/Corridor Signal Coordination		6	9	15
Phase III: Integration with Regional ITS Systems		6	3	9
U.S. Route 7 Shelburne Road Smart Corridor Northern Extension	ITS-002			
Phase I: Initial Deployment		6	9	15
Phase II: Integration I-89/189 ATMS		6	9	15
Phase III: Integration with Regional Systems		3	6	9
Interstate 89/189 ATMS	ITS-003			
Phase I: Initial Deployment		9	12	21
Phase II: Integration with Route 7 ATMS and Chittenden County UTMS		6	3	9
Phase III: Regional Integration		3	3	6
Chittenden County Urban Traffic Management System	ITS-004			
Phase I: Initial Deployment at 4 Intersections		9	12	21
Phase II: Expansion to 4 more Intersections		3	12	15
Southern Connector ATMS	ITS-005			
Phase I: Permanent ITS Infrastructure Installation		6	12	18
Phase II: Integration with Regional ITS System		3	3	6
Circumferential Highway ATMS	ITS-006			
Phase I: ITS Infrastructure Installation as part of Construction		6	12	18
Phase II: Integration with Regional ITS Systems		3	3	6
Traffic Management Information Center (TMIC) Enhancements	ITS-007			
		9	15	24
Transit Automatic Vehicle Location	ITS-008			
Phase I: Paratransit AVL and Dispatch Software		9	9	18
Phase II: Fixed Route AVL and Transit Traveler Information		6	6	12
Phase III: In-vehicle Enhancements		9	12	21
Integrated Fare Management	ITS-009			
Phase I: Initial Study and Scope Definition		3	9	12
Phase II: Trial Deployment		6	9	15
Phase III: Full Deployment		9	18	27
Transit Traveler Information System	ITS-010			
Phase I: Static Planning Information and Manual Updates through Web		3	6	9
Phase II: Link to AVL for Real-time and Initial Deployment of Information Devices		6	6	12
Phase III: Advanced Trip Planning and Broad Deployment of Devices		3	9	12
Regional Traveler and Tourism Information System	ITS-011			
Phase I: Database and Initial Dissemination		6	12	18
Phase II: Expanded Dissemination		6	9	15
VT Route 15 Corridor	ITS-012			
Phase I: Signal Coordination and Preemption		9	12	21
Phase II: Traveler Information Enhancement		6	9	15
Phase II: Integration with Regional Systems		6	3	9

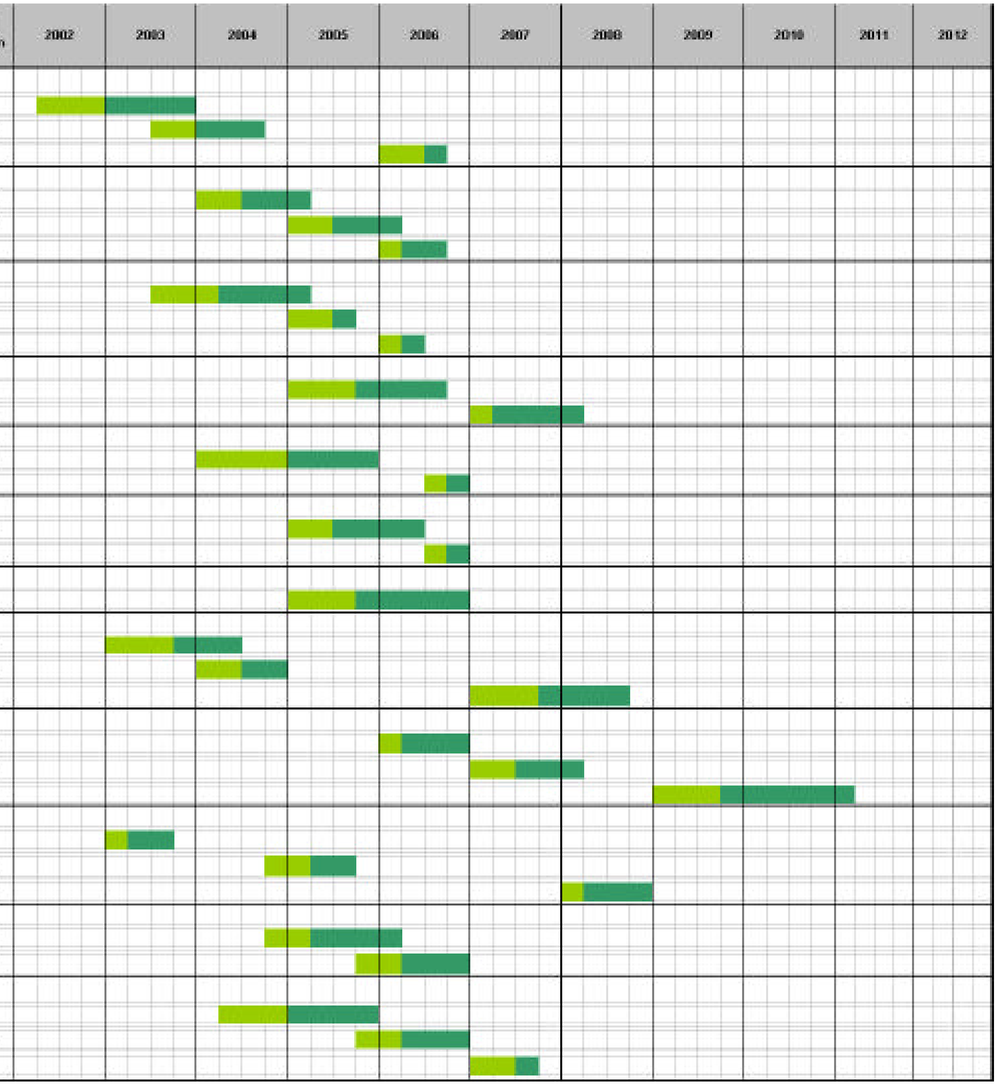

Figure C: Chittenden County ITS Proposed Project Deployment Schedule

In updating the project list, the following elements need to be considered:

1. Reassessment of the needs, existing ITS elements and institutional structure;
2. Reevaluation of the needed actions and associated functional requirements;
3. Reevaluation of the proposed system architecture strategies; and
4. Reevaluation of the specific list of proposed projects and their funding sources.

When the project list is reassessed, it is suggested that candidates for deployment should include:

?? Projects from the short-term implementation time frame which have not yet been implemented;
?? Projects from the medium-term implementation time frame;
?? Projects from the broader list of candidate actions identified in this study which were not originally identified as core; and
?? New initiatives/technologies that have emerged.

The consultant team also recommends that the Steering Committee continue to exist as a regional ITS Coordination Committee. Because the members of the Steering Committee make up the core interest group for the region, their continued involvement in the ITS planning and deployment process with expedite ITS development in the region and promote inter-agency dialog and coordination on ITS issues.

1. Introduction

This document presents the methodology and recommendations of the Intelligent Transportation Systems (ITS) Project Development project prepared on behalf of the Chittenden County Metropolitan Planning Organization (CCMPO). The study team was lead by IBI Group in association with Robert Chamberlain, Resource Systems Group, and Dr. Adel Sadek, Department of Civil and Environmental Engineering, University of Vermont. The study began in June 2001 and concluded in February 2002.

1.1 Objectives

The objective of this project was to translate the recommendations of the *Chittenden County ITS Strategic Deployment Plan* into specific projects that can be incorporated into the regional Transportation Improvement Program (TIP). The recommended projects must take into consideration the unique attributes of Chittenden County and present an efficient, effective means of deploying ITS to achieve both early success and long-term integration with regional, state, and interstate advanced technology infrastructure. Each recommended project is described in terms of its objectives, geographic scope, lead agency, functional requirements, anticipated benefits, costs, deployment timeline, and other relevant information.

The study findings culminate with a deployment plan and schedule illustrating the recommended implementation timeline over the next 10+ years.

The project development process is multi-modal in breadth, encompassing roadways, bus transit, paratransit, and commuter rail. The participation of key local stakeholders, including representatives from state, regional, and local entities, was critical to the success and credibility of this process.

1.2 Project Tasks

The project was composed of four tasks:

Task 1: Review of the ITS Strategic Plan: This task reviewed the ITS Strategic Plan for Chittenden County to identify functional needs and priorities, revisit the study's findings, and identify changes based on advances in technology, the experiences of other regions, and/or regional traffic conditions since the study was produced.

Task 2: Development of Project Development Process and Sample Project: This developed an ITS project development process based on similar national models and adapted to the specific needs of Chittenden County. A sample project description (the Shelburne Road Smart Corridor) was developed to illustrate the process.

Task 3: Development of ITS Projects: The ITS project development process was applied to generate the remainder of the short-term ITS projects presented in this report.

Task 4: Development of the Final Report: IBI Group has prepared a Final Report documenting the background, methodology, and recommendations of this study.

1.3. Approach

A one-size-fits-all approach to metropolitan ITS planning is not appropriate in Chittenden County given its overall size and its mixed urban/suburban/rural character. The general approach to this project was to combine the region's unique attributes and needs with ITS "lessons learned" and demonstrated benefits from other regions. In addition, it is important that the deployment plan is realistic in terms of the scale and phasing of the deployment, ensuring free-standing operability of projects in the short term.

Other key aspects of the approach include:

- **Responsiveness to Regional Needs:** Large-scale traffic management solutions typical in larger metropolitan areas were not necessarily relevant in an area such as Chittenden County. The scale and cost of the ITS projects proposed, as well as the deployment plan for those projects, must be appropriate to the size of the region and its combination of rural and metropolitan transportation characteristics.

- **Multi-Functional ITS Technologies:** To maximize the value of ITS deployments in Chittenden County, the projects have been developed so that when possible ITS equipment can serve more than one purpose. For example, it is prohibitively expensive to deploy traffic detectors throughout the County's roadway system for traffic management. However, in certain corridors, the onboard Automatic Vehicle Location (AVL) equipment on CCTA transit vehicles can be used as traffic "probes" to collect data on traffic conditions, in addition to improving transit management.

- **Inter-Regional and Interstate Coordination:** While the boundaries of this project were limited to Chittenden County, regional ITS projects will be impacted by statewide and inter-state initiatives. An example is the TRaveler Information Online (TRIO) initiative involving Vermont, New Hampshire, and Maine. Integration opportunities and issues involving external projects have been considered and highlighted in the project descriptions.

- **ITS as a Solution to Real Needs:** The *Strategic Plan* develops a regional ITS architecture based on real transportation needs, and this project has involved consultation of the Steering Committee to determine their real day-to-day concerns. This linkage is critical to avoid the circumstance where technology is "a solution looking for a problem." Such projects tend to lack tangible benefits to justify the investment, and create poor public perceptions of ITS.

?? **Incremental Deployment Based Upon Early Success:** Early success projects, i.e., low-cost deployments which demonstrate real benefits within a short timeframe, build momentum and confidence for the ITS program. These projects address short term needs while providing a basis for eventual region-wide deployments. For example, a construction traffic management system operating out of a project trailer is a modest project in itself, but it demonstrates the potential of the technology while preparing agencies for the new operational mindset that ITS requires.

1.4 Project Steering Committee

The following individuals comprise the Project Steering Committee:

Dan Bradley
City of Burlington
Department of Public Works

George Gerecke
Town of Williston

Richard Hosking
District Administrator
Vermont Agency of Transportation
District #5

Amy Jestes
Planning Coordinator
Vermont Agency of Transportation
Policy & Planning Division

Bruce Bender
Senior Planner
Vermont Agency of Transportation
Policy & Planning Division

E.J. Blondin
Vermont Agency of Transportation
Construction Division

Jeanette Berry
Planner
Chittenden County Transit Authority

Murray Benner
Executive Director
Special Services Transportation Agency

Albert (Sonny) Audette
Town of South Burlington

Lew Wetzel
Town of Colchester

Chris Jolly
Federal Highway Administration

James Bush
Federal Highway Administration

Dan Grahovac
Vermont Agency of Transportation

Ann Kreis
Vermont Agency of Transportation

Peter Keating
Senior Planner
Chittenden County Metropolitan Planning Organization

1.5 Abbreviations

Abbreviations used in this report are listed below:

APTS	Advanced Public Transportation System
ATIS	Advanced Traveler Information System
ATMS	Advanced Traffic Management System
AVL	Automatic Vehicle Location
CCMPO	Chittenden County Metropolitan Planning Organization
CCTA	Chittenden County Transit Authority
CMS	Changeable Message Sign
GPS	Global Positioning System
HAR	Highway Advisory
IDAS	ITS Deployment Analysis System
ITS	Intelligent Transportation Systems
SSTA	Special Services Transportation Agency
TIP	Transportation Improvement Plan
TRIO	TRaveler Information Online, (VT-NH-ME Traveler Info. System)
TMIC	Traffic Management Information Center
VMS	Variable Message Sign
VTrans	Vermont Agency of Transportation

2. Review of Chittenden County ITS Strategic Deployment Plan

2.1 Introduction

This chapter summarizes IBI Group's review of the *Chitttenden County Intelligent Transportation Systems (ITS) Strategic Deployment Plan* (CCMPO, September 20, 2000). This document was reviewed in partial fulfillment of the requirements of Task 1 of the *Intelligent Transportation Systems Project Development* effort.

The objectives of this review were as follows:

?? To ascertain the status of ITS planning and deployment in Chittenden County, including the region's ITS needs, vision, and goals;

?? Evaluate the recommendations of the Plan as they relate to project definition and deployment, including the timeframe and prioritization of projects; and

?? Recommend modifications and amendments to the Plan to advance the ITS program from strategic planning to project deployment in a proven and cost-effective manner.

The *Chitttenden County Intelligent Transportation Systems (ITS) Strategic Deployment Plan* was designed to facilitate the deployment and coordination of ITS in Chittenden County. The plan was based on the Federal Highway Administration's National ITS Architecture as well as local stakeholder input to define a strategy that meets the specific needs of the region.

The major steps in the planning process included: Identification of Transportation Issues/Problems in Chittenden County; Development of a Vision of the Regional ITS System; Development of an ITS Market Package Plan; Development of an ITS System Architecture; Identification of Recommended ITS Projects; and Development of an ITS Program Evaluation Plan.

2.2 Findings of the Review

Based on our review of the Plan and prevailing traffic conditions, the following issues were recommended to be taken into consideration when developing project descriptions and an ITS deployment plan:

?? **Functional vs. Project Planning:** It is logical and appropriate for strategic ITS planning to occur at a functional level, because this approach clearly articulates the link between transportation needs and potential ITS solutions. However, experiences elsewhere show that it is often more advantageous to *deploy* ITS through a series of multi-functional, corridor-specific projects rather than function-by-function. This is because of a number of practical considerations which are discussed below;

?? **Information Dissemination as an Early Priority:** There are a number of low-cost, high visibility information dissemination technologies that can be deployed in the short term in conjunction with early traffic surveillance projects;

?? **Probe Surveillance:** Consider re-introduction of excluded market package ATMS02, Probe Surveillance, to take advantage of the state's interest in using Automatic Vehicle Location (AVL) to collect traffic information;

?? **Traffic Management and Information Center:** The region should consider deploying the Traffic Management and Information Center (TMIC) in stages on a corridor-by-corridor basis, rather than function-by-function as suggested in the Plan. This approach offers practical advantages in terms of funding potential, deployment lead-time, interagency coordination, and "early success" system effectiveness.

These points are discussed in greater detail below.

2.3 Functional Planning vs. Project-Based Deployment

The ITS Plan rightly described the ITS architecture and needs in terms of *functionality*, i.e., surveillance, traveler information, incident management, etc. This was important because it articulated the connection between transportation needs, goals, and objectives and the capabilities of ITS technology. This is the foundation of any viable ITS system architecture.

In terms of ITS *deployment*, however, it is not always feasible or desirable to implement ITS function-by-function. More often, ITS projects are implemented project-by-project or corridor-by-corridor, often in conjunction with broader (non-ITS) construction or enhancement projects.

Such projects tend to contain multiple ITS functionalities over a limited geographic area. Of course, these initial projects must contain a "critical mass" of equipment in order to function as effective stand-alone implementations, until additional project are brought online.

Advantages of this approach are as follows:

?? It is generally easier to fund ITS in conjunction with broad-based projects (new roadway construction; roadway widening/improvement projects; transit vehicle procurements, etc.) than as stand-alone initiatives;

?? ITS benefits often derive from the interaction of multiple functionalities (e.g., surveillance, control, and information dissemination). Thus, deployment of several ITS technologies will yield more benefits and be more successful in building momentum for the program;

?? When funding is limited, the highest-need corridors can be addressed first, reserving less urgent areas until a later time when additional funding becomes available;

?? The demonstrated early success of a "smart corridor" will be more visible to the public and stakeholders, and will help to garner momentum for further roll-out of the ITS program; and

?? Because ITS infrastructure often introduces new organizational responsibilities and behaviors, inter-jurisdictional issues, and new operational requirements, implementing complex projects over a limited area can help to test and refine agency responsibilities and procedures at a more manageable scale.

A key to the success of this approach is that ITS investments must be implemented with *future expansion and integration* in mind. The National ITS Architecture is designed to promote interoperability and expansion, but other issues such as jurisdiction, equipment and software compatibility, and the capacity of communications infrastructure must also be taken into account.

Corridor-based early success opportunities include the U.S. Route 7/Shelbourne Road reconstruction project and the VT 289 circumferential highway project.

2.4 Information Dissemination Projects in the Short Term

The Plan logically advocates investing in traffic surveillance and traffic technologies to collect information before information dissemination technologies. Only "Broadcast Traveler Information" is suggested in the Short Term, while "Traffic Information Dissemination," "Roadway Weather Information Systems," and "Interactive Traveler Information" are classified as medium-term packages.

This prioritization was premised on the logical fact that one must collect traffic information before it can be disseminated. However, it illustrates one more advantage of the project-based, multi-functional approach to ITS deployment, whereby surveillance and information dissemination can be deployed simultaneously over a discrete geographic area.

It was recommended that the CCMPO deploy relatively simple, low-cost information dissemination technologies in the short term in conjunction with early smart corridor ITS initiatives. These can include traveler information websites or a limited network of

Changeable Message Signs or Highway Advisory Radio (including temporary CMS or HAR installations in conjunction with major construction projects).

This approach was suggested in order to promote high-visibility, early success projects that provide tangible benefits to the traveling public rather than delaying those benefits until the system is more fully deployed.

2.5 Probe Surveillance

Table 6 on page 13 of the Plan discusses National ITS Architecture market packages that were excluded from analysis because they were considered "inappropriate or unsuitable for deployment in Chittenden County." Among these is market package ATMS02, Probe Surveillance.

Because the State of Vermont Agency of Transportation has applied for funding for Automatic Vehicle Location (AVL) to track transit vehicles and collect traffic information, it was recommended that this package be re-included. Probe surveillance using AVL (particularly GPS-based) can be used to collect traffic information (travel time, speed, etc.) as well as information on the location of transit vehicles. Probe Surveillance is very effective in rural areas where the use of traditional detectors is costly.

2.6 Implementation of the Traffic Management and Information Center (TMIC)

Section 7 of the Plan described recommended ITS projects for Chittenden County based upon the selected market packages and system architecture. These are:

- Advanced Traffic Signal Systems (§7.1)
- Chittenden County Traffic Management and Information Center (§7.2)
- Advanced Public Transit Systems (§7.3)
- ITS Planning and Data Archiving (§7.4)

Section 7.2. discussed a planned Traffic Management and Information Center (TMIC) consisting of surveillance, incident management and traveler information elements. The TMIC would be located in a strategic location such as a VTrans office, a State Police barracks, CCMPO, or at a new downtown Burlington Multimodal Center. The latter location may provide additional funding options if space construction/improvements for the TMIC was included in the development of a multi-modal center.

The deployment of the TMIC was envisioned in the Plan as a series of functional sub-projects, beginning with setting up the TMIC, followed by sequential deployment of: network surveillance equipment; Changeable Message Signs (CMS)/Highway Advisory Radio (HAR); an Incident Management Information System; and a pre-trip traveler information system.

As discussed above, there are practical reasons for implementing the TMIC in a project-based format rather than function-by-function:

?? There is unlikely to be adequate funding to implement these project in this stand-alone, region-wide fashion; and

?? The public and stakeholders will not realize immediate benefit from the early "behind the scenes" investments; and

?? The system will be functionally "one-sided" (i.e., all surveillance) until the latter phases of the project are brought online. Thus the TMIC will not be able to realize significant "early success" benefits.

Based on the Consultant's experience, a preferable alternative approach would be to implement the project on a corridor-by-corridor or project-by-project basis with diverse ITS functionality in each stage. The system would gradually grow in geographic area as new corridor or specialized functional enhancements are brought online. A modest amount of up-front TMIC planning and development of inter-agency operation and funding agreements will still be required, but this may be included under the umbrella of an early, large-scale corridor deployment project (e.g., Route 7) or construction management project.

Adopting this approach would suggest that the second and third tracks of the Project Deployment and Sequencing Plan (Section 7.5) would be more closely intertwined, as the TMIC was initiated and gradually enhanced as Track 2 corridor projects were brought online.

3. ITS Project Development Process

3.1 Introduction

This chapter discusses the ITS project development process that was used to generate specific ITS projects for incorporation into the Transportation Improvement Program (TIP). These ITS projects were developed following the recommendations of the *Strategic Plan*, but also taking into account other relevant deployment considerations. The project development process was initially illustrated for the Steering Committee using an example project, entitled the U.S. Route 7-Shelburne Road Smart Corridor (project ITS-001).

3.2 Identification of Deployment Opportunities

The Project Development Process is illustrated in Figure 1. While it was imperative to maintain and demonstrate the connection between the ITS TIP projects and the *Strategic Deployment Plan*, a number of other factors were also taken into consideration. These include:

?? Regional deployment opportunities and challenges,
?? The state of technology, and
?? Lessons learned from other regions.

Some important principles that could be garnered from ITS deployments around the United States are as follows:

Identifying Early Success Projects: In order to build momentum for the ITS program in its early phases when it is unproven to stakeholders and the traveling public, the TIP projects should address high-priority transportation needs and corridors in the region. Thus the benefits of ITS will be most immediately apparent and have the highest benefit/cost ratios for the region.

Coordination with Programmed Construction and Rehabilitation Projects: It is advantageous to implement ITS in conjunction with larger, broad-based transportation projects for several reasons. First, up-front capital costs for ITS installation are often lower if equipment and communications installation takes place concurrent with other transportation construction. To take an example, trench excavation work occurring as part of a highway project may be used to install ITS fiber-optic conduit as well. Second, ITS elements may be able to mitigate construction phase disruptions to the traffic network. Third, construction or construction mitigation may open up funding mechanisms for ITS deployment that are not available for stand-alone projects. Less tangible, but equally important, coordination of ITS with other improvements in the regional transportation system emphasizes that ITS is an integral part of the transportation network.

