City of Bellevue

ITS Master Plan
Executive Summary

"Enhancing Transportation Safety and Efficiency"

Prepared by

DKS Associates
TRANSPORTATION SOLUTIONS

July 28, 2004
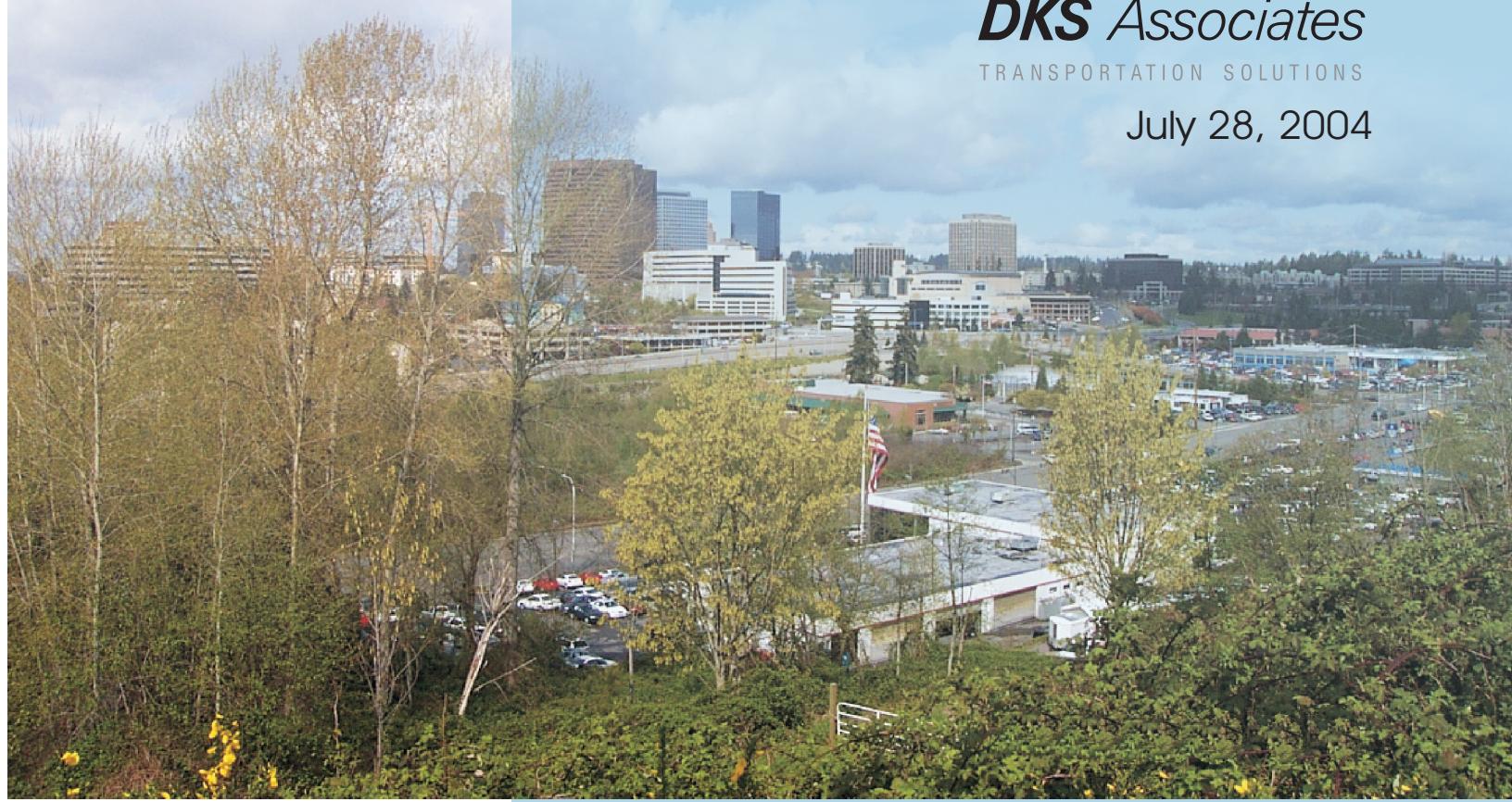
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THE CITY OF BELLEVUE IS CENTRALLY LOCATED EAST OF SEATTLE IN THE PUGET SOUND REGION. THE CITY HAS IMPLEMENTED SOME BASIC TECHNOLOGY-BASED TOOLS AND INTELLIGENT TRANSPORTATION SYSTEMS (ITS) STRATEGIES. HOWEVER, UNTIL NOW THERE HAS NOT BEEN A COMPREHENSIVE, SYSTEMATIC LOOK AT FUTURE EXPANSION AND MANAGEMENT OF ITS. THIS PLAN REPRESENTS A COMPREHENSIVE EVALUATION OF THE CITY'S NEEDS AND OPPORTUNITIES FOR ITS APPLICATIONS OVER THE NEXT 20 YEARS. THE PRIMARY OBJECTIVE OF THE PLAN IS TO IDENTIFY POTENTIAL ITS SOLUTIONS THAT WILL ADDRESS SPECIFIC TRANSPORTATION RELATED PROBLEMS BASED ON A SET OF CLEARLY DEFINED NEEDS.

The City of Bellevue has had steady growth in both population and employment over the past thirty years. Since 1970, the population has almost doubled, and by the year 2020, the population is expected to grow another 24 percent. The significant growth, coupled with reliance on the automobile as the primary means of transportation, has placed a tremendous burden on the City's transportation infrastructure. As the City continues to expand, a coordinated, systematic approach will be necessary to effectively manage the transportation infrastructure. By working efficiently and cooperating with other local agencies, the City can build and manage a smarter transportation system using ITS.

Bellevue Population Growth

| Year	Population
1960	12,806
1970	61,196
1980	73,903
1990	86,874
2000	109,935
2020	135,885
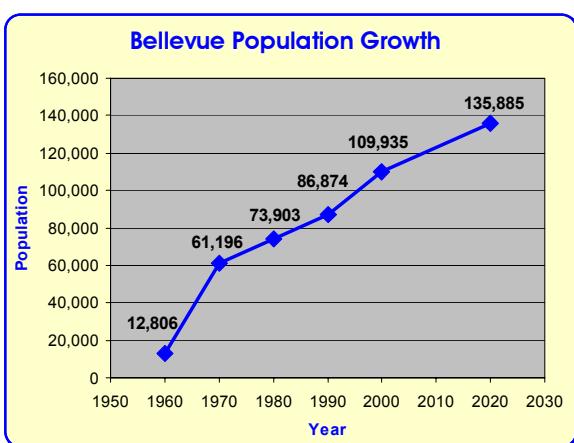
What is ITS?

ITS is the application of a range of advanced technologies and proven management techniques to enhance mobility and transportation productivity, enhance safety, conserve energy resources and reduce adverse environmental effects.

ITS uses real-time information to integrate and manage the components of a conventional transportation system (roads, transit, ramp meters, traffic signals, etc.). ITS can perform the following functions:

■ Alert motorists, commercial vehicles, emergency response personnel and transit operators of congestion by collecting, processing and disseminating real-time information.

■ Provide real-time transit arrival and departure information to passengers allowing them to time their departure from work or home to transit stops.

■ Reduce corridor congestion by rapidly detecting and responding to traffic incidents.

■ Reduce response times to incidents and emergencies for City maintenance staff and emergency services personnel through enhanced data and surveillance.
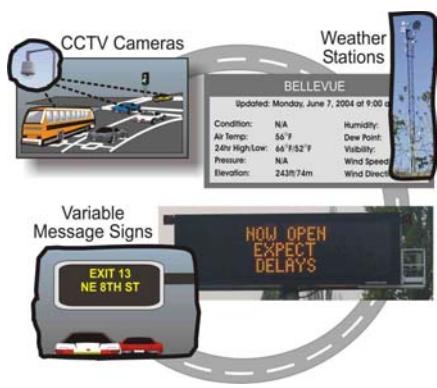
In the past, the common belief was that we could meet the demand for mobility by building and expanding highways and bridges. However, as many areas of the country have built out the roadway network, traffic congestion has increased to overfill the infrastructure and we must consider new ways of managing traffic. ITS provides new tools to compliment traditional transportation thinking and the approach is catching on worldwide.

Deployment of ITS tools and strategies, seen as the next major evolutionary stage of surface transportation, is expected to be the focus of implementation efforts early in this century, much like the highway system program was the focus of the last 60 years. ITS is no longer an alternative or option in dealing with congestion and increasing highway travel, but rather it is one of the most cost effective ways to obtain a more efficient transportation system.
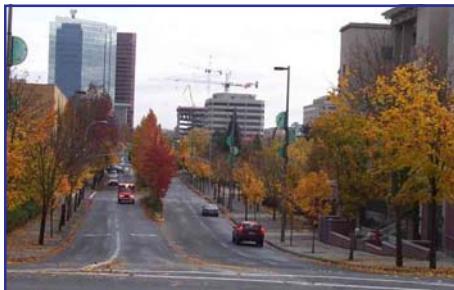
What is the Bellevue ITS Plan?

The Bellevue ITS Plan is a road map to implement an integrated system of transportation strategies based on a set of identified opportunities. The plan's purpose is to establish the need for ITS investments in the region, to identify relative priorities to direct ITS investment, and to identify specific projects to be deployed to address identified needs.

Why is the Plan Important?

An ITS plan:

- creates the framework from which ITS benefits can be realized;
- represents a comprehensive analysis of the City's ITS goals;
- ensures that ITS projects in the City will be eligible for Federal ITS funding; and
- prioritizes financial resources for ITS opportunities.
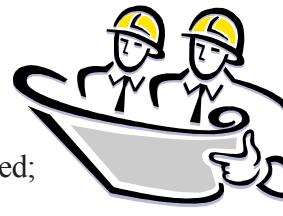
ITS is no longer an alternative or option in dealing with congestion and increasing highway travel. It is one of the most cost effective ways to obtain a more efficient transportation system.

Table E-1. Regional ITS System Engineering Analysis Compliance

System Engineering Analysis	ITS Plan Compliance
1. Description of how project fits into the Regional ITS Architecture	
Review of Applicable Market Packages	Regional Architecture
Regional ITS Integration Strategy	Concept of Operations
Other Stakeholders to Consider	Concept of Operations
Develop a Project Operational Concept	Deployment Plan
Develop a Project ITS Architecture	Concept of Operations
2. Roles and responsibilities of participating agencies	Concept of Operations
3. Requirements definition	Project specific and not part of the regional plan. This will need to be developed at the time of project deployment.
4. Analysis of alternative system configurations and technology options	Project specific and not part of the regional plan. This will need to be developed at the time of project deployment.
5. Procurement options	Project specific and not part of the regional plan. This will need to be developed at the time of project deployment.
6. Applicable ITS standards and testing procedures	Regional Architecture
7. Procedures and resources necessary for operations and management of the system	Project specific and not part of the regional plan. This will need to be developed at the time of project deployment.

This plan was coordinated with regional efforts, such as the Puget Sound Region ITS Architecture, to ensure ITS strategies throughout the region are integrated and complementary. In addition, this coordination helps assure that Bellevue is eligible for Federal ITS funding. During the development of the Regional ITS Architecture, the Puget Sound Regional Council (PSRC) created a document outlining procedures for local agencies to follow to comply with the regional ITS plan and Federal guidelines. The guidance document outlined a "System Engineering Analysis" that should be followed by local ITS projects. Table E-1 summarizes how the System Engineering Analysis was incorporated into the Bellevue ITS Master Plan.

Introduction

How was the ITS Plan Developed?

The development of the ITS plan started with identifying the ITS Vision for Bellevue. This Vision maintains a consistent goal in the identification of future projects, and when coupled with the inventory of the existing ITS conditions, it helped determine the City's ITS related needs.

