TRAFFIC SIGNAL POLICY AND GUIDANCE MANUAL

PORTLAND, MAINE

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Introduction

The *City of Portland Traffic Signal Policy and Design Guidance Manual* is comprehensive resource on traffic signal and intersection design guidelines, policies, and the project development process. This is intended to be used as a planning and design aid for any proposed traffic signal or intersection improvements in Portland. The requirements set forth herein were developed primarily for the downtown Peninsula, but there is sufficient guidance provided for the remainder of the signals in the City. Therefore, this document should be consulted before planning and design of any traffic signal in the City of Portland. Chapter 1 of this document provides an overview of the need for this policy guidance, the geographic scope of this resource, and the relevant standards which are referenced to in this document.

1.1 Introduction to Project

The *City of Portland Traffic Signal Policy and Design Guidance Manual* ("The Manual") is a supplemental aid to be used in conjunction with national, state, and other local reference materials during the planning and design phases of intersection and traffic signal projects in the City of Portland. Extensive research into existing infrastructure, modern design standards and best practices, and trends in mobility in Portland has gone into developing the information presented in this document.

This document is divided into two major components: project development and design guidance. The first component, project development, is explained in detail in Chapter 2 and lays the framework for a typical project development process from the design review process through as-built drawings following completion of construction. The design guidance is to be used by City staff or consulting engineers during the design phase of a project to ensure consistency of designs throughout Portland and is presented in Chapters 3 and 4. These chapters cover design elements and equipment specifications, respectively. Throughout the document, there are references to intersections on and off the Peninsula. For the sake of this document, the Peninsula is defined as the geographic area north of the Casco Bay Bridge and south of Interstate 295.

1.2 Need for The Manual

As projects continue to occur in Portland, through public or private development, a need has arisen for a guidance document which will provide a framework for effective, consistent, and goal-oriented designs of intersections and traffic signals.

An inventory of existing infrastructure on the Peninsula for example, revealed that of the 60 intersections of primary interest to The Manual, 38 of them required infrastructure upgrades to meet modern standards set by national, state, and local authorities. One of the main reasons why this is the case is the age of the infrastructure. Much of the existing infrastructure needs replacement as it consists of outdated infrastructure including aluminum mast arms, non-compliant pedestrian signals, and older generations of signal controller technology and communications.

The State of Maine, as well as the nation, has been actively working towards providing more accessible infrastructure for roadway users of all ages and abilities. The Americans with Disabilities Act (ADA) and the Public Rights-Of-Way Access Guidelines (PROWAG) have laid out specific regulations for users with accessibility needs. The design guidance presented in this document conforms to these regulations and provides planners and engineers the resources needed to meet ADA requirements and remain consistent with the vision for infrastructure in Portland.

The goal of this manual is to set design standards and principles for the planning and construction of traffic signal and associated infrastructure. The major considerations for these standards are driven by the needs described in Figure 1.

Figure 1: Traffic Signal and Intersection Design Considerations

The intersection of State St and Park Ave safely accommodates pedestrians with ADA compliant facilities.

Safety

Safety is at the forefront of Portland's efforts towards infrastructure improvements across the City. Safety enhancements can be achieved through various strategies and implementation techniques.

- Design streets for all users, particularly vulnerable users such as pedestrians, bicyclists, and users with disabilities.
- Establish cohesive designs to provide consistency and predictability for roadway users.
- Design streets for slower traffic to reduce the frequency and severity of crashes.
- Stay current on state-of-the-art safety enhancements which have been successful in other areas.

Spring St provides safe and clearly marked facilities for vehicles, pedestrians, and bicyclists.

Design for All Users

By designing for all roadway users (i.e. vehicles, pedestrians, bicyclists, transit, emergency vehicles), it can be ensured that everyone has a designated area so that conflict areas can be reduced.

- Provide safe and accessible facilities for vulnerable users such as bicyclists and pedestrians.
- Clearly mark all facilities to ensure the reduction in conflict points.
- Meet or exceed all local and national standards (i.e. ADA, PROWAG) for users with disabilities.
- Accommodate transit and emergency vehicles using pre-emption or queue jump lanes, where applicable.

Implementation of the latest SurTrac Wavetronix signal controller technology has begun around the City of Portland.

Advancement of Technology

Portland has been on the cutting edge of signal technology including adaptive signals, real-time data collection, passive pedestrian detection devices, amongst others. This trend helps to ensure operational efficiency for all users.

- Continue to research and implement new technology at pilot intersections for testing.
- Implement technology on a larger scale after pilots prove success.
- Establish a standard for signal technology to ensure ability for communications between devices.

A project prioritization and implementation plan is vital to the success of large-scale cost-effective construction programs.

Cost Effectiveness

Balancing cost of design and construction of infrastructure with the goals of advancing technology is a crucial component to sustainable investments in traffic signals on the peninsula.

- Develop and maintain a prioritized implementation plan of infrastructure needs.
- Strategically identify and apply for grants which could mostly or entirely fund priority projects.
- Combine projects, where possible, to cut down design and construction costs.
- Regularly inventory signal infrastructure to ensure prioritization of projects reflects actual needs.

1.3 Standards

This manual has been developed in accordance with current standards including:

- *American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets ("The Green Book")*
- *City of Portland Department of Public Works Technical Manual*
- *Manual on Uniform Traffic Control Devices (MUTCD)*
- *National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide*
- *United States Access Board Public Rights-of-Way Guidelines and Standards (PROWAG)*

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Project Planning and Development

This chapter of The Manual provides general guidance on the design approval process for traffic signals within the City of Portland. The design review and approval process for Portland intersections is detailed in the following sections.

2.1 Private Sector Projects

For projects not led by the City, State, or Portland Area Comprehensive Transportation System (PACTS) (i.e. project initiated by a party other than the City, such as via Site Plan approvals and/or projects requiring off-site mitigation as per Traffic Movement Permit rules, etc.), design approval will go through the Transportation Engineering Group at the Department of Public Works and then be sent along to the Transportation Program Manager at the Planning and Urban Development Department as well as the Traffic Operations Coordinator at the Department of Public Works (DPW) for additional review. The signal designer should work closely with the Transportation Systems Engineer or designer to define the scope of improvements, requirements of the project, and plan requirements. Checklists for all design review phases for signal plans are provided in Appendix A. The signal designer shall submit these completed checklists (with signature) with each signal design submittal.

The bidding Plan Sets shall be prepared and stamped by a Professional Engineer licensed in the State of Maine and possessing an IMSA Signal Level II certification or better.

2.2 Public Sector Projects

For City, State, or PACTS projects, the signal designer should work closely with the Transportation Systems Engineer or designee to understand the scope of improvements, requirements of the project, and plan requirements.

2.3 Design Review Phases

The following sections, and Figure 2, provide a general overview of the various design stages and the intent and outcomes of each stage. These apply to both private and public sector projects described above. It should be noted that this process roughly correlates to the MaineDOT design process. Portland DPW reserves the right to combine submittals on a case by case basis, with agreement from Transportation Systems Engineer or staff designee occurring prior to any project submissions.

2.3.1 50% (Preliminary Design):

The objective of the 50% design phase is to confirm the general design concept and scope, set major equipment locations (poles, controllers, panels), and identify any significant conflicts. For signal plans, the general signal operations and phasing should be identified, pole types and locations set, and controller cabinet location identified. For street lighting plans, light pole locations should be set. Any required photometric analysis should be performed during this stage to inform pole locations. This submission shall be accompanied by an opinion of cost, and appropriate contingencies applied to account for the early stage of project development.

2.3.2 70% (Plan Impacts Complete):

This stage of plan development is primarily to determine the potential for temporary or permanent property impacts. For any project utilizing federal or state funds, the right-of-way process shall be conducted as per Federal Highway requirements, with the process likely being led by MaineDOT. Projects utilizing City funding shall coordinate with Public Works staff to determine what appropriate steps shall be taken, including licenses, easements, or acquisitions.

If a project is determined to trigger no property impacts, this stage of submittal is not required.

2.3.3 90% (Draft Final Plans, Specifications and Construction Estimate):

Most of the detailed design work is performed during this phase, since the general design concept and property impacts have already been confirmed. The plans shall detail all equipment, wiring, controllers, accessible pedestrian signals (APS), poles, and mast arms. Detection locations and devices shall be provided. Conflicts between traffic signal structures and overhead utilities or trees shall be identified and resolved. All curb ramps shall be shown, with sufficient information, including spot grades, to result in compliance with ADA requirements. Ramps not meeting these requirements shall be documented with a narrative and listing of the aspects not meeting ADA and notation/justification as to why full compliance cannot be achieved. This documentation regarding technical or feasibility exceptions shall be submitted to DPW Transportation Systems Engineer for completion and approval.

The objective of the 90% design and review phase is to address all comments received at 50% and 70%, develop any special details, and develop draft Special Provisions for review. The Standard Drawings used in the design should also be identified and provided with the plan sets.

The plans shall be submitted with the appropriate specification booklet, which incorporates appropriate sections from MaineDOT as well as City of Portland. The City of Portland requirements are detailed elsewhere in this document.

Lastly, an updated opinion of construction cost shall be included with this submittal.

2.3.4 100% (Final Plans, Specifications and Construction Estimate):

All remaining comments from the previous stages are addressed during the 100% plans phase, and signed plans are submitted for Final Plan Approval (see Section 2.3.5). Special Provisions are finalized and signed by the Engineer of Record. Electronic copies of the design plans are also provided to the City for records and documentation of the project.

2.3.5 Final Plan Approval

The plans must be reviewed, approved, and signed by the Transportation Systems Engineer and the City Engineer. The signal designer should coordinate with the Transportation

Systems Engineer or designee as early as practical for feedback on the overall scope of improvements, to avoid late changes in the design or scope of improvements.

2.3.6 As-Built Drawings

The engineer of record is responsible for providing electronic AutoCAD (.DWG files) as-built drawings to the City Engineer upon completion of construction. Drawings must show a complete representation of all equipment in the field for the signalized intersection/location. This includes the equipment installed as part of the project and the existing equipment that is part of the traffic signal. For example, if work was only done on one corner of an intersection, the as-built must show and call out the existing equipment, conduit, wiring, etc. for the rest of the intersection.