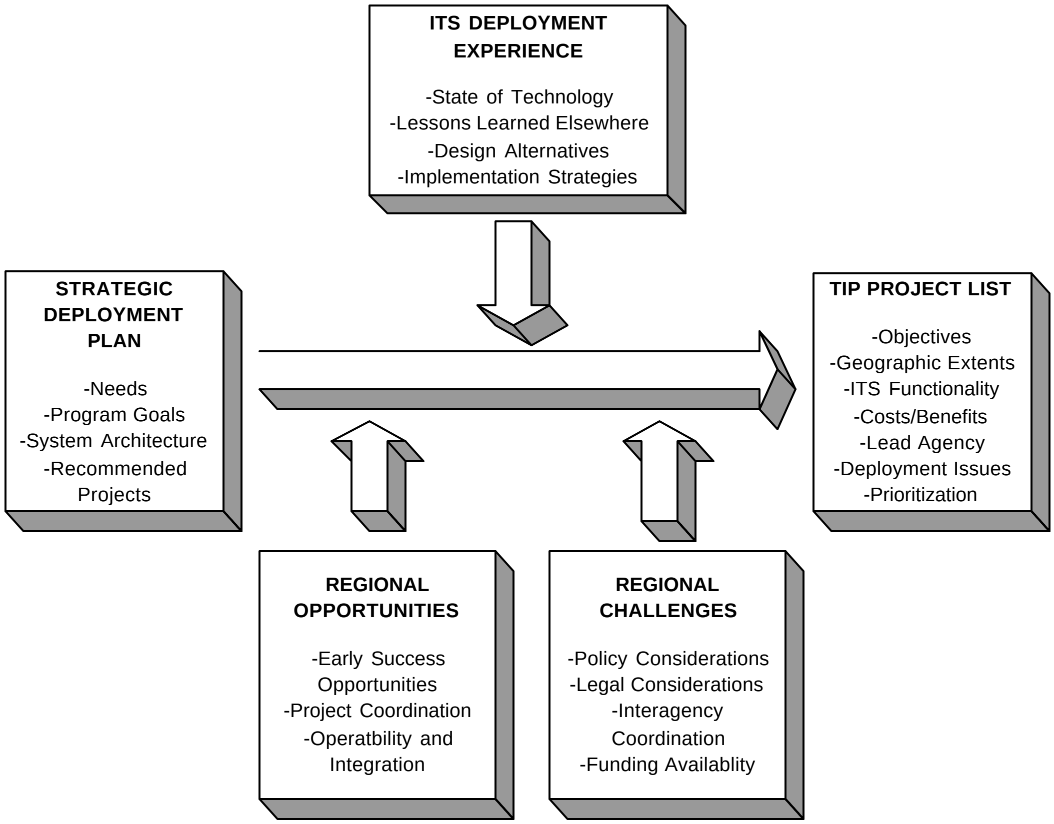

Figure 1. Project Development Process.

Identifying Funding Opportunities: Funding availability influences the prioritization and definition of ITS projects. It is necessary to consider the availability of funding from federal, state, and local agencies (including those agencies' overall objectives for the use of the funds), and the selection criteria for specific programs (e.g., Congestion Mitigation and Air Quality (CMAQ), USDOT demonstration programs, etc.)

Operability and Integration: As stated earlier, the early initiatives in the ITS program should be engineered to demonstrate significant and tangible benefits. They should also form the foundation for future expansion of the ITS systems. Therefore short-term ITS projects should meet two important criteria:

?? Projects programmed earlier in the TIP must have the adequate **short-term "critical mass"** to operate effectively as a stand-alone system in the initial phase. In other words, a deployment must contain enough ITS infrastructure, and cover an appropriate geographic extent to effectively achieve a meaningful transportation objective; and

?? Projects programmed earlier in the TIP must be designed for **long-term expansion and integration** (functional and/or geographic) with other ITS deployments, in accordance with the system architecture described in the *Strategic Plan*. This approach ensures that the ITS system is converging towards a common, integrated regional system rather than scattered and independent systems.

3.3 Descriptive Requirements for TIP ITS Projects

The outcome of the project development process was a set of project descriptions that sufficiently portrayed the nature and objectives of ITS projects for the Chittenden County region. The descriptions for each project contained the following information that outlined the important parameters of the project:

Project Description and Objectives

A general overview was given for each project, including each project's objectives and the relationship to broad-based mobility needs and goals. This overview described the operational capabilities of the project, suggested candidate technologies, and described the anticipated impacts and benefits.

ITS Functional Areas

The relevant ITS functional areas and/or market packages from the National ITS architecture were identified. This illustrated the linkages between the project and the functional objectives of the *Strategic Plan*, which had to be demonstrated in order to apply federal funds toward the project.

Geographic Extents

The approximate geographic extent of the project was described. Example project extents are: localized ("spot") projects; corridor; regional; or inter-regional; statewide; interstate; and international.

Estimated Cost

The estimated cost of the project was provided on an "order of magnitude" basis. Where possible, costs were broken down by line item on a per-unit basis for ease of understanding. These cost estimates were based on the consultant team's professional judgment from similar applications, and the team's understanding of the region.

Anticipated Benefits

Anticipated project benefits were also identified in the project development process based on IDAS (ITS Deployment Analysis System, explained further in section 3.4) modeling and/or other rule-of-thumb statistics published by the US

DOT or other agencies. These benefits can take numerous forms, from improved travel times to reduce vehicle emissions or lower operating costs.

Lead Agency

The public agency or agencies judged to be the most appropriate lead agency for each deployment were identified.

Other Key Participants

Principle stakeholders and agencies whose cooperation and support is critical to the implementation and success of the project were also identified.

Deployment Considerations

Jurisdictional, policy, legal, or other special considerations were identified to the fullest extent possible. These are issues that needed to be addressed in order to insure the success of the project.

Deployment and Phasing

Project deployment alternatives, such as phased implementation options, were described where relevant.

Funding Opportunities

Targeted funding opportunities (other projects, federal or state programs, etc.) for this project were identified where relevant.

Prioritization

The relative deployment priority for each project was identified as Short Term (0-5 years), Medium-Term (5-10 years), or Long Term (10+ years). Within each of those categories the most desirable deployments were indicated in the event that funding were not available for all projects within a given time horizon.

3.4 Benefits Estimation Using IDAS

When applicable, project benefits can be analyzed using the ITS Deployment Analysis System (IDAS) developed for the Federal Highway Administration. IDAS is a sketch-planning tool for estimating the benefits and costs of ITS deployment, operating as a post-processor to traditional planning models. It can be applied where network models are available for existing traffic conditions, as well as specific information about the type and location of ITS information to be deployed. For projects analyzed through IDAS, a benefit/cost (b/c) ration has been provided.

General Methodology of IDAS

The benefits evaluated by IDAS can be categorized under four main areas, namely: (1) Travel time/Throughput benefits; (2) Environmental benefits; (3) Safety-related benefits; and (4) Travel-time reliability benefits (i.e. reductions in travel time variability). Examples of the specific impacts evaluated include changes in user mobility, travel time/speed, travel time reliability, fuel costs, operating costs, accident costs, emissions, noise, among others.

Although IDAS is a sketch-planning tool, it actually runs the modal split and the traffic assignment steps of the traditional planning process itself, because these two steps are central to estimating the changes in the mode, route, and time of departure choices resulting from ITS deployments.

Estimating ITS benefits using IDAS involves running the 4-step transportation-planning model, along with IDAS's postprocessor modules designed for estimating ITS deployment impacts, twice. The first run involves running the model for the base case (i.e. without the planned ITS components), while the second run involves running it with the planned ITS components in place. Before running the model for the ITS case, however, IDAS adjusts the network parameters that are likely to be impacted by ITS deployment.

Adjustments are made based upon default values stored in IDAS benefits database that was compiled from numerous evaluations of observed and simulated impacts of the different ITS technologies from all over the country. For example, deploying a coordinated traffic signal system signal along a corridor is assumed by IDAS to increase the capacity of that corridor by between 13 and 20%, with the exact value depending upon site-specific factors such as demand variability, time between timing plans update, etc. With the parameters adjusted, the transportation model is run for the second time, and a comparison of travel conditions between the base case and the ITS case then gives an estimate of the benefits to be expected from that particular ITS project.

4. Chittenden County ITS Project Descriptions

4.1 Introduction

This chapter presents the twelve Project Descriptions and the Regional ITS Deployment Plan based on the ITS project development process and the Committee-approved ITS project list. These ITS projects were developed following the recommendations of the *ITS Strategic Deployment Plan for Chittenden County*, but also take into account other relevant deployment considerations. The functional elements of the *ITS Strategic Plan* have been translated into project-based deployments that can be prioritized, programmed into the TIP, funded, and implemented strategically over time.

A list of initial project descriptions was presented to the Steering Committee in August of 2001 for approval. An initial draft of 11 project descriptions was presented to the Steering Committee on November 29, 2001, based upon the format of the Shelburne Road Smart Corridor sample project presented. In January 2002, the consultant team was asked to add an additional project for the VT Route 15 Corridor. All twelve Project Descriptions and the ITS Deployment Plan were finalized in February 2002, based on comments received from the Steering Committee. Appendix B identifies the written comments that were received and identifies the changes that were made to the project descriptions in the course of review.

The following important points must be kept in mind during further project planning and implementation:

1.) Privacy issues surrounding the use of video surveillance cameras is significant in Vermont, however we have included video monitoring technology in the descriptions in order to satisfy the functional needs. There are potential technical solutions to mitigate privacy concerns, including digital blurring of images at the camera or use infrared cameras. The use of this video should be further reviewed at them time of design and may result in changes to the overall project functionality deployed.

2.) Many of these projects include significant reliance on communications infrastructure. In some cases, particularly where video is recommended, a high bandwidth regional telecommunications network would provide significant functionality and possibly cost benefits to the projects. These needs should be coordinated with other regional municipal telecommunications needs to ensure that any regional communications network development will effectively serve the Chittenden County ITS projects.

4.2 ITS Projects

Table 1 below summarizes the ITS projects identified and described during this study. Full project descriptions for each are provided as Appendix A.

Project Title	ITS Project No.	Estimated Cost	Timeframe	Lead Agency
U.S. Route 7 – Shelburne Road Smart Corridor	ITS-001	Phase I: $207k Phase II: $653k	Phase I and II: Short-Term Phase III: Long-Term	VTrans
U.S. Route 7 – Shelburne Road Smart Corridor Northern Extension	ITS-002	Phase I: $566k Phase II: $50k Phase III: $24k	Medium Term – build on success of initial Shelburne Road project	VTrans
Interstate 89/189 ATMS	ITS-003	Phase I: $735k Phase II: $46k Phase III: $55k	Phase I and II: Short-Term	VTrans
Chittenden County Urban Traffic Management System	ITS-004	Phase I: $483k Phase II: $366k	Medium Term – Phase 1: 3 years, Phase 2: 4 years	CCMPO / VTrans
Circumferential Highway ATMS	ITS-005	Phase I: $458k Phase II: $24k	Phase I and II: Medium-Term	VTrans
Southern Connector ATMS	ITS-006	Phase I: $484k Phase II: $24k	*Medium* Phase I in Concert with road construction	City of Burlington
Traffic Management Information Center (TMIC) Enhancements	ITS-007	$364k	Medium Term (5 years) to coordinate individual projects	VTrans
Transit Automatic Vehicle Location (AVL)	ITS-008	Phase I: $271k Phase II: $260k	Phase I - High priority project for regional transit Phase II – medium term (3 years) Phase III – Long Term (6 years)	CCTA /SSTA
Integrated Fare Management	ITS-009	Phase I: $75k Phase II: $229k Phase III: $1,686k	Medium priority to take advantage of current investments being made by CCTA (5-1 0 years)	CCTA
Transit Traveler Information System	ITS-010	Phase I: $91k Phase II: $84k Phase III: $222k	Phase I- Near Term Phase II- in concert with broad AVL deployment (3 years) Phase III- Long term (> 5 years)	CCTA
Regional Traveler and Tourism Information System	ITS-011	Phase I: Web $210k Phase II: Kiosks $231k	Medium-Term (Within 5 years) to build on momentum created by initial projects	Vtrans
U.S. Route 15 ITS Improvements	ITS-012	Phase I: $342k Phase II: $216k Phase III: $24k	Medium Term	Vtrans

Table 1. Recommended ITS Projects

4.3 ITS Project Descriptions

The following is a brief description of each project. Full descriptions can be found in Appendix A.

4.3.1 ITS-001: U.S. Route 7-Shelburne Road Smart Corridor

The Route 7-Shelburne Road Smart Corridor project is envisioned as a corridor traffic management system for one of the County's most important and congested arterials.

The objectives of the project include:

?? Improving construction management and mitigating construction-related congestion;
?? Increasing the user-friendliness of the corridor;
?? Improved monitoring and control of the corridor to reduce congestion;
?? Providing traveler information about conditions in the corridor to the public;
?? Coordinating traffic signal operation in the corridor, eventually including key signals in on Route 7 within the City of Burlington;
?? Providing signal preemption for emergency vehicles in the corridor; and
?? Collecting transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

By coordinating this project with the reconstruction of Shelburne Road, it could be implemented at reduced cost, and could provide the added benefit of mitigating the negative short-term traffic impacts of the construction period. The Smart Corridor is capable of operating initially as a freestanding traffic management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center. Traffic flow and traffic management options would be greatly enhanced by integrating key Route 7 signals in the southern part of the City of Burlington (just north of the reconstruction project boundary) in subsequent phases (this is proposed in the Shelburne Road Northern Extension Project).

4.3.2 ITS-002: U.S. Route 7 – Shelburne Road Smart Corridor Northern Extension

The section of Route 7 south of Burlington, also known as Shelburne Road, is a principle arterial in the region. This project will build upon that initial Shelburne Road Smart Corridor deployment and will continue the technology deployment to the portion of the corridor north of the reconstruction project, from I-189 to Downtown Burlington encompassing nine signalized intersections. This project will therefore extend signal coordination and other ATMS functionality ensuring that the benefits gained through the initial deployment are continued the along the road. This project will also ensure that conditions are not worsened at the boundary between the instrumented and non-instrumented sections due to improvement on the south section. The full benefits of signal coordination and preemption can only be realized through this geographic extension.

This project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

- Build on the initial ITS deployments on the Southern end of this corridor help to create an ITS critical mass, fulfilling VTrans' desire to increase the user-friendliness of the corridor;
- Improve monitoring and control to reduce congestion and prevent future congestion in the corridor;
- Build on a solid foundation towards the overall regional architecture.
- Support coordination with the Interstate 89/189 ATMS project to enable congestion reduction and improved emergency vehicle access at the I-189 and Route 7 intersection.
- Provide traveler information about conditions in the corridor to the public;
- Coordinate traffic signal operation including key signals in on Route 7 within the City of Burlington;
- Provide signal preemption for emergency vehicles in the corridor; and
- Collect transportation planning data on roadway performance, including data for a before-and-after study of the travel time benefits of the ITS infrastructure.

4.3.3 ITS-003: Interstate 89/189 ATMS

The section of I-89 from Exit 12 (VT 2A) to Exit 16 (U.S.7) on I-89 and the I-189 Spur to Shelburne Road are principal urbanized freeways in the region. There is a need to detect and respond effectively to incidents as well as recurring congestion hotspots at exits 12, 14, 15 and 16 and issues with traffic flowing on to Route 7, Shelburne Road, particularly when emergency vehicles need to use this spur. This project will provide freeway monitoring and control for these sections of roadway and provide for integration with the Shelburne Road Smart Corridor project.

The Interstate 89/189 ATMS project has the following objectives that are consistent with the problems, opportunities, program goals and objectives described in the Chittenden County ITS strategic deployment plan:

- Fulfill VTrans' desire to increase the user-friendliness of the corridor;
- Improve monitoring and control to improve incident detection, reduce incident related congestion and prevent future congestion in the corridor;
- Build on a solid foundation towards the overall regional architecture.
- Support coordination with the Route 7 project to enable congestion reduction and improved emergency vehicle access at the I-189 and Route 7 intersection.
- Support information dissemination through travel alert infrastucuture (e.g. VMS signs) on key arterial highways;
- Provide data to the traveler information system to allow information on traffic conditions and incidents in the corridor to be communicated to the public;

- Support signal preemption for emergency vehicles that are traveling in the corridor but will be entering surface streets; and
- Collect transportation planning data on roadway performance, including data for a before-and-after study of the travel time benefits of the ITS infrastructure.

4.3.4 ITS-004: Chittenden County Urban Traffic Management System

This project will provide monitoring and signal coordination for key congestion "hotspots" in the region including, but not limited to: downtown Burlington, its radial access corridors (U.S. 2, U.S. 7, VT 15), and other regional arterials.

The Chittenden County Urban Traffic Management System project has the following objectives, which are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

- Improve monitoring and control to reduce congestion and prevent future congestion in the county;
- Build on a solid foundation towards the overall regional architecture.
- Support coordination with the freeway ATMS projects to enable congestion reduction and improved emergency vehicle access throughout the region
- Provide traveler information about conditions in the region to the public;
- Coordinate traffic signal operation across the county
- Provide signal preemption for emergency vehicles and transit vehicles in the county; and
- Collect transportation planning data on roadway performance, including data for a before-and-after study of the travel time benefits of the ITS infrastructure.

4.3.5 ITS-005: Circumferential Highway ATMS

The Circumferential Highway ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed.

The objectives of the Circumferential Highway ATMS project include:

- Fulfill VTrans' desire to enhance the user-friendliness of the corridor;
- Take advantage of construction to reduce ITS installation costs;
- Monitor and control the corridor to avoid congestion;
- Provide traveler information about conditions in the corridor to the public; and
- Collect transportation planning data on roadway performance.

Implementation of the system would benefit significantly through coordination with the planned road construction project. The system is capable of operating initially as a freestanding corridor management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center.

4.3.6 ITS-006: Southern Connector ATMS

The Southern Connector ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed. The Southern Connector runs parallel to Route 7 and it will therefore be important to provide good information on travel conditions on the two instrumented roadways.

The objectives of the Southern Connector ATMS project include:

- Fulfill VTrans' desire to enhance the user-friendliness of the corridor;
- Take advantage of construction to reduce ITS installation costs;
- Monitor and control the corridor to avoid congestion;
- Providing traveler information about conditions in the corridor to the public; and
- Collecting transportation planning data on roadway performance, including data for a before-and-after study of the travel time benefits of the ITS infrastructure.

Implementation of the system would benefit significantly through coordination with the planned road construction project. The ATMS is capable of operating initially as a freestanding traffic management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center.

4.3.7 ITS-007: Traffic Management Information Center (TMIC) Enhancements

This project will consolidate and upgrade the central control software and hardware systems of previous advanced traffic management system deployments. The discrete desktop control systems from the individual projects will be integrated into a single regional traffic management system, operated from a shared central software platform. Advanced algorithms for response plans, signal coordination and emergency vehicle preemption will be implemented on the central system. The system will provide a central repository for regional data for use by other systems, including the traveler information system.

The project will also include the design of a data archiving and reporting user service to allow data collected by ITS to be used for long-range planning and other similar purposes.

The TMIC project will provide linkages to other regional centers such as the transit management center, state police, emergency response providers, dispatchers and public safety answering points (E911). Development of this project must be coordinated with these agencies to ensure their needs are incorporated and that the response plans are coordinated and agreed by all.

The objectives for the TMIC Enhancements project are therefore:

- Upgrade the traffic management hardware and software platform;
- Communicate with existing field equipment;
- Provide a central data repository and control system;
- Implement enhanced algorithms for coordinating traffic management strategies across multiple jurisdictions and facilities in the region;
- Develop multi-facility and jurisdiction response plans;
- Provide information sharing and cross-agency real-time response planning and coordination;
- Provide consistent information to travelers on all facilities;
- Support central 24/7 operations to provide back-up to individual jurisdictions;
- Continue to support individual facilities and agencies through remote workstations and low speed video feeds; and
- Share information with other regional systems.

4.3.8 ITS-008: Transit Automatic Vehicle Location (AVL)

Automatic Vehicle Location (AVL) uses a vehicle mounted device which communicates the locations of the vehicle to a control center in real-time. The control center can then use this data to display the location of vehicles on a map for dispatcher use. The information can also be used to calculate schedule adherence; calculate headways; provide information to riders on route status and predicted arrival times; as well as real-time assignment and routing functions in a paratransit system or deviated fixed route system. The data generated can also be used to calculate vehicular travel times for road sections for use in monitoring travel conditions and providing accurate traveler information. This system therefore can provide a particularly useful function by filling in gaps in regional travel time data from buses in non-instrumented, less urban areas.

The Transit Automatic Vehicle Location project has the following objectives:

- Improve efficiency and responsiveness of paratransit and future deviated fixed route operations;
- Reduce variability of transit services provided;
- Provide real-time information on transit vehicle status;
- Improve transit planning through use of real-time and historical data improve routes and schedules;
- Improve real-time management efficiency through selection of routes and schedules
- Improve real-time transit information provided to travelers;
- Collect vehicle travel times for input into traffic management and traveler information systems; and
- Collect traffic planning and operations data.

4.3.9 ITS-009: Integrated Fare Management

This project will develop an integrated fare medium, such as a smart card, that will build on the existing magnetic card deployment to support bus, rail, parking, ferry applications, and possibly other retail/service locations in the region. The information stored and collected through this type of smart card could also provide valuable service and fare planning information to the region's transit providers. The fare medium would likely include a prepaid balance that would be decremented as the device is used to pay for services and/or purchases. The medium will support transfers, intermodal discounts and periodic passes.

The Integrated Fare Management project will have the following objectives:

?? Provide a user-friendly and secure payment method for all modes;
?? Improve traveler convenience and boarding times;
?? Increase ridership by reducing barriers to riding and increasing efficiency of cross mode trips;
?? Improve management data on transit ridership patterns;
?? Implement a single electronic payment media across all transportation modes;
?? Utilize a common clearinghouse and back office for processing customer payments on all modes;
?? Reduce management and processing costs by integrating with retail businesses; and
?? Support other regional initiatives such as tourism discounts.

4.3.10 ITS-010: Transit Traveler Information System

The transit traveler information system will provide travelers with access to real-time updates and transit planning capabilities when planning their trips or while en-route. A variety of dissemination media will be available including web, telephone, kiosks and specialized displays at bus stop locations. The system will disseminate both static data for planning purposes and real-time data for providing updates to travelers. This traveler information system will be combined with the regional traveler and tourist information system and with TRIO (TRaveler Information Online).

The Transit Traveler Information System project will have the following objectives:

?? Implement a scalable, manageable traveler information system;
?? Improve utilization and increase ridership of transit options;
?? Improve the accessibility and availability of travel options information to users;
?? Simplify use of public transportation;
?? Provide multi modal trip planning functions to users;
?? Deliver real-time updates to users where they can make best use of the information; and
?? Deliver real-time information to users to increase the level of satisfaction with performance.