The data from the needs assessment and the existing conditions inventory were used to develop the Bellevue Regional Architecture, which is a view of ITS in Bellevue displayed in a format developed by the United States Department of Transportation (U.S. DOT). The Regional Architecture helped identify where interagency arrangements will be needed. The interagency relationships are documented in the Concept of Operations. All of these steps help develop the final product, which is the deployment plan. This process is shown graphically in Figure E-1.
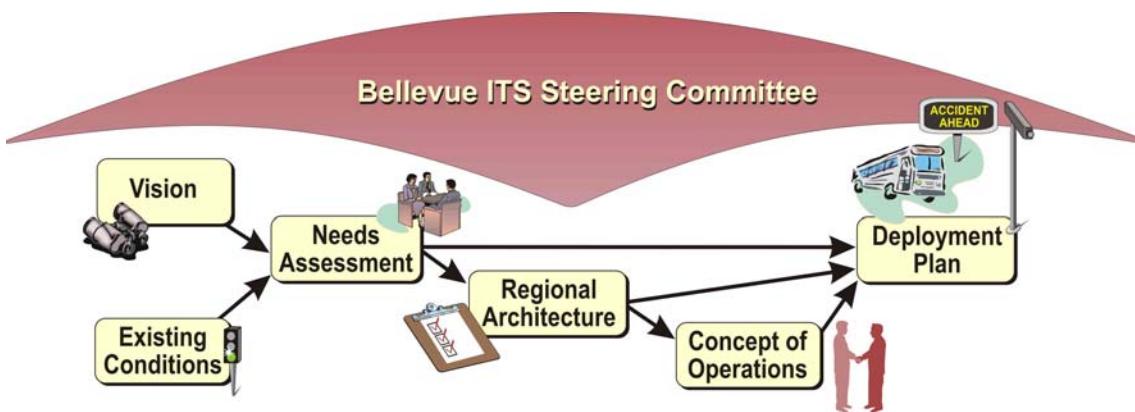

Figure E-1. ITS Planning Process

ITS Master Plan Vision

The City of Bellevue Transportation Department Executive Team developed the following four statements to capture the vision of ITS in Bellevue.

Vision Statement #1
Maximize the safety and efficiency of the City's transportation system for residents, business owners, and visitors to the City of Bellevue.

Vision Statement #2
Support Emergency Services in their efforts in saving lives and protecting the City's transportation infrastructure.

Vision Statement #3
Maximize the quality of transportation service provided by the City of Bellevue to residents, business owners, and visitors.

Vision Statement #4
Be active in and support regional ITS initiatives.

The existing conditions analysis describes the City's ITS infrastructure as well as planned ITS elements included in other local planning efforts. The benefits of ITS to the City are quite broad, so the implementation of ITS is recommended in a variety of reports including the Bellevue Transit Plan, the Bellevue-Redmond Overlake Transportation Study, the 148th Avenue Mobility Improvements, the Bellevue Capital Investment Program, the Downtown Implementation Plan, the PSRC Regional Architecture, and the Bellevue Emergency Operations Plan.

The ITS related equipment operated by the City includes:

- Traffic signals at 170 intersections (See Figure E-2)
- Approximately 500 system detectors (See Figure E-3)
- Computran central signal system
- Copper traffic signal interconnect (See Figure E-4)
- Traffic management center (TMC)
- Closed Circuit Television (CCTV) cameras at 20 locations
- Fiber optics for communications between the TMC and CCTV cameras (See Figure E-4)
- Portable message signs and highway advisory radio
- Emergency vehicle pre-emption at nearly all signalized intersections
- Transit Signal Priority (TSP) at two signalized intersections
- Driver feedback signs for traffic calming
- Variable speed limit signs at school zones
- 911 and emergency operation centers
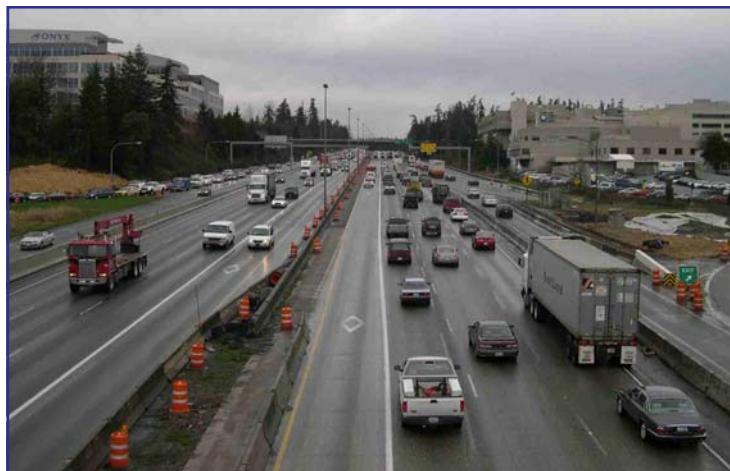
The Washington State Department of Transportation (WSDOT) also operates ITS equipment within City boundaries, including:

- CCTV cameras at 31 locations
- Metering at 24 ramps
- Variable message signs at six locations
- Highway Advisory Radio (HAR) at two locations
- Data stations throughout the Bellevue area freeways

Legend

Signal System
- Prot/Perm with Interconnect
- Prot/Perm with No Interconnect
- Signal with Interconnect
- Signal with No Interconnect
- City of Redmond Signal
- WSDOT Signal
- King County Signal
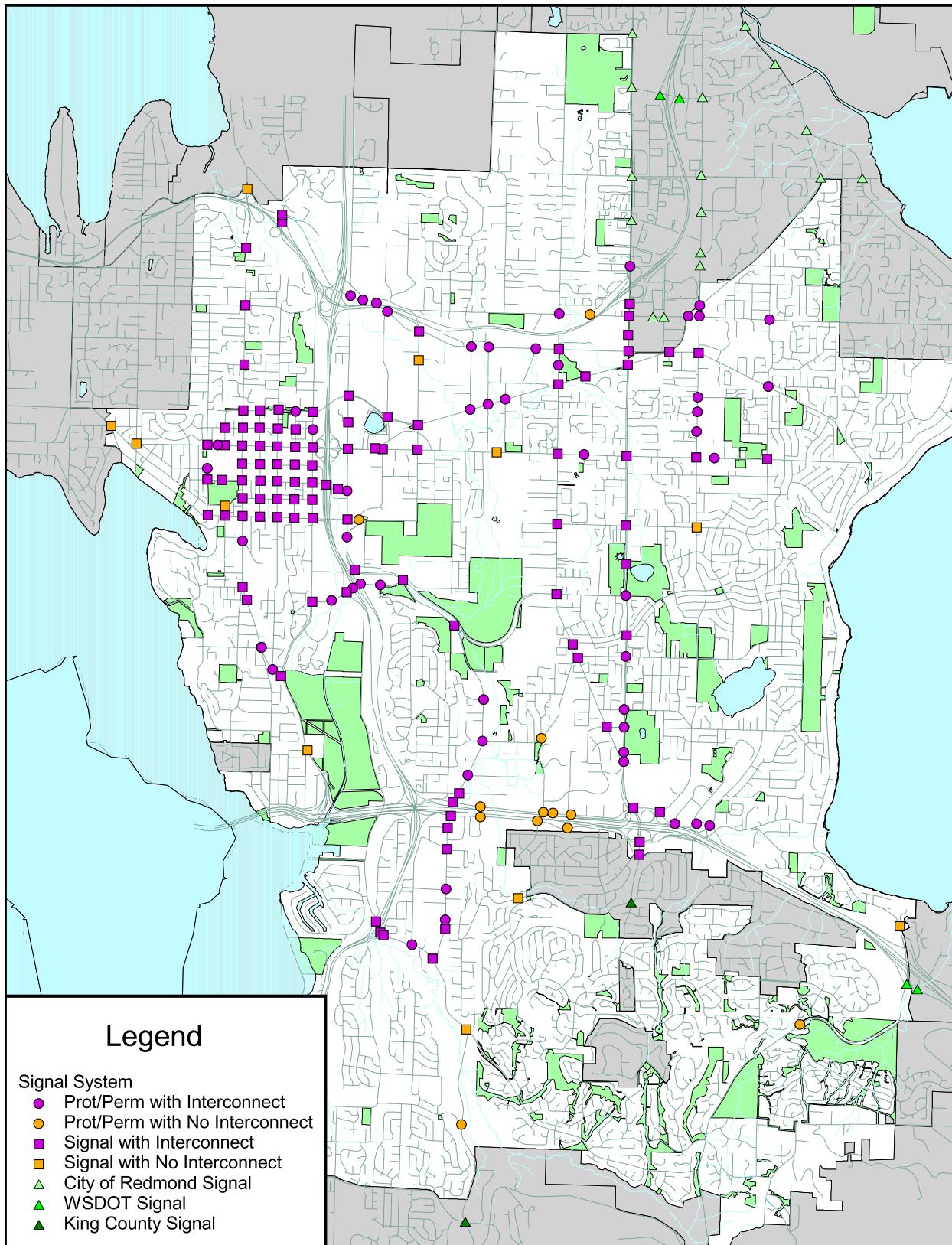
Figure E-2. Existing Traffic Signal Locations

Legend

System Loops
- System

Traffic Signals
- Bellevue Signal
- Other Signal
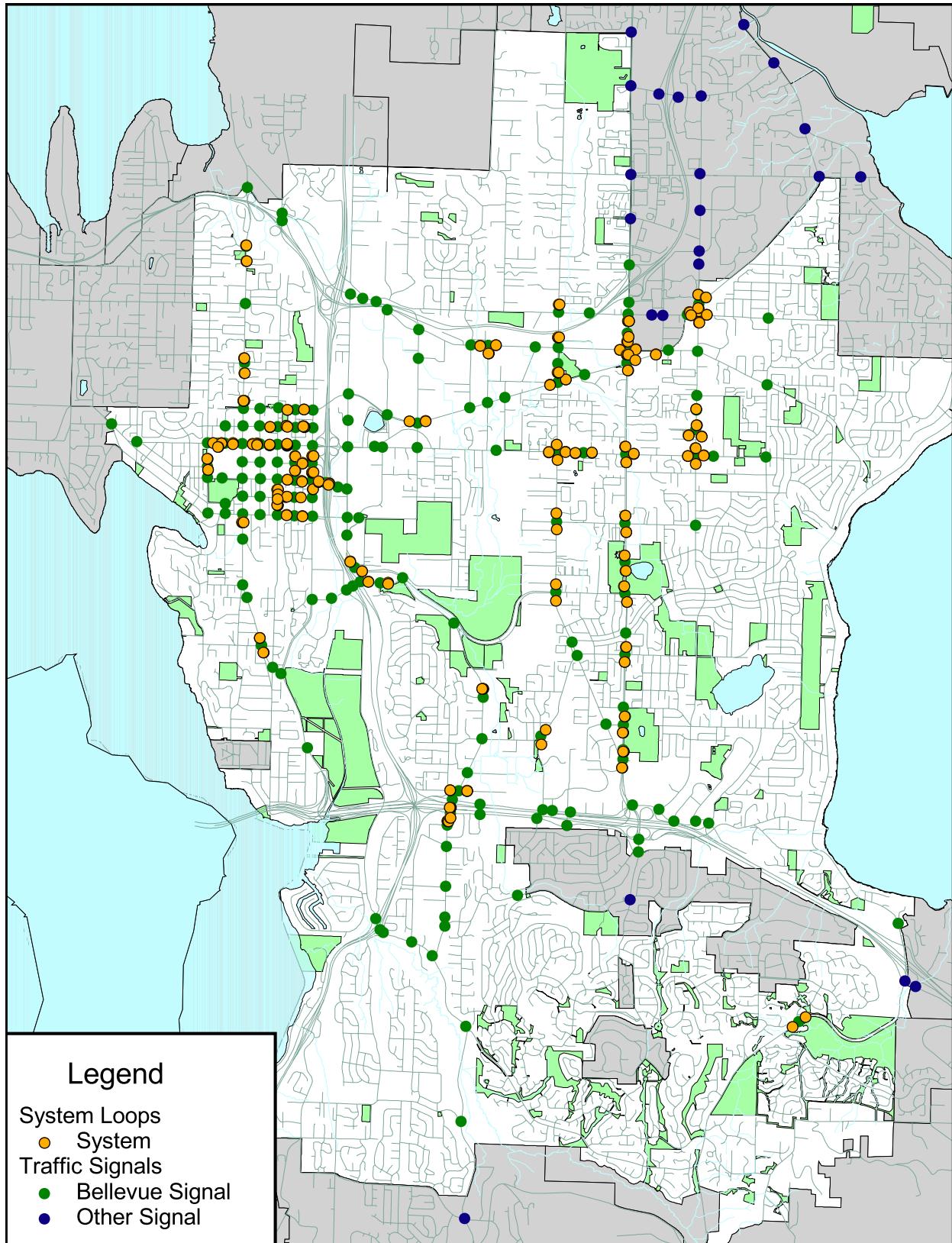
Figure E-3. Existing Data Station Locations
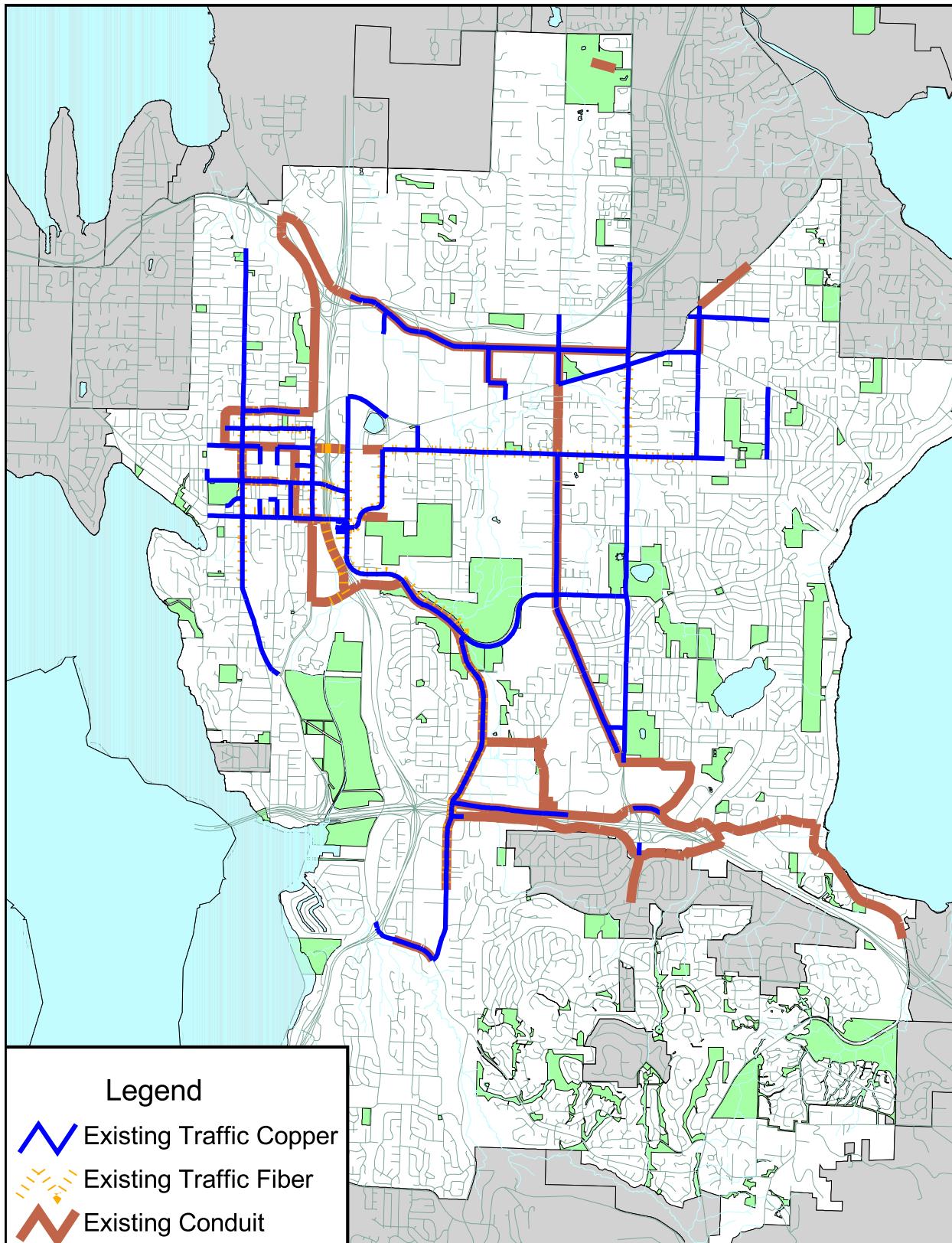
Figure E-4. Existing Communications Infrastructure

