Council Meeting: 06/04/2013
Agenda: Study Session
Item #: 3. a.

CITY OF KIRKLAND
Department of Public Works
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MEMORANDUM

To: Kurt Triplett, City Manager

From: David Godfrey, P.E., Transportation Engineering Manager
Pam Bissonnette, Interim Public Works Director

Date: May 23, 2013

Subject: ITS Study Session

RECOMMENDATION:

It is recommended that the Council conduct a study session with staff in order to receive an update on Kirkland's ITS projects and programs.

BACKGROUND DISCUSSION:

Overview
Intelligent Transportation Systems (ITS) consist of the application of a variety of tools and advanced technologies to improve the operation of almost any transportation mode. Key feature of ITS are their reliance on advanced communication technology such as fiber optic and/or wireless networks to connect various field devices to a central management location, referred to as the Traffic Management Center (TMC).

ITS is not new to Kirkland. Kirkland partnered with King County to construct one of the first ITS corridors in the region on NE 124th Street between 100th Avenue and SR 202. Design of that project began in 1999 and became operational in 2006. King County also built ITS improvements on 100th Ave and on the Juanita-Woodinville Road, areas that are now part of Kirkland.

This memo describes:

- Planning and goals that support Kirkland's ITS plans
- Common parts of the ITS system in Kirkland
- Benefits of ITS
- Three projects currently underway to construct ITS improvements
- Some aspects of operating ITS systems.

ITS Strategic Plan

The Kirkland Intelligent Transportation System (KITS) Strategic Plan was adopted by Council in 2008. The Plan's main purpose is to guide the implementation of ITS in Kirkland. It has two elements; the KITS Master Plan and the Implementation Plan. The KITS Master Plan establishes the City's ITS vision, identifies needs, documents the ITS architecture and details the communication plans.

The KITS Implementation Plan builds on the Master Plan by detailing and prioritizing the recommended ITS projects. A total of 13 projects are identified at an estimated cost (in 2008 dollars) of $6.78 million. Five of these projects are included in the ITS Phase I Project and four are part of ITS Phase II. The Phase I and Phase II projects are described later in this memo.

City's ITS Vision from ITS Strategic Plan:

- ***Maximize the safety and efficiency of the City's transportation system for all residents, local businesses and visitors.***
- ***Optimize the City's investment in transportation infrastructure.***
- ***Support emergency services in their effort to save lives, provide security and protect the City's transportation infrastructure.***
- ***Enhance the quality of all modes (transit, pedestrian, bicycle, freight and personal vehicles)***
- ***Enhance the City's environmental quality by managing congestion.***

Relationship to other goals

In addition to the ITS Master Plan described above, ITS supports other City goals. In particular, the Council goal for Balanced Transportation includes elements of improved travel times and safety. ITS facilitates traffic signal coordination and maintenance activities that improve travel times and safety. One of the performance measures associated with this goal is implementation of the ITS Master Plan.

BALANCED TRANSPORTATION

Kirkland values an integrated multi-modal system of transportation choices.

Council Goal: To reduce reliance on single occupancy vehicles and improve connectivity and multi-modal mobility in Kirkland in ways that maintain and enhance travel times, safety, health and transportation choices.

ITS also supports Goal T-4 and policy T-4.1 in the Transportation Element of the Comprehensive Plan which call for a safe and efficient vehicle network and making the most of existing roadway capacity. An ITS system allows the actions that improve safety and efficiency to be accomplished more easily.

Comprehensive Plan Goal

Goal T-4: Establish and maintain a roadway network which will efficiently and safely provide for vehicular circulation.

Policy T-4.1: Promote efficient use of existing rights-of-way through measures such as…Signal timing optimization

Elements of Intelligent Transportation Systems

ITS consists of various advanced equipment connected to a TMC where it can be controlled. The illustration on the next page describes key pieces of hardware that are installed in the field and in the TMC. At the study session, equipment will be exhibited along with some demonstrations of CCTV, video detection and controller software in order for Council to get a better feel for how the equipment works.

F I E L D E Q U I P M E N T

Advanced Traffic Controller

Controls traffic signals, collects detector data, and communicates with central system computer

Advanced features to meet challenging intersection needs

Interoperable with other vendor's equipment, and with third party software, using national standards

Maintenance Malfunction Unit

Detects conflicting signal indications and unusual power conditions, placing the intersection into flashing operation when dangerous conditions are detected

Communicates directly to controller, which provides redundancy – both devices monitor the same diagnostic information, either can place the intersection into flash

Emergency Vehicle Preemption

Responds to strobe light signals from police, fire, and ambulances

Sends signal to the Advanced Traffic Controller, which activates appropriate emergency vehicle preempt routines to keep signals green for the vehicle.

Video Detection

Provides for many detection zones within a single camera view

Can detect bicycles and pedestrians as well as large vehicles

Allows for quick relocation of detection zones for construction or detours

Must be positioned properly (i.e. trees may block views at some times of year, sun angle varies and can cause problems)

CCTV Camera

Located on poles at the intersection or along the roadway

Camera is fully adjustable to center the view to the area of interest.

It has high power zoom capabilities to show details of how well traffic is operating along a corridor

Ethernet Switch

Directs communications from the system servers to the appropriate field device

Fiber Optic Cable

The fiber optic network is the link between the field equipment and the TMC. From the Ethernet switch in the cabinet we tap into the City fiber network, made of bundles of individual strands of glass covered in protective coatings. These glass fibers can carry large amounts of data, and are immune to electrical noise.

