City of Tacoma

Tideflats Intelligent Transportation System Engineering and Implementation Plan

January 27, 2017

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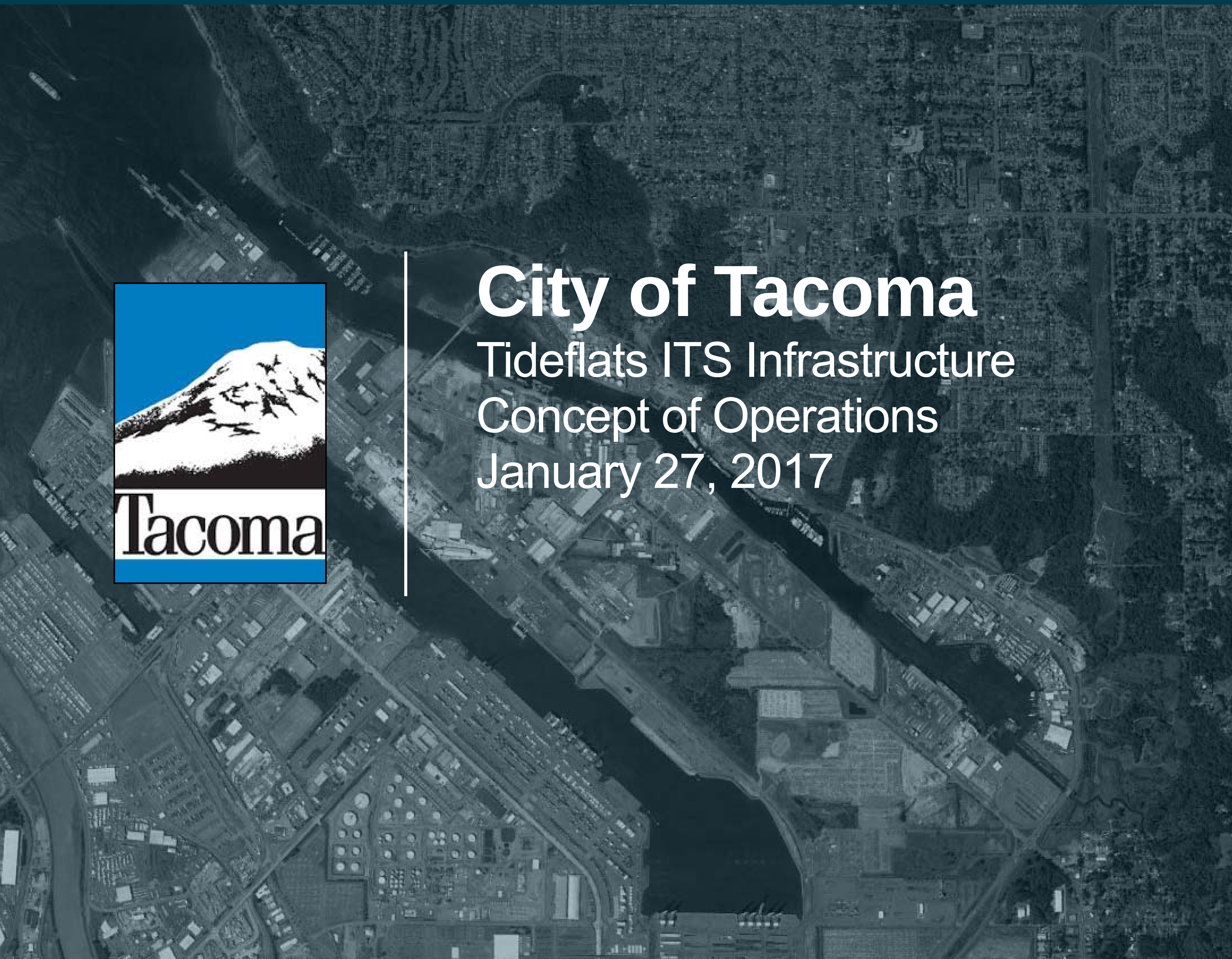

City of Tacoma

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1 INTRODUCTION

This document presents the Concept of Operations for the City of Tacoma Tideflats and Port of Tacoma ITS Strategic Plan. It describes the objectives of the proposed system; describes the components of the system; describes the operation of each ITS strategy through illustrative scenarios; describes which stakeholders would be involved in operating and maintaining the elements of the system; and discusses the costs and benefits of deploying and operating those elements. The purpose of the Concept of Operations is to describe the scope of the proposed system, the users' perspectives and how stakeholders are to be involved in the operation and management of the system.

1.1 Approach

In December 2015, Fehr & Peers prepared the Tideflats and Port of Tacoma ITS Strategic Plan which defined the study area and provided background on the current issues in the Tideflats, described the existing ITS infrastructure, and planned projects both past and future. The ITS Strategic Plan defined the goals and objectives of the ITS system, and described strategies and elements of the system meant to meet those goals.

This document will briefly review the existing conditions and the planned ITS system, and then build upon the Tideflats and Port of Tacoma ITS Strategic Plan. It will describe the operation of each ITS strategy; discuss the stakeholder involvement in operating and maintaining the elements of the system; and identify final costs and benefits of deploying and operating those elements.

1.2 Study Area and Stakeholders

As a major industrial hub in the Puget Sound Region, covering over 2,400 acres and operating as one of the top ten largest ports in the US, the Tideflats area is the heart of the area's industrial activity and encompasses portions of the City of Tacoma, the Port of Tacoma, portions of the City of Fife, unincorporated Pierce County, and the Puyallup Indian Reservation as shown in Figure 1. Major freeways passing through the area include I-5 and SR-509 and other key corridors include Pacific Highway, Port of Tacoma Road and 54th Avenue. Due to the nature of the area with over 20 million tons of cargo moving through each year, and growing demand for space, the constrained transportation network is at or near capacity. The study area for this Concept of Operations will focus on the area including and directly surrounding the Port of Tacoma, specifically the three peninsulas of Commencement Bay.

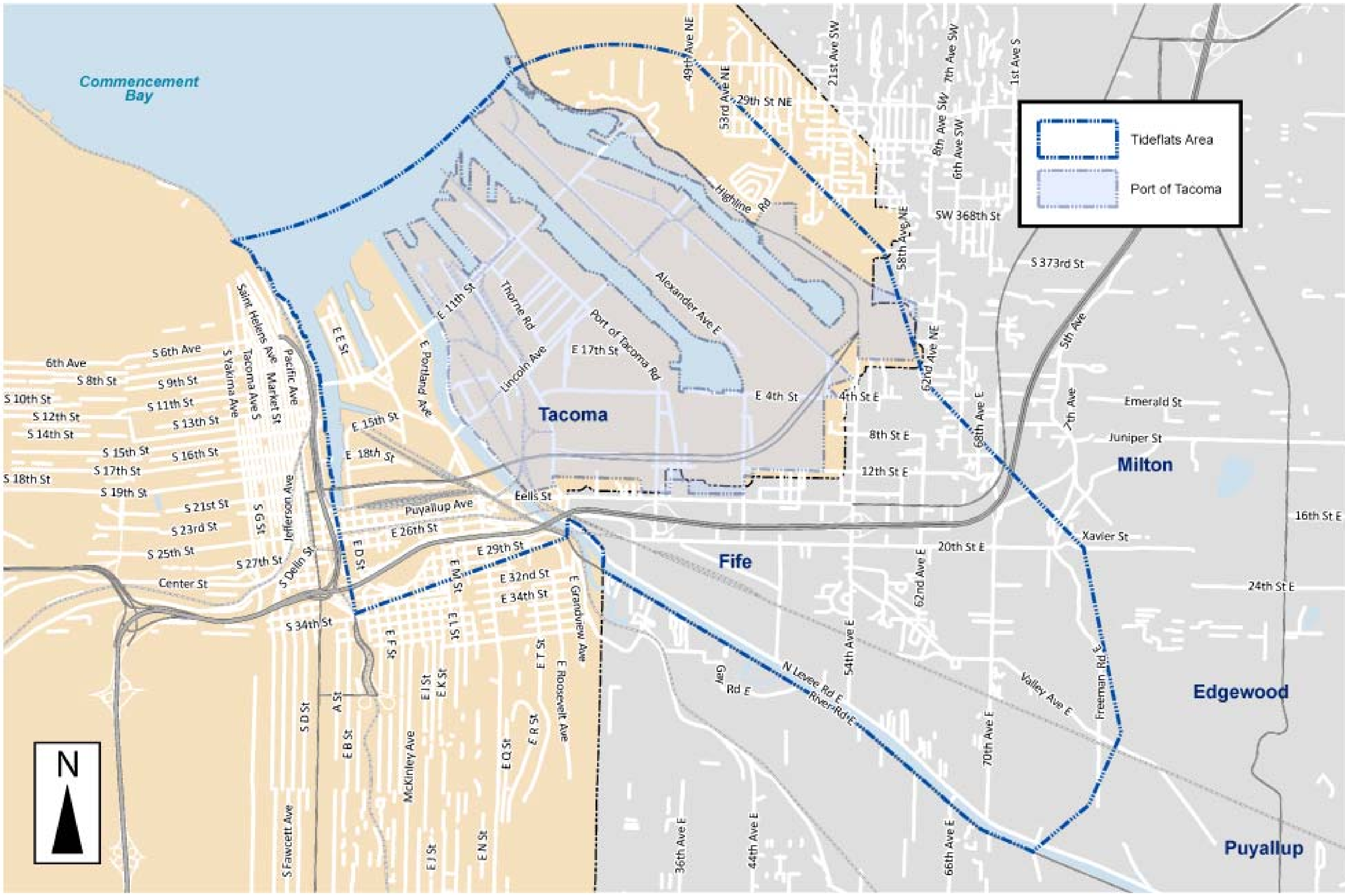


Figure 1. Tideflats Area

Stakeholders in the Tideflats area include:

- City of Tacoma Public Works Department
  - Primary stakeholder, driving the implementation of the system.
- Port of Tacoma/Northwest Seaport Alliance (NWSA)
  - Owner/operator of the majority of land and of existing ITS infrastructure in Tideflats.
- Washington Department of Transportation (WSDOT)
  - Owner/Operator of much of the existing ITS infrastructure in Tideflats, as well as two major state highways, I-5 and SR-509. In addition, WSDOT owns/operates/maintains the WSDOT 511 travel information system.
- City of Tacoma Fire Department
  - Owner of communications infrastructure and a real-time emergency response data system in Tideflats.
- Tacoma Rail
  - Owner/Operator of rail facilities within Tideflats.
- City of Fife
  - The southeast region of Tideflats is within the borders of Fife.
- Puyallup Tribe of Indians
  - Land surrounding Tideflats, to the south and east, is owned by the Puyallup Tribe of Indians.

1.3 Existing Traffic and ITS Infrastructure

The Tideflats area currently has a robust traffic and ITS infrastructure with components owned, operated and maintained by a variety of stakeholders. **Figure 2** shows the extent of the existing ITS infrastructure in the Tideflats area.

- Traffic Signal Maintenance and Operations – The city maintains most signals within the Port of Tacoma, except those which are under local jurisdiction, owned and maintained by WSDOT and the City of Fife.
- WSDOT ITS: Currently, the ITS Infrastructure in Tideflats owned and maintained by WSDOT includes closed-Circuit Television (CCTV) cameras, Highway Advisory Radio Systems (HARS), Variable Message Signs (VMS), and ramp meters.
- Fiber Optic Network: A network of underground and overhead conduit and fiber optic and copper interconnect cable exists throughout the Tideflats area. These are owned and maintained by multiple agencies including the Tacoma Fire Department, City of Tacoma Public Works, and Tacoma Public Utilities.
- Port Security CCTV: A network of cameras throughout the Tideflats area is owned and operated by the Port of Tacoma Security Department. Camera locations are not mapped nor shared for security concerns.
- Tacoma Fire Department CAD: A Computerized Automated Dispatch (CAD) system is used by the Tacoma Fire Department to identify the locations of all of the response units in real time, as well as incident location information.
- PierTrucker.com: This site is a third-party resource that provides real-time camera feeds of terminal entrances and WSDOT traffic information.
- WSDOT 511 System: WSDOT supports the 511 Travel Information System, which provides real-time traffic and road incident information primarily for the state highway system, as well as weather forecast information and emergency alert messages.

1.4 Operational Needs

The goals of the ITS Strategic Plan are sorted into two categories; outcome goals and implementation goals. Outcome goals look at what the ITS Strategic Plan aims to achieve through projects and system

management, while implementation goals focus on the process of plan development to ensure the installation and operation of the system is successful. Each of the goals is further defined by the objective that goal is attempting to achieve.

Outcome Goals

- Improve public safety
- Reduce the number of traffic incidents
- Improve incident and emergency response
- Enhance freight mobility and productivity
- Minimize delay and provide route guidance
- Accommodate growth in an environmentally sustainable manner
- Reduce energy use and emissions

Implementation Goals

- Coordinate among agencies
- Ensure integrated maintenance and operations of systems
- Implement strategically
- Leverage existing investments
- Design for scalability

1.5 Referenced Documents and Previous Plans

The following documents have been used in the preparation of this Concept of Operations and stakeholder discussions. Some of these documents provide policy guidance for traffic signal operation in this area, while some are standards with which the system must comply. Additionally, some are previous studies and plans, which influenced the Tideflats and Port of Tacoma ITS Strategic Plan.

- Intelligent Transportation Systems (ITS) Regional Architecture, Puget Sound Regional Council, http://www.psrc.org/assets/3515/Final_Report_20AUG-06_updated_22DEC-08.pdf
- Systems Engineering Guidebook for ITS, California Department of Transportation, Division of Research & Innovation, Version 3.0, http://www.fhwa.dot.gov/cadiv/segb/
- Tideflats Area Transportation Study (TATS)
- Port of Tacoma Land Use and Transportation Plan (LUTP)
- City of Tacoma Comprehensive Plan
- Washington State Department of Transportation (WSDOT) Strategic ITS Plan

Additionally, the following planned ITS infrastructure had an impact on the Strategic Plan:

- Tideflats Area Transportation Study (2011)
    - Variable Message Signs (VMS)
    - Warranted signalized intersections
- Port of Tacoma Land Use and Transportation Plan (2014)
    - Roadway investments
    - Street design standards
    - Street vacations
    - Automatic Vehicle Locator System
    - Advanced Transportation Management Information System
    - VMS
    - Railroad Crossing Monitoring System
    - Real-time information delivery
    - Reversible Lane Operations

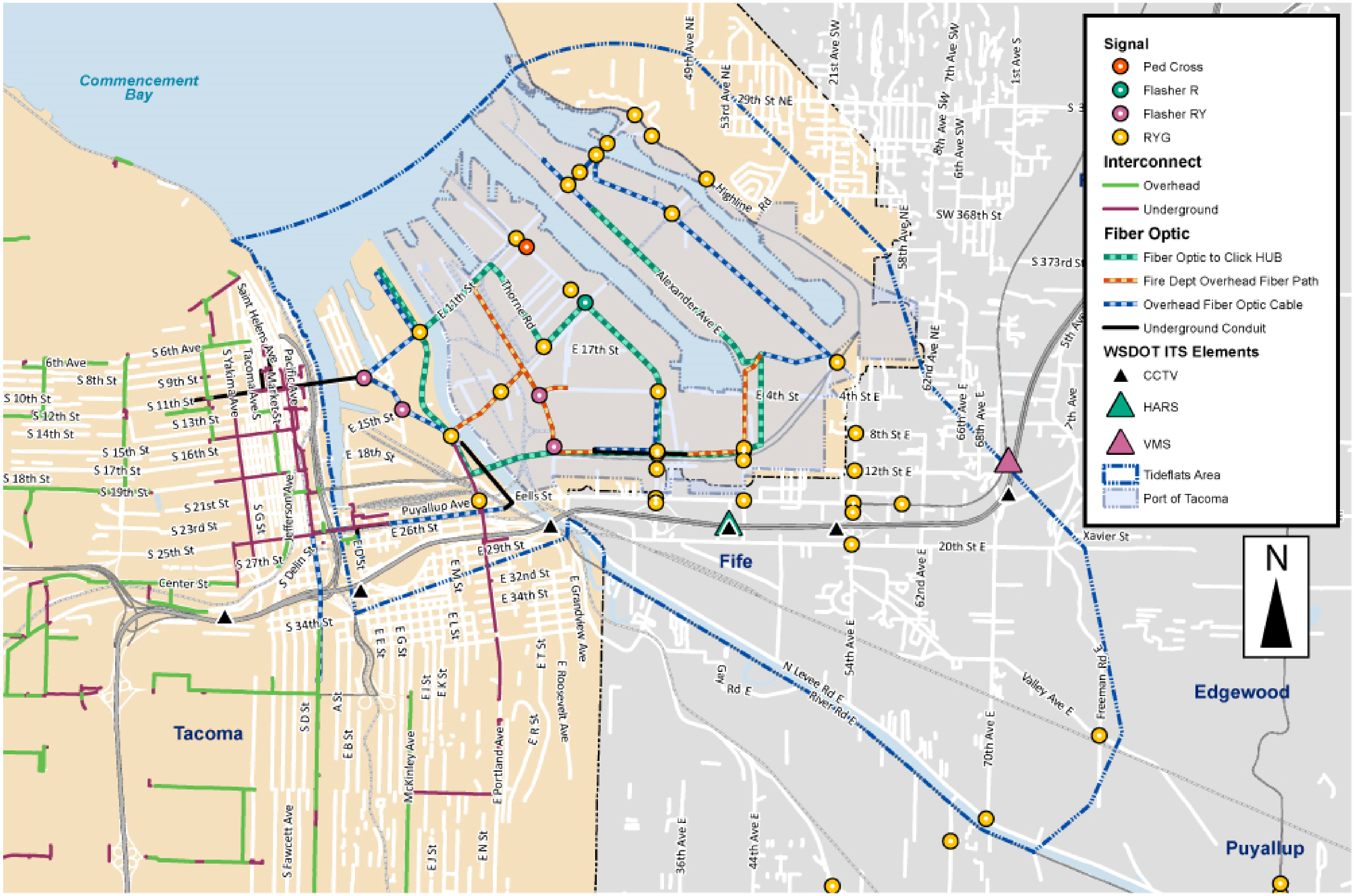


Figure 2. Existing ITS Infrastructure

- WSDOT ITS Plan
  - Closed Circuit Television (CCTV) cameras
  - Highway Advisory Radio System (HARS)
  - VMS
  - Communications hub
- Tacoma Transportation Master Plan
  - Proposed traffic signals
- Tideflats Emergency Response Plan
  - Consistent with Tideflats and Port of Tacoma ITS Strategic Plan
- Viewpoint
  - Information software for real-time emergency response data
- Operations Service Center (2014)
  - Northwest Seaport Alliance (NWSA) formed to unify management of the Port of Seattle and Port of Tacoma; created the Operations Service Center (OSC) to enable the Seaport to coordinate operational oversight and management; and to maximize efficiency of the supply chain.

2 SYSTEM OVERVIEW

Six ITS strategies were developed in order to achieve three primary goals; improve public safety, enhance freight mobility, and accommodate growth. Along with accomplishing these goals, the strategies are to meet the needs of the City of Tacoma and the stakeholders in the Tideflats area. An ITS strategy is a solution that defines general strategy to address the goals and objectives. The strategies are further defined by ITS projects, which install the ITS elements in support of the ITS strategies. To further support the strategies developed for the Tideflats and Port of Tacoma ITS Strategic Plan, they and the prior planning studies were reviewed against the National ITS Architecture standards to ensure that any of the proposed strategies would be consistent with both the national standards, as well as prior planning efforts. Each strategy was then reviewed and evaluated based on relevance to the goals and objectives of the strategic plan, that is, to see how each strategy addressed the goals previously defined. Only those strategies which achieved multiple objectives were further developed.

Each of the strategies is described in detail on the following pages and includes a description; goals addressed by the strategy; ITS elements that will be utilized to achieve those goals; stakeholders that could be involved in the installation, operation and maintenance of the system; estimated benefits to the transportation system and the stakeholders; and costs. Table 2.1 (below) identifies the strategies and the goals which will be addressed by that strategy.

Table 2.1 – ITS Strategies Matched to Goals

ITS Strategy		Goal		
		Improve Public Safety	Enhance Freight Mobility	Accommodate Growth
1	Optimization of Traffic Signal Operations	■	■	■
2	Traffic Signal Priority and Pre-Emption	■		
3	Incident Management	■		
4	Tideflats-Area 511 Service		■	■
5	Active Lane Management		■	■
6	Provision of Supporting System Infrastructure	■	■	■

2.1 Optimization of Traffic Signal Operation

To optimize traffic signal operations, the first step is to perform engineering analysis in order to understand the current traffic operations and identify the problem areas which are experiencing the most delay. With the trouble locations determined, modifications to signal timing and phasing is implemented such that delay in these areas are improved. Coordination along the selected corridors further enhances the optimization, ensuring that the signals are working together to reduce delay.

The primary benefits achieved by optimizing traffic signal operations include a reduction in travel time due to signal re-timing. Additionally, the coordination of signals will reduce delay as well.

Stakeholders can expect to see benefits as well. The City of Tacoma will see improvement in traffic operations and reductions in congestion in the Tideflats area. An overall improvement in freight mobility, increasing the efficiency of freight and container movement will benefit the Port of Tacoma directly. A potential benefit to WSDOT is the alleviation of spillback queues onto state facilities, such as SR-509 and I-5 due to the optimization of signal timing.

Goals	• **Improve public safety due to a reduction in the number of traffic incidents.** • **Enhance freight mobility and productivity due to minimized delay and route guidance provided to users.** • **Accommodate growth in an environmentally sustainable manner by reducing energy use and emissions.**
Strategy	• Lower cost solutions (timing and coordination) shall be implemented first such that the need for the higher cost solution (actuation infrastructure) is mitigated.
ITS Elements	• Signal timing update ($8,000-$30,000 per intersection) • Signal actuation infrastructure ($60,000-$120,000 per intersection)

Impacted Stakeholders

2.2 Traffic Signal Priority and Pre-Emption

Installing traffic signal priority and pre-emption provides emergency service providers the ability to pre-empt traffic signals as emergency vehicles approach. This stops all traffic except that of the direction in which the emergency vehicle is approaching. In addition to emergency vehicles, pre-emption can also allow for lower-level priority for other modes. In the Port of Tacoma this would most likely be rail crossings near signalized intersections.

Benefits of implementing traffic signal priority and pre-emption include reduced emergency response times and the reduced probability of collisions between emergency responders and general traffic. The goal is to achieve emergency response times of less than four minutes.

The City of Tacoma and Port of Tacoma both benefit from the reduction in response times and the reduction of collisions. In addition, Pierce Transit can expect a longer-term benefit by allowing future transit signal priority implementations within the Port.

Goals	• **Improve public safety due to a reduction in the number of traffic incidents and improved incident and emergency response.** • **Achieve the nationally recognized minimum response time of 4 minutes.**
Strategy	• Utilizing existing pre-emption systems in emergency vehicles makes this a relatively low-cost solution, only requiring hardware at the intersections.
ITS Elements	• Signal pre-emption upgrade ($8,000-$10,000 per intersection)

Impacted Stakeholders

City of Tacoma WASHINGTON · Port of Tacoma · PIERCE TRANSIT

2.3 Incident Management

Provides emergency responders with real-time incident information and information with regard to the occupancy by trains at strategic at grade crossings through the utilization of CCTV imagery. The goal is to identify key blockages that could impede emergency response. To facilitate the sharing of data between agencies, the incident management strategy should leverage the ongoing developments of the Viewpoint System, the South Sound 911 System, and the NW Seaport Alliance Operations Service Center.

Benefits of implementing incident management include a reduction of response times, depending on the location of the incident and improvement in overall emergency response travel time due to optimized routing. Freight routing should also see improvement due to additional information on railroad blockages.

The Port and City of Tacoma will both benefit from the reduction in emergency response times.

Goals	• **Improve public safety due to a reduction in the number of traffic incidents and improved incident and emergency response.**
Strategy	• Deployment of this system shall utilize existing traffic signal cameras coupled with placement of new traffic signal cameras to capture railroad crossings and other strategic locations.
ITS Elements	• PTZ Camera and pole infrastructure ($30,000 to $42,000 per location) • Fiber splice and switching equipment ($28,000 to $39,000 per location)

Impacted Stakeholders

City of Tacoma WASHINGTON

Port of Tacoma

2.4 Tideflats-Area 511 Service

Provides a central source of transportation information to users in the Tideflats area, targeted primarily to emergency responders and goods transportation, predominantly freight users accessing the Port from I-5 and SR-509. Information can be disseminated via variable message signs and/or mobile or web-based applications in real-time for data on roadway facilities and routing options. Current status of railroad crossings, rail operations (i.e. current train positions and movement), roadway speeds and delays, incidents and non-recurring congestion, real-time video, port drayage operations and other alerts could all be provided. The 511 service strategy could utilize elements provided via the continued development of the Northwest Seaport Alliance Operations Service Center and the Freight Advanced Traveler Information System (FRATIS).

Expected benefits of the Tideflats-Area - 511 Service are a reduction in travel times, a reduction in fuel consumption, a reduction in freight-involved incidents and increased productivity. Additional benefits include savings of costs related to drayage trips, and an increase in customer satisfaction.

City of Tacoma will benefit due to improvements in communication within the Tideflats area, while the Port of Tacoma benefits from vastly improved travel times, incidents, and productivity due to the ability to disseminate information to its users in real-time. WSDOT also stands to benefit from the potential opportunities to leverage the Tideflats 511 system with the existing WSDOT 511 system, resulting in more data and improved operations as an outcome.

Goals	• **Enhance freight mobility and productivity due to minimized delay and route guidance provided to users.** • **Accommodate growth in an environmentally sustainable manner by reducing energy use and emissions.**
Strategy	• 511-System costs include staffing and labor required to manage the dissemination of data through the system as well as software development for dissemination tools. A significant portion of the cost in the deployment of the data collection infrastructure would be borne by other projects.
ITS Elements	• 511 Deployment service ($1 to $3 million depending on scale) • GPS and/or Bluetooth probe data ($5,000 minimum with additional per-lane-mile costs) • Vehicle detectors ($500 – loops, up to $20,000 – video, per location) • Variable Message Signs ($20,000 – lightweight up to $200,000 – large structure) • Website/Text Information Distribution ($25,000 to $50,000 depending on scope)

Impacted Stakeholders

City of Tacoma WASHINGTON

Port of Tacoma

Washington State Department of Transportation

2.5 Active Lane Management

Fixed or variable modifications to the lane configuration on key arterials, Port of Tacoma Road for example, are implemented so as to allow the management of roadway capacity in response to demands of terminal operations. Additionally, lane configurations may be pre-set based on time-of-day or may fluctuate based on specific vessel loading schedules.

Benefits of implementing active lane management include improved intersection traffic operations and a reduction in travel times. The City of Tacoma benefits from improvement to overall operations of the Tideflats area roadway operations, additionally providing Tacoma Fire Department with a less congested path of travel during peak congestion periods. The Port of Tacoma benefits from improvements to overall congestion related to terminal operations while also increasing throughput of container movements.

Goals	• **Enhance freight mobility and productivity due to minimized delay and route guidance provided to users.** • **Accommodate growth in an environmentally sustainable manner by reducing energy use and emissions.**
Strategy	• Costs range dependent on scale. New signal equipment will be required at intersections, as well as additional signal equipment along the corridor to implement lane configurations based on variable time-of-day operations.
ITS Elements	• PTZ Camera and pole infrastructure ($30,000 to $42,000 per location) • Fiber splice and switching equipment ($28,000 to $39,000 per location) • Lane Configuration signage ($4,000 to $8,000 per location)

Impacted Stakeholders

2.6 Provision of Supporting System Infrastructure

Proper deployment and implementation of the ITS strategies outlined in this chapter require that communications and data collection infrastructure be installed. Each strategy leverages the existing ITS infrastructure, requiring expansion or supplementation to communications, data collection, and information dissemination.

By building out the infrastructure now, the necessary backbone is provided to implement a number of projects, rather than completing piece-by-piece infrastructure installations. Funding opportunities for future projects are improved as a baseline infrastructure for deploying those projects will already be in place. While the City and Port of Tacoma benefit from this baseline infrastructure, WSDOT also benefits as this provides the potential to incorporate Tideflats infrastructure into state ITS planning efforts.

Goals	• **Improve public safety due to a reduction in the number of traffic incidents and improved incident and emergency response.** • **Enhance freight mobility and productivity due to minimized delay and route guidance provided to users.** • **Accommodate growth in an environmentally sustainable manner by reducing energy use and emissions.**
Strategy	• Cost is dependent on scope and the proper leverage of existing ITS infrastructure. Currently City of Tacoma is in talks with WSDOT, Click! and Tacoma Fire Department are in regarding usage of planned and existing fiber infrastructure in the Tideflats area.
ITS Elements	• Fiber splits on Taylor Way for camera locations ($170,000 - $230,000) • Installation/burying of fiber on Port of Tacoma Road using newly installed conduit ($350,000 - $450,000) • Burying of overhead fiber and gap filling installation throughout Tideflats ($2,200,000 - $2,990,000)

Impacted Stakeholders

City of Tacoma WASHINGTON | Port of Tacoma | Washington State Department of Transportation

3 OPERATIONAL ENVIRONMENT

This section describes the physical operational environment in terms of facilities, equipment, computing hardware, software, personnel, operational procedures, and support necessary to operate the deployed Tideflats ITS systems.

3.1 Optimization of Traffic Signal Operation

Optimizing traffic signal operation is an iterative process. Initially, it requires engineering analysis, either by City engineers or a consulting firm, to identify the problem areas. Timing plans are then prepared to mitigate the problem areas, typically by the agency that performed the analysis. Finally, City staff are required to visit the individual traffic signal locations and modify the controller settings to implement the new timing plans. If multiple plans had been prepared, special event timing for example, then these are also programmed into the controller at this time. Beyond installation of the timing plans, the locations must undergo observation, traffic counts taken, and so on in order to determine how the changes are working. Ideally this observation and any data collection can be done remotely by camera and/or data collected by loops or other detection means. If special event or other pre-programmed timing plans need to be implemented, the City of Tacoma Police Department is deployed to initiate the pre-programmed timing plans and then revert them once the special event is complete. It should be noted that traffic in the Tideflats area is inconsistent at best. Commuter traffic for employees of the various facilities are regular, but the freight traffic that is the root problem of the area is not based on any set schedule. It is based on when the ships dock at the Port and the truck traffic entering and exiting the Port to load and unload those ships. Maintaining timing plans for multiple purposes (i.e. general traffic flow, heavy freight, etc…) as well as the ability to implement those timing plans remotely and as needs dictate will be beneficial to the system as a whole.

Coordination of signals requires initial design and construction in order to install the physical facilities needed for the system. In addition to the facilities required at the individual signals, communications hardware and coordination hardware are installed at the TMC. As Tacoma has only a rudimentary TMC which would require significant upgrades to meet the anticipated needs, this will likely be the TMC of WSDOT or the Port Alliance. The system will then be accessible by the City remotely for observation and adjustment if necessary. In addition to typical hardware maintenance, minimal interaction is required on the part of the staff at the hosting TMC or the City, as the system is largely automated. City staff will be able to observe the system and make adjustments as necessary and, depending on the arrangement with the hosting TMC, they will also be able to observe, but likely will not be able to make adjustments without further agreements.

3.2 Traffic Signal Priority and Pre-Emption

Traffic signal priority (TSP) is a hardware-based system which interacts with a signal to implement phasing changes when the priority call is placed. The City of Tacoma will maintain and operate the system. Once installed observation is needed to ensure that the system is working properly and that timing and phasing are accurate and working efficiently. Implementation of the system will begin with the preparation of plans by a consultant, which will then be installed by a contractor. Each signal will require the necessary hardware. In addition, hardware will need to be installed in any vehicles that will be able to use the system that are not already equipped for it. For example, most emergency vehicles (fire, police, ambulance) are already equipped. Non-emergency priority will likely be due to rail crossings near signalized intersections. Each of these locations would require the installation of hardware to detect approaching rail traffic as well as hardware and cabling to connect and communicate with the adjacent traffic signal cabinet. Once installed, initial programming is needed to encode the phasing and timing changes, then observation, occasional adjustments to timing, and standard maintenance are required for the life of the system.

3.3 Incident Management

The initial facilities for the incident management system will include analysis, design and installation of CCTV cameras at strategic railroad crossings. In addition to the cameras, communications facilities in the form of fiber optic cable and communication hardware are required to return that data back to the stakeholders that are able to access the data. Communications hardware will be installed in the field at the camera locations, at the TMC, and at the City of Tacoma City Hall. Remote access to the stakeholders will be provided via terminal at their location. This type of access will typically utilize common web browsers and require no special hardware on the part of the stakeholder.

Within each entity, the ability will exist to access the system; view and control the PTZ cameras; and analyze the situation prior to making a decision. Primarily, this will be emergency dispatch personnel who can review the video feeds to determine if the path is clear, determine which emergency services are needed, .

However, this could also include personnel from other stakeholders, for example the City could receive notice of an incident that is causing delay and, ideally, they could review the feeds to assess the situation and determine the course of action needed to alleviate the situation, or the Port Alliance could monitor the feed and alert a particular occupant should a primary ingress or egress route become congested. The ability will exist within the system for the City of Tacoma to adjust the level of access to each individual allowed access to the system.

3.4 Tideflats-Area 511 Service

The Tideflats-Area 511 service can build off of facilities implemented in previous systems, primarily the communication infrastructure and data collection, such as vehicle detection and live CCTV video. In addition, it will deploy other systems to gather data, including GPS vehicle tracking and additional detection. Other existing sources of data will include elements provided via the Northwest Seaport Alliance Operations Service Center and the Freight Advanced Traveler Information System (FRATIS). The system will utilize a 511 deployment service to organize and disseminate the data gathered via multiple mediums, including changeable message signs which will require structures to be installed throughout the Port, as well as web and/or mobile-based applications, which will require development and maintenance. In addition, an employee may be required to monitor the system and determine which information is made available. This would primarily be for the changeable message sign system.

3.5 Active Lane Management

To implement active lane management, the system first has to be designed by a consultant. Then the infrastructure, pavement striping, static signage, variable signage, additional CCTV PTZ cameras to monitor the system and the means to power and communicate with the system will be installed. The system could then be utilized in multiple ways, either based on time of day and/or based on live occupancy, or it could be utilized manually in the case of emergency situations or special events. Communication, as in previous systems, is funneled to the TMC, which then allows access to remote users, such as the City of Tacoma.

3.6 Provision of Supporting System Infrastructure

The primary purpose of the provision of supporting system infrastructure is to install the communications backbone necessary for all of these systems to function properly. Existing fiber optic cable will be utilized as much as possible. Much of the existing fiber in the Tideflats area is aerial and, as such, it will be relocated underground into new conduit. For areas where existing fiber either does not exist or is not accessible for whatever reason, new conduit and fiber will be installed. Fiber would then be spliced at each point where a data drop was necessary, typically at each traffic signal, but potentially at each CCTV camera (if they are not near a signal) and each CMS location. This fiber will then be routed back to the TMC, ideally through existing cables, and then data may be shared with the various stakeholders.

4 SUPPORT ENVIRONMENT

This section describes the current and planned physical support environment for the Tideflats ITS systems. This includes facilities, utilities, equipment, computing hardware, software, personnel, operational procedures, maintenance, and disposal. This includes expected support from outside agencies. By utilizing various components across multiple systems, as well as utilizing systems owned, operated, and maintained by outside stakeholders, the cost of the various systems is reduced overall. In this section, each of the components to be utilized across the systems will be identified, as well as which systems that component will be utilized in.

4.1 Traffic Management Center

The majority of the systems discussed in this document will require a centralized data collection location. This would typically be the City's traffic management center (TMC), however the City of Tacoma does not have a TMC. Therefore, it will be necessary for the City of Tacoma to coordinate with a stakeholder to utilize their TMC. Both the Northwest Seaport Alliance (NWSA) and Washington State Department of Transportation (WSDOT) maintain facilities within the City of Tacoma.

While the NWSA facility is located within the Port itself, the WSDOT facility located in Tacoma just south of SR-512, is more likely to have systems already in place that deal with traffic and ITS-related data. The systems that need to integrate into the TMC will be able to do so more conveniently in the WSDOT facility than in the NWSA facility. Additionally, WSDOT maintains six TMC facilities in the state of Washington and, as such, depending on the inter-local agreement made between the City of Tacoma and WSDOT, a wider array of data may be available to the Tideflats ITS systems than if the NWSA facility was utilized.

Once the infrastructure within the TMC is put into place, the data will be accessible not only by WSDOT employees on-site, but also remotely by other stakeholders, primarily the City of Tacoma, via a terminal within their own facilities. Maintenance and direct operation of the software and hardware tied to the systems installed at the TMC would fall to the staff of the TMC, but costs associated with the replacement of failing hardware or upgrading software would fall to the City of Tacoma. In addition, the City of Tacoma would either incur costs for utilizing WSDOT's facilities and infrastructure, or that cost would be mitigated by some sort of data-sharing agreement. Maintenance of the various software and hardware systems would also be built into the contract with the vendors of those systems.

4.2 Fiber Optic Communications

In order for the devices in the field to communicate with each other and with the TMC, a system of fiber optic cable, as well as fiber optic communications equipment, will be required. It would be ideal to utilize the fiber optic cable that already exists in the Tideflats area. Various entities own and maintain this existing fiber including WSDOT, Tacoma Fire Department, and Click! Cable TV. Of the existing fiber optic cable, the most populous throughout the Tideflats area is that of Click! Cable TV. This existing fiber optic cable is also known to have adequate available unused fibers. If the City of Tacoma is able to broker a mutually beneficial deal with Click! Cable TV it would save a significant amount of cost as opposed to installing infrastructure of their own.

Where sharable existing fiber optic cable is currently installed aerially, it will need to be removed and re-installed in underground conduit. This allows for flexibility in the placement of fiber drops and increases the ability to maintain and protect the cable. Where fiber optic cable does not exist or an agreement cannot be made to share the cable, then a new system of conduit, junction boxes, and fiber optic cable will need to be installed.

Fiber optic cable will consist primarily of trunk-line fiber, typically a high fiber-count cable from which branches (low fiber count cable) will be spliced to the various ITS field devices and traffic signal cabinets. In addition to the cable, communications hardware will also be required. In most cases this will be an Ethernet switch at each field device and traffic signal cabinet. Typically, just one Ethernet switch is required

even if multiple devices share the same cabinet, i.e. if a traffic signal cabinet acts as the hub for a CCTV camera and a changeable message sign, all devices will be connected to the same Ethernet switch. Communications equipment also consists of the various termination and splice points for the fiber optic cable. In a vault near the ITS device, a splice closure will be installed, in which the branch fiber cable will be spliced to the trunk fiber cable. Each drop point will also require a termination panel upon which the branch cable can be terminated. Jumper cables connect the termination panel, and therefore the branch fiber, to the Ethernet switch. The TMC also requires termination panels, though with much more capacity than those required in cabinets, as well as Ethernet switches. It may be determined that fiber optic hubs are desirable in which case fiber cabinets with high capacity termination panels will be installed in the field. These are typically installed where multiple fiber cables meet. By terminating all fiber cables and utilizing jumpers, maximum flexibility is obtained while also saving the cost of having to re-splice cables in the future.

Fiber optic cable that is owned by another entity, like Click! Cable TV, but is being shared with the City will be maintained by the owner, but if damaged by actions of the City, maintenance may incur costs which will then be passed on to the City. Fiber that is owned by the City will be maintained by the City. Hardware is also maintained by the City, though agreements may be made for equipment which resides in a non-City facility to be maintained by the owner of the facility, at the cost of the City. Installation of the infrastructure, as well as integration of the existing infrastructure (i.e. splicing into Click! Cable TV-owned fiber optic cable), will be the responsibility of the City, with the caveat that owner staff may be required to be present during the process. The City would likely incur costs associated with leasing space in existing fiber cables.

4.3 Shared Communications

Sharing communications can greatly reduce costs due to shared infrastructure as previously discussed. It also introduces the need for interagency agreements. Shared communications can have two meanings:

1. Sharing common infrastructure (conduit, fiber optic cable)
2. Sharing a network (a particular strand in a fiber optic cable that also carries data from another agency).
3. Sharing data directly with another agency

The first is the most common approach, and is the approach that is to be utilized as part of this plan. The second creates issues with bandwidth and security that are undesirable, particularly when government agencies are concerned. The third option also generates potential security issues, but as long as the agencies and users that have access to the system are approved, and the system has sufficient security, then the sharing of data directly poses far less threat than transmitting data in the same fiber as a different agency.

Similar agreements have been made between WSDOT and other agencies, most notably the Traffic Busters program which allows approximately twenty agencies in the central Puget Sound region to connect to the WSDOT fiber optic network and exchange traffic video.

Through agreements, the City of Tacoma will connect ITS devices to the fiber optic network within the Tideflats area. Other agencies could also utilize this fiber network for the purposes of This will ultimately connect into the WSDOT fiber optic network and connect to the WSDOT TMC. From there it will connect back through the WSDOT network to the City of Tacoma maintenance yard and eventually City Hall. WSDOT and other approved users benefit by having access to the monitoring/remote access platform without requiring the agency to invest in a system of their own. In addition to gathering and re-transmitting the Tideflats data, fiber connections can be made to share WSDOT data with the City and other stakeholders as well.

4.4 ITS Devices

A variety of ITS devices will be installed for the various systems identified in this report. These will include variable message signs, PTZ CCTV cameras, vehicle detection (both in-ground loops or pucks and video) and lane configuration signage. Each of these devices would be installed in City right of way, and therefore

would be the responsibility of the City. One caveat to this would be devices installed at WSDOT-owned traffic signals, along SR-509 for example. In those cases, the City would still be responsible for installation and maintenance, but ultimately the equipment would be the property of WSDOT, depending on the agreement that is made. Another caveat would be for devices that are installed in Tacoma Rail right of way, for example, rail detection equipment. This equipment could be installed by either the City or by Tacoma Rail, but maintenance would be the responsibility of Tacoma Rail.

4.5 Operational Mitigation

In order to apply the operational changes that are required to implement several of the systems, studies must be conducted, timing plans created, and equipment installed in the cabinets and in the field. Studies would include collecting data related to existing traffic signal timing and traffic volume for the roadways that are to be studied. Volumes and timing are analyzed and the first step is to adjust the timing in order to maximize the level of service given the current conditions. Additionally, key intersections are analyzed to determine the effects of non-emergency pre-emption and special timing plans are developed to incorporate the associated pre-emption. Then signals are updated as necessary to be able to completely incorporate the desired changes. This may include mitigation, such as the installation of detection and/or upgrading the existing controllers. Vehicle pre-emption hardware is also installed throughout the Port and special timing plans are implemented at those key non-emergency pre-emption locations.

5 OPERATIONAL SCENARIOS

This chapter will utilize examples applied to the project area in an effort to better understand the systems detailed in chapter 2. Rather than look at the entire project area, an exploration of a single, important segment or situation can provide insight to the impact of the proposed systems on that area. In addition, the results from that segment can then be applied to other locations in which we would be able to expect reasonably similar results.

5.1 Operational Scenario 1 - Hylebos Peninsula

The first scenario that we will look at will be the Hylebos Peninsula, which includes the Taylor Way corridor, identified by the Port of Tacoma as a problem corridor with potential for improvement due to the ITS improvements proposed herein. The Hylebos Peninsula also includes Alexander Avenue E, and the lateral roadways of Lincoln Avenue and E 11th St. The peninsula is bounded on the south end by SR-509. **Figure 3** below highlights the Hylebos Peninsula.

Taylor Way runs approximately north/south and becomes 54th Avenue E which extends into the City of Fife. Where 54th Avenue E intersects I-5, there are entrances and exits for both the northbound and southbound directions on I-5. Alexander Avenue E also runs approximately north/south and does not extends beyond the Tideflats area. There is segment of Alexander Avenue E that is interrupted by private property. At this point there is a gate through which emergency response vehicles can access the continuation of Alexander. This gate works via the Opticom hardware that is used for signal pre-emption.

Multiple at-grade railroad crossings exist across the Hylebos Peninsula, which can cause backups during times when trains are utilizing these tracks. Typically, these blockages are scheduled for periods when traffic volumes are at their lowest levels. Inbound trucks queue in the northbound lane to enter facilities fronting Taylor Way, most of which are on the east side of the roadway. Outbound trucks also queue starting at the intersection with SR-509, and the only viable option for through traffic is to utilize the two-way, left-turn lane. If any vehicles queue to turn from the two-way, left-turn lane, then gridlock is unavoidable.

Image Courtesy of Google Earth Street View

There are minimal existing ITS facilities on the Hylebos Peninsula which consist of video detection at the two intersections as mentioned above, and existing aerial fiber optic cable which is privately owned.

This scenario considering just the Hylebos Peninsula is to demonstrate how the changes posited in this document might affect a single segment of the Tideflats area. These results may then be superimposed on the other, similar segments of the Tideflats area, namely the other two peninsulas. It can be assumed that though the systems will have to be altered to match the specific conditions of the target area, the general effect of those systems on that peninsula will be very similar to the effect of those systems on the Hylebos Peninsula.

5.1.1 Optimization of Traffic Signal Operations

The primary source of southbound queueing on the Hylebos Peninsula is due to the traffic signal at Taylor Way and SR-509. A large number of trucks approach the intersection, but only a few are able to move through the intersection on each cycle. Optimizing this signal, as well as the other signals, and introducing coordinated timing options will allow the signal to adapt to the traffic volumes and provide more green time for the southbound traffic, thereby shortening the lengthy queues. If it is determined that the southbound right turn is the primary source of the backup, then a right turn overlap can be implemented at the intersection to further reduce the queue. The next step beyond optimization is coordination.

Traffic signal coordination utilizes communications between the traffic signals so that each receives the data from the signals around it. Timing can then be adapted such that if one signal is adjusted because it detects extended queueing, then the adjacent signals will also adjust to favor that phase. Timing between the signals can also be adjusted to facilitate the consistent flow of platooned vehicles, that is to say, a group of vehicles that can travel the length of the corridor without delay as they are all travelling at the same speed. The signals coordinate based on that speed such that the platoon always has the green light.

5.1.2 Traffic Signal Priority and Pre-emption

Emergency vehicle response times are improved by the existence of emergency pre-emption, as traffic is halted in each direction except that of the approaching emergency vehicle. In addition to emergency vehicle pre-emption, low priority pre-emption can also be employed for non-emergency situations. For example, approaching traffic can be stopped if a train is occupying a rail crossing, while non-conflicting movements are given the green light.

Taylor Way, Alexander, and E 11th Street all have railroad crossings at signalized intersections. While the intersection which is directly impacted is pre-empted, additional benefit could be gained by adjusting adjacent signals as well. For example, if a train is crossing the north leg of Lincoln Avenue and Taylor Way, then that intersection is pre-empted, stopping the northbound traffic and allowing the east and westbound traffic to flow freely. However, the signal at Taylor Way and SR-509 is still functioning under its usual timing. This allows traffic onto Taylor Way and adds to the backup at the occupied rail crossing. If, through interconnect and coordination the signal at Taylor Way and SR-509 were to prioritize the east/west movement, then additional backup at the rail crossing is reduced. This allows the signal at Taylor Way and Lincoln Avenue to recover more efficiently once the crossing is clear, and only introduces a bit of delay per cycle at the Taylor/SR-509 intersection. Each intersection will be evaluated to determine if the existing pre-emption hardware is adequate, and if not, then it will be replaced with new hardware.

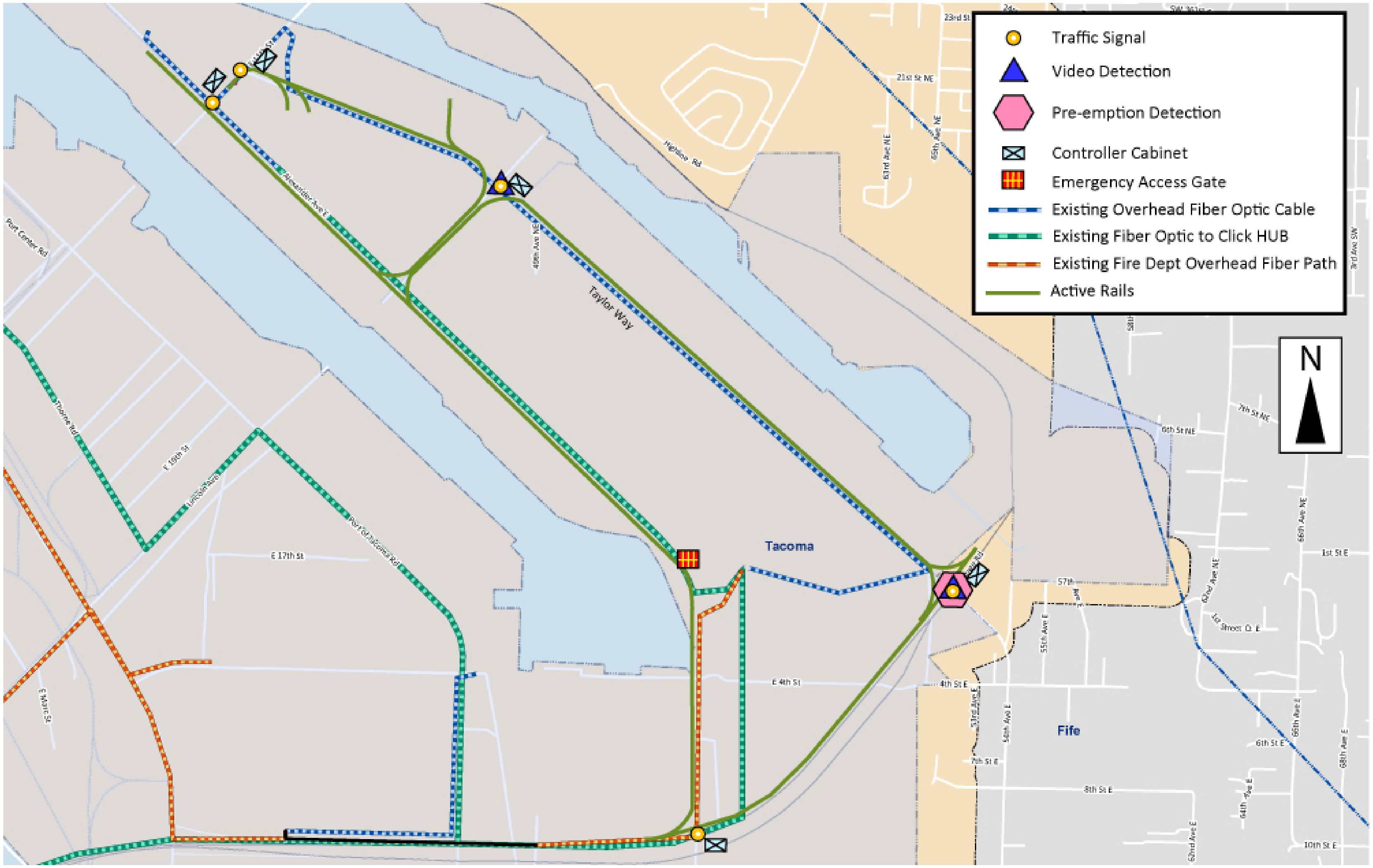


Figure 3. Hylebos Peninsula

5.1.3 Provision of Supporting System Infrastructure

In order to provide communication capability for all of these systems to work, a base fiber-optic cable infrastructure is necessary. Ideally, the existing aerial fiber optic cable along Taylor Way will be able to be utilized by the City, if the owner of the cable is willing and spare fibers exists in the cable. If so, then this fiber will be removed from the overhead and installed in a new conduit system for the length of Taylor Way and E 11th Street. If not, then the same conduit will still be utilized and new fiber optic cable will need to be installed. New Splice vaults will be provided at each point where a device needs to communicate; each of the four traffic signals, any variable message signs, any variable signage related to the active lane management, and CCTVs are all locations where fiber optic drops will be made to tie into the fiber optic trunk. The fiber optic cable would then need to be connected to an existing fiber optic trunk connecting back to the traffic management center (TMC). The City of Tacoma does not have its own TMC, but the cable can be tied back to the existing traffic management centers for the Port of Tacoma or WSDOT. This assumes that the City is able to coordinate a deal with either or both of these entities. Once the connection is made, the TMC would then be able to share that data remotely with a workstation or workstations at the City of Tacoma. Figures 4 and 5 below show the proposed infrastructure, communications and equipment locations for the implementation of the various systems.

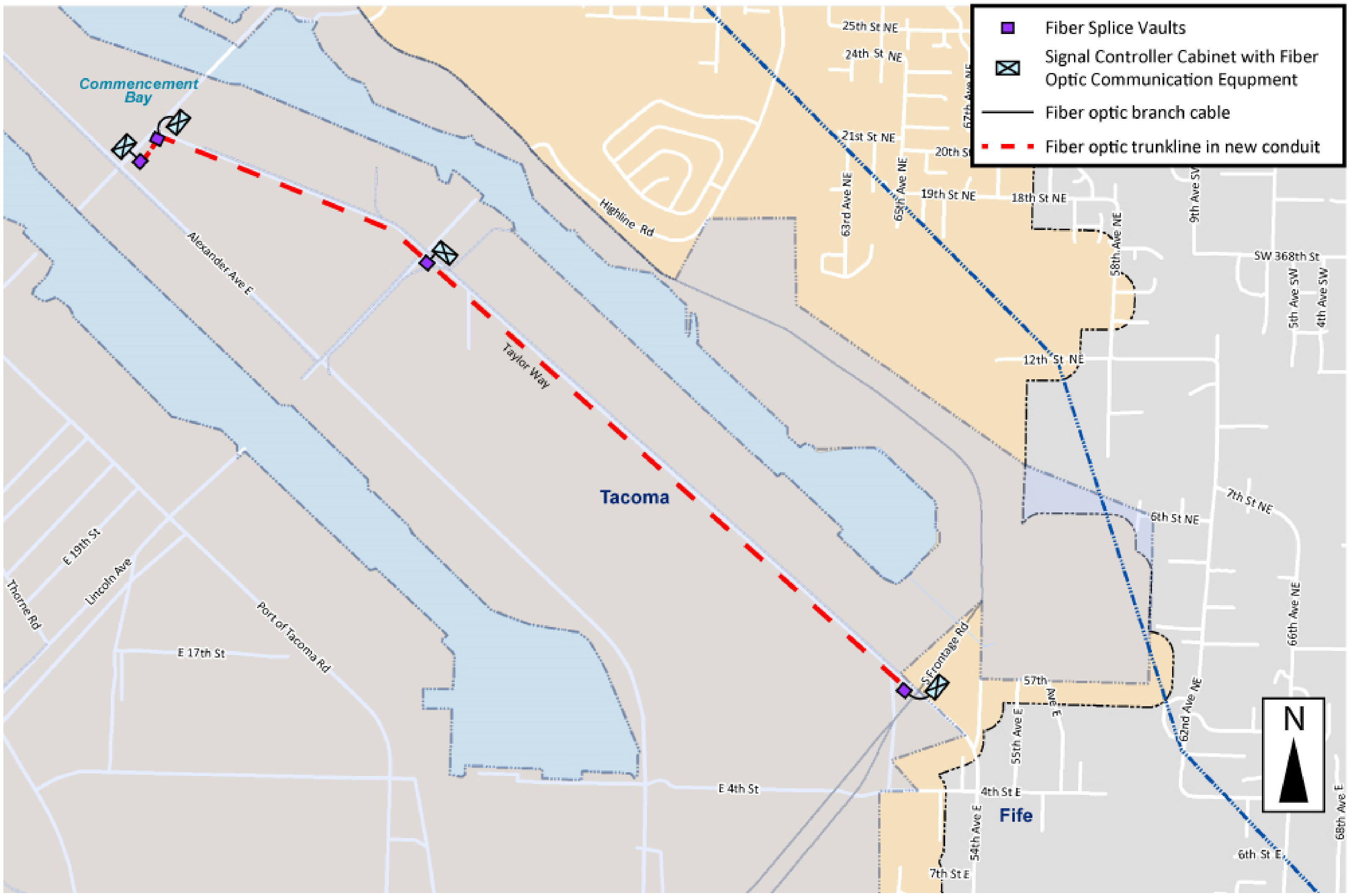


Figure 4. Proposed Fiber Optic Cable

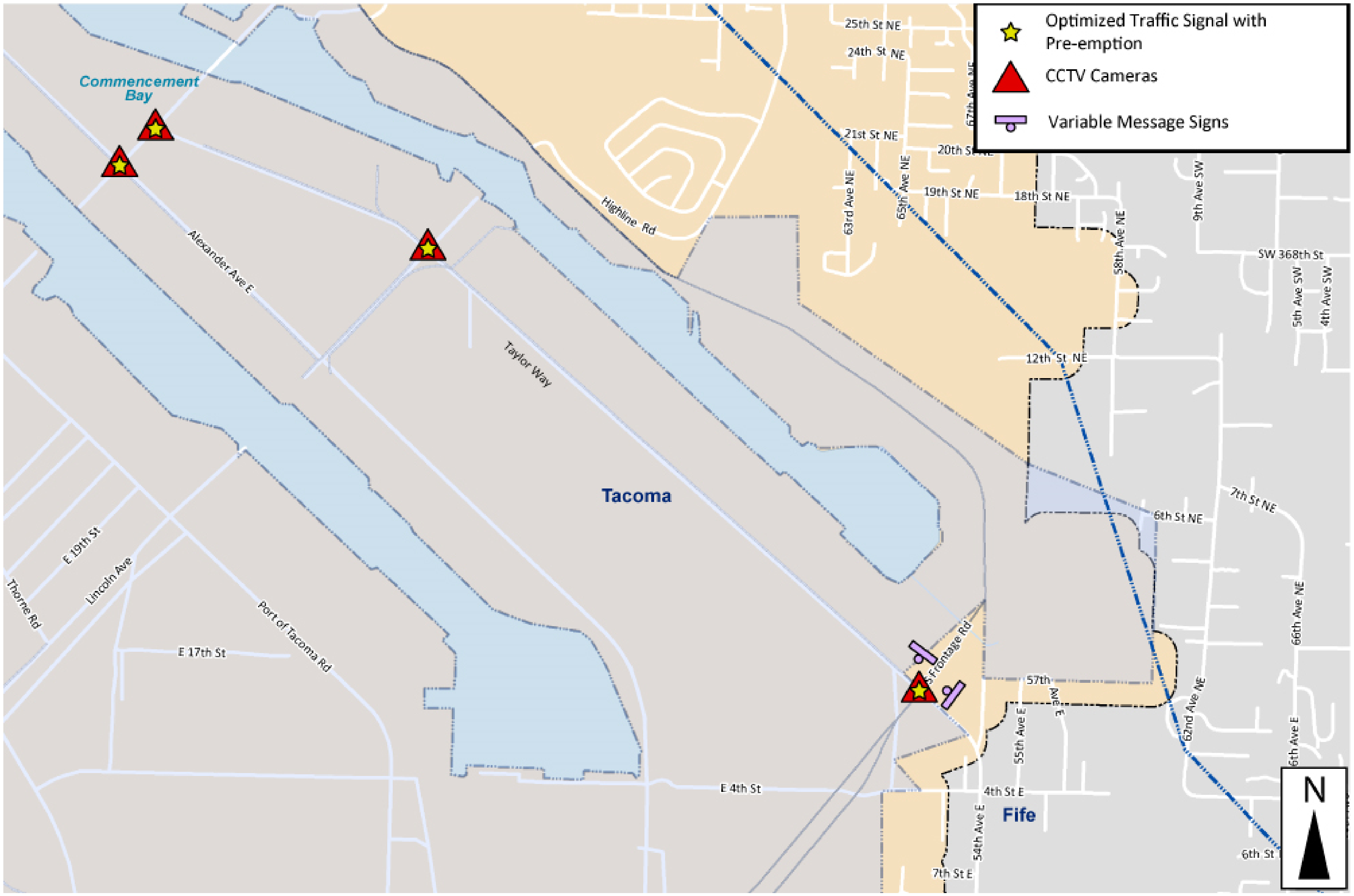


Figure 5. Proposed ITS Devices

5.2 Operational Scenario 2 - Incident Involving Extended Occupancy of At-Grade Rail Crossing

In this scenario we will look at a fictional incident to determine the effects of the various systems which have been discussed in this document. Imagine that a train is occupying the crossing at the north leg of the intersection of Taylor Way and Alexander, and that this train, for whatever reason, will continue to occupy the crossing for an extended period of time. Next we imagine that a life-threatening accident, perhaps a fire, has occurred near the intersection of Alexander Avenue E and Lincoln Avenue and emergency calls have been placed. The fire department and paramedics have been dispatched to the scene.

With the rail crossing blocked, traffic that normally would continue northbound on Taylor Way is forced to turn left at Lincoln Avenue. Traffic that would turn southbound onto Taylor from 11th Ave E would be forced to continue to Alexander. These restricted movements would cause an increase in volume on the detour routes, and therefore delay for those routes. For the sake of this scenario we will say that the fire is located off of the roadways, and therefore won't cause additional blockages, however, it will cause additional delays as drivers proceed cautiously when in the vicinity of an incident like this.

Based on the Fehr & Peers Emergency Response and Intelligent Transportation Systems Study conducted in October of 2014, the average travel time from the nearest Fire Department to any site on the three major peninsulas in the Tideflats area is within an eight-minute travel time. The nationally recognized maximum travel time for first responders is four minutes. The map in Figure 6 below indicates the incident location, as well as primary, secondary, and alternate emergency response routes. The primary route is from Tacoma Fire Station 3, northeast of the Tideflats. Per Google Maps, travel time to the site is approximately seven minutes. In an emergency event, it is likely that this route will be impacted increasing that response time. The next closest response unit is Tacoma Fire Station 12, in Fife, south of I-5. Responders have to make their way north and enter the Hylebos Peninsula via Taylor Way. Per Google Maps, travel time to the site from Station 12 is approximately eleven minutes. In the event that Taylor Way is impassable, there is an alternate route, utilizing Alexander Avenue E and an Opticom-controlled gate allowing emergency response vehicles access to a private access road connecting the southern portion of Alexander Avenue to the northern section of Alexander Avenue E. In any situation such as this, the emergency response time is key, as peoples' lives could be at stake. In this scenario, we will identify improvements to travel time that can be obtained by implementing the systems outlined in chapter 2. Ideally, travel time to the site via the primary route can be improved to four minutes or better, and the secondary route can be improved to eight minutes or better.

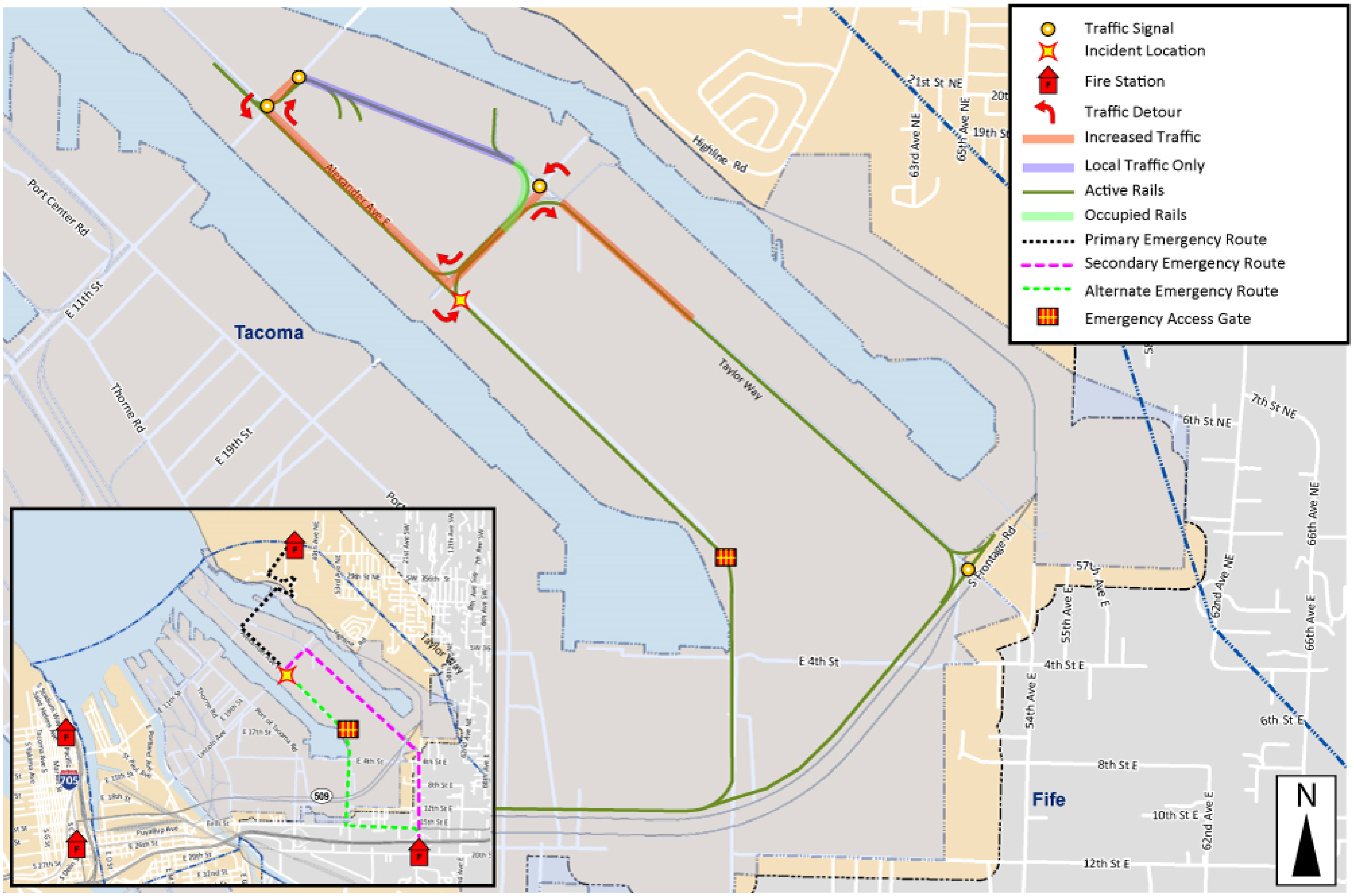


Figure 6. Derailment Map and Emergency Response Route

5.2.1 Optimization of Traffic Signal Operation

As mentioned, there is a primary route, and a secondary route that could be utilized in reaching the incident site. The primary route passes through four signalized intersections, two of which are in the Tideflats area. The secondary route passes through eight signalized intersections, with two being in the Tideflats area. Emergency vehicles typically do not obey traffic signals while en-route to an emergency, therefore it would seem that signal optimization would not affect the travel time for them, but what it would do is create a better flow of traffic on the links that the emergency vehicles have to utilize, thereby improving the travel time of those vehicles.

5.2.2 Traffic Signal Priority and Pre-Emption

Giving priority to emergency vehicles provides a huge benefit to response times. On a typical emergency response, when the vehicle approaches an intersection, they must slow down, nearly to a stop in order to confirm that vehicles in the intersection are aware of them, and will not interfere with their path, then they press on through the intersection, repeating the process at each intersection they pass through. If a signal is equipped with equipment to implement emergency vehicle priority, then the signal cycles through to the phase favoring the emergency vehicle as it approaches the intersection. While the vehicle will still proceed cautiously through the intersection to verify no conflicts, they don't have to come to the crawl or standstill and then proceed. Neither signal on the primary route is equipped with emergency pre-emption equipment, nor is one signal on the secondary route. The installation of EVP equipment will benefit both routes by reducing the emergency response times.

In addition to the benefits to the fire and medical response, we shouldn't forget about law enforcement. Typically, in an incident like this, in addition to investigative work, law enforcement provides many support roles from crowd control to directing traffic, all of which are very important for safety and for the flow of traffic through the area.

5.2.3 Incident Management

Being able to see the incident before ever sending an emergency vehicle to the scene can be of great benefit to the emergency response teams. If you can see the incident location, then you can determine who and what to send as a response. In addition, if you can see intersections and rail crossings along the route, then you can utilize that to determine which route is best. In the figure above we identified a primary and secondary route that are viable for reaching the incident at Alexander and Lincoln. While a source like Google Maps is great in determining routes, it is not likely to be real-time. In an emergency situation, traffic data that is out of date by even a few minutes could mean the difference between a clear route and a blocked route. This system will install pan-tilt-zoom (PTZ) cameras at various places throughout the Tideflats area, primarily at railroad crossings, and in particular those railroad crossings at signalized intersections. Three will be installed on Taylor Way, one at each signalized intersection, and one at Alexander and E 11th St. If these cameras are in place during an incident, emergency services could point the cameras to view the incident and to view the routes and determine if they are clear or not. Depending on what they find, they can plan their route to utilize the route that will result in the fastest response time.

5.2.4 Tideflats-Area 511 Service

The Tideflats area 511 service will leverage the data provided by the existing WSDOT 511 service, and combine it with new data gathered by various devices throughout the Tideflats area, typically GPS probe data and vehicle detection. This data is then disseminated to the public via variable message signs, website, and mobile application. The primary focus of this service is to reduce response times and incidents. As it applies to the incident at Alexander Ave E and Lincoln Avenue, information can be passed to local motorists using variable message signs installed at Taylor Way and SR-509, informing them of the incident and the traffic detour. Figure 7 below gives an example of how this could be utilized. At least some number of the drivers who would otherwise utilize Taylor Way would find an alternate route, thereby reducing congestion on Taylor Way. The expected result is that emergency responders would have less congestion to contend with as they enter into the Taylor Way corridor, thus reducing response times.

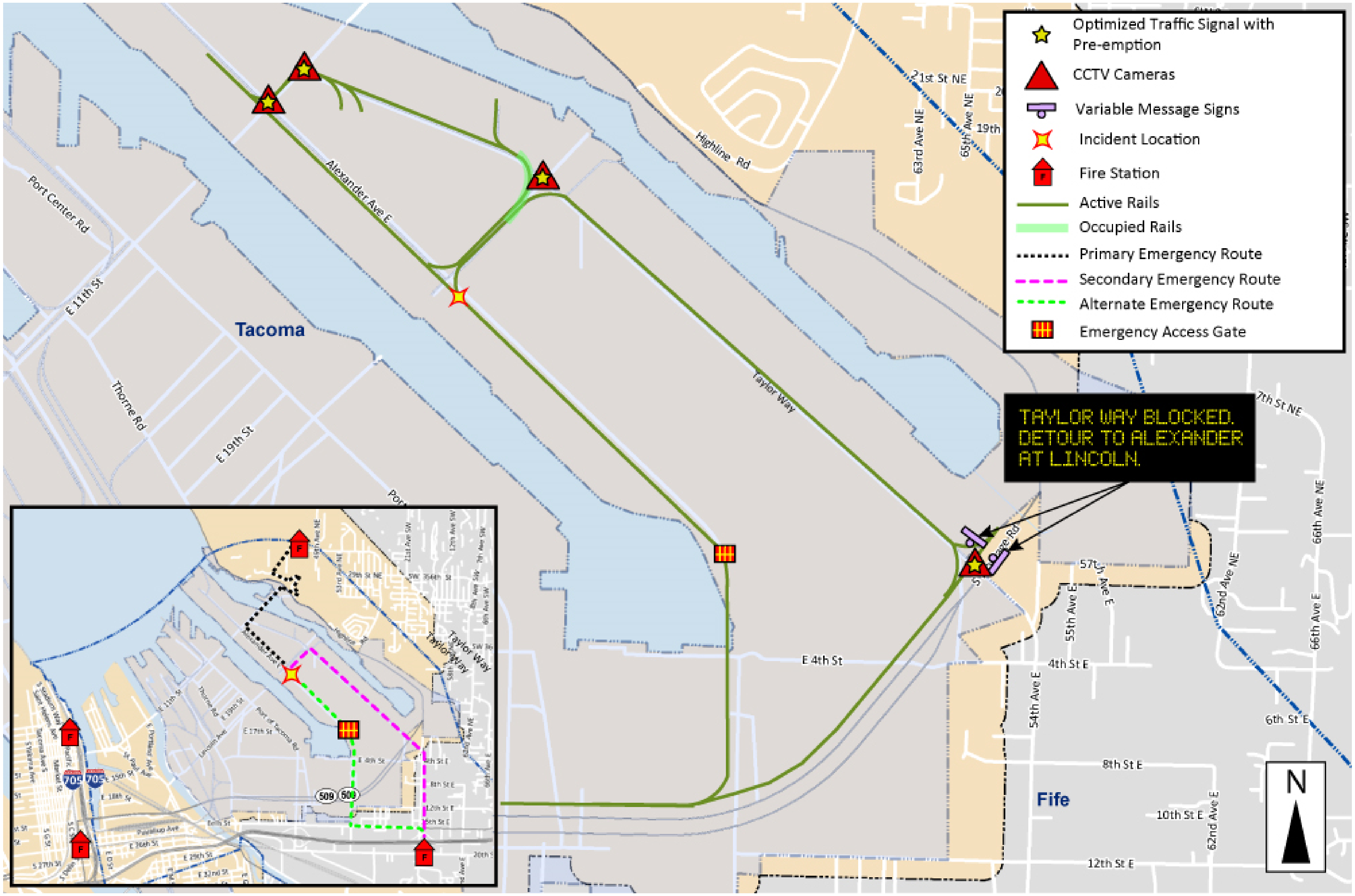


Figure 7. Variable Message Sign Example

5.2.5 Active Lane Management

As previously discussed, the segment of Taylor Way between SR-509 and Lincoln Avenue has two travel lanes and a two-way-left-turn lane in the existing configuration. By implementing active lane management, we can utilize the two-way-left-turn lane as a variable direction travel lane instead. In the case of the incident on Alexander Ave E, the initial action would be to ensure the variable lane is set to allow traffic in the northbound direction. This reduces the congestion for the en-route emergency vehicles and improves the response time. Once the necessary emergency crews reach the site, the variable lane can be switched to allow southbound traffic instead, providing a better flow of traffic away from the incident. This will be beneficial both to the general traffic and the emergency vehicles who need to leave the scene, if an ambulance had to transport an injured patient to the hospital for example. **Figure 8** below shows how this system could work.

5.2.6 Provision of Supporting System Infrastructure

Without the supporting infrastructure, none of the above systems could function properly. Fiber optic cable and communications hardware is essential for the people utilizing the system to be able to receive the necessary data and send out the necessary responses. The Hylebos Peninsula has existing aerial fiber-optic cable which, as a part of this scenario would be relocated to an underground infrastructure instead. With the proper agreements in place for the City to utilize this fiber optic cable, the various signals will be interconnected and all data emanating from each signal and each ITS device will be available to all who have access to the system. System communication is the backbone of making an ITS system work.

5.2.7 Conclusion

Each of the systems that have been discussed in this chapter improve the emergency response time. While each of these is a relatively small improvement, the combined impact would be significant. The study incident at Alexander Avenue E and Lincoln Avenue is impacted by a concurrent rail crossing occupation at Taylor Way and Lincoln, imposing route restrictions and increasing congestion near the incident site as well as en-route to the incident site. Currently, response time to the location is between four and eight minutes, and with each system doing its part to reduce congestion and improve traffic flow through the area the response time for the first responders is reduced with the goal being four minutes or less. Upon first look, the Hylebos Peninsula seems to be difficult to access, with only two viable access points, Taylor Way from the South and the Hylebos bridge on E 11th Street from the north and east. However, we have also identified the potential usage of the Opticom controlled access gate at Alexander Ave E and E 4th Street as another option for access should the others be impassable. The various systems, working in conjunction will allow responders to reach the site faster and well informed, thus abler to handle whatever the situation presents.

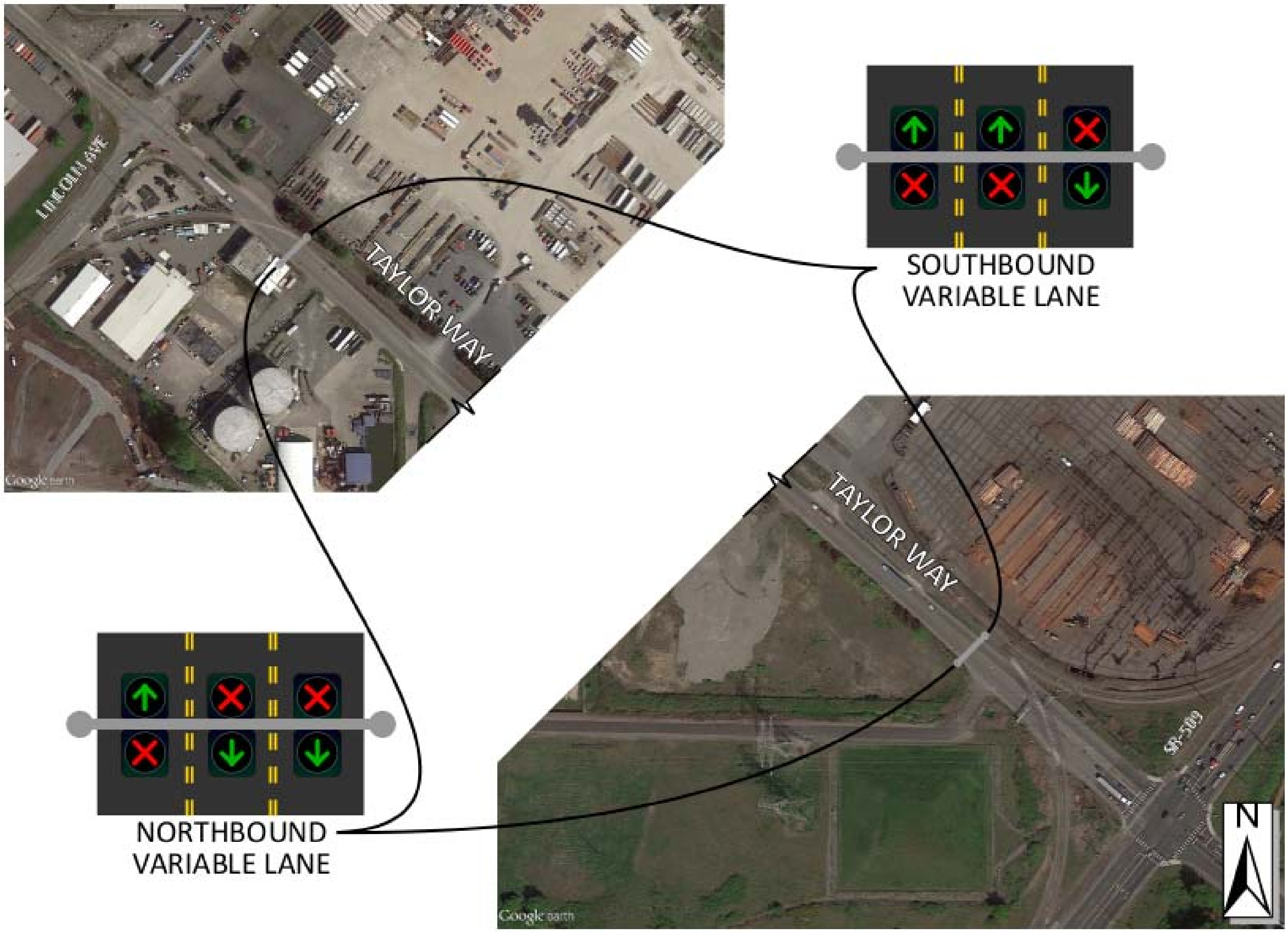
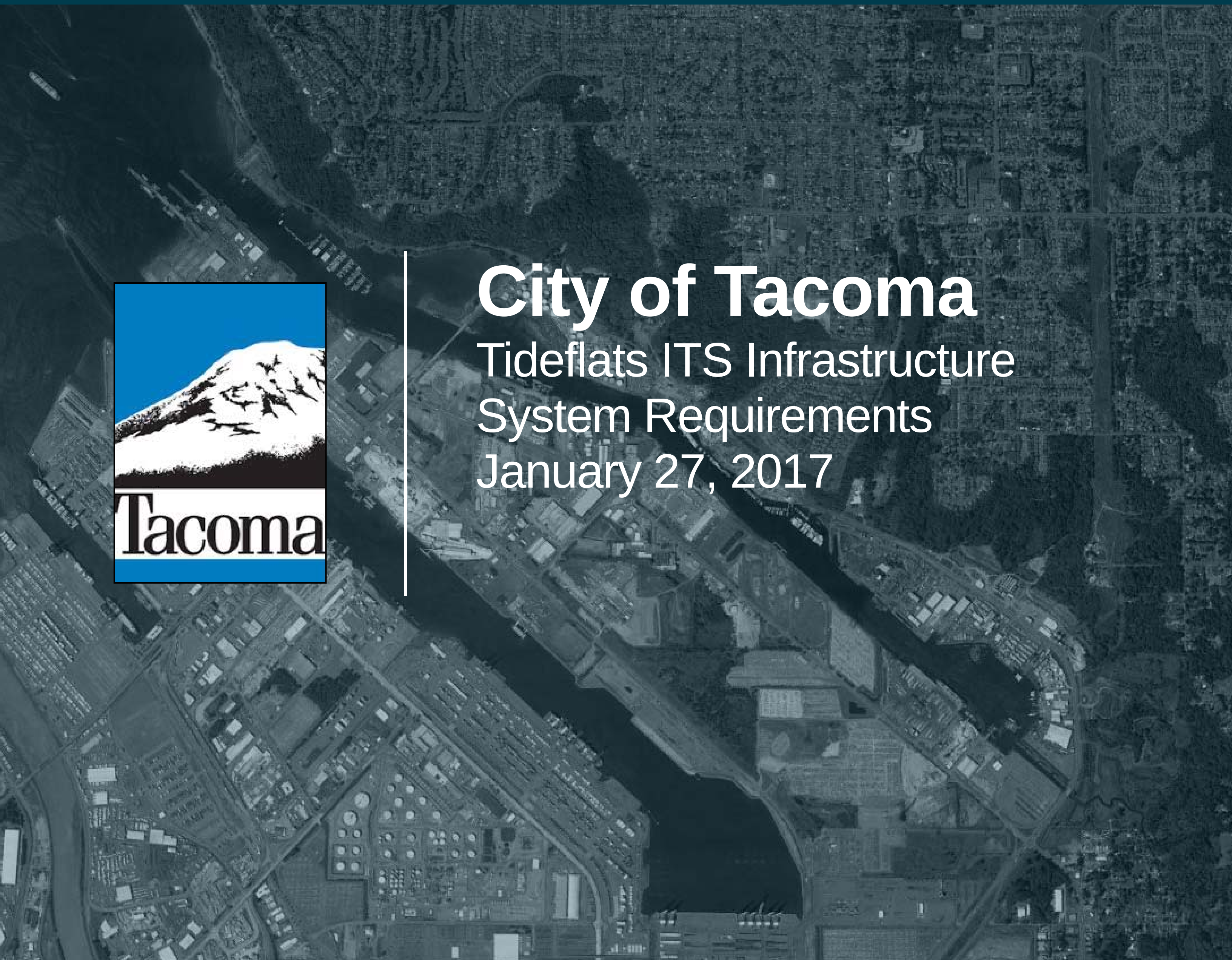


Figure 8. Taylor Way Active Lane Management



City of Tacoma

Tideflats ITS Infrastructure System Requirements

January 27, 2017

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City of Tacoma Tideflats ITS Infrastructure **DRAFT**
Optimization of Traffic Signal Operations
System Requirements
Last Updated: 1/27/2017

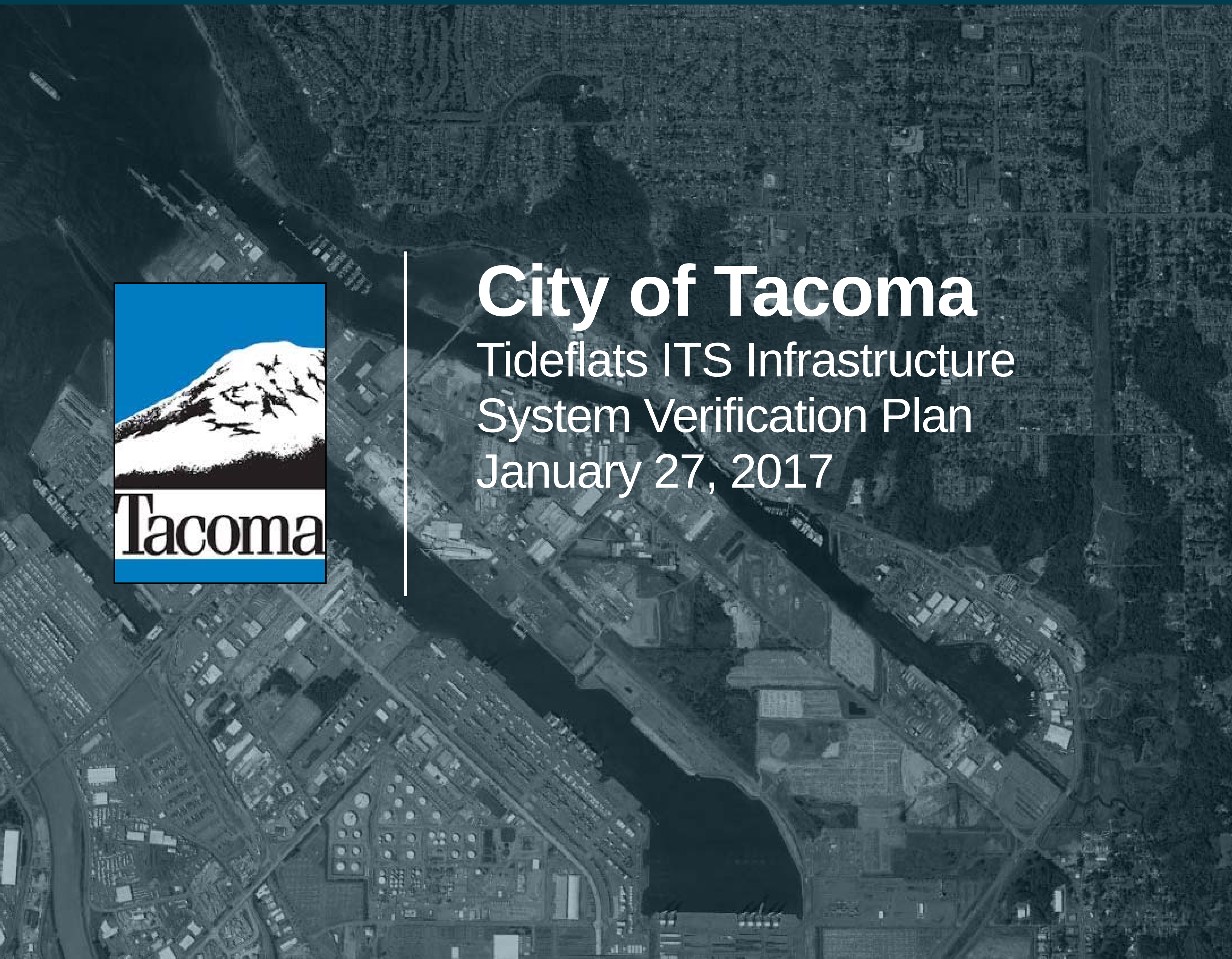
Requirements Reference Number	System Requirements	Need Statement (#.# Represents Relevant Concept of Operations Section)	Meets Requirements	Partially Meets Requirements	Requirements in Development	Requirements Not Available	Briefly discuss how requirement is met and if partially met or in development, how it could be met before the City of Tacoma Verification	Proposed Test Location	Pass/Fail	Briefly discuss the reasons if the verification test fails and how the issues will be resolved.	Desirable/ Mandatory
1.0	**Functional Requirements**										
1.1	*Optimization of Traffic Signal Operations*										
1.1.1	Conduct engineering analysis.	Understand existing traffic operations in order to identify problem areas 2.1									
1.1.2	Modify signal timing and phasing to maximize level of service.	Improvement upon existing level of service to generate reduction in delay 2.1									
1.1.3	Implement signal coordination along the project corridors; East 11th Street, Lincoln Avenue, East Portland Avenue, Milwaukee Way, Port of Tacoma Road, Alexander Avenue East and Taylor Way.	Improvement on flow through corridors to generate reduction in travel times 2.1									
1.2	*Traffic Signal Priority and Pre-Emption*										
1.2.1	Install emergency pre-emption at each traffic signal in the study area.	Meet nationally accepted response time for first responders. 2.2									
1.2.2	Install traffic signal priority at signals adjacent to freight corridors (i.e. rail crossings)	Improve active phases to reduce impact of interruption in service due to rail crossing activations, improving travel times. 2.2									
1.3	*Incident Management*										
1.3.1	Install CCTV cameras to obtain video coverage at signalized intersections with at-grade rail crossings.	Allow for remote view of event/incident locations such that alternate routes, estimation of response needs, etc. can be determined prior to travel. 2.3									
1.3.2	Install CCTV cameras to obtain video coverage at non-signalized at-grade rail crossings	Allows for remote view of event/incident locations such that alternate routes, estimation of response needs, etc. can be determined prior to travel. Don't have to be physically at the crossing so long as it has a view of the crossing. 2.3									
1.3.3	Install CCTV cameras to obtain coverage at signalized intersections without at-grade crossings.	Allows for remote view of event/incident locations such that alternate routes, estimation of response needs, etc. can be determined prior to travel. 2.3									
1.3.4	Determine feasible utilization of ongoing developments to minimize need for new facilities.	Viewpoint System, South Sound 911 system, NW Seaport Alliance Operations Service Center could all benefit from acquiring more data, and City, Port and other stakeholders can benefit from access to the data generated by those developments. 2.3									
1.4	*Tideflats Area 511 Service*										
1.4.1	Integrate data collection of relevant data from existing WSDOT 511 system.	Collection of existing WSDOT data to integrate with new data 2.4									
1.4.2	Collect data within the Tideflats area via various methods (video [Flir, gridsmart], Bluetooth, Wi-Fi, Wavetronix, Leddar, etc.)	Augment existing WSDOT 511 data with new data collection within the Tideflats area. (Leidos) 2.4									
1.4.3	Analyze collected data and format results to desired dissemination method(s).	Collected data is analyzed (either via software or user) and prepared for dissemination to the public. 2.4									
1.4.4	Disseminate information to users via various methods (website, mobile app, changeable message sign)	Data is sent to users via various means so as to reach as many users as possible. 2.4									
1.5	*Active Lane Management*										
1.5.1	Install static and variable signage to implement variable lane controls on key arterials.	Improve maximum capacity as determined but need dependent on time of day, collected volumes, incident or other event. 2.5									
1.6	*Provision of Supporting System Infrastructure*										
1.6.1	Minimize installation of new fiber optic facilities by leveraging existing fiber optic facilities.	Leverage existing facilities by forming relationships with existing owners to reduce costs of installing new infrastructure. 2.6									
1.6.2	Install new fiber optic facilities to fill in gaps that are unable to be completed by utilizing existing facilities.	Complete the network such that communication between the Tideflats area and the City is complete, reliable and redundant. 2.6									
2.0	**Performance Requirements**										
2.1	*Traffic Signal Operations*										
2.1.1	Maintain Level of Service D	Minimum acceptable level of service per City of Tacoma. 2.1									
2.1.2	Measure of progression (number of stops, adaptive)	Progression is measured at intervals (identify industry standard amount of time) to determine overall improvement in system. 2.1									
2.1.3	System shall be capable of alerting the City when maintenance is required	Maintain system when alerted to issues in real-time. 2.1									

2.1.4	Signal controllers shall be compatible with the existing City system (TACTICS, M60)	Compatible with existing City systems	2.1									
2.1.5	Signal controllers shall be capable of running adaptive system	Adaptive is potential for future implementation. Equipment shall not have to be upgraded in order to implement.	2.1									
2.1.6	Traffic signal installations/modifications shall meet requirements set forth in the City of Tacoma Right of Way Design Manual	Adhere to owner/operator standards	2.1									
2.1.7	Video/other detection shall be capable of transmitting live video footage to approved users.	Ability to share video feeds from all video sources.	2.3									
2.1.8	Vehicle detection shall be capable of collecting volume by lane.	Improved operation due to diversity of data.	2.1									
2.1.9	Vehicle detection shall be capable of collecting vehicle velocity.	Improved operation due to diversity of data.	2.1									
2.1.10	Vehicle detection system shall be capable of accepting video from non-fixed CCTV cameras as well as traditional video detection cameras.	Allow PTZ cameras to collect data for use in multiple systems	2.1									
2.2	*Traffic Signal Signal Preemption Control*											
2.2.1	System shall accommodate both GPS and Opticom detection	Current use of standard Opticom system with ability to update to GPS as agencies transition.	2.2									
2.2.2	System shall improve response times for any location within public right of way in the Tideflats area to a maximum of 4 minutes.	Meet nationally accepted response time for first responders.	2.2									
2.2.3	Signalized intersections with pre-emption control shall have battery back-up.	As required by MUTCD	2.2									
2.2.4	Traffic control signals that are designed to respond under preemption or priority control to more than one type or class of vehicle should be designed to respond in the relative order of importance or difficulty in stopping the type or class of vehicle.	The order of priority should be: train, boat, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired freight, rubber-tired transit.	2.2									
2.3	*Freight Vehicle Priority Control*											
2.3.1	If an at-grade rail crossing is equipped with a flashing-light signal system and is located within 200 feet of an intersection or midblock location controlled by a traffic control signal, the traffic control signal shall be provided with preemption.	As required by MUTCD	2.2									
2.3.2	At-grade rail crossings within 200 feet of an intersection or midblock location controlled by a traffic control signal shall have flashing-light signal systems.	Provide more points of interaction between rail and signals and clear indication of potential conflict between road vehicles and rail vehicles.	2.2									
2.3.3	System shall be capable of favoring platooning of Port-specific cargo/traffic.	Automobile imports typically transfer from location to location in platoons of vehicles.	2.2									
2.3.4	Signalized intersections with priority control shall have battery back-up.	As required by MUTCD	2.2									
2.3.5	Traffic control signals that are designed to respond under preemption or priority control to more than one type or class of vehicle should be designed to respond in the relative order of importance or difficulty in stopping the type or class of vehicle.	The order of priority should be: train, boat, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired freight, rubber-tired transit.	2.2									
2.4	*Video/ Traffic Observation*											
2.4.1	System shall be capable of visual confirmation of all active at-grade rail crossings	Allow for confirmation of accessibility of any active rail crossing location.	2.3									
2.4.2	System shall be capable of transmitting live video footage to approved users.	Permissions can be set to allow some users to view/use specific data.	2.3									
2.4.3	System shall be capable of setting user permissions defining which agencies have access and to what extent they can utilize it.	Permissions can be set to allow some users to view/use specific data.	2.3									
2.4.4	CCTV camera video and power cables shall route to the one of the following locations in the listed priority; 1) Nearest existing traffic signal cabinet, 2) Nearest existing CCTV cabinet, 3) New CCTV cabinet.	Utilize existing infrastructure as much as is feasible.	2.3									
2.4.5	If the cost to install conduit and cables to the nearest existing cabinet outweighs the cost to install a new cabinet, then a new CCTV cabinet shall be constructed. This cabinet shall receive power from the nearest service feed point as determined by Tacoma Power, and it shall tie into the fiber optic cable network at the nearest feasible point.	Only install new infrastructure in the event that the cost to utilize existing infrastructure is greater.	2.3									
2.5	*Fiber Optic Network*											

2.5.1	Fiber optic network shall form a redundant ring within the Tideflats area.	Ensure redundancy within the Tideflats. (i.e. all data collected within Tideflats shall have a complete path to WSDOT TMC even if a fiber cable is interrupted)	2.6									
2.5.2	Fiber optic data shall route through WSDOT TMC, City of Tacoma signal shop and shall terminate at City of Tacoma City Hall.	Data and systems shall always be accessible by City of Tacoma users.	2.6									
2.5.3	City of Tacoma Network shall be compatible with existing Click! Network fiber optic cable.	Ensure ability to maximize use of existing facilities.	2.6									
2.5.4	City of Tacoma Network shall be compatible with existing City of Tacoma Fire Department fiber optic cable.	Ensure ability to maximize use of existing facilities.	2.6									
2.5.5	City of Tacoma Network shall be compatible with existing WSDOT fiber optic cable.	Ensure ability to maximize use of existing facilities.	2.6									
2.6	*Data Collection*											
2.6.1	City of Tacoma staff shall have priority access to the system.	WSDOT shall not be able to block City of Tacoma access to system.	2.6									
2.6.2	System shall be configurable such that City manages connection.	City of Tacoma shall set user permissions and control flow of data in and out of the hub (WSDOT TMC)	2.6									
2.7	*Data Dissemination (i.e. VMS, App, etc.)*											
	System shall be capable of storing a library of pre-determined messages for VMS.	Library of most common messages used. i.e. standard detours and road closures	2.4									
	User shall have the option of generating a VMS message or utilizing a message library.	Custom messages for occurrences where a message in the library does not fit the scenario.	2.4									
3.0	**Interface Requirements**											
3.0.1	All systems shall be operable via web-based interface from any City of Tacoma terminal with access to the network.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.0									
3.0.2	Interface shall be capable of showing all independent systems on an interactive map of the City.	User-friendly graphical interface.	3.0									
3.0.3	Specific systems shall be accessible via click-through of symbols on the interactive map.	User-friendly graphical interface.	3.0									
3.0.4	System shall be capable of displaying on a multi-screen video wall that is fully configurable.	Entire video wall shall be able to display one interface across all screens or an individual interface on each screen.	3.0									
3.1	*Optimization of Traffic Signal Operation*											
3.1.1	Operators shall be able to view current signal timing and phasing from any terminal with access to the traffic signal network.	Maximum flexibility and no special hardware needed for full access to the system.	3.1									
3.1.2	Operators shall be able to modify signal timing and phasing from any terminal with access to the traffic signal network.	Maximum flexibility and no special hardware needed for full access to the system.	3.1									
3.1.3	Terminals outside of City of Tacoma that are able to access the traffic signal network shall require special access in order to view signal timing.	Access only given to those authorized to have access to traffic signal operations data.	3.1									
3.1.4	Terminals outside of City of Tacoma that are able to access the traffic signal network shall require special access in order to modify signal timing.	Access only given to those authorized and properly trained to modify signal operations.	3.1									
3.1.5	System shall be capable of saving and utilizing timing programs for special events and incidents.	Ability to pre-program timing scenarios to be implemented as needed, then easily returned to normal operation when need passes.	3.1									
3.2	*Traffic Signal Priority and Preemption*											
3.2.1	Preemption and priority settings shall be adjustable through the same interface as traffic signal operations.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.2									
3.2.2	Emergency preemption shall be configurable independent of non-emergency priority.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.2									
3.2.3	Non-emergency priority shall be configurable independent of emergency preemption.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.2									
3.3	*Closed Circuit Television Cameras*											
	Camera interface shall include controls for pan/tilt/zoom operation of cameras.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.3									
	Each camera shall have an individual interface and system shall be capable of accessing and displaying multiple camera feeds simultaneously.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.3									
3.4	*Variable Message Signs*											

	Representation of VMS on interactive city map shall indicate accurate position including side of road and direction of sign face.	User-friendly graphical interface.	3.4									
	VMS interface shall represent the real-world limits of the physical sign including number of lines and number of characters per line.	User-friendly graphical interface.	3.4									
	Message library shall be easily accessible either through menus or clickable icons.	User-friendly graphical interface.	3.4									
	All facets of message formatting supported by the physical hardware shall be represented in the sign interface.	Signs shall be capable of advance formatting features such as blinking text, bold text, variable font sizes, etc.	3.4									
3.5	*System Detection*											
	Data collection stations not associated with a signalized intersection shall be graphically represented on the interactive map.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.4									
	Interface shall have the ability to generate reports from collected data.	User-friendly data analysis	3.4									
	Report function shall have user-specified variables including specific date or date range, time of day, and type of data to view (i.e. hourly volumes, daily volumes, peak hour volumes, velocity, etc.)	User-friendly data analysis	3.4									
	Report function shall be capable of exporting data to .xls or .cvs format, to be chosen by the user.	User-friendly data analysis	3.4									
3.6	Active Lane Signage											
	Interactive city map shall always show the current configuration of the active lane signage.	User-friendly graphical interface.	3.5									
	Operators shall be able to modify active lane settings from any terminal with access to the network.	Maximum flexibility and no special hardware or software needed for full access to the system.	3.5									
	Terminals outside of City of Tacoma that are able to access the network shall require special access in order to modify active lane settings.	Remove potential for modification of system in a detrimental manner.	3.5									
4.0	**Data Requirements**											
4.1	*Review of Intersection Performance Data*											
4.1.1	Intersection performance data shall be reviewed every 5 years to determine whether geometric improvements can remedy approaches exceeding 90% saturation for 200 hours per year on weekdays and 100 hours per year at other times.	Continually ensure that best possible performance is maintained.	2.1									
4.1.2	Intersection performance data shall be reviewed to determine whether phasing or type of signal control (actuation, etc.) can improve performance.	Continually ensure that best possible performance is maintained.	2.1									
4.1.3	Signal timing performance shall be reviewed using a documented methodology every 3 years to identify the need for retiming. Where automatically collected data is available, signal timing performance shall be reviewed every 6 months. A methodology to establish the priority of retiming requirements shall be used.	Continually ensure that best possible performance is maintained.	2.1									
4.2	*System Detection*											
4.2.1	All detection data whether from loops or video and whether at an intersection or midblock shall be usable by an adaptive signal system.	Flexibility of data for all potential future applications.	2.1									
4.3	*Tideflats Area 511 Service*											
4.3.1	System shall be compatible with and able to utilize all data provided by the existing WSDOT 511 service.	Compatible symbiotic systems	2.4									
4.3.2	Data generated for the 511 service shall be compatible with and available to the existing WSDOT 511 service.	Compatible symbiotic systems	2.4									
4.3.3	Data generated for the 511 service shall be compatible with all potential means of dissemination	Compatible symbiotic systems	2.4									
5.0	**Non-Functional Requirements**											
5.1	*Reliability*											
5.1.1	System shall be capable of recognizing when something in the system is malfunctioning.	Minimize downtime due to equipment, data failure of the system.	4.0									

5.1.2	System shall alert users when it detects a malfunction.	Minimize downtime due to equipment, data failure of the system.	4.0										
5.1.3	System shall undergo regularly scheduled maintenance.	Minimize downtime due to equipment, data failure of the system.	4.0										
5.2	*Safety*												
5.2.1	All at-grade rail crossings should have crossing signage with actuated flashing beacons.	Reduce potential for train/vehicle collisions	3.2										
5.2.2	All at-grade rail crossings shall have appropriate signage indicating the crossing and the number of tracks (if more than one).	Per MUTCD	3.2										
6.0	**Enabling Requirements**												
6.1	*Fiber Optic Network*												
6.1.1	Agreement shall be made with Click! Network for the use of their fiber optic cable within the Tideflats area.	Leverage existing fiber optic facilities	2.6										
6.1.2	Agreement shall be made with City of Tacoma Fire for the use of their fiber optic cable within the Tideflats area.	Leverage existing fiber optic facilities	2.6										
6.1.3	Agreement shall be made with WSDOT for the use of their fiber optic cable within the Tideflats area and to complete connection from Tideflats area to WSDOT TMC and from WSDOT TMC to City of Tacoma.	Leverage existing fiber optic facilities	2.6										
6.1.5	City of Tacoma network shall consist of new fiber optic cable in new conduit between gaps in the existing fiber optic cable networks of Click! Network, City of Tacoma Fire Department and WSDOT.	Install new fiber optic facilities to fill gaps and form a complete fiber-optic communication network.	2.6										
6.2	*Traffic Signal Operations*												
6.2.1	Permissions to modify traffic signal operations shall not be granted to any user who is not trained in traffic signal operations.	Remove potential for modification of system in a detrimental manner.	2.1										
7.0	**Constraints**												
7.1	*Security*												
7.1.1	System shall employ security measures to block access by non-approved users.	Remove potential for modification of system in a detrimental manner.	2.6										
7.1.2	System shall record a log of all user access including date, time of day, and duration every time a user logs into the system.	Remove potential for modification of system in a detrimental manner.	2.6										
7.1.3	System shall alert system administrator whenever a user attempts to access the system with incorrect credentials.	Remove potential for modification of system in a detrimental manner.	2.6										
7.1.4	System shall warn a user with 29 minutes of inactivity that they will be disconnected from the system. After one minute (total 30 minutes of inactivity), the system will automatically disconnect the user from the system.	Remove potential for modification of system in a detrimental manner.	2.6										



City of Tacoma

Tideflats ITS Infrastructure System Verification Plan

January 27, 2017

Prepared by:

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TABLE OF CONTENTS

1 Introduction

This document presents the verification plan for the systems identified in the concept of operations for the City of Tacoma Tideflats and Port of Tacoma ITS Strategic Plan. This document is part of the System Engineering documents that have been developed by the City of Tacoma to identify various systems to be deployed in the Tideflats area. Completion of this testing procedure will be a requirement to obtain federal grant money to fund the projects which will implement the systems. This document describes the scope of the project; the referenced documents that are used to prepare the verification plan; details of conducting the verification; and a list of the operational needs, (defined by the "Needs Statements" in the attached table) and corresponding System Requirements to be tested.

2 Project Scope

The scope of this project is to create a deployment plan with projects prioritized that will effectively meet the existing and future transportation needs and expectations for the City of Tacoma, in particular in the Tideflats area. This plan will consider various ITS systems enabled by ITS devices and will provide a deployment plan which will identify individual projects which will install the devices and provide a complete system within a ten-year period.

3 Referenced Documents

The following documents supported the preparation of the verification plan:

- Systems Engineering Guidebook for ITS, California Department of Transportation, Division of Research & Innovation, Version 3.0, http://www.fhwa.dot.gov/cadiv/segb/
- Tideflats and Port of Tacoma ITS Strategic Plan (Fehr & Peers)
- Tideflats Concept of Operations
- Tideflats System Requirements

4 Conducting Verification

Each of the System Requirements identified by the City of Tacoma shall be tested according to this Verification Plan. The system vendors shall conduct the verification in the presence of City of Tacoma staff or its consultant. The attached verification table identifies the test location for each System Requirement. The test location is to be identified by the Vendor as “bench”, “field”, or both. If required, the Vendor shall conduct bench testing of the identified System Requirements at a City of Tacoma facility. If both bench and field testing is required, the Vendor shall conduct bench testing before the field verification tests for the identified System Requirements. The Vendor shall coordinate all field tests with the City of Tacoma to schedule testing time periods and to gain access to hardware such as detection, controller equipment, and traffic surveillance cameras.

The Vendor shall use the table provided to document the test results. Any failure or lack of performance to meet the stated System Requirements shall be recorded at the time of test and when all are complete, the Vendor shall prepare a report stating why any System Requirements were not met. The report shall include a proposed solution to resolve the deficiency and shall be submitted to the City within seven days of the failure. Those solutions shall not include software revisions. Upon completion of all required verification testing, the Vendor shall prepare a final verification report, which will contain all information regarding testing, including both failures and successes. This shall also include a summary of plans developed to resolve failures. The final verification report shall include a list of all hardware, software and special equipment utilized in the testing.

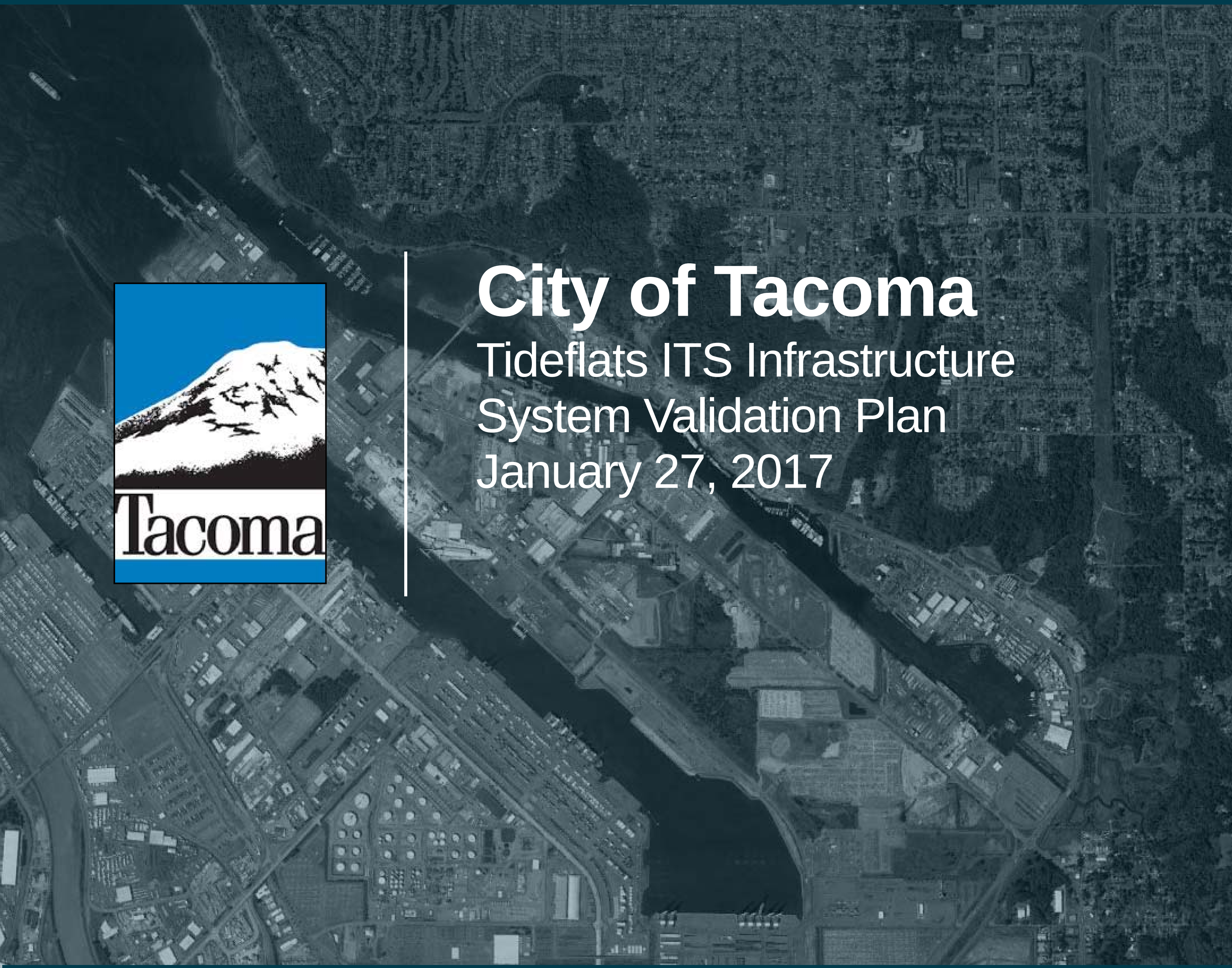
5 Verification Identification

The System Requirements table shall be utilized to document the verification testing completed by the Vendor. Each System Requirement consists of one or more “Need Statements.” The number above each Need Statement references the Concept of Operations document section that describes that need. The tests do not need to be conducted in the order presented. The Vendor is allowed to rearrange the verification tests into “cases,” as desired, to more efficiently test the system. A “case” is a logical grouping of functions and performance criteria that are verified together. The verification conductor shall provide the proposed logical grouping (if re-arranged) to the City for review and approval before conducting the verification tests.

Prior to testing, the Vendor and City of Tacoma staff shall review the verification table and proposed cases to document the following:

- Hardware and software items needed to perform the verification and a description of the setup requirements
- Data to be recorded, if any, that is specific to the output of the selected system

A list of any other important assumptions or constraints on the testing that are specific to the selected system



City of Tacoma

Tideflats ITS Infrastructure System Validation Plan

January 27, 2017

Prepared by:

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TABLE OF CONTENTS

1 Introduction

This document presents the system validation plan for the systems identified in the concept of operations for the City of Tacoma Tideflats and Port of Tacoma ITS Strategic Plan. This document is part of the System Engineering Documents that have been developed by the City of Tacoma to identify various systems to be deployed in the Tideflats area. Completion of this testing procedure will be a requirement to obtain federal grant money to fund the projects which will implement the systems. This document describes the scope of the project; the referenced documents that are used to prepare the validation plan; details of conducting the validation; and a list of the operational needs that shall be validated.

2 Project Scope

The scope of this project is to create a deployment plan with projects prioritized that will effectively meet the existing and future transportation needs and expectations for the City of Tacoma, in particular in the Tideflats area. This plan will consider various ITS systems enabled by ITS devices and will provide a deployment plan which will identify individual projects which will install the devices and provide a complete system within a ten-year period.

3 Referenced Documents

The following documents supported the preparation of the verification plan:

- Systems Engineering Guidebook for ITS, California Department of Transportation, Division of Research & Innovation, Version 3.0, http://www.fhwa.dot.gov/cadiv/segb/
- Tideflats and Port of Tacoma ITS Strategic Plan (Fehr & Peers)
- Tideflats Concept of Operations
- Tideflats System Requirements

4 Conducting Validation

The Validation Test will be performed after the implementation of the selected ITS system(s). City of Tacoma staff or its consultant will conduct the system validation. The person conducting the test will be referred to as the "validation conductor" in this document. The validation conductor will record the results and prepare a summary report of the results.

Before conducting any validation tests, the validation conductor will prepare a validation procedure for the validation test. The validation procedure will describe the equipment setup, responsible personnel and steps to be followed to conduct the validation test that are specific to the system selected by the City of Tacoma.

The validation tests will be conducted after the system deployment and verification tests are complete. The validation conductor will configure the system software to collect and process data for validation tests. The validation conductor may need to observe traffic operation in the field or via traffic cameras to measure test outcomes of some validation tests.

Validation of some tests will require a comparison of operations before and after implementation of the system. Data to be used for validation should be collected prior to implementation of the system or during a brief period after implementation when the system is turned off, specifically for collecting before data.

5 Validation Identification

The following table identifies the validation tests that will be collected and documented by the validation conductor. The validation tests will validate user needs described in the Concept of Operations document. The first two numbers of the "Validation Number" correspond to the section of the Concept of Operations that describes the "Needs Statement".

The Data Source identified for each test is an estimation of the means for collecting the data needed to complete the test. The final source will be customized to match data available with the selected system. User needs related to system interface and control features will be tested through the system verification only (per "System Verification").

City of Tacoma Tideflats ITS Infrastructure

DRAFT

Optimization of Traffic Signal Operations

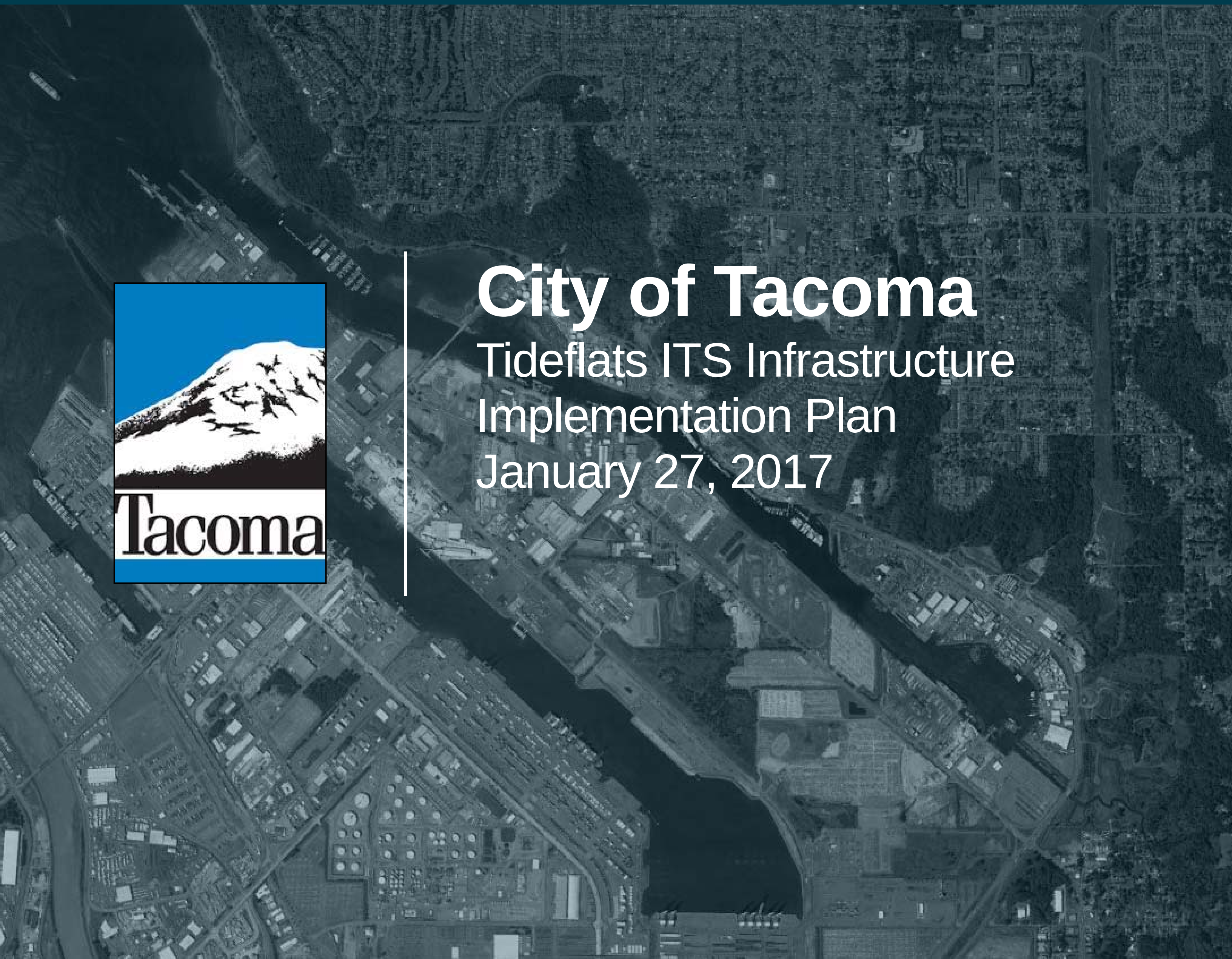
Validation Plan

Last Updated: 1/27/2017

Validation Reference No.	Need Statement (#.# Represents Relevant Concept of Operations Section)		Proposed Data Source	Pass/Fail
1.0	**Functional Requirements**			
1.01	Allow for remote view of event/incident locations such that alternate routes, estimation of response needs, etc. can be determined prior to travel.	2.3	Live Video Feed	
1.02	Augment existing WSDOT 511 data with new data collection within the Tideflats area. (Leidos)	2.4	System Verification	
1.03	Collected data is analyzed (either via software or user) and prepared for dissemination to the public.	2.4	System Verification	
1.04	Collection of existing WSDOT data to integrate with new data	2.4	System Verification	
1.05	Complete the network such that communication between the Tideflats area and the City is complete, reliable and redundant.	2.6	Planning	
1.06	Data is sent to users via various means so as to reach as many users as possible.	2.4	System Verification	
1.07	Improve active phases to reduce impact of interruption in service due to rail crossing activations, improving travel times.	2.2	Observation	
1.08	Improvement on flow through corridors to generate reduction in travel times	2.1	Observation	
1.09	Improvement upon existing level of service to generate reduction in delay	2.1	Observation	
1.10	Leverage existing facilities by forming relationships with existing owners to reduce costs of installing new infrastructure.	2.6	Contract	
1.11	Improve maximum capacity as determined but need dependent on time of day, collected volumes, incident or other event.	2.5	Observation	
1.12	Understand existing traffic operations in order to identify problem areas	2.1	Observation	
1.13	Viewpoint System, South Sound 911 system, NW Seaport Alliance Operations Service Center could all benefit from acquiring more data, and City, Port and other stakeholders can benefit from access to the data generated by those developments.	2.3	Planning	
2.0	**Performance Requirements**			
2.01	Allow PTZ cameras to collect data for use in multiple systems	2.1	Vendor	
2.02	Adaptive is potential for future implementation. Equipment shall not have to be upgraded in order to implement.	2.1	System Verification	
2.03	Adhere to owner/operator standards	2.1	System Verification	
2.04	Ability to share video feeds from all video sources.	2.3	System Verification	
2.05	Allow for confirmation of accessibility of any active rail crossing location.	2.3	Live Video Feed	
2.06	As required by MUTCD	2.2	System Verification	
2.07	Automobile imports typically transfer from location to location in platoons of vehicles.	2.2	Observation	
2.08	Maintain system when alerted to issues in real-time.	2.1	System Verification	
2.09	City of Tacoma shall set user permissions and control flow of data in and out of the hub (WSDOT TMC)	2.6	System Verification	
2.10	Compatible with existing City systems	2.1	Equipment Specifications	
2.11	Current use of standard Opticom system with ability to update to GPS as agencies transition.	2.2	Vendor	
2.12	Custom messages for occurrences where a message in the library does not fit the scenario.	2.4	Vendor	
2.13	Data and systems shall always be accessible by City of Tacoma users.	2.6	System Verification	
2.14	Ensure redundancy within the Tideflats. (i.e. all data collected within Tideflats shall have a complete path to WSDOT TMC even if a fiber cable is interrupted)	2.6	Planning	
2.15	Ensure ability to maximize use of existing facilities.	2.6	Planning	
2.16	Library of most common messages used. i.e. standard detours and road closures	2.4	Vendor	
2.17	Minimum acceptable level of service per City of Tacoma.	2.1	City Standards	
2.18	Improved operation due to diversity of data.	2.1	Observation	
2.19	Meet nationally accepted response time for first responders.	2.2	Observation	
2.20	Only install new infrastructure in the event that the cost to utilize existing infrastructure is greater.	2.3	Planning	
2.21	Permissions can be set to allow some users to view/use specific data.	2.3	System Verification	
2.22	Progression is measured at intervals (identify industry standard amount of time) to determine overall improvement in system.	2.1	Observation	
2.23	Provide more points of interaction between rail and signals and clear indication of potential conflict between road vehicles and rail vehicles.	2.2	Planning	
2.24	The order of priority should be: train, boat, heavy vehicle (fire vehicle, emergency medical service), light vehicle (law enforcement), light rail transit, rubber-tired freight, rubber-tired transit.	2.2	System Verification	
2.25	Utilize existing infrastructure as much as is feasible.	2.3	Planning	
2.26	WSDOT shall not be able to block City of Tacoma access to system.	2.6	Contract/Vendor	
3.0	**Interface Requirements**			

City of Tacoma Tideflats ITS Infrastructure **DRAFT**
Optimization of Traffic Signal Operations
Validation Plan
Last Updated: 1/27/2017

Validation Reference No.	Need Statement (#.# Represents Relevant Concept of Operations Section)		Proposed Data Source	Pass/Fail
3.01	Access only given to those authorized to have access to traffic signal operations data.	3.1	System Verification	
3.02	Access only given to those authorized and properly trained to modify signal operations.	3.1	System Verification	
3.03	Ability to pre-program timing scenarios to be implemented as needed, then easily returned to normal operation when need passes.	3.1	System Verification	
3.04	Entire video wall shall be able to display one interface across all screens or an individual interface on each screen.	3.0	Vendor	
3.05	Signs shall be capable of advance formatting features such as blinking text, bold text, variable font sizes, etc.	3.4	Vendor	
3.06	Maximum flexibility and no special hardware needed for full access to the system.	3.1	System Verification	
3.07	User-friendly data analysis	3.4	Vendor	
3.08	User-friendly graphical interface.	3.5	Vendor	
4.0	**Data Requirements**			
4.01	Continually ensure that best possible performance is maintained.	2.1	Observation	
4.02	Flexibility of data for all potential future applications.	2.1	Vendor	
4.03	Compatible symbiotic systems	2.4	System Verification	
5.0	**Non-Functional Requirements**			
5.01	Minimize downtime due to equipment, data failure of the system.	4.0	System Verification	
5.02	Reduce potential for train/vehicle collisions	3.2	Observation	
6.0	**Enabling Requirements**			
6.01	Install new fiber optic facilities to fill gaps and form a complete fiber-optic communication network.	2.6	Planning	
6.02	Leverage existing fiber optic facilities	2.6	Contract	
6.03	Remove potential for modification of system in a detrimental manner.	2.1	System Verification	



City of Tacoma

Tideflats ITS Infrastructure Implementation Plan

January 27, 2017

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TABLE OF CONTENTS

1 INTRODUCTION

In the Concept of Operations, we looked at six ITS strategies that would be used in the Tideflats area. In this section we will categorize and prioritize the various projects that will complete these strategies such that the City has a well-defined plan for the order in which to implement as well as a timeline of when to implement these projects.

1.1 Project Development

Through the process of creating the Concept of Operations and System Requirements, as well as referring back to the Fehr & Peers report, the six ITS strategies were identified. From these strategies specific projects were identified to accomplish the goals of the strategies.

1.2 Project Priority Strategy

The general strategy for determining priority of projects had two facets. The first was to establish the infrastructure needed for the projects that would come after and the second was to focus on the areas that need the most improvement. priority was given to specific areas of the Tideflats region, as well as to specific projects, primarily based on the order of implementation needed for each piece of the whole system to function as it is installed. The highest priority was given to the area of the Tideflats that was deemed the most problematic and would see the most near-term growth, the Hylebos Peninsula. Further, priority was given to those projects which would complete infrastructure necessary for the implementation of the projects that would come after it. Priority then generally moves from east to west, and south to north, with the final piece being a small segment on SR 509 which in this area is also Marine View Drive. This small section is technically part of the Tideflats area, but the signal modifications implemented here will have minimal impact on the Tideflats itself, so they fall into the lowest category, Priority Level 3.

The defined projects were then categorized into priority based on time-frame of installation. Short-Term projects are the highest priority and are identified to be installed within 0-3 years. Mid-term projects are slated for 4-6 years. Long-term projects are from 7-10 years, and future projects are identified as beyond 10 years. The following table and figure identify the regions of the Tideflats area and their priority, as well as the specific project list.

Category	Project ID	Project Area	Description	ITS Strategies	Cost
Short Term (0-3 years)	S1	Hylebos Peninsula	Install emergency vehicle pre-emption.	1	$ 24,000.00
	S2	Hylebos Peninsula	Install traffic signal modifications and implement signal optimization.	2	$ 750,000.00
	S3	Tideflats	Implement agreement with Click! Networks for usage of existing fiber optic network infrastructure.	6	
	S4	Tideflats	Implement agreement with Tacoma Fire Department for usage of existing fiber optic network infrastructure.	6	
	S5	City of Tacoma	Implement agreement with WSDOT for usage of existing fiber optic network infrastructure.	6	
	S6	Hylebos Peninsula	Install fiber optic infrastructure and cable to complete the network.	6	$ 500,000.00
	S7	Blair Peninsula	Install fiber optic infrastructure and cable to join Tideflats to existing WSDOT fiber optic network and complete connection between Tideflats and WSDOT TMC.	6	$ 250,000.00
	S8	Pacific Avenue	Install fiber optic infrastructure and cable to join WSDOT TMC to City of Tacoma signal shop and complete connection between Tideflats and City of Tacoma signal shop.	6	$ 250,000.00
	S9	Hylebos Peninsula	Install priority level 1 CCTV cameras.	3, 4	$ 75,000.00
	S10	Tideflats	Implement data sharing agreement with Tacoma Fire Department for CCTV video feed access.	3	
Mid Term (4-6 years)	M1	Blair Peninsula	Install emergency vehicle pre-emption.	2	$ 32,000.00
	M2	Blair Peninsula	Install traffic signal modifications and implement signal optimization.	1	$ 1,800,000.00
	M3	Blair Peninsula	Install fiber optic infrastructure and cable to complete the network.	6	$ 250,000.00
	M4	Blair Peninsula	Install priority level 1 CCTV cameras.	3, 4	$ 175,000.00
	M5	Hylebos Peninsula	Install priority level 2 CCTV cameras.	3, 4	$ 25,000.00
	M6	Tideflats	Install dynamic message signs.	3, 4	$ 500,000.00
	M7	Tideflats	Set up Port of Tacoma "Port Traveler Information" website and incorporate into State of Washington 511 system.	4	
Long Term (6-10 years)	L1	Thea Foss Peninsula	Install emergency vehicle pre-emption.	2	$ 24,000.00
	L2	Thea Foss Peninsula	Install traffic signal modifications and implement signal optimization.	1	$ 450,000.00
	L3	Thea Foss Peninsula	Install fiber optic infrastructure and cable to complete the network.	6	$ 150,000.00
	L4	Thea Foss Peninsula	Install priority level 1 CCTV cameras.	3, 4	$ 25,000.00
	L5	Blair Peninsula	Install priority level 2 CCTV cameras.	3, 4	$ 25,000.00
Future (10+ years)	F1	Hylebos Peninsula	Install Active Lane Management system, Taylor Way.	5	$ 200,000.00
	F2	Tideflats	Implement adaptive traffic control.	1	$ 2,400,000.00

Table 1.1 Implementation Plan

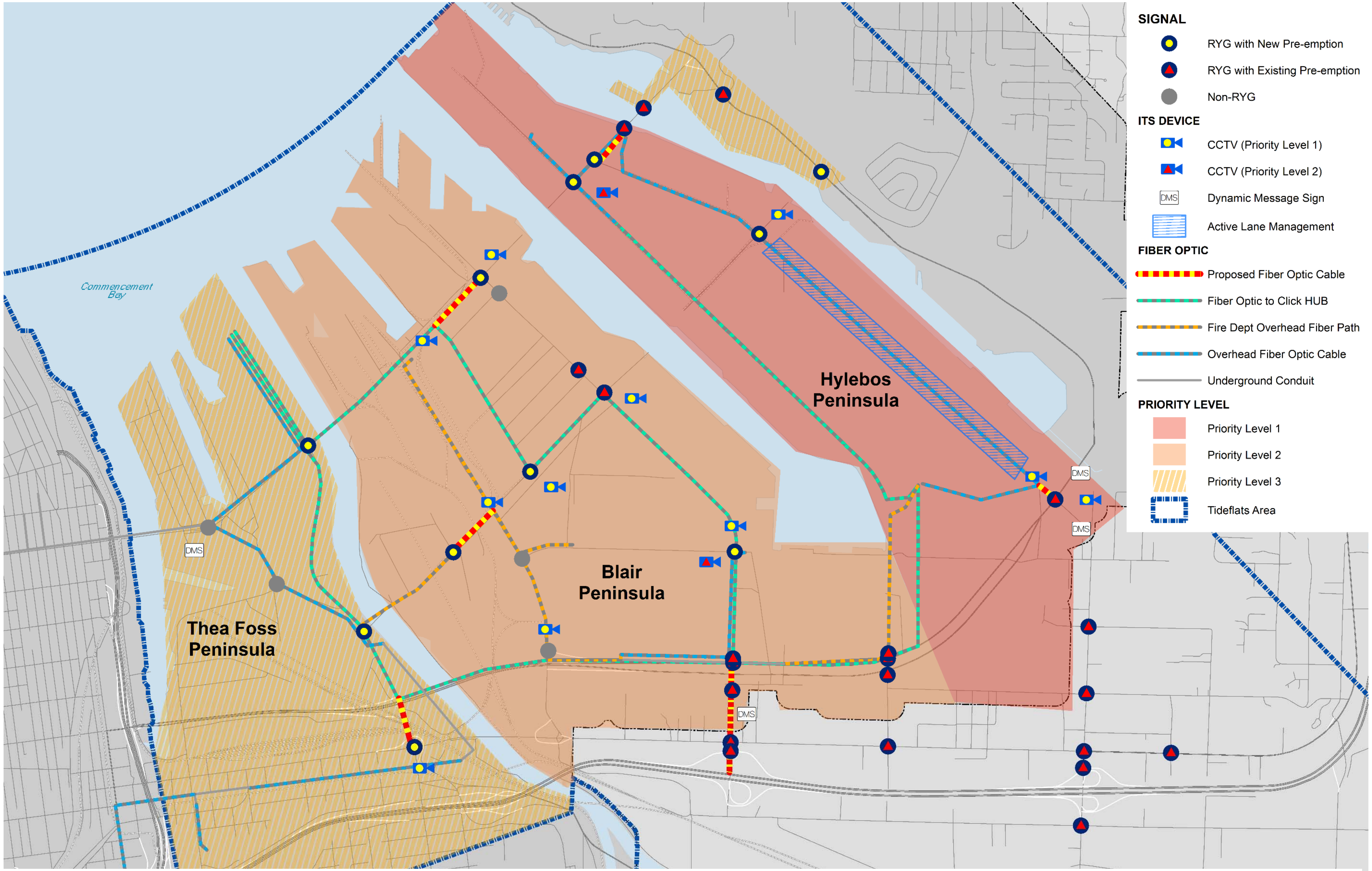

Figure 1. Implementation Plan