Legend

Existing Traffic Copper

Existing Traffic Fiber

Existing Conduit

The Vision statements developed for the Bellevue ITS plan provided a high-level view of the ITS goals in the region, however a more detailed view is needed to determine the specific elements for deployment in the future. Through an interview process with a variety of City departments, the needs assessment identified many potential uses for ITS technology in the City. The groups interviewed included: Traffic Management, Information Technology, Right-of-Way, Planning, Modeling and Forecasting, Maintenance, Fire, Police, Emergency Management and the Transportation Commission.

Table E-2 summarizes the Bellevue ITS needs. These needs are categorized into the five functional areas used throughout this report to manage needs and future projects.

Table E-2. Summary of Needs

Travel and Traffic Management		Public Transit Management	
Communications		28	Transit signal priority support
1	Utilize City's existing communications infrastructure	29	Real-time transit arrival and departure information
2	Expand existing traffic operations communications		
3	Upgrade communications (multi-mode to single-mode fiber)	**Emergency Managmeent**	
Traffic Operations and Management		30	Remote monitoring
4	Pedestrian and bicycle treatment (detection)	31	CCTV Video at 911 Dispatch, EOC, and Police
5	Expanded video surveillance	32	Automatic incident detection
6	Enhanced traffic control capabilities	33	Mobile data terminals for incident management
7	Expanded use of driver feedback signs	34	Dynamic route mapping for dispatch center
8	Probe vehicle data	35	AVL on all emergency vehicles
9	Signal pre-empt for police vehicles		
10	Center-to-center link to neighboring agencies		
11	Red light and speed photo enforcement	**Information Management**	
12	Procurement of standards based equipment	36	Query-able traffic data
13	Automatic detection of traffic equipment malfunctions	37	Expanded interagency data sharing
14	Improved vehicle classification system	38	GIS based equipment management
15	Expand system detection		
16	Traffic management center equipment upgrade		
17	Heavy-rail crossing advanced preempt	**Maintainance and Construction**	
Traveler Information		39	Ice and flood detection and weather information
18	Expanded use of VMS (includes additional installation)	40	Improve traffic management in work zones
19	Dynamic detour route development and management	41	AVL on maintenance vehicles
20	Real-time construction information		
21	Web-based traveler information		
22	Automated commuter alerts		
23	Parking management system		
24	Driver information via other agency VMS		
25	Highway advisory radio		
Incident Management			
26	Incident management system		
27	Interagency incident management		

The U.S. DOT defines a Regional ITS Architecture as a specific, tailored framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region. Simply stated, the Regional Architecture helps define the elements of the ITS system and the standard information that is exchanged between these elements. The guidelines for developing a Regional Architecture are defined in the National ITS Architecture.

The National ITS Architecture is a tool used to create a common framework for planning, defining, and integrating intelligent transportation systems. The architecture was developed to define the following ITS features:

- Functional area of ITS
- The physical entities or subsystems where the functions reside (e.g. roadside or vehicle)
- The information flows that connect the functional areas and subsystems

The creation of a Regional Architecture provides the following benefits:

- Displays a high-level view of the integration of ITS systems within the City of Bellevue.
- Creates a common platform to compare architectures with neighboring regions.
- Permits the identification of jurisdictional and system interconnections that will ultimately be referenced when designing Elements of the ITS Plan.
- Serves as a focal point for discussions among the Stakeholders concerning respective roles and responsibilities.
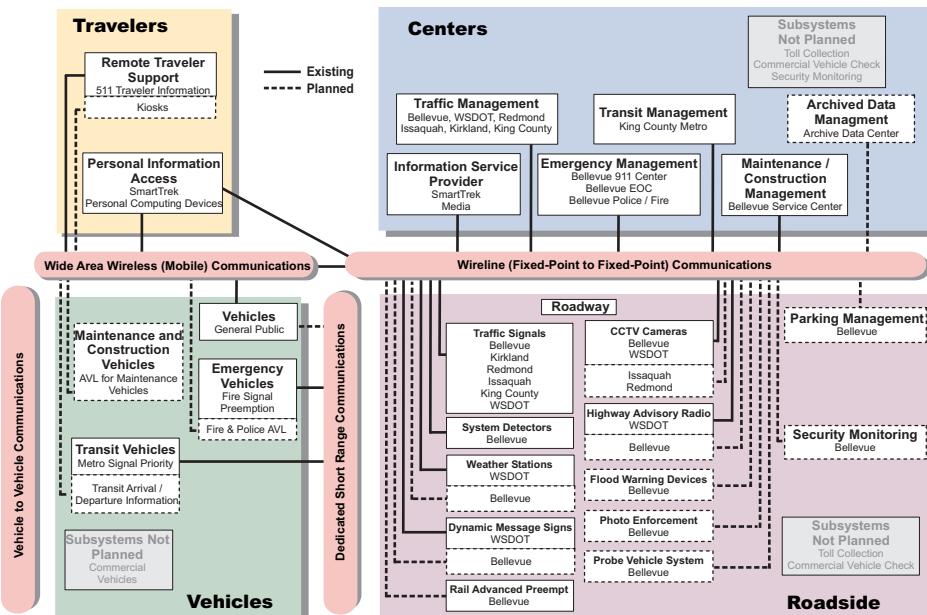

Figure E-5. Bellevue's National ITS Architecture Sausage Diagram

In addition to these benefits, a Regional Architecture must be created to meet the requirements to obtain Federal ITS funding. The Federal Highway Administration (FHWA) Federal-Aid Policy Guide, Title 23, Part 940 states that a Regional Architecture must be developed to show conformance of the region's ITS projects to the National ITS Architecture.

Regional Architecture

A list of the complete inventory of all existing and planned ITS elements was developed. This included their relationship with associated Stakeholders as well as their relationship with the appropriate National ITS Architecture defined subsystem. The subsystems applied to this project are shown in the National ITS Architecture standard "Sausage Diagram" in Figure E-5.

The process of developing a Regional Architecture also helps identify the Market Packages needed in the ITS Plan. A Market Package is a categorization of ITS technologies into individual packages for guiding the design and deployment of ITS. The Market Packages are used in the ITS Plan to organize the interagency ITS concepts of operations and to define projects in the Deployment Plan. Selecting Market Packages also helps identify the ITS standards that should be applied to future projects.

Concept of Operations

ITS strategies often require a high level of coordination and cooperation among multiple agencies in order to realize their maximum benefits. The concept of operations provides an outline of the roles and responsibilities of the many agencies that are Stakeholders in ITS projects within Bellevue.

From the Market Packages identified in the Regional Architecture process, the following packages were recognized as potentially needing interagency cooperation:

■ ITS Data Warehouse, ■ Multi-modal Coordination, ■ Interactive Traveler Information, ■ Network Surveillance, ■ Traffic Information Dissemination, ■ Regional Traffic Control, ■ Traffic Incident Management System, ■ Regional Parking Management, ■ Emergency Management and ■ Construction Management.

For each interagency Market Package identified, both the agency-to-agency relationship and the information exchange is determined. Agency-to-agency relationships range from a one-time consultation to operations and maintenance of another agency's equipment. Information exchange includes video, data, command, data requests and status updates.

Interagency coordination is nothing new to the City as it already has agreements with other cities, counties and the state to share resources such as video feeds, signal equipment and emergency response personnel.

Figure E-6 provides an example of the interagency relationships for the Regional Traffic Control Market Package.


Figure E-6. Regional Traffic Control Interagency Relationship

This section summarizes all of the components of the Deployment Plan, which is broken out into three phases: 0 - 5 Year Plan, 6 - 10 Year Plan, and 11 - 20 Year Plan. The capital costs and operations and maintenance costs for each phase are listed in Table E-3. All identified projects and their estimated deployment timeframe are listed in Table E-4 and are described in detail in Table E-5 at the end of this section. The high priority projects scheduled for the 0 - 5 Year Plan are highlighted following Table E-4. Figures E-7 through E-14 illustrate proposed locations for ITS equipment including variable speed limit signs, proposed weather stations, CCTV cameras, dynamic message signs, fiber optic communications, transit signal priority, flood warning sensors and real time transit arrival signs, respectively.