The engineer of record will provide the Transportation Engineering Group with a specific memorandum identifying which traffic signal infrastructure is ADA compliant with the modifications that was previously non-compliant so that the City can update GIS etc. accordingly and remove such items from its priority listing.

Figure 2: Overview of Project Development Process

Project Development		Project Design & Approval					Project Completion	
Project Identification	**Scoping and Design Selection**	**50% Submission** *Preliminary Design*	**70% Submission** *Plan Impacts Complete*	**90% Submission** *Draft Final Plans, Specifications, and Cost Estimate*	**100% Submission** *Final Contract Plans*	**Final Plan Approval**	**Construction**	**As-Built Drawings**
An intersection or corridor has been identified by the City of Portland as requiring upgrades to infrastructure, technology, roadway geometry, or other reasons. The City can apply for funding for the project scoping process during this phase.	After a project has been identified by the City for improvements, a planning study that includes an alternatives analysis must be completed to evaluate the costs and benefits of alternatives and select a preferred alternative for the design which will be pursued.	Initial design phase that contains the following elements: » Major equipment locations, » General signal phasing and operations, » Street lighting analysis and pole locations, and » Cost estimates including contingencies.	This phase specifically involves the identification and extent of any temporary or permanent property impacts ***Note:** This submission is not required if there will be no property impacts.*	This design phase includes all elements required in the Preliminary Design submission and: » Finalized locations of major equipment locations, » Wiring, controller, and other utility locations, » Conflicts of signal equipment and utilities and/or trees, » Curb ramp design, » Standard drawing details, and » Item specifications booklet.	The Final Contract Plans include responses to all comments provided on the previous submission and finalized Special Provisions and estimates. These plans must be signed by the Engineer of Record before the plans can be officially approved.	A review, approval, and signature by the Transportation Systems and City Engineers is required for construction.	After approval is received from the City Engineers before the project can go out to bid. Construction should be completed according to the plans, as site conditions allow.	Electronic copies of As-Built drawings are required to be submitted to the Transportation Engineering Group after completion of construction. These plans show final locations for all existing and new equipment.

3

Design Elements

Chapter 3 provides design guidance for project engineers and designers on the typical elements to be included in traffic signal and intersection construction projects in Portland. These elements are intended to provide safe accommodations for all roadway users. Included in this chapter is guidance for geometric components and signal equipment to be included in projects. The guidance provided should be consider early in the design process to ensure compliance with all standards.

3.1 Geometry

Outside of the travel lanes at a signalized intersection on the Peninsula, other geometric elements require consideration to safely accommodate pedestrians and bicyclists. An important component of intersections is the interactions between bicycle lanes, parking, and transit with vehicle travel lanes. The following sections provide detailed guidance on how to address these aspects of design.

3.1.1 Curbside Elements and Crosswalks

Accessibility standards for curbside elements and pedestrian crossings can be found in the PROWAG Standards and Section 1 of the Portland Technical Manual (DPW Manual). These standards provide design guidance for elements including pedestrian street crossings, curb ramps, detectable warning surfaces, and locations and dimensions of pedestrian pushbutton and signals. Both of these documents should be referenced when developing designs for sidewalks and crosswalks/ramps at intersections.

Curbside elements often need to be designed in conjunction with the layouts of traffic signal equipment so as to avoid conflicts of pedestrians and equipment. All equipment should be placed outside of the pedestrian clear zone to provide safe areas for pedestrian passage.

Table 1 provides a summary of the standards presented in these documents.

Table 1: Overview of Intersection Design Elements

Design Element	**Guidance**	**Standard Reference**
Crosswalks	All crosswalks shall be 8′ wide and 4′ from the stop bar Crosswalks shall have longitudinal blocks made of 24″ white lines spaced 4′ on center	DPW Manual
Curb Ramps	Curb lip height shall be ¼-inch or less Preferred one ramp per pedestrian crossing Level landing shall be 5′ x 5′ 8.33% Maximum Slope of Ramp in Direction of Travel 2% Maximum Slope of landing in all other directions Cross Slope of Ramp shall meet street grade and be 2% maximum Maximum Slope of Flared sides is 10%, measured parallel to the curb line. If flared sides are not in the pathway, there is no maximum slope and vertical curbs may be used	DPW Manual / PROWAG
Detectable Warning Surfaces	Material shall be uncoated cast iron Truncated domes shall be aligned on a square grid in the direction of pedestrian travel (preferred) or installed radial to the grade break Front of Surface shall be 4″ minimum and 8″ maximum from the back of curb with neither corner of the surface more than 5′ from the face of curb Length of surface shall be 24″ Width of Surface shall be a minimum of 48″ and extend the entire width of the ramp, excluding flared sides.	DPW Manual / PROWAG
Pedestrian Pushbuttons	Pedestrian pushbuttons shall be placed 1.5′ minimum and 6′ maximum from the face of curb and 5′ maximum from the edge of the crosswalk Pushbuttons are to be located a maximum of 42″ from the ground and within 24″ from the level landing Pushbuttons should be positioned parallel to the approach (preferred) Two pushbuttons on a corner should be separated by 10′. In cases with apex ramps, two pushbuttons on a single pole are the preferred design	MUTCD

All elements are to meet the previously mentioned standards, unless extenuating circumstances occur, and are up to the discretion of the City Engineers.

Typical layouts of three and four leg intersections can be in Figure 3 and Figure 4.

3.1.2 Bicycle facilities

Where bicycle lanes exist at intersections, marked crossings should be provided in accordance with MUTCD standards. Bike lanes are to be extended through intersections using 6-inch white dotted lines marking the edges of the bike lanes and may also include green colored pavement, per the discretion of City Engineers, as shown in Figure 4. Where a left turning movement is the common bicycle movement, a two stage turn box or bike box should be considered and discussed with DPW Transportation Engineering. An example of this scenario is shown in Figure 3.

3.1.3 Adjacent parking

If curbside parking exists on any of the intersection approaches, parking must terminate at least 25 feet before the intersection, per the City Ordinance. Examples of on-street parking approaching an intersection is shown in Figure 4.

3.1.4 Transit Queue Jump Lanes

On transit priority corridors, such as Congress Street, queue jump lanes may be considered for transit vehicles where feasible. These lanes allow transit vehicles to get to the front of a queue and have a clear travel path to a stop on the far side of an intersection. Per City and METRO guidance, transit stops should be provided on the far side of intersections to avoid additional queuing and allow for smoother transitions back into vehicle travel lanes. An example of a queue jump lane with access to a transit stop is shown in Figure 3.

3.2 Signals, Detection, and Operations

Signal equipment and operations should be consistent throughout the City to ensure consistency for all roadway users. This leads to higher efficiency in vehicle operations and provides vulnerable users, such as bicycles, pedestrians, and users with disabilities, with predictability.

3.2.1 Mast Arms

The City standard is the use of mast arm poles in all new signal and retrofit installations. Mast arms are to be placed out of the furnishing zone at the curbline and are to avoid impacts to pedestrian through zones. There should be one mast arm per intersection approach to achieve perpendicular orientation to the approach which it is serving, unless approved by the Transportation Systems Engineer. If signs including lane assignment, right

turn on red restrictions, or turn prohibitions, are placed along the mast arm, they shall be placed in accordance with the MUTCD.

Generally, all equipment should be placed out of the pedestrian through zone in all directions and avoid sight triangle obstructions for vehicles. The placement of various signal equipment will need to be coordinated on a case by case basis and, in some designs, may be combined. For example, the placement of a mast arm can be done such that the pedestrian pushbutton and signal can be placed on the same structure while meeting ADA compliance guidelines. Typical placement of mast arms can be found in Figure 3 and Figure 4 of this document.

3.2.2 Vehicle Signal Heads

Per MUTCD guidance in Part 4, signal heads should be placed within the cone of vision (Figure 4D-4, MUTCD) from each stop bar on each approach. The number of signal heads required is prescribed by Table 4D-1 in the MUTCD. In addition, where there is a dedicated left-turn lane Flashing Yellow Arrows (FYA) shall be used along the approach to convey permissive only (see Figure 4D-7, MUTCD) and protected/permissive (see Figure 4D-12) modes of operation. Typical placement of mast arms and vehicle signal heads can be found in Figure 3 and Figure 4 of this document.

3.2.3 Pedestrian Signals

All pedestrian signals used at signalized intersections on the Portland Peninsula must meet the requirements presented in Chapter 4E of the MUTCD and Section 3.2.7 of this Manual. These requirements include the use of a steady walking person with sufficient time to allow pedestrians to exit the curb ramp and enter the crosswalk, an upraised hand to indicate flashing don't walk and don't walk time, and a countdown to indicate the remaining time allotted to the pedestrian phase. The amount of provided flashing don't walk time should allow for a pedestrian to cross the length of the crosswalk at an average speed of 3.5 feet/second.

Various guidance exists to ensure proper access to pedestrian signals for all roadway users. Where pushbuttons are used for pedestrian detection, they must be Accessible Pedestrian Signals (APS) and include tactile arrows on the button and be located in accordance with the standards presented in Chapter 4E of the MUTCD. In addition to actuated detection, passive detection, may be used. If this type of detection is used, it should be used in conjunction with audible and visual feedback, such as a "wait" message or a confirmation light on the pedestrian pedestal that indicates to the user that they have been detected by the signal. When passive detection is used, the detection zone must be carefully located to ensure proper detection and avoid false detection calls. This technology is currently being tested at certain locations on the Peninsula and is not appropriate for all intersection configurations.

Additional accessibility features may be used for pedestrian signals including vibrating surfaces or speech messages or audible tones for crossings . The preferred audible assistance is a speech message and it should clearly indicate which crosswalk is safe for the pedestrian to cross.

3.2.4 Bicycle Signal Heads

The City does not presently use bicycle signal heads to control bike movements at signalized intersections, but staff are open to consideration where such a treatment would be applicable, particularly if the potential exists for lead bicycle phasing. If there is a specific circumstance where bicycles signals are deemed desirable (i.e. heavy vehicle right turning movements, high vehicle speeds, etc.), the signal designer should work with the Transportation Systems Engineer and Traffic Engineering Group to determine if they are needed.

3.2.5 Vehicle Detection

Video-based (thermal imaging) vehicle detection should be used at all intersections in Portland. Detection devices are to be placed on all mast arms, providing one detector per approach with detection zones for each movement. The devices must be able to detect bicycles.