4.3.11 ITS-011: Regional Traveler and Tourism Information System

The regional traveler and tourist information system is a centralized system that consolidates and distributes static and real-time traveler, weather, and tourist information for transportation agencies and the general public. It will also form the regional data interface with the multi-state rural advanced traveler information system, known as TRIO.

The system will utilize a variety of information dissemination media to communicate data collected from transportation, tourism and weather providers in the region. The system should also support provision of travel options relating to the chosen tourism or business destinations. By combining these information types, the region's tourist economy will be enhanced and opportunities created for potential private financial underwriting and participation in the system.

This system will supplement the transit traveler information system, providing more general travel information targeting the tourist and non-transit user. The transit traveler information system will focus on supporting local residents and users who know they want to use the transit system. A link between the systems will help to promote transit to general system users. This system will present travel time comparisons between highways and commuter rail once these data are available from other projects.

The system would also support information being shared among transportation and emergency services agencies to support their respective decision-making and operations needs.

The Regional Traveler and Tourist Information System project will have the following objectives:

?? Increase user-friendliness of the region;
?? Improve access to transportation options information;
?? Improve access to activities, events, and services available in the region;
?? Provide a central repository for all regional transportation information;
?? Leverage the value of the transportation information by providing access to relevant tourism information;
?? Provide accessible information in ways that will be used by tourists and local citizens;
?? Provide a local portal to real-time and planned transportation network information; and
?? Interface with TRIO to exchange broader area information.

4.3.12 ITS-012: U.S. Route 15 ITS Improvements

The section of Route 15 between Essex Junction and Burlington is the subject of a mult-modal alternatives analysis. There are currently seven signalized intersections in this corridor, three of which are very congested during peak periods. An additional signal is recommended as part of a transportation systems management option along with each alternative being considered in the analysis. During peak periods, emergency vehicles access in the corridor is adversely impacted for a number of agencies.

This project will provide signal coordination and other ATMS functionality to enhance throughput and also to minimize the delays faced by emergency vehicles. Traveler information will be implemented and most useful once potential alternative corridors, such as the Circumferential Highway are completed and are also instrumented.

The U.S. Route 15 ITS Improvements project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

- ?? Improve monitoring and control to reduce congestion and prevent future congestion in the corridor;
- ?? Build on a solid foundation towards the overall regional architecture.
- ?? Provide traveler information about conditions in the corridor to the public;
- ?? Coordinate traffic signal operation
- ?? Provide signal preemption for emergency vehicles in the corridor; and
- ?? Collect transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

5. Deployment

Figures 2 and 3 illustrate the Deployment Plan and Schedule, respectively, for ITS projects in Chittenden County.

5.1. Deployment Plan

The deployment plan (Figure 2) designates projects as short term, medium term, or long term and illustrates the interdependencies among them. The lead agency, project budget, and duration is also indicated for each. Note that short-term projects are either those with unique, time-dependent deployment opportunities (such as the opportunity to coordinate the Shelburne Road Smart Corridor project with the reconstruction of Route 7), and/or are "Early Success" projects that can deliver tangible benefits as freestanding deployments. Longer-term projects integrate the short-term projects into consolidated, regional systems that leverage existing deployments and enhance the traffic management, transit management, and traveler information capabilities of the regional ITS infrastructure. Such projects require longer lead-times, larger capital investments, and an existing basis of ITS field equipment to be successful. They may also address traffic needs (e.g., congestion) that do not presently exist but are anticipated in the future.

5.2. Project Schedule

The schedule shown in Figure 3 shows a proposed deployment timeframe for each phase of the 12 projects. The duration for Design/Procurement and Implementation, in months, is also listed. Dynamic conditions such as funding availability, emerging project coordination opportunities, new technologies, and/or changing needs may influence the actual project deployment schedule. These issues, and the resulting need to keep the deployment plan up-to-date, are discussed further in the next section.

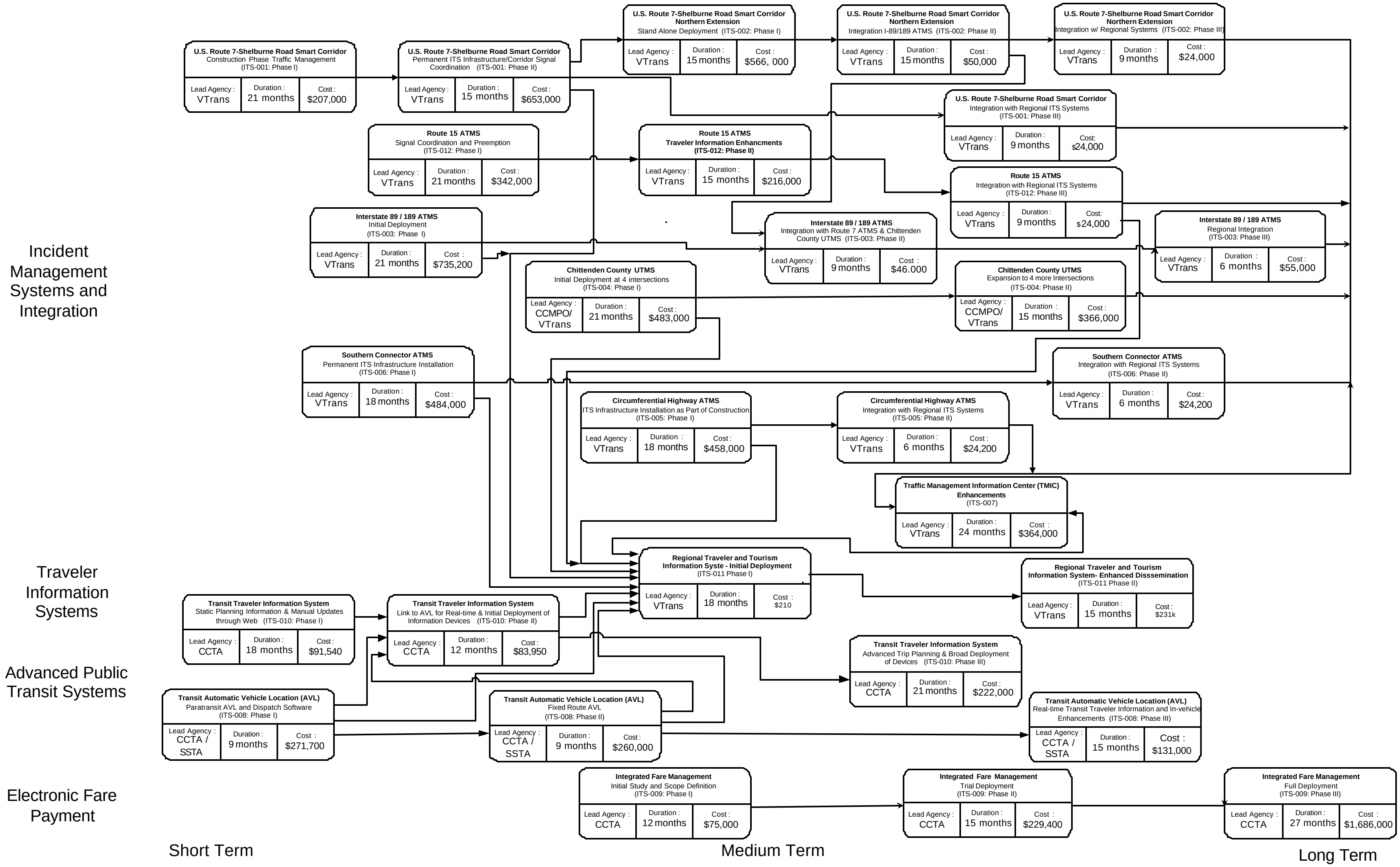

Figure 2. Chittenden County ITS Project Deployment Plan.

	Project Number	Design and Procure Duration	Implementation Duration	Total Duration	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
U.S. Route 7-Shelburne Road Smart Corridor	ITS-001														
Phase I: Construction Phase Traffic Management		9	12	21											
Phase II: Permanent ITS Infrastructure/Corridor Signal Coordination		6	9	15											
Phase III: Integration with Regional ITS Systems		6	3	9											
U.S. Route 7-Shelburne Road Smart Corridor Northern Extension	ITS-002														
Phase I: Initial Deployment		6	9	15											
Phase II: Integration I-89/189 ATMS		6	9	15											
Phase III: Integration with Regional Systems		3	6	9											
Interstate 89/189 ATMS	ITS-003														
Phase I: Initial Deployment		9	12	21											
Phase II: Integration with Route 7 ATMS and Chittenden County UTMS		6	3	9											
Phase III: Regional Integration		3	3	6											
Chittenden County Urban Traffic Management System	ITS-004														
Phase I: Initial Deployment at 4 Intersections		9	12	21											
Phase II: Expansion to 4 more Intersections		3	12	15											
Southern Connector ATMS	ITS-005														
Phase I: Permanent ITS Infrastructure Installation		6	12	18											
Phase II: Integration with Regional ITS System		3	3	6											
Circumferential Highway ATMS	ITS-006														
Phase I: ITS Infrastructure Installation as part of Construction		6	12	18											
Phase II: Integration with Regional ITS Systems		3	3	6											
Traffic Management Information Center (TMIC) Enhancements	ITS-007														
		9	15	24											
Transit Automatic Vehicle Location	ITS-008														
Phase I: Paratransit AVL and Dispatch Software		9	9	18											
Phase II: Fixed Route AVL and Transit Traveler Information		6	6	12											
Phase III: In-vehicle Enhancements		9	12	21											
Integrated Fare Management	ITS-009														
Phase I: Initial Study and Scope Definition		3	9	12											
Phase II: Trial Deployment		6	9	15											
Phase III: Full Deployment		9	18	27											
Transit Traveler Information System	ITS-010														
Phase I: Static Planning Information and Manual Updates through Web		3	6	9											
Phase II: Link to AVL for Real-time and Initial Deployment of Information Devices		6	6	12											
Phase III: Advanced Trip Planning and Broad Deployment of Devices		3	9	12											
Regional Traveler and Tourism Information System	ITS-011														
Phase I: Database and Initial Dissemination		6	12	18											
Phase II: Expanded Dissemination		6	9	15											
VT Route 15 Corridor	ITS-012														
Phase I: Signal Coordination and Preemption		9	12	21											
Phase II: Traveler Information Enhancement		6	9	15											
Phase II: Integration with Regional Systems		6	3	9											

Figure 3. Chittenden County ITS Proposed Project Deployment Schedule

6. Conclusions and Next Steps

6.1 Ongoing Review and Renewal of the ITS Project Plan

The *ITS Strategic Plan* and Project List provide a road map that can be used to guide the deployment of future ITS components in a manner that is complimentary to existing and planned infrastructure and operational investments. The *Plan* ensures that the ITS deployments are responsive to real transportation needs, functional requirements, and technological advances. The projects developed in this study are a snapshot of ITS opportunities based on current conditions in the region.

The *ITS Strategic Plan* and the project list developed in this study are evolving documents that present an outlook and strategy for ITS deployment in Chittenden County. As such, they need to be updated as Chittenden County's transportation needs change and as technology changes. It is recommended that the *ITS Strategic Plan* and the project list be reassessed at regular and frequent intervals.

In updating the project list, the following elements need to be considered:

1. Reassessment of the needs, existing ITS elements and institutional structure;
2. Reevaluation of the needed actions and associated functional requirements;
3. Reevaluation of the proposed system architecture strategies; and
4. Reevaluation of the specific list of proposed projects and their funding sources.

When the project list is reassessed, it is suggested that candidates for deployment should include:

?? Projects from the short-term implementation time frame which have not yet been implemented;
?? Projects from the medium-term implementation time frame;
?? Projects from the broader list of candidate actions identified in this study which were not originally identified as core; and
?? New initiatives/technologies that have emerged.

The consultant team also recommends that the Steering Committee continue to exist as a regional ITS Coordination Committee. Because the members of the Steering Committee make up the core interest group for the region, their continued involvement in the ITS planning and deployment process with expedite ITS development in the region and promote inter-agency dialog and coordination on ITS issues.

6.2 Commence Design of Short-Term Projects

The next step for implementation is to begin the conceptual design and construction of the short-term projects, which were designed to take advantage of short-term opportunities and build momentum for the ITS program. It will be important to leverage immediate deployment opportunities such as the reconstruction of Shelburne Road, which were designed to be early success projects.

Appendix A:

ITS Project – Full Descriptions

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	U.S. Route 7-Shelburne Road Smart Corridor
CCMPO Project Number	ITS-001
Project Objectives	Provide traveler information to increase user-friendliness Mitigate construction-phase traffic impacts Collect traffic planning and operations data Monitor operation of median U-turn lanes Expedite movement of emergency vehicles (Phase II) Improve long-term traffic management (Phase II)
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems Emergency Management Systems ITS Planning and Data Archiving
Geographic Extents	U.S. Route 7 corridor, Towns of Shelburne and South Burlington. Subsequent phases might include key traffic signals in the southern portion of the City of Burlington.
Estimated Cost	Phase I: $207k + $25k O+M/year Phase II: $653k + $65k O+M/year
Anticipated Benefits	Mitigation of construction congestion Improved construction management Real-time traveler information Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Increased modal split to commuter rail Emergency vehicle prioritization Enhanced planning data collection
Lead Agency	VTrans
Other Key Participants	Towns of Shelburne City of South Burlington City of Burlington Emergency Service Providers CCTA (bus transit) Vermont Transportation Authority (rail)
Deployment Considerations	Significant interagency/interproject coordination Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Construction Phase Traffic Management Phase II: Permanent ITS Infrastructure/ Corridor Signal Coordination Phase III: Integration with Regional ITS Systems
Funding Opportunities	Shelburne Road Reconstruction Funds CMAQ
Prioritization	*Early Success Opportunity* Phase I and II: Short-Term (Within 5 years) Phase III: Long-Term (5+ years)

Shelburne Road Smart Corridor

Project Description and Objectives

The Route 7-Shelburne Road Smart Corridor project is envisioned as a corridor traffic management system for one of the County's most important and congested arterials. The geographic extents of the corridor contain approximately 3.5 miles of Route 7 in Shelburne, South Burlington, and City of Burlington from LaPlatte River Bridge (in Shelburne) to the south and Imperial Drive (in South Burlington.) There are 10 signalized intersections within this corridor.

The objectives of the project include:

?? Improving construction management and mitigating construction-related congestion;
?? Increasing the user-friendliness of the corridor;
?? Improved monitoring and control of the corridor to reduce congestion;
?? Providing traveler information about conditions in the corridor to the public;
?? Coordinating traffic signal operation in the corridor, eventually including key signals in on Route 7 within the City of Burlington;
?? Providing signal preemption for emergency vehicles in the corridor; and
?? Collecting transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Implementation of the system would benefit significantly through coordination with the Vermont Agency of Transportation's planned U.S. 7-Shelburne Road reconstruction project. In this case, the Smart Corridor project could be implemented at reduced cost, and could provide the added benefit of mitigating the negative short-term traffic impacts of the construction period.

The project is an "early success" opportunity because it can deliver significant benefits in a visible, high-need corridor at relatively low cost. This project is recommended for the Short Term (within the next five years).

The Smart Corridor is capable of operating initially as a freestanding traffic management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center. Traffic flow and traffic management options would be greatly enhanced by integrating key Route 7 signals in the southern part of the City of Burlington (just north of the reconstruction project boundary) in subsequent phases (this is proposed in the Shelburne Road Northern Extension Project).

Project Elements

The system would deploy a variety of ITS technologies under four National Architecture functional areas: Advanced Traffic Management Systems, Advanced Traveler Information Systems, Emergency Management Systems, and ITS Planning Data Archiving. There is a tremendous amount of technological flexibility in achieving the project objectives.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility such as the project construction trailer (construction phase), VTrans district office, or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. For construction phase field devices, certain field equipment can take advantage of low-cost cellular digital packet data (CDPD) technology or leased lines for data, and microwave point-to-point communications for video transport. For permanent installation, this project would benefit from the installation of a regional fiber optic network and could contribute funding towards the development of such a network. Without this network, it is anticipated that field equipment will be supported through leased lines for roadside controllers and leased lines or wireless communications for video data transport. This will limit the functionality and possibly increase ongoing operational costs.

Traffic Detection

CCTV camera technology is already planned for the corridor in order to observe and evaluate the performance of median strip U-turn lanes that will be installed during the reconstruction project. In addition to this purpose, CCTV cameras (on the frequency of approximately one camera per mile) could provide real time traffic images to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras.

License plate readers, which determine actual travel times by matching vehicle registrations at two points on the roadway, can be used to monitor traffic flow as well as flagging potential incidents or congestion. This system can also be used to provide actual travel time information to the general public, as discussed below.

Traffic detection data gathered through these technologies will generate a vast traffic data log that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor, particularly during the construction phase when sporadic congestion will occur. The system can be designed to alert the traveling public of current travel times, incidents, long queues, or other adverse conditions in the corridor. Valuable construction updates and traffic information can be provided to the public *without* the need to endorse a specific alternate travel route.

Diverse information dissemination technologies are candidates for this project. Low cost solutions which are easy to implement include Interactive Voice Recording (IVR) linked to the state 511 system and accessible from telephones or cellular phones), and Portable Variable Message Signs (PVMS). PVMS signs are already planned for the project and thus will not constitute an additional expense.

The pre-trip traveler information website should contain real-time travel information as well as links to other trip planning resources or construction information. Using a system that scans license plate to record actual travel times through the corridor, it is possible to provide an accurate estimate of current travel time through the construction area, as well as a comparison of driving and commuter rail travel times. This information can be sent to the traveler information website and the telephone IVR system.

En-route traveler information may be provided on the PVMS signs (major events, incidents, or construction information). Based on the success of PVMS signs, the desirability of installing permanent Variable Message Signs (VMS) at key decision points near the corridor can be evaluated.

Traffic Control

The two most viable traffic control alternatives for this corridor are Traffic Signal Coordination and Emergency Vehicle Signal Preemption.

Traffic signal coordination allows multiple signals in the corridor to operate in an optimized fashion based on real-time traffic volumes. Initially, coordination of 8 signals in the corridor is proposed. The two remaining intersections in the construction area are too isolated to benefit from signal coordination.

Emergency vehicle prioritization, such as central control center signal override or in-vehicle signal preemption, would allow emergency vehicles to bypass traffic queues at signals, reducing emergency response travel times. This functionality could also be deployed during the construction phase, if desired, as significant traffic delays are expected. Signal preemption can be expanded to transit vehicles as well.

Deployment Strategies

A phased approach is recommended to ensure early success, and reduce the initial capital cost of the system, and expedite the deployment of construction phase ITS equipment. A three-phase deployment approach is recommended:

?? **Phase I: Construction Phase Traffic Management.** The phase has two primary objectives: 1.) construction-phase public outreach and traveler information, 2.) improved construction management. Traveler information will be provided through a project website (providing updates on construction/major events and travel time estimates and commuter rail comparisons). Construction management will be enhanced through CCTV cameras, two-way radios (for on-site traffic/incident management), and PVMS signs. The system will be managed through a simple data processing and control headend operating out of the construction field trailer. This phase utilizes low-cost, rapid-deployment ITS technologies that addresses immediate construction-phase needs that are highly visible to stakeholders.

?? **Phase II: Permanent Traffic Monitoring and Management,** expands upon the construction phase installation with more permanent communication, traffic detection and monitoring devices. The success of the video traffic planning technology and the desirability of permanent Variable Message Signs will be evaluated. Phase II would also provide for central control and coordination of 8 signals in the Route 7 construction corridor, as well as emergency vehicle preemption.

?? **Phase III: Regional Integration** focusing on integration of the Route 7 system with other emerging regional ITS infrastructure such as the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

As was previously described in this section, this project has two phases. The first phase involves deploying a traveler information system for mitigating construction impacts. The second phase, on the other hand, involves coordinating a number of traffic signals in the City of South Burlington and the town of Shelburne, and equipping those signals with signal preemption capabilities for emergency vehicles. In estimating the benefits to be expected from this project, the analysis was run separately for phase 2 (signal coordination and preemption), as well as for the whole project (phases 1 and 2 combined). The reason for doing so is that while the primary objective of phase I of the Smart Corridor project was to mitigate the negative impacts of the construction period, the version of IDAS used in the current study is not designed to explicitly account for construction impacts on traffic flow.

For phase 2, IDAS estimated an expected Benefit-Cost (B/C) ratio of 3.38. The benefits included improvements in user mobility, modest reductions in operating and accident costs, and slight reductions in emissions levels. For the project as a whole (phases 1 and 2), IDAS was irrelevant because the current version of IDAS fails to account for the negative impacts of construction.

U.S. Route 7-Shelburne Road Smart Corridor

PHASE I-Stand-Alone Construction Phase Deployment

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras (U-Turn/traffic monitoring)	$15,000	5	$75,000
Travel Time Measurement System	$30,000	1	$30,000
Portable VMS Signs (Available at no add'l. cost)	$0	3	$0
Two-Way Construction Zone Radios	$500	10	$5,000
Interactive Voice Response Telephony System	$20,000	1	$20,000
Traveler Information Website	$10,000	1	$10,000
Control Center Equipment (Installed)			
Central Computer/Server	$15,000	1	$15,000
Video Monitors	$1,000	2	$2,000
Networking Equipment	$3,000	1	$3,000
Central Software			$20,000
Communications (Installed)			
Lease Line (Video Transport)	$1000	4	$4,000
CDPD (data)	$1000	5	$5,000
Design and Soft Costs (10%)			$18,900
TOTAL CAPITAL COSTS-Phase I			**$207,900**
ANNUAL COMMUNICATIONS COST	$1000	4	$4,000
ANNUAL OPERATIONS & MAINTENANCE (10%/yr+ COMMS)			**$24,800**

U.S. Route 7-Shelburne Road Smart Corridor

PHASE II-Permanent Traffic Monitoring and Management Infrastructure

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Interactive Voice Response Upgrade	$20,000	1	$20,000
Traveler Information Website Upgrade	$20,000	1	$20,000
Signal Coordination-Intersection	$30,000	6	$180,000
Signal Preemption-Intersection	$5,000	6	$30,000
Signal Coordination-Onboard Equipment	$200	20	$4,000
Control Center Equipment (Installed)			
Central Computer/Server Upgrade			$50,000
Control Center Upgrade			$50,000
Communications (Installed)			
Fiber Optics (Corridor to Control Center) per mile	$24,000	10	$240,000
Design and Soft Costs (10%)			$59,000
TOTAL CAPITAL COSTS-Phase II			**$653,000**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$65,000**

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	U.S. Route 7-Shelburne Road Smart Corridor Northern Extension
CCMPO Project Number	ITS-002
Project Objectives	Increase user-friendliness of the corridor Improved traffic flow through the corridor Expedite movement of emergency vehicles Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems Emergency Management Systems ITS Planning and Data Archiving
Geographic Extents	U.S. Route 7 corridor in the southern portion of the City of Burlington.
Estimated Cost	Phase I: $566k + $77k O+M/year Phase II: $50k + $5k O+M/year Phase III: $24k + $2.4k O+M/year
Anticipated Benefits	Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Real-time traveler information Increased modal split to commuter rail Emergency vehicle prioritization Enhanced planning data collection
Lead Agency	VTrans
Other Key Participants	City of South Burlington City of Burlington Emergency Service Providers CCTA (bus transit) Vermont Transportation Authority (rail)
Deployment Considerations	Significant interagency/interproject coordination Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Initial deployment Phase II: Integration I-89/189 ATMS Phase III: Integration with regional systems
Funding Opportunities	CMAQ
Prioritization	Medium Term – build on success of initial Shelburne Road project (within 5 years)

Shelburne Road Smart Corridor-Northern Extension

Project Description and Objectives

The section of Route 7 south of Burlington, also known as Shelburne Road, is a principle arterial in the region. This roadway is a signalized, multi-lane commercial strip and commuter corridor that is increasingly prone to congestion. A separate, priority ITS project, timed to take advantage of construction on a 3.51-mile stretch of the road. in South Burlington and Shelburne, including the LaPlatte River Bridge, has already been defined.

