

TRAFFIC SIGNAL MAINTENANCE CONSOLIDATION STUDY

BINGHAMTON METROPOLITAN
TRANSPORTATION STUDY

April 2012



(Approved by the BMTS Policy Committee on August 15, 2012)

This study was funded by the Federal Highway Administration (FHWA) Metropolitan Planning Program.
The views expressed herein are solely those of the Binghamton Metropolitan Transportation Study, and
do not represent an official position of the FHWA.

**BINGHAMTON METROPOLITAN TRANSPORTATION STUDY
POLICY COMMITTEE
RESOLUTION 2012-08**

Resolution accepting the Traffic Signal Maintenance Consolidation Study as complete.

WHEREAS the Binghamton Metropolitan Transportation Study Policy Committee has been designated by the Governor of the State of New York as the Metropolitan Planning Organization responsible, together with the State, for the comprehensive, continuing, and cooperative transportation planning process for the Binghamton Urban Area, and

WHEREAS Federal regulations (23 CFR Chapter 1, Part 450, Subpart C, and 49 CFR Chapter VI, Part 613, Subpart B) require that the urban transportation planning process shall include development of a Unified Planning Work Program which shall annually describe all urban transportation and transportation related planning activities anticipated within the next one or two year period, and will document the work to be performed with technical assistance provided under the Federal Highway Administration metropolitan planning (PL) program and the Federal Transit Administration Section 5303 program, and

WHEREAS the BMTS Policy Committee has created a Planning Committee of technical representatives to advise it on matters concerning the implementation of the urban transportation planning process, and

WHEREAS the approved 2010-2011 Unified Planning Work Program included an FHWA funded task to perform a Traffic Signal Consolidation Study, and

WHEREAS BMTS staff has conducted the study, met with local municipal representatives and prepared a final report describing the findings and including recommendations for the consideration of the affected municipalities, and

WHEREAS on August 2, 2012 the BMTS Planning Committee passed by consensus a resolution recommending BMTS Policy Committee approval of the *DRAFT Traffic Signal Maintenance Consolidation Study* for Policy Committee approval, and

NOW THEREFORE BE IT RESOLVED THAT the BMTS Policy Committee accepts the Traffic Signal Maintenance Consolidation Study as complete.

CERTIFICATION OF RESOLUTION 2012-08

I, the undersigned, duly elected Chair of the Binghamton Metropolitan Transportation Study Policy Committee, do hereby certify that the foregoing is a true and correct copy of BMTS Policy Committee Resolution 2012-08, adopted by consensus this 15th day of August, 2012.


Michael Marinaccio, Chair

8-15-12
Date

INTRODUCTION:

Proper maintenance of traffic signals helps municipalities save money, keep the roads safe, and reduce liability if an accident does occur. Maintenance costs are something that any municipality who has jurisdiction over traffic signals within their boundaries must budget for. Municipalities are always looking for the most efficient and cost effective way to spend tax dollars. The goal of this study is to show municipalities within the BMTS planning area how to determine the most cost effective method for maintaining their own local traffic signals. This study will discuss the current procedure of each municipality, along with best practices and recommendations from current literature. This study will also look at different maintenance options and their associated costs.

Maintenance for traffic signals falls into two general categories: preventive maintenance and response maintenance. According to *ITE's Traffic Control System Operations: Installation, Management, and Maintenance*, preventive maintenance is defined as a set of checks and procedures to be performed at regularly scheduled intervals for the upkeep of traffic signal equipment. It is intended to ensure reliable mechanical and electrical operation of the signals and signal control equipment, thereby reducing equipment failures, response maintenance, road user costs, and liability exposure.

Response maintenance is defined as the initial response to any reported equipment or system malfunction. Some examples of response maintenance situations are lamp burnout, failure of the loop detector sensor, or failure of the coordination unit. Maintenance for these types of issues should have a response plan describing acceptable response times for every conceivable, reportable problem.

CURRENT LOCAL MAINTENANCE PROCEDURES:

Of the municipalities that are contained within the Binghamton Metropolitan Transportation Study's planning area, six own and maintain local traffic signals. The rest of the signals are owned by the New York State Department of Transportation (NYSDOT). Appendix A shows all of the locally owned traffic signals and NYSDOT owned traffic signals by municipality.

The following municipalities have locally owned and maintained signalized intersections:

City of Binghamton,	82 intersections
Village of Endicott	21 intersections
Village of Johnson City	15 intersections
Town of Union	9 intersections
<u>Town of Vestal</u>	<u>8 intersections</u>
TOTAL:	135 signalized intersections

Town of Chenango, 1 signal*

Each municipality that maintains their own signals has established maintenance schedules and emergency response policies. Appendix B is a chart showing current local procedures for signal maintenance.