3.2.6 Lighting

Lighting at intersections on the Portland is to be light emitting diode (LED) street lighting which may be mounted on the top of mast arm poles, based on the completed lighting analysis. The primary goal of lighting placement is to ensure adequate lighting of crosswalks. If this results in unnecessary utility conflicts, alternative locations can be determined at the discretion of the Traffic Systems Engineer, Traffic Operations Coordinator, or another DPW designated individual.

3.2.7 Signal Operations

The signal controllers described in Section 4.1.1 are equipped with technology both in basic stand-alone mode or through supplemental devices like adaptive signal control technologies which can update signal timing and phasing through real time data collection, but there are guiding principles which need to be followed in the design phase of traffic signals.

Intersection timing plans shall provide a minimum cycle length of 45 seconds and maximum cycle length of 90 seconds, unless determined it should be longer based on a capacity analysis. Intersection phasing plans should generally include a five-second minimum leading pedestrian intervals (LPI), concurrent phasing of the major approaches with optional lagging left turn phases, and concurrent phasing of the minor approaches with optional lagging left turn phases. All approaches shall be actuated with the major approaches running on soft (or minimum) recall. At most intersections using an LPI, the pedestrian phases will also operate on soft recall.

3.2.8 Connected Vehicles

The City does not presently use Connected Vehicle (CV) technology within its traffic signal systems but is aware of MaineDOT projects using CV through Dedicated Short Range Communications (DSRC) by way of Road Side Units (RSUs). If there are specific circumstances

where CV is desired within the Peninsula, the signal designer should work with the Transportation Systems Engineer and Traffic Engineering Group to determine if they are needed. If deemed appropriate, the CV application should follow applicable specifications under development by MaineDOT in forthcoming Section 654 Intelligent Transportation Systems. Solutions that easily allow for switching between DSRC and high-speed cellular communications with minimum cost and impact are preferred.

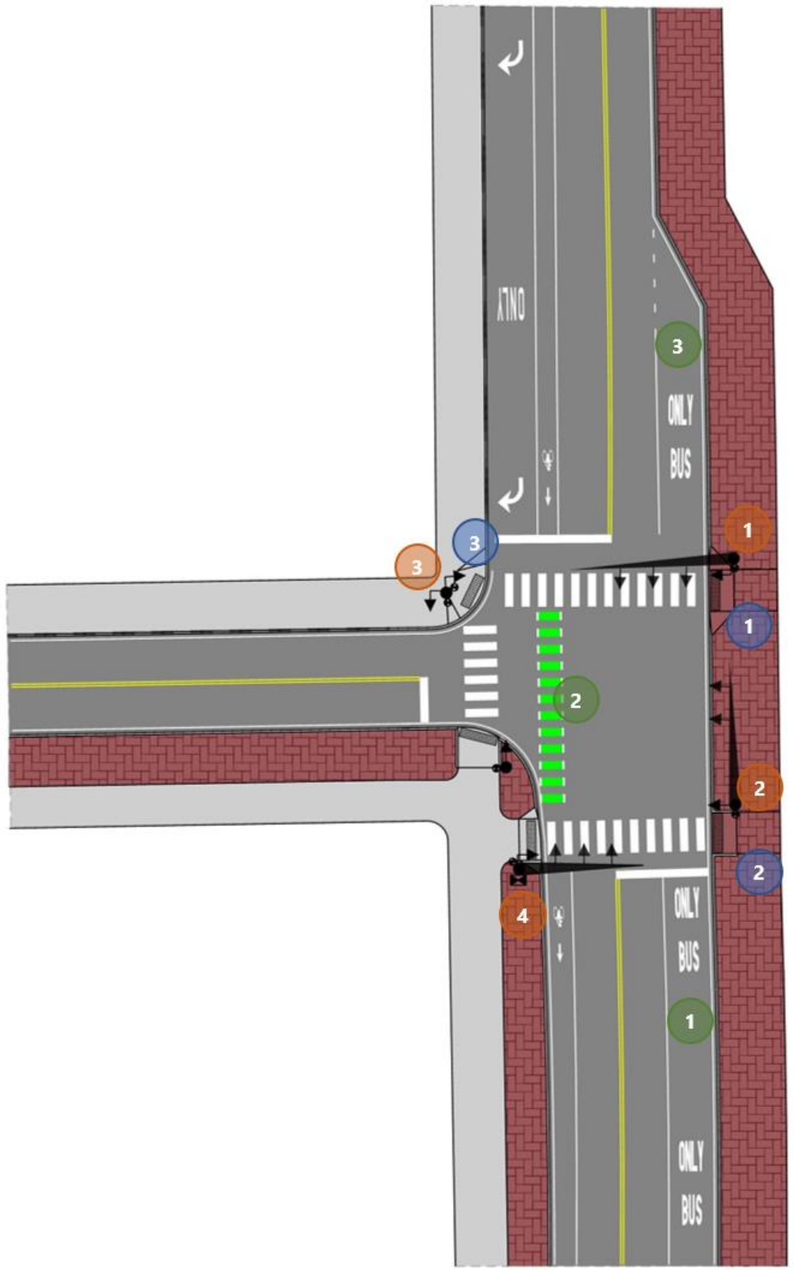
3.2.9 Data Collection

Much of the technology being recommended for use as part of this document has the capability to collect data. Data collection will lead to more efficient signal operations and interactions between the multiple modes of travel. With adaptive signals, connected vehicles, and other smart infrastructure becoming prevalent in our streetscapes, these devices should be compatible with systems already in place such as ATMS.now, as well as forthcoming technology. As the City of Portland implements more advanced pieces of technology, planners and designers should consult with City Engineers to determine what capabilities are preferred for a project.

3.3 Typical Intersections

The following figures present examples of typical intersection design at three and four leg intersections. These figures are meant to show how various elements of design should interact with each other at an intersection.

Figure 3: Typical 3-Leg Intersection

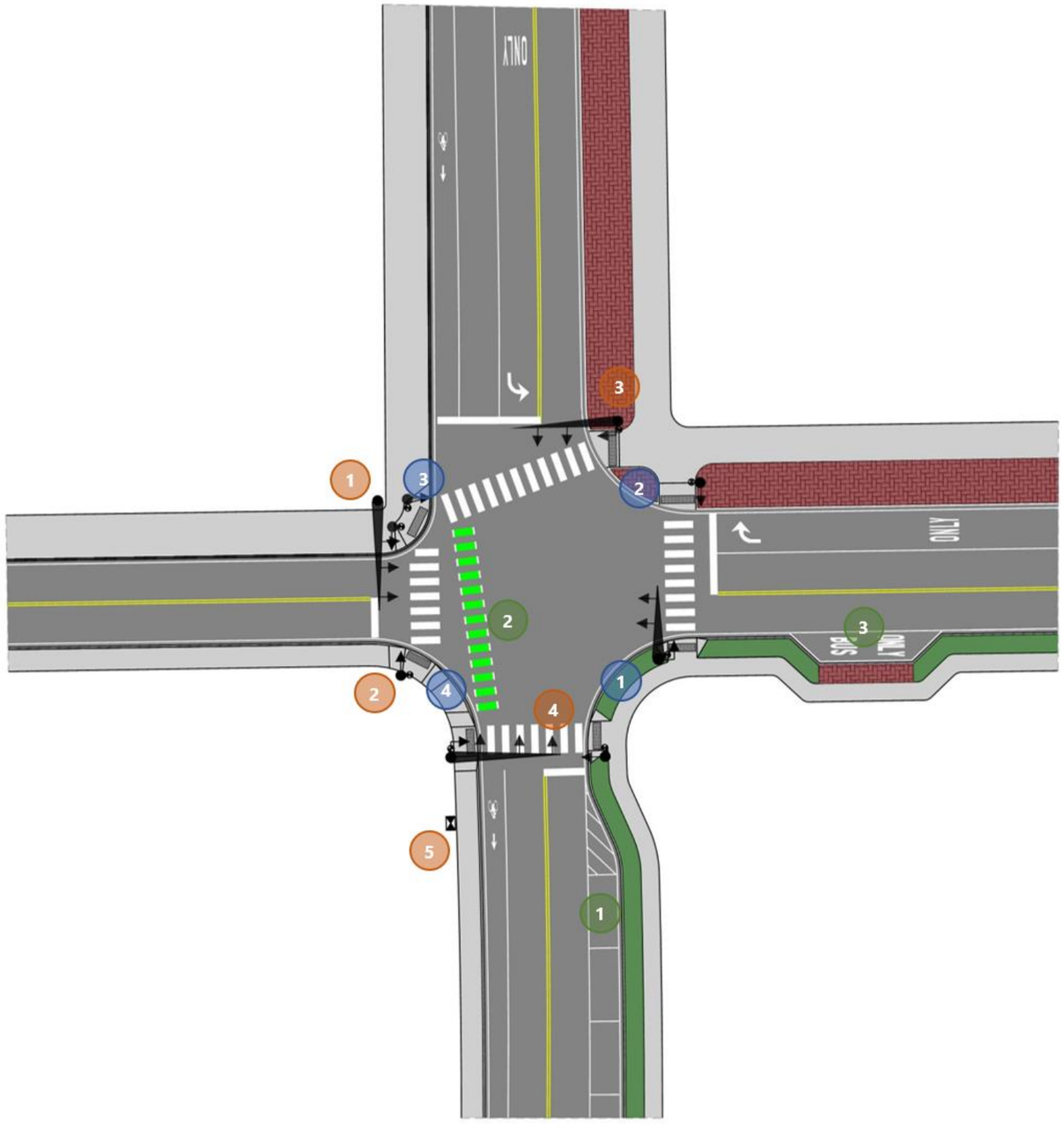


Crosswalk Ramps	
1	One ramp per crosswalk with flared sides (preferred design)
2	One ramp per crosswalk with curbs and no flares (preferred design)
3	Single apex on small radius

Traffic Signal Equipment	
1	One mast arm per approach perpendicular to intersection leg (preferred design)
2	Mast arm mounted APS or passive pedestrian detection device
3	Pedestal mounted APS or passive pedestrian detection device
4	Pole-mounted signal controller

Design Elements	
1	Transit queue jump lane
2	Bike lane extension through intersection (optional)
3	Bus stop on far side of intersection

Figure 4: Typical 4-Leg Intersection



Crosswalk Ramps	
1	One ramp per crosswalk with flared sides (preferred design)
2	One ramp per crosswalk with curbs and no flares (preferred design)
3	Single apex on small radius
4	Parallel ramps along sidewalk

Traffic Signal Equipment	
1	One mast arm per approach perpendicular to intersection leg (preferred design)
2	Pedestal mounted APS or passive pedestrian detection device
3	Mast arm mounted APS or passive pedestrian detection device
4	Flashing yellow left arrow
5	Ground-mounted signal controller

Design Elements	
1	Parking lane with bumpout
2	Bike lane extension through intersection (optional)
3	Bus stop on far side of intersection with passenger loading/unloading area

4

Equipment Specifications

The specifications for traffic signal equipment referenced in the following sections can be found in the Portland DPW Technical Manual. In addition to this document and the DPW Manual, MaineDOT Standards and the MUTCD and other technical references should be used to ensure compliance and consistency between Portland traffic signals.