C O M M U N I C A T I O N S

T M C E Q U I P M E N T

Central Ethernet Switch

Directs the communications from the field equipment to the appropriate system server

ITS Servers

The communications, control, and database software for the various systems reside on the system servers

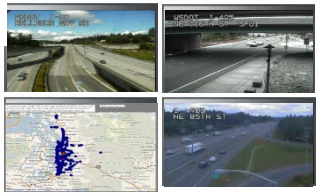
The servers communicate with, and make changes to, the field equipment

Stores the database for set-up data such as controller timing and system operational settings

Archives information returned from field equipment, like detection data and emergency vehicle activation

Desktop Workstation

Contains client software to communicate with the ITS servers, providing the ability to display and make changes to all ITS equipment settings Multiple monitor display provides efficient viewing of the different ITS systems such as the central traffic signal control software (TACTICS), and the CCTV surveillance control software (Camera Cameleon)



4 Monitor Video Wall

The video wall for the TMC will consist of an array of four 40" to 46" LCD monitors

This will allow large format presentations of system information, optimization/simulation animations, and intersection video feeds for group discussions and analysis.

Benefits of ITS

Benefits of installing ITS elements accrue from the activities that it facilitates and improves. These activities improve traffic conditions and create benefits for users. This concept is illustrated in Figure 1. For example, traffic signal coordination was accomplished with even the earliest generations of traffic signals. But now, with advanced equipment and communications we are able to establish and fine tune better coordination with greater ease.

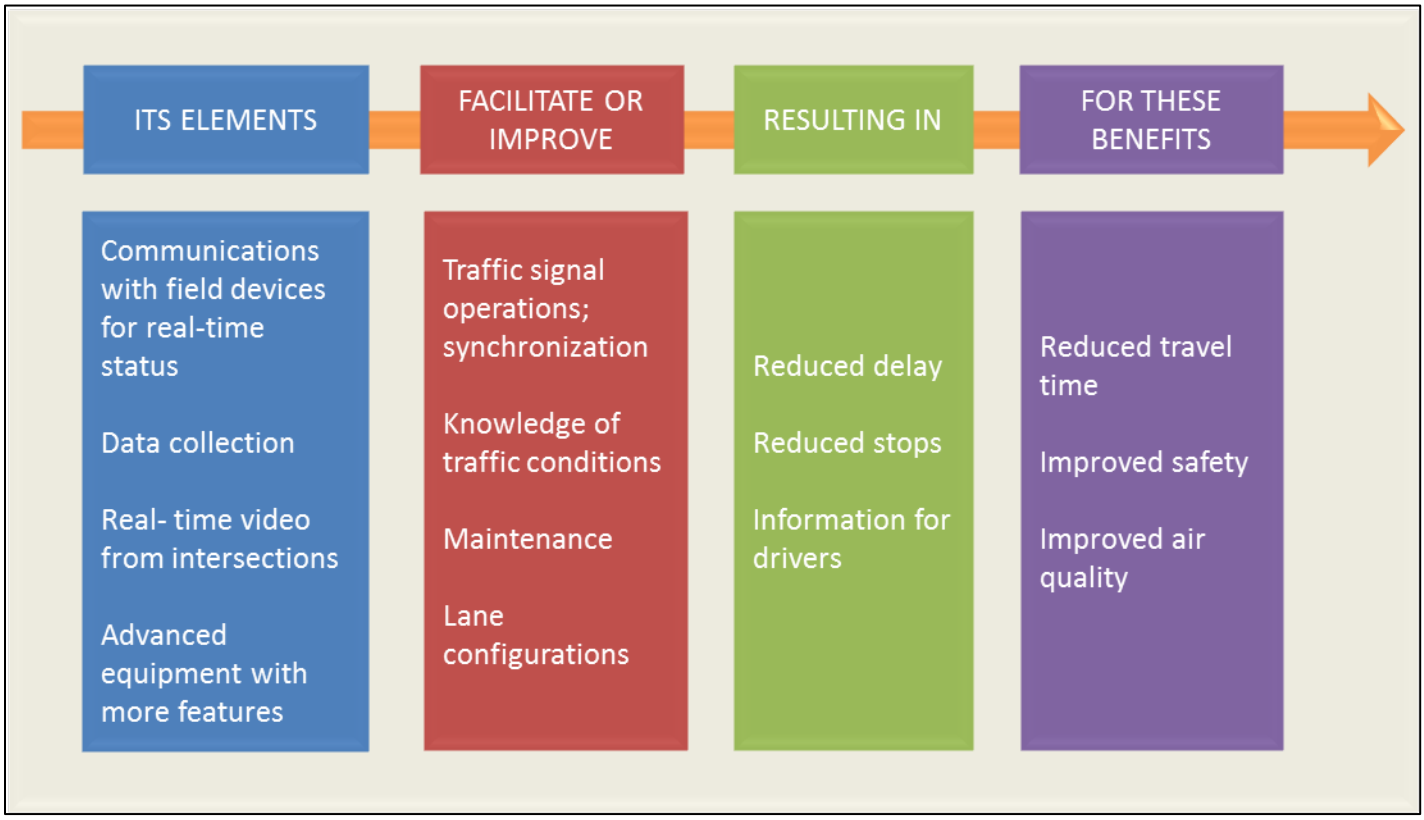


Figure 1 Relationship between ITS elements and benefits to users

Some examples of ITS elements, how they improve operations, maintenance and other elements along with the resulting benefits are described below:

Intelligent Transportation Systems improve maintenance. Because of advanced equipment and real time communication, the system can automatically alert operators of problems, and allow checks of the on-street operation quickly without trips to the field. In many cases, changes can be made remotely to eliminate or reduce the consequences of malfunctions such as delays to users. Based on information from the field, crews also know what to expect for remaining field repairs.