This project will build upon that initial Shelburne Road Smart Corridor deployment and will continue the technology deployment to the portion of the corridor north of the reconstruction project, from I-189 to Downtown Burlington encompassing nine signalized intersections . This project will therefore extend signal coordination and other ATMS functionality ensuring that the benefits gained through the initial deployment are continued the along the road. This project will also ensure that conditions are not worsened at the boundary between the instrumented and non-instrumented sections due to improvement on the south section. The full benefits of signal coordination and preemption can only be realized through this geographic extension.

This project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

?? Build on the initial deployments ITS on the Southern end of this corridor help to create an ITS critical mass. Fulfilling VTrans' desire to increase the user-friendliness of the corridor;
?? Improve monitoring and control to reduce congestion and prevent future congestion in the corridor;
?? Build on a solid foundation towards the overall regional architecture.
?? Support coordination with the Interstate 89/189 ATMS project to enable congestion reduction and improved emergency vehicle access at the I-189 and Route 7 intersection.
?? Provide traveler information about conditions in the corridor to the public;
?? Coordinate traffic signal operation including key signals in on Route 7 within the City of Burlington;
?? Provide signal preemption for emergency vehicles in the corridor; and
?? Collect transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Project Elements

The Shelburne Road smart corridor northern extension ITS project will consist of the following key ITS architecture market packages:

?? Network Surveillance,
?? Surface Street Control,
?? Traffic Information Dissemination,
?? Multi-modal Coordination,
?? Emergency Routing,
?? Interactive Traveler Information, and
?? ITS Data Mart.

While there is considerable flexibility in which technologies to deploy to meet the objectives of this project the following technology areas will be required:

?? Head end system and communications,
?? Traffic detection,
?? Traveler information, and
?? Traffic control.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility such as the VTrans district office or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. This project would benefit from the installation of a regional fiber optic network and could contribute funding towards the development of such a network. Without this network, it is anticipated that field equipment will be supported through leased lines for roadside controller and video data transport which will limit the functionality and possibly increase ongoing operational costs.

Traffic Detection

CCTV cameras located at specific intersections could provide real time traffic images to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras.

Traffic detection data gathered through these technologies will be stored in an ITS data mart that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

This project will utilize the traveler information system set-up for the initial Shelburne Smart Corridor project which will implement, a web site, interactive voice response (IVR; accessible from telephones or cellular phones), highway advisory radio (HAR) and portable variable message signs (PVMS). Each of these systems could be configured to provide travelers with a comparison of travel time estimates for driving and commuter rail.

It is also anticipated that this project will make information available to the Tri-State RATIS (Trio) project of wider dissemination.

Traffic Control

The two most viable traffic control alternatives for this corridor are traffic signal coordination and emergency/transit vehicle signal prioritization.

Traffic signal coordination allows multiple signals in the corridor to operate in an optimized fashion based on real-time traffic volumes. This project will add coordination of nine intersections to the initial six coordinated through the earlier Shelburne Road project. The additional nine intersections are: S7/Mcintosh; US7/Baldwin; US7/Laurel Hill Drive; US7/Brewer Parkway; US7/Queen City Parkway; US7/Swift St.; US7/I189 RampC; US7/Shelburne Road Plaza; US7/Home Ave./Odell Parkway. The last three intersections are in the City of Burlington and thus there is a potential to coordinate then with other signals in the urban core.

This project will also implement emergency and transit vehicle prioritization at the covered intersections, implementing technology compatible with other regional deployments. This will allow emergency vehicles to bypass traffic queues at signals, reducing emergency response travel times. Signal preemption can be expanded to transit vehicles as well. This project will provide ventral control of the signal prioritization as well as coordination between the vehicle and the individual intersection. Central control will be important when this system is integrated with the Interstate 89/189 ATMS to ensure smooth flow of emergency vehicles off of these freeways and onto the surface streets.

Deployment Strategies

This project will be implemented in phases based on integration with other regional systems. The anticipated phases are as follows:

?? **Phase I: Stand alone deployment**, of CCTV cameras, traffic detection, and signal coordination with the Southern part of Route 7 already instrumented. Integration with the existing pre-trip traveler information website. Implementation of intersection based emergency and transit vehicle prioritization.

?? **Phase II: Integration with I-89/189 ATMS,** Implementation of central control over signal prioritization and integration between the control system on these two projects to provide effective emergency vehicle traffic flow at the 189 Route 7 interchange. This will include implementation of strategies to flush vehicles on Route 7 that may be impeding emergency vehicle flow off 189.

?? **Phase III: Regional Integration** focuses on integration of the system into the overall regional architecture through the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

This project will build upon the previous project (ITS-001) and will continue the technology deployment to the portion of the corridor north of the reconstruction project, from I-189 to Downtown Burlington. Given this, the B/C ratios for this project are expected to be quite similar to those estimated for the previous project, with a relatively high B/C ratio for the signal coordination and preemption component of the project.

U.S. Route 7-Shelburne Road Smart Corridor Northern Extension

Phase I: Stand alone deployment

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras	$15,000	6	$90,000
Traffic Detectors	$18,000	6	$108,000
Interactive Voice Response upgrade	$3,000	1	$3,000
Traveler Information Website upgrade	$2,000	1	$2,000
Signal Preemption-Intersection	$5,000	9	$45,000
Signal Preemption-Onboard Equipment	$200	10	$2,000
Signal Coordination per Intersection	$20,000	9	$180,000
Control Center Equipment (Installed)			
Central Computer/Server	$15,000	1	$15,000
Video Monitors	$1,000	2	$2,000
Networking Equipment	$3,000	1	$3,000
Central Software			$20,000
Furniture			$2,000
Communications (Installed)			
Per Leased Line	$ 2,000	21	$42,000
Design and Soft Costs (10%)			$51,400
TOTAL CAPITAL COSTS-Phase I			**$565,400**
ANNUAL COMMUNICATIONS COSTS	$1,000	21	$21,000
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			**$77,540**

Preliminary Cost Estimate

U.S. Route 7-Shelburne Road Smart Corridor Northern Extension

Phase II: Integration with I-89/189 ATMS

	Unit Cost	Qty.	Total Cost
Control Center Equipment (Installed)			
Central Computer/Server Upgrade	$15,000	1	$15,000
Control software upgrade	$20,000	1	$20,000
Communications (Installed)			
Comunications equipment to communicate with I-89/189 system			$5,000
Design, planning coordination and soft Costs			$10,000
TOTAL CAPITAL COSTS-Phase II			**$50,000.0**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$5,000**

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Interstate 89/189 ATMS
CCMPO Project Number	ITS-003
Project Objectives	Increase user-friendliness of the corridor Improved traffic flow through the corridor Improve incident detection and response Reduce congestion at exits 12, 14, 15 and 16 Expedite movement of emergency vehicles Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems ITS Planning and Data Archiving
Geographic Extents	Interstate 89/189 from Exit 12 to Exit 16. I-189 spur to Shelburne Road ATMS
Estimated Cost	Phase I: \$735k + \$73k O+M/year Phase II: \$46k +\$5k O+M/year Phase III: \$55k +\$6k O+M/year
Anticipated Benefits	Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Real-time traveler information Enhanced planning data collection
Lead Agency	Vtrans
Other Key Participants	Town of South Burlington Town of Burlington Town of Winooski
Deployment Considerations	Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Initial deployment Phase II: Integration with Shelburne Road system Phase III: Regional integration
Funding Opportunities	CMAQ, TIP, ITS Earmark
Prioritization	Phase I and II: Short-Term (Within 5 years)

Interstate 89/189 ATMS

Project Description and Objectives

The section of I-89 from Exit 12 (VT 2A) to Exit 16 (U.S.7) I-89 and the I-189 Spur to Shelburne Road are principal urbanized freeways in the region. There is a need to detect and respond to incidents effectively as well as recurring congestion hotspots at exits 12, 14, 15 and 16 and issues with traffic flowing on to Route 7, Shelburne road, particularly when emergency vehicles need to use this spur. This project will provide freeway monitoring and control for these sections of roadway and provide for integration with the Shelburne Road Smart Corridor project.

This project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

?? Fulfill VTrans' desire to increase the user-friendliness of the corridor;
?? Improve monitoring and control to improve incident detection, reduce incident related congestion and prevent future congestion in the corridor;
?? Build on a solid foundation towards the overall regional architecture.
?? Support coordination with the Route 7 project to enable congestion reduction and improved emergency vehicle access at the I-189 and Route 7 intersection.
?? Support regional projects by allowing access to traveler alert infrastructure (e.g. VMS signs.)
?? Provide data to the traveler information system to allow traffic conditions and incidents in the corridor to be communicated to the public;
?? Support signal preemption for emergency vehicles that are traveling in the corridor but will be entering surface streets;
?? Collect transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Project Elements

The Interstate 89/189 ATMS project will consist of the following key ITS architecture market packages:

?? Network Surveillance,
?? Traffic Information Dissemination,
?? Freeway Control,
?? Emergency Routing, and
?? ITS Data Mart – the collection and storage of real-time data for future analysis and planning.

While there is considerable flexibility in which technologies to deploy to meet the objectives of this project the following technology areas will be required:

?? Head end system and communications,
?? Traffic detection,
?? Traveler information, and
?? Traffic control.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a simple control center. This control center can be housed in compact space in an existing facility such as the VTrans district office or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. This project would benefit from the installation of a regional fiber optic network and could contribute funding towards the development of such a network. Without this network, it is anticipated that field equipment will be supported through leased lines for roadside sensors, controllers and wireless communications for video data transport. This will limit the functionality and possibly increase ongoing operational costs.

Detection

CCTV cameras located at specific locations will provide real time incident images to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of images, alternate methods of incident detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras. The chosen detectors should be positioned to enable detection of exit ramp queue spill back on to the interstate, such as at Exit 14 Southbound. Future regional coordination may be able to make use of this data to alter the downstream signal timing to help clear the queue. Emergency vehicle detectors can also be deployed to support similar exit ramp queue flushing.

Traffic detection data gathered through these technologies will be stored in an ITS data mart that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

This project will provide data to the broader traveler information system project which will implement technologies such as a web site, interactive voice response (IVR; accessible from telephones or cellular phones), and highway advisory radio (HAR). Each of these systems could be configured to provide travelers with a comparison of travel time estimates for driving and transit options.

In order to directly affect traffic flow on the interstate segments that are the subject of this project, Variable Message Signs (VMS) will be implemented prior to strategic decision points. The VMS will be used to inform travelers of conditions ahead in order to allow them to leave the Interstate or to provide confidence in expected travel times.

It is also anticipated that this project will make information available to the (Trio) RATIS project for wider dissemination.

Traffic Control

The most viable traffic control alternatives for this corridor are use of VMS to affect traveler behavior as discussed above and provision of information on approaching emergency/transit vehicles to adjacent signalized intersections. Active emergency vehicles traveling on these Interstates will be detected and this information will be transmitted along with traffic flow information to receiving systems on the surface streets. This will allow the adjacent systems to take traffic flow into account and clear the path for emergency vehicle passage.

Deployment Strategies

This project will be implemented in phases based on integration with other regional systems. The anticipated phases are as follows:

?? **Phase I: Initial deployment**, of CCTV cameras, traffic detection, and VMS. Integration with the pre-trip traveler information website.

?? **Phase II: Integration with Route 7 ATMS and Chittenden County UTMS,** This phase will include addition of emergency vehicle detectors and communications links to other regional systems.

?? **Phase III: Regional Integration** focuses on integration of the system into the overall regional architecture through the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

This project will provide freeway monitoring and control for the section of I-89 from Exit 12 (VT 2A) to Exit 16 (U.S.7), allowing for the quick detection and response to incidents. The IDAS analysis shows an expected B/C ratio of 2.89. The benefits are primarily due to improvements in travel time reliability. They are also the result of savings in fuel and accident costs, and reductions in emissions.

Interstate 89/189 ATMS

Phase I: Initial deployment

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras	$15,000	4	$60,000
Traffic Detectors	$6,000	4	$24,000
VMS	$100,000	5	$500,000
Control Center Equipment (Installed)			
Central Computer/Server	$12,000	1	$12,000
Video Monitors	$1,000	2	$2,000
Networking Equipment	$3,000	1	$3,000
Central Software			$25,000
Furniture			$2,000
Communications (Installed)			
Per Leased Line	$ 1,000	4	$4,000
Point-to-point wireless	$10,000	4	$40,000
Design and Soft Costs (10%)			$63,200
TOTAL CAPITAL COSTS-Phase I			**$735,200**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$73,520**

Preliminary Cost Estimate

Interstate 89/189 ATMS

Phase II: Integration with Shelburne Road ATMS

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Emergency vehicle recievers	$2,000	6	$12,000
Control software upgrade	$25,000	1	$25,000
Communications (Installed)			
Comunications equipment to communicate with Shelburne Rd system			$5,000
Design, planning coordination and soft Costs (10%)			$4,200.0
TOTAL CAPITAL COSTS-Phase II			$46,200.0
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			$4,620

Interstate 89/189 ATMS

Preliminary Cost Estimate

Phase III: Integration with regional system

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Emergency vehicle recievers	$2,000	10	$20,000
Control software upgrade	$25,000	1	$25,000
Communications (Installed)			
Comunications equipment to communicate with TMIC			$5,000
Design, planning coordination and soft Costs (10%)			$5,000.0
TOTAL CAPITAL COSTS-Phase II			$55,000.0
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			$5,500

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Chittenden County Urban Traffic Management System
CCMPO Project Number	ITS-004
Project Objectives	Increase user-friendliness of signalized corridors Improved traffic flow through signalized corridor Expedite movement of emergency vehicles Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems Emergency Management Systems ITS Planning and Data Archiving
Geographic Extents	County wide
Estimated Cost	Phase I: $483k O+ $61k M/year Phase II: $366k O+$47k M/year
Anticipated Benefits	Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Real-time traveler information Increased modal split Emergency vehicle prioritization Enhanced planning data collection
Lead Agency	CCMPO/VTrans
Other Key Participants	City of South Burlington City of Burlington Town of Winooski Town of Essex Junction Town of Colchester Emergency Service Providers
Deployment Considerations	Significant interagency/interproject coordination Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Initial deployment at 8 intersections Phase II: Expansion to 8 more intersections
Funding Opportunities	CMAQ, ITS Earmark, TIP
Prioritization	Medium Term – Phase 1: 3 years, Phase 2: 4 years

Chittenden County Urban Traffic Management System

Project Description and Objectives

There are a number of congestion hotspots within Chittenden County that can benefit from closer monitoring and intersection control. This project will provide monitoring and signal coordination for these key hotspots including, but not limited to: downtown Burlington and its key radial corridors (U.S. 2, U.S. 7, VT 15) and South Burlington, Winooski, Colchester and Essex Junction.

This project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

?? Improve monitoring and control to reduce congestion and prevent future congestion in the county;
?? Build on a solid foundation towards the overall regional architecture.
?? Support coordination with the freeway ATMS projects to enable congestion reduction and improved emergency vehicle access throughout the region
?? Provide traveler information about conditions in the region to the public;
?? Coordinate traffic signal operation across the county
?? Provide signal preemption for emergency vehicles and transit vehicles in the county; and
?? Collect transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Project Elements

The Chittenden County Urban Traffic Management System (UTMS) project will consist of the following key ITS architecture market packages:

?? Network Surveillance,
?? Surface Street Control,
?? Traffic Information Dissemination,
?? Multi-modal Coordination,
?? Emergency Routing,
?? Interactive Traveler Information, and
?? ITS Data Mart which will store ITS gathered data for future planning analysis.

While there is considerable flexibility in which technologies to deploy to meet the objectives of this project the following technology areas will be required:

?? Head end system and communications,
?? Traffic and queue detection,
?? Traveler information, and

?? Traffic control.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility or a new facility such as the multi-modal center. Eventually the equipment will be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. This project would benefit from the installation of a regional fiber optic network and could contribute funding towards the development of such a network. Without this network, it is anticipated that field equipment will be supported through leased lines for roadside controller and video data transport which will limit the functionality and possibly increase ongoing operational costs.

Traffic Detection

CCTV cameras located at specific intersections could provide real time images of traffic flows and queues to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Perhaps a more viable and traffic and queue detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras.

An interface to the transit AVL system being developed under another ITS project will be able to provide travel time data based on actual transit vehicle travel times. This will supplement the detector data and will provide data for non-instrumented corridors.

Traffic detection data gathered through these technologies will be stored in an ITS data mart that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

This project will provide data to the traveler information system which is being implemented under a separate project. This system will provide the data which may be disseminated through a web site, interactive voice response (IVR; accessible from telephones or cellular phones), highway advisory radio (HAR) and portable variable message signs (PVMS).

This UTMS project will provide the facility for creating alerts, diversions and response plans based on traffic conditions and incidents. This information will be shared with regional agencies and provided to the traveler information system for dissemination.

It is also anticipated that this project will make information available to the Tri-State RATIS (Trio) project for wider dissemination.

Traffic Control

The traffic control alternatives for the UTMS are traffic signal coordination, emergency/transit vehicle signal prioritization and portable variable message signs (VMS.)

Traffic signal coordination allows multiple signals in the corridor to operate in an optimized fashion based on measured real-time traffic volumes. This project will provide coordination for all integrated signals within the county.

This project will also implement emergency and transit vehicle prioritization at the covered intersections, implementing technology compatible with other regional deployments. This will allow emergency vehicles to bypass traffic queues at signals, reducing emergency response travel times. Signal preemption can be expanded to transit vehicles as well. This project will provide central control of the signal prioritization as well as coordination between the vehicle and the individual intersection.

Portable VMS signs can be used and integrated with the overall response plans. These signs would tend to be used to manage traffic flow during construction, for planned events or for long duration incidents.

Deployment Strategies

This project will be implemented in phases based on individual intersection needs. The anticipated phases are as follows:

?? **Phase I: Initial deployment**, of CCTV cameras, traffic detection, signal coordination, and portable VMS signs at four selected locations. Integration with the existing pre-trip traveler information website. Implementation of intersection based emergency and transit vehicle prioritization.

?? **Phase II: Expansion of the system** to four more locations.

Preliminary Benefits Analysis

This project is essentially an extension of the basic principles of the previous three projects to other hotspots in the County, including, but not limited to downtown Burlington and its key radial corridors (U.S. 2, U.S. 7, VT 15), South Burlington, Winooski, Colchester and Essex Junction. Given this, a B/C ratio similar to that of project ITS-001 is to be expected for the signalized arterials to be included. For the limited-access portions of the system, a B/C ratio similar to project ITS-003 should be expected.

Chittendon County Urban Traffic Management System

Phase I: Initial deployment - 8 intersections

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras	$15,000	0	$0
Traffic Detectors	$18,000	8	$144,000
Intersection equipment upgrades	$10,000	8	$80,000
Signal Preemption-Intersection	$5,000	8	$40,000
Signal Preemption-Onboard Equipment	$200	25	$5,000
Portable VMS	$25,000	3	$75,000
Control Center Equipment (Installed)			
Central Computer/Server	$15,000	1	$15,000
Video Monitors	$1,000	2	$2,000
Networking Equipment	$5,000	1	$5,000
Central Software			$60,000
Furniture			$2,000
Communications (Installed)			
Per Leased Line / Wireless (CDPD) Connection	$ 1,000	11	$11,000
Design and Soft Costs (10%)			$43,900
TOTAL CAPITAL COSTS-Phase I			**$482,900**
ANNUAL COMMUNICATIONS COSTS	**$1,200**	**11**	**$13,200**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			**$61,490**

Preliminary Cost Estimate

Chittendon County Urban Traffic Management System

Phase II: UTMS expansion 8 more intersections

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras	$15,000	0	$0
Traffic Detectors	$18,000	8	$144,000
Intersection equipment upgrades	$10,000	8	$80,000
Signal Preemption-Intersection	$5,000	8	$40,000
Portable VMS	$25,000	1	$25,000
Control Center Equipment (Installed)			
Cenral software upgrade	$10,000	1	$30,000
Networking Equipment Upgrade	$5,000	1	$5,000
Communications (Installed)			
Per Leased Line / Wireless (CDPD)	$ 1,000	9	$9,000
Design, planning coordination and soft Costs			$33,300.0
TOTAL CAPITAL COSTS-Phase II			$366,300.0
ANNUAL COMMUNICATIONS COSTS	**$1,200**	**9**	**$10,800**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$47,430**

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Circumferential Highway ATMS
CCMPO Project Number	ITS-005
Project Objectives	Increase user-friendliness of the corridor Mitigate construction-phase traffic impacts Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems ITS Planning and Data Archiving
Geographic Extents	Consistent with extents of new road
Estimated Cost (see attached sheet)	Phase I: $458k + $46k O+M/year Phase II: $24k + $2.4k O+M/year
Anticipated Benefits	Mitigation of construction congestion Real-time traveler information Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Enhanced planning data collection
Lead Agency	VTrans
Other Key Participants	Cities and Towns of Burlington, South Burlington, Winooski, Essex Junction, Williston and Colchester
Deployment Considerations	Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: ITS Infrastructure installation as part of construction Phase II: Integration with Regional ITS Systems
Funding Opportunities	Circumferential Highway Construction Funds
Prioritization	*Medium*, Take advantage of highway construction to install ITS equipment Phase I and II: Medium-Term (Within 5 years)

Circumferential Highway ATMS

Project Description and Objectives

The Circumferential Highway ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed.

The objectives of the project include:

- ?? Fulfill VTrans' desire to enhance the user-friendliness of the corridor;
- ?? Take advantage of construction to reduce ITS installation costs;
- ?? Monitor and control the corridor to avoid congestion;
- ?? Provide traveler information about conditions in the corridor to the public;
- ?? Collect transportation planning data on roadway performance..

Implementation of the system would benefit significantly through coordination with the planned road construction project. In this case, the system can be implemented at reduced cost.