4.1 Technology

4.1.1 Signal Controllers and Cabinets

The type of signal controllers and cabinets that can be used in Portland are dictated by MaineDOT, with detailed information provided in their Special Provisions for item 718.07 (Controllers) and item 718.08 (Cabinets). These specifications identify the use of Advanced Transportation Controllers (ATC), preferably the Trafficware COMMANDER, to provide compatibility with the City's ATMS.now system. The controllers shall be rack-mounted and solid-state units conforming to the ATC 5201 v06.25 standard. It shall be in a four-door controller with size varying depending on the type of mounting. Controllers shall have the capavilities to support flashing yellow and red arrows, collect, store, and report various measures of effectiveness, and upgrade controller firmware via a USB device, among others. Briefly, the controllers and cabinets shall contain the elements described in Table 2 and the special provisions are provided in Appendix C.

4.1.2 Power Supply

MaineDOT states in their standard specifications, Section 626.0301, that power meters and breaker panels for traffic signal controllers shall be constructed within 30-feet of the service drop. In Section 643.09 of the same specifications, it prescribes that the meter shall be placed in the vicinity of the controller and installed with the top of the meter between 48- and 60-inches from the floor to the final grade.

4.1.3 Detection

As specified in the DPW Technical Manual, all vehicle detection units shall be of the following brands, models, and have the specified software capabilities, unless determined by the Transportation Systems Engineer or staff designee that another detection system may be used:

- Video detection units shall be Traficon Model VIP3.1 & VIP3.2 Series only
- Video detection cameras shall be FLIR Trafisense 2

On priority transit and emergency vehicle corridors, such as Congress Street, Automatic Vehicle Locations (AVL)-based priority may be included per the discretion of the City Engineer. Priority should be considered for emergency vehicles where lanes may be narrow or there are limited sight lines from minor approaches.

4.2 Mast Arms

Standard details for mast arms and pedestals can be found in MaineDOT Standard Details 643(03), 643(07), and 643(08). Traffic signal and street lighting foundations details are found in details 626(01) through 626(07). Other traffic signal equipment such as conduit, service connections, and junction boxes can also be found in Section 600 of these standard details.

Traffic signal structures off Peninsula may have a galvanized finish, with no decorative base requirement.

Per the DPW Manual, mast arms for signals on the Peninsula shall be Valmont SM16 or CB16 Series with anodized black powder coat only. Mast arm span may range in five-foot increments from 15-feet to 45-feet, with a preferred maximum length of 30-feet on the Peninsula and 45-feet off the Peninsula, with exceptions approved by the Transportation Systems Engineer. Mast arm length is dependent on foundation location, number of signal heads required, and necessary signal head locations. All mast poles on the Peninsula shall have Valmont Enduro decorative bases in Huntington style. This does not apply to pedestrian pole bases.

4.3 Vehicle Signal Heads

All vehicle signal heads and housings proposed at signalized intersections shall be of the following brands and models:

- Signal housings shall be McCain Model MTSTA or MTSTP Series only
- LED modules for vehicle indications shall be GELcore Model DR6 Series only

Signal heads must be fitted with visors and have a MUTCD compliant louvered backplate with 3-inch retroreflective stripe to increase visibility to drivers.

4.4 Pedestrian Equipment

Pedestrian equipment including signal faces, detection devices, and pedestal poles are used at nearly all intersections identified as relevant to The Manual. MaineDOT, the DPW Technical Manual, and the MUTCD provide guidance on these elements and these recommendations are outlined in the following sections.

4.4.1 Pedestrian Signals and Detection

Standards for pedestrian signals and detection are prescribed by a number of sources including the DPW Technical Manual, MaineDOT, and the MUTCD and consist of the elements described in Table 2.

4.4.2 Pedestrian Pedestal Poles

Standards for pedestrian pedestal poles should follow MaineDOT standards and be painted black. The following pole heights are to be used depending on the equipment to be added to the structure:

- 4-foot pedestal poles shall be used if only the APS is to be attached to the structure.
- 8-foot pedestal poles shall be used if the APS and/or countdown pedestrian signal is to be attached to the structure.

- 10-foot pedestal poles shall be used where there is a top mounted traffic signal head, regardless of whether the structure provides APS and/or countdown pedestrian signals.

4.5 System Control

The City is presently using the ATMS.now Traffic Management System for remote monitoring and control of traffic signals in Portland. Generally, ATMS.now is being used to keep traffic signal synchronized to provide coordinated operations along principal corridors. In addition, adaptive signal control using SurTrac and Rhythm systems are being used at select locations in conjunction with ATMS.now. SurTrac is being utilized on the Peninsula along Forest Avenue, Marginal Way, and Franklin Street and Rhythm is being utilized off the Peninsula along Washington Avenue/Auburn Street.

Any signal project should include a discussion with the Transportation Systems Engineer or designee with regards to whether adaptive should be included and, if so, which technology is appropriate.

4.6 Communications

All proposed wired communication equipment shall be made of 12 strand signal node fiber. This standard applies to both aerial or underground conduit installation. Communication devices (wired and/or wireless) are to be associated only with traffic signal operations. Any other proposed use much be approved by the Director of DPW. A map of the current traffic signal communications network is provided in Appendix B.

4.7 Lighting

Lighting at intersections on the Portland is to be light emitting diode (LED) street lighting which may be mounted on the top of mast arm poles, based on the completed lighting analysis. This guidance only dictates lighting that is provided on mast arm poles to light crosswalks and intersections. If lighting analysis determines that lights shall be placed on mast arm poles, but this results in utility conflicts, coordinate with DPW to determine alternative locations.

Table 2: Overview of Signal Standards

Design Element	**Guidance**	**Standard Reference**
Controllers	Controllers shall be rack-mounted, solid-state, menu driven, keyboard units confirming to the ATC 5201 v06.25 Advanced Transportation Controller (ATC) Standard Contain ATC API operational software conforming to ATC 5401 Standard v02 and configured to operate in an ATCC 5301 v02 cabinet platform Support Flashing Yellow and Flashing Red Arrows with the ability to provide a minimum of six flashing pairs	MaineDOT
Cabinets	Cabinets shall be dust and moisture-proof aluminum housings with an auxiliary door in door feature Configured to eliminate arc flash with all electrical equipment being dead front, no open terminals, busbars, breakers, or exposed terminal strips Cabinets may be ground mounted (NEMA "P" Size – 44"W x 26"D x 67"H) or pole mounted (Model 336S – 24"W x 20"D x 46"H) Supplied with four doors; two on the front and two on the back Supplied with police door and technician panels mounted in the appropriate locations	MaineDOT / DPW Manual
Vehicle Detection	Units shall be Traficon Model VIP3.1 & VIP3.2 Series Cameras shall be Traficon approved models	DPW Manual
Pedestrian Signals	LED modules for pedestrian indications shall be GELcore Model PS7 Series only Pedestrian signal head indications shall be displayed on a rectangular background and shall consist of symbolized messages (i.e. hand and pedestrian) of at least 6" height and a numerical countdown of remaining phase time	DPW Manual
Pedestrian Detection	Accessible Pedestrian Signals and Pushbuttons shall be Campbell Advisor Series only Pushbuttons are to be installed per MUTCD standards on mast arm poles or pedestals Contain vibro-tactile walk indications and, if approved by the City Engineer, audible indications of walk phase provided.	DPW Manual

Appendix

Appendix A – Design Review Checklists

Traffic Signal Improvement Project
Planning and Scoping Checklist

Project Name: _____
Project Number: _____
Project Manager: _____
Date Checked:

Designer Signature:

City Engineer Signature:

1. Existing Conditions

- ☐ Peak Hour Traffic Count Data
- ☐ Current Signal Timing and Phasing
- ☐ Existing Geometric Design
- ☐ Existing Equipment Specifications
- ☐ ADA / PROWAG Compliance Assessment of Current Design
- ☐ Street Lighting Assessment Applicable?
- ☐ Bicycle Facility Assessment Applicable?
- ☐ Transit Facility Assessment Applicable?

2. Alternatives Analysis / Evaluation Matrix

- ☐ At Least 2 Alternative Designs Applicable?
- ☐ Conceptual Plans
- ☐ Evaluation Criteria
- ☐ Traffic Analysis of Alternatives
    - ☐ Current and Future Year AM and PM Peak Hour Analysis
- ☐ Conceptual Cost Estimates
- ☐ Potential Permitting Needs
- ☐ Potential Right-of-Way Needs
- ☐ Bicycle Facility Assessment

3. Public Outreach

- ☐ Process determined by DPW

4. Preferred Alternative

- ☐ Identification of Preferred Alternative Applicable?

Traffic Signal Improvement Project
50% Submission (Preliminary Design) Checklist

Project Name: _____
Project Number: _____
Project Manager: _____
Date Checked:

Designer Signature:

City Engineer Signature:

1. Existing Infrastructure

- ☐ Underground and above ground utilities
- ☐ Right-of-way and property lines
- ☐ Edge of pavement and curb ramps
- ☐ Pavement markings
- ☐ Existing traffic signal equipment
  - ☐ Cabinet
  - ☐ Pull boxes
  - ☐ Mast arms Applicable?
  - ☐ Strain poles Applicable?
  - ☐ Pedestal poles Applicable?
  - ☐ Signal heads
  - ☐ Pedestrian pushbuttons
  - ☐ Detection
  - ☐ Signal Priority (Transit or Emergency Services) Applicable?