Table E-3. Deployment Cost Summary

Deployment Years	Capital Cost	Operations and Maintenance
0 - 5 Years	$4,500,000	$154,000
6 - 10 Years	$4,600,000	$188,000
11 - 20 Years	$4,600,000	$419,000
TOTAL	**$13,700,000**	**$761,000**

Table E-4. Deployment Schedule

Project ID	Project Title	5-Year Plan 1	2	3	4	5	10-Year Plan 6	7	8	9	10	20-Year Plan 11	12	13	14	15	16	17	18	19	20
Travel and Traffic Management																					
TM_01	Bicycle Detection						■	■	■	■											
TM_02	911 Computer Aided Dispatch Interface							■	■	■											
TM_03	Photo Enforcement											■	■	■	■	■	■	■	■	■	■
TM_04	Traffic Management Center Build-out		■	■																	
TM_05	Dynamic Route Guidance											■	■	■	■	■	■	■	■	■	■
TM_06	Automated Commuter Alert System									■	■										
TM_07	Downtown Parking Management System											■	■	■	■	■	■	■	■	■	■
TM_08	Permanent Highway Advisory Radio (HAR)						■														
TM_09	Vehicle Classification Detection						■	■													
TM_10	Driver Feedback Signs	■	■																		
TM_11	Rail Crossing Interconnect						■														
TM_12	Traveler Information Kiosks						■	■													
TM_13	Variable Speed Limit Signs	■	■	■			■	■													
TM_14	City-Wide CCTV Deployment	■	■	■	■	■						■	■	■	■	■	■	■	■	■	■
TM_15	Dynamic Message Signs	■	■	■	■	■															
TM_16	City-Wide Communications	■	■	■	■	■															
TM_17	Communications to Isolated Signalized Intersections	■	■																		
TM_18	Arterial Congestion Map	■	■																		
TM_19	Central Signal System Replacement								■	■											
TM_20	Center to Center Integration - Redmond and WSDOT	■	■																		
TM_21	Signal System Upgrade for TSP and TRPS	■																			
Public Transportation																					
PT_01	Transit Signal Priority	■	■	■	■	■						■	■								
PT_02	Smart-Bus TSP Enhancements						■														
PT_03	Real-Time Transit Arrival Signage				■																
Emergency Management																					
EM_01	Intra-Agency Video Sharing			■	■																
EM_02	Traffic Information on Mobile Data Terminals						■	■	■	■											
EM_03	Remote Monitoring of City Facilities						■														
EM_04	Flood Warning System	■	■				■	■													
Information Management																					
IM_01	Traffic Data Query System	■																			
Maintenance and Construction																					
MC_01	Roadway Weather Information System		■	■	■								■								
MC_02	Portable Work Zone ITS Equipment						■														
MC_03	Maintenance Vehicle AVL Tracking System											■	■	■	■	■	■	■	■	■	■

High Priority Projects

High priority projects are identified for deployment within the first five-year timeframe. This section describes each high priority project.

TMC Build Out

This project will provide new video displays, switching equipment and consoles for the designated TMC space at the new City Hall.

City-Wide CCTV Deployment

CCTV cameras will be used to monitor traffic conditions, monitor emergency events, optimize signal timing, view high accident locations, and monitor flooding and weather.

Driver Feedback Signs

The City would like to expand the use of Driver Feedback signs in Bellevue as a means of traffic calming. These signs notify the driver of their current speed and flash the speed when they are traveling over the speed limit. The City currently has approximately 20 signs and would like to deploy an additional 10 signs.

Variable Speed Limit Signs

This project will deploy approximately 72 variable speed limit signs in school speed zones on Bellevue streets. These signs will adjust the posted speed by time of day with respect to school schedule. The City deployed their first set of time of day signs at Lake Hills Elementary. The City would like to have the ability in the future to communicate to the signs directly from the TMC.

Dynamic Message Signs

Full function VMS signs and limited state wayfinding signs will be deployed to manage traffic during incidents such as flooding, large freeway accidents and special events in downtown Bellevue. The need for six full function VMS signs and three wayfinding signs has been identified.

Communications to Isolated Signalized Intersections

This project will provide communications to all the signalized intersections in the City that are currently isolated from the signal interconnect network.

City-Wide Communications

This project will phase in new fiber optic cables throughout the City to communicate to the new field devices and to upgrade communications to existing field devices.

Arterial Congestion Map

This project will develop an arterial congestion map based on system detector data and future floating car data from GPS sensors. The City has an extensive deployment of system detectors that can initially be used for measuring congestion in the region. It is assumed that GPS data will provide a more accurate measurement in the future, so it is anticipated that the system will eventually migrate to a GPS system.

Deployment Plan

Center-to-Center Integration

This project will implement center-to-center communications with Redmond's future central signal system and will re-establish the connection to WSDOT. The center-to-center communications to WSDOT requires software upgrades on the interface servers.

Washington State Department of Transportation

Signal System Upgrade for TSP and TRPS

This project will upgrade the City's Computran system to improve traffic responsive pattern selection (TRPS) and TSP operations.

Transit Signal Priority

In a joint effort with King County Metro and Sound Transit, The City of Bellevue will deploy new TSP sites near the Bellevue Transit Center as part of the Downtown Access Project. In addition, the City is starting a project to evaluate TSP along the corridor of six of the most heavily traveled transit routes in Bellevue. This project involves a joint effort with King County Metro and Sound Transit to install TSP at up to 120 sites in the next twenty years.

Real-Time Transit Arrival Signage
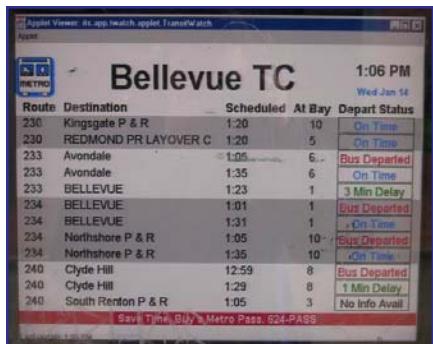
This project will be a joint effort with King County Metro and Sound Transit to deploy signage at major transit hubs and transfer points to notify travelers of the estimated arrival and departure time for specific transit routes. The high priority locations include the Bellevue Transit Center, Eastgate, South Bellevue, Wilburton and Newport Hill Park and Rides, Factoria Mall, Bellevue Square and the Crossroads Shopping Center.

Intra-Agency Video Sharing

This project will provide video to the Police, Fire, the 911 center, the Emergency Operations Center and the Bellevue Service Center.

Remote Monitoring of City Facilities

This project will monitor City facilities such as Downtown Park or water reservoirs. The monitoring may be via CCTV or other technologies.

Flood Warning System

This project will deploy flood monitoring equipment at six critical locations in Bellevue.

Traffic Data Query System

This project will enhance the loop data management program in the Computran system to improve access to historic system detector data and provide access to automated traffic count information.

Roadway Weather Information System

Weather stations with roadway temperature monitoring will be included at six critical locations.

Road Conditions
- Above 38 F
- 33 F to 38 F
- 32 F and below
- No data

Table E-5. Project Summary Table

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
Travel and Traffic Management									
TM_01	Bicycle Detection	This project will install permanent bicycle detection throughout the City on arterials designated as bike routes and on bike trails. This project does not include bicycle detection at signalized intersections. A total of 10 locations are assumed.	M	$50,000	$2,000	Primary: Bellevue	Requires communications through the City-Wide Communications Project (TM_16).	The communication requirements for the bike detectors is minimal so it may be possible to use existing signal interconnect. A larger issue will be bring power to detector sites on bike trails away from existing lighting or traffic signal circuits.	• Reduce staff time needed to set detectors in the field • Increase available data for evaluating bicycle usage in Bellevue • Better meet the needs of the Bellevue biking community
TM_02	911 Computer Aided Dispatch Interface	This project will provide a direct interface with the Bellevue 911 Computer Aided Dispatch system to automatically post incidents related to traffic in the Commuter Alert System.	M	$150,000	$10,000	Primary: Bellevue	Feeds incident data to the Automated Commuter Alert System in TM_06.	The incident reporting system could be a stand alone program. The platform for this program will be evaluated further when the project is in design.	• Increase driver awareness of traffic conditions • Decrease traffic operations staff time • Reduce congestion
TM_03	Photo Enforcement	This project will deploy photo enforcement for speeding and red light running. For this project, it is assumed Bellevue will deploy this equipment at 5 sites.	L	$375,000	$300,000	Primary: Bellevue	None	The City is interested in deploying photo enforcement equipment, but its use will depend on photo enforcement lawmaking in the state. The O&M cost for this project could be significantly reduced if Bellevue contracts with a vendor that installs, operates and maintains the equipment for a percentage of the fines paid by violators.	• Reduce red light running and speeding in the City • Improve driver safety • Reduce accidents at high accident locations
TM_04	Traffic Management Center Build-out	This project will provide new video displays, switching equipment and consoles for the designated TMC space at the new City Hall.	H	$300,000	$10,000	Primary: Bellevue	None	Although this is a high priority project, the TMC is functional with the existing equipment leaving the option open for a phased deployment and build out of equipment.	• Replacement of antiquated/failing equipment • Increased flexibility for viewing cameras and signal system maps • Space for multiple operators • Improved emergency management and operation capabilities
TM_05	Dynamic Route Guidance	This system will automatically calculate the ideal route between two points based on real-time roadway congestion data. Initially this project would be used to provide route information for emergency vehicles.	L	$250,000	$15,000	Primary: Bellevue	This project will require congestion data collected in the Arterial Congestion Map project (TM_18).	This system could be mapped using the City's GIS database.	• Decrease in response time for emergency vehicles • Decrease in travel time for motorists
TM_06	Automated Commuter Alert System	This system will automatically alert motorists through e-mail, pagers and other wireless devices of potential issues along their predefined commute route. This system would require the input of real-time incident data into a database that could be queried by the commuter alert system. The incident database could be shared with the media and posted on the internet.	M	$100,000	$5,000	Primary: Bellevue	None	The City would like to expand upon their current e-mail alert system for the Downtown Access project by sending out real time information. The current e-mail system only addresses planned events.	• Availability of real-time incident information • Improved traffic coverage of Bellevue by local media • Reduction in congestion around incident locations
TM_07	Downtown Parking Management System	This project will install active signs around Bellevue Square to direct motorists to parking facilities with available parking. This project assumes monitoring equipment for the west and southeast parking facilities (it already exists for the northeast facility) and four advisory signs.	L	$300,000	$15,000	Primary: Bellevue Secondary: Bellevue Square Management	None	This project will require the cooperation of the Bellevue Square Management.	• Reduce driver frustration during shopping season • Reduce congestion around mall due to circling traffic • More efficient use of parking
TM_08	Permanent Highway Advisory Radio (HAR)	A permanent HAR will be located in Bellevue to notify motorists of incidents or construction in the HAR region.	M	$20,000	$1,000	Primary: Bellevue	None	The frequency and location of the antenna will need to be coordinated with WSDOTs HAR equipment.	• Increase availability of real-time traveler information • Reduce congestion and delay • Increase flexibility for distribution of traveler information

Table E-5. Project Summary Table

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
TM_09	Vehicle Classification Detection	This project will deploy detectors strategically around the City to collect vehicle classification information. It is assumed 10 detectors will be deployed.	M	$100,000	$2,000	Primary: Bellevue	None	It is assumed these detectors will be tied to a nearby traffic signal for communications back to central.	• Increase availability of vehicle classification information • Ability to track truck route adherence • Ability to improve traffic signal simulation • More accurate data for pavement design
TM_10	Driver Feedback Signs	The City would like to expand the use of Driver Feedback signs in the City as a means of traffic calming. These signs notify the driver of their current speed and flash the speed when they are traveling over the speed limit. The City has approximately 20 signs and would like to deploy an additional 10 signs.	H	$84,000	$4,000	Primary: Bellevue	In the future the City may want to incorporate these signs into the Photo Enforcement project (TM_03).	None	• Improved safety for motorists, pedestrian and cyclists • Reduce traffic speed • Increase in speed limit adherence • Increase in driver awareness of speed limits and personal driving characteristics • Wide-spread support • Low-impact traffic calming
TM_11	Rail Crossing Interconnect	City would like interconnect to the rail crossing at NE 8th Street to the signal at 116th, and the crossing at SE 1st Street to the adjacent signals at 116th Avenue NE and at Main St. This interconnect will notify the neighboring signals of the approaching train to allow for the clearing of queued vehicles backed up to the tracks. The cost includes interconnect to the nearby signal via a new preempt cable in existing conduit.	M	$50,000	$4,000	Primary: Bellevue Secondary: BNSF	None	To provide enough warning of an arriving train to clear queued vehicles, improvements may need to be made to the train detection system. This rail detection upgrade is assumed in the cost.	• Increase in safety near rail crossings
TM_12	Traveler Information Kiosks	City will support efforts by Metro and the local malls to deploy traveler information kiosks at transit centers, Bellevue Community College (BCC), and major shopping centers.	M	$0	$1,000	Primary: Metro, BCC, and Local Malls Secondary: Bellevue	Bellevue could enhance the kiosks by providing data from the Arterial Congestion Map (TM_18) and the Automatic Commuter Alert System (TM_06).	It is assumed that Metro, BCC and the local malls will furnish, install, operate and maintain the kiosks. The City will probably spend a small amount of time each year addressing data needs for the kiosks.	• Increase availability of traveler information in public places • Decrease congestion and delay
TM_13	Variable Speed Limit Signs	This project will deploy approximately 72 variable speed limit signs within school speed zones on Bellevue streets. These signs will adjust the posted speed by time of day. The City deployed their first set of time of day signs at Lake Hills Elementary. The City would like to have the ability in the future to communicate to the signs from the TMC.	H / M	$504,000 / $650,000	$12,000 / $10,000	Primary: Bellevue	Requires communications through the City-Wide Communications Project (TM_16) when remote communications to the signs is added.	It is unknown if it is possible to interconnect the signs for remote communications. As the deployment of signs continues, this requirement will need to be integrated into the product procurement specification.	• Reduced speeds in school zones • Increased safety for students and drivers • Increase in driver awareness • Decrease in motorist confusion
TM_14	City-Wide CCTV Deployment	High, medium and low priority CCTV locations have been identified throughout the City. These cameras will be used to monitor traffic conditions, monitor emergency events, optimize signal timing, view high accident locations and monitor flooding and weather. • 16 cameras • 23 cameras • 12 cameras	H / M / L	$400,000 / $575,000 / $300,000	$16,000 / $23,000 / $12,000	Primary: Bellevue	Requires communications from the City Wide Communications Project (TM_16). The TMC build out (TM_04) would increase quality and flexibility of viewed images.	The City's local video switcher will need to be expanded as more cameras are installed.	• Improved signal coordination and real-time signal timing adjustments • Increased information during emergency events and incidents • Increased ability to report congestion information for local arterials • More wide spread driver information