The system is capable of operating initially as a freestanding corridor management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center.

Project Elements

The Circumferential Highway ATMS will deploy a variety of ITS technologies under four National Architecture functional areas: Advanced Traffic Management Systems, Advanced Traveler Information Systems, and ITS Planning Data Archiving. There is a tremendous amount of technological flexibility in achieving the project objectives.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility such as the VTrans district office or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. It is recommended that fiber optic cable be installed along the length of the road during construction. This will support a high level of monitoring functionality and can contribute to the development of a regional fiber optic network.

Traffic Detection

CCTV camera technology can provide real time traffic images to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras.

Traffic detection data gathered through these technologies will generate a traffic data log that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

Information dissemination will be achieved by providing information from this project to the traveler information system that is being implemented under a separate project. This system will provide the data, which may be disseminated through a web site, interactive voice response (IVR; accessible from telephones or cellular phones), highway advisory radio (HAR) and permanent Variable Message Signs (VMS) at key decision points on the highway.

Traffic Control

The most viable traffic control alternatives for this corridor are use of VMS to affect traveler behavior.

Deployment Strategies

A phased approach is recommended to reduce the initial capital cost of the system, and expedite the deployment of construction phase ITS equipment. A two-phase deployment approach might be implemented as follows:

?? **Phase I: Installation of Traffic Monitoring and Management devices,** will be implemented in concert with the construction phase installation to install permanent communication, traffic detection, VMS and monitoring devices.

?? **Phase II: Regional Integration** focuses on integration of the Circumferential Highway system with other regional architecture such as the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

IDAS runs were not performed for this project, since the Circumferential Highway is yet to be built. However, one should expect the B/C ratio for the ITS deployments proposed for these two projects to resemble that of project ITS-003, because in both cases, the deployment will involve monitoring and control of a limited-access highway, similar to I-89.

Circumferential Highway ATMS

Phase I: ITS Installation

	Unit Cost		Qty.	Total Cost
Equipment (Installed)				
CCTV Cameras	$12,000		4	$48,000
Traffic Detectors	$5,000		4	$20,000
VMS	$90,000		2	$180,000
Fiber optic (Installed in existing project conduit)	$24,000	per mile	5	$120,000
Control Center Equipment (Installed)				
Central Computer/Server	$15,000		1	$15,000
Video Monitors	$1,000		2	$2,000
Networking Equipment	$10,000		1	$10,000
Central Software				$20,000
Furniture				$2,000
Design and Soft Costs (10%)				$41,700
TOTAL CAPITAL COSTS-Phase I				**$458,700**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)				**$45,870**

Preliminary Cost Estimate

Circumferential Highway ATMS

Phase II: Integration with other systems

	Unit Cost	Qty.	Total Cost
Control Center Equipment (Installed)			
Central Computer Configuration	$20,000	1	$20,000
Communications (Installed)			
Permanent leased line locations	$1,000	2	$2,000
Design, planning coordination and soft Costs			$2,200.0
TOTAL CAPITAL COSTS-Phase II			$24,200.0
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			$2,420

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Southern Connector ATMS
CCMPO Project Number	ITS-006
Project Objectives	Increase user-friendliness of the corridor Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems ITS Planning and Data Archiving
Geographic Extents	Consistent with extents of road construction
Estimated Cost	Phase I: $484k + $49k O+M/year Phase II: $24k + $2.4k O+M/year
Anticipated Benefits	Real-time traveler information Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Enhanced planning data collection
Lead Agency	City of Burlington
Other Key Participants	VTrans, City of South Burlington
Deployment Considerations	Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Permanent ITS Infrastructure Installation Phase II: Integration with Regional ITS Systems
Funding Opportunities	Southern Connector Construction Funds CMAQ
Prioritization	*Medium* Phase I in Concert with road construction (Within 5 years)

Southern Connector ATMS

Project Description and Objectives

The Southern Connector ATMS will provide installation of ITS components as part of the construction to help manage operations, detect incidents and inform travelers once the road is constructed. The Southern Connector runs parallel to Route 7 and it will therefore be important to provide good information on travel conditions on the two instrumented roadways.

The objectives of the project include:

?? Fulfill VTrans' desire to enhance the user-friendliness of the corridor;
?? Take advantage of construction to reduce ITS installation costs;
?? Monitor and control the corridor to avoid congestion;
?? Providing traveler information about conditions in the corridor to the public;
?? Collecting transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Implementation of the system would benefit significantly through coordination with the planned road construction project.

The ATMS is capable of operating initially as a freestanding traffic management system, and can be integrated with other regional ITS infrastructure at a later time through the Traffic Management and Information Center.

Project Elements

The Southern Connector ATMS will deploy a variety of ITS technologies under four National Architecture functional areas: Advanced Traffic Management Systems, Advanced Traveler Information Systems, and ITS Planning Data Archiving. There is a tremendous amount of technological flexibility in achieving the project objectives.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility such as the VTrans district office or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. It is recommended that fiber optic cable be installed along the length of the road during construction. This will support a high level of monitoring functionality and can contribute to the development of a regional fiber optic network.

Traffic Detection

CCTV camera technology can provide real time traffic images to the control center and/or a public traveler information web site. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras. Since this facility will be feeding in to a signalized section, emergency vehicle detection and queue detection should be incorporated

Traffic detection data gathered through these technologies will generate a traffic data log that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

Information dissemination will be achieved by providing information from this project to the traveler information system that is being implemented under a separate project. This system will provide the data, which may be disseminated through a web site, interactive voice response (IVR; accessible from telephones or cellular phones), highway advisory radio (HAR) and permanent Variable Message Signs (VMS) at key decision points on the highway.

Traffic Control

The most viable traffic control alternatives for this corridor are use of VMS to affect traveler behavior, provision of information on approaching emergency/transit vehicles to adjacent signalized intersections and signal coordination on the facility and connecting roads. Active emergency vehicles traveling on this facility will be detected and coordinated with emergency dispatch and this information will be transmitted along with traffic flow information to receiving signal control systems on the arterial streets. This will allow the systems to take traffic flow into account and clear the path for emergency vehicle passage.

Deployment Strategies

A phased approach is recommended to reduce the initial capital cost of the system, and expedite the deployment of construction phase ITS equipment. A two-phase deployment approach might be implemented as follows:

?? **Phase I: Installation of Traffic Monitoring and Management devices,** will be implemented in concert with the construction phase installation to install permanent communication, traffic detection, VMS, signal control and monitoring devices.

?? **Phase II: Regional Integration** focuses on integration of the Southern Connector system with other regional architecture such as the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

IDAS runs were not performed for this project, since the Southern Connector is yet to be built. However, one should expect the B/C ratio for the ITS deployments proposed for these two projects to resemble that of project ITS-003, because in both cases, the deployment will involve monitoring and control of a limited-access highway, similar to I-89.

Southern Connector ATMS

Phase I: ITS Installation

	Unit Cost		Qty.	Total Cost
Equipment (Installed)				
CCTV Cameras	$12,000		4	$48,000
Traffic Detectors	$5,000		4	$20,000
Intersection traffic detectors	$14,000		4	$56,000
Signal pre-emption equipment	$5,000		4	$20,000
VMS	$90,000		2	$180,000
Fiber optic (intsalled in existing project conduit)	$24,000	per mile	3	$72,000
Control Center Equipment (Installed)				
Central Computer/Server	$15,000		1	$15,000
Video Monitors	$1,000		2	$2,000
Networking Equipment	$10,000		1	$10,000
Central Software				$20,000
Furniture				$2,000
Design and Soft Costs (10%)				$44,500
TOTAL CAPITAL COSTS-Phase I				**$489,500**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)				**$48,950**

Preliminary Cost Estimate

Southern Connector ATMS

Phase II: Integration with other systems

	Unit Cost	Qty.	Total Cost
Control Center Equipment (Installed)			
Central Computer Configuration	$20,000	1	$20,000
Communications (Installed)			
Permanent leased line locations	$1,000	2	$2,000
Design, planning coordination and soft Costs			$2,200.0
TOTAL CAPITAL COSTS-Phase II			$24,200.0
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			$2,420

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Traffic Management Information Center (TMIC) Enhancements
CCMPO Project Number	ITS-007
Project Objectives	Increase user-friendliness throughout the region Improve traffic flow throughout the region Improve coordination of incident response Support coordination of event planning and development of regional response plans Expedite movement of emergency vehicles throughout the region Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems Emergency Management Systems ITS Planning and Data Archiving
Geographic Extents	Region wide
Estimated Cost	$364k + $206k O+M/year
Anticipated Benefits	Improvement in travel time reliability More effective incident detection and management Reduced travel times and vehicle emissions Real-time traveler information Increased modal split Emergency vehicle prioritization Enhanced planning data collection
Lead Agency	VTrans
Other Key Participants	CCMPO, Towns and cities of Chittenden County
Deployment Considerations	Significant interagency/interproject coordination
Deployment and Phasing Options	Deploy once significant number of individual local systems are in place
Funding Opportunities	CMAQ
Prioritization	Medium Term (5 years) to coordinate individual projects

Traffic Management Information Center (TMIC) Enhancements

Project Description and Objectives

This project will consolidate and upgrade the central control software and hardware systems of previous advanced traffic management system deployments. The discrete desktop control systems from the individual projects will be integrated into a single regional traffic management system, operated from a shared central software platform. Individual agencies will have access via remote workstations where applicable. A regional center will be co-located with one or more jurisdiction's centers. Advanced algorithms for response plans, signal coordination and emergency vehicle preemption will be implemented on the central system. The system will provide a central repository for regional data for use by other systems, including the traveler information system.

The project will also include the design of a data archiving and reporting user service to allow data collected by ITS to be used for long-range planning and other similar purposes.

The TMIC project will provide linkages to other regional centers such as the transit management center, state police, emergency response providers, dispatchers and public safety answering points (E911.) Development of this project must be coordinated with these agencies to ensure their needs are incorporated and that the response plans are coordinated and agreed by all.

The objectives for this project are therefore:

- Upgrade the traffic management hardware and software platform
- Communicate with existing field equipment
- Provide a central data repository and control system
- Implement enhanced algorithms for coordinating traffic management strategies across multiple jurisdictions and facilities in the region
- Develop multi-facility and jurisdiction response plans
- Provide information sharing and cross-agency real-time response planning and coordination
- Provide consistent information to travelers on all facilities
- Support central 24/7 operations to provide back-up to individual jurisdictions
- Continue to support individual facilities and agencies through remote workstations and low speed video feeds
- Share information with other regional systems

Project Elements

The TMIC ITS project will integrate and implement the following key ITS architecture market packages:

- ?? Network Surveillance
- ?? Probe Surveillance using the transit AVL system data
- ?? Surface Street Control
- ?? Freeway Control
- ?? Regional Traffic Control
- ?? Incident Management System
- ?? Traffic Forecast and Demand Management
- ?? ITS Data Warehouse to store ITS collected data from multiple agencies in a single searchable database for planning and analysis purposes

Central software

The TMIC will consist of software to provide the following primary functions:

- ?? Analyze the data from the individual ATMS systems and any supplemental sources, update status displays,
- ?? Identify and alert operators to detected or suspected incidents,
- ?? Analyze the data and implement predictive algorithms for identifying potential impacts to the network operation; and
- ?? Make recommendations on appropriate response plans including VMS messages, signal timing changes

Incident management aspect of this project will manage both predicted and unexpected incidents so that the negative impact to the transportation network and traveler safety is minimized. Incident detection capabilities will include regional coordination with other traffic management and emergency management centers, weather service entities, and event promoters. Information from these diverse sources will be collected and correlated to detect and verify incidents and implement an appropriate response.

The software will support traffic operations personnel in developing an appropriate response in coordination with emergency management and other incident response personnel to confirmed incidents. The response may include traffic control strategy modifications and presentation of information to affected travelers using the VMS or regional traveler information systems. The system should also assists the operator by monitoring incident status as the response unfolds. The coordination with emergency management could be supported through a CAD system, shared white boarding facilities or through other communication with emergency field personnel. The coordination should also extend to tow trucks and other field service personnel.

Regional traffic control adds to the surface street control and freeway control systems implemented in earlier projects by adding the communications links and integrated control strategies that enable integrated inter-jurisdictional traffic control. This project therefore provides for the sharing of traffic information and control to support a regional control strategy. The nature of optimization and extent of information and control sharing is determined through working arrangements between jurisdictions. This project relies on roadside instrumentation supported by the earlier projects and adds hardware, software, and wire line communications capabilities to implement traffic management strategies that are coordinated across the affected areas.

Traffic forecast and demand management functions will include advanced algorithms, processing, and storage capabilities that support historical evaluation, real-time assessment, and forecast of the roadway network performance. This includes the prediction of travel demand patterns to support better link travel time forecasts. The source data would come from the TMIC itself as well as other regional traffic management centers.

The software will provide remote device status, switching and control functions, including VMS and CCTV camera control. The software will arbitrate between different users trying to take control of the devices. The software will allow users to access and display any video streams and cameras that they are authorized to have access to.

Hardware

The TMIC system will utilize the following principal hardware items:

?? **Workstations**, both at the TMIC central facility and at participating jurisdictions, that will provide access to system data, VMS sign controls, and utilities for creating incident descriptions and selecting response plans. Remote workstations will have limited access to these functions;

?? **Video display console** at the central location for monitoring multiple cameras simultaneously to assist with incident detection and management. It is anticipated that a freestanding unit housing approximately 6 video displays and corresponding control and computer equipment would be of the right order of magnitude; and

?? **Communications** between participating agencies for transport of detector information, device control, other system data and video signals. Data will also be shared with the regional traveler information systems and emergency response providers.

Deployment Strategies

This project will build on the separate ATMS initiatives being undertaken around the region to enhance the management of incidents and traffic. This project will therefore be implemented in a single phase once sufficient critical mass has been achieved through deployment of the individual ATMS systems. Additional ATMS deployments can be added to the TMIC as they occur.

Preliminary Benefits Analysis

The project also aims to integrate the different components deployed as a part of the previous project into one integrated system or center for the County. The discrete desktop control systems from the individual projects will be integrated into a single regional traffic management system, operated from a shared central software platform. Given this, the benefits of such a project will essentially represent the aggregated benefits of the previous projects. In addition, additional benefits, in terms of operations cost savings, could be realized through equipment and operating staff sharing.

Traffic Management Information Center

	Unit Cost	Qty.	Total Cost
Control Center Equipment (Installed)			
Central computer system	$50,000	1	$50,000
Workstations	$3,000	6	$18,000
Video console	$25,000	1	$25,000
Netwrok equipment	$20,000	1	$20,000
Central Software			$200,000
Furniture			$10,000
Communications (Installed)			
Per Leased Line	$ 1,000	8	$8,000
Design and Soft Costs (10%)			$33,100
TOTAL CAPITAL COSTS			**$364,100**
ANNUAL STAFFING COSTS FOR 24/7 OPERATION			**$170,000**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$206,410**

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Transit Automatic Vehicle Location (AVL)
CCMPO Project Number	ITS-008
Project Objectives	Reduce variability and simplify use of transit Improve efficiency of paratransit operations Improve transit planning and real-time management efficiency Improve transit information provided to travelers Collect traffic planning and operations data
ITS Functional Areas	Advance Public Transportation Systems Advanced Traveler Information Systems ITS Planning and Data Archiving
Geographic Extents	County-wide
Estimated Cost	Phase I: $271k + $62k O+M/year Phase II: $260k + $67k O+M/year
Anticipated Benefits	Improvement in transit travel time reliability More effective transit resource management Reduced travel times Real-time traveler information Increased modal split to transit Identify locations of transit vehicles during emergencies Additional travel time data for traffic management Enhanced planning data collection
Lead Agency	CCTA /SSTA
Other Key Participants	CATMA, Vtrans and other transit service providers as appropriate
Deployment Considerations	Interagency coordination on technology Wireless communications choices
Deployment and Phasing Options	Phase I: Paratransit AVL and Dispatch Software Phase II: Fixed Route AVL and traveler information integration Phase III: In-vehicle enhancements
Funding Opportunities	FTA
Prioritization	Phase I - High priority project for regional transit Phase II – Medium term (3 years) Phase III – Long term (6 years)

Transit Automatic Vehicle Location (AVL)

Project Description and Objectives

Automatic Vehicle Location (AVL) uses a vehicle mounted device which communicates the locations of the vehicle to a control center in real-time. The control center can then use this data to display the location of vehicles on a map for dispatcher use. The information can also be used to calculate schedule adherence; calculate headways; provide information to riders on route status and predicted arrival times; and for real-time assignment and routing functions in a paratransit system or deviated fixed route system. The data generated can also be used to calculate vehicular travel times for road sections for use in monitoring travel conditions and providing accurate traveler information. This system therefore can provide a particularly useful function by filling in gaps in regional travel time data from buses in non-instrumented, less urban areas.

Depending on the needs of the individual agencies, the system can also be used to communicate vehicle and driver status to the control center and electronically send route updates or other information to the vehicle's driver.

This project has the following objectives:

- ?? Improve efficiency and responsiveness of paratransit and future deviated fixed route operations
- ?? Reduce variability of transit services provided
- ?? Provide real-time information on transit vehicle status
- ?? Improve transit planning through use of real-time and historical data improve routes and schedules
- ?? Improve real-time management efficiency through selection of routes and schedules
- ?? Improve real-time transit information provided to travelers
- ?? Collect vehicle travel times for input into traffic management and traveler information systems
- ?? Collect traffic planning and operations data

Project Elements

The AVL ITS project will consist of the following key ITS architecture market packages:

- ?? Transit Vehicle Tracking
- ?? Demand Response Transit Operations
- ?? Transit Fixed-Route Operations
- ?? Transit Maintenance
- ?? Multi-modal Coordination
- ?? Probe Surveillance
- ?? ITS Data Mart to retain collected data for planning and operational analysis

The AVL project will consist of the following basic technology areas:

- ?? In-vehicle equipment and wireless communications
- ?? Central software
- ?? Traveler information dissemination

In-vehicle equipment and wireless communications

In vehicle equipment can range from a fairly simple GPS and cell phone combination unit to a full GPS-enabled on-board-computer with two-way driver messaging, vehicle status monitoring and a custom communications system. In order to meet the goals of this project, it is anticipated that a fairly simple in-vehicle unit will be utilized. This will communicate via a commercial wireless service such as cell phone or using a 218-219MHz service. For the paratransit and future enhanced deviated fixed route services, the system should support the provision of routing information to the drivers to allow them to respond effectively to real-time requests.

Central software

The paratransit and future deviated fixed route central system will provide enhanced computer aided dispatching and scheduling (CADS) software, which will provide the following functions:

- ?? Poll remote units or receive position updates and retrieve location information
- ?? Display and identify remote unit positions on a graphical map display
- ?? Develop routing, scheduling and driver assignment plans
- ?? Accept and validate reservations for rides
- ?? Develop most efficient routes to support reservations using operator-defined criteria
- ?? Modify routes in real-time based on GPS location information and on reservation updates (such as cancellations.)
- ?? Save real-time data information by route, run, driver and bus to support performance analysis, planning and schedule modification

Software to support he fixed route bus system will provide functions including the following:

- ?? Poll remote units or receive position updates and retrieve location information
- ?? Display and identify remote unit positions on a graphical map display
- ?? Develop routing, scheduling and driver assignment plans
- ?? Identify buses that are off schedule
- ?? Support cut throughs and temporary route changes

The central software shall also support the traveler information aspects of the system by generating and outputting the appropriate bus location and predicted stop arrival information. This information will be made available at the central transfer facility (The Downtown Transit Center in Burlington) and distributed system wide through a variety of media.

Basic CADS software already in use at SSTA will be replaced to support use of the real-time vehicle location data.

Traveler information dissemination

A separate project has been defined to provide coordinated regional transit traveler information. However, the AVL systems must be designed to support provision of the appropriate information. For example, the AVL system will likely calculate expected arrival times at specific stops. These data should not only be used for on-time performance monitoring but should also support traveler information needs therefore covering stops that might not have been included for a management only system. There are several elements to the potential traveler information systems that can be supported by the real-time data including:

- ?? In-vehicle signing
- ?? Bus stop signing, and
- ?? Broad area information dissemination by telephone, web, radio and kiosk.

Given the user friendliness of the transportation services, it is assumed that **in-vehicle signing** will not be needed as drivers can provide passengers with the services they require.

Bus stop signing will require a display and/or annunciator at bus stop locations and some kind of wireless or wire-line communications. The system will then provide travelers with the real-time expected arrival times and route numbers of a certain number of buses. This system is therefore applicable to fixed route services such as operated by CCTA. Given the cost to deploy these systems at every bus stop, it is anticipated that these displays would only be placed at major hub locations.

Depending on timing of transit traveler information project, the AVL project may need to provide its own basic level of **broad area dissemination** service including a simple web site and dial-in telephone system. The web site should display the status of current routes, along with a graphical display of bus positions (providing there are no security concerns over this information.) The telephone system would provide automated information on the status of user selected routes and arrival times of buses at certain selected bus stops or at requested locations for paratransit riders.

Links to other regional systems will be used to provide travel time data to the region Traffic Management and Information Center (TMIC.) As a minimum, the AVL system will provide vehicle location and timestamp information to allow the TMIC to calculate link travel times. The system should also provide stop location and duration information to enhance the accuracy of the travel time data. This communication of data will also support traffic signal control from the TMIC for transit prioritization.

Deployment Strategies

This project will be implemented in two phases as follows:

Phase I: Paratransit AVL - this phase will include the installation of AVL units on all paratransit vehicles and implementation of central CADS software to allow monitoring of vehicle locations by dispatch personnel and providing automated reservation, cancellation, and real-time routing functions.

Phase II: Fixed Route AVL – Expansion of the system to the fixed route vehicles and installation of appropriate CADS software. Integration with the regional transit traveler information system.

Preliminary Benefits Analysis

In conducting the benefits analysis for this project, separate runs were made for the use of AVL on the fixed-route CCTA transit vehicles, and its use on the SSTA paratransit vehicles. IDAS results indicate an expected B/C ratio of 1.54 for CCTA vehicles, and a B/C ratio of 1.94 for the SSTA vehicles. The benefits are the result of expected reductions in agencies' capital and operating costs, improvements in user mobility, and a very slight reduction in accidents and emissions costs.