2. Proposed Infrastructure

- ☐ Edge of pavement and curb ramp locations
- ☐ Pavement markings
- ☐ Power Source
- ☐ Approximate ATC Controller and Cabinet location
- ☐ Approximate pull box locations
- ☐ Approximate conduit locations
- ☐ Mast arms (size, approximate location, number of signal heads, etc.) Applicable?
- ☐ Strain poles Applicable?
- ☐ Pedestal poles Applicable?
- ☐ Signal heads
- ☐ Pedestrian pushbuttons
- ☐ Signal Priority (Transit or Emergency Services) Applicable?
- ☐ Street light locations
  - ☐ Lighting analysis

3. Signal Operations and Analysis

- ☐ Signal Warrant
- ☐ Synchro, SimTraffic, or other traffic analysis approved by Transportation Systems Engineer
- ☐ Phasing Plan

3. Signal Operations and Analysis (Continued)

- ☐ Approximate Signal Timings and Calculations
- ☐ Approximate Signal Priority Plan Applicable?

4. Other

- ☐ Property Impact Evaluation (To determine need for 70% Submission)
- ☐ Quantities of equipment items
- ☐ Cost estimate (including contingencies)

5. Plan Development

- ☐ Cover Sheet
  - ☐ Project Title
  - ☐ Project Locus Map
  - ☐ Submission Phase
- ☐ Index of Sheets
- ☐ Notes and Legend
- ☐ North Arrow (oriented to top of page)
- ☐ Scale (1”=10’ or 1”=20’)

Traffic Signal Improvement Project
70% Submission (Plan Impact) Checklist – *If Required*

Project Name: _____
Project Number: _____
Project Manager: _____
Date Checked:

Designer Signature:

City Engineer Signature:

1. Plan Impacts

- ☐ Identified Impacted Properties
  - ☐ Temporary or Permanent?
  - ☐ Quantity of Impact
  - ☐ Identified Property Owner
- ☐ Federally Funded Project Applicable?
  - ☐ Contact MaineDOT for Further Coordination with Federal Highway Administration (FHWA)
- ☐ City Funded Project Applicable?
  - ☐ Contact DPW for Further Coordination
  - ☐ Identified Property Owner(s)

Traffic Signal Improvement Project
90% Submission (Plans, Specifications, and Estimate) Checklist

Project Name: _____
Project Number: _____
Project Manager: _____
Date Checked:

Designer Signature:

City Engineer Signature:

1. Previous Submissions

- ☐ Planning and Scoping Study
- ☐ 50% (Preliminary) Plans
- ☐ 70% (Impact Plans) Plans (If required due to property impacts) Applicable?

2. Proposed Infrastructure

- ☐ Level landing and curb ramp design
  - ☐ ADA design exemption approval Applicable?
- ☐ Power Source
- ☐ Finalized ATC Controller and Cabinet location
- ☐ Finalized pull box locations
- ☐ Finalized mast arm design (size, location, signal heads, etc.) Applicable?
- ☐ Strain poles Applicable?
- ☐ Pedestal poles Applicable?
- ☐ Borings and Equipment Foundation Design Applicable?
- ☐ Signal heads
- ☐ Pedestrian pushbuttons
- ☐ Wiring and Conduit Schedule
- ☐ Street light locations
- ☐ Proposed Signage
- ☐ Utility Locations
  - ☐ Conflicts with equipment?
    - If yes, contact DPW and Utilities to coordinate relocation

3. Signal Operations

- ☐ Phasing Plan
- ☐ Finalized Signal Timings
- ☐ Finalized Signal Priority Plan (Transit or Emergency Services) Applicable?
- ☐ Detector Schedule

4. Plan Development

- ☐ Cover Sheet
  - ☐ Project Title
  - ☐ Project Locus Map
- ☐ Index of Sheets
- ☐ Notes and Legend

4. Plan Development (Continued)

- ☐ North Arrow (oriented to top of page)
- ☐ Scale (1″=10′ or 1″=20′)
- ☐ Standard drawing details
- ☐ Right-of-Way Plans
- ☐ Item specifications booklet
- ☐ Quantity Sheet

5. Other

- ☐ Finalized cost estimate (including contingencies)

Traffic Signal Improvement Project
100% Submission (Final Plans) Checklist

Project Name: _____
Project Number: _____
Project Manager: _____
Date Checked:

Designer Signature:

City Engineer Signature:

1. Previous Submissions

- ☐ Planning and Scoping Study
- ☐ 50% (Preliminary) Plans
- ☐ 70% (Impact Plans) Plans Applicable?
- ☐ 90% (Plans, Specifications, and Estimate) Plans

2. Proposed Infrastructure

- ☐ Updated per 90% Submission Comments

3. Signal Operations

- ☐ Updated per 90% Submission Comments

4. Plan Development

- ☐ Updated per 90% Submission Comments

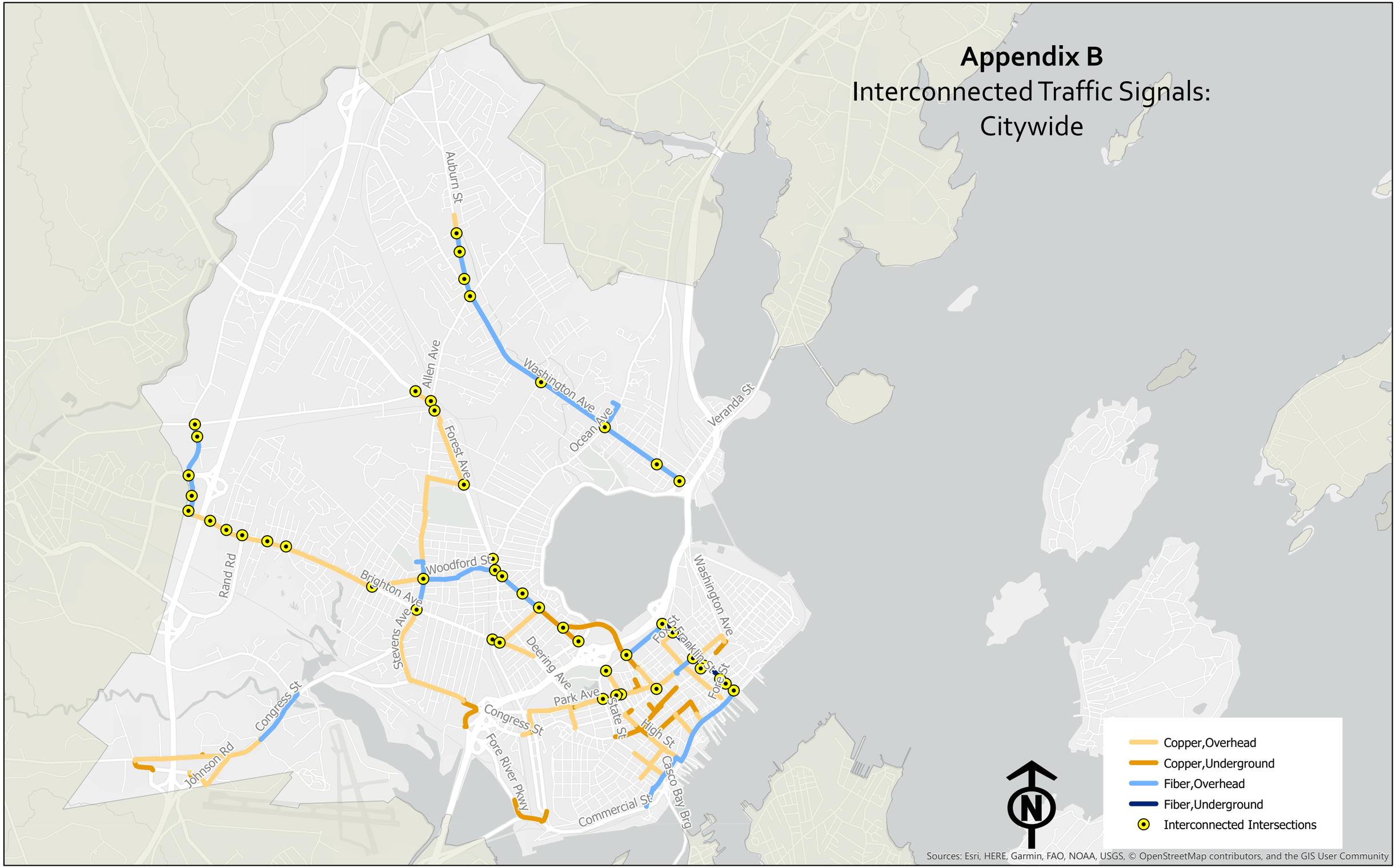
5. Other

- ☐ Final Special Provisions
- ☐ Final Cost Estimate

Appendix B – Portland Signal Communications Map

Appendix B

Interconnected Traffic Signals: Citywide



Appendix B-1
Interconnected Traffic Signals: Peninsula

Appendix B-2

Interconnected Traffic Signals: Forest Ave/Woodfords Corner

Appendix C – MaineDOT Special Provisions

SPECIAL PROVISION
SECTION 718
TRAFFIC SIGNALS MATERIAL

The provisions of Section 718 of the Standard Specifications shall apply with the following additions and modifications:

718.07 Controllers Traffic signal controllers shall be modified as follows:

Delete all paragraphs in 718.07 and add the following text:

All controllers shall be rack-mounted, solid state, menu driven, keyboard units conforming to the ATC 5201 v06.25 Advanced Transportation Controller (ATC) Standard. The controller shall be supplied with all necessary interfaces needed to support Advanced Transportation Controller Cabinet (ATCC) / Serial Interface Unit (SIU) communications. Controllers shall be supplied with an internal real-time clock/calendar capable of daily, weekly, and yearly events time programming. The controller shall be designed and supplied to provide the number of phases and sequencing as shown on the plans without any auxiliary equipment.