* The Town of Chenango owns one traffic signal. They pay a yearly flat fee to the NYSDOT to maintain the signal. Because of this agreement, this signal will not be included in the study even though it is locally owned.

The City of Binghamton performs maintenance to their signals with their own employees. They employ a signal maintenance supervisor who maintains the signals within the City. There are also three other City of Binghamton employees that are available to help with maintenance. Even though they do regular/routine maintenance in house, they use outside vendors for most major repairs such as replacing loops or when a traffic signal cabinet is knocked down. There have been instances where a controller cabinet was damaged by a motor vehicle accident and the repair work was done in-house. The insurance company was then billed for the City's labor costs, materials, and the cost of hiring a contractor or NYSEG to help.

According to the *Signal Maintenance Supervisor* civil service job description for the City, this position involves responsibility for overseeing the installation, maintenance, and repair of fire, police, and traffic signal equipment. Minimum qualifications are graduation from high school or possession of an equivalency diploma and either:

- a) Graduation from a regionally accredited or New York State registered two year college with an Associate's degree in electrical engineering or electrical technology and one year of experience in the installation and repair of fire alarm and traffic signal equipment; or
- b) Three years of experience in the installation and repair of fire alarm and traffic signal equipment; or
- c) An equivalent combination of training and experience as defined by the limits of (a) and (b) above.

The Town of Union, Town of Vestal, and Village of Johnson City all contract out for yearly maintenance, timing issues and emergency response (ex. If a traffic signal is not working correctly). The Village of Endicott uses three Village employees each for different aspects of maintaining the signals, which include general maintenance, traffic, and electrical. Currently, the municipalities that contract out for maintenance each pay the same hourly rate for response maintenance and the same set yearly fee for preventive maintenance. Each municipality maintains their own stock of replacement parts.

The Village of Johnson City, the Village of Endicott, and the Town of Vestal each own a bucket truck and the Town of Union has an agreement with the Village of Johnson City to use their truck as needed for signal maintenance. All of the municipalities are responsible for purchasing and providing equipment, replacement parts, bulbs, etc.

The City of Binghamton, the Town of Union, the Town of Vestal, and the Village of Johnson City all have an established yearly maintenance schedule that is performed on all of their traffic signals but are all not as inclusive as the sample checklist in Appendix A. The Village of Endicott does more reactive maintenance because of limited availability of staff.

According to the City of Binghamton, their yearly maintenance routine consists of cleaning the lenses of the signals and changing the yellow bulbs (which are incandescent bulbs). The Town of Union cleans each of the filters on the signals and checks that the timings are correct. The Town of Vestal's yearly maintenance schedule includes cleaning signal lenses, preventative maintenance on signal cabinets, checking detectors where applicable, checking the wiring in the cabinets, checking head alignment of signal heads and checking RAM sheets. The Village of

Johnson City's maintenance consists of cleaning signal lenses and checking timings. The Village of Endicott does more reactive maintenance because of limited availability of staff. See Appendix B for a chart showing the current maintenance procedures for each municipality.

Many municipalities have studied the differences between LED and incandescent bulbs and have determined that LED bulbs provide a cost savings over the life of the bulb. LED bulbs use less energy and have a life span as long as 7-10 years. The City of Binghamton and the Town of Vestal have installed LED bulbs in the reds and greens of all of their signals. The Town of Union has installed LED bulbs in all reds, greens, and yellows. Currently the Village of Endicott has 9 intersections with all LED bulbs. They have purchased LED bulbs for the rest of the 12 intersections within the municipality and as the current incandescent halogen bulbs burn out they will be replaced with LED bulbs. The Village of Johnson City has 7 intersections with all LED bulbs with one more scheduled to be changed over to LED bulbs in 2011. Because of the longer life span of LED bulbs, each municipality has been able to cut down on maintenance calls pertaining to bulb outages.

If a small power outage occurs where power is expected to return within a short period of time all of the municipalities rely on police direction of traffic. If the power outage is expected to be longer in duration the Village of Johnson City and the Town of Vestal have portable generators to power the signal. The City of Binghamton, Town of Union, and Village of Johnson City have portable stop signs that can be placed at the intersection where the power is out.

Four of the municipalities provided signal malfunction response procedures for this study.