Transit Automatic Vehicle Location

Phase I: Paratransit AVL

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Equip 35 vehicles with AVL and comms	$4,000	35	$140,000
Shared central computer system and workstations	$22,000	1	$22,000
CADS software	$85,000	1	$85,000
Design and Soft Costs (10%)			$24,700
TOTAL CAPITAL COSTS-Phase I			**$271,700**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$27,170**
ANNUAL COMMUNICATIONS	$1,000	35	**$35,000**
TOTAL ANNUAL COSTS			$62,170

Transit Automatic Vehicle Location

Phase II: Fixed Route AVL

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Equip 30 vehicles with AVL and comms	$4,000	41	$164,000
Central computer system and workstations	$22,000	1	$22,000
CADS software	$50,000	1	$50,000
Design and Soft Costs (10%)			$23,600
TOTAL CAPITAL COSTS-Phase II			**$259,600**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$25,960**
ANNUAL COMMUNICATIONS	$1,000	41	**$41,000**
TOTAL ANNUAL COSTS			$66,960

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Integrated Fare Management
CCMPO Project Number	ITS-009
Project Objectives	Increase user-friendliness of transit in the corridor Improve efficiency of transit and fare collection management Reduce intermodal exchange times Improved planning and operations data
ITS Functional Areas	Electronic payment Public Transportation Management
Geographic Extents	County-wide
Estimated Cost	Phase I: $75k Phase II: $229k + $150k O+M/year Phase III: $1,686k + $200k O+M/year
Anticipated Benefits	Improved user frie ndliness and convenience of transit Increased transit ridership Reduced transit operational and financial handling costs Enhanced planning data collection
Lead Agency	CCTA
Other Key Participants	Vermont Transportation Authority (rail) SSTA Cities and towns of Chittenden County VTrans
Deployment Considerations	Integration with other services, including tourism to participate in deployment
Deployment and Phasing Options	Phase I, Initial study and scope definition Phase II, Trial deployment Phase III Full deployment
Funding Opportunities	FTA, ITS Earmark
Prioritization	Medium priority to take advantage of current investments being made by CCTA (5-1 0 years)

Integrated Fare Management

Project Description and Objectives

This project will develop an integrated fare medium, such as a smart card, that will build on the existing magnetic card deployment to support bus, rail, parking, ferry applications, and possibly other retail/service locations in the region. The information stored and collected through this type of smart card could also provide valuable service and fare planning information to the region's transit providers.

The fare medium would likely include a prepaid balance that would be decremented as the device is used to pay for services and/or purchases. The medium will support transfers, intermodal discounts and periodic passes.

This project will have the following objectives:

?? Provide a user-friendly and secure payment method for all modes
?? Improve traveler convenience and boarding times
?? Increase ridership by reducing barriers to riding and increasing efficiency of cross mode trips
?? Improve management data on transit ridership patterns
?? Implement a single electronic payment media across all transportation modes
?? Utilize a common clearinghouse and back office for processing customer payments on all modes
?? Reduce management and processing costs by integrating with retail businesses
?? Support other regional initiatives such as tourism discounts

Project Elements

The integrated fare management ITS project primarily consists of the Transit Passenger and Fare Management ITS architecture market package. This project will encompass the following elements:

?? Payment media
?? Vehicle and infrastructure based media readers
?? Host transaction processing system; and
?? Financial clearinghouse

Payment media can be as simple as magnetic cards or as complex as a microprocessor based smart card. The payment media may include stored value, which is decremented on use or may contain an ID, which points to a central account at the financial institution. As the number of applications increases for the security of the payment media device or account validation process increases. The payment media should also support improved transaction speed to enhance customer convenience. While a magnetic card may be suitable for a limited transit deployment, expanding the system to retail will likely involve the use of a stored value smart card.

Vehicle and infrastructure based media readers are required on each vehicle, at boarding points, at participating retailer or service provider location and at recharging points. In-vehicle and boarding point devices should provide fast enough transaction times to ensure that rider throughput is not impeded. Recharging points are stations where the value of a card, or the money in a central account can be added. These may be installed at transit hubs, multi-modal centers or in some retailers. Ongoing demonstrations around the country are investigating the use of bank ATMs as recharging stations.

The **host transaction processing system** will be installed by each agency or provider to manage and report on the electronic transactions undertaken within their system. For a retailer with one processing device this functionality may be combined with the device reader. In this scenario, which is analogous to a credit card acceptance terminal, the device itself can provide reports of the he values of transactions handled during a given time period.

For transit agencies, the host would likely be a networked computer system, collecting transaction information from all owned vehicles and recharging points and forwarding this information to a clearinghouse. The host would provide reports on usage and expected revenues for auditing the disbursements made by the clearinghouse.

The **financial clearinghouse** will manage the funds deposited by the users and distribute funds to the service and goods providers based on electronic transactions received from these facilities. The clearinghouse will manage accounts, including black or white lists of invalid or valid media. The financial clearinghouse may be operated by a bank, or by a selected agency within the region. Users of the clearinghouse will likely pay a transaction fee or some other fee in order to cover the operating costs incurred by this organization.

Deployment Strategies

Phase I. Regional electronic payment study - The first step in the deployment of an electronic payment system is a study of the costs and benefits and establishment of the appropriate institutional structure to support trial, procurement and deployment of a multi-agency, multi-vendor system. Establishment of an institutional structure early on can ensure that all agencies have input in to the technology and clearinghouse decisions, rather than presenting a de-facto standard corresponding to decisions made by a single agency. The study will also define the realistic scope, and implementation approach for the deployment of electronic payment. The study will therefore incorporate the following objectives:

?? Identify what would need to be done to support broader application of the current magnetic card deployment being pursued by CCTA;
?? Explore integration with the University of Vermont and other major employers;
?? Explore integration with the CatCard debit card – in its simplest form the CatCard might be used for transportation payments, in it most complex, a joint smart card may

be issued that can act as a CatCard and a transportation payment card and links the transportation payments with the CatCard account;

?? Identify anticipated regional retail and service provider potential for participation

?? Explore potential tourism initiatives;

?? Investigate and formulate an appropriate stakeholder group and organizational structure for managing the testing and deployment of the system; and

?? Identify a phased implementation plan

Phase II. Initial trial deployment – the system would be deployed in a small number of vehicles and participating service or retail providers to prove the functionality of the system and to gauge local user acceptance.

Phase III. Full deployment – The system would gradually be rolled out to all participating providers in the region. The central clearinghouse serving all functions would be established.

Preliminary Benefits Analysis

This project will develop an integrated fare medium, such as a smart card, that will build on the existing magnetic card deployment to support bus, rail, parking, ferry applications, and possibly other retail/service locations in the region. The information stored and collected through this type of smart card could also provide valuable service and fare planning information to the region's transit providers. Regarding the benefits of integrated fare management systems, IDAS estimates that these systems would, on average, result in a 14% increase in the revenue, and a 3% increase in ridership.

Integrate Fare Management

Phase I: Initial study

	Unit Cost	Qty.	Total Cost
Study cost	$75,000	1	$75,000

Preliminary Cost Estimate

Integrate Fare Management

Phase II: Initial Deployment

	Unit Cost	Qty.	Total Cost
Capital Costs			
Back End Data Management System	$100,000	1	$100,000
Agency Hosts	$30,000	1	$30,000
On-vehicle equipment	$4,000	10	$40,000
Card recharge stations	$7,500	2	$15,000
Vendor Terminals	$1,000	2	$2,000
Communications (Installed)			
Comunications between agencies			$5,000
Design, planning coordination and soft Costs (20% of capital)			$37,400.0
TOTAL CAPITAL COSTS-Phase II			$229,400.0
ANNUAL OPERATIONS & MAINTENANCE			$150,000

Preliminary Cost Estimate

Integrate Fare Management

Phase III: Full Deployment

	Unit Cost	Qty.	Total Cost
Capital Costs			
Clearinghouse	$1,000,000	1	$1,000,000
Agency Hosts	$30,000	4	$120,000
On-vehicle equipment	$4,000	50	$200,000
Card recharge stations	$7,500	6	$45,000
Vendor Terminals	$1,000	20	$20,000
Communications (Installed)			
Comunications between agencies			$20,000
Design, planning coordination and soft Costs (20% of capital)			$281,000.0
TOTAL CAPITAL COSTS-Phase III			$1,686,000.0
ANNUAL OPERATIONS & MAINTENANCE			$200,000

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Transit traveler information system
CCMPO Project Number	ITS-010
Project Objectives	Implement a scalable, manageable traveler information system Increase ridership of transit options Improve the accessibility and availability of travel options information to users Simplify use of public transportation Provide multi modal trip planning functions to users Deliver real-time updates to users where they can make best use of the information Deliver real-time information to users to increase the level of satisfaction with performance
ITS Functional Areas	Advanced Traveler Information Systems Advance public transportation systems
Geographic Extents	County-wide
Estimated Cost	Phase I: $91k + $9k O+M/year Phase II: $84k + $11k O+M/year Phase III: $222k + $42k O+M/year
Anticipated Benefits	Pre trip planning information and support Real-time traveler information Increased user friendliness of transit options Increased level of satisfaction with services provided Increased ridership Enhanced planning data collection
Lead Agency	CCTA
Other Key Participants	SSTA CATMA Vermont Transportation Authority (rail)
Deployment Considerations	
Deployment and Phasing Options	Phase I: Static planning information and manual updates through web Phase II: Link to AVL for real-time and initial deployment of information devices Phase III: advanced trip planning and broad deployment of devices
Funding Opportunities	FTA
Prioritization	Phase I Near Term (2 years) Phase II in concert with broad AVL deployment (3 years) Phase III Long term (> 5 years)

Transit traveler information system

Project Description and Objectives

The transit traveler information system will provide travelers with access to real-time updates and transit planning capabilities when planning their trips or while en-route. A variety of dissemination media will be available including web, telephone, kiosks and specialized displays at bus stop locations. The system will disseminate both static data for planning purposes and real-time data for providing updates to travelers. This traveler information system will be combined with the regional traveler and tourist information system and with the Tri-State RATIS (rural advanced traveler information system, known as Trio.)

This project will have the following objectives:

?? Implement a scalable, manageable traveler information system
?? Improve utilization and increase ridership of transit options
?? Improve the accessibility and availability of travel options information to users
?? Simplify use of public transportation
?? Provide multi modal trip planning functions to users
?? Deliver real-time updates to users where they can make best use of the information
?? Deliver real-time information to users to increase the level of satisfaction with performance

Project Elements

The ITS project will consist of the following ITS architecture market packages:

?? Interactive traveler information,
?? Broadcast traveler information,
?? Dynamic ridesharing, and
?? Transit traveler information

The types of information that will be disseminated by the transit traveler information system include:

?? Static schedule, route and cost information
?? Information on transfer costs and rules
?? Discount information
?? Real-time schedule updates through manual input or interface to the AVL system
?? Real-time arrival times at specific stops through integration with the AVL system
?? Bus locations via data provided by the AVL system
?? Multi-modal, multi route trip planning support services (providing data to enable the user to select appropriate routes and companies)
?? Multi-modal, multi-route automated trip planning based on user-defined criteria (providing recommended routes and exchanges)

?? Route reservation entry
?? Reservation updates

There are several elements to the potential traveler information systems that can be supported including:

?? In-vehicle signing
?? Bus stop signing,
?? Web,
?? Kiosks, and
?? Telephone.

Given the user friendliness of the transportation services, it is assumed that **in-vehicle signing** will not be needed as drivers can provide passengers with the services they require.

Bus stop signing will require a display and/or annunciator at bus stop locations and some kind of wireless or wire-line communications. The system will then provide travelers with the real-time expected arrival times and route numbers of approaching buses. This system is therefore applicable to fixed route services such as operated by CCTA. Given the cost to deploy these systems at every bus stop, it is anticipated that these displays would only be placed at major hub locations or facilities. Less expensive audio announcer options could be assessed for wider deployment.

The transit information **web site** will provide the most flexible, interactive and powerful access to the transit data. It is anticipated that the web site will also be used by the transit agencies to modify the transit data. The web site will support all information types, planning capabilities and reservation options discussed above and can include maps of routes and detailed information on costs, agencies and options. It should allow users to register for real-time updates by email. The web site will also be integrated with the Tri-state RATIS (Trio) traveler information project. The web site will be used mainly for pre-trip planning although would be used for real-time updates immediately prior to departure.

Kiosks at major employers or other activity centers can provide interactive access to the web site services for travelers away from their office or home. Kiosks can also utilize overhead screens that provide status updates to multiple travelers without interaction, much like airport departure monitors.

The **telephone system** would provide automated information on the status of user selected routes and arrival times of buses at certain selected bus stops or at requested locations for paratransit riders. The telephone system should be designed to have shallow menu trees and limited options to ensure effective use. Interaction can be through simple touch-tone button presses or through advanced speech recognition. Use of caller ID or cell phone location data could be used to tailor the information to the caller's location. The telephone enquiry system should be integrated within a broader, regional 511 initiative as well at the Tri-state RATIS (Trio) project.

Deployment Strategies

Phase I – initial web and telephone deployment. Static schedule, route and cost information. On-line reservations and route status updates, including commuter rail travel times which will be fed to the regional traveler information system for comparison with highway travel times.

Phase II - integration of web and telephone with AVL systems to provide real-time updates and email alert capabilities. Test installation of kiosks and bus stop signs at selected locations.

Phase III - addition of automated multi-mode, multi agency route planning services to the web and interactive kiosks. Broader deployment of bus stop signs and kiosks, based on results of Phase II.

Preliminary Benefits Analysis

At the present time, it is very hard to use IDAS to come up with an accurate estimate of the benefits for recommended projects ITS-010. The benefits to be expected from this project will largely depend upon the area of coverage, which is not specifically defined at the current moment. In addition, the current version of IDAS does not consider tourism-related benefits of traveler information systems. Moreover, it is somewhat challenging to accurately estimate the costs of this project. This is because the deployment of all traveler information systems and services in Chittenden County will likely be integrated with two major statewide traveler information initiatives that are currently underway at the State level (the Tri-state Rural Advanced Traveler Information System (TRIO); and (2) the ConnectVermont project). As a result of this integration, the cost of deploying traveler information services within Chittenden County will likely be reduced. For these reasons, IDAS runs were not performed for this project. However, generally speaking, one should expect the following benefits out of the project:

- ?? Pre trip planning information and support
- ?? Increased user friendliness of transit options
- ?? Increased transit ridership
- ?? Increased level of satisfaction with the transportation system for visitors and residents
- ?? Real-time traveler information
- ?? Increased predictability of travel time
- ?? Increased county tourism revenues

Transit Traveler Information System

Phase I: Stand alone deployment

	Unit Cost	Qty.	Total Cost
Control Center Equipment (Installed)			
Web site for dissemination and data collection	$35,000	1	$35,000
Central computer system	$5,000	1	$5,000
Telephone dial-in system	$30,000	1	$30,000
Central Software	$7,000	1	$7,000
Furniture			$2,000
Communications (Installed)			
Telephone lines	$ 150	4	$600
Design and Soft Costs (15%)			$11,940
TOTAL CAPITAL COSTS-Phase I			**$91,540**
ANNUAL OPERATIONS & MAINTENANCE (10%/yr)			**$9,154**

Transit Traveler Information System

Phase II: Real-time data and remote display trial

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Bus Stop Displays	$10,000	2	$20,000
Kiosks	$15,000	1	$15,000
Control Center Equipment (Installed)			
Upgrade server to accept real-time AVL data	$15,000	1	$15,000
Upgrade web	$10,000	1	$10,000
Upgrade telephone system	$10,000	1	$10,000
Communications (Installed)			
Communications to kiosk and signs	$1,000	3	$3,000
Design, planning coordination and soft Costs (15%)			$10,950.0
TOTAL CAPITAL COSTS-Phase II			$83,950.0
ANNUAL COMMUNICATIONS COSTS	$720	3	$2,160
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			$10,555

Transit Traveler Information System

Phase III:Automated trip planning and remote display deployment

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Bus Stop Displays	$3,000	16	$48,000
Kiosks	$15,000	4	$60,000
Control Center Equipment (Installed)			
Trip planning software	$50,000	1	$50,000
Web enhancements	$7,500	1	$7,500
Telephone system enhancements	$7,500	1	$7,500
Communications (Installed)			
Communications to kiosk and signs	$1,000	20	$20,000
Design, planning coordination and soft Costs (15%)			$28,950.0
TOTAL CAPITAL COSTS-Phase III			$221,950.0
ANNUAL COMMUNICATIONS COSTS	$1,000	20	$20,000
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			$42,195

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	Regional Traveler and Tourism Information System
CCMPO Project Number	ITS-011
Project Objectives	Increase user-friendliness of the corridor Improve access to transportation options information Improve access to activities, events, and services available in the region Provide accessible information in ways that will be used by tourists and local citizens Provide local portal to real-time and planned transportation network information Interface with (Trio) RATIS to exchange broader area information
ITS Functional Areas	Advanced Traveler Information Systems
Geographic Extents	Regional
Estimated Cost	Phase I: Web $210k + $36k O+M/year Phase II: Kiosks $231k + $8.5k O+M/year
Anticipated Benefits	Real-time traveler information Increased level of satisfaction with the transportation system for both visitors and local residents Increased predictability of travel time Increased county tourism revenues
Lead Agency	Vtrans
Other Key Participants	Cities and Towns of Chittenden County Chambers of commerce Tourism agencies
Deployment Considerations	Development of partnerships with businesses and University of Vermont
Deployment and Phasing Options	Phase I: Database, Web and Telephone Deployment Phase II: Expand Dissemination Options
Funding Opportunities	ITS earmark
Prioritization	Medium-Term (Within 5 years) to build on momentum created by initial projects

Regional Traveler and Tourism Information System

Project Description and Objectives

The regional traveler and tourist information system is a centralized system that consolidates and distributes static and real-time traveler, weather, and tourist information for transportation agencies and the general public. It will also form the regional data interface with the multi-state rural advanced traveler information system (RATIS.)

The system will utilize a variety of information dissemination media to communicate data collected from transportation, tourism and weather providers in the region. Tourism information on attractions, restaurants, lodging, and services will complement the traveler information, allowing travelers to explore options related to the current travel conditions. For example, a traveler hearing about a long delay on their route may decide to find a local restaurant in which to wait out the delay. The system should also support provision of travel options relating to the chosen tourism or business destinations. By combining these information types, the region's tourist economy will be enhanced and opportunities created for potential private financial underwriting and participation in the system.

In order to realize the potential benefits, it is crucial that the system provide current data and a reasonable level of availability. Because of its small geographic area, the region would benefit from a combined traveler information system that serves as a shared repository and processor of traffic data for highway, urban, and transit applications. This will help consolidate the operation and maintenance efforts and make it more cost effective for a partner, such as the University of Vermont, to manage.

This system will supplement the transit traveler information system, providing more general travel information targeting the tourist and non-transit user. The transit traveler information system will focus on supporting local residents and users who know they want to use the transit system. A link between the systems will help to promote transit to general system users. This system will present travel time comparisons between highways and commuter rail once these data are available from other projects.

The system would also support information being shared among transportation and emergency services agencies to support their respective decision-making and operations needs.

This project will have the following objectives:

?? Increase user-friendliness of the region

?? Improve access to transportation options information

?? Improve access to activities, events, and services available in the region

?? Provide a central repository for all regional transportation information

?? Leverage the value of the transportation information by providing access to relevant tourism information

?? Provide accessible information in ways that will be used by tourists and local citizens

?? Provide a local portal to real-time and planned transportation network information

?? Interface with (Trio) RATIS to exchange broader area information

Project Elements

The regional traveler and tourism information system ITS project will consist of the following key ITS architecture market packages:

?? Transit Traveler Information
?? Broadcast Traveler Information
?? Interactive Traveler Information
?? Yellow Pages and Reservation

This project will involve the following elements:

?? Data exchange with regional ATMS systems, TMIC and transit traveler information system
?? Entry and management of tourism data
?? Interface to weather data
?? Information dissemination
- o Internet
- o Kiosk
- o Telephone
- o Kiosk
- o VMS
- o Radio

?? Marketing

Data Exchange

The traveler information system will collect and store data initially from the individual regional systems and eventually from the regional TMIC. This data will include travel times, traffic flow data, construction, and incidents. The system should also provide an interface to collect data that is not provided by these systems, such as winter road maintenance data.

This system must be tightly integrated with the transit traveler information system to minimize duplication and to ensure that each system can cater to its own target audience. This system will be display basic route status information from the transit system but will link to the transit system for more detailed information. Trip planning capabilities will be integrated between the two systems, such that users planning a trip will be provided with appropriate links to the transit traveler information system. Travel time information generated by the AVL system will be presented to show a comparison between transit and private vehicle options and to provide accurate general road segment travel time information.

Entry and management of tourism data

A significant database has already been developed by the Vermont Department of Tourism and Marketing (http://www.1-800-vermont.com/.) This project should be able to utilize this data and will provide a targeted regional portal to this information. Businesses that want to be included in this database can register through http://www.vermontbusinessregistry.com/. This project could enhance this information by allowing local businesses to provide real-time discounts, coupons or promotions or provide real-time status data, such as room availability, restaurant wait times, or outdoor activity closings. This project will also integrate with the tourism information functions provided through the Tri-Sate RATIS project.

Interface to weather data

The RATIS project will be providing detailed predictive weather and road condition information. Again, this system will utilize this data through an exchange link to support the targeted regional portal.

Information dissemination

<u>Internet</u>

The Internet site will provide interactive map and text displays of the transportation and tourism data and will focus primarily on pre-trip planning. The Internet site shall also provide the functionality for maintaining any real-time tourism data such as that described above. The web server could be housed at one of the participating agencies or at a regional Internet Service Provider who can provide the necessary bandwidth, redundancy and backup for service reliability.

The Internet site should provide a forum for users to provide comments and to register for email or text updates and alerts based on their area of interest. The web site could also provide trip planning and itinerary planning functions.

The web site should support common browsers a well as the increasing number of mobile browsers using WAP or HDML.

<u>Kiosk</u>

Kiosks typically consist of a computer, screen, mouse and/or keyboard, and possibly a printer all housed in a robust and attractive enclosure. The kiosks will provide interactive access to the web site at strategic locations in the region, such as at the Burlington International Airport, Fairgrounds, the multi-modal center or selected parking garages. Kiosks are fairly expensive to purchase and maintain and have a fairly limited life (less than 5 years) making it important to carefully consider the number and location of deployments. Kiosks need to be installed in high visibility, high dwell time areas to be effective. Kiosk deployment should integrate or upgrade existing kiosk deployments including those at the Williston Rest Stop.

Web terminal kiosks, consisting of an inexpensive, self contained PC with restricted user-interface software could also be deployed in controlled conditions where vandalism and weather issues are not a problem. Such device s could be installed in local lodging or other business establishments.

<u>Telephone</u>

An interactive voice response (IVR) system will provide telephone access to the data managed under this project. This system can provide real-time updates to travelers while en-route. To minimize safety risks, the system should use voice recognition in addition to touch-tones for selecting the information the user requires. It is anticipated that the telephone system will be implemented as part of a broader regional 511 strategy and would likely provide a local server within that network.

The IVR system should provide seamless integration with transit traveler IVR if user selects this data type.

<u>Radio</u>

Both real-time and static data can be broadcast over an appropriate radio channel. Channels available include commercially licensed stations, low power FM, AM highway advisory radio or partnership with an existing station. Depending on the method chosen, different levels of advertising and business promotion can be included, providing opportunities for sponsorship and ongoing cost recovery. It is likely that the TriState RATIS project will implement low power FM stations. It will therefore be important for this project to integrate with that deployment to provide a consistent traveler experience.