Traffic signal controllers shall be supplied as follows:

- Contain ATC API operational software conforming to ATC 5401 Standard v02.
- Be configured to operate in an ATCC 5301 v02 cabinet platform.
- Be supplied with the appropriate version of the Linux operating system, Board Support Package (BSP) and internal processing levels necessary to support connected vehicle (CV) as well as local and system operations.
- Shall be fully compliant with NTCIP 1201 and 1202 standards.
- Include a minimum of 3 High Speed USB 2.0 ports.
- Include a minimum of 3 10/100BaseT, RJ45 Ethernet connector ports.
- Meet the functional requirements of the NEMA TS-2, 2016 Standard, including all amendments.
- Support Flashing Yellow Arrow (FYA) and Flashing Red Arrow (FRA) operation with the ability to provide a minimum of 6 flashing pairs.
- Contain the ability to alter the controller unit's internal database using a built-in front panel keyboard, using a computer connected to the controller unit with a USB cable or an Ethernet cable, and remotely using the central management system application.
- Be supplied and installed with the ability to collect, store, and report various measures of effectiveness (MOE's).
- Shall collect and process all 255 high resolution enumerations as defined in the report "Indiana Traffic Signal Hi Resolution Data Enumerations", dated November 2012. This data will be processed in the controller and available via download from the controller

USB Ethernet port or, if available, via system communications. As a minimum, the controller will be set up to provide the following performance reports:

- Approach delay
- Preemption events
- Transit Priority Events
- Split Monitor
- Approach Volumes
- Purdue Coordination Diagrams
- Arrivals on Red
- Arrivals on Green
- Phase Termination
- Pedestrian Delay

- Be able to backup and restore Controller programing data to a USB memory device connected to the front of the controller. No additional software shall be required to perform this function.
- Be able to upgrade the Controller firmware via USB memory device connected to the front of the controller. No additional software shall be required to perform this function.

The field electrical loading for flash operation shall be wired through the transfer relays such that the load on the 2-circuit flasher is as balanced as possible within the limitations of the signal phasing.

Electrical filtering/surge protection shall be supplied and installed in each cabinet in accordance with ATCC 5301 v02 requirements and the manufacturer's recommendations. At a minimum, surge suppression shall be provided for incoming electric utility power conductors, all signal control circuits, vehicle detection, and pedestrian detection terminations.

All equipment inputs, outputs, and terminals shall be identified by the phase designations shown on the plans.

The reliability of the equipment shall be demonstrated by test performance detailed in 718.08 that will confirm that the controller unit, fully wired cabinet, and auxiliary equipment meet the operational and functional requirements of the plans and specifications.

Each traffic controller unit, flasher and all other current interrupting devices shall be equipped with a suitable radio interference suppressor installed at the input power point. Interference suppressors shall be designed to minimize interference in both broadcast and aircraft frequencies. Suppressors shall be designed for 125 percent of the total connected load and shall meet standards of the UL and the EIA.

The type of controller, auxiliary equipment and other operational features shall be as noted on the plans.

All controllers shall be capable of providing flashing operation of the signal lights, as indicated on the plans. Transfer from flashing operation or to flashing operation shall conform to the MUTCD.

If noted on the plans, hardwire preempt circuits shall be provided for emergency vehicles and/or railroad crossings. The clearance and preempt indications shall be as noted on the plans. Preempt circuits shall function during stop and go and flashing operation unless otherwise noted. The duration of clearance and preempt intervals shall be adjustable over the range noted on the plans and shall be labeled according to function. The railroad preempt circuit shall be designed to operate as a fail-safe loop through a normally made contact on the railroad's control relay in the railroad's control cabinet. Railroad preemption shall have precedence over all preemption intervals for other purposes.

Actuated vehicle phases and actuated pedestrian phases shall be served in that interval of the cycle indicated on the plans. Time for an actuated interval shall be taken from the non-actuated phase(s) as noted on the plans.

Automatic transfer to or from flashing operation shall conform to the MUTCD. Manual advance of the intervals by use of hand cord control shall cause the controller to advance to the next programmed interval only upon pulse signal from the hand cord circuit, interval timing shall hold the interval for the minimum programmed amber and red clearance intervals.

The controller unit shall be enclosed in a sheet metal case with protective painted finish, designed to permit easy access to the interior and removal of printed circuit boards and modules without the use of special tools. All program controls, fuses, and indicator lights shall be mounted on the front panel and shall be clearly and permanently labeled.

When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit, except yellow and red clearance intervals shall be timed for the duration programmed.

An exclusive pedestrian phase shall not extend or recycle until a vehicle phase has been serviced. When on manual operation, all phases shall be called regardless of vehicle detection and the controller shall be advanced upon pulse from the hand cord circuit except yellow and red clearance intervals shall be timed for the duration programmed. Automatic transfer from or to flashing operation shall conform to the MUTCD.

Pedestrian phases shall not be extended by actuations, during the walk or clearance interval. Actuations during the clearance intervals shall be placed in memory.

Each controller supplied shall be the same manufacturer, model and contain the same firmware level and version number.

<u>718.08 Controller Cabinets</u> Traffic signal controller cabinets shall be modified as follows:

Delete all paragraphs in 718.08 and add the following text:

The traffic signal control equipment shall be enclosed within a dust and moisture-proof aluminum housing with an auxiliary door in door feature. The door hinge pins shall be made of stainless steel. There are two cabinet configuration options that are specified for use; a ground mounted cabinet and a side of pole mounted cabinet.

All new controller cabinets, traffic signal or lighting, shall be configured to eliminate arc flash. All electrical equipment will be dead front, no open terminals, busbars, breakers, or exposed terminal strips. The cabinet shall be designed, constructed and installed with all necessary provisions to comply with the latest NFPA 70E requirements. All electrically live parts over 50 volts shall be covered with Lexan or a suitable physical barrier to eliminate the possibility of an arc flash.

The ground mounted cabinet shall be a NEMA "P" size cabinet (44"W x 26"D x 67"H). The cabinet shall be supplied with two side by side, 19" rack cages which shall extend from the bottom to top of the cabinet. The cabinet shall be supplied with four doors; two on the front and two on the back. The doors shall open independently with an independent center post latching for each of the four doors. The cabinet front will provide for user interface to the in-cabinet devices including the front panel of the controller, the cabinet status displays and detection system control interface. The cabinet rear would support cable termination and would not typically be accessed except for installation and the troubleshooting of wiring problems. The left-side rack of the cabinet, relative to facing the cabinet from the front, shall house the control devices such as the controller, Cabinet Monitor Unit (CMU) and Auxiliary Display Unit (ADU), switch packs and power distribution panel. As such, this rack shall be referred to as the "Control" side of the cabinet. The right-side rack of the cabinet, relative to facing the cabinet from the front, shall house the spare card cage assembly and battery back-up devices and communications elements. As such, this rack shall be referred to as the "Power and Auxiliary" side of the cabinet. The ground mounted cabinet shall be supplied with 32 output channels and 48 input channels.

The side of pole mounted cabinet shall be a Model 336S cabinet (24" W x 20" D x 46" H). The cabinet shall be supplied with a 19" rack cage which shall extend from the bottom to top of the cabinet. The cabinet front will provide for user interface to the in-cabinet devices including the front panel of the controller, the cabinet status displays and detection system control interface. The cabinet rear would support cable termination and would not typically be accessed except for installation and the troubleshooting of wiring problems. The side of pole mounted cabinet shall be supplied with 16 output channels and 24 input channels.

Both the ground mount and side of pole mount cabinets shall be configured to provide the following output/input channel assignments:

Channel	Input	Output
1-8	Vehicle Phase Call 1-8	Vehicle Phase 1-8
9-12	Pedestrian Phase Call 2,4,6,8	Pedestrian Phase 2,4,6,8
13-16	-	Overlap A, B, C, D
17+	Special Functions	-

The ground mount cabinet shall be supplied with a spare equipment card cage assembly. This card cage assembly will not be wired to any cabinet device, but rather used to store spare rack mounted cabinet devices such as switch packs, SIU's, CMU's and phases selectors. This spare rack assembly shall be located at the top of the power rack.

The cabinet shall be supplied with a GPS system to provide an accurate time reference for the cabinet. The antenna shall be mounted at the top of the cabinet in the back-left corner of the enclosure. The antenna shall be mounted such that it provides a waterproof seal; eliminating any possibility for water penetration into the cabinet. The GPS system cable shall be connected and integrated into the controller.

The cabinet shall be supplied with a police door panel located in the middle area of the front door for both cabinet types. The switches shall be mounted in the police panel and labelled as to function. Four switches shall be supplied as follows:

1. Power On/Off
2. Signal On/Off
3. Signal/Flash
4. Manual/Auto with cord

The manual control cord shall be a coiled type, sealed weather proof covered hand switch extending to six feet when fully stretched. The cord shall be fastened to the cabinet via a compression type connector to provide strain relief for the cord's electrical connections. The police door panel shall be of sufficient size so as to store the manual control cord when panel door is closed.

The cabinet shall be supplied with a technician's panel mounted on the back of the police panel. This panel shall be supplied with the following switches:

1. Controller On/Off
2. Flash/Auto (Allows the controller to cycle while flashing)
3. Signals On/Off (Allows the controller to cycle with signal displays being dark)
4. Stop Time Normal/On (Provides the ability to manually activate a controller stop time input)

The cabinet shall be supplied with white LED light panels which shall automatically illuminate via a door open switch whenever one of the four main cabinet doors are opened for the ground mount cabinet or two main doors for the side of pole cabinet. The LED panels shall produce a minimum of 1,000 lumens on the Control side of the cabinet and 1,000 lumens on

the Power/Auxiliary side of the cabinet and be protected by a clear shatterproof shield. The ground mount cabinet shall contain four light panels; two at the top of each rack assembly and two at the bottom portion of each rack assembly. The side of pole mounted cabinet shall contain two light panels; one at the top of the rack assembly and one at the bottom rack assembly. A second door open status switch per door shall activate a controller input to log a report event that one of the doors was opened. All door open status switches shall be connected to the same controller input. For the ground mount cabinet, there shall be two switches on each of the four main doors. For the side of pole mount cabinet, there shall be two switches on each of the two main doors.