- Town of Union:
 - single bulb out or flash – within 24 hours
 - no indications - within 4 hours
- Village of Johnson City
 - bulb(s) out – replaced in-house
 - timing or other issues – contract employees called out
- Town of Vestal:
 - single bulb out – replaced during regular workday hours
 - multiple bulbs out (same indication) – 24 hour response
 - on flash – repaired during regular workday hours except during holiday weekends
 - no indications - within 4 hours
- City of Binghamton
 - single bulb out - regular workday hours
 - on flash - regular workday hours, major intersection, immediate response
 - no indications - immediate response

INDUSTRY STANDARD PRACTICE:

ITE's Traffic Signal Maintenance Handbook states that it can be reasonably argued that the frequency and severity of response maintenance calls can be significantly reduced provided that a proper program of preventive maintenance is in place with the appropriate level of training for the technicians who respond. Small preventive maintenance tasks help keep the intersection operating properly and will extend the life of some components. Performing them is time well spent according to *ITE's Traffic Signal Maintenance Handbook*. Preventive maintenance

provides the means for identifying and correcting problems before they turn into more costly repairs.

According to *ITE's Traffic Signal Maintenance Handbook*, government agencies and their employees have a duty to maintain all roadways, including traffic signal equipment, in a reasonably safe condition. Liability due to negligent traffic signal maintenance can be the responsibility of the government agency if an accident or injury were to occur.

The Handbook also states that preventive maintenance should be performed at regularly scheduled intervals. As a minimum, it should be performed once a year. The frequency of regularly scheduled maintenance can be determined by reviewing previous maintenance records or service calls. A sample preventive maintenance checklist can be found in Appendix C. The sample checklist is from *ITE's Traffic Signal Maintenance Handbook*.

There are different costs associated with each different maintenance option. *ITE's Traffic Signal Maintenance Handbook* has provided a cost comparison table of in-house versus contractor maintenance services. If a municipality is able to provide the dollar amounts needed for the table, they should be able to, with reasonable accuracy, calculate which maintenance option would be the most cost-effective option for them. The table is below.

Table 3-2. Cost Comparison Worksheet			
In-House	Cost (\$)	Contractor	Cost (\$)
1. Total salary(s) of personnel		1. Total loaded salary cost (actual salary(s)) Salary + item 5	
2. Fringe benefits: Social Security Pension Workers' compensation Holidays Medical insurance Life insurance Sick leave Vacation Other		2. Equipment (usually a factor x labor)	
3. Overhead: Building Utilities Vehicles Communications Tools Test equipment Training Other		3. Parts (includes 10-15% markup)	
4. Replacement parts (for preventive maintenance, emergency maintenance, knock-downs; includes discount)		4. New materials (includes 10-15% markup)	
5. New materials (includes discount) Other		5. Administration and profit @ %	
Subtotal		Subtotal	
Work efficiency rate* (%) In-house productive total cost		Work efficiency rate* (%) Contractor productive total cost	

* The work efficiency rate is a factor unique to each in-house or contractor maintenance department and represents the percentage of productive time.

TABLE 1

When looking at contracting out for maintenance, there are also different options. A municipality may hire an experienced maintenance contractor to perform all or part of the system maintenance functions. Below is a chart, from *ITE's Traffic Signal Maintenance Handbook*, that depicts various contractor maintenance options for both preventive and response maintenance.

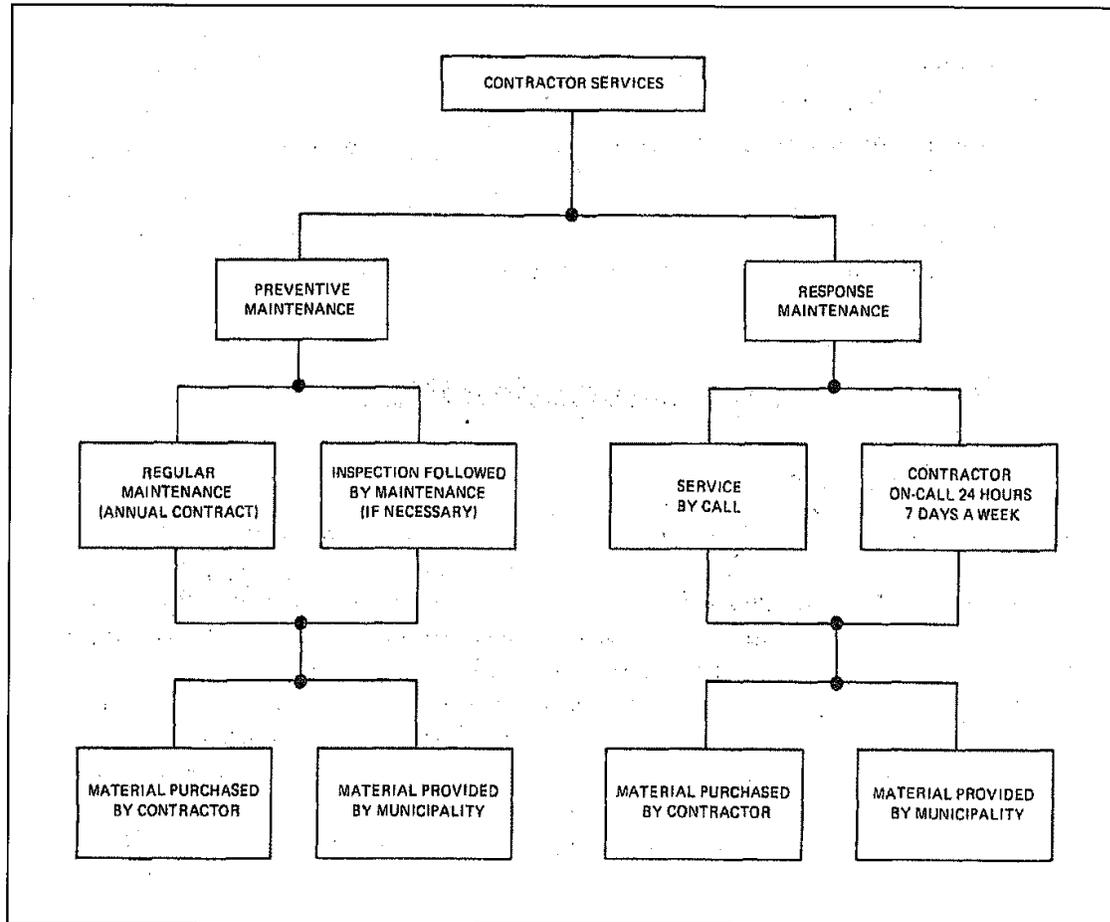


FIGURE 1

ITE's Traffic Control System Operations book also gives recommendations of how to estimate personnel time and costs for preventive maintenance. Using the time estimates for individual tasks, labor requirements for preventive maintenance can be determined for the particular number and type of signalized intersection and control equipment maintained by any given municipality. This information will be helpful in filling out Table 1. As the complexity of the intersection increases, so does the time required for preventive maintenance. To obtain a reasonable budget approximation without a detailed inventory of the types of controllers in each municipality, *ITE's Traffic Control System Operations* recommends using an average of 42 hours of preventive maintenance time per intersection per year (ex. Two-phase, fully actuated, solid state intersection). Since BMTS is aware that a relatively large number of the local signals are 2-phase, semi-actuated, solid state signals, this study will use 35 hours as the average annual labor requirement for preventive maintenance according to *ITE's Traffic Control System Operations*. For budgeting purposes *ITE's Traffic Control System Operations* recommends that maintenance time per intersection be allocated as follows:

- 70 percent preventive maintenance
- 25 percent response maintenance
- 5 percent design modification maintenance

The “average” intersection (35 hours) as described above would therefore require approximately 50 hours for annual maintenance. Similar estimates can easily be prepared for traffic signal systems with above or below average preventive maintenance requirements.

Below is a chart that estimates maintenance staff productivity. This estimate is based on a schedule of 52 weeks of 40 hours each, with allowances for vacations, sick leave, holidays, training, and breaks.

Estimated Annual Work Hours per Person <i>(ITE's Traffic Control System Operations)</i>		
Item	Assumption	Hours
Work hours per year	52 weeks x 40 hours	2,080
Vacation	3 weeks x 40 hours	-120
Sick leave	2 weeks x 40 hours	-80
Annual training	1 week x 40 hours	-40
Legal holidays	13 x 8 hours	-104
Subtotal	1,736 (217 days)	
Breaks	0.5 hour per day x 217	-109
Total Productive Time		(203 days) 1,627

CHART 1

Assuming an average annual maintenance requirement of 50 hours per intersection, one signal mechanic should be able to maintain a signal system of approximately 32 intersections. See calculation below:

$$\frac{\text{Hours available per signal mechanic}}{\text{Hours required per intersection}} = \frac{1,627}{50} = 32 \text{ intersections per signal mechanic}$$

ITE's Traffic Control System Operations also gives information on average salaries of traffic signal and lighting technicians. The salaries given were from information gathered by the Transportation Research Board/National Research Council, Circular Number 493, “Progress Report on Maintenance and Operations Personnel” (March 1999). Because the salaries reported are from 1998, BMTS has converted the numbers to a 2011 salary equivalent using www.inflationdata.com 's CPI (Consumer Price Index) Inflation Calculator. *ITE's Traffic Control System Operations* reports the North Atlantic geographical region 2011 salary equivalent as \$50,374. *ITE's Traffic Control System Operations* then adds 58% to the salary figure to account for fringe benefits, for a total annual personnel cost of \$79,591. This figure can be used to help determine an approximate cost to each municipality to house maintenance staff for traffic signals.

CURRENT LABOR, EQUIPMENT AND MATERIALS COSTS:

The capital and labor costs for each municipality vary year to year based on the number of response maintenance events. Most of the municipalities were able to provide some cost information.

To better understand the chart below, the following definitions will be helpful:

- Labor: The cost paid by the municipality for man-power services for signal maintenance
- Equipment: Vehicles, tools or other devices necessary to perform signal maintenance.
- Materials: Bulbs or other parts needed to fix a traffic signal as part of preventive maintenance or response maintenance.

		Labor Costs	Capital Costs		Total
			Equipment	Materials	
TOWN OF VESTAL:	2009	\$3,275	N/A	\$2,209.36	\$5484.36
	2010	\$2,875	N/A	\$1,876.14	\$4,751.14
	2011	--	--	--	--
CITY OF BINGHAMTON	2009	N/A	N/A	N/A	N/A
	2010	N/A	N/A	N/A	N/A
	2011	\$12,207.42	\$6,258.80	\$16,287.44	\$34,753.66
TOWN OF UNION	2009	\$3,000	N/A	\$1,800	\$4,800
	2010	--	--	--	--
	2011	--	--	--	--
VILLAGE OF ENDICOTT	2009	N/A	Bucket truck purchased for \$70,000 in 2007 (80% use for signal work)	--	N/A
	2010	\$30,000	See above	\$13,007	\$43,007
	2011	--	See above	--	--
VILLAGE OF JOHNSON CITY	2009	\$5,994.20	\$801	<\$100	\$6,898.20
	2010	\$5,563.38	\$455	<\$100	\$6,118.38
	2011	\$5,861.64	\$695	<\$100	\$6,656.64

(N/A: not available, --: did not obtain from municipality)

CHART 2

Because each municipality has a different method of collecting and recording costs associated with signal maintenance, it is important to note that these discrepancies make the numbers hard to compare directly.

Some other facts that should be noted about this chart above are:

- The Town of Vestal figures are what they pay for the maintenance that they contract out for. If there is a bulb out or a “simple fix” their resident engineer will try and fix the problem. Costs associated with his time spent on signal maintenance are not included.
- The Village of Endicott and the City of Binghamton included salary and fringe benefits in their labor cost of employees and management. The other municipalities did not.

- The cost for labor for the Village of Endicott would be the number of hours spent multiplied by the hourly rate of the employee doing the work. The Village was not able to provide an accurate breakdown of hours spent therefore it was not possible to determine a labor cost for the Village of Endicott.
- The Village of Endicott also spent \$2,180 on materials plus an additional \$10,827 for a large purchase of LED indicators to replace the incandescent bulbs that were being used in their traffic signals. This is a one-time purchase. After the initial purchase, a much smaller amount of bulbs will be purchased as needed to replace the LED bulbs as necessary.

The Towns of Union and Vestal and the Villages of Johnson City and Endicott are currently in a unique situation. The two people that they contract out to for yearly maintenance are local Department of Transportation traffic signal professionals. The fees that they charge are not in line with what a typical contractor would charge; the NYSDOT employees charge considerably less. It is possible that once the current contractors retire there will be another qualified individual that will provide the same services as a similar cost to the municipalities but there is no guarantee that will happen. The estimated cost to contract with another entity to do preventive maintenance would be much higher.

ANALYSIS:

In comparing other municipalities across New York State, as the number of intersections maintained increased, the more likely the municipality was to be providing maintenance in-house. BMTS would hypothesize, based on the current number of intersections maintained locally by the municipalities, only the City of Binghamton would be a likely candidate for in-house maintenance.

By keeping each of the other municipality's current preventive maintenance protocol the same, cost savings would not be realized by consolidating to one maintenance contract. However, it would seem reasonable to assume that if one combined maintenance contract was used for all of the municipalities (except for the City of Binghamton) more consistent and extensive preventive maintenance would be accomplished. As mentioned earlier, *ITE's Traffic Signal Maintenance Handbook* states that it can be reasonably argued that the frequency and severity of response maintenance calls can be significantly reduced provided that a proper program of preventive maintenance is in place with the appropriate level of training for the technicians who respond.

