Construction Impact Mitigation Report
NEXT GENERATION ITS

Prepared for:

SDOT

Seattle Department of Transportation

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Executive Summary

The City of Seattle recognizes the need to employ strategies to minimize the impacts of construction on the travelling public by establishing the Access Seattle initiative, which focuses on a multi-modal approach for maintaining and improving accessibility into the downtown core. The plan focuses on the use of Intelligent Transportation Systems (ITS) strategies, based on studies showing that ITS tools are a cost-effective way to optimize roadway capacity without investing in major civil improvements. The scope of this construction mitigation plan addresses the anticipated transportation system impacts from the following five major construction projects:

- Alaskan Way Viaduct Replacement / Tunnel
- Elliott Bay Seawall Project
- Waterfront Seattle
- Proposed SODO arena
- Mercer West

While SDOT prepares larger ITS design and procurement packages, quick wins have been recommended as immediate implementation strategies that are anticipated to result in significant benefit. The quick win strategies recommended include, but are not limited to:

- Citywide Bluetooth reader deployment
- Traveler Information Map (TIM) enhancements
- "Access Seattle" mobile application

The larger ITS design and procurement packages require a larger capital investment as well as longer implementation timescales. These projects are assigned chronologically after the quick wins and are divided into separate corridors and geographic areas. Projects are separated into corridors and areas so that implementation would generally be completed prior to the anticipated construction impact. Understanding that SDOT is late in implementing ITS mitigation strategies with many major construction projects already significantly underway, several early projects were slightly delayed to reflect an implementation schedule that is both practical and feasible for SDOT to accomplish. Included in the recommended ITS mitigation projects are the following components and their primary benefits:

- CCTV Cameras: Provides operators with visual access for active management
- Dynamic Message Signs: Provides travelling public with on-route information regarding roadway conditions
- Origin-Destination Trackers: Provides data to provide travel time information for the travelling public.
- Blank-out Signs: Dynamically changes roadway restrictions to facilitate certain modes.
- Signal Re-timing: Adjusts signal timing parameters to adapt to changes in vehicle, pedestrian, and bicycle demands.
- Traffic Detection Systems: Improves operational efficiencies at intersections for vehicles, pedestrians, and bicyclists.

Construction projects typically results in added road closures, traffic detours, and restricted access. In addition to mobility impacts, the actual and perceived impediments to accessing downtown can have a negative economic impact on businesses, tourism, and freight movement, affecting the economic vitality and growth of the city. Without implementing the recommended mitigation strategies, SDOT's transportation system will be unable to keep up with the evolving construction environment, resulting in increased congestion, poor traveler awareness, citizen frustration, and reduced operational efficiencies. The strategies outlined in this report are purposed to alleviate these concerns and provide SDOT with a robust ITS system that will dynamically meet the upcoming needs of all modes during the next 8 years of construction and beyond as well as provide City staff with the necessary tools to proactively manage a complex transportation system.

Section 1:
Major Projects Overview

1. Major Projects Overview

Within the scope of this construction impact mitigation plan, the five major projects considered are:

- Alaskan Way Viaduct Replacement / Tunnel
- Elliott Bay Seawall Project
- Waterfront Seattle
- Proposed SODO Arena
- Mercer West

These projects were selected because they are expected to have the most significant impacts to the transportation system in Seattle's downtown core. Current project schedules indicate that the five identified projects will coincide at varying levels of completion, compounding the impact to the transportation system. There are other, smaller construction projects that will also contribute to the stress on the transportation network: Seattle City Light will replace street lighting along certain corridors and Puget Sound Energy will replace a major gas line during the construction of the tunnel. The impacts of these smaller projects were not included in the impact assessment of this report.

Alaskan Way Viaduct Replacement/Tunnel

The Alaskan Way Viaduct Replacement/Tunnel is a Washington State Department of Transportation (WSDOT) project that will replace the existing SR 99 Alaska Way Viaduct with a 2-mile long bored tunnel beneath the downtown city center. The south portal to the tunnel will be located adjacent to the existing stadiums: Safeco Field and Century Link Field. The north portal of the tunnel will be located near Seattle Center within the vicinity of the existing entrance to the Battery Street Tunnel between South Lake Union and Seattle Center. This project began in 2010 and is expected to continue through to the end of 2013 when the new tunnel will be open to the public. Although the AWV replacement tunnel will be complete in 2015, there will be subsequent work that will take place as part of other major projects to restore the Seattle Waterfront as a result of the viaduct removal.

Elliott Bay Seawall Project

The Elliott Bay Seawall Project is a City project that replaces the existing seawall from S. Washington St to Broad St. The seawall replacement will improve public safety by protecting Seattle's waterfront developments and infrastructure from seismic failure and tidal erosion. The existing wall is over 100 years old and has suffered from corrosion which could lead to a potential disaster should it fail. The Seattle waterfront is a major piece of the city's industrial and cultural history. The vibrant waterfront community includes businesses, residences, and multi-modal transportation facilities, all of which support recreation, tourism, and commerce. As a prerequisite in the redevelopment of Seattle's Waterfront, the Elliott Bay Seawall project will begin in late 2013 and continue through 2015.

Waterfront Seattle

The Waterfront Seattle project is an effort led jointly by the SDOT, the Department of Planning and Development, and the Central Waterfront Committee to revitalize the Seattle Waterfront. The Seawall Replacement and the Alaskan Way Viaduct projects will create new public space along the waterfront for 26 blocks from the Olympic Sculpture Park to Pioneer Square. This new space will be used for parks and paths as well as a new street designed to accommodate multiple modes of travel. The project is currently undergoing environmental review and is estimated to begin construction in early 2016 and be completed in 2019.

Proposed SODO Arena

The proposed SODO Arena project consists of a new sports arena on 1st Ave South between Edgar Martinez Drive and South Holgate Street, south of Safeco Field. The construction of the new arena will have an impact on congestion in the surrounding area. The presence of a new arena may also have an impact on the area's existing industrial land uses as well as the current traffic demand during events. Construction of the arena is contingent upon the City's acquisition of a professional basketball team. However, if constructed, the project is expected to begin mid-year 2014 and be completed by late 2015.

Mercer West

The Mercer West Project consists of the final phase of the City of Seattle's Mercer Corridor project. Mercer West changes the roadway alignment on Mercer Street from Dexter to 5th Ave West to a two way street that will provide east-west connections between I-5 and Elliot Avenue West. This project will provide a crossing across Aurora Avenue and enhance the connection between South Lake Union and Lower Queen Anne , including the Seattle Center. Construction began in April of 2013 and is expected to be completed in the summer of 2015.

Figure 1. Major Construction Projects

Section 2:

Mitigating Construction Effects

2. Mitigating Construction Effects

The primary objective of this task is to develop a strategic mitigation plan that utilizes ITS technologies to offset the cumulative major construction impacts, in accordance to the Access Seattle initiative. The following elements were completed to provide the City with a roadmap to the recommended mitigation strategies:

- Identify construction project schedules and impacts
- Identify impacted corridors
- Identify construction mitigation strategy
- Inventory existing ITS equipment
- Recommend ITS technology and improvements
- Identify implementation projects
- Prioritize projects and provide cost estimates

Construction Project Schedules and Construction Impacts

The first step to identify the impacts of the construction was to evaluate the phasing and schedule of each project to determine anticipated closures and detours.

Project phasing plans and schedules were obtained from the project websites and charted to gain an understanding of the overlaps, parallel, and sequential activities. The identified closures and phasing plans were entered into a GIS map to illustrate the progressions for each project in quarterly time periods (see Appendix A for more details). The GIS maps were reviewed with representatives from the projects to confirm planned closures and predicted impacts to traffic. During this process, impacted roadway segments were defined based on the planned phasing and anticipated diversion routes. One conclusion drawn from these discussions was that the impact area of the construction should not be contained only to the immediate vicinity, and should encompass the arterial streets and corridors affected by traffic diversion. Furthermore, the impact of multiple projects occurring simultaneously would have a compounding effect.

Using the GIS map along with a quarterly snapshot provided an opportunity to cycle through the predicted cumulative impact of multiple construction projects. These were grouped into a series of representative quarters based on when projects, or a major phase, would have significant traffic impacts. This resulted in six impact-based project groupings as shown in Table 1.

Table 1. Impact-Based Projects Groupings

Timescale	Projects Under Construction
Q3 2013	Alaska Way Viaduct, Mercer West
Q4 2013 – Q2 2014	Alaska Way Viaduct, Mercer West, Seawall
Q3 2014	Alaska Way Viaduct, Mercer West, Seawall, SODO Arena
Q4 2014 – Q3 2015	Opening of Tunnel, Mercer West, Seawall, SODO Arena
Q1 2016	Viaduct Demolition, Seawall, SODO Arena, Waterfront Seattle
Q2 2016 – Q4 2016	Waterfront Seattle, Tunnel Surface Street

For each timeframe, the anticipated routes impacted were identified by the cumulative effect. One important finding to note is that the culmination of project impact would reach its peak during 2015 Q4. The GIS maps associated with each timescale are presented in Appendix A.