All cabinets shall be provided with a thermostatically controlled ventilating fan and throwaway glass fiber air filters. The electric fan shall have ball or roller bearings and shall have a capacity of 100 ft^3 per minute. The fans shall be rated for continuous duty with a minimum service life of 3 years. The fan blades shall be supplied with a safety screen to prevent accident contact with the blades. The ventilating system shall be designed to prevent the entrance of rain, snow, dust, and insects. The fan and vents shall be arranged in such a manner that the air intake is at the cabinet bottom and the exhaust is at the cabinet top. The air intake shall be rain tight and covered with a removable filter. There shall be vents at the bottom of both front doors for a ground mount cabinet and a vent at the bottom of the single front door for the side of pole mount cabinets. The removable air filter shall be firmly held in place such that cracks and openings are eliminated to ensure that all air is filtered. The ground mounted cabinet shall contain two fans while the side of pole mounted cabinet shall contain one fan. The thermostat shall be mounted on the top interior of the cabinet and user adjustable to allow for temperature settings from a minimum of 70°F to 140°F and capable of activating the fans within plus or minus five degrees of the set temperature. The intake vent shall be rain tight and located on the bottom half of the cabinet, covered with a removable air filter. There shall be two intake vents provided with the ground mount cabinet and one intake vent supplied with the side of pole mount cabinet.

The cabinet shall contain a pull-out drawer, 19” wide with sufficient strength to hold a laptop computer. The top of the drawer shall be covered with a non-conductive, non-skid material and hinged such that a storage space is available to store cabinet documentation or small parts. The pull-out shelf shall be located in the rack space directly under the controller unit. The back of the control side front door shall contain a resealable, heavy-duty opaque plastic envelope with two grommets that provide mounting to two integrated hooks installed on the back side of the front cabinet door. The heavy-duty plastic envelope will be used to store cabinet wiring diagrams and operations manuals that cannot be accommodated in the pull-out draw storage tray.

The side of pole cabinet shall accommodate all control equipment including temperature control equipment. It shall be designed to be attached to the type of pole indicated in the contract plans. If the controller cabinet is to be ground mounted, details of the installation will be shown on the plans. Piano type hinges on cabinet doors shall be fabricated of stainless steel with a stainless-steel hinge pin. The cabinet shall be supplied with reinforcing plates where the cabinet is supported by the pole hangers.

The ground mounted cabinet shall be supplied with a 6” minimum high riser aluminum base that elevates the cabinet above the cabinet foundation.

All manual control switches, push button control, flashing switch, signal switch and any other specified switches shall be located to be accessible within the outside door, without exposing the controller mechanism.

The cabinet shall be supplied with detector test switch panel. This panel shall be rack mounted and located above the controller. There shall be a total of 12 switches to allow for the manual placement of detector calls into the controller. Each switch shall be clearly labelled as to input channel and function. Each switch position shall correspond to the same controller input; switch one is for controller input channel one, switch two is for controller input channel 2, etc. Switches 1-8 shall correspond to phase 1-8 vehicle calls. Switches 9-12 shall correspond to pedestrian calls 2, 4, 6 and 8. The switch labels shall define the corresponding vehicle or pedestrian phase called and switch position function. Detector switches shall be three position and function as follows:

- Up Position = Provides a constant call
- Center Position = Normal operation (Phase receives call from detectors)
- Down Position = Provides a momentary call

The cabinet shall be supplied with a laminated door sticker. This sticker shall be permanently affixed to the inside front control side of the cabinet door for the ground mount cabinet and the inside front side of the side of pole mount cabinets. At a minimum, the sticker shall contain the following information:

- Vehicle detection information including detector channel assignment, phase assigned, approach and cabinet termination points.
- If applicable, network communications information for all in-cabinet devices. This includes IP addresses, subnet mask and MAC address.
- Per approach preemption information including channel, approach/direction and termination points.
- Field termination chart showing per approach/per phase numbering of all signal circuits.
- Signal phasing and signal plan with intersection geometry and signal head designations.

The locks for the switch compartment door of the cabinet shall unlock with a skeleton style (#1) key. The locks for the main doors of the cabinet shall unlock with a Corbin #2 key. Two sets of two keys (main door/switch door) shall be furnished with each cabinet.

The cabinet shall be supplied with a permanent label mounted on the upper portion of the inside front main door which contains the name of the cabinet manufacturer, controller manufacturer, model/part number and year/month of assembly.

All traffic signal controller cabinets shall be supplied with a GFCI duplex outlet, as well as a multi-outlet strip.

The cabinet shall be supplied with a generator panel. The generator panel shall consist of a manual transfer switch and a twist-lock connector for generator hookup. The transfer switch knob and twist-lock connector shall be located inside a generator access panel with a separate lockable door mounted on the lower left, exterior of the control side wall of the ground mount cabinet and on the lower left side of the side of pole mounted cabinet. The door shall be equipped tamper resistant hinge. The generator panel assembly shall be housed in a heavy-duty, vandal resistant, weatherproof, dustproof enclosure designed for exterior applications. The generator access panel door shall have a moveable plate to cover an opening for the generator cable. The connection to an external generator shall be a waterproof, secure connection. The connection shall allow authorized personnel; to access, connect and secure an external electrical source to the cabinet for power restoration. The generator panel door shall contain a weather proof seal and supplied with a lock accessed with a skeleton style (#1) key.

The cabinet main doors shall be provided with a stop to limit door opening to both 90° and 180° ±10°. The door stop bar shall be a captive type mechanism that serves to keep the bar in contact with the cabinet at both stop bar ends and provided with a catch that can be operated when the door reaches these 2 positions and will hold the door open securely until released. The cabinet shall be supplied with a three-point draw roller latching system consisting of the following latching points:

- Center of the cabinet (lock)
- Top of the cabinet – controlled by door handle
- Bottom of the cabinet – controlled by door handle

The latching points on the top and bottom of the cabinet door shall remain in the locked position until the door lock is disengaged. The locking mechanism shall be equipped with nylon rollers to secure the top and bottom of the door.

The cabinet shall be supplied with a ¾" diameter shank, stainless steel latching handle for each door. The latching handle shall have a provision for padlocking the door in a closed position.

Controller cabinets designated on the plans to be ground mounted shall have a pliable seal composed of caulking compound or mastic placed between the cabinet base and the concrete foundation to prevent dust and dirt from entering the cabinet.

A Cabinet Monitor Unit (CMU) and Auxiliary Display Unit (ADU) shall be supplied and installed in each cabinet. The CMU and ADU shall conform to requirements defined in the Advanced Transportation Controller Cabinet (ATCC) 5301 v02 standard. The CMU/ADU units supplied and installed as part of this project shall support 32 channels. All configuration programming shall be resident in a non-volatile Datakey device. Each CMU shall be supplied with a Datakey programmer and associated software. The Datakey programming software shall include a set-up wizard which shall assist the user with the initial set up of the device. The

Contractor shall program the Datakey with data entries appropriate for each intersection. All programing resident on the Datakey shall be included in the hardcopy.

The Contractor shall reconfigure the default user name and passwords on all communications / control equipment within the ATC Controller and Cabinet. This includes but is not limited to the ATC traffic controller, ATC ancillary equipment, video detection equipment, Ethernet switches, and routers. The new user name and passwords shall be created in coordination with the MaineDOT IT staff and or as directed by the engineer; no manufacture default level passwords shall be allowed. The Contractor shall utilize network communications encryption settings on all forms of wired Ethernet data paths. No "in the clear" communications shall be allowed. At a minimum all wired Ethernet connections shall meet 802.1AE standards. The Contractor shall supply and configure a Cyber Intrusion and Prevention Device (CIPD) in each ATC cabinet. The CIPD shall prevent any unauthorized access / connections to the traffic control system. Upon detection of unauthorized attempts, the CIPD shall notify the agency via SMS message and or email and log the event. The CIPD shall be installed prior to any remote access device. The Contractor shall coordinate with the agencies Information Technology and Operational Technology (IT/OT) staff and or the engineer for finale configuration of the CIPD. No direct access to the traffic system shall be allowed without the installation of a CIPD and or Router/Firewall.

A cabinet power supply shall be supplied with each cabinet. The cabinet power supply shall comply with ATCC 5301 v02 (EDI Model 2216-2412-HV or equivalent).

A full complement of switch packs shall be supplied with each cabinet. Switch packs shall comply with ATCC 5301 v02.

A full complement of flashers shall be supplied with each cabinet. Flashers shall comply with ATCC 5301 v02.

A full complement of SIUs shall be supplied with each cabinet. The Serial Interface Units (SIU) shall comply with ATCC 5301 v02.

A full complement of flash transfer relays shall be supplied with each cabinet. Flash transfer relays shall comply with ATCC 5301 v02.

In addition to the full complement of switch packs, flashers, SIU's and flash transfers relays, two additional SIU's shall be supplied. All spare equipment required to be supplied with the ground mounted cabinet shall be store in the spare equipment rack. Spare equipment required to be supplied with the side of pole cabinet shall be delivered to MaineDOT.

The field electrical loading for flash operation shall be wired through the transfer relays such that the load on the 2-circuit flasher is as balanced as possible within the limitations of the signal phasing.

Electrical filtering/surge protection shall be supplied and installed in each cabinet in accordance with ATCC 5301 v02 requirements and the manufacturer's recommendations. At a

minimum, surge suppression shall be provided for incoming electric utility power conductors, all signal control circuits, vehicle detection, pedestrian detection, communications and preemption system terminations.

Three copies of the database programming for all in cabinet devices shall be provided with each cabinet. The database programming sheets shall reflect as-built programming resident in each unit at the time of acceptance.

The cabinet monitor unit shall be connected to the field terminals of the signal light circuit to provide protection against conflicting green, yellow or walk indications being simultaneously energized as a result of controller failure, relay or solid-state switch failure, short circuited field wiring or other failures.

When a conflict is detected, the cabinet monitor unit shall cause the signal system to commence flashing operation; energize the stop-timing circuit of the controller while controller power shall remain on; lock-in flashing operation until manual actuation of the momentary contact reset push button resident on the cabinet monitor unit.

The cabinet shall be equipped with a thermostatically controller fan; two fans shall be supplied and installed for the ground mount cabinet and one fan shall be supplied and installed for the side of pole mounted cabinet. The fans shall be rated for continuous duty with a minimum service life of 3 years. The fan blades shall be supplied with a safety screen to prevent accident contact with the blades.

The cabinet shall be supplied with a GFI outlet to be installed on the upper left, exterior of the control side wall of the ground mount cabinet and the upper left side of the side of pole cabinet. The electrical outlet will be GRCI protected, house in a locked access enclosure. The GFI outlet shall be supplied via its own 15-amp circuit breaker. The GFI outlet assembly shall be housed in a heavy-duty vandal resistant, weatherproof, dustproof enclosure designed for exterior applications. The GFI enclosure door shall contain a weather proof seal and supplied with a lock accessed with a skeleton style (#1) key.