Table E-5. Project Summary Table

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
TM_15	Dynamic Message Signs	Full function VMS signs and limited state wayfinding signs will be deployed to manage traffic during incidents such as flooding and large freeway accidents as well as during special events in downtown Bellevue. The following signs will be deployed: • SB 148th Ave NE south of Bel-Red Rd • NB 148th Ave NE north of SE 22nd St. • Wayfinding for diverting around flooding on Factoria Blvd near SE 36th St (3 signs). • WB NE 8th St west of 112th Ave NE • SB Lake Hills Connector north of Richards Road. • WB NE 4th St west of 112th Ave NE • Wayfinding signs for WB I-90 traffic diverting off the freeway at 156th Ave NE (2 signs). • Wayfinding signs for traffic diverting of WB SR-520 at 148th Ave NE (2 signs). • Wayfinding for diverting around flooding on Kamber Road (3 signs).	H H H H M M L L L	$50,000 $50,000 $75,000 $50,000 $50,000 $50,000 $50,000 $50,000 $75,000	$5,000 $5,000 $9,000 $5,000 $5,000 $5,000 $6,000 $6,000 $9,000	Primary: Bellevue	Requires communications from the City-Wide Communications Project (TM_16).	The City does not have any permanent VMSs so they will need to decide how they want to manage the control. It may be possible to integrate the control into the Computran system.	• Improved driver safety during incidents and events • Improved travel time through alternate route and closure advisories • Reduction in staff time needed to deploy temporary signs • Provide motorist information on incident/events more quickly
TM_16	City-Wide Communications	This project will phase in new fiber optics throughout the City to communicate to the new field devices and to upgrade communications to existing field devices.	H M L	$1,400,000 $1,400,000 $2,800,000	$5,000 $5,000 $10,000	Primary: Bellevue	Required for numerous projects in the City.	The City currently uses multi-mode fiber for communications to CCTV cameras. The City may need to gradually switch to single mode fiber cabling as the need for faster speeds and higher bandwidths increases.	• Communication to existing isolated field devices • Communication to new field devices • Improved reliability for communications • Redundancy in communications
TM_17	Communications to Isolated Signalized Intersections	This project will provide remote communications to all the signalized intersections in the City that are currently isolated from the signal interconnect network.	H, M, L	$0	$0	Primary: Bellevue	Relies heavily on the City-Wide Communications project.	Cost built into the City-Wide Communications project.	• More efficient operations of isolated signals • Decrease in staff time needed to maintain these signals • Quicker response time when problems occur with the isolated signals • Ability to obtain data from remote signals

Central Signal System Upgrades

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
TM_18	Arterial Congestion Map	This project will develop an arterial congestion map based on system detector data and future floating car data from GPS sensors. The City has an extensive deployment of system detectors that can initially be used for measuring congestion in the region. It is assumed that GPS data will provide a more accurate measurement in the future, so it is anticipated that the system will eventually migrate to a GPS system.	H	$250,000	$15,000	Primary: Bellevue Secondary: KC Metro, Sound Transit, Cell Carriers	Feeds data into the Dynamic Route Guidance project (TM_05) and the Traveler Information Kiosk project (TM_12).	A standard methodology for using system detector data to report congestion has not been developed in the traffic industry. Many agencies are waiting to use GPS or probe vehicle data. The use of GPS data from cell phones has been identified as a possible means of collecting probe vehicle data.	• Increase driver awareness to congested areas • Increase distribution of traffic on parallel arterials • Decreased motorist delay
TM_19	Central Signal System Replacement	The City of Bellevue's central computer for traffic signal control will be due for replacement by 2010. This project will define and procure a new signal system for the City of Bellevue. With this replacement will also come a migration of the signal system to Ethernet communications. The replacement of controller cabinets will be part of the annual cabinet replacement program.	M	$400,000	$15,000	Primary: Bellevue	Could incorporate the 911 Computer Aided Dispatch Interface (TM_02), the Dynamic Route Guidance Project (TM_05), the Automated Commuter Alert System (TM_06) and the Traffic Data Query System (IM_01).		• Decrease in motor vehicle delay • Decrease in emergency vehicle response times • Enhanced system communications • Improved transit speed and reliability

Table E-5. Project Summary Table

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
TM_20	Center to Center Integration - Redmond and WSDOT	This project will implement center-to-center communications with Redmond's future central signal system and will re-establish the connection to WSDOT. The center-to-center communications to WSDOT requires software upgrades on the interface servers.	H	$200,000	$10,000	Primary: Bellevue Secondary: Redmond WSDOT	Needs to connect to a common point with the Redmond fiber optic system. The interface point is currently designed for 152nd Avenue NE near NE 24th Street.	WSDOT has recently selected a new central signal system for managing its traffic signals. Additional software design may be required to establish a connection to their new system. $50,000 of the deployment cost was allocated to connect to their old MIST system. The remaining $100,000 is for the connection to Redmond.	• Improved traffic management across jurisdictional boundaries • Increase in information available for traffic management
TM_21	Signal System Upgrade for TSP and TRPS	This project will upgrade the City's Computran system to improve traffic responsive pattern selection (TRPS) and transit signal priority (TSP) operations.	H	$75,000	$5,000	Primary: Bellevue	None	None	• Decrease transit travel time • Increase transit reliability • Decrease in motor vehicle delay • Signal timing adjustments based on real-time traffic conditions
Public Transportation									
PT_01	Transit Signal Priority	In a joint effort with King County Metro and Sound Transit, The City of Bellevue will deploy new TSP sites near the Bellevue Transit Center as part of the Downtown Access Project. In addition, the City is starting a project to evaluate TSP along the corridor of six of the most heavily traveled transit routes in Bellevue. This project involves a joint effort with King County Metro and Sound Transit to install TSP at up to 120 sites in the next twenty years. • 20 sites • 60 sites • 40 sites	H M L	$480,000 $360,000 $240,000	$20,000 $60,000 $40,000	Primary: Bellevue Secondary: Metro Sound Transit	The Signal System software upgrade described in project TM_21 will be beneficial with the deployment of new TSP sites. Future TSP sites can funnel data into the Arterial Congestion Map (TM_18)	King County is in the process of developing new TSP hardware that will use wireless communications from the bus to the controller cabinet to activate TSP. This will reduce the installation cost from roughly $35,000 to $5,000. The High priority location assumed half at the current cost and half at the future cost. All Medium and Low priority projects assumed the future cost.	• Increased transit reliability • Decreased transit travel times • Reduction in transit operation and passenger time cost • Increased transit ridership • Increased travel time information
PT_02	Smart-Bus TSP Enhancements	This project is a joint effort with King County Metro and Sound Transit to improve the use of TSP through the new technology deployed on the future Smart-Buses. The Smart-Buses will have the ability to track ridership and schedule adherence real-time. This project will use this information to prioritize which buses receive TSP.	M	$200,000	$10,000	Primary: Metro, Sound Transit Secondary: Bellevue	This project will use the TSP deployed in PT_01.		• Increase TSP efficiency • Reduction in impact to signal operations
PT_03	Real-Time Transit Arrival Signage	This project will be a joint effort with King County Metro and Sound Transit to deploy signage at major transit hubs and transfer points to notify travelers of the estimated arrival and departure time for specific transit routes. The high priority locations include the Bellevue Transit Center, Eastgate, South Bellevue, Wilburton and Newport Hill Park and Rides, Factoria Mall, Bellevue Square and the Crossroads Shopping Center.	H	$80,000	$2,000	Primary: Metro, Sound Transit Secondary: Bellevue	The sign deployment will require communications deployed through the City-Wide Communications project (TM_16).	It is assumed that this equipment will be operated and maintained by Metro and Sound Transit. The cost only includes the signs and infrastructure for the communications (conduit and junction boxes to the site.) Metro is currently implementing a pilot project on Aurora Avenue N in Seattle.	• Increased ridership • Increase in rider awareness/information
Emergency Management									
EM_01	Intra-Agency Video Sharing	This project will provide video to the Police, Fire, the 911 center, the Emergency Operations Center and the Bellevue Service Center.	H	$30,000	$2,500	Primary: Bellevue	Will be enhanced by the additional cameras included in the City-Wide CCTV Deployment Project (TM_14).	Communication exists to the Bellevue Service Center and communications will be installed in the new City Hall for connections to the EOC and 911 Center. The only expense is the hardware.	• Improved emergency and incident identification, verification, monitoring and management • Reduction in travel time to emergencies • Improved efficiency in the response to maintenance calls and traffic accidents • Increased safety for Bellevue residents