Another predicted impediment to downtown Seattle access caused by construction is parking capacity. The reduction of available on-street parking may result in a reduction of overall downtown activity. A component of the Seattle Next Generation ITS project addresses parking needs and is further discussed in Task 4.

Impacted Corridors

Table 2 provides a summary of all of the corridors affected by identified construction projects. These have been determined using the criteria mentioned previously. The corridors are separated into three primary geographic areas:

- North: Corridors north of Denny Way
- Central: Corridors between Yesler Way and Denny Way
- South: Corridors south of Yesler Way

Table 2. Affected Corridors

North	Central	South
1st Ave North/ Queen Anne Ave North	1st Ave	1st Ave South
5th Ave North / Valley St	2nd Ave / 4th Ave	4th Ave South
6th Ave North	5th Ave	6th Ave South
Elliot Ave / Western Ave (North of Denny)	Elliot Ave / Western Ave	Yesler Way
Dexter Ave	Stewart St / Howell St / Olive Way	Airport Way South
Denny Way	Marion St / Madison St	
Westlake Ave North		South Spokane St.
Nickerson St.		

The approach to selecting projects was based on the following criteria in order of importance:

1. Proximity of the corridor to one (or more) of the major construction projects
2. Quantity/impact of construction projects affecting the corridor
3. Broadest impact to user types including transit, freight, pedestrians and cyclists
4. Project packaging and scheduling

It was established that focusing on key decision-making points would be considered highest priority, followed by operational necessity. This held true even when an entire corridor may have been impacted by a specific project. Through this strategy and the approach for ITS device placement mentioned previously, cameras, DMS, and LPRs were proposed according to the device maps presented in Appendix B.

Stakeholder Outreach

Several functional stakeholders were identified and contacted to create a better picture of Seattle's transportation infrastructure, system status, and perceived impact of upcoming construction projects. These stakeholders included emergency services, freight mobility, IT, major projects, parking, signal maintenance, signal ops, TMC, tolling, traffic management, and transit. Different departments within the City of Seattle were contacted to give their input and a series of meetings were held to better understand the role each stakeholder would play in the operation of a network. Below is a sample of the department specific questions asked:

- **Freight** - What are the major existing bottlenecks for freight mobility and port traffic within the city?
- **Emergency** - How does your group currently interact with the SDOT TMC and describe the effectiveness of emergency response coordination efforts?
- **Major Projects** - What are you project's known impacts to the surrounding transportation system?
- **Signal Maintenance** – How is the signal maintenance group involved with deploying temporary ITS systems to support the upcoming major construction projects?
- **Parking** - How do you foresee the major construction projects impacting the existing parking facilities within the city?
- **TMC** - Which areas in the transportation network are most impacted by the current construction activities in the City? With the additional major projects that will take place, which areas do you foresee as being impacted the most?
- **Transit** – With the major construction projects that will take place in the City, what type of coordination has taken place between the City and the various transit agencies (KC Metro, Sound Transit, and Community Transit) to maintain or improve transit service?

Construction Impact Mitigation Strategy

Construction Impact mitigation in the next 8 years will be accomplished by providing the traveling public with the information to make the best decisions on travel mode and travel route. The best information will be a combination of advanced notice of potential impacts and real-time traffic conditions. This will be accomplished by deploying adequate ITS field devices within and approaching the impacted areas to collect real-time data and implementing the adequate technologies to communicate information to travelers. Information should reach the traveling public in real-time, on the road, and at the home and office before trips begin. This information should benefit all downtown users and multiple modes of travel (commuters, commercial vehicles, leisure visitors, ferry riders, etc.).

Existing ITS Equipment Inventory

In order to develop a strategic ITS implementation plan, an understanding of the existing ITS system is required. Existing infrastructure and ITS field equipment were inventoried and stored on the GIS tool which was developed as part of this task using data acquired from SDOT's GIS database and city records. The data includes locations of traffic signals, communication systems, CCTV cameras, Dynamic Message Signs (DMS), and License Plate Readers (LPR). Once an understanding of the existing signal and ITS system was achieved, a gap analysis was performed to identify system deficiencies on the impacted corridors.

Recommended ITS Technologies and Improvements

After assessing the traffic impacts of the major construction projects and identifying the construction mitigation strategy, the appropriate ITS technologies and improvements were recommended. The combined use of the following technologies and improvements will allow the successful roll out of the identified strategy in a reasonable time frame and cost:

- **CCTV Cameras**: Provides traffic management operators the ability to monitor incidents and traffic conditions in real-time.

- **Dynamic Message Signs**: Provides the ability to communicate information to travelers (drivers, bicyclists, pedestrians) in real-time.
- **Vehicle ID Technology**: Provides the ability to identify unique vehicles to calculate travel times.
- **Blank-out Signs**: Dynamically prohibits specific movements during a specific conditions
- **Traffic Signal Retiming**: Updates signal timing plans to accommodate current traffic demand (vehicles, bicycles, and pedestrians)
- **Traffic Signal Detection**: Improves a signal system's ability to detect vehicles and bicycles for better operational capability and future upgrade potential.

In addition to what is listed above, adaptive signal control (ASC) was also considered as a mitigation strategy. It is our recommendation that ASC not be deployed for construction mtitgation and that further analysis and modeling should take place to analyze the true benefits from ASC. Task 3 discusses the potential of ASC in detail.

1. CCTV Cameras

Pan-Tilt-Zoom (PTZ) CCTV cameras allow for the active monitoring of traffic conditions and incidents from the Traffic Management Center (TMC). Real-time streaming video of the traffic system is the most useful tool for assessing current traffic conditions and incidents. CCTV video provides the most interpretable and digestible format of information to the public. As part of SDOT's procedures, operators are required to verify incidents through CCTV camera prior to public dissemination. With anticipated increase in traffic as well as continual shifts in construction impacts, additional CCTV coverage is necessary for TMC operators to proactively detect incidents and system irregularities. A more complete and comprehensive CCTV network enhances overall traffic management capability and response.

Typical SDOT PTZ Camera

Deployment Strategy

Given the terrain of downtown Seattle and the number of high-rise buildings, providing full coverage and eliminating all blind spots is not economically feasible in the context of construction impact mitigation; therefore, strategic placement of cameras is essential. The following criteria were used to select locations for camera placement:

- Intersections of identified impacted routes
- Key access/decision points
- Vicinity of at-grade railroad crossings
- High accident locations
- Additional strategic locations

The general strategic pattern for camera placement is a grid array throughout the downtown core at approximately every other intersection.

Benefits

CCTV cameras are SDOT's primary tool used by TMC operators to confirm incidents. More coverage in the existing camera network will be necessary to deploy the defined mitigation strategy. CCTV coverage allows for the quick dissemination of traffic incidents and conditions to the public.

2. Dynamic Message Signs

Dynamic Message Signs (DMS) are effective for providing information to the travelling public "on the streets." DMS are effective because they capture a wide audience including drivers, bicyclists, and pedestrians. Information typically conveyed on a DMS includes delay times, suggested alternate routes, as well as information on closures and incidents. The two main types of DMS are portable and permanent fixtures. Portable signs are typically installed on mobile trailers and are commonly used during construction or event management. Permanent DMS are installed at strategic locations where there is as identified need for specific information. Determining the placement of DMS signs requires a tactical system approach to identify decision points where the displayed information has value to influence a user's route or mode choice.

Deployment Strategy

Several DMS at strategic locations have already been installed in anticipation of the Alaskan Way Viaduct project. Additional DMS locations are recommended to provide users with information at key decision points. These DMS deployments are designed to target travelers approaching the central business district with a few within downtown targeting ferry traffic.

Typical SDOT Dynamic Message Sign

Benefits

Dynamic message signs benefit the travelling public by keeping them informed about major incidents, route-specific information, and advisories. The benefit of DMS is that is can be observed by all roadway users including vehicles, pedestrians and cyclists. During the next 8 years of major construction, DMS will provide the City with the flexibility to post a wide array of messages and proactively communicate to roadway users in the transportation system. One of the largest benefits of DMS in a construction setting is the ability to suggest alternative routes and modes to distribute the roadway volumes to relieve congestion. As such, deployment at key decision points is vital. Where a DMS is strategically located is just as important as the information they convey.