The main cabinet circuit breaker shall be rated at 30 amps. Circuit breakers shall be approved and listed by the UL. The operating mechanism shall be enclosed and shall be trip-free from operating handle under load and shall be trip-indicating. All circuit breakers shall be quick-make, quick-break on either automatic or manual operation. Contacts shall be silver alloy enclosed in an arc quenching chamber. Overload tripping of breakers shall not be influenced by an ambient temperature range of from 0 to +158°F.

The testing process is required to ensure that the controller and cabinet assembly perform properly and meet all requirements described and required as part of this project have been met. This includes testing of all hardware and all software supplied and installed as part of this project. All tests shall be conducted in accordance with the approved test procedures developed by the Contractor. The Contractor shall submit test procedures and forms/checklists for review and approval to the Engineer.

All components of the controller and cabinet shall be bench tested for a minimum of 72 continuous hours by the Contractor at the Contractor's facility prior to delivery to the project. Testing shall be performed by an IMSA, level 3 (Field or Bench) Certified Signal Technician using a test board and in conformance with the design loads, phasing, timing and auxiliary equipment such as pre- emption. Upon completion of satisfactory bench testing, a written approval will be supplied to the Contractor by the Engineer. This approval does not relieve the Contractor from ensuring proper operation of the equipment. The approval shall accompany the cabinet and controller when delivered to the project.

At a minimum, the test plan developed by the Contractor shall contain the following sampling of test items:

(a) Installation of all the equipment into the cabinet as required per the plans and specifications.

(b) Setting of the phase timings of the controller in accordance with plans.

(c) Checking all of the wiring connections for physical tightness.

(d) Observing the sequences, timings and operations of the controller to verify conformance to the plans and specifications.

(e) Test the police panel switches installed in the panel.

(f) Test Pre-emption and/or Priority operation - Optical Detector - with the receivers wired in the cabinet and using an emitter, test each pre-emption or priority run as per the plans. Hard Wired - Attach a temporary push button as per the plans and test each pre-emption or priority run as per the plans.

(g) Check exhaust fan controls by applying heat from a 100-watt lamp on an extension cord to the thermostat.

(h) Check heat lamp controls by cooling the thermostat.

(i) Check cabinet monitor unit by testing for any conflicting Greens or Yellows by the use of a jumper wire attached to a displayed Green or Yellow and to the other non-parent Greens or Yellows to ascertain that conflicting colors are not present. Test all possible combinations of conflicting displays.

Upon completion of the project, a print out of the databases contained in the controller, CMU, Preemption, Video Detection or any other equipment shall be provided to the Engineer. The databases shall be provided either via a hard copy printout or on a "thumb drive."

Tests shall be conducted by the Contractor, witnessed by the Engineer, at the Contractor's facility. The test facility shall be located in the State of Maine and be clean, heated/air conditioned and have provisions for the simultaneous testing of at least three (3) controller

and cabinet assemblies. The controller and cabinet assembly shall be wired and programmed to provide the signal phasing, timing and operations shown on the design plans for that particular location. A test light board and a manual detector call panel shall be connected to each cabinet assembly to verify display outputs and vehicle/pedestrian input calls.

This test plan, when approved and executed, must demonstrate that the controller and cabinet assembly meet all of the requirements contained in the project Plans and Specifications.

The Contractor shall propose testing plans and submit the test plan(s) and procedures as detailed herein to the Resident and Design Engineers for approval prior to testing. Each of the test plans shall contain the following elements:

- Proposed date, time, and location of the testing
- Names of the Contractor personnel who will be conducting the testing
- Descriptive overview of the proposed test procedure
- List of test equipment required to perform the testing
- Test cases and test logging forms which detail every step of the test procedure:

Test logging forms shall be presented in tabular format, with separate columns for each of the following:

- Test case description detailing the test step to be performed.
- Expected result
- Actual result
- Pass/fail
- Comments

The Contractor shall supply separate test logging forms at the time of testing for each test plan, and for each device location. The test logging forms shall show the device location, date, and the start and end times of the test.

At the end of each test logging form, there shall be signature and date locations for each of the following:

- Contractor personnel conducting the test
- MaineDOT representative witness
- Engineer witness

Signatures on the test logging form will signify only that the test was performed and witnessed, not that it passed or failed.

The detailed Test Plans shall be submitted to the Engineer no later than thirty (30) days prior to the beginning of each test phase.

The Contractor shall have approved test plans prior to submitting a request to schedule the start of any test activities. The Contractor shall notify the Engineer no less than fourteen (14) days prior to the beginning of any equipment or systems testing.

Testing shall provide verification and documentation that all requirements included in the Contract Documents are met. The Test Plans shall be developed by the Contractor to provide a mechanism that ensures that all contract requirements have been tested fully and verified.

If any deviations or changes to the approved Test Plans arise, it shall be resubmitted by the Contractor for review and approval by the Engineer at least fourteen (14) calendar days prior to any planned test activity stage. No tests shall be conducted until the Engineer have approved the test plan.

A summary of all tests shall be produced at the completion of each testing phase of the project to ensure that all requirements defined by the system are satisfied.

MaineDOT reserves the right to examine and test or retest any or all materials furnished by the Contractor for the project to determine if they meet the requirements specified within the Contract Documents.

If MaineDOT decides that any material used in the construction of this project is defective or otherwise unsuitable, and the workmanship does not conform to the requirements of this Contract, the Contractor shall replace such defective parts and material at no cost to the Project.

The times and dates of the tests shall be approved by the Engineer. The Contractor shall conduct all tests in the presence of the Engineer. Testing shall take place only on weekdays, which are official working days, unless the Engineer allows the test to be conducted and/or continued on weekends and non-working days. The Contractor shall make a request in writing at least fourteen (14) days prior to the proposed testing, and schedule tests only if permission is granted by MaineDOT in writing.

The Contractor shall be responsible for the conduct and documentation of the results of these tests that will be countersigned by the Engineers at the end of each test. The signature of the Engineer implies only proof of presence. Test results shall be packaged and submitted to the Engineer within one week of test completion. No test phase shall begin until all prior test phases have been completed, and test results have been approved by the Engineer.

The Contractor shall utilize vendor supplied or any test specific software for testing, as needed, at no additional cost.

Appendix D – ATC Cabinet Detail

350 ATC Cabinet

EAGLE®
Traffic Control Systems

Dimensions
67"H x 44.5"W x 26"D

Standard Features

- 16 output channels - standard quad intersection with 4 pedestrian and 4 overlap phases.
- 24 Channels of Vehicle Detection, Pedestrian Inputs, and EVP.
- 2 or 4 channel Detector Modules.
- High-efficiency, switching power supply.
- Programmable yellow/red or all red flash through the use of color-coded flash plugs.
- Field Output Panel with Phoenix pluggable connectors for connection to signal heads.
- 4 channel flasher output, monitored by conflict monitor.
- 48VDC Coil Flash Transfer Relays.
- CMU2212 for conflict monitoring with auxiliary display unit.
- Pluggable surge suppressor/line filter on incoming power.
- Pluggable surge protection on output field terminals.
- Pull-out drawer / shelf.
- Thermostatically controlled ventilation system with 100 CFM fans.
- Door-switch controlled LED lighting above each door.
- Simple migration path to 48VDC signal operation.

Standard Door Specifications

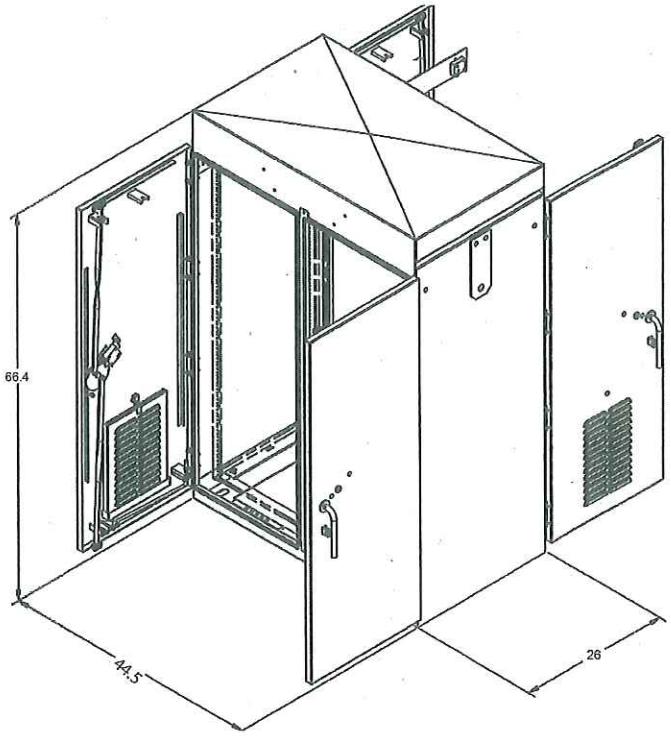
- Provided with three-point locking mechanism with duplex nylon rollers, top and bottom.
  ¾" diameter stainless steel inward-turning handles with provisions for padlocking.
- Main door lock - industrial standard pin tumbler lock with #2 key.
- Louvered inlet with filter to prevent dirt from entering with air flow.
- Closed-cell neoprene door seal gasket.
- Stainless steel leave hinges with .190" diameter stainless steel hinge pins. Pin ends are welded to the hinge and ground smooth. Hinge pins and bolts are covered by the door edge and not accessible when the door is closed.

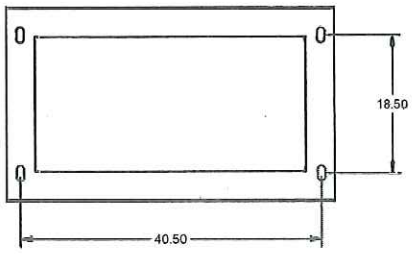
Ordering Information

- ELS340 - Cabinet with 19" rack
- JBS2352TMT01 - Terminal Facility with 16 channel output assembly

Common Optional Features

- Additional Input Files for up to 120 channels of detection.
- 2nd 16 channel Output Assembly.
- Auxiliary Display Unit for CMU.
- Powdercoating or anodizing.
- Manual control cable located in police panel.





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