Provision of radio programming can be a costly exercise; therefore radio dissemination deployed within this project should utilize automated programming to the greatest extent possible. Regional informational programs should be interspersed at regular intervals with travel and weather updates. Higher priority announcements should be automatically played on a more regular basis.

<u>VMS</u>

Variable or changeable message signs are normally installed prior to key decision points over or adjacent to the highway. VMS can be permanently mounted or utilize trailers which can be moved from location to location. Although a traveler information device, VMS are typically a traffic management tool and are normally controlled by the agencies that have jurisdiction over the roadway. This project will therefore not directly control messages or signs but will require some level of integration for two reasons: to ensure that consistent information is disseminated by the traveler information system and the VMS; and to use the VMS to direct users to access the traveler information system for more information relating to certain events.

Marketing

The effective marketing of a traveler information system such as this is crucial if the full benefits are to be realized. Potential users of the system must be made aware of the system, what it can do for them and they must have easy access to the information outlets. One benefit of the kiosks is that they provide a visible identity to the system and can be placed a strategic locations where travelers spend time. Other marketing efforts that need to be considered are partnerships with regional hotels to feature the system; flyers; advertising and linking on other regional, statewide or New England tourism sites; and email lists.

Deployment Strategies

The regional traveler and tourism information system will build upon efforts undertaken within other regional ITS projects. The regional system should be deployed once a sufficient critical mass of implementation and instrumentation has been reached according to the following phases:

Phase I - Since the project will build on previous efforts, an initial project implementation incorporating the information exchange, supporting data base and web site can be undertaken in a single phase.

Phase II - Once the initial database is deployed, additional dissemination technologies can be added in a phased approach. Marketing of the system will be an ongoing initiative.

Preliminary Benefits Analysis

At the present time, it is very hard to use IDAS to come up with an accurate estimate of the benefits for recommended project ITS-011. The benefits to be expected from this project will largely depend upon the area of coverage, which is not specifically defined at the current moment. In addition, the current version of IDAS does not consider tourism-related benefits of traveler information systems. Moreover, it is somewhat challenging to accurately estimate the costs of this project. This is because the deployment of all traveler information systems and services in Chittenden County will likely be integrated with two major statewide traveler information initiatives that are currently underway at the State level (the Tri-state Rural Advanced Traveler Information System (TRIO); and (2) the ConnectVermont project). As a result of this integration, the cost of deploying traveler information services within Chittenden County will likely be reduced. For these reasons, IDAS runs were not performed for this project. However, generally speaking, one should expect the following benefits out of the project:

?? Pre trip planning information and support
?? Increased user friendliness of transit options
?? Increased transit ridership
?? Increased level of satisfaction with the transportation system for visitors and residents
?? Real-time traveler information
?? Increased predictability of travel time
?? Increased county tourism revenues

Regional Traveler and Tourism Information System

Phase I:Intitial database, telephone and web deployment

	Unit Cost	Qty.	Total Cost
Equipment and software (Installed)			
Central database and web server	$20,000	1	$20,000
Web site development	$30,000	1	$30,000
Data exchange software	$20,000	1	$20,000
Telephone system	$80,000	1	$80,000
Tourism data management software	$15,000	1	$15,000
Network and communications equipment	$10,000	1	$10,000
Design, planning and soft costs (20%)			$35,000
TOTAL CAPITAL COSTS-Phase I			**$210,000**
Annual operational costs			
Internet service	$200	12	$2,400
Site updates and quality control	$12,000	1	$12,000
Maintenance	$2,000	1	$2,000
Annual marketing costs			$20,000
TOTAL ANNUAL OPERATING COSTS			**$36,400**

Phase II: Enhanced dissemination

	Unit Cost	Qty.	Total Cost
Equipment and software (Installed)			
Custom Kiosks	$15,000	5	$75,000
Web terminals	$1,500	15	$22,500
Radio	$20,000	4	$80,000
Software customization	$15,000	1	$15,000
Design, planning and soft costs (20%)			$38,500
TOTAL CAPITAL COSTS-kiosks			**$231,000**
Annual operational costs			
Utilities and service	$100	5	$500
Upgrade and maintenance	$1,600	5	$8,000

Chittenden County Metropolitan Planning Organization
Intelligent Transportation Systems (ITS) Program

Transportation Improvement Plan (TIP) Project Evaluation

Project Title	U.S. Route 15 ITS Improvements
CCMPO Project Number	ITS-0012
Project Objectives	Increase user-friendliness of the corridor Improved traffic flow through the corridor Expedite movement of emergency vehicles Collect traffic planning and operations data
ITS Functional Areas	Advanced Traffic Management Systems Advanced Traveler Information Systems Emergency Management Systems ITS Planning and Data Archiving
Geographic Extents	U.S. Route 15 between Burlington and Essex
Estimated Cost (see attached sheet)	Phase I: $342k + $45k O+M/year Phase II: $216k + $26k O+M/year Phase III: $24k + $2.4k O+M/year
Anticipated Benefits	Improvement in travel time reliability Reduced travel times and vehicle emissions Real-time traveler information Increased modal split to commuter rail Emergency vehicle prioritization Enhanced planning data collection
Lead Agency	VTrans
Other Key Participants	City of Burlington Town of Winooski Town of Essex Junction Emergency Service Providers Vermont Transportation Authority (rail)
Deployment Considerations	Implications of VT privacy laws for CCTV cameras
Deployment and Phasing Options	Phase I: Signal coordination and preemption Phase II: Travel time monitoring and traveler information Phase III: Integration with regional systems
Funding Opportunities	CMAQ
Prioritization	Medium Term

U.S. Route 15 ITS Improvements

Project Description and Objectives

The section of Route 15 between Essex Junction and Burlington is the subject of a mult-modal alternatives analysis. There are currently seven signalized intersections in this corridor, three of which are very congested during peak periods. An additional signal is recommended as part of a transportation systems management option along with each alternative being considered in the analysis. During peak periods, emergency vehicles access in the corridor is adversely impacted for a number of agencies.

This project will provide signal coordination and other ATMS functionality to enhance throughput and also to minimize the delays faced by emergency vehicles. Traveler information will be implemented and most useful once potential alternative corridors, such as the Circumferential Highway are completed and are also instrumented.

This project has the following objectives that are consistent with the problems and opportunities and program goals and objectives described in the Chittenden County ITS strategic deployment plan:

?? Improve monitoring and control to reduce congestion and prevent future congestion in the corridor;
?? Build on a solid foundation towards the overall regional architecture.
?? Provide traveler information about conditions in the corridor to the public;
?? Coordinate traffic signal operation
?? Provide signal preemption for emergency vehicles in the corridor; and
?? Collect transportation planning data on roadway performance, including a before-and-after study of the travel time benefits of the ITS infrastructure.

Project Elements

The Route 15 ITS project will consist of the following key ITS architecture market packages:

?? Network Surveillance,
?? Surface Street Control,
?? Traffic Information Dissemination,
?? Multi-modal Coordination,
?? Emergency Routing,
?? Interactive Traveler Information, and
?? ITS Data Mart.

While there is considerable flexibility in which technologies to deploy to meet the objectives of this project the following technology areas will be required:

?? Head end system and communications,

?? Traffic detection,
?? Traveler information, and
?? Traffic control.

Head End/Communications

The head end of the system would initially consist of PC computer equipment, monitors, and communications equipment housed in a control center. This control center can be housed in compact space in an existing facility such as the VTrans district office or State Police barracks. Eventually this equipment can be integrated into the Traffic Management and Information Center (TMIC) as that facility is deployed.

The control center can be linked to field equipment through a variety of technologies, with tradeoffs between cost, data capacity, and reliability. This project would benefit from the installation of a regional fiber optic network and could contribute funding towards the development of such a network. Without this network, it is anticipated that field equipment will be supported through leased lines for roadside controller and video data transport which will limit the functionality and possibly increase ongoing operational costs.

Traffic Detection

CCTV cameras located at specific intersections could provide real time traffic images to the control center and to emergency service providers. These images would be particularly helpful in routing emergency vehicles and using signal preemption to clear intersections on the vehicles planned route. Because it is unclear whether existing Vermont privacy laws will permit these uses of traffic images, alternate methods of traffic detection and information dissemination are available for consideration. Another viable and complementary traffic detection option is non-intrusive sensors, such as Remote Traffic Microwave Sensors (RTMS), which should be considered regardless of the installation of CCTV cameras.

Traffic detection data gathered through these technologies will be stored in an ITS data mart that can be used for transportation planning purposes.

Traveler Information

The purpose of disseminating traveler information is to provide real-time information on traffic conditions in the corridor. The system can be designed to alert the traveling public of incidents, long queues, or other adverse conditions in the corridor. Valuable information can be provided to the public *without* the need to endorse a specific alternate travel route.

This project will utilize the broader regional traveler information system. This system could be configured to provide travelers with a comparison of travel time estimates for driving and commuter rail.

It is also anticipated that this project will make information available to the Tri-State RATIS (Trio) project of wider dissemination.

Traffic Control

The two most viable traffic control alternatives for this corridor are traffic signal coordination and emergency/transit vehicle signal prioritization. In the future, VMS can provide travel time information for alternate routes on approaches to the corridor.

Traffic signal coordination allows multiple signals in the corridor to operate in an optimized fashion based on real-time traffic volumes. It is anticipated that the signals would be coordinated in two zones at either end of the corridor.

This project will also implement emergency and transit vehicle prioritization at the covered intersections, implementing technology compatible with other regional deployments. This will allow emergency vehicles to bypass traffic queues at signals, reducing emergency response travel times. Signal preemption could be expanded to transit vehicles as well. This project will provide central control of the signal prioritization as well as coordination between the vehicle and the individual intersection.

Deployment Strategies

This project will be implemented in phases based on integration with other regional systems. The anticipated phases are as follows:

?? **Phase I: Signal Prioritization and preemption**, signal coordination at either end of the corridor along with intersection and central control based emergency and transit vehicle prioritization.

?? **Phase II: Traveler information,** Enhancement of the traveler information to provide travel time estimates for alternate routes once they have also been instrumented.

?? **Phase III: Regional Integration** focuses on integration of the system into the overall regional architecture through the TMIC, other regional traffic signal control systems, and other smart corridors.

Preliminary Benefits Analysis

This project will provide signal coordination and other ATMS functionality for the section of Route 15 between Essex Junction and Burlington, in en effort to enhance throughput and also to minimize the delays faced by emergency vehicles. Traveler information is also envisioned for the corridor. However, traveler information will be most useful once potential alternative corridors, such as the Circumferential Highway are completed and are also instrumented. Given this, the benefits analysis for this project was limited to evaluating the benefits of the signal coordination and preemption components.

Results from IDAS indicate an estimated B/C ratio of 1.73, for the signal coordination and preemption components. Benefits included improvements in user mobility, modest reductions in operating and accident costs, and slight reductions in emissions levels. The fact that the B/C ratio for Route 15, while clearly a desirable B/C ratio, is less that the ratio obtained for Route 7 (ITS-001), can be attributed to differences in traffic volume and signal spacing between the two routes.

Rotue 15 ATMS

Phase I: Signal coordination and preemption

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
CCTV Cameras	$15,000	3	$45,000
Signal Preemption-Intersection	$5,000	8	$40,000
Signal Preemption-Onboard Equipment	$200	10	$2,000
Signal Coordination per Intersection	$20,000	8	$160,000
Control Center Equipment (Installed)			
Central Computer/Server	$15,000	1	$15,000
Video Monitors	$1,000	2	$2,000
Networking Equipment	$3,000	1	$3,000
Central Software			$20,000
Furniture			$2,000
Communications (Installed)			
Per Leased Line	$ 2,000	11	$22,000
Design and Soft Costs (10%)			$31,100
TOTAL CAPITAL COSTS-Phase I			**$342,100**
ANNUAL COMMUNICATIONS COSTS	$1,000	11	$11,000
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			**$45,210**

Preliminary Cost Estimate

Route 15 ATMS

Phase II: Travel time prediction and traveler information enhancements

	Unit Cost	Qty.	Total Cost
Equipment (Installed)			
Traffic Detectors	$18,000	3	$54,000
VMS Signs	$50,000	2	$100,000
Control Center Equipment (Installed)			
Central Computer/Server Upgrade	$5,000	1	$5,000
Networking Equipment	$3,000	1	$3,000
Central SoftwareUpgrade	$25,000	1	$25,000
Communications (Installed)			
Per Leased Line	$ 2,000	5	$10,000
Design and Soft Costs (10%)			$19,700
TOTAL CAPITAL COSTS-Phase I			**$216,700**
ANNUAL COMMUNICATIONS COSTS	$1,000	5	$5,000
ANNUAL OPERATIONS & MAINTENANCE (10%/yr + COMMS)			**$26,670**

Appendix B:

Comments from Steering Committee

The following are written comments on the draft project descriptions from the Steering Committee, along with responses from the Consultant team.

Q - As stated by IBI they used a flat 10 % percent to estimate the Operation and Management, O & M, cost. Based upon the current number of projects in there proposal, the O & M cost could reach an additional $1.0M per year. It would be nice to have a better estimate if that is at all possible? I do understand that IBI may not be able at this time to more accurately represent the O & M cost.

A - *Where possible, more accurate estimates have been included. The actual costs will vary depending on the implementation schedule and how much operation can be shared between projects. The combined O&M cost of all projects may be lower than that obtained by adding the values for the individual projects. However, since there may be changes to the projects or sequencing it would be better to maintain individual cost estimates.*

Q - IBI suggested that the proposed CCTV could use existing phone lines for transmission of data? Phones lines have a limited transmission capability and do not really work well with CCTV. CCTV works very well with fiber optics and wireless transmission. We, meaning the state/MPO should be looking at enhancing a potential communications system within the I-89 corridor to enhance our ATIS/ATMS ITS capabilities. The State Police have been working on installation of fiber optics in this corridor and may be a good source to consider in the future.

A- It is proposed that leased lines and/or microwave communications be used in the absence of access to fiber. Leased lines will not provide full motion video and would instead provide for a limited number of frames (e.g. 2 to 5) per second. For full time monitoring of the road network this frame rate is not suitable due to operator fatigue. However, for use during incidents or emergency vehicle passage, this rate should be acceptable. If fiber becomes available, the functionality and usability of the cameras can be significantly enhanced.

Q - Systems capability and expandability. The Trio contract, that the state is currently managing, will deploy many ITS systems that can be successfully expanded into the MPO region to assist in managing any ITS deployments within your region. In particular the contract will deploy a FORETELL weather reporting system and a CARS roadway condition/delay reporting system. Additionally, the Travel & Tourism Department is forging ahead with an ITS travel type information system that will include items such as; wayfinding, pretrip travel, travel delay information, B2B, etc. I would like to discuss the possibility of having our consultant, Castle Rock, come up sometime to give a presentation of these product items the members of the steering committee? I would also like to have the T & T Department consultant do the same if you agree?

A - This document defines how the individual CCMPO ITS projects are expected integrate with the broader regional projects.

Q - Transit Automatic Vehicle Location (AVL) - The CCTA is currently interested in an APTS that contains an AVL? The CCTA is a good candidate for not only the AVL but for a more robust APTS system. The APTS should be located within the proposed Multimodal Transit Center, MMTC, on Battery Street but should have a connection to a proposed TMIC system that would be remote from the MMTC. The necessary link would provide for traveler information sharing through a TMIC.

A - Information sharing has been incorporated.

Q - TMIC - Appears to be a need to coordinate development of this center very closely with what is going on within the Vtrans stakeholders meeting that the Maintenance Division is sponsoring. Any center would need to be coordinated with other stakeholders such as state police, fire, EMS, 911, etc.

A - Coordination with these organizations has been included in the write-up.

Q - For Transit AVL In-vehicle equipment:
Future combination modes of transit should be mentioned. A deviated fixed route vehicle might also warrant a mobile data terminal to transmit routing information from dispatch to the driver. This could occur as part of the fixed route system, rather than as part of the paratransit system.

A - Text has been updated.

Q - Central software
Although discussed in the section of traveler information, I believe this section should also include a mention of the software to support traveler information, systemwide, and specifically at the central transfer facility (The Downtown Transit Center in Burlington).

A - Text has been updated.

The last sentence in the Central Software section for AVL should read Basic CADS software... will be 'replaced', not ‘upgraded’. What they have won't support what we want to do.

A - Text has been updated.

The assumed agencies for deployment of these projects are CCTA and SSTA. I don't dispute that, however, we may want to include a statement like "and other service providers as appropriate". My only concern is that when we bid out our ADA service in 2003, and if someone else gets the bid, we may want to deploy AVL differently. SSTA would continue to be a major player in the demand respond market, but there might be other providers. If CCTA is contracting with an "other" we will want to have the flexibiltity to deploy AVL differently.

A - Key participants have been updated to reflect this.

Q - AVL Phase II costs
CCTA has 41 buses now. Cost to equip vehicles and related communication expense should be for all of them. Report says 30 vehicles.

A – Quantities have been updated

Q - AVL Phase III Costs
The budget includes package. equipping 65 vehicles with information displays, however the text of section on traveler information suggests that in-vehicle signing won't be needed. Also, there is no mention of a budget for bus stop real time signing, which is included in the discussion and should be considered for inclusion in this market

A - Phase III has been removed. Bus stop signing is included in the transit traveler information project.

Q - I concur that the fare media integration package should be a medium or long-term project. Having recently made the investment in magnetic fare card readers on our current fleet, it makes little sense to jump to something else soon.

A - Agreed – while a project could possibly be designed to look at the broader applicability of the magnetic fare media, the variety of fare tables, transfers and pass types that would need to be supported would probably make this infeasible.

Appendix C:

Summary of IDAS Evaluation

1. EVALUATING THE COST-EFFECTIVENESS OF RECOMMENDED ITS PROJECTS USING IDAS

Dr. Adel Sadek, University of Vermont

To help transportation planners in quantifying the benefits of ITS deployments, the Federal Highway Administration (FHWA) has recently sponsored the development of a sketch planning analysis tool for estimating the benefits and costs of ITS deployment called the ITS Deployment Analysis System (IDAS). IDAS, which was developed by Cambridge Systematics for the FHWA, operates as a post-processor to traditional planning models based on the four-step planning process, and is designed to evaluate several traditional as well as non-traditional ITS benefits as will be explained later in this paper (Cambridge Systematics and ITT Industries, 2000).

The current section describes how IDAS was used to predict the likely benefits of the primary ITS projects recommended for Chittenden County. The section is divided into the following three subsections. The first subsection provides some background information on IDAS. In the second subsection, the steps of applying IDAS to evaluate each of the proposed ITS projects are outlined. The results obtained are then summarized in the third subsection.

1.1 The ITS Deployment Analysis System (IDAS)

As was previously mentioned, IDAS was developed in recognition of the critical need for tools for quantifying the benefits and costs of deploying ITS. At the core of the software is a comprehensive ITS benefits library, which provides default values for the likely impacts of the different ITS components that the software is designed to analyze. This ITS library was compiled from numerous evaluations of observed and simulated impacts of different ITS technologies from all over the country and the world. The software is also equipped with an equipment database, which provides a comprehensive inventory of ITS equipment and costs associated with various ITS applications. These two resources allow the user to estimate the costs and benefit of the suggested ITS improvements, and to perform cost-benefit analyses.

IDAS operates as a postprocessor for traditional transportation planning models based on the 4-step planning process. In general terms, using IDAS to estimate ITS benefits involves running the 4-step transportation-planning model, along with IDAS's postprocessor modules designed for estimating ITS deployment impacts, twice. The first run involves running the model for the base case (i.e. without the planned ITS components), while the second run involves running it with the planned ITS components in place, after adjusting those network parameters that are likely to be impacted by ITS deployment. These adjustments are made based on default values stored in the ITS benefits library.

<u>1.1.1 IDAS Components</u>

The software consists of five basic modules as described below.

Input/Output Interface Module (IOM): This module is responsible for receiving the required data files from a travel demand model, and for translating these data into a format that can be used internally within IDAS.

Alternatives Generator Module (AGM): This is the module where the user specifies the proposed ITS improvements. This is done using a graphical user interface (GUI) that allows the user to graphically select the links and nodes where the different ITS equipment would be deployed.

Benefits Module: This module is responsible for estimating the benefits to be anticipated from the ITS improvements specified using the AGM. Determining the benefits is based on the values stored in the ITS benefits library. The benefits evaluated can be divided into the following four groups: (1) Travel time/Throughput benefits; (2) Environmental benefits (energy and emissions); (3) Safety-related benefits; and (4) Travel-time reliability benefits. Each group is computed using a separate submodule within IDAS.

Cost Module: This module is responsible for estimating the costs of deploying the specified improvements.

Alternatives Comparison Module (ACM): This module provides the user with information on the benefits anticipated from ITS deployments, the associated costs of the deployments, and a comparison of the benefits and costs for different ITS deployment options.

1.1.2 IDAS Input Data

To use IDAS, the user is required to provide the following two groups of data: (1) Data from travel demand models describing the supply and demand characteristics of the study area transportation system; and (2) details about the proposed ITS improvements. For the travel demand model data, as a minimum, the following input files, which can be in either fixed format or delimited text files, are required:

(1) Node coordinate file;
(2) Network link file;
(3) Trip Origin-Destination (O-D) data files;
(4) Trip in-vehicle travel time O-D tables; and
(5) Trip out-of-vehicle travel time O-D tables.

IDAS uses the concept of market sectors to describe discrete segments of the traveling public in the study area; market sectors are thus somewhat similar to trip purposes, commonly used within transportation planning models. For example, single occupant vehicles can be regarded as one market sector and transit can be regarded as another sector.

In addition to travel demand models data, the user is required to provide IDAS with details describing the ITS improvements to be evaluated. As previously mentioned, this is performed using the AGM within IDAS and its GUI. Generally, the information to be provided includes information about the year of opening of the project, the mid-point of construction, deployment locations and deployment specifics. The specific information, however, varies with the different types of ITS improvements. For example, for a signal coordination project, the user will be required to identify the specific signals to be coordinated, the roadway links that will be affected by signal coordination, among others.

It should be noted that while the user is specifying the different ITS improvements, IDAS makes some assumptions regarding the equipment that will be required to implement such improvements (for example, for signal coordination, IDAS assumes that the controllers will have to be upgraded and that a communications link will have to be established between the controllers). This information is then used to compute the costs of implementing the ITS improvement. IDAS however allows the user to check these assumptions and to make any desired modification. For example, the user is allowed to change the number of equipment to be deployed, as well as to specify whether new ITS equipment is to be installed, whether it already exists, or whether it is to be shared with other suggested ITS improvements in the region.

1.1.3 Output Reports

IDAS is capable of generating a wide range of reports. However, one can generally regard the software output as consisting of the following three elements:

(1) An analysis of the cost of the project;
(2) An analysis of the benefits of the project; and
(3) A benefit-cost analysis of the project relative to the control alternative.