3. Vehicle ID Technologies

There are different vehicle ID technologies available for roadside application. Two popular choices are License Plate Readers (LPR) and Bluetooth sensors. Vehicle identification technologies allow for the match of unique identifiers from two locations to calculate travel times. This information can be shared with the public through DMS, local media, and traveler information sites on the web. A thoroughly deployed vehicle identification network can also provide operators and engineers with valuable origin-destination data for transportation planning and performance measurement.

With a large selection of different roadside device options, SDOT will need to consider deployment cost, ease of installation, and ability to interface with other ITS systems including the SDOT TMC system. Past deployment within the City has predominantly been LPR as they have exhibited a high level of accuracy.

Deployment Strategy

Regardless of the vehicle identification technology selected, we generally recommend that each new DMS include a corresponding set of vehicle identification devices to provide travel time data. Many existing LPR placements are located at corridor limits to capture traffic as it passes into key areas. Gaps in the existing system were considered in the proposed locations of DMS placements and additional locations were considered to provide times at key decision points. As a strategy for quick procurement and deployment, Bluetooth readers have been recommended as they require minimal infrastructure and communication upgrades.

Benefits

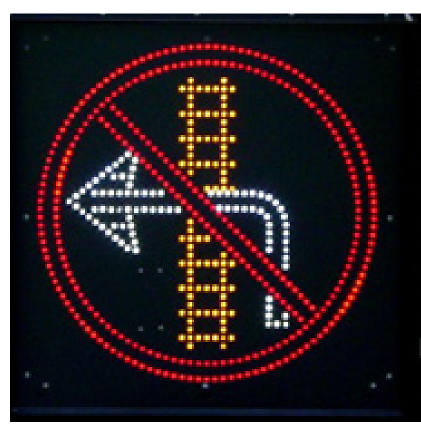
Travel time information is valuable to both traffic operators and the traveling public (including Freight and Public Transport). Corridor performance can be measured in real-time using travel time information, and on the operations side, certain protocols can be triggered when travel times reach a determined threshold. Operators will be able to utilize their given tools to quickly respond to traffic events and conditions (signal timing, emergency response, DMS, etc.). Additionally, publishing travel times in real-time allows the public to make the best route and mode choices based on the most up to date information available.

4. Blank Out Signs

Electronic blank-out signs are dynamic signs with one dedicated message and can be controlled through various methods such as signal controller actuation or contact closures. These signs are commonly used in locations where there is a specific message that needs to be conveyed during a specific condition or time of day, rather than at all times.

Deployment Strategy

One of the other challenges identified through the SODO area is the delay caused by the various modes of transportation coming together in the same area. At-grade crossings of trains with other vehicles are a major concern for traffic operations. Advanced notice blank-out signs integrated with the rail crossing systems are an effective means of prohibiting movements onto blocked roadways. This could help mitigate the queuing that can occur at a railroad crossing. This will provide advanced warning to travelers when a rail crossing is closed and encourage users to take alternate routes. Placements of these signs will primarily



Typical Blank Out Sign

be for turning movements where the rail crossing may not be visible. Blank out signs will also be used to restrict turning movements at intersections with high pedestrian movements. This strategy will improve pedestrian safety at high pedestrian volume intersections and minimize congestion created by vehicles waiting to turn. In addition to rail crossings, we recommend blank out signals to re-enforce a "NO RIGHT ON RED" restriction where heavy pedestrian activity is experienced. Blank-out signs are a relatively low cost option for a location that requires one active dedicated message. DMS may be considered at locations where there would be a benefit to multiple dynamic messaging.

Benefits

Blank-out signs can significantly enhance message importance (such as NO RIGHT ON RED) when compared to traditional static signs. The dynamic sign uses a more active approach to tell the motorist if the governing condition exists rather than what to do when the condition might exist. The Blank-out sign uses the active approach to tell the motorist if the governing condition currently exists, rather than what to do when a condition might exists. Blank-out signs are a relatively low cost option for a location that requires one active dedicated message. DMS may be considered at locations where there would be a benefit to multiple dynamic messaging.

5. Traffic Signal Retiming

The traffic signals within the study area are predominately operated in fixed time (time-of-day) plans (see Task 3). The signals were last re-timed in 2008/2009 and do not account for the change in demand since nor the impacts caused by construction already underway. Fixed plans do not cope well with changing traffic patterns and many locations already do not handle existing traffic efficiently. Changing traffic signals to a more responsive solution such as Adaptive Signal Control is very capital-intensive and is not recommended as a construction mitigation strategy. Retiming existing plans to accommodate predicted demand changes is a more cost effective option to make existing traffic signals operate more efficiently.

Deployment Strategy

Three different timing options have been considered for deployment at almost 400 signals in the central business district:

1. Retime large areas with closely-linked signals
2. Retime signal corridors to "meter" traffic approaching the CBD by increasing the wait times at key intersections in order to minimize the effect on the core intersections
3. Introduce a Leading Pedestrian Interval (LPI), which delays a right or left turn for 3-5 seconds while crossing pedestrians have an opportunity to enter the crosswalk and increase their visibility to turning traffic

Options 1 and 2 both require substantial effort for data collection and modeling but yield more widespread results. Option 1 requires a large number of linked intersections so it will be deployed in the CBD core, where efficiencies in data collection and the close inter-relationship of all major corridors make it the most viable option. Option 2 will be deployed in three areas on major corridors entering the CBD. Option 3 will be deployed at selected locations in the CBD where high pedestrian and turning vehicle volumes create conflict points that require mitigation.

Benefit

Options 1 and 2, while being resource-intensive, allow for substantial gains in efficiency without impacts to traffic (i.e., from construction). Their primary drawback is that this efficiency fades over time as traffic flows shift, in particular with shifting construction impact areas, and may require constant revision. Option 3 allows for increased pedestrian safety at crossing points, with only nominal impacts to vehicle efficiency.

6. Traffic Signal Detection

Historically, there has been limited vehicle detection deployed at intersections in downtown Seattle because they operate on fixed timing. There are several opportunities to supplement this limited detection for specific target groups (i.e., cyclists, pedestrians, high left turning volumes). Detection can be installed on a temporary basis and shifted as needs change due to construction. These supplemental detection options include quadrupole loops for bicycle detection, passive pedestrian detection, and temporary video detection.

Deployment Strategy

Temporary video detection will be deployed where volumes are expected to shift or additional detection would allow for a signal to operate more efficiently. The temporary nature of the recommended video detection system allows it to be relocated to new intersections as volumes due to construction activity shift. Pedestrian detection systems will be deployed where moderately high pedestrian volumes exist, particularly in locations where there is potential for slow-moving or distracted pedestrians (such as tourists on the waterfront). The pedestrian detection can be configured to influence signal phasing/timing. Bicycle traffic will be better detected with the use of quadrupole loops on identified bicycle routes.

Benefit

Supplemental detection options provide a number of benefits to their targeted groups and overall mobility. Temporary video detection can increase the ability of an intersection to react to changing flows, and to make phasing more efficient. Pedestrian detection has benefits to safety and efficiency by extending walk phases for slow pedestrians, calling a walk phase for pedestrians who have not pressed the push-button, and canceling a call for pedestrians who leave the crossing. Likewise, quadrupole loops have benefits to safety and efficiency for cyclists by providing more reliable detection on bike facilities.

Section 3:
Projects

3. Projects

Project Descriptions

1. Bluetooth Reader Pilot Project (2013 Q3)

The Bluetooth reader pilot project will test the accuracy and reliability of Bluetooth readers to produce travel times. The project results will determine whether or not Bluetooth readers are a viable alternative to LPRs. Compared to LPRs, the Bluetooth readers will be assessed for cost, ease of operation, and ease of installation.

Project Components:

Bluetooth Readers: 10

Project Cost:............. $70,000

2. Access Seattle Mobile Application (2013 Q3)

The project will create a mobile phone application called "Access Seattle" that pulls construction-staging data, TIM, project staging and construction timetables, as well as real time transit information. This application would allow users to access information about what to expect in terms of current and future detours and road closures. The application will provide users with routes to navigate through Seattle while avoiding congestion. Additionally, the application could automatically push information to users about certain routes they personally "subscribe" to.

Project Cost:............. $350,000

3. Center City Active Traffic Management (2014 Q1)

The project will install 75 Bluetooth readers and 8 DMS on selected corridors allowing the City to obtain time stamped vehicle location data such that travel times can be calculated and disseminated. This travel time information can provide both passenger travelers and freight/commercial vehicles with travel information to be used at key decision making points for selecting alternate routes, enticing modal change and influencing traffic demand. Travel time information can be displayed on DMS, TIM, and the "Access Seattle" Mobile Application. This information allows roadway users to make better decisions resulting in a reduction of congestion on major corridors as well as enhanced pedestrian and bicycle safety. The travel time data is also a valuable insight into network performance for the Traffic Management Center and can be used to increase speed of incident response, assist in signal timing efforts, corridor optimization and transit reliability. High priority candidates for Bluetooth reader installation are: 1st Ave S, 1St Ave, 4th Ave, 2nd Ave, Broad Street, Mercer Street, E Marginal Way, Spokane, Denny Way and Alaskan Way.

Project Components:

Bluetooth Readers: ... 75

DMS: 8

Project Cost: $3,800,000

4. Center City Dynamic Signal Timing (2014 Q1)

Travel demand through the Center City is expected to fluctuate during construction of major projects. Dynamic signal timing patterns can be implemented to respond in real-time to accommodate the changing demand. Expected improvements include reduced travel times on primary corridors through the Center City, quicker access to freeways, and increased transit service reliability. Corridor and locations considered for signal timing upgrades include Denny Way, SODO, Capitol Hill, South Lake Union, Queen Anne, and Central CBD.

Project Components

Signal Retiming: 300

Signal Equipment Upgrades: 20

Project Cost: $1,350,000

5. Center City Traffic Camera Deployment (2014 Q1)

This project will install CCTV cameras on major routes into the Center City; specifically on Alaskan Way, 1st, 2nd, 4th, and 5th Avenues. This project will increase the coverage within the Center City to monitor traffic and assess traffic management strategies. Emergency responders will be allowed access to the camera images.

Project Components

CCTV Cameras 64

Project Cost: $1,900,000

6. Railroad Crossing Information Signs (2014 Q1)

This project will install blank-out signs at signalized intersections adjacent to major east-west railroad crossings at Broad St, S Atlantic St, S Spokane St, Lander St, and S Holgate St. These signs will lessen queues at the crossing gates and provide advanced warning of the temporary closure to approaching traffic including emergency responders.

Project Components

LED Blank-out Signs .. 20

Project Cost: $435,000

7. Ferry Arrival Signal Preemption (2014 Q1)

This project will provide SDOT with the capability to obtain and use real-time vehicle capacity data from Washington State Ferries to efficiently clear ferry traffic. This data will be used to automatically select and implement the appropriate signal timing plan for Marion Street upon ferry disembarkation. Blank-out signs will inform drivers on Alaskan Way, Western Ave, 1st Ave, and 2nd Ave of ferry arrival and the estimated duration of the delay. Turn restrictions may also be triggered along the Marion Street corridor.

Project Cost: $80,000

8. Spot ITS Improvements (2014 Q1)

This project will install DMS, Bluetooth (or LPR readers), and CCTV cameras on major routes into the Center City; specifically at Elliott Ave W/W Mercer Pl in Interbay, Delridge Way SW in West Seattle, W Marginal Way S in South Park, and Airport Way S/S Lander St in South Seattle. These devices will allow SDOT to provide travel time and incident information to travelers of these major routes.

Project Components

CCTV Cameras: 25

Bluetooth/ LPR Readers: 12

DMS: 5

Project Cost: $2,800,000

9. Denny Way ITS (2014 Q3)

The Denny Way corridor between I-5 and Western Avenue carries a large percentage of general purpose traffic and freight and distributes it onto major north-south corridors including I-5 and 1st, 2nd, and 5th Avenues. Upgraded signals, vehicle detection, traffic cameras, dynamic message signs, and fiber communication will be installed on Denny Way to improve traffic flow and provide enhanced traveler information. A system engineering evaluation will be completed to determine if adaptive signal control should be included as part of the project.

Project Components

CCTV Cameras: 6

DMS: 1

Signal Upgrades: 14

Project Cost: $4,315,000

10. South Spokane Street ITS (2015 Q1)

Bluetooth readers and dynamic message signs will be installed on South Spokane Street from Airport Way to Terminals 5 and 18 (Port of Seattle) to provide travel times. This is an important corridor for freight traffic. The project will provide travel information for trucks with destinations north of Seattle.

Project Components

Bluetooth Readers: 20

DMS 1

Project Cost:.............. $665,000

11. 1st Avenue South ITS (2015 Q1)

1st Ave S between S Spokane St and East Marginal Way is important for movement of freight and access to the stadium area. Traffic responsive signal operation will be extended on this segment of 1st Ave. This will involve upgrading signals and installing vehicle detection, fiber communication, and traffic cameras.

Project Components

CCTV Cameras:......... 3

Signal Upgrades: 5

Project Cost:.............. $1,590,000

12. South Michigan Street ITS (2015 Q2)

Bluetooth readers and traffic cameras will be installed along S Michigan Street between East Marginal Way S and Carleton Avenue S to provide general purpose traffic and freight information for travel through Georgetown, I-5, SR 509, and SR 99. Signals will be upgraded and vehicle detection and fiber communication will be installed.

Project Components

CCTV Cameras:......... 6

Bluetooth Readers: 8

Signal Upgrades: 5

Project Cost:.............. $1,600,500

13. Nickerson/Westlake ITS (2015 Q1)

This project will install Bluetooth readers on the W Nickerson St/Westlake Ave N corridor that links Ballard's industrial area to South Lake Union and I-5. Ten Bluetooth readers will be installed on portions of 15th Ave W, W Nickerson St, Westlake Ave N, Mercer Street, and Fremont Avenue North to provide travel time information on the corridor.

Project Components

Bluetooth Readers: 10

Project Cost:.............. $50,000

Supplemental Project Descriptions

14. 1st Avenue CBD ITS (2013 Q4)

It is anticipated that 1st Avenue will be most severely impacted from major construction consistently throughout the next 8 years. This corridor has close proximity to SR 99 and the Seattle waterfront, so it is one of the first corridors that many roadway users consider as an alternative for north-south connectivity. It is highly congested at present time and will require investment just to maintain existing performance. This project will install CCTV cameras to help City staff monitor congestion and detect incidents along 1st Avenue. Due to this corridor's proximity to the Colman Dock, it will also include DMS installations SB at Spring St and Marion St to inform the public on queuing conditions at the ferry terminal. Finally, blank-out lane control signs to ban right turns during heavy pedestrian flows will be installed at 3 locations along the corridor – tentatively placed at Yesler, University, and Pike Streets pending further evaluation. By banning right turns, crossing pedestrians face fewer conflicts while through vehicle traffic on 1st Avenue has less friction.

Project Components

CCTV Cameras:......... 10

DMS:......................... 2

LED Blank-out Signs: . 3

Project Cost:............. $551,000

15. Alaskan Way ITS (2013 Q4)

Alaskan Way and the Elliott Bay Trail along the waterfront will have frequent demand changes impacting motorists, freight, pedestrians, and bicyclists from the waterfront and SR 99 projects. Four CCTV cameras will be installed along Alaskan Way to monitor these frequently changing conditions. This area is also isolated from other City surveillance by the viaduct so the new cameras are required for the City to monitor traffic along the waterfront. An additional camera will be installed on Columbia St to aid transit exiting SR 99 to access 3rd Ave. Temporary passive pedestrian detection will be installed at two locations along the waterfront to make pedestrian crossings safer and more efficient. These installations are envisioned for University St and Pike St but will require further evaluation to finalize.

Adaptive signal control is not recommended for Alaskan Way; see the Task 3 report for more details.

Project Components

CCTV Cameras:......... 5

DMS .... -

Passive Pedestrian Detection: 2

Project Cost:............. $72,500

16. Citywide LPR Deployment (2013 Q4)

The City's existing LPR network will be bolstered with the deployment of 21 additional readers in one rollout. These additional readers will add some missing coverage on southern approaches to the CBD. They will further set up cordons along Denny Way at the north edge of the CBD and between University and Seneca Streets in the middle of the CBD. This expanded coverage will provide better data on travel habits through the CBD and as well as travel times on most major north-south arterials. Deployment of the LPRs is necessary before substantial rollout of DMSs in other projects in order to produce travel times. It has also been placed early in the overall program schedule because data from the LPRs will be beneficial for the traffic signal retiming scheduled for 2014 Q1.

Project Components

CCTV Cameras:......... 0

DMS:......................... 0

LPR: 21

Project Cost:............. $1,827,000

17. SODO Phase 1 ITS (2014 Q1)

The SODO Phase 1 ITS will include an area-wide deployment of CCTV cameras and DMS in the area bounded by Yesler Way, 1st Avenue S, 4th Avenue S, and Spokane St. It will also install blank-out signs at signalized intersections adjacent to major east-west railroad crossings at S Atlantic St, S Spokane St, Lander St, and S Holgate St; these signs will reduce queuing at the crossing gates and provide advanced warning to oncoming traffic of the temporary closure. Temporary solar-powered flashing warning signs for pedestrians and cyclists will be installed on E Marginal Way S adjacent to construction haul routes and mobilization yards for SODO projects. This project will also include S. Dearborn St as it provides connections to I-5 from the SODO area. Providing arterial connections into Seattle from the south, 1st Ave S and 4th Ave S are important corridors to improve traffic monitoring capabilities through the use of CCTV cameras as well as inform roadway users of construction impacts in the CBD. Additionally, ITS upgrades in the SODO area will also help to improve efficiencies for freight movement.

Project Components

CCTV Cameras:......... 19

DMS:......................... 2

LED Blank-out Signs:. 8

Temporary
Warning Signs:........... 4

Project Cost:............. $870,000

18. Mercer ITS (2014 Q2)

The Mercer ITS project will include CCTV cameras and DMS upgrades in the area bounded by 5th Avenue N, Roy St, Westlake Ave N, and Denny Way. This project will provide ITS upgrades primarily on 5th Ave N, Dexter Ave N, and Westlake Ave N, which are the major corridors impacted by the Mercer West and SR 99 projects. The additional CCTV cameras provide monitoring of north-south arterials that do not currently exist. The arterial DMS will provide travel time and incident information to motorists before they reach decision points at Denny Way. It is most important that this project be implemented prior to the Broad St closure of the SR 99 North Portal construction in Q3 of 2014 as this closure will have major impacts.

Project Components

CCTV Cameras:......... 5

DMS:......................... 3

Project Cost:............. $493,000

19. I-5 Connector ITS (2014 Q2)

The I-5 Connector ITS project covers the streets that provide CBD access to/from I-5/90: Union, University, Seneca, Spring and James Streets. It will install CCTV cameras along these streets to provide congestion monitoring of traffic interchanging with the freeways. The cameras will be installed primarily at existing signalized intersections and provide fuller coverage of the steep grades along these streets. These freeway accesses relieve longer-distance freight and motorist traffic that might otherwise use SR 99 to northern and southern destinations.

Project Components

CCTV Cameras:......... 6

Project Cost:............. $188,500

20. 2nd Avenue CBD ITS (2014 Q3)

It is anticipated that 2nd Ave, similar to 1st Ave, will be highly utilized as a southbound corridor through the CBD. This corridor will serve as an alternative southbound connector for SR 99 and 1st Avenue. This project will install CCTV cameras to help City staff monitor congestion and detect incidents along 2ndAvenue. DMS will also be installed along this corridor to inform travelers of ferry terminal conditions. Finally, three blank-out lane control signs to ban turns during heavy pedestrian flows will be installed at University, Pike, and Pine Streets pending further evaluation. By banning turns, crossing pedestrians face fewer conflicts while through vehicle traffic on 2nd Avenue has less friction from stopped turning traffic.

Project Components

CCTV Cameras: 9

DMS:......................... 1

LED Blank-out Signs:. 3

Project Cost:............. $290,000

21. 4th Avenue CBD ITS (2014 Q3)

4th Avenue is expected to operate with similar characteristic as 2nd Avenue, providing northbound connections through the CBD. This corridor will serve as an alternative northbound connector for SR 99 and 1st Avenue. This project will install CCTV cameras to help City staff monitor congestion and detect for incidents along 4th Avenue as well as DMS to inform travelers of ferry terminal conditions. Two blank-out lane control signs to ban turns during heavy pedestrian flows will be installed at Pike and Pine Streets pending further evaluation. By banning turns, crossing pedestrians face fewer conflicts while through traffic on 4th Avenue has less friction from stopped turning traffic.

Project Components

CCTV Cameras:......... 10

DMS:......................... 2

LED Blank-out Signs:. 2

Project Cost:............. $493,000

22. Belltown ITS (2014 Q4)

The Belltown ITS grouping primarily covers Western Avenue and Elliott Avenue. As a major north-south corridor that serves as a convenient alternative to Alaskan Way traffic, Western and Elliott will experience higher demands. The implementation of CCTV cameras will be the primary ITS strategy to monitor traffic in this corridor. A DMS will be installed on Elliott Avenue W at approximately W. Harrison St. Although just outside of the Belltown neighborhood, this DMS is placed strategically to provide information before the key decision point at Denny Way and Western Avenue. By displaying travel times, incidents, and event notifications, the DMS can help travelers make more informed choices. Solar-powered flashing warning signs for pedestrians and cyclists will be installed adjacent to construction haul routes and mobilization yards. Finally, a blank-out sign will be installed at Broad St and Elliott Ave; this sign will reduce queues at the crossing gates and provide advanced warning to approaching traffic when a train is crossing.

Project Components

CCTV Cameras:......... 8

DMS:......................... 1

LED Blank-out Sign:... 1

Temporary
Warning Signs:........... 4

Project Cost: $377,000

23. Denny Triangle ITS (2015 Q1)

CCTV cameras will be installed along Westlake, Stewart, Olive, and Howell corridors. Implementation of this grouping will allow for improved video monitoring and traffic management capabilities. This will help improve flow for traffic entering the CBD on Stewart St and exiting the CBD via Olive Way to the east and Howell St to I-5. It also improves monitoring of vehicle and streetcar traffic along Westlake Ave. CCTVs will be installed at existing signalized intersections. Additional fiber optics may be required along Olive Way. A blank-out lane control sign to prohibit left turns (except transit) during heavy pedestrian flows will be installed on Stewart St at 5th Ave pending further evaluation. By prohibiting turns, pedestrians crossing around McGraw Square face fewer conflicts while through traffic on Stewart St have less friction. These corridors provide the primary access to the CBD, north I-5 and South Lake Union, as well as a detour route for Mercer St traffic during Mercer West construction closures.

Project Components

CCTV Cameras:......... 7

DMS:......................... 0

LED Blank-out Sign:... 1

Project Cost:............. $464,000

24. 5th Avenue ITS (2015 Q2)

The 5th Avenue corridor through the CBD from S. Dearborn St to Olive Way will have CCTV cameras installed. This provides congestion monitoring of southbound traffic traversing the CBD as well as a high volume of southbound suburban and regional buses. Two blank-out lane control signs to prohibit turns during heavy pedestrian flows will be installed at Pike and Pine Streets pending further evaluation. By prohibiting turns, crossing pedestrians face fewer conflicts while through traffic on 5th Avenue has less friction. 5th Ave provides an alternative southbound route when construction impacts SR 99, 1st Ave, and 4th Ave.

Project Components

CCTV Cameras:......... 9

DMS:......................... 0

LED Blank-out Signs:. 2

Project Cost:............. $174,000

25. SODO Phase 2 ITS (2015 Q3)

The SODO Phase 2 ITS will include ITS upgrades along 6th Ave S and Airport Way S. Due to impacts from the Arena project, traffic is expected to divert to these two north-south corridors. In addition to providing north-south connectivity, Airport Way also serves as one of the major alternate routes to I-5. With the cumulative impacts of projects anticipated in Quarter 4 of 2015, Airport Way S will attract many more users. Airport Way S is also identified as a future bicycle route into the CBD so bicycle detection will be installed as necessary for bicycle detection at major intersections along Airport Way S – S Lander St, S Holgate St, Maynard Ave S, 6th Ave S.

Project Components

CCTV Cameras:......... 8

DMS:......................... 2

Quadrupole
Loop Installation:........ 8+/-

Project Cost:.............. $681,500

Project Prioritization and Cost Estimates

The projects implementing the recommended ITS technologies need to be prioritized considering operational and logistical criteria. The approach to prioritizing the ITS deployments was based on the composite construction impact maps presented in Appendix A. Ideally, all planned elements along a corridor would be implemented in advance of the anticipated impact. Based on the significant impacts anticipated in the short term, other factors had to be considered for prioritization to account for lost time. It is important to note that many of the major construction projects underway have already introduced impacts- this includes The Alaska Way Viaduct project, Mercer West project, and preparations for the seawall replacement. Because this is not an ideal situation, an aggressive deployment schedule has been proposed to first catch up and get ahead of the existing construction.

By reviewing the construction scheduling and using the GIS tool, it was apparent that all improvements should be implemented prior to Q4 of 2015 as all major projects have construction occurring at that time.

Table 3. ITS Projects Implementation Schedule Summary

Project Name	2013		2014				2015		
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
1. Bluetooth Reader Pilot Project	X								
2. Access Seattle Mobile App	X								
3. CBD Active Traffic Management			X						
4. CBD Dynamic Signal Timing			X						
5. CBD Traffic Camera Deployment			X						
6. Railroad Crossing Information Signs			X						
7. Colman Dock Ferry Arrival Information			X						
8. Spot ITS Improvements			X						
9. Denny Way ITS					X				
10. South Spokane Street ITS							X		
11. 1st Avenue South ITS							X		
12. South Michigan Street ITS								X	
13. Nickerson/Westlake ITS							X		
Supplemental Project Name									
14. 1st Avenue CBD ITS		X							
15. Alaskan Way ITS		X							
16. Citywide LPR Deployment		X							
17. SODO Phase 1 ITS			X						
18. Mercer ITS				X					
19. I-5 Connector ITS				X					
20. 2nd Avenue CBD ITS					X				
21. 4th Avenue CBD ITS					X				
22. Belltown ITS						X			
23. Denny Triangle ITS							X		
24. 5th Avenue ITS								X	
25. SODO Phase 2 ITS									X

Table 4. ITS Projects Cost Summary

Project Name	Project Cost
1. Bluetooth Reader Pilot Project	$70,000
2. Access Seattle Mobile App	$350,000
3. CBD Active Traffic Management	$3,800,000
4. CBD Dynamic Signal Timing	$1,350,000
5. CBD Traffic Camera Deployment	$1,900,000
6. Railroad Crossing Information Signs	$435,000
7. Colman Dock Ferry Arrival Information	$80,000
8. Spot ITS Improvements	$2,800,000
9. Denny Way ITS	$4,315,000
10. South Spokane Street ITS	$665,000
11. 1st Avenue South ITS	$1,590,000
12. South Michigan Street ITS	$1,600,500
13. Nickerson/Westlake ITS	$50,000
Supplemental Project Name	
14. 1st Avenue CBD ITS	$551,000
15. Alaskan Way ITS	$72,500
16. Citywide LPR Deployment	$1,827,000
17. SODO Phase 1 ITS	$870,000
18. Mercer ITS	$493,000
19. I-5 Connector ITS	$188,500
20. 2nd Avenue CBD ITS	$290,000
21. 4th Avenue CBD ITS	$493,000
22. Belltown ITS	$377,000
23. Denny Triangle ITS	$464,000
24. 5th Avenue ITS	$174,000
25. SODO Phase 2 ITS	$681,500

Figure 2. ITS Mitigation Projects

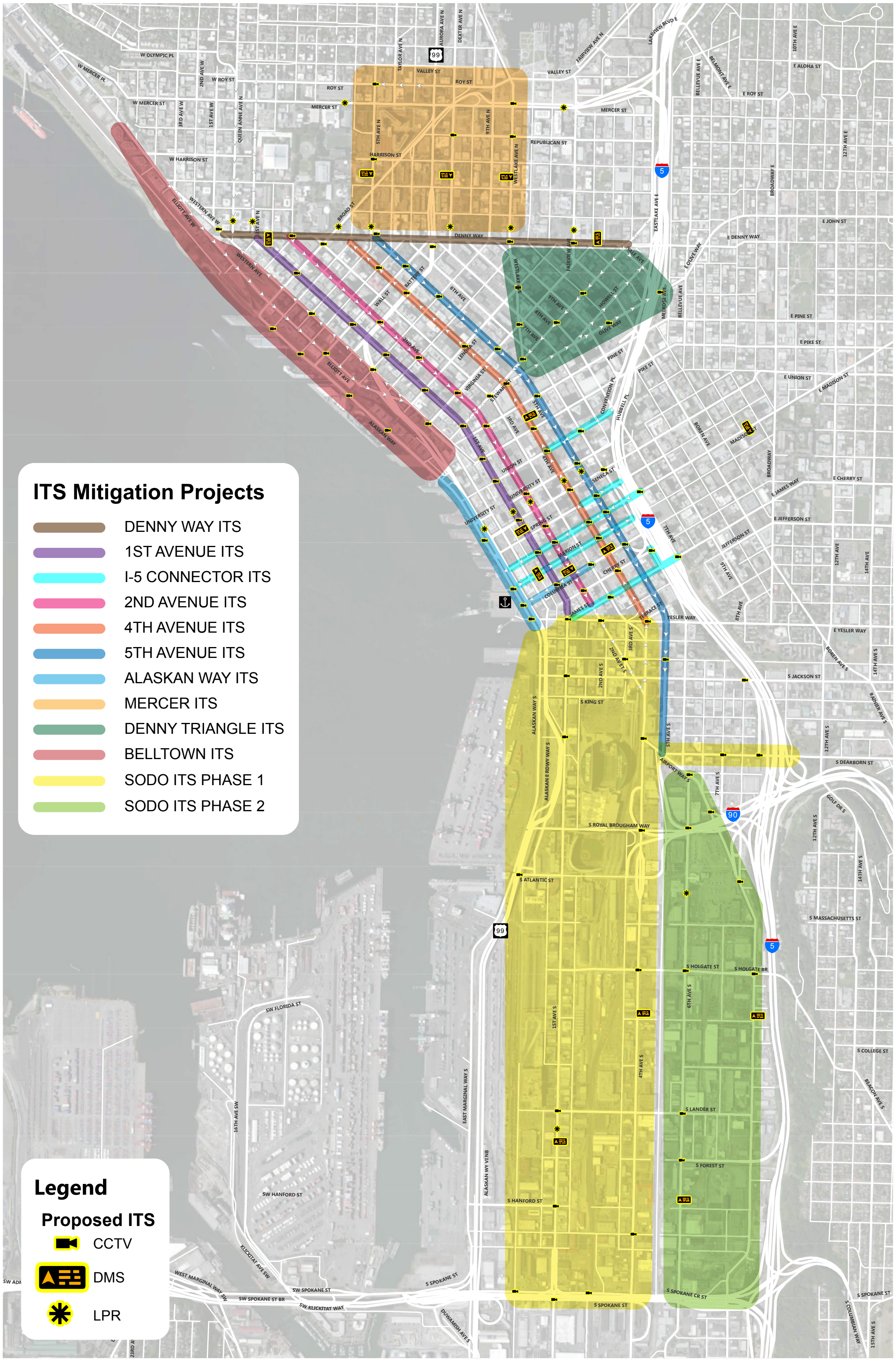


Figure 3. Construction Impacts (Q3 2013)

Figure 4. Construction Impacts (Q4 2013 - Q2 2014)

Figure 5. Construction Impacts (Q3 – 2014)

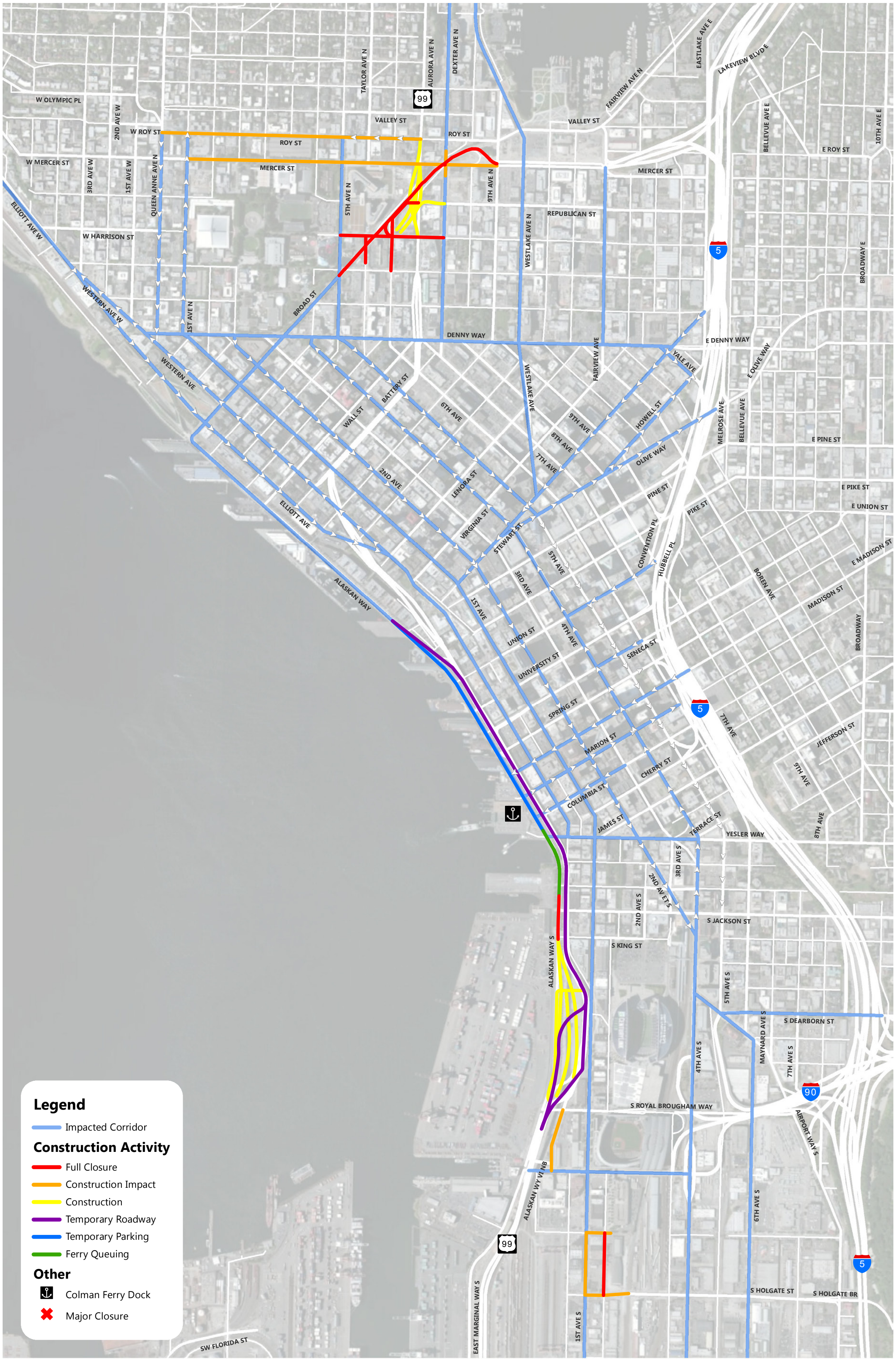


Figure 6. Construction Impacts (Q4 2014 - Q3 2015)

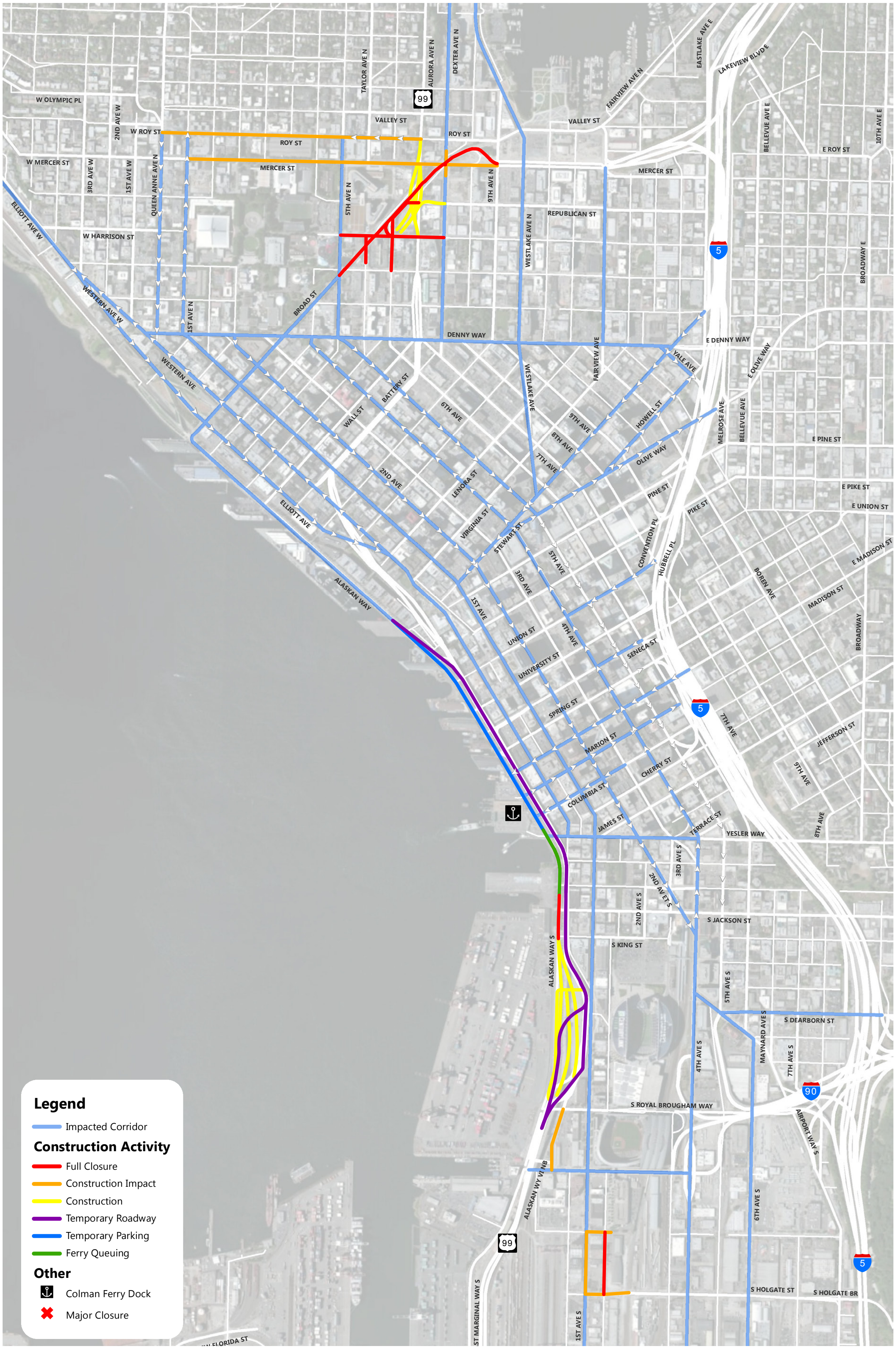


Figure 7. Construction Impacts (Q4 – 2015)

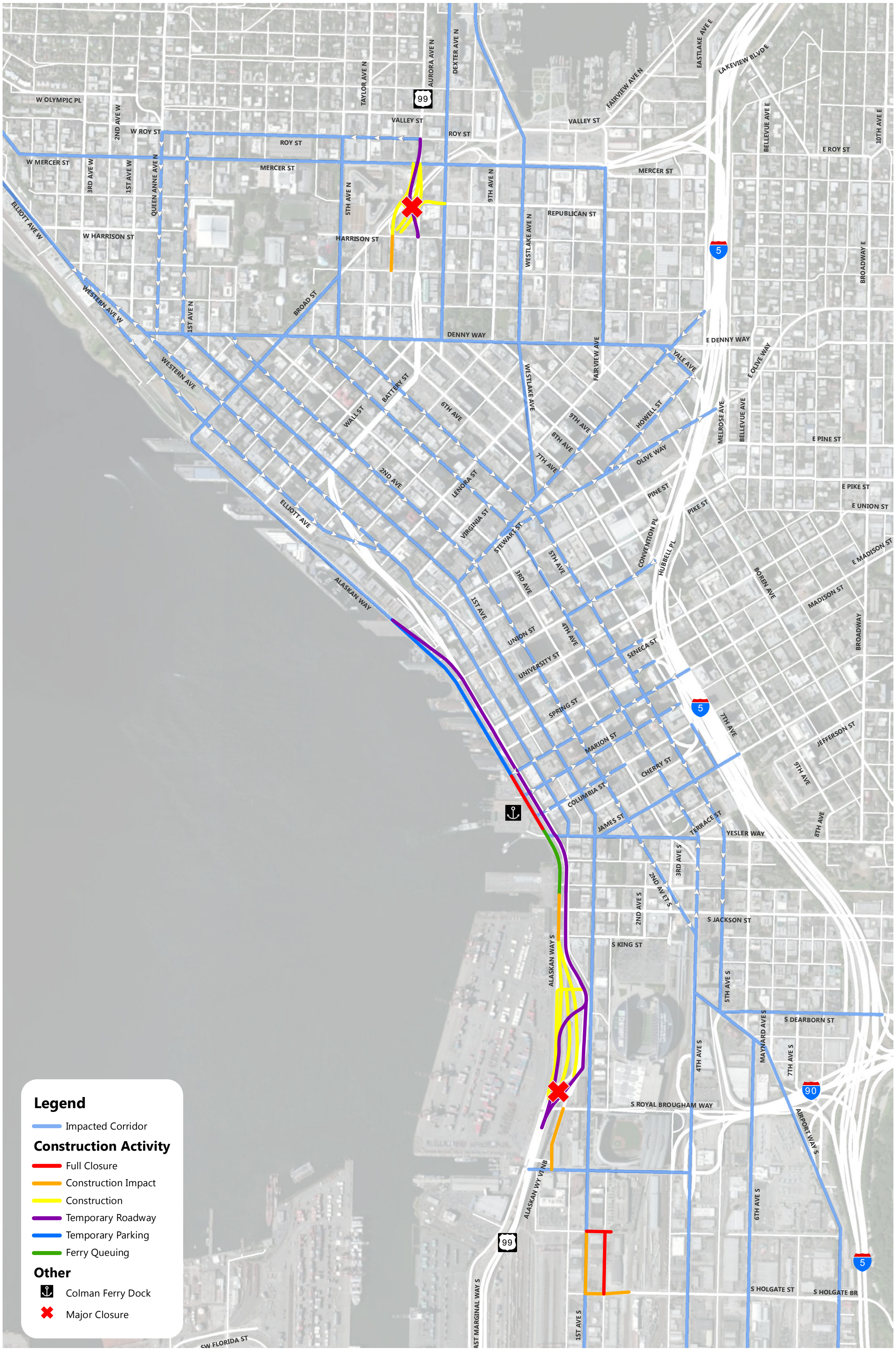


Figure 8. Construction Impacts (Q1 2016)

Figure 9. Construction Impacts (Q2 2016 - Q4 2016)

Figure 10. Construction Impacts (Q1 2017 - Q2 2018)

Section 4:
Recommendations

4. Recommendations

Following the above discussion, project identification and prioritization, the following high level recommendations are being made as part of the delivery of this Task:

ITS Projects

The Project Implementation Schedule (Table 3) does not completely align with when the corridors are impacted; however, this takes into account the City's best efforts in obtaining necessary budget, establishing RFP's, awarding contracts, and carrying out work. It is our recommendation that this schedule be followed as closely as possible in order to minimize the effects of construction.

Signal Timing

In conjunction with the implementation of ITS technology, a series of signal retiming efforts should be considered in the CBD at locations where the network has reached saturation. These timing efforts should be carried out in-house utilizing existing resources, using current and forecasted traffic data.

Back Office Requirements

The necessary improvements to the existing TMC / Back Office should be in place to support the ITS deployments immediately as they come on line. This includes additional staffing and the upgrade of the existing video wall. Implemented ITS will not be used to its full potential without these improvements. These requirements are discussed further in Task 2 and also recommended here to highlight its importance.

Geographical Information System

The GIS system should be improved and maintained. This can occur by integrating the system with current SDOT GIS systems or by introducing additional construction projects and impacted corridors. This effort will provide a tool for the City to gauge whether current and future deployed ITS strategies are adequate for construction mitigation and possibly identify any gaps in the system.

Appendix A:
GIS Tool Description

Appendix A: GIS Tool Description

Geographical Information System (GIS) Tool Description

To assist in the complex task of identifying impacted corridors, the timeframe in which those impacts occur, and development of the ITS mitigation strategies, an interactive Geographic Information System (GIS) map was created to display all construction projects through their different phasing on one platform noting overlaps, and highlighting major closures.

GIS is a digital mapping system that allows for relation of physical points, lines or polygons with metadata, in this case construction activities and time. The interactive layered nature of a GIS platform allows for construction phasing data to be entered and the impacts measured in an interactive manner without the need to resort to lengthy documentation and large static maps.

GIS Tool Purpose

The large number of major projects, unprecedented project overlap, and long timelines of these projects made the GIS tool critical to the project approach. Major construction projects, impacted corridors and the proposed ITS mitigation projects were mapped with time metadata. This allows for the use of a time slider in to advance or reverse through time while viewing all data sources.

The inventory taken for all ITS field devices and systems (such as existing CCTV cameras, existing DMS, existing LPR, existing Fiber and existing copper) was stored within this tool to provide SDOT with a single point of reference. Once ITS projects were identified, future ITS field devices and systems were also stored within this tool.

Using this GIS tool, a user can advance through time using the time slider. The different projects phasing's are displayed and the impacted routes highlighted. Along with the highlighted routes, ITS field devices are displayed in the priority and time frame they should be in place.

Tool Development

The GIS tool was developed using construction phasing documentation and stakeholder interviews. First, construction activities and closure dates were coded into the GIS tool for each project Construction activities from full roadway closures to temporary parking were coded and given a start and end date by quarter and year. This was done for all five major projects.

The interactive GIS tool was then used to identify major changes in construction activities and which downtown corridors would be most impacted. As the number of projects and their impacts increase from 2013 up till 2016 additional corridors are impacted. Identification of the impacted corridors and the time in which they are impacted was then used to identify, prioritize and create a phased ITS implementation plan.

Future Possible Uses

This tool will give SDOT staff an “easy to use” platform to understand and plan into the future. Where this tool contains the 5 major projects currently ongoing and planned, SDOT can continue to develop the construction, impacted corridors and ITS plan as new projects such as utility work or lighting are planned. This tool could also be used to quickly communicate construction phasing and ITS mitigation strategies to policy makers or the public.

Another use would be with 3rd party data integration. As identified within this report, one of our quick win recommendations was to integrate 3rd party data such as that from INRIX with current SDOT systems. This data, if fed directly into the GIS map, can highlight Network Performance. Using the same time slider can provide a means to measure how successful the ITS deployment strategies have been in relation to the current network performance.

Appendix B:
Proposed ITS Devices

Figure 11. Proposed DMS and LPRs

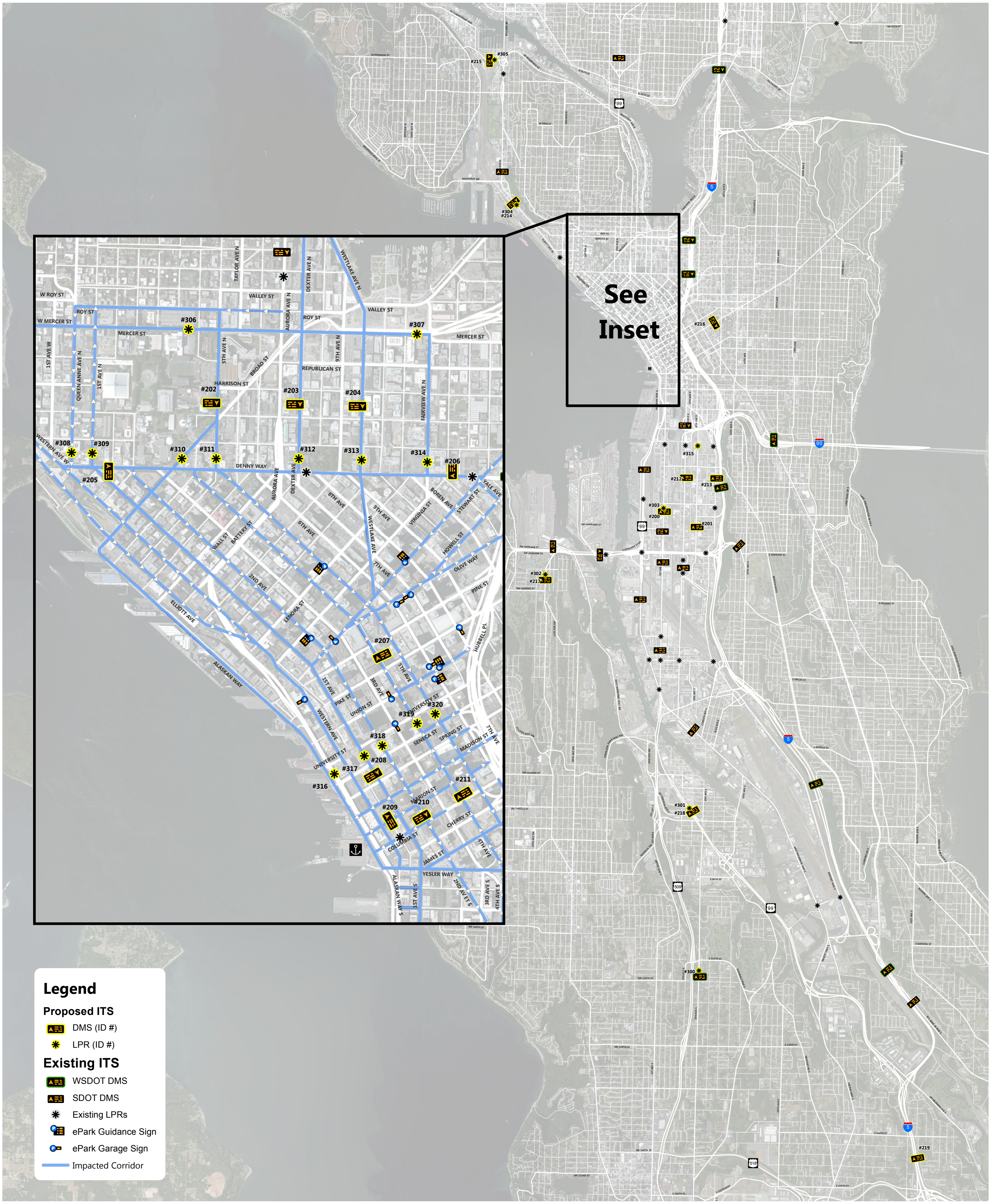


Figure 12. Proposed CCTVs