Table E-5. Project Summary Table

Project ID	Project Title	Description	Priority	Capital Cost	O&M Cost	Stakeholders	Relationship to Other Projects	Other Considerations	Expected Benefits
EM_02	Traffic Information on Mobile Data Terminals	This project will provide incident information, the City's congestion map, variable message sign status and video feeds directly to the mobile data terminals in police and fire vehicles in Bellevue.	M	$50,000	$5,000	Primary: Bellevue	Relies on the 911 CAD Interface project (TM_02) for incident data and the development of an Arterial Congestion Map as described in project TM_18.	Data terminals should be installed in all Bellevue emergency response vehicles by the end of the year. This cost could be significantly reduced if the data terminals have access to the internet. All but the VMS status data would be accessible from the web.	• Improved emergency management • Reduction in travel time to emergencies • Reduction in congestion near incidents
EM_03	Remote Monitoring of City Facilities	This project will monitor City facilities such as Downtown Park or water reservoirs. The monitoring may be via CCTV or other technologies.	M	$200,000	$10,000	Primary: Bellevue	It will require communications from the City-Wide Communications project (TM_16).	Ideally, some of the cameras needed to monitor City facilities could be strategically placed to also benefit observation of traffic conditions.	• Increase security at City facilities • Improve response time to incidents at City facilities • Increase staff efficiency
EM_04	Flood Warning System	This project will deploy flooding monitoring equipment at the following locations: • 148th at Larson Lake • Factoria Blvd at SE 36th Street • Kamber Road just east of Richards Road • SE 7th Place just east of Lake Hills Connector • NE 21st St just east of 140th Ave NE • SE 30th Street just east of Richards Road	H H M M M M	$50,000 $50,000 $50,000 $50,000 $50,000 $50,000	$2,500 $2,500 $2,500 $2,500 $2,500 $2,500	Primary: Bellevue	City-Wide Communications (project TM_16) is required to communicate to the flood monitoring devices. These projects will be incorporated with the dynamic message signs identified in project (TM_15).	The City currently has a flood monitoring device deployed on SE 30th Street near Richards Road.	• Increase in flood awareness for the City • Decreased response time for maintenance crews • Decrease in congestion on roadways in flood zones • Increase in safety for drivers • Ability to easily monitor multiple flood locations
Information Management									
IM_01	Traffic Data Query System	This project will enhance the loop data management program in the Computran system to improve access to historic system detector data and provide access to automated traffic count information.	H	$50,000	$10,000	Primary: Bellevue	Could be packaged together with projects TM_18, TM_20 and TM_21 to potentially reduce software development cost.	Database could be integrated with the City's GIS database, with the Computran System, or a hybrid that uses both.	• Increase in staff efficiency and safety • Enhanced management of roadway operations • Better use of existing data
Maintenance and Construction									
MC_01	Roadway Weather Information System	Weather stations with roadway temperature monitoring will be included at the following locations: • Lakemont Boulevard near Fire Station 8. • The two Lakemont Bridges near I-90 • Near Somerset Elementary school. • Lake Hills Connector west of 140th Ave NE • Meydenbauer Bridge on NE Lake Washington Blvd. • NE 12th St bridge over the BNSF railroad tracks.	H H M M L	$25,000 $25,000 $25,000 $25,000 $25,000	$1,000 $1,000 $1,000 $1,000 $1,000	Primary: Bellevue	City-Wide Communications (project TM_16) is required to communicate to the weather stations.	The distribution of this weather information should be combined with the information currently collected by WSDOT. Some of the WSDOT weather stations may need to be enhanced to include features such as roadway temperature.	• Better, more efficient response to current weather conditions • Faster response time to ice conditions by roadway maintenance crews • Increase in available local weather information • Increase in driver safety • Increase in staff efficiency
MC_02	Portable Work Zone ITS Equipment	This project will procure portable CCTV cameras, variable speed limit signs and speed detection devices to monitor and control conditions in construction zones.	M	$80,000	$1,000	Primary: Bellevue	None	This equipment can be procured as separate portable devices or as a complete portable ITS unit.	• Increased safety in work zones • Reduction in congestion and delay
MC_03	Maintenance Vehicle AVL Tracking System	This project will track Bellevue maintenance vehicles to enhance dispatch of personnel and equipment to daily events and projects.	L	$ 150,000	$5,000	Primary: Bellevue			• Decreased maintenance response times • Decreased emergency response times • Increased personnel coordination
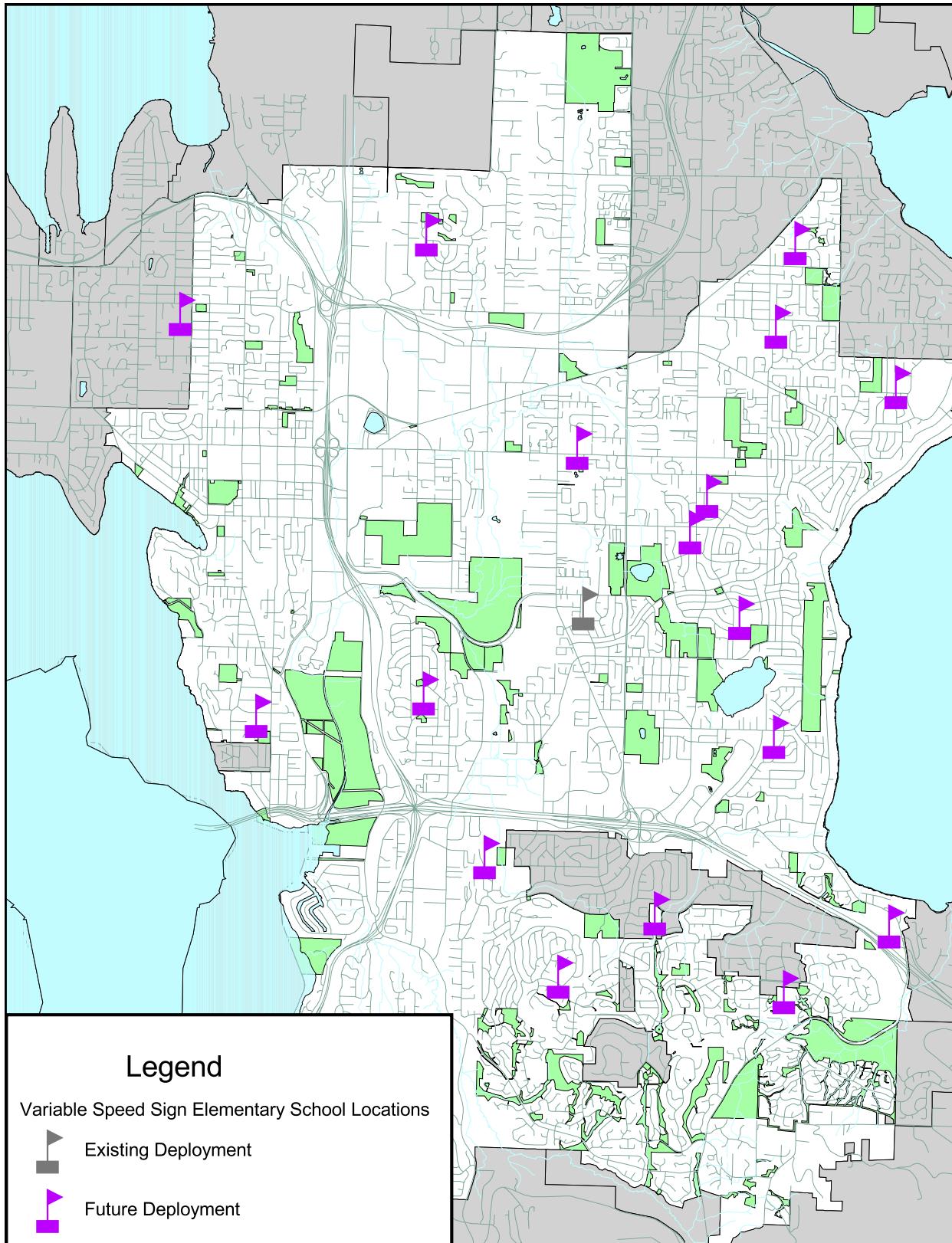
**Figure E-7. Proposed Variable Speed Limit Sign Locations**

Legend

Variable Speed Sign Elementary School Locations

Existing Deployment

Future Deployment
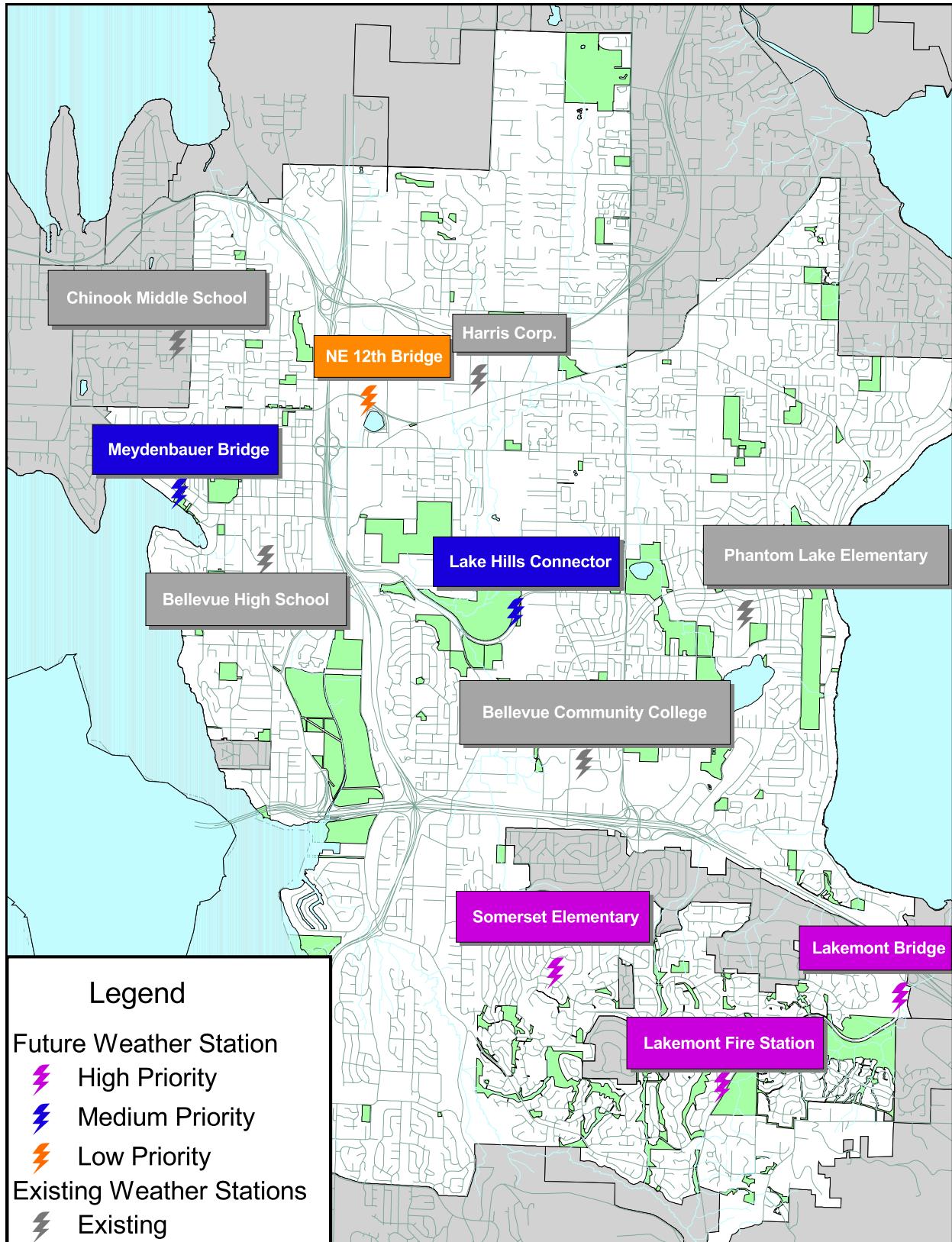
Figure E-8. Proposed Weather Station Locations
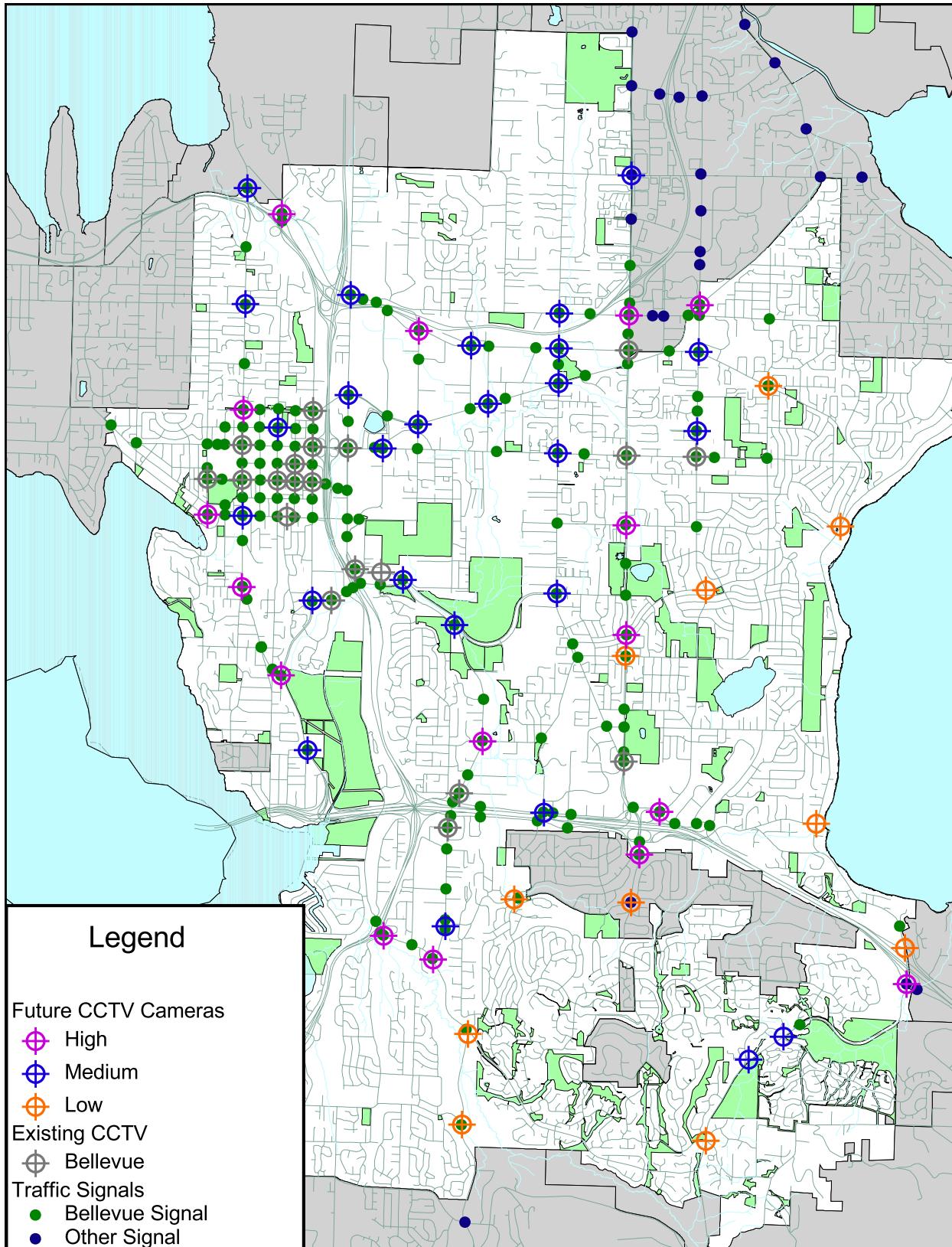
Figure E-9. Proposed City-Wide CCTV Deployment