For the cost of the project, IDAS calculates the capital and operating costs for both the public and private sectors. IDAS calculates the stream of costs over the life cycle of the project, and then computes the average annual cost, which is later used in benefit-cost analyses. For the benefits, IDAS evaluates under the following 5 categories: (1) travel time/throughput benefits; (2) emissions benefits; (3) energy benefits; (4) safety benefits; and (5) travel time reliability benefits. Finally, IDAS generates benefit-cost statistics and system performance measures (e.g. vehicle-miles and vehicle-hours) for each ITS option relative to the control alternative (Cambridge Systematics and ITT Industries, 2000).

1.2 Evaluating the Proposed ITS Projects With IDAS

The current study has recommended a number of ITS projects aimed at improving transportation efficiency and safety in the region. Among the most significant of these projects are the following 4 projects:

1. The Shelburne Road Smart Corridor Project;
2. Interstate 89 Advanced Traffic Management System;
3. Automatic Vehicle Location (AVL) on Chittenden County Transit Authority (CCTA) transit vehicles;
4. AVL and automated scheduling on the Special Services Transit Authority (SSTA) paratransit vehicles;

These projects were described earlier in this report.

To evaluate the cost-effectiveness of the proposed ITS projects, the IDAS software was used. The first step was to import the travel demand data required by IDAS. To do this, the required data were obtained from the CCMPO transportation planning model in the form of ASCII text files, which were then imported into IDAS. Two market sectors were defined, one for autos and another for transit. The details of the four proposed ITS projects were then specified using the GUI of the Alternatives Generator Module (AGM) of the software, and the ITS equipment assumed by IDAS were edited according to the specification of each project. Following the specification of each project, the cost, benefit, and the ACM modules were successively run to determine the benefit-cost ratio for each project. The following paragraphs will describe how each ITS project was specified, and describe the methodologies used within IDAS to evaluate the benefits of each project.

1.2.1 Shelburne Road Smart Corridor Project

The two phases of this project were specified separately as described below.

Phase I – Traveler Information System for Mitigating Construction Impacts

ITS Improvement Specification

Specifying this phase of the project required specifying:

(1) The number and location of the CCTV cameras and traffic detectors;
(2) The roadway links that will be covered by the traveler information system;
(3) The means of information dissemination (i.e. in our case, this included a website, a phone system and PVMS); and
(4) The year of project opening and midyear of construction.

Benefit Estimation Methodology

To estimate the benefits to be expected from Traveler Information Systems, IDAS first performs a traffic assignment for the control alternative and computes the delay time for the links that will be covered by the traveler information system. The delay time is computed as the difference between the loaded travel time and the free-flow travel time in addition to the incident delay computed in the travel reliability module. The savings in delay time as a result of the traveler information system is then computed as:

Number of trips x market penetration x delay time x delay savings.

The default values for the market penetration and delay savings used by IDAS are 1% and 15% respectively for phone traveler information systems. For web-based traveler information systems, the market penetration is assumed to be 0.5% in the year 2000 and 5% in 2005. The delay savings are assumed to be 20%.

Phase II – Signal Coordination and Preemption

ITS Improvement Specification

Specifying this second phase of the project involved specifying:

(1) The signals that will be coordinated;
(2) The type of signal control (pre-timed, actuated, or central control)
(3) The arterial links that will be affected by coordination;
(4) The variability of demand and the frequency of signal timing plan updates;
(5) The signals that will be equipped with signal preemption capability;
(6) The arterial links that will be equipped with signal preemption;
(7) The number of emergency vehicles to be equipped with signal preemption capability;
(8) The percentage of emergency vehicles in the traffic stream; and
(9) The year of project opening and midyear of construction.

Benefit Estimation Methodology

For estimating the benefits of signal coordination, IDAS first performs a traffic assignment for the control alternative. It would then increase the operational capacity of the arterial links affected by the coordination. The default values for the increase in the capacity is in the range of 14 to 20% for a coordinated system of actuated controllers, depending upon demand variability and the frequency of updating timing plans. A second traffic assignment is then performed for the ITS option to determine changes in vehicle miles of travel (VMT), travel time and speeds. IDAS also determines reductions in accident risk, emission levels and energy consumption as a function of changes in VMT, travel times and speeds.

For emergency vehicle signal preemption, IDAS would apply a default value of 30% increase in the speed for the links affected by signal preemption, and determine the savings in vehicle-hours of travel relative to the control alternative. The travel time benefits are then determined for the emergency vehicles assuming that the value of time for emergency vehicles is 30 times the normal value of time (this large value of time is assumed because saving time could translate into saving lives in the case of emergency vehicles).

1.2.2 I89 Advanced Traffic Management System

ITS Improvement Specification

To define this project in IDAS, the following elements needed to be specified:

(1) The number and location of the CCTV cameras and traffic detectors;
(2) The freeway links that equipped with freeway monitoring and incident management capabilities;
(3) The number and location of VMS and HAR; and
(4) The year of project opening and midyear of construction.

Benefit Estimation Methodology

To estimate the benefits of freeway monitoring and incident management, IDAS assumes the following values: a 55% reduction in incident duration, a 27% reduction in emissions levels, a 27% reduction in fuel consumption, and a 10% reduction in accident fatality rate. These estimates are based on reported savings from a number of deployments around the country. Because travel demand models typically do not consider non-recurrent congestion, IDAS attempts to quantify the benefits of incident management by focusing on improvements in travel time reliability, instead of direct travel time benefits. This calculation is based on the links' volume/capacity ratios, taking into account the reductions in incident durations between the control and the ITS alternative. In addition to calculating the travel time reliability benefits, IDAS also calculates benefits resulting from reductions in emissions, fuel consumptions and accident fatality rates.

1.2.3 AVL & Automated Scheduling For CCTA Transit Vehicles and SSTA Paratransit Vehicles

ITS Improvement Specification

Defining these two projects in IDAS required specifying the following:

(1) The year of project opening and midyear of construction;
(2) The origin-destination zones affected (i.e. where mode shift could occur);
(3) The total number of transit and paratransit vehicles in the CCTA and SSTA fleets;
(4) The total number of transit and paratransit vehicles to be equipped with AVL;
(5) Average capital cost per vehicle (default values are $225,000 for a transit vehicle, and $85,000 for paratransit); and
(6) Annual operating costs for CCTA and SSTA

Benefit Estimation Methodology

IDAS assumes that the use of AVL and/or automated scheduling will result in both capital cost as well as operating cost savings to the operating agency. The default values are a reduction between 1 and 2% in the fleet size, and a reduction in the range of 5 to 8% in operating costs. In addition, IDAS assumes a reduction in both in-vehicle and out-of-vehicle travel time for transit and paratransit in the range of 15% for the combined use of AVL and automated scheduling. IDAS then evaluates the effect of reductions in transit travel times on the mode split in the region (by performing a mode split run), and estimates changes in vehicle miles of travel and speeds. Changes in vehicle mile of travel and speeds are finally used to estimate reductions in emissions, fuel consumption and accident frequency.

1.3. Results

In this section, the results for each of the four ITS projects analyzed are presented. For the Shelburne Road Smart Corridor project, the analysis was run separately for phase II (which involved signal coordination and preemption), as well as for the whole project (phases I and II combined). The reason for doing so is that while the primary objective of phase I of the Smart Corridor project was to mitigate the negative impacts of the construction period, the version of IDAS used in the current study is not designed to explicitly account for construction impacts on traffic flow. For each project, three tables, summarizing the output from the analysis, will be presented. The first table gives the annual capital as well as maintenance and operations cost of the project over an analysis period of 10 years. The second table converts the yearly stream of costs into an average annual cost for the purpose of conducting the Benefit-Cost (B/C) ration. The third table presents the annual benefits to be expected of the project, and gives the Annual B/C ratio.

1.3.1 Shelburne Road Smart Corridor Project – Phase II: Signal Coordination and Preemption

TABLE 1. CAPITAL AND MAINTENANCE AND OPERATIONS COSTS

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
IMP #1 Signal Coordination											
Public Capital	24167	24167	24167	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	3400	3400	3400	3400	3400	3400	3400	3400	3400
IMP #2 Signal Preemption											
Public Capital	17483	17483	17483	0	0	8667	8667	8667	0	0	17483
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	844	844	844	844	844	844	844	844	844
TOTAL:											
Public Capital	41650	41650	41650	0	0	8667	8667	8667	0	0	17483
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	4244	4244	4244	4244	4244	4244	4244	4244	4244

TABLE 2. AVERAGE ANNUAL COST

IMP #1 Signal Coordination	
Public Capital	$6,843.49
Private Capital	$0.00
Public O&M	$3,400.00
SUBTOTAL	$10,243.49
IMP #2 Signal Priority	
Public Capital	$10,107.04
Private Capital	$0.00
Public O&M	$843.50
SUBTOTAL	$10,950.54
TOTAL:	
Public Capital	$16,950.53
Private Capital	$0.00
Public O&M	$4,243.50
GRAND TOTAL:	**$21,194.03**

TABLE 3. ANNUAL BENEFITS

Annual Benefits	
Change in User Mobility	59,551
Change In User Travel Time	
Travel Time Reliability	(0)
Change in Costs Paid by Users	
Fuel Costs	63
Non-fuel Operating Costs	837
Accident Costs (Internal Only)	1,077
Change in External Costs	
Accident Costs (External Only)	190
Emissions	
HC/ROG	324
Nox	73
CO	7,538
Noise	(773)
Other Mileage-Based Costs	(0)
Other Trip-Based External Costs	(0)
Change in Public Agencies Costs	0
Other Calculated Benefits	2,858
User Defined Additional Benefits	0
Total Annual Benefits	**71,736**
Annual Costs	
Average Annual Private Sector Cost	0
Average Annual Public Sector Cost	21,194
Total Annual Cost	**21,194**
Benefit/Cost Comparison	
Net Annual Benefit (Benefit - Cost)	**50,542**
Annual B/C Ratio	**3.38**

1.3.2 Shelburne Road Smart Corridor Project – Phases I & II Traveler Information and Signal Coordination & Preemption

TABLE 4. CAPITAL AND MAINTENANCE AND OPERATIONS COSTS

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
IMP #1 Phase I Signal Coordination											
Public Capital	45,417	45,417	45,417	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400	3,400
IMP #2 Emergency Signal Preemption											
Public Capital	17,483	17,483	17,483	0	0	8,667	8,667	8,667	0	0	17,483
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	844	844	844	844	844	844	844	844	844
IMP #3 IVR Traveler Information System											
Public Capital	38,667	38,667	38,667	0	0	7,667	7,667	7,667	0	0	7,667
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	119,650	119,650	119,650	119,650	119,650	119,650	119,650	119,650	119,650
IMP #4 Traveler Information Website											
Public Capital	9,667	9,667	9,667	0	0	7,667	7,667	7,667	0	0	7,667
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	49,150	49,150	49,150	49,150	49,150	49,150	49,150	49,150	49,150
IMP #5 CCTV Cameras											
Public Capital	62,667	62,667	62,667	0	0	0	0	0	0	0	33,333
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	98,600	98,600	98,600	98,600	98,600	98,600	98,600	98,600	98,600
IMP #6 Portable VMS											
Public Capital	25,750	25,750	25,750	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200	10,200
TOTAL:											
Public Capital	199,650	199,650	199,650	0	0	24,000	24,000	24,000	0	0	66,150
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	281,844	281,844	281,844	281,844	281,844	281,844	281,844	281,844	281,844

TABLE 5. AVERAGE ANNUAL COST

IMP #1 Signal Coordination	
Public Capital	$12,861.04
Private Capital	$0.00
Public O&M	$3,400.00
SUBTOTAL	$16,261.04
IMP #2 Signal Preemption	
Public Capital	$10,107.04
Private Capital	$0.00
Public O&M	$843.50
SUBTOTAL	$10,950.54
IMP #3 IVR Traveler Information System	
Public Capital	$14,388.03
Private Capital	$0.00
Public O&M	$119,650.00
SUBTOTAL	$134,038.03
IMP #4 Traveler Information Website	
Public Capital	$6,175.84
Private Capital	$0.00
Public O&M	$49,150.00
SUBTOTAL	$55,325.84
IMP #5 CCTV Cameras	
Public Capital	$22,544.33
Private Capital	$0.00
Public O&M	$98,600.00
SUBTOTAL	$121,144.33
IMP #6 Portable VMS	
Public Capital	$7,291.85
Private Capital	$0.00
Public O&M	$10,200.00
SUBTOTAL	$17,491.85
TOTAL:	
Public Capital	$73,368.13
Private Capital	$0.00
Public O&M	$281,843.50
GRAND TOTAL:	**$355,211.63**

TABLE 6. ANNUAL BENEFITS

Annual Benefits	
Change in User Mobility	61,619
Change In User Travel Time	
Travel Time Reliability	(0)
Change in Costs Paid by Users	
Fuel Costs	63
Non-fuel Operating Costs	837
Accident Costs (Internal Only)	1,077
Change in External Costs	
Accident Costs (External Only)	190
Emissions	
HC/ROG	324
Nox	73
CO	7,538
Noise	86
Other Mileage-Based Costs	(0)
Other Trip-Based External Costs	(0)
Change in Public Agencies Costs	0
Other Calculated Benefits	5,714
User Defined Additional Benefits	0
Total Annual Benefits	**77,520**
Annual Costs	
Average Annual Private Sector Cost	0
Average Annual Public Sector Cost	355,212
Total Annual Cost	**355,212**
Benefit/Cost Comparison	
Net Annual Benefit (Benefit - Cost)	**(277,692)**
Annual B/C Ratio	**0.22**

1.3.2 I89 Advanced Traffic Management System

TABLE 7. CAPITAL AND MAINTENANCE AND OPERATIONS COSTS

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
IMP #1 CCTV Deployment											
Public Capital	72000	72000	72000	0	0	0	0	0	0	0	33333
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	68400	68400	68400	68400	68400	68400	68400	68400	68400
IMP #2 Loop Detectors											
Public Capital	14667	14667	14667	0	0	14667	14667	14667	0	0	14667
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	4000	4000	4000	4000	4000	4000	4000	4000	4000
IMP #3 VMS											
Public Capital	160417	160417	160417	0	0	9167	9167	9167	0	0	9167
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	18200	18200	18200	18200	18200	18200	18200	18200	18200
IMP #4 HAR											
Public Capital	5500	5500	5500	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	1200	1200	1200	1200	1200	1200	1200	1200	1200
Incident management											
Public Capital	140533	140533	145033	4500	9000	77033	81533	77033	9000	4500	81533
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	219225	219225	219225	219225	219225	219225	219225	219225	219225
TOTAL:											
Public Capital	393117	393117	397617	4500	9000	100867	105367	100867	9000	4500	138700
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	311025	311025	311025	311025	311025	311025	311025	311025	311025

TABLE 8. AVERAGE ANNUAL COST

IMP #1 CCTV Deployment	
Public Capital	$25,187.33
Private Capital	$0.00
Public O&M	$68,400.00
SUBTOTAL	$93,587.33
IMP #2 Loop Detectors	
Public Capital	$10,731.19
Private Capital	$0.00
Public O&M	$4,000.00
SUBTOTAL	$14,731.19
IMP #3 VMS	
Public Capital	$49,537.78
Private Capital	$0.00
Public O&M	$18,200.00
SUBTOTAL	$67,737.78
IMP #4 HAR	
Public Capital	$1,557.48
Private Capital	$0.00
Public O&M	$1,200.00
SUBTOTAL	$2,757.48
IMP #5 Incident management	
Public Capital	$78,519.21
Private Capital	$0.00
Public O&M	$219,225.00
SUBTOTAL	$297,744.21
TOTAL:	
Public Capital	$165,532.99
Private Capital	$0.00
Public O&M	$311,025.00
Private O&M	$0.00
GRAND TOTAL:	**$476,557.99**

TABLE 9. ANNUAL BENEFITS

Annual Benefits	
Change in User Mobility	4,383
Change In User Travel Time	
Travel Time Reliability	1,285,776
Change in Costs Paid by Users	
Fuel Costs	1,422
Non-fuel Operating Costs	(0)
Accident Costs (Internal Only)	7,370
Change in External Costs	
Accident Costs (External Only)	1,301
Emissions	
HC/ROG	3,751
Nox	19,393
CO	55,142
Noise	(0)
Other Mileage-Based Costs	(0)
Other Trip-Based External Costs	(0)
Change in Public Agencies Costs	0
Other Calculated Benefits	(0)
User Defined Additional Benefits	0
Total Annual Benefits	**1,378,538**
Annual Costs	
Average Annual Private Sector Cost	0
Average Annual Public Sector Cost	476,558
Total Annual Cost	**476,558**
Benefit/Cost Comparison	
Net Annual Benefit (Benefit - Cost)	**901,980**
Annual B/C Ratio	**2.89**

1.2.4 AVL & Scheduling For CCTA Transit Vehicles

TABLE 10. CAPITAL AND MAINTENANCE AND OPERATIONS COSTS

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AVL & Scheduling											
Public Capital	131,500	131,500	131,500	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	67,165	67,165	67,165	67,165	67,165	67,165	67,165	67,165	67,165
TOTAL:											
Public Capital	131,500	131,500	131,500	0	0	0	0	0	0	0	0
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	67,165	67,165	67,165	67,165	67,165	67,165	67,165	67,165	67,165

TABLE 11. AVERAGE ANNUAL COST

IMP #1 AVL & Scheduling	
Public Capital	$39,469.29
Private Capital	$0.00
Public O&M	$67,165.00
SUBTOTAL	$106,634.29
TOTAL:	
Public Capital	$39,469.29
Private Capital	$0.00
Public O&M	$67,165.00
GRAND TOTAL:	**$106,634.29**

TABLE 12. ANNUAL BENEFITS

Annual Benefits	
Change in User Mobility	76,241
Change In User Travel Time	
Travel Time Reliability	(0)
Change in Costs Paid by Users	
Fuel Costs	2
Non-fuel Operating Costs	294
Accident Costs (Internal Only)	569
Change in External Costs	
Accident Costs (External Only)	100
Emissions	
HC/ROG	40
Nox	55
CO	452
Noise	2
Other Mileage-Based Costs	(0)
Other Trip-Based External Costs	(0)
Change in Public Agencies Costs	86,250
Other Calculated Benefits	(0)
User Defined Additional Benefits	0
Total Annual Benefits	**164,005**
Annual Costs	
Average Annual Private Sector Cost	0
Average Annual Public Sector Cost	106,634
Total Annual Cost	**106,634**
Benefit/Cost Comparison	
Net Annual Benefit (Benefit - Cost)	**57,371**
Annual B/C Ratio	**1.54**

1.2.5 AVL & Automated Scheduling For SSTA Vehicles

TABLE 13. CAPITAL AND MAINTENANCE AND OPERATIONS COSTS

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
AVL & Automated Scheduling											
Public Capital	74,917	74,917	74,917	0	0	0	0	0	0	0	17,250
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	48,093	48,093	48,093	48,093	48,093	48,093	48,093	48,093	48,093
TOTAL:											
Public Capital	74,917	74,917	74,917	0	0	0	0	0	0	0	17,250
Private Capital	0	0	0	0	0	0	0	0	0	0	0
Public O&M	0	0	48,093	48,093	48,093	48,093	48,093	48,093	48,093	48,093	48,093

TABLE 14. AVERAGE ANNUAL COST

IMP #1 AVL & Automated Scheduling	
Public Capital	$23,698.01
Private Capital	$0.00
Public O&M	$48,092.50
SUBTOTAL	$71,790.51
TOTAL:	
Public Capital	$23,698.01
Private Capital	$0.00
Public O&M	$48,092.50
GRAND TOTAL:	**$71,790.51**

TABLE 15. ANNUAL BENEFITS

Annual Benefits	
Change in User Mobility	76,241
Change In User Travel Time	
Travel Time Reliability	(171)
Change in Costs Paid by Users	
Fuel Costs	2
Non-fuel Operating Costs	294
Accident Costs (Internal Only)	569
Change in External Costs	
Accident Costs (External Only)	100
Emissions	
HC/ROG	40
Nox	55
CO	452
Noise	2
Other Mileage-Based Costs	(0)
Other Trip-Based External Costs	(0)
Change in Public Agencies Costs	61,900
Other Calculated Benefits	(0)
User Defined Additional Benefits	0
Total Annual Benefits	**139,484**
Annual Costs	
Average Annual Private Sector Cost	0
Average Annual Public Sector Cost	71,791
Total Annual Cost	**71,791**
Benefit/Cost Comparison	
Net Annual Benefit (Benefit - Cost)	**67,693**
Annual B/C Ratio	**1.94**

1.4 Discussion

As can be seen from the above, the results indicate that, with the exception of phase I of the Smart Corridor project, all proposed ITS projects are expected to yield a favorable Benefit/Cost (B/C) ratio. As previously mentioned, the failure of IDAS to account for the negative impacts of construction could very well explain the rather low benefit-cost ratio obtained for the Smart Corridor project. In addition, the value of traveler information systems becomes more obvious with large-scale deployment. Deploying a traveler information system only for Route 7 is not likely to have a significant impact on travel conditions in the region. However, as the system is expanded, one should expect to observe more significant benefits.

With regard to the projects yielding a positive B/C ratio, signal coordination appears to yield the maximum ratio (B/C = 3.38), followed by incident management for I-89 (B/C = 2.89). AVL and automated scheduling for paratransit comes third with a B/C ratio of 1.94, and AVL and scheduling for transit comes fourth with a B/C ratio of 1.54. It is worth mentioning here, however, that in conducting the analysis for Chittenden County, we have used unit costs for the ITS equipment that are somewhat on the low side. This is because the County, given the current demographics and travel conditions and the absence of real congestion from its transportation system, will likely deploy ITS applications at a smaller scale compared to larger metropolitan areas.

A word of caution regarding the IDAS analysis results is warranted here. IDAS output should always be regarded as just what it really is - an *estimate*. A number of assumptions are implicit in IDAS's analyses, among the most basic of which is the assumption that the observed values of ITS benefits are transferable to other regions. In other words, if a particular ITS application was observed to yield certain benefits in one area of the country, a similar application deployed in a different region would be expected to yield similar benefits. While this is one of the most fundamental of IDAS's assumptions, evaluation studies have shown that there could be a rather wide range for the benefits to be expected from similar ITS applications, depending upon local conditions at the site where they are deployed. This should be kept in mind, particularly given the fact that a majority of the values regarding ITS benefits stored in IDAS benefits library comes from evaluation studies conducted in areas that are larger than Chittenden County. Having said so however, it is fair to mention that IDAS, despite its limitations and shortcomings, is currently the *only* tool available for conducting Benefit/Cost analyses for ITS deployment. IDAS output could thus provide valuable direction and insight with respect to the likely cost-effectiveness of different ITS deployments, provided that its output is used with caution.