Scheduled construction work or emergency utility repairs can require the temporary movement of traffic lanes. This can move traffic off of normal vehicle detection zones, or onto the wrong zone. This means the traffic signal must operate without inputs from traffic. With video

detection and a connection to the TMC, the detection zones can be "redrawn" remotely allowing smoother operation and then set back to normal when the construction is complete.

Figure 2. View of NE 68th Street and 108th Avenue NE from camera located at intersection.

CCTV is an example of an ITS feature that allows better knowledge of field conditions. Knowing how systems are operating allows them to be improved. Site visits are time consuming, and many problems are intermittent. Watching live video of intersections through CCTV cameras provides an opportunity to evaluate signal timing. Video screens in the TMC allow watching many locations simultaneously. They can also provide a simultaneous look at how a whole set of traffic signals are working in a way that isn't possible while driving in traffic.

Some problems can be difficult to see because of infrequency or time of occurrence (i.e. late at night or on weekends when personnel are normally not working.) Although there is no current plan to archive video, the ability to record video to look for specific problems, allows fast-forwarding through long video sequences to pinpoint problems.

System detectors are "extra" detectors that give information about traffic flow. They can be used to detect incidents, count vehicles, determine traffic speed, indicate congestion level, and trigger special event programs. Archived system detector data can also be used to update offline optimization and simulation programs to keep timing plans current as traffic flow changes over time. A common database for data collection, archiving, and sharing reduces duplication and complexity. System detectors are usually installed in the pavement.

Traveler information

Using our ITS data we can provide information to give people choices on transportation modes and traffic routes. Web based traveler information can distribute information to home, office, or mobile users. We plan to make still images of CCTV available on the web via the WSDOT traffic flow map in a manner similar to that provided by Redmond and Issaquah. Information dissemination systems like Twitter can provide updates to travelers.

ITS data can be used to give people information so that they can make choices about transportation modes and traffic routes. CCTV images and congestion maps show current operating conditions. Information like detour routes, construction projects, travel times, and even parking information can be included; and system information can also be provided to third party providers for redistribution.

King County Metro and the City of Kirkland have discussed implementing transit signal priority which uses transmitters on buses to feed information to the signal system. The signals can then alter their operation to increase transit speed and reliability.

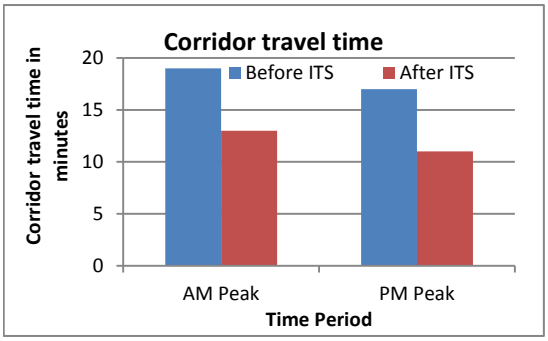
Sharing data between ITS systems across jurisdictions is known as center to center communications. Kirkland participates in WSDOT's "Traffic Busters" system. This allows sharing of video and signal timing from other partners in the system for the purposes of coordinating operations across jurisdictional boundaries.

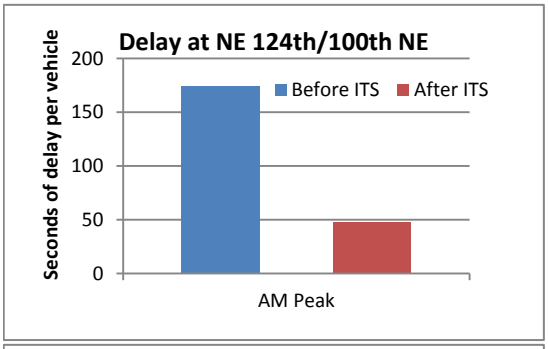
After Phase I improvements are completed (see description below) to the intersection of Lake Washington Blvd. and NE 38th Street, this intersection will be operated and maintained by the City of Bellevue. Kirkland will maintain ownership of the intersection and have capability of monitoring its operations. Bellevue will be operating the intersection in conjunction with the other nearby signals they will operate on the SR 520/Bellevue Way interchange. Allowing Bellevue to operate these signals as a system will result in the best results for the public.

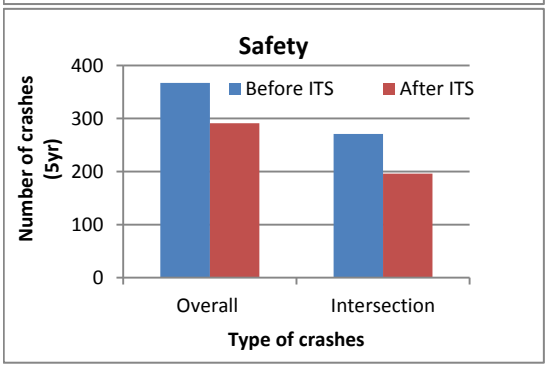
Because the details of each project vary, yet are important to assessing their value, it is difficult to directly compare the benefits of ITS improvements with the benefits of projects such

Examples of Benefits: NE 124th Street Corridor

ITS improvements and improved signal timing were deployed by King County and the City of Kirkland on NE 124th Street in 2006. As shown in the charts below, significant improvements were made in travel time, reduced delay at the 100th Avenue NE intersection and safety improved. The 100th Avenue intersection benefitted in particular because of the extra left turn lane that is created by special signing and traffic signal changes in the AM period.