Legend

Future CCTV Cameras
- High
- Medium
- Low

Existing CCTV
- Bellevue

Traffic Signals
- Bellevue Signal
- Other Signal

Legend

Future VMS
- ▲ High (magenta)
- ▲ Medium (blue)

Future Wayfinding
- ⇨ High (magenta outline)
- ⇨ Low (orange outline)

Existing VMS
- ▲ WSDOT (gray)
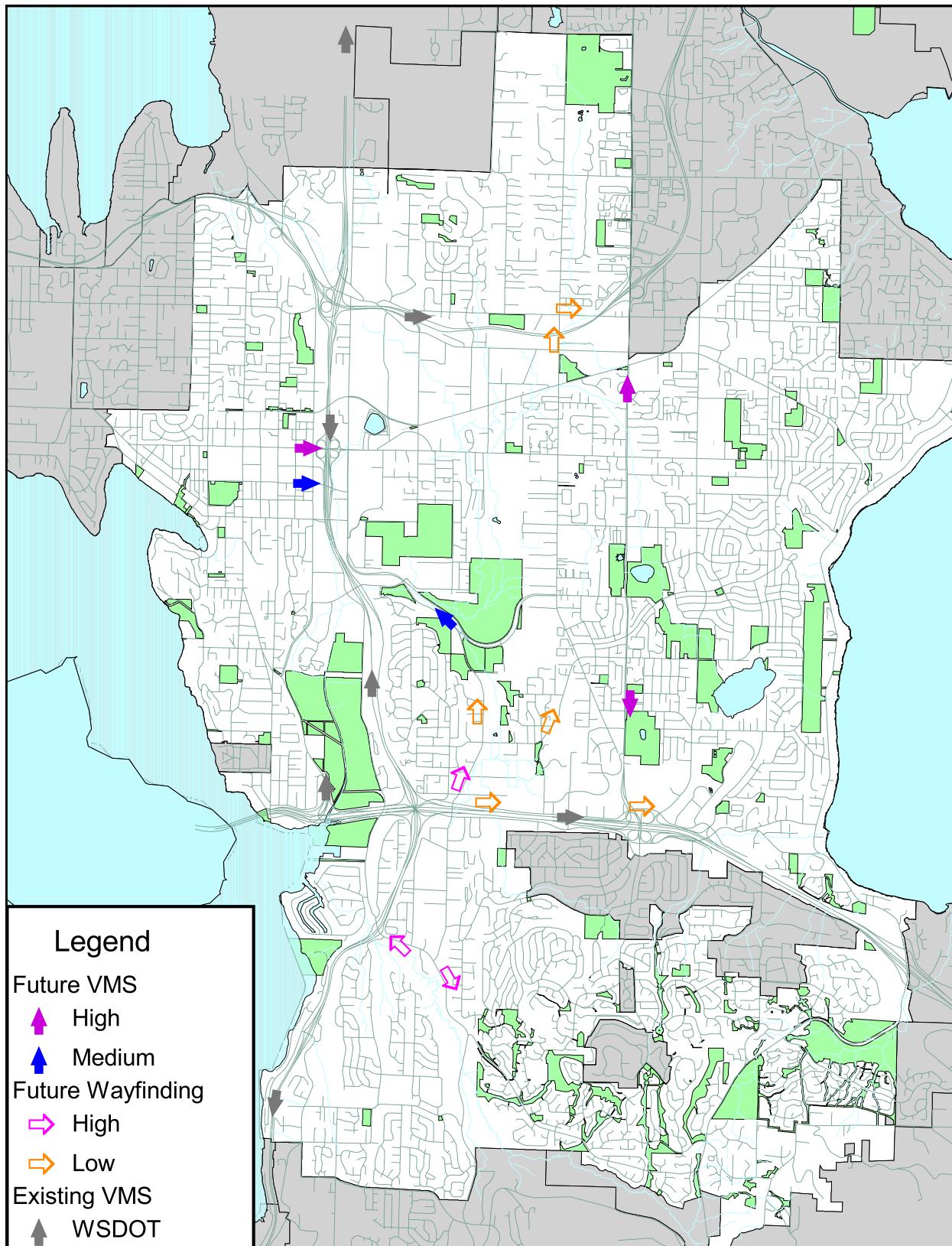
Figure E-10. Proposed Dynamic Message Signs
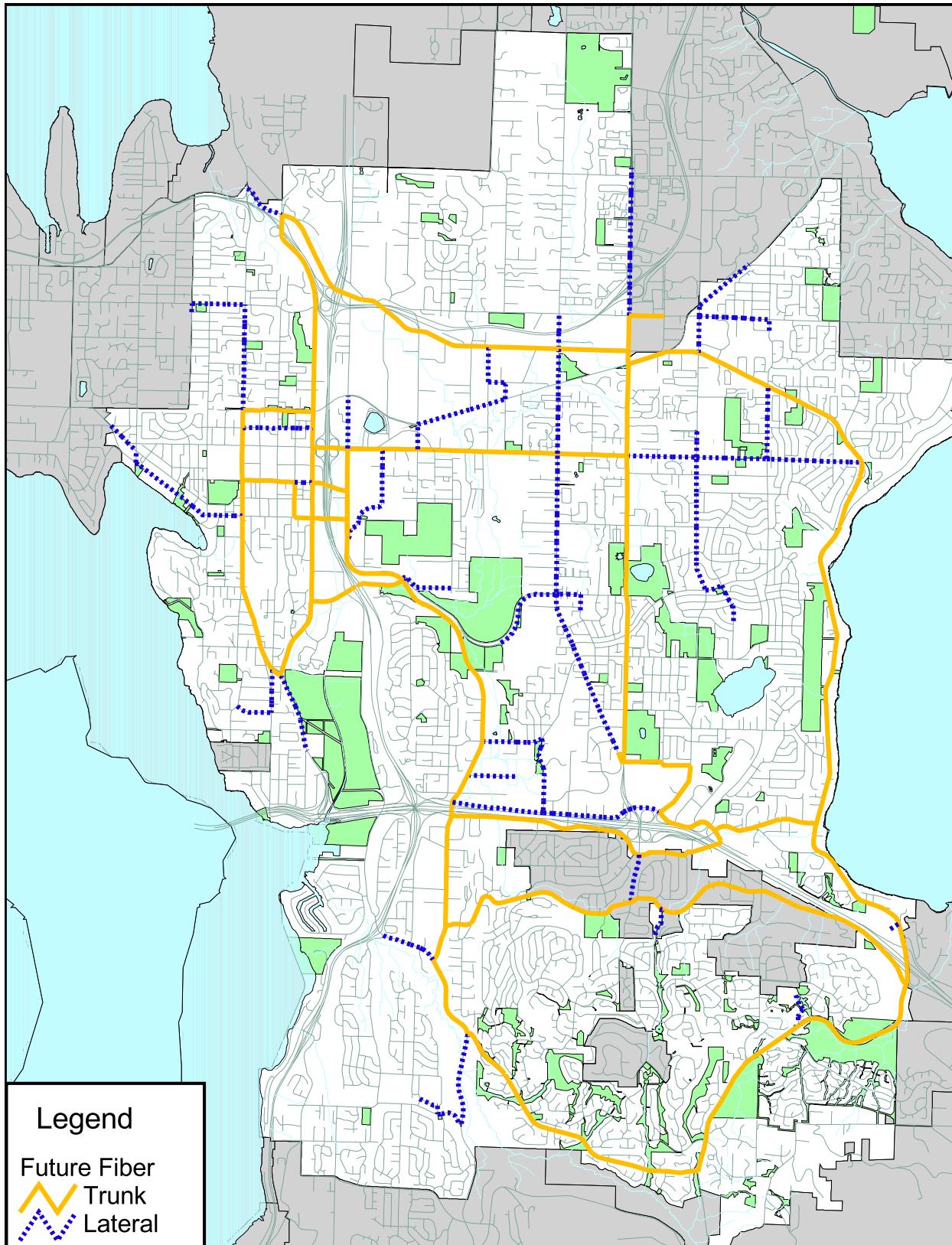
Figure E-11. Proposed Fiber Optic Communications
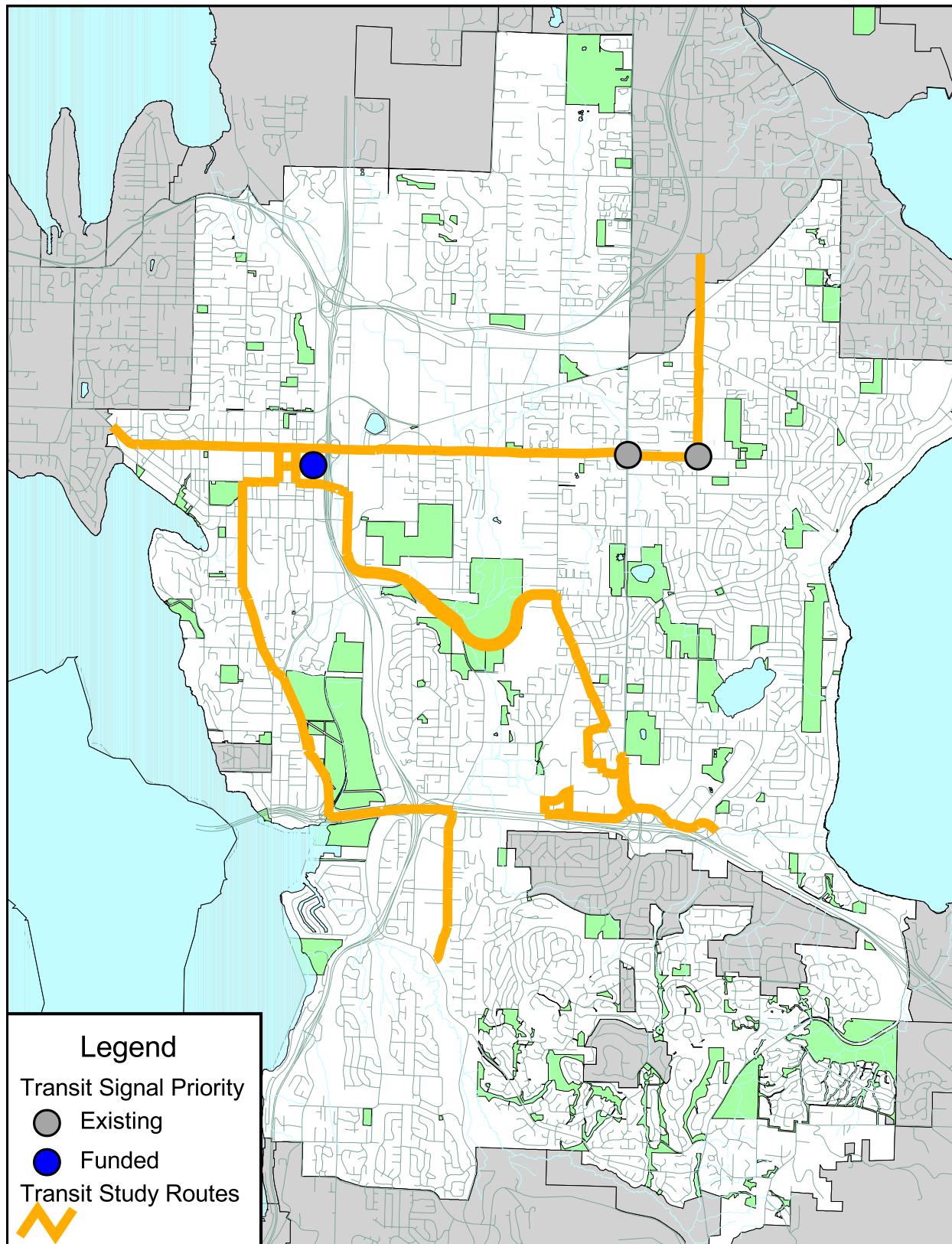
Figure E-12. Proposed Transit Signal Priority

Legend

Transit Signal Priority

⬤ Existing

🔵 Funded

Transit Study Routes
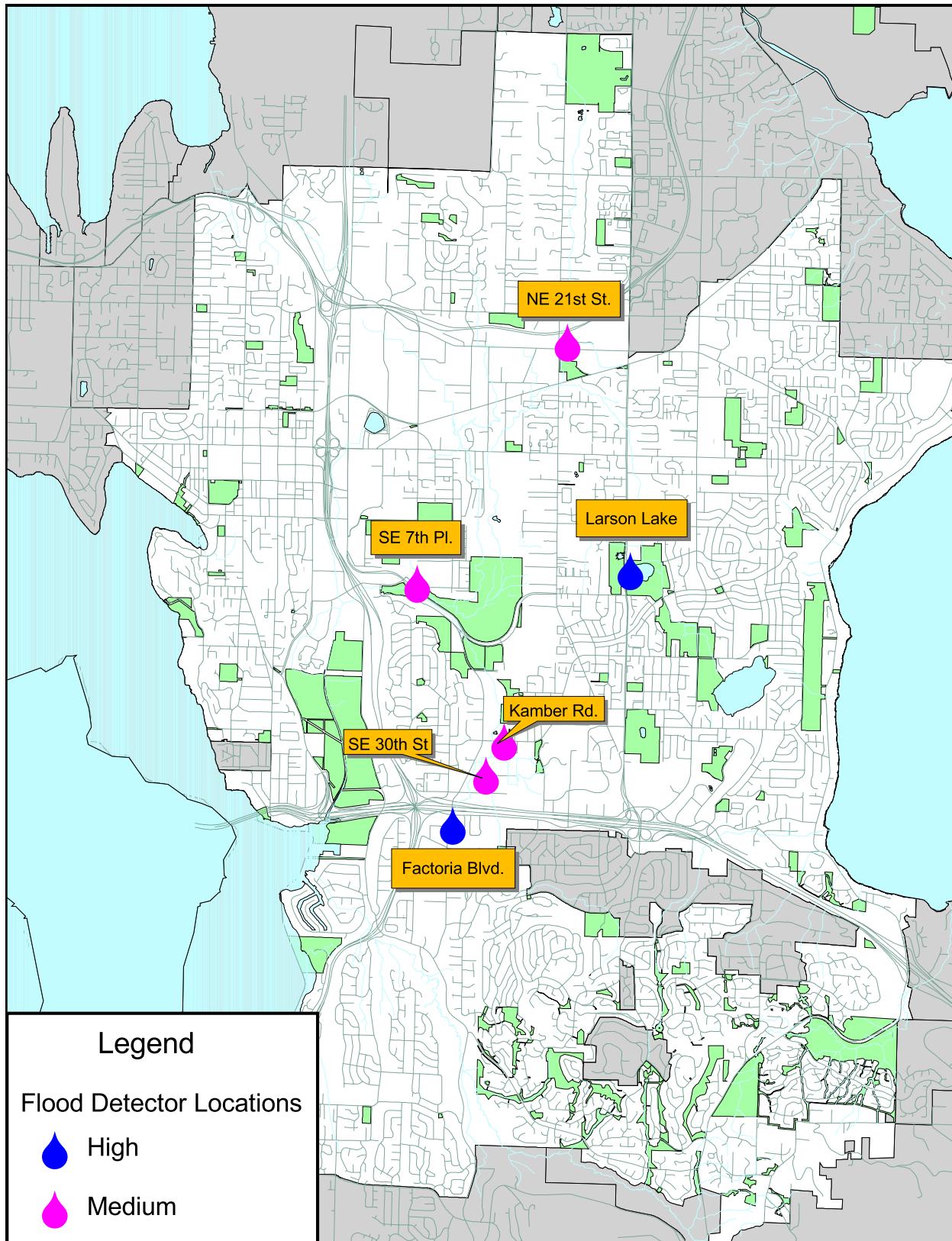
Figure E-13. Proposed Flood Warning Equipment Locations
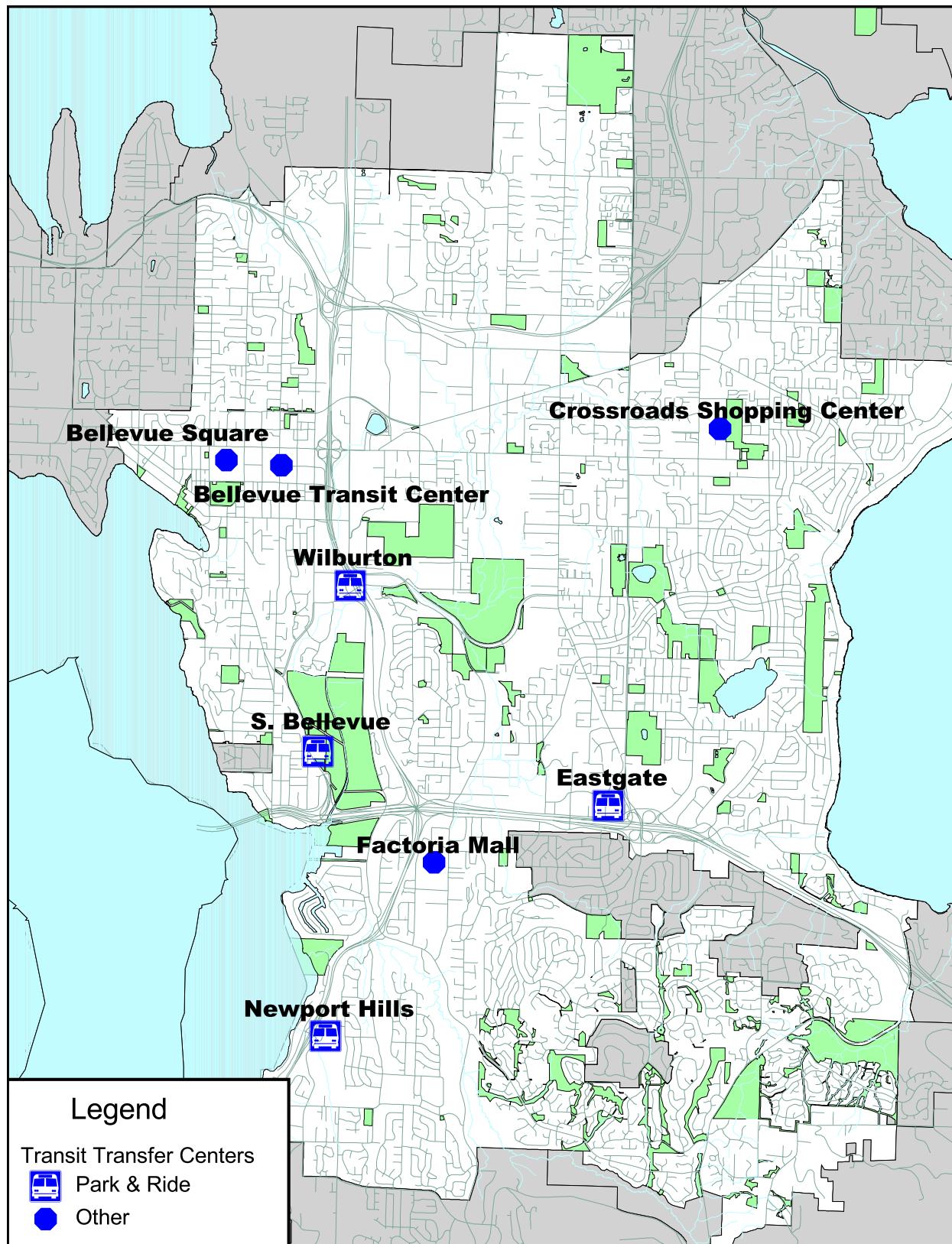
Figure E-14. Proposed Real Time Transit Arrival Signs

ITS Benefits
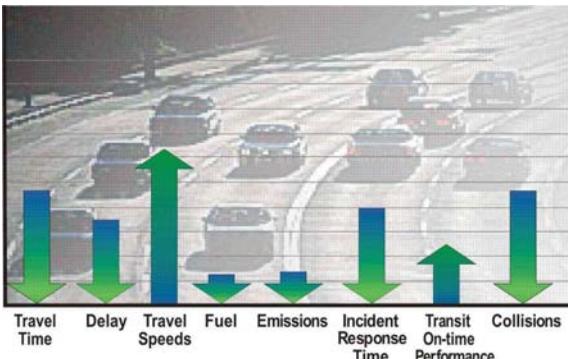
Implementation of the Bellevue ITS Master Plan has the potential to provide the following benefits to the City:

Improve Vehicle Travel Time

By decreasing the response time of City Staff to incidents such as flooding and icy roads, vehicle travel times can be greatly reduced. In addition, the Signal System Upgrade for TSP and TRPS will provide more options for City Staff to improve network efficiency.

Improve Traveler Safety

Driver feedback signs, variable speed limit signs and photo enforcement will increase safety by reducing vehicle speeds and erratic behavior at signalized intersections. City facility, flood, and weather monitoring will improve the safety of the City's roadways and infrastructure by reducing maintenance response time.

Improve Emergency Management

Projects like Intra-Agency Video Sharing, Traffic Information on Mobile Data Terminals, and City-Wide CCTV Deployment provide more critical information to emergency personnel; therefore increase their ability to respond to emergencies.

Improve Communications Coverage and Reliability

Both the City-Wide Communications project and the Communications to Isolated Signalized Intersections project will add scalability and redundancy to Bellevue's communications infrastructure.

Improve Traffic Conditions Awareness

Permanent Highway Advisory Radio, Dynamic Route Guidance, Automatic Commuter Alert System, Dynamic Message Signs and the Downtown Parking Management System all provide information to motorists that can be used to adjust their trip patterns based on real-time information.

Improve Transit Speed and Reliability

Transit Signal Priority and Smart-Bus TSP Enhancements encourage transit use by decreasing transit travel time.

Improve Interagency Communication

The Center-to-Center Integration with Redmond and WSDOT will provide traffic managers with the traffic data and video necessary to manage traffic effectively near agency boundaries.

Improve Data Management

Projects like the creation of a Traffic Data Query System and an Arterial Congestion Map will provide City staff with the data needed to enhance the operations of Bellevue's surface street network.

Improve Staff Efficiency

By adding the ability to remotely monitor weather, flooding and arterials, City staff will increase their efficiency to monitor and respond to traffic and weather related incidents and emergencies.

Completion of this plan is just the beginning of the work required to meet the City's ITS vision. The next step is to find ways to fit ITS into the future capital and O&M expenditures for the City. The City currently spends roughly $200,000 a year on ITS related projects. To keep up with the deployment goals developed in this ITS plan, the City will need to increase this value to roughly $1.0M a year for the next ten years.
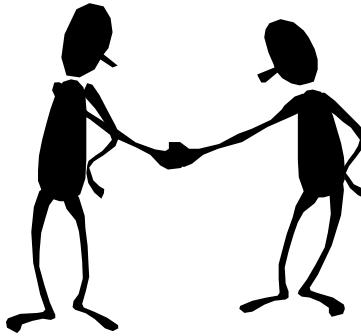
Given today's budget conditions, allocating this amount of money into the City's annual budget would be difficult. However, opportunities exist to use a small portion of local funds to match state or federal grant money. Partnering with local transit agencies on ITS projects can also open additional funding doors. There is also homeland security money available from the federal government for projects that enhance emergency management and surveillance.

Annual ITS Spending

The future of ITS in Bellevue will also rely on the maintenance of this document. The City should reevaluate it's ITS needs every three to five years and update their list of projects and priorities, as well as the Regional Architecture. An updated and evolving plan will better position the City to take advantage of opportunities to deploy ITS projects.

Reevaluate ITS Plan Every 3 - 5 Years: Needs, Prioritized Project List and Regional Architecture

AVL	Automated Vehicle Location
BCC	Bellevue Community College
BNSF	Burlington Northern Santa Fe
CAD	Computer Aided Dispatch
CCTV	Closed Circuit Television
EB	Eastbound
EM	Emergency Management
EOC	Emergency Operations Center
FHWA	Federal Highway Administration
GIS	Geographical Information System
GPS	Global Positioning System
H	High Priority
HAR	Highway Advisory Radio
IM	Information Management
ITS	Intelligent Transportation System
L	Low Priority
M	Medium Priority
MC	Maintenance & Construction
NB	Northbound
O&M	Operations and Maintenance
PSRC	Puget Sound Regional Council
PT	Public Transportation
SB	Southbound
TM	Travel & Traffic Management
TMC	Traffic Management Center
TRPS	Traffic Responsive Pattern Selection
TSP	Transit Signal Priority
U.S. DOT	United States Department of Transportation
VMS	Variable Message Sign
WB	Westbound
WSDOT	Washington State Department of Transportation