Communications and Technology Report

Task 140

King County Metro Transit

FINAL

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King County Metro Transit

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Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

API	Application programming interface
AVL	Automatic vehicle location
BRT	Bus rapid transit
C2C	Center-to-Center
CAD	Computer aided dispatch
Eastrail	King County’s eastside rail corridor trail
ETA	Estimated time of arrival
FTA	Federal Transit Administration
GTFS-RT	General Transit Feed Specification - Realtime
I-405 Stride	Sound Transit Interstate 405 Stride bus rapid transit service
K Line	RapidRide K Line
LPA	Locally preferred alternative
LTE	Long term evolution
Metro	King County Metro Transit
NACTO	National Association of City Transportation Officials
NEMA	National Electrical Manufacturers Association
NextGen	Next generation
NTCIP	National Transportation Communications for ITS (Intelligent Transportation Systems) Protocol
ORCA	One regional card for all
RTIS	Real time information sign
SAFTP	Stand-alone fare transaction processor
SCATS	Sydney Coordinated Adaptive Traffic System
TMC	Traffic management center
TSP	Transit signal priority
TTS	Text-to-speech
WBS	Work breakdown structure
WSDOT	Washington State Department of Transportation

1 Introduction

1.1 RapidRide K Line Overview

The RapidRide K Line Project will provide frequent, fast, reliable, efficient, and environmentally friendly bus service between the cities of Kirkland and Bellevue in East King County, connecting Totem Lake, Downtown Kirkland, South Kirkland Park & Ride, Downtown Bellevue, Bellevue College, and the Eastgate Park & Ride. In addition to connecting these regional and local centers, K Line implementation would also provide key transit connections to other regional transportation systems, including Sound Transit's Link Light Rail and bus rapid transit (BRT)systems, and to regional trails such as Eastrail and the SR 520 trail. Improvements will include an upgraded RapidRide bus fleet with increased transit service frequency, upgraded stops with additional passenger amenities, improved access to transit, increased transit speed and reliability delivered through transit priority treatments, faster station boarding, more widely spaced stops, and signal upgrades.

The K Line will serve a 16-mile corridor between Totem Lake Transit Center in Kirkland and Eastgate Park & Ride in Bellevue following portions of existing bus routes: 239, 245, 250, 255, and 271.

1.2 Purpose of this Report

Communication and technology improvements are integral to deploying transit signal priority(TSP) at signalized intersections to improve transit speed and reliability, and in providing real-time arrival information for passengers and off-board fare collection at RapidRide station locations. This report is intended to document the process to develop and deliver the communication and technology improvements for the future K Line route. This report provides an overview of Metro's communication and technology elements for RapidRide corridors, summarizes existing agency equipment and infrastructure available to support those systems, and identifies the conceptual design and estimated costs for those improvements.

The Communication and Technology Report will be used to develop a Locally Preferred Alternative (LPA) for the K Line, helping Metro to prioritize investments as part of a holistic, fiscally constrained project. It will also serve as a repository of concept ideas that might be implemented after the initial project opening when additional funds, including local grants, become available.

1.3 Study Corridor

The K Line study corridor is approximately 16 miles long and will serve the East King County cities of Kirkland and Bellevue in a north-to-south alignment. The K Line is designed to connect multiple nodes of demand and points of transfer to the regional transit system and other transportation services. The downtown cores of both cities will be served, providing excellent connections to other bus and light rail services at the Kirkland (bus only) and Bellevue (bus and light rail) Transit Centers. Three other regional bus transit centers are served by the K Line (Totem Lake, South Kirkland, and Eastgate) along with key connections to the planned Sound Transit Stride BRT at NE 85th St in Kirkland and the Bellevue Transit Center. Stride will be a highway running BRT service with two routes on the I-405 corridor from Lynnwood to Burien with an anticipated start of service in 2027/2028.

The corridor has been divided into five segments for analysis and planning purposes (Figure 1-1):

- **Segment A** includes the portion of the corridor within the City of Kirkland from the Totem Lake Transit Center to the K Line station pair at the intersection of 124th Ave NE and NE 108th Pl, near the Kirkland Boys and Girls Club. This segment includes access to Evergreen Hospital and the dense, mixed-use Village at Totem Lake.
- **Segment B** includes the portion of the corridor within the City of Kirkland from the intersection of 124th Ave NE and NE 108th Pl to the K Line station pair at the intersection of 108th Ave NE and NE 60th St. Segment B incorporates the Kirkland Transit Center extending to the southern end of the Kirkland City Center at Kirkland Ave and 6th St S. This segment includes a transfer point to the future Sound Transit I-405 Stride BRT corridor at NE 85th St/I-405, and provides access to the Kirkland Google Campus locations along Central Way (Kirkland Urban) and on 6th St S. The City of Kirkland has adopted significant upzoning in the downtown core to allow for future development growth to support increased transit with the K Line and other regional investments.
- **Segment C** includes the section of the corridor from the intersection of 108th Ave NE and NE 60th St in Kirkland to the K Line station pair at the intersection of 116th Ave NE and NE 20th St in Bellevue. Segment C includes the South Kirkland Park & Ride at the intersection of 108th Ave NE and NE 38th Pl.
- **Segment D** includes the portion of the corridor between the intersection of 108th Ave NE and NE 20th St to the K Line station pair at the intersection of Lake Hills Connector and SE 8th St/SE 7th Pl. Segment D provides service to Overlake Medical Center along 116th Ave NE and continues through Downtown Bellevue along NE 10th St, 110th Ave NE and Main St. In Downtown Bellevue, the K Line will offer easy connections to the Bellevue Transit Center (including connection points to RapidRide B Line and Sound Transit's I-405 Stride BRT), Sound Transit’s Link light rail, as well as the City's planned Grand Connection. South of Downtown Bellevue, the K Line will also offer connections to the Wilburton neighborhood and King County's Eastside Rail Corridor Trail (Eastrail). The City of Bellevue is currently considering adopting changes to its Land Use Code and Comprehensive Plan that would facilitate redevelopment that supports transit growth and would establish the Wilburton Transit Oriented Development Area.

- **Segment E** serves areas south of Downtown Bellevue and north of I-90 along Lake Hills Connector and 145th Pl SE adjacent to Bellevue College, concluding at Eastgate Park & Ride.

The K Line will generally run in parallel to the I-405 freeway, a heavily congested highway corridor that acts as a regional bypass for long-haul vehicle and truck trips traveling through the Puget Sound region and a key access route for people traveling to jobs and services in East King County. Tremendous land use changes and job growth in the three regional-designated growth centers of Totem Lake, Greater Downtown Kirkland, and Bellevue, continue to increase travel pressures in the corridor and worsen congestion.

Many people travel from residential neighborhoods along the alignment to jobs, education, and other services in Kirkland and Bellevue, as well as in Redmond and Seattle. The I-90 and SR-520 bridges serve as the two main connections for people in vehicles and on bus transit. East Link Light Rail (Sound Transit's 2 Line) will use the I-90 Bridge to provide frequent rail transit to Seattle by 2026. As a fully grade-separated service, this will provide a highly reliable travel option and create demand for transfers from bus to light rail. In advance of connection to Seattle, the 2 Line is now partially completed and open, operating between South Bellevue and Redmond Technology Station with trains every 10 min (5:30 am - 9:30 pm), 7 days per week. One purpose of the K Line will be to serve as a reliable feeder for people connecting to the light rail system in Downtown Bellevue.

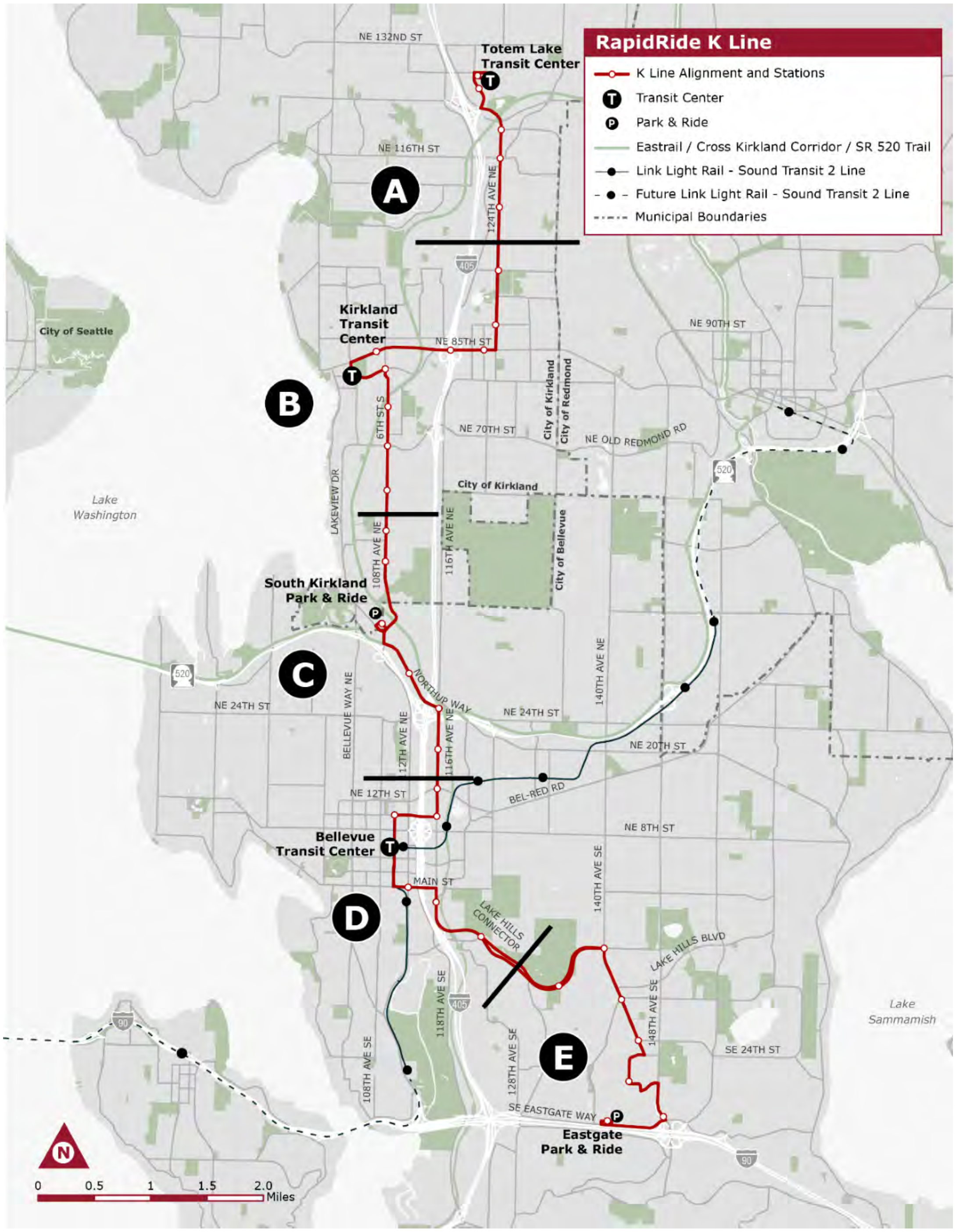

Figure 1-1. K Line Study Corridor

1.4 Report Overview

This report is comprised of five chapters, including:

- Chapter 1 – Introduction
- Chapter 2 – RapidRide Communication and Technology Elements
- Chapter 3 - Existing Conditions Summary
- Chapter 4 – Conceptual Design
- Chapter 5 – Work Breakdown Structure

2 RapidRide Communication and Technology Elements

2.1 K Line RapidRide Communications and Technology Overview

This chapter provides a general overview of King County Metro's (Metro) communication and technology elements for RapidRide corridors, which include TSP, real-time bus arrival data and off-board fare collection at stations.

2.2 What is Transit Signal Priority (TSP)?

TSP is a bus detection technology that gives transit vehicles preferential treatment at traffic signals over general purpose vehicles. TSP can either be provided passively through coordination of signal timings based on bus travel times through a corridor or can be provided actively by adjusting the underlying traffic signal timings at an intersection when a bus is detected approaching a specific signalized intersection. Metro's TSP system is focused on active TSP within the RapidRide corridors.

The National Association of City Transportation Officials (NACTO) *Transit Street Design Guide*[1] identifies the following six active TSP strategies and provides a description of how each of the following TSP strategies function:

1. Green Extension
2. Green Reallocation
3. Red Truncation
4. Upstream Green Truncation (Reverse Queue Jump)
5. Phase Insertions and Phase Sequence Changes
6. Phase Reservicing

The most common TSP strategies that have historically been used in King County are green extensions and red truncations. Green extensions hold a signal phase in green longer when a bus is approaching an intersection so that the bus can travel through the intersection without having to stop. Red truncations shorten other signal phases when a bus has arrived at an intersection during a red so that the bus waits for less time on a red light before getting a green light again to move through the intersection.

[1] https://nacto.org/publication/transit-street-design-guide/intersections/signals-operations/active-transit-signal-priority/

Active TSP requires three primary components to function as intended:

1. Accurate, real-time detection of the bus location and speed in the corridor.
2. A transit priority request server and generator that is capable of:
    a. Estimating bus travel time from the bus location to the next signalized intersection(s).
    b. Predicting what phase a traffic signal controller will be serving at the time when the bus is estimated to arrive at the intersection.
    c. Generating a TSP request to send to the traffic signal controller if the bus is predicted to arrive at the intersection on a green phase with insufficient time to travel through the intersection prior to the signal changing to a red phase.
3. A traffic signal controller capable of adjusting the signal phasing based on the TSP strategies programmed for the intersection.

2.3 Next Generation TSP Center-to-Center System

Metro deployed TSP on all the original RapidRide corridors (A through F) using a legacy system that required the installation of significant amounts of roadside equipment within each corridor to detect the bus and to place a TSP request to the traffic signal controller. The key components of the legacy equipment have reached their end of life and are no longer being supported. Therefore, Metro has been developing a Next Generation (NextGen) TSP system to replace the legacy TSP system and to be deployed on new RapidRide corridors. Metro's NextGen TSP project identified the need to improve the TSP system's accuracy and reliability. The NextGen TSP project also identified the need to reduce the time and expense to design, implement, operate, and maintain the TSP system. The NextGen TSP system will rely on the local agency's traffic signal interconnect network to relay TSP requests. It will also use a secure connection between Metro and the local agency traffic management center (TMC) to establish a Center-to-Center (C2C) configuration for centralized TSP control with each traffic agency throughout Metro's service area.

NextGen TSP will be deployed on the K Line project and a C2C configuration will be implemented between Metro and the City of Kirkland, the City of Bellevue, and the Washington Department of Transportation (WSDOT). The C2C connection will be used to relay the bus position data from Metro to each of the K Line local agencies. Figure 2-1 shows a general concept diagram of how Metro's NextGen TSP C2C system is intended to function.

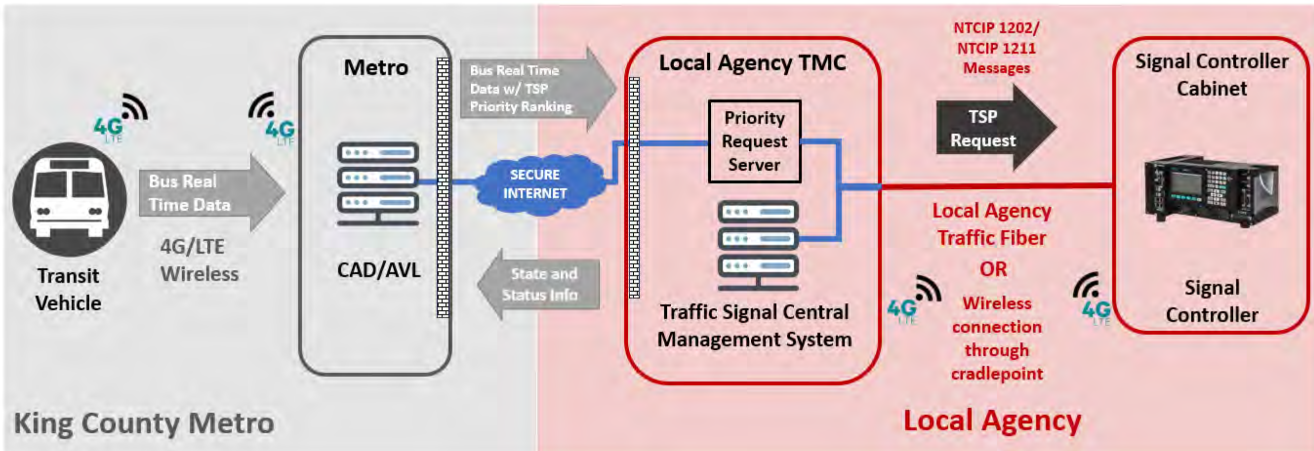

Figure 2-1. Next Generation TSP C2C Configuration

K Line buses will communicate their position in real-time using a 4G LTE cellular connection to Metro's computer-aided dispatch/automatic vehicle location (CAD/AVL) system. Metro's CAD/AVL system will publish real-time bus data in an API format that can be shared with local agencies. The API with the real-time bus information data will be passed over a secure connection from Metro's CAD/AVL system to the traffic agency's TMC with centralized control of the traffic signal network. The traffic agency will be equipped with a TSP request generator and server that can process the data from the API feed, determining if TSP should be granted, and then submitting a TSP request via the agency's fiber optic interconnect to the signal controller at the intersection. The signal controller will then adjust the signal timing(s) based on its programming to provide TSP for the bus approaching the intersection.

Metro recognized that not all partner agencies have the resources to develop a transit priority request generator and server capable of processing all Metro real time bus location data within their agency and converting that data into transit priority requests in a format that their traffic signal central system could process. Therefore, King County Metro held a competitive selection for a TSP request generator and server that could be used by local agencies to process Metro's bus real-time data and convert that into TSP requests. LYT was the vendor selected by Metro for the NextGen TSP project. LYT is a cloud-based open architecture software solution that uses real-time streaming vehicle data, artificial intelligence, and machine learning technology to prioritize the flow of public transport, emergency, and other vehicles across agencies and corridors.

Local agencies have the option to either develop their own TSP request generator and server that is capable of reading and executing on Metro's real-time data or to adopt Metro's LYT system as the TSP request generator and server.

For agencies that utilize the LYT system as the TSP request generator and server, a LYT edge device (Maestro) would be located within the agency's TMC. The LYT Maestro device would receive the priority request from LYT cloud services and issue the TSP requests from the TMC out to the controllers in the traffic signal cabinets on the corridor. One LYT Maestro can process requests for all intersections and bus routes that operate within the local agency. Figure 2-2 shows the NextGen TSP system diagram for agencies that use the LYT system.

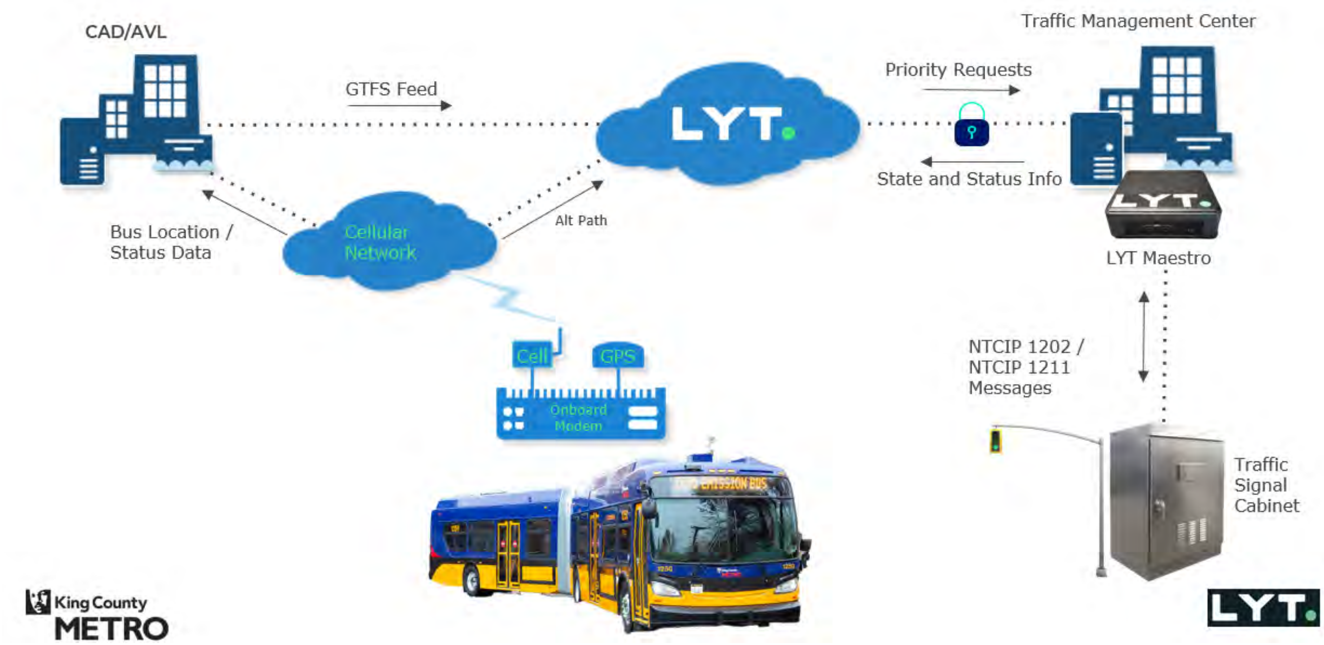

Figure 2-2. Metro NextGen LYT TSP System Diagram

Regardless of whether the local agencies elect to use the LYT priority request generator and server or to develop their own, Metro's NextGen C2C TSP system will require the following infrastructure to properly function:

- Reliable traffic signal interconnect from each traffic agency's TMC to the signal controller in the traffic signal controller cabinet. Fiber optic is the preferred form of interconnect, but data requests can also be supported by copper and cellular communication connections.
- A traffic signal controller with controller software capable of accepting and executing TSP requests to adjust the signal timing.
- Development and implementation of signal timing plans for the traffic signal controller at the TSP intersection, so that the controller is programmed to react when it receives a TSP request.

The National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) [2] is a data dictionary that defines the management of signal control and prioritization systems through parameters that represent configuration, status, and control information. Essentially, the protocols provide a universal language for communicating with actuated traffic signal control units. For agencies that use the LYT system for TSP, the traffic signal controllers need to be compliant with NTCIP 1202 at a minimum, and will preferably be NTCIP 1211 compliant to receive the greatest functionality of TSP.

Agencies with traffic signal controllers that have NTCIP 1202 compliant controllers will be able to support localized TSP that provides green extensions or red truncations as low priority calls to the traffic signal controller in the intersection that the bus is approaching. With these conditions, the TSP calls are placed for each intersection in isolation based on the bus location and next intersection that the bus is approaching.

Agencies with traffic signal controllers that are compliant with NTCIP 1211 protocols will be able to utilize estimated time of arrival (ETA) based TSP. ETA based TSP will communicate TSP requests to traffic signal controllers within two minutes of travel time downstream of the bus location and optimize the traffic signal timings at multiple intersections to reduce transit stop delays. Minor adjustments can be made to the signal timing across multiple intersections to improve bus progress with less impacts to other modes than traditional TSP strategies.

Table 2-1 includes a list of signal controller vendors that are NTCIP 1202 compliant, and Table 2-2 includes a list of signal controller vendors that are NTCIP 1211 compliant as it relates to Metro's NextGen TSP LYT system.

[2] Transit Signal Priority – A Planning and Implementation Handbook, USDOT

Table 2-1. Traffic Signal Controllers meeting NTCIP 1202 Protocols

Signal Controller Vendor	NTCIP 1202 Compliant*
Fourth Dimension	Fully supported on 2070 or ATC Hardware Platform
Econolite	ASC/3 Firmware; 2070 and ATC Hardware Platform
Q-free	MaxTime 2.6 and above
Swarco/McCain	Omni on 2070 or ATC Hardware Platform
Cubic/Trafficware	Trafficware 76 firmware and above
Yunex/Siemens	SEPAC 5.2.5 firmware and above

**NTCIP 1202 support, at a minimum, is required for TSP using low-priority preemption.*

Table 2-2. Traffic Signal Controllers meeting NTCIP 1211 Protocols

Signal Controller Vendor	NTCIP 1211 Compliant
Fourth Dimension	Fully supported
Econolite	EOS
Q-free	MaxTime 2.6 and above
Swarco/McCain	Omni eX 3.6 and above
Cubic/Trafficware	Scout 85.5.0 and above**
Yunex/Siemens	SEPAC 5.2.5 and above**

***Subject to verification by LYT engineering*

2.4 K Line Station Communication Elements

Metro's RapidRide corridors include a standard kit of parts for station amenities, which includes a technology pylon equipped with real-time information signs (RTIS) and text-to-speech (TTS) button, and may be equipped with a one-regional-card-for-all (ORCA) stand-alone fare transaction processor (SAFTP). Each technology pylon also includes an internal National Electrical Manufacturer Association (NEMA) cabinet that houses the communication equipment necessary to support the RTIS, TTS button and SAFTP. The RTIS will display projected arrival times for buses approaching the station as well as customer service announcements, and the TTS button will provide real-time voice announcement of the information displayed on the RTIS at the press of a button for visually impaired customers. The SAFTP will allow for off-board fare collections by those customers paying with an ORCA card at the station in advance of boarding a bus.

The K Line buses will communicate their position in real-time using a 4G LTE cellular connection back to Metro's CAD/AVL system. Metro's CAD/AVL system generates a General Transit Feed Specification – Realtime (GTFS-RT) data feed that will be transmitted via a 5G LTE cellular connection to the technology pylon to provide next bus arrival information for the RTIS. The same cellular connection will also be used to transmit fare transaction data from the SAFTP back to Metro. A separate cellular connection is also provided for the TTS button. Figure 2-3 shows a general concept diagram showing the communication to key components for Metro's technology pylons at stations.

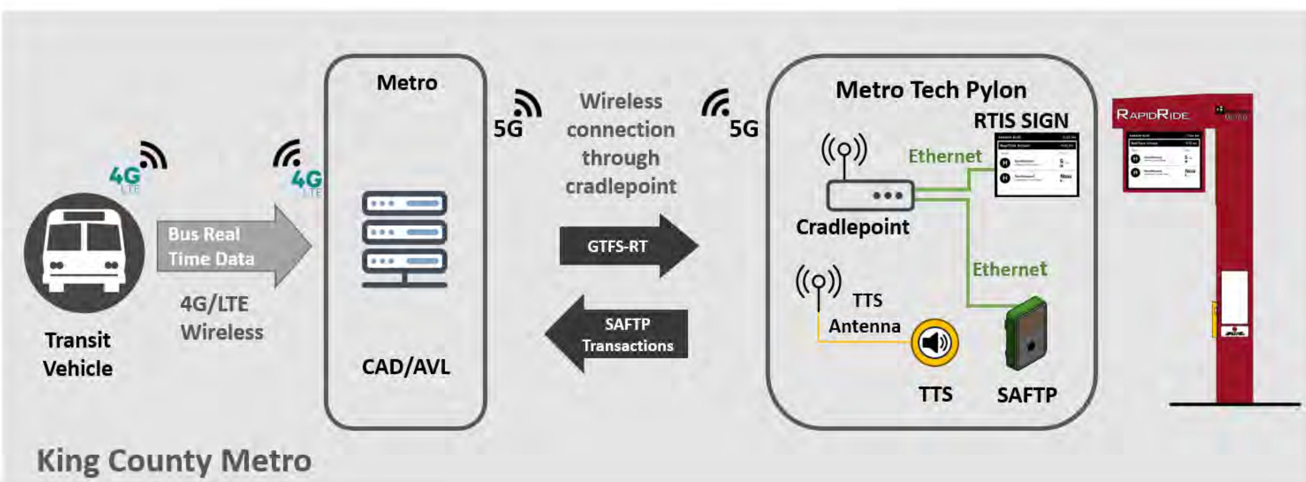

Figure 2-3. RapidRide Technology Pylon Communications

Metro's *RapidRide Expansion Program Standards and Implementation Guidance*, 2019, defines four sizes of RapidRide stations including Large Raised, Large, Medium, and Small. These are based on the projected number of people who may be boarding the bus at the station. The *RapidRide Expansion Program Standards and Implementation Guidance* provides a list of what passenger amenities should be included for each size of station. However, based on lessons learned from the implementation of those standards on the RapidRide H Line, Metro has refined requirements for Small stations. The refined requirements for a Small station are outlined in the description below.

The level of investment in communication and technology elements at station areas vary based on the size and ridership of the station as summarized in Table 2-3.

Table 2-3. K Line Communication and Technology Elements by Station Size

Station Size	Communication and Technology Elements
Large Raised Station	Tech Pylon with (2) 32" RTIS, TTS button, and (1) ORCA SAFTP
Large Station (with more than 100 boardings in one hour)	Tech Pylon with (2) 32" RTIS, TTS button, and (1) ORCA SAFTP
Large Station (with less than 100 boardings in one hour)	Tech Pylon with (2) 32" RTIS and TTS button
Medium Station	Tech Pylon with (2) 32" RTIS and TTS button
Small Station	One 13" solar powered RTIS and TTS button mounted to shelter
Station at Transit Center	Tech Pylon with (2) 32" RTIS, TTS button, and (1) ORCA SAFTP

The Large Raised, Large and Medium stations will require installation of power pedestal and underground electrical conduits to provide power to the technology pylon (for the RTIS, TTS button and technology pylon lighting) and to the shelter (for internal shelter lighting). While cellular communication will be used to provide real-time bus arrival data and fare collections for the stations, the Large Raised, Large and Medium stations will also include underground communication conduits within the station area. The communication conduits will connect to the technology pylon and shelter in case Metro chooses to deploy additional technology elements at the stations in the future that require higher bandwidths than what may be supported with wireless communication.

For Large Raised, Large, and Medium stations, the spare communication conduits will extend from a junction box for a future fiber meet-me point located at the end of the station (where the sidewalk is disturbed) to the technology pylon, and from the technology pylon to the shelter. Figure 2-4 shows the planned communication and technology elements and underground conduits and junction box infrastructure that will be included for Large Raised, Large and Medium stations.

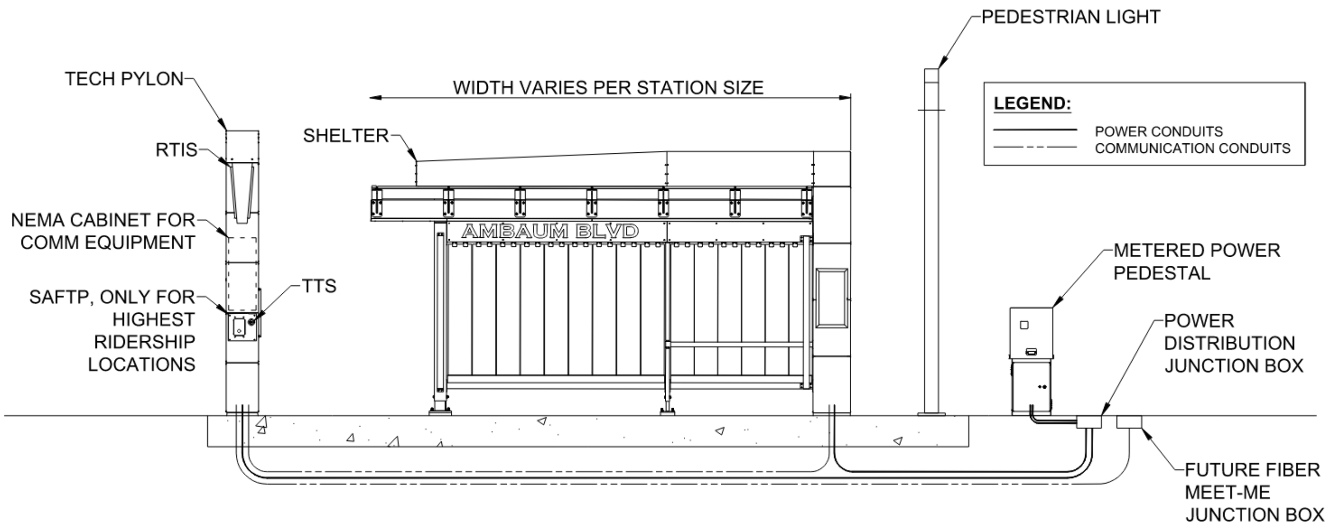

Figure 2-4. Large Raised, Large, and Medium Station Technology Elements and Underground Infrastructure

The Small stations with the lowest projected ridership will be equipped with a solar powered 13" RTIS and solar powered TTS mounted to a standard shelter at the station. Small stations will not include any underground conduits within the station area for power or future communications, except for locations meeting the following:

1. A solar evaluation of the station indicates that the site receives insufficient sunlight, and solar power is not a viable option for the 13" RTIS to function, in which case a hard-wired, metered power connection may be provided.
2. A local agency has constructed the underground infrastructure to support a hard-wired power connection from the nearest commercial service point to the station area, and had the infrastructure reviewed and approved for use by the electrical service provider in advance the K Line project construction, in which case a hard-wired metered power connection may be provided.

Figure 2-5 shows the planned communication and technology elements that will be included for Small stations.

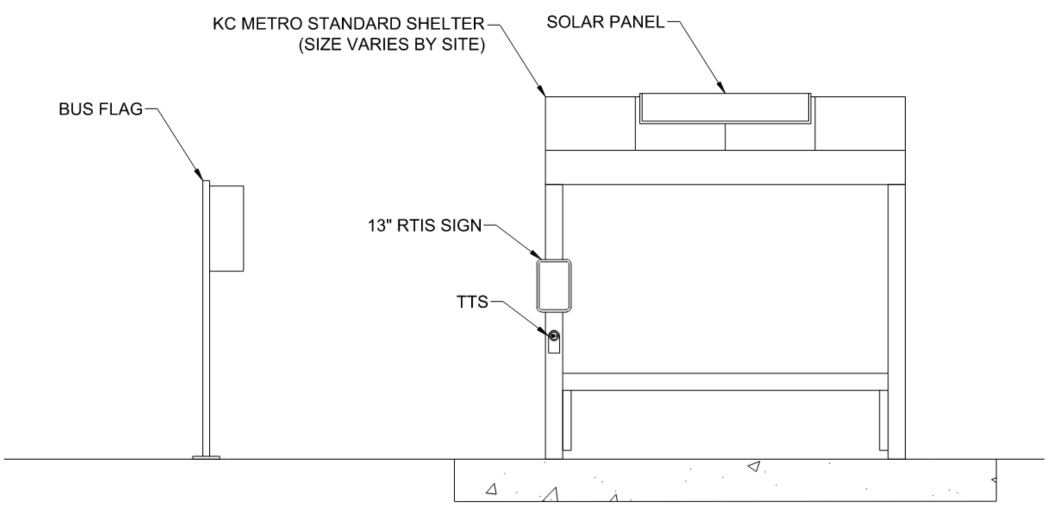

Figure 2-5. Small Station Technology Elements and Underground Infrastructure

For stations that are located at transit centers, the level of investment at each transit center will be determined based on the routes specific to the bus bays and the current level of amenities available at the future K Line bay. For planning purposes, it is assumed that stations at transit centers will be equipped with a technology pylon with RTIS, TTS button, and SAFTP. At transit centers, underground electrical conduits will be installed to provide hard-wired power to the technology pylon. Metro will investigate availability of power to be fed from the existing service at the transit center. If power is not available from the transit center, then a new service connection may be installed. Therefore, power for the technology pylon may either come from the electrical panel of the transit center, or from a new metered power pedestal. Figure 2-6 shows the planned communication and technology elements for stations that are located at transit centers.

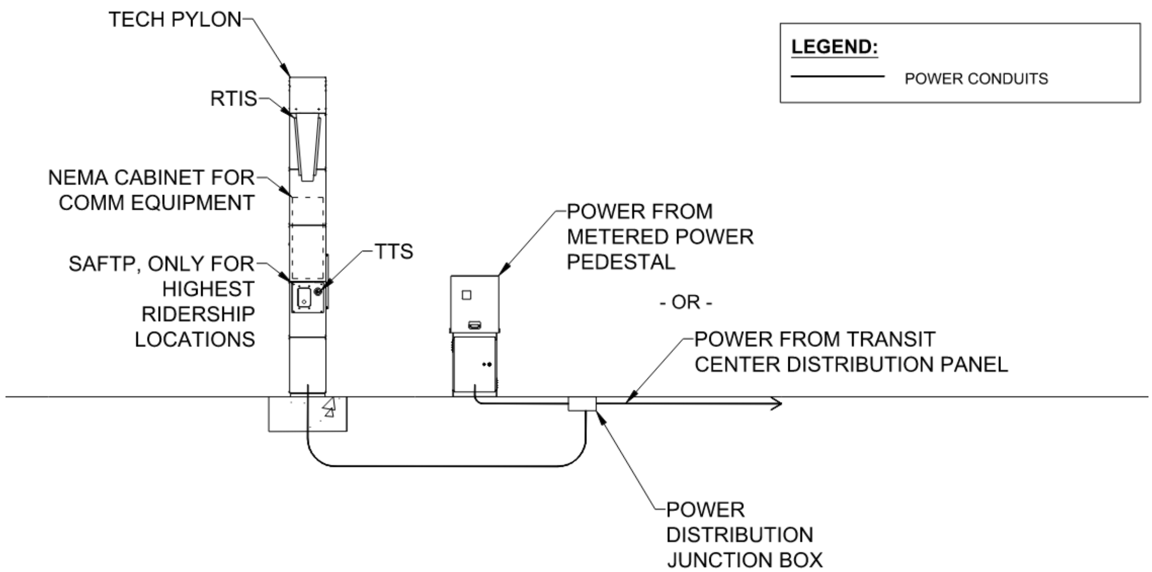

Figure 2-6. Technology Elements for Stations at Transit Centers

In some circumstances, a local jurisdiction or property owner may request custom station designs that deviate from the standard RapidRide Kit of Parts. This can occur when a jurisdiction or property owner desires a station that matches the unique aesthetic conditions of a neighborhood, district, or adjacent private development. In these instances, a public or private party requesting custom station designs must coordinate specifications and location placements with Metro. If custom station designs are requested by a private party and are located within the public right of way, the party must also coordinate design specifications with the applicable local jurisdiction. Because custom station designs often include components and materials not found in the standard RapidRide Kit of Parts, custom stations must be maintained by the local jurisdiction or private party. Custom station designs are reviewed and approved by Metro staff on a case-by-case basis. The communication and technology components to be incorporated with the design of custom stations will align with the size designation of the station, as summarized in Table 2-3.

3 Existing Conditions Summary

3.1 Overview

This chapter summarizes the existing conditions within the K Line corridor with respect to signalized intersections as well as the type of centralized systems and communication network used by each agency to support signal operations. The evaluation of existing signal equipment and communication network was used to help identify improvements needed to support the implementation of Metro's NextGen TSP system.

3.2 Existing Signal Interconnect

There are 48 existing and proposed signalized intersections along the K Line alignment. Nineteen of the existing signalized intersections along the route are operated by the City of Kirkland. The K Line project is also planning to install one new signal at the intersection of 108th Avenue NE and NE 60th St as part of the 108th Avenue NE BAT lane improvements. One of the existing City of Kirkland signalized intersections at NE 85th St and 114th Avenue NE will be removed and replaced with a roundabout as part of the WSDOT/Sound Transit I-405/NE 85th Street interchange improvement project, which is estimated for completion in 2027. Therefore, there will be nineteen total City of Kirkland signalized intersections as part of the K Line project. Additionally, there is one existing signalized intersection operated by WSDOT on the K Line alignment within the City of Kirkland. There are 29 existing signalized intersections operated by the City of Bellevue (one of which is owned by WSDOT but operated by Bellevue), but the K Line project is planning to convert the intersection of 145th Place SE and Se 24th Street to a roundabout, so there will be 28 signalized intersections within the City of Bellevue. The traffic signal communication network used for each agency was provided by each local agency.

The cities of Kirkland and Bellevue maintain existing fiber optic interconnect to each of the signalized intersections along the K Line alignment providing communication from the traffic signal controller to the City's corresponding central system. WSDOT also has fiber interconnect to the signals that the State operates along the I-405 alignment.

Figures 3-1 to 3-5 illustrate the existing and planned signalized intersections and the fiber interconnect used by each agency to support communication to the signal controllers along the K Line route.

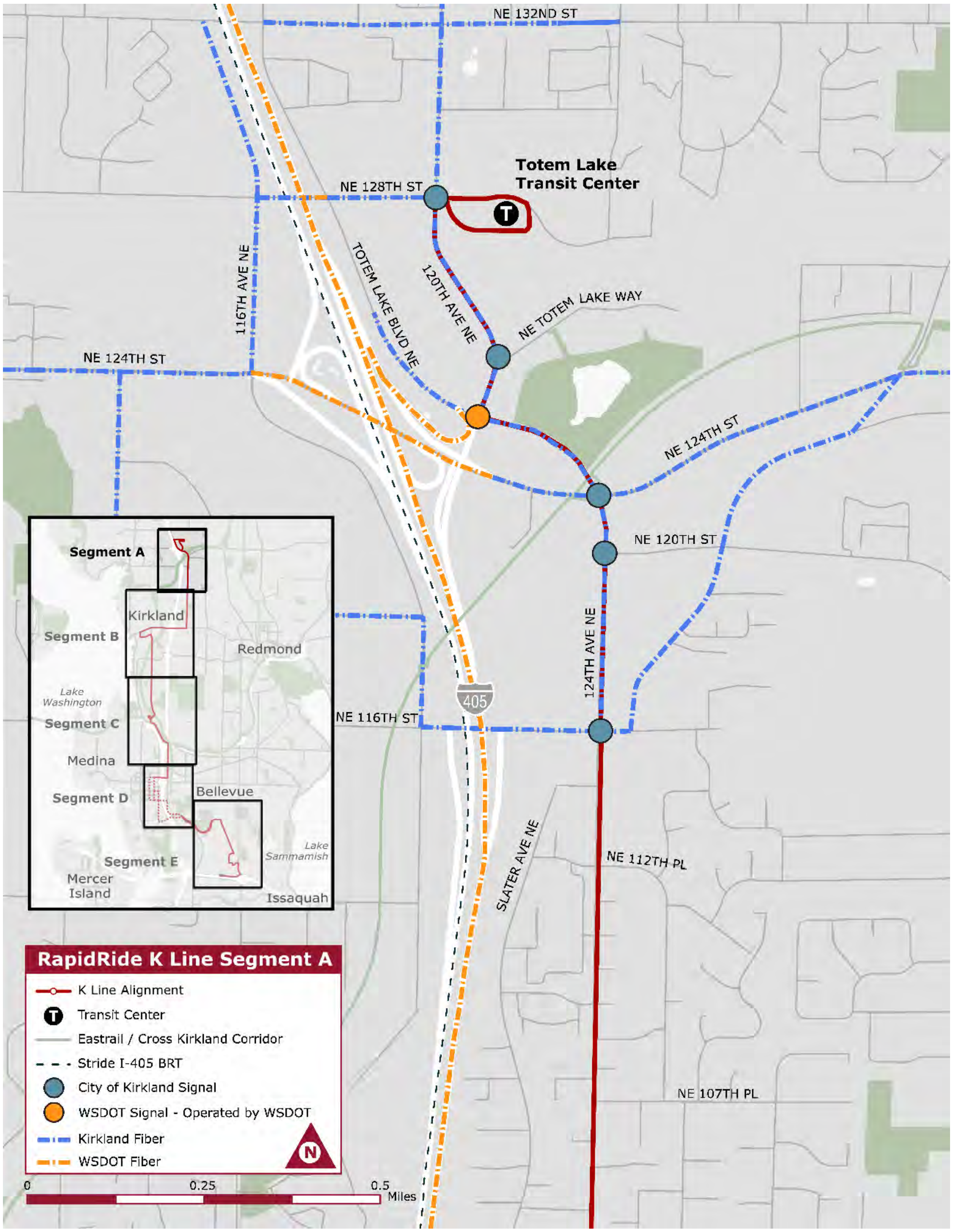

Figure 3-1. Segment A Existing Fiber & Existing Signals

Figure 3-2. Segment B Existing Fiber & Existing Signals

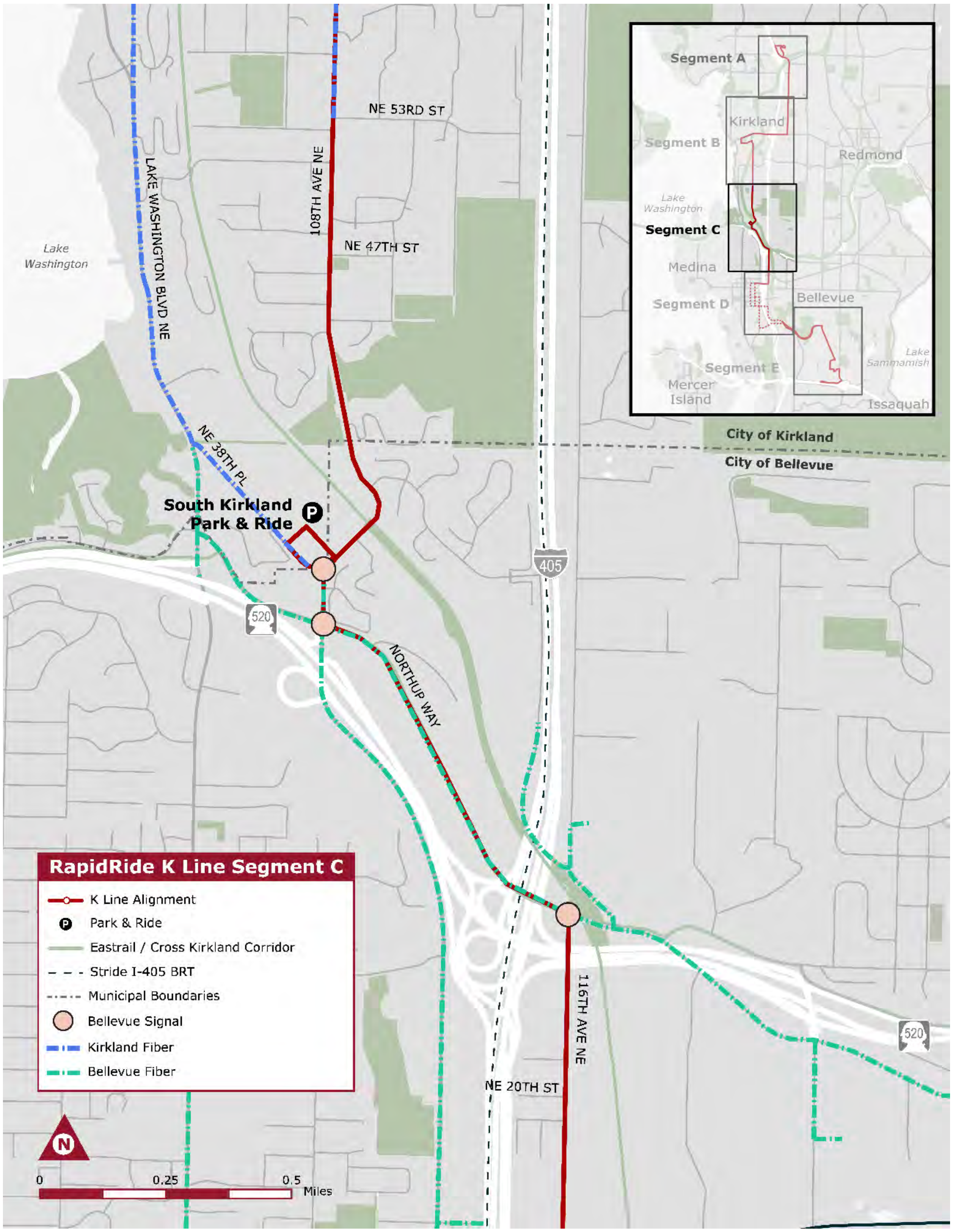

Figure 3-3. Segment C Existing Fiber & Existing Signals

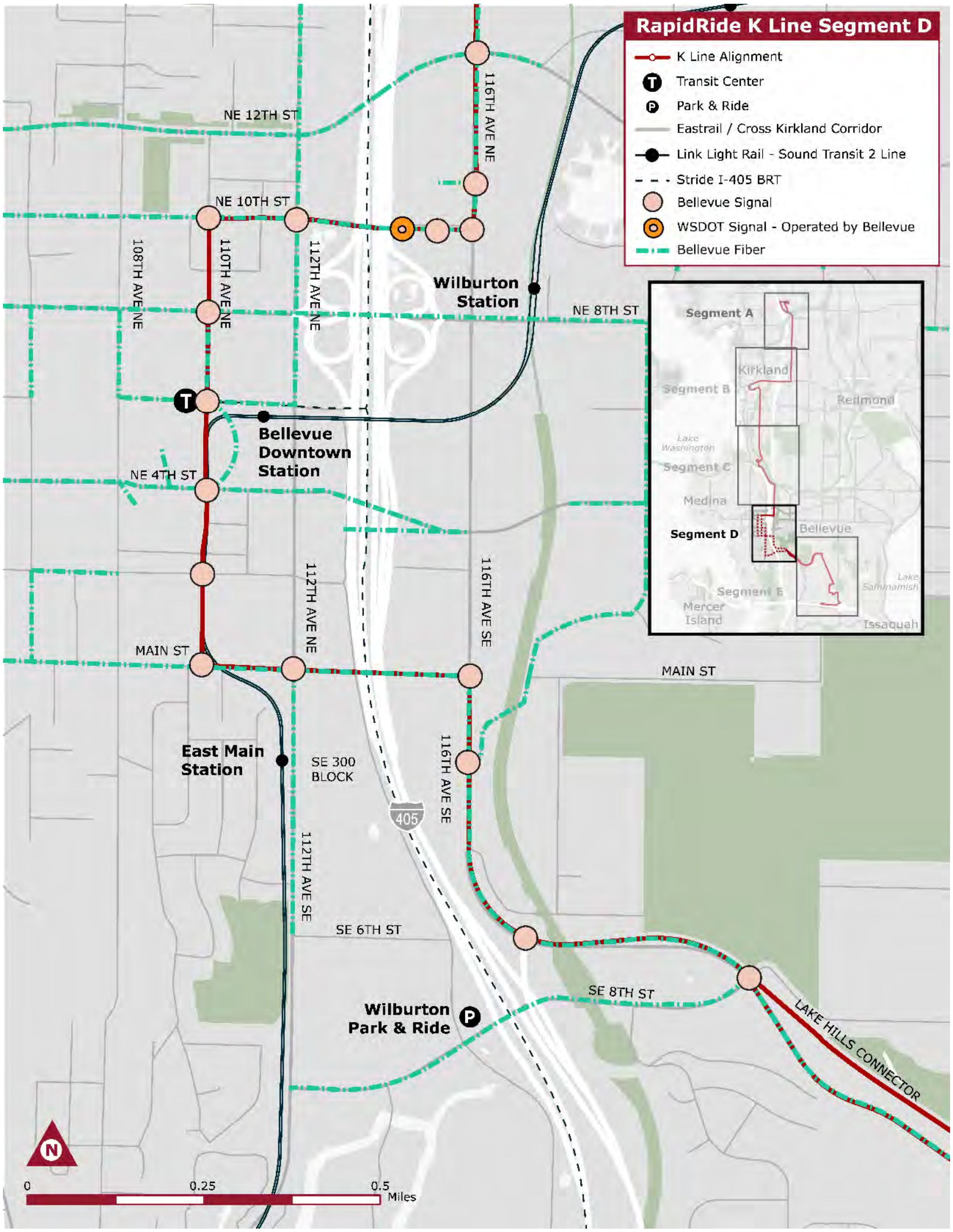

Figure 3-4. Segment D Existing Fiber & Existing Signals

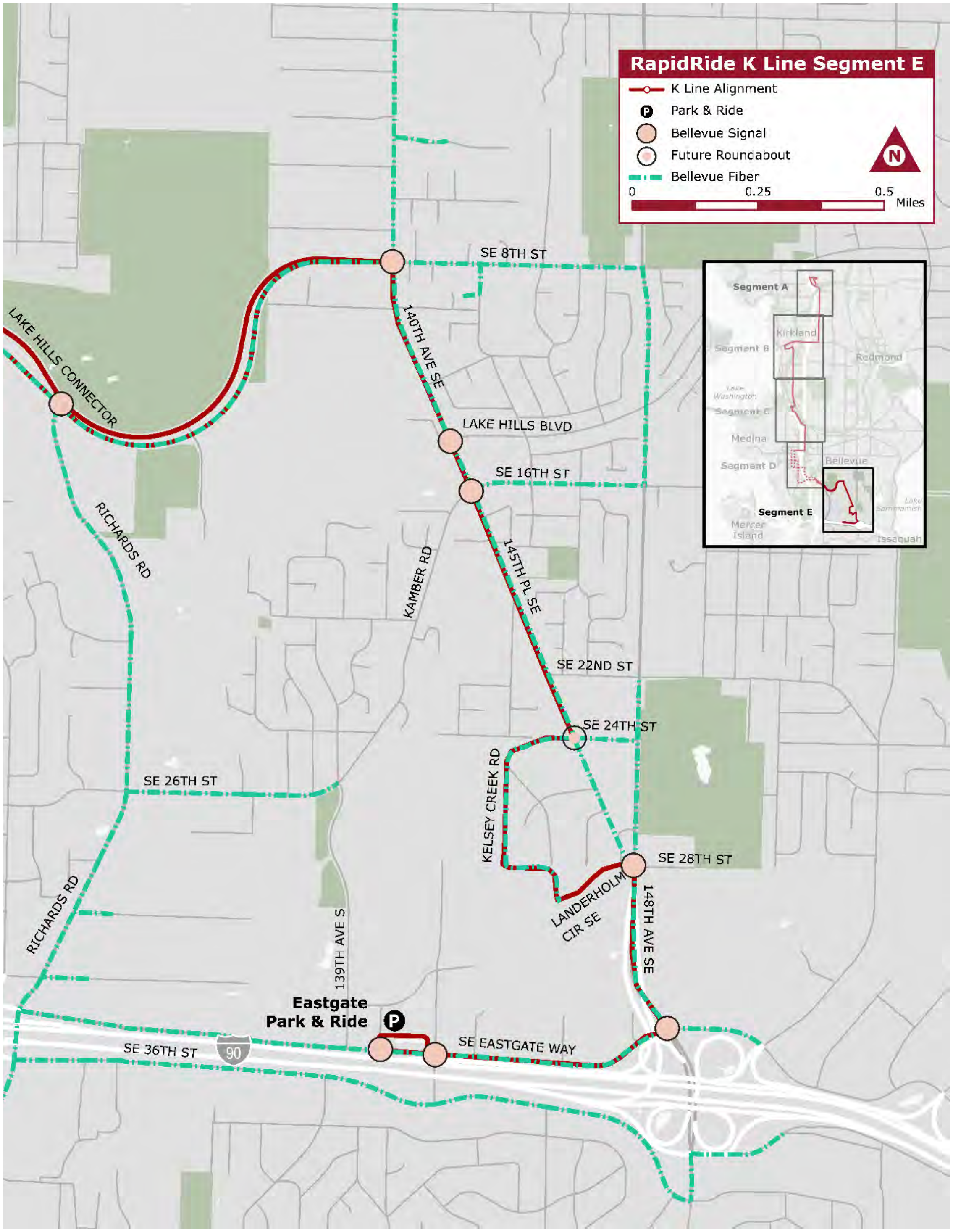

Figure 3-5. Segment E Existing Fiber & Existing Signals

3.3 Existing Signal Systems

The cities of Kirkland and Bellevue provided a summary of the signal equipment at intersections along the K Line corridor to assist in identifying the existing signal system components for each jurisdiction. This data included the type of traffic signal cabinet, signal controller model and software version, intersection communication components, and the presence of the legacy TSP service. These summaries were provided in lieu of conducting field reviews with signal technicians from the local agencies as well as WSDOT.

The City of Kirkland has existing fiber optic interconnect from their TMC to all existing signal cabinets along the K Line. The City of Kirkland has Yunex M60 controllers and TACTICS central management software. Metro’s Legacy TSP system is not deployed at any intersections within the City of Kirkland.

The City of Bellevue has existing fiber optic interconnect from the city’s TMC to all traffic signal cabinets along the K Line corridor. The City of Bellevue has Yunex M52 controllers and is using SCATS adaptive signal control and central system to control the signalized intersections throughout the city. TSP is deployed at intersections within the City of Bellevue along the RapidRide B Line alignment, but none of these locations overlap with the proposed K Line corridor.

WSDOT operates the signal at the I-405 NB ramps located at 120th Ave NE & Totem Lake Blvd in the City of Kirkland. WSDOT has existing fiber optic interconnect to signals on the I-405 corridor back to its central management system. WSDOT has 2070 controllers with Q-Free MaxTime central management software for their intersections. Metro’s Legacy TSP system is deployed at various intersections operated by WSDOT, but none of these locations overlap with the proposed K Line corridor.

Appendix A summarizes the data provided by each agency for each of the signalized intersection on the K Line alignment in Kirkland, Bellevue and WSDOT. Table 3-1 summarizes the existing signal controllers, signal central system, and signal control strategies being used by each agency along the K Line corridor.

Table 3-1. Existing Signal Systems

Jurisdiction	Traffic Signal Controllers	Signal Central System	Signal Control Strategies
Kirkland	Yunex M60	TACTICS Central System	Time of Day Plans
Bellevue	Yunex M52	SCATS Central System	Adaptive Control Software
WSDOT	2070	Q-Free MaxTime Central System	Time of Day Plans

4 Conceptual Design

4.1 K Line TSP Conceptual Design

Utilize existing fiber to signalized intersections for TSP

Each jurisdiction having authority over the traffic signals on the K Line alignment has existing fiber optic interconnect from their respective TMC to each of the traffic signal controller cabinets. TSP implementation at all the existing signalized intersections does not currently need any additional fiber installations to deploy Metro's NextGen TSP.

Proposed TSP Locations

TSP is recommended for implementation at all signalized intersections on the K Line alignment within the City of Kirkland. Within the City of Bellevue, TSP is recommended for implementation at all signalized intersections east of I-405 and at select intersections where queue jumps are proposed within the downtown area west of I-405. TSP implementation is cost effective for the K Line project because all signalized intersections in the corridor have existing fiber connections to the local agency TMC.

TSP implementation at Kirkland signalized intersections

Based on discussions with the City of Kirkland during the planning phase, the city has expressed an interest in utilizing Metro's NextGen TSP LYT ETA based TSP system. The City of Kirkland currently has Yunex traffic signal controllers which are not NTCIP 1211 compliant. To provide more advanced TSP operations, upgrades to the City's traffic signal controllers to a controller platform that is NTCIP 1211 compliant, such as Q-Free MaxTime controllers would be required. The city has indicated an interest in utilizing Metro's NextGen TSP LYT system. Therefore, the K Line project will install central management software for the new controllers within the TMC and upgrade controllers for all signalized intersections within Kirkland on the K Line alignment to an NTCIP 1211 compliant controller platform of the city's choice. Installation of the new controllers will also include controller configuration and testing, conversion of existing timings to a new controller platform and development of TSP timings. The K Line project will also install and setup of the LYT Maestro device in the TMC and pay for the LYT intersection set up and licensing fees for the first year of operations for a total of 19 intersections within the City of Kirkland.

TSP implementation at Bellevue signalized intersections

Metro's Legacy TSP system was deployed at intersections within the City of Bellevue, so Metro's NextGen project has been responsible for establishing the C2C connection between Metro and the City of Bellevue. The City of Bellevue has been actively working with King County Metro's NextGen TSP project to develop a Bellevue transit signal priority request generator and server that functions in conjunction with the city's SCATS adaptive signal control system, which is now operational and being used to support TSP for intersections on the RapidRide B Line. Therefore, the K Line project assumes that TSP will be provided with the City of Bellevue's TSP request generator and server. The K Line project will include the development of TSP signal timings based on the priority rules that have already been established as part of the TSP upgrades and will also include the licensing fee for Bellevue's (Nicander) TSP server for a total of 22 TSP enabled signalized intersections within the City of Bellevue.

TSP implementation at WSDOT signalized intersections

Metro's Legacy TSP system is deployed at intersections operated by WSDOT, so Metro's NextGen project is responsible for establishing the C2C connection between Metro and WSDOT. WSDOT uses a traffic signal system that is NTCIP 1211 compliant, so controller upgrades are not needed if WSDOT opts to use Metro's NextGen TSP LYT system. Therefore, the K Line project will include development of TSP timings and installation and LYT intersection set up and licensing fees for the one signalized intersection on the K Line corridor operated by WSDOT.

4.2 K Line Station Communication Conceptual Design

The K line project is proposing communication systems investments at all future K Line stations in alignment with current King County Metro Rapid Ride standards. The team utilized station sizes identified in the Task 130 Passenger Facilities Upgrade Report when developing communication system conceptual design to future stations.

A total of 35 general station areas have been identified within the corridor: 18 locations in Kirkland and 17 in Bellevue. This includes stations at the transit hubs (Totem Lake Transit Center, NE 85th St & I-405 Interchange, Kirkland Transit Center, South Kirkland Park and Ride, Bellevue Transit Center, and Eastgate Park and Ride) and stations on-street along the corridor. General station areas located on-street include two station platforms (one in each direction) while station areas in transit centers may include one shared station platform.

The K Line station communication conceptual design assumes communication system investments including:

- Tech Pylon with RTIS and ORCA SAFTP readers at 14 transit centers and large ridership stations which meet ridership thresholders for raised platform treatments.
- Tech Pylon with RTIS at 13 Large and 24 Medium station platforms.
- Solar 13" RTIS installations at 16 Small station platforms.

4.3 Cost Estimates

Planning level cost estimates were developed for the communications and technology elements proposed within the K Line corridor to prepare for funding evaluation during K Line LPA development and the FTA Small Starts Grant application process. The communication and technology planning level costs were based on late 2024 and early 2025 prices from Metro's vendors for the material costs and labor prices from recent RapidRide projects include the RapidRide I Line and J Line. A six percent escalation was applied to unit costs to account for K Line anticipated construction date. Since costs for TSP and technology pylons are typically associated with separate FTA standard cost categories, the costs of TSP and technology pylons are summarized separately in Table 4-1 and Table 4-2, respectively.

Table 4-1. K Line TSP Cost Estimate

Category	Kirkland	Bellevue	Total
TSP Subtotal	$637,727	$373,120	$1,010,392
General/Soft Cost (25%)	$159,318	$93,280	$252,598
Contingency (25%)	$199,148	$116,600	$315,748
Risk Allocation (10%)	$79,659	$46,640	$126,299
Estimated Cost	**$1,075,397**	**$629,800**	**$1,705,307**

Table 4-2. K Line Technology Pylon Cost Estimate

Category	Kirkland	Bellevue	Total
Tech Pylon Subtotal	$2,361,831	$2,276,883	$4,638,714
General/Soft Cost (25%)	$590,458	$569,221	$1,159,678
Contingency (25%)	$738,072	$711,526	$1,449,598
Risk Allocation (10%)	$295,229	$284,610	$579,839
Estimated Cost	**$3,985,590**	**$3,842,240**	**$7,827,829**

In addition to the construction costs listed in the subtotal, the estimates include general costs which include items such as permitting, engineering design, construction management and administration staff as well as contingency to cover elements such as changes to design and right-of-way procurement costs. Considering the cost of the technology components are well defined and predominately associated with equipment and parts for which Metro has established vendor contracts, a lower allocation for general/soft costs and contingencies was assumed for the technology estimate than for general civil estimates as included in the Task 120, 130 and 150 reports.

The City of Kirkland TSP costs shown in Table 4-1 includes the cost for TSP at the WSDOT operated intersection that is located within the City of Kirkland. More detailed breakdowns of costs for both TSP and Technology Pylons are included in Appendix B.

5 Work Breakdown Structure

A draft work breakdown structure (WBS) was developed itemizing the K Line tasks related to the planning, design, configuration, testing, and implementation of communication and technology features for the K Line RapidRide corridor and is included in Appendix C. The WBS is a living document and will be updated as the design progresses in Phase 2.