The project also installed CCTV cameras that display images on the web for the purposes of traveler information.

as installing turn lanes. Traditional capacity projects tend to have higher costs but higher localized benefits. ITS projects tend to have lower costs but benefits that are extended across corridors.

ITS Coordination Methods

Isolated operation is the most basic form of traffic signal control. Under this type of operation, each signal operates independently. It responds to vehicle inputs from its own detector systems.

"Time of Day" plans are often used to coordinate groups of intersections along arterials. Under this operation, each signal runs a certain plan (developed to optimize flow for the typical conditions at that time) depending on the day of the week and time of day. Control systems at the TMC direct the controllers based on the time in order to keep the signals coordinated. "Time of Day" plans are best when traffic patterns are uniform from day to day.

Traffic responsive control provides the ability to select traffic patterns based on traffic conditions, not just the time of day. These conditions are recognized by inputs from vehicle detection systems. This operation typically lags the activity in the street by 5 to 15 minutes, but it can respond to unexpected volume increases to help alleviate congestion. It is most useful when used as a supplement to good time of day plans.

Traffic adaptive control is similar to traffic responsive in that it uses system detectors; however, it responds to traffic fluctuation much more quickly. Traditionally it requires a more rigorous detector regime, resulting in a much higher cost for detection. Additionally, while traffic responsive is typically included with central systems, adaptive control is an additional cost, and may cost two to four times as much as the central system itself.

The City of Kirkland currently uses time of day programs, but will be installing responsive features. Adaptive control is an option for the future. Adaptive systems are growing in popularity and some of the difficulties and complications with installing adaptive control are decreasing. There are options for installing adaptive or adaptive-style control on top of the ITS equipment we are planning.

ITS Projects

There are two primary projects that are underway to construct ITS improvements, **ITS Phase I** and **ITS Phase II**. A third project is aimed at improving safety by retiming traffic signals. Each project is funded primarily through grants.

ITS Phase I Project

Scope:

The Phase I Project builds ITS along two major corridors: Central Way/ NE 85th St and Lake Washington Blvd/Market St/ 98th/100th Ave NE. (See Map Attachment 1). It also will convert the existing Everest Conference Room in City Hall to a TMC.

Two key pieces of software are included in the TMC. One is a video management program that coordinates video feeds and transmits them to monitors in the TMC. That software also provides capabilities for recording and playback of video. The other is a central traffic management system that interfaces between signal controllers and the TMC.

Besides constructing a TMC, Phase I includes field equipment upgrades, including traffic signal controllers, cabinets and switches, CCTV traffic monitoring cameras and video detection. Connections to the City's existing fiber optic network will be made to this equipment enabling the TMC to communicate with and control the new field devices.

The Phase I Project has also been designed to work in conjunction with two independent traffic signal improvement projects planned along the Central/NE 85th Street Corridor: TR 0078 – 132nd Avenue NE Intersection Improvement Project and TR 0080 – 124th Avenue NE Intersection Improvement Project. These two intersection projects, as part of the NE 85th Street Corridor Improvement Project, were not included within the original scope of the ITS grant as each project is going to provide the required conduit, new cabinet foundation, signal controller cabinet, and controller. What is included within the ITS scope at these two locations is the fiber connections and other software needs for communication with the TMC. All three projects come with independent budgets; however, their schedules are such that the ITS improvements are reliant on the completion of the two intersection improvements.

Budget:

The total budget for this Project is $2,081,000, and is comprised of a federal Congestion and Mitigation of Air Quality (CMAQ) grant of $1,800,000 and City funds of $281,000 (See Attachment 2).

The Phase I Project was conceived with the idea that the City would procure equipment for the Project and it would be installed by a contractor. This would give the City more control over the schedule and allow items with long lead times to be secured sooner. The equipment is sole sourced and is available under State Purchasing contracts. The WSDOT Seattle office initially supported local force procurement; however, the Olympia office has questioned this decision and is currently reviewing whether or not procurement by the City will be allowed with Federal grant funds.

There are potential budget and schedule implications if the City is not allowed to procure the equipment. The Project would need additional budget funding due to Contractor markups and

changes of the plans, specifications, and estimate (PS&E); the current estimate for this impact is about $110,000 (see Schedule below).

Schedule:

The project Design is 95% complete and will be finalized upon WSDOT determination on procurement. The construction funds were obligated in 2012 and with authorization to procure with local forces, the City is ready to advertise for the TMC construction with field work construction scheduled to begin before or in winter 2013. However, as described above, with the new WSDOT guidelines/standards, we are working with WSDOT Local Programs (the funds administrator) for approval to move forward and allow the City to procure the equipment. If the City is not allowed to procure the equipment, the schedule delay is estimated to be 6 - 8 months.

ITS Phase II Project

Scope:

Scope for the Phase II Project is similar to the field equipment upgrades in Phase I. As shown in Map 1 (Attachment 1), improvements are mainly in the Totem Lake Urban Center and the new neighborhoods, as prioritized by KITS. This Project calls for the design and construction of ITS upgrades to field equipment at up to 27 signals (15 of which are currently on the King County network) and communication links to connect the ITS equipment with the TMC.

Budget:

The total budget for this Project is $2,911,000, and is comprised of a federal Congestion and Mitigation of Air Quality (CMAQ) grant of $2,201,141 and City funds of $709,859. See Attachment 3.

Schedule:

Application for this CMAQ grant was made in 2012. PSRC approved this Project in February 2013 and FHWA authorized the PE funds on May 6, 2013. Consultant selection process is expected to be completed in July 2013. Design can begin as soon as a contract is in place with the selected consultant. The procurement/construction is scheduled to begin in March 2014. The TMC from Phase I is to be completed before Phase II construction can begin.

Citywide Safety and Traffic Flow Improvement Project

Scope:

This Project is targeted at Kirkland's arterial corridors that carry the heaviest traffic volumes and experience the highest number of vehicular, pedestrian and cyclist accidents. (See Map Attachment 1). It has two main elements: signal timing optimization at 32 intersections and procurement and installation (by City Crews) of traffic signal and communication equipment

upgrades at 14 intersections. Some intersections that are receiving upgrades in the Citywide Safety Project are also receiving improvements from the Phase II ITS Project. The improvements are compatible with each other and together provide a complete upgrade.

The signal timing optimization element consists of the development, implementation and evaluation of signal coordination plans for morning (AM), Noon and evening (PM) traffic periods. Each coordination plan consists of a set of timing parameters tailored to the traffic conditions prevailing on the corridor during a given time period. It also includes updates/adjustments to signal timing parameters such as pedestrian clearance (Walk and Flashing Don't Walk) and vehicle clearance (Yellow and all Red) intervals. Adjustment to these parameters has been shown to result in safety benefits, and it is also needed in order to comply with the latest requirements for these timing intervals.

The second element consists of the procurement and installation, by the City's traffic signal technicians, of new signal and communication equipment including signal controllers and Ethernet switches at 14 intersections. The equipment upgrade also includes design and implementation of a minor fiber optic link, in existing conduit, connecting City Hall with the NE 124th Street and 100th Ave-Juanita Woodinville corridors.

Budget:

The total budget for this Project is $302,145, comprised of the federal Highway Safety Improvement Program funds of $300,000 plus City funds of $2,145. See Attachment 4

Schedule:

The grant for the Citywide Safety Project was originally applied for in 2011. The Puget Sound Regional Council (PSRC) approved this project in October 2012 and Federal Highway Administration authorized design funds on April 26, 2013; design will begin after a consultant selection process now scheduled to be complete in August 2013. With WSDOT approval, the procurement and construction are scheduled to begin in December 2013 and June 2014, respectively.

NE 124th Street

One of the goals of the ITS Phase II and Citywide Safety and Traffic Flow Improvement projects described above is to upgrade the signals connected by earlier County projects so that they are compatible with and connected to the City communications system and TMC.

As mentioned above, King County received a grant in 1996 to construct ITS improvements on NE 124th Street from 100th Avenue NE to SR 202. The City of Kirkland contributed $42,000 to the Project and agreed to maintain new equipment at City intersections. A County TMC was established at the County Department of Transportation offices in Seattle and the NE 124th

Street corridor was connected to this location. After the annexation was completed in 2011, the County no longer maintains signals on the NE 124th Street corridor. Other ITS equipped signals on the 100th Avenue and the Juanita-Woodinville Drive Corridors were also inherited by the City of Kirkland through annexation.

Kirkland currently has some capabilities for monitoring and remotely operating these signals via a workstation connected to the King County system, but contracts with the County for the majority of monitoring services at a rate of approximately $1000 per month.

Other projects

Several intersections (See Map Attachment 1) have been upgraded to be part of the City's ITS system during their construction as CIP projects. Others have been or are being upgraded using signal maintenance funding. The latter were done where only small amounts of fiber were needed to connect to the network and relatively small investments in new hardware were required.

All of Kirkland's ITS projects have taken advantage of the City's existing fiber optic network. Without such a communications "backbone" the cost of providing communications would be much greater. Information Technology Department Staff has worked closely with Public Works Staff to plan connections to the network and to implement the traffic network that allows communications to take place. Information Technology Staff will also be integral in setting up and maintaining the systems needed for successful operations of the TMC.

Aspects of operating ITS systems

Ongoing maintenance costs

Software used to operate the TMC requires annual maintenance fees for support and upgrades. In the 2013-2014 budget, $20,000 was allocated toward these costs.

There is currently no funding for systematic replacement of traffic signal equipment. Although the ITS program updates a large amount of equipment, there is still a large amount of equipment that does not have a planned replacement.

Scheduled equipment replacement reduces maintenance costs. As equipment becomes obsolete, it is difficult to maintain. New parts are not available, and scavenged parts become increasingly difficult and time consuming to find.

Scheduled purchasing also spreads costs out over time. When equipment is not regularly updated, a large, expensive, and often urgent need to make an unbudgeted purchase often results. Regular upgrades also provide an orderly transition that takes advantage of technology advancements and an incremental integration of new features.

Older equipment can malfunction more frequently and be more difficult and time consuming to repair. Support from vendors and other users becomes increasingly difficult to obtain. If the device can't be repaired, an unplanned purchase may be required.

Planning for the expenses of thorough and systematic traffic signal maintenance will be addressed in the Transportation Master Plan process, the upcoming CIP process and the 2015-2016 budget process.

Staffing

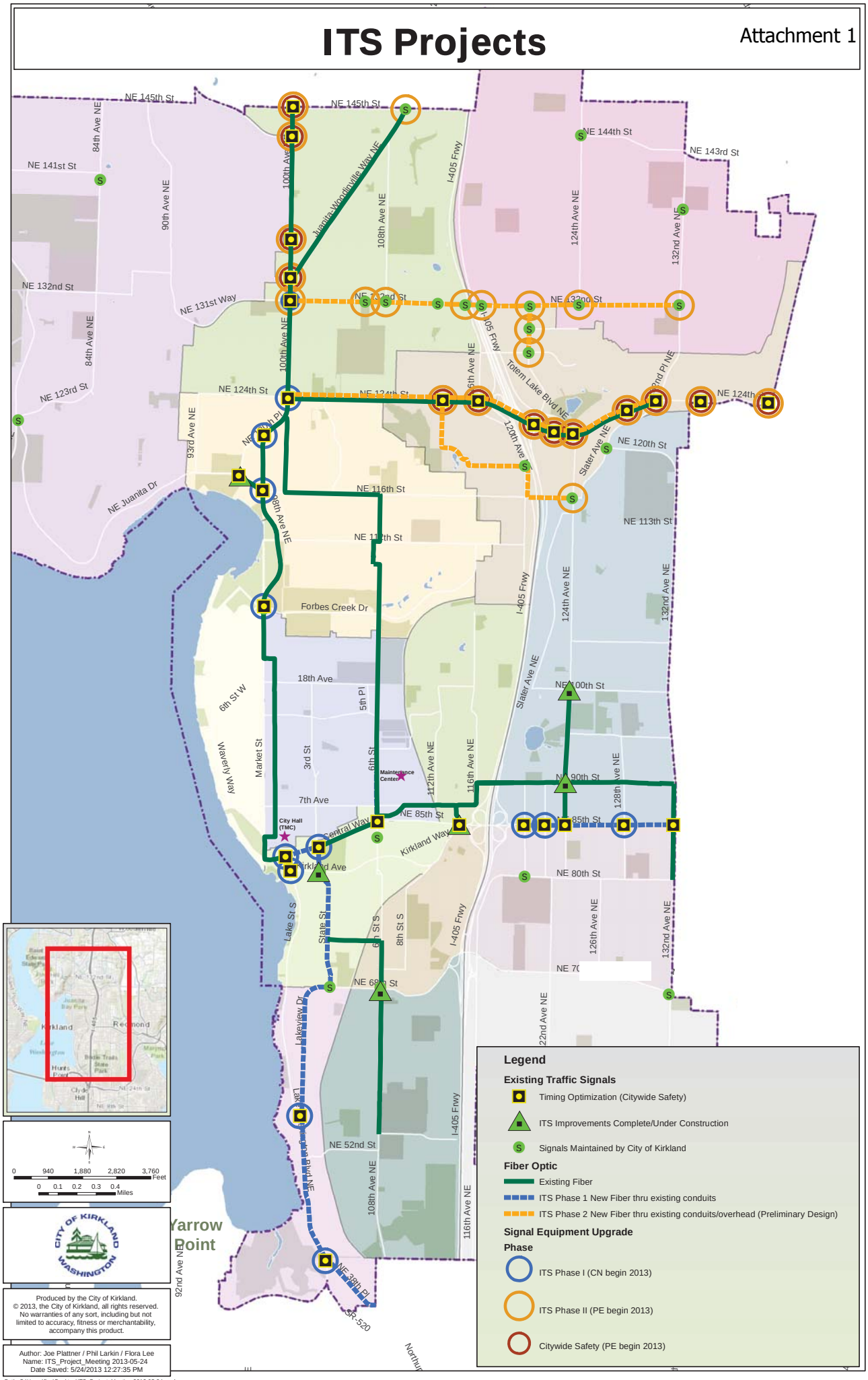
In the 2013-2014 budget a 0.75 FTE Transportation Engineer with a focus on Traffic Signal Operations was added to the budget. This position was filled by Chuck Morrison who previously worked for the City of Seattle, helping to start their ITS program and develop it over the next 20 years. After the Phase I and Phase II projects are completed and the TMC is up and running, we will reassess the staffing needs for support of ITS. Based on this assessment, staffing needs will be brought forward for consideration in the 2015-2016 budget process.

Conclusion

This memo was intended to be an introduction to Kirkland's ITS program and initial Phases, which are a series of complicated and technical projects. Staff will be reporting back to the Council periodically as the current ITS projects are implemented. The ITS program and projects will also be reviewed and updated as part of the Transportation Master Plan process.

ITS Projects

Attachment 1



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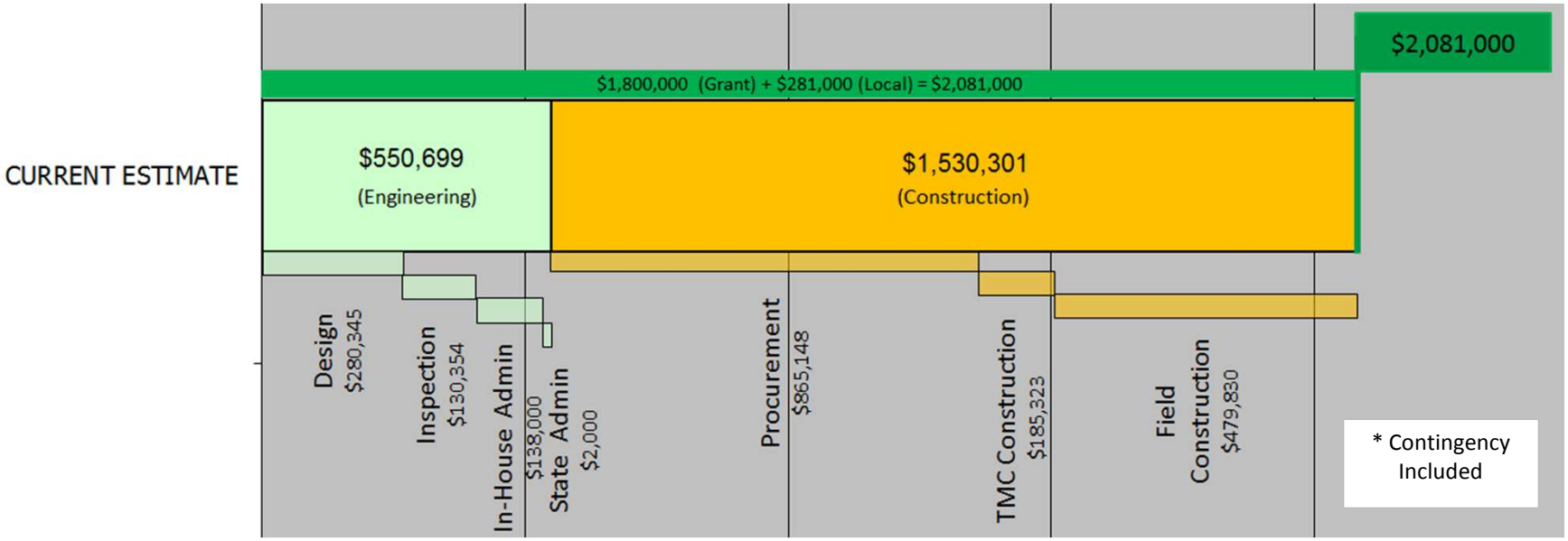
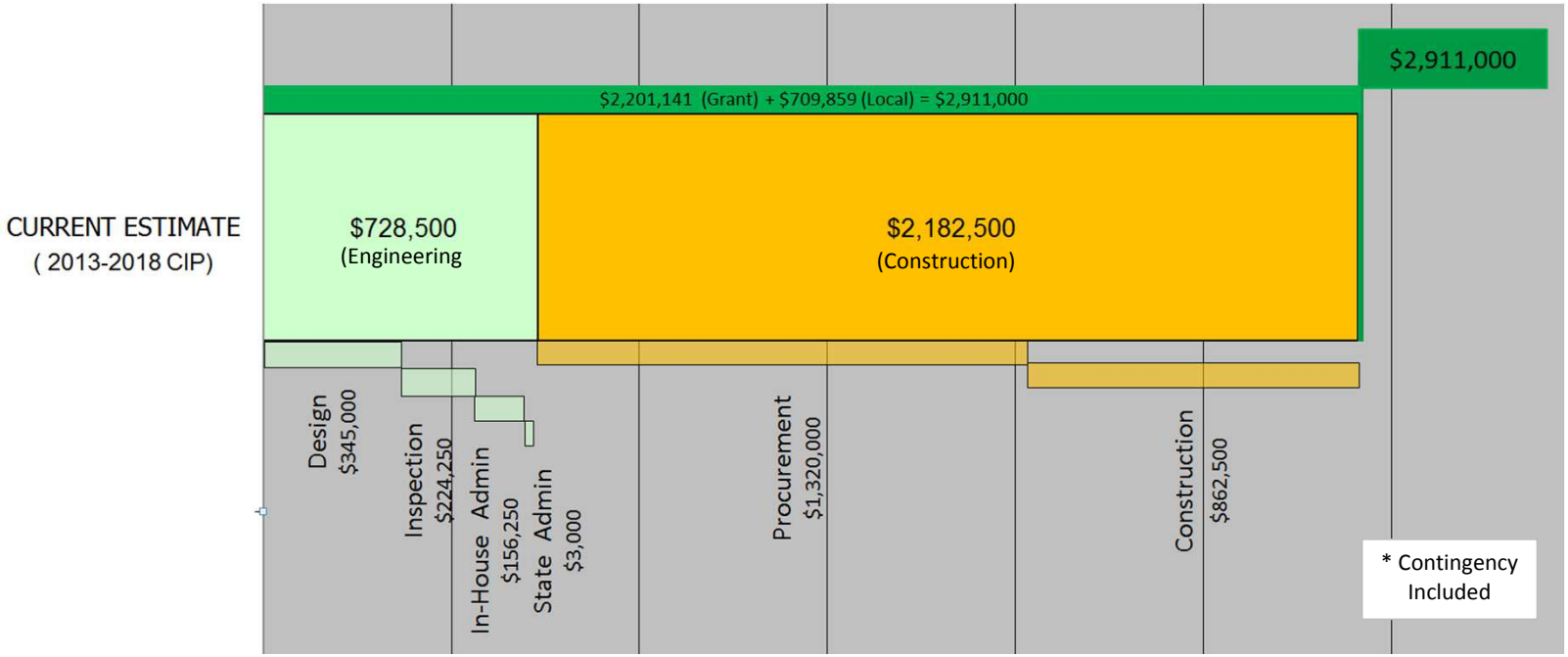
Citywide ITS Improvements Phase 1 (CTR0111-000)

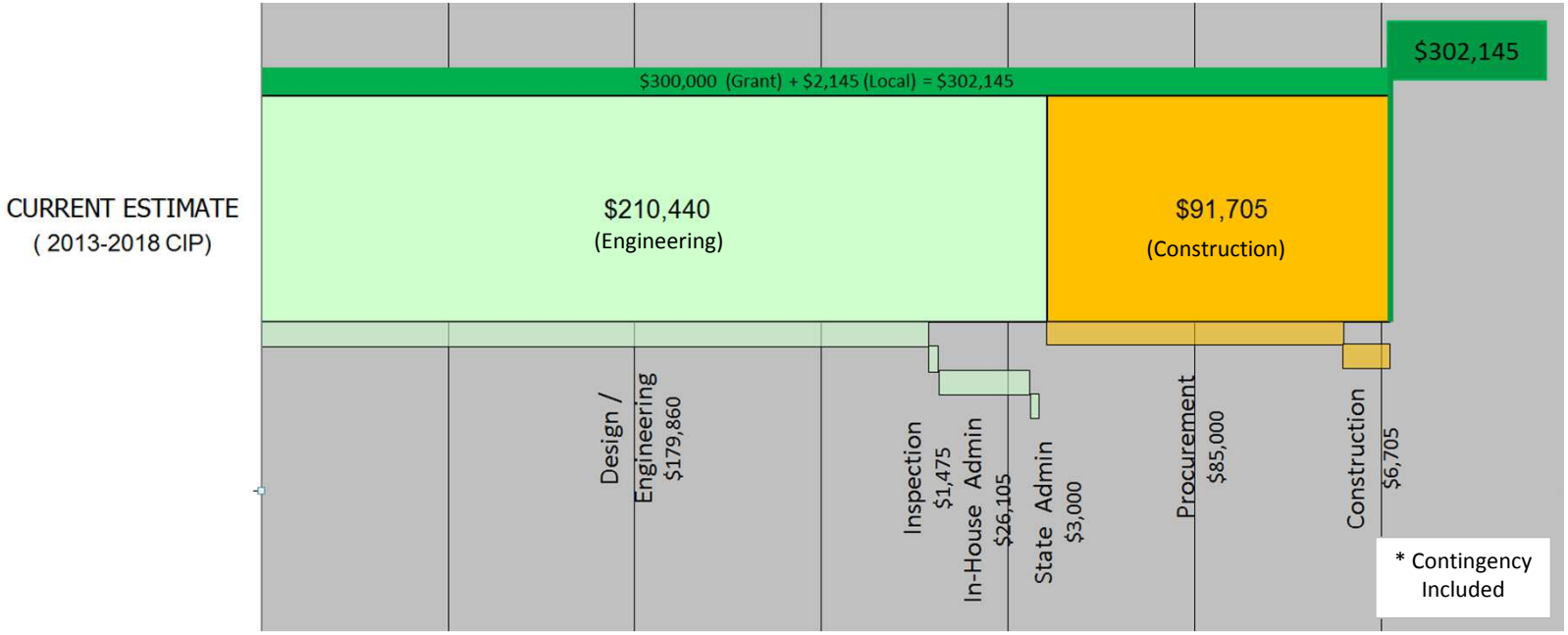
	Type of Work	Current Estimate	Cost-to-Date	Cost-to-Complete	% Cost Remaining	% Work Complete
PE	Consultant	$280,345	$214,366	$65,978	24%	95%
	State	$1,000	$50	$950	95%	95%
	In-House	$85,000	$82,240	$2,760	3%	95%
	PE Phase Subtotal	$366,345	$296,657	$69,688	19%	95%
CN	Equipment - City Procurement	$865,148	$0	$865,148	100%	0%
	Contractor - TMC Remodel	$185,323	$0	$185,323	100%	0%
	Contractor - Field Equipment	$479,830	$0	$479,830	100%	0%
	Inspection	$130,354	$0	$130,354	100%	0%
	State	$1,000	$0	$1,000	100%	0%
	In-House	$53,000	$0	$53,000	100%	0%
	Construction Phase Subtotal	$1,714,655	$0	$1,714,655	100%	0%
	PE + Construction Total	**$2,081,000**	**$296,657**	**$1,784,343**	86%	**17%**



Kirkland ITS Implementation Phase II: Totem Lk Urban Center (CTR0111-003)

	Type of Work	Current Estimate	Cost-to-Date	Cost-to-Complete	% Cost Remaining	% Work Complete
PE	Consultant	$345,000	$0	$345,000	100%	0%
	State	$1,000	$0	$1,000	100%	0%
	In-House	$78,125	$7,828	$70,297	90%	0%
	PE Phase Subtotal	$424,125	$7,828	$416,297	98%	0%
CN	Equipment - City Procurement	$1,320,000	$0	$1,320,000	100%	0%
	Contractor	$862,500	$0	$862,500	100%	
	Inspection	$224,250	$0	$224,250	100%	0%
	State	$2,000	$0	$2,000	100%	0%
	In-House	$78,125	$0	$78,125	100%	0%
	Construction Phase Subtotal	$2,486,875	$0	$2,486,875	100%	0%
	PE + Construction Total	**$2,911,000**	**$7,828**	**$2,903,172**	**100%**	**0%**



Citywide Safety and Traffic Flow Improvement (CTR0113-000)

	Type of Work	Current Estimate	Cost-to-Date	Cost-to-Complete	% Cost Remaining	% Work Complete
PE	Consultant/In-House Engineering	$59,640	$0	$59,640	100%	0%
	State	$1,000	$0	$1,000	100%	0%
	In-House	$8,590	$3,613	$4,977	58%	0%
	PE Phase Subtotal	$69,230	$3,613	$65,617	95%	0%
CN	Equipment - City Procurement	$85,000	$0	$85,000	100%	0%
	Consultant/In-House Engineering	$120,220	$0	$120,220	100%	0%
	Contractor	$6,705	$0	$6,705		
	Inspection	$1,475	$0	$1,475	100%	0%
	State	$2,000	$0	$2,000	100%	0%
	In-House	$17,515	$0	$17,515	100%	0%
	Construction Phase Subtotal	$232,915	$0	$232,915	100%	0%
	PE + Construction Total	**$302,145**	**$3,613**	**$298,532**	**99%**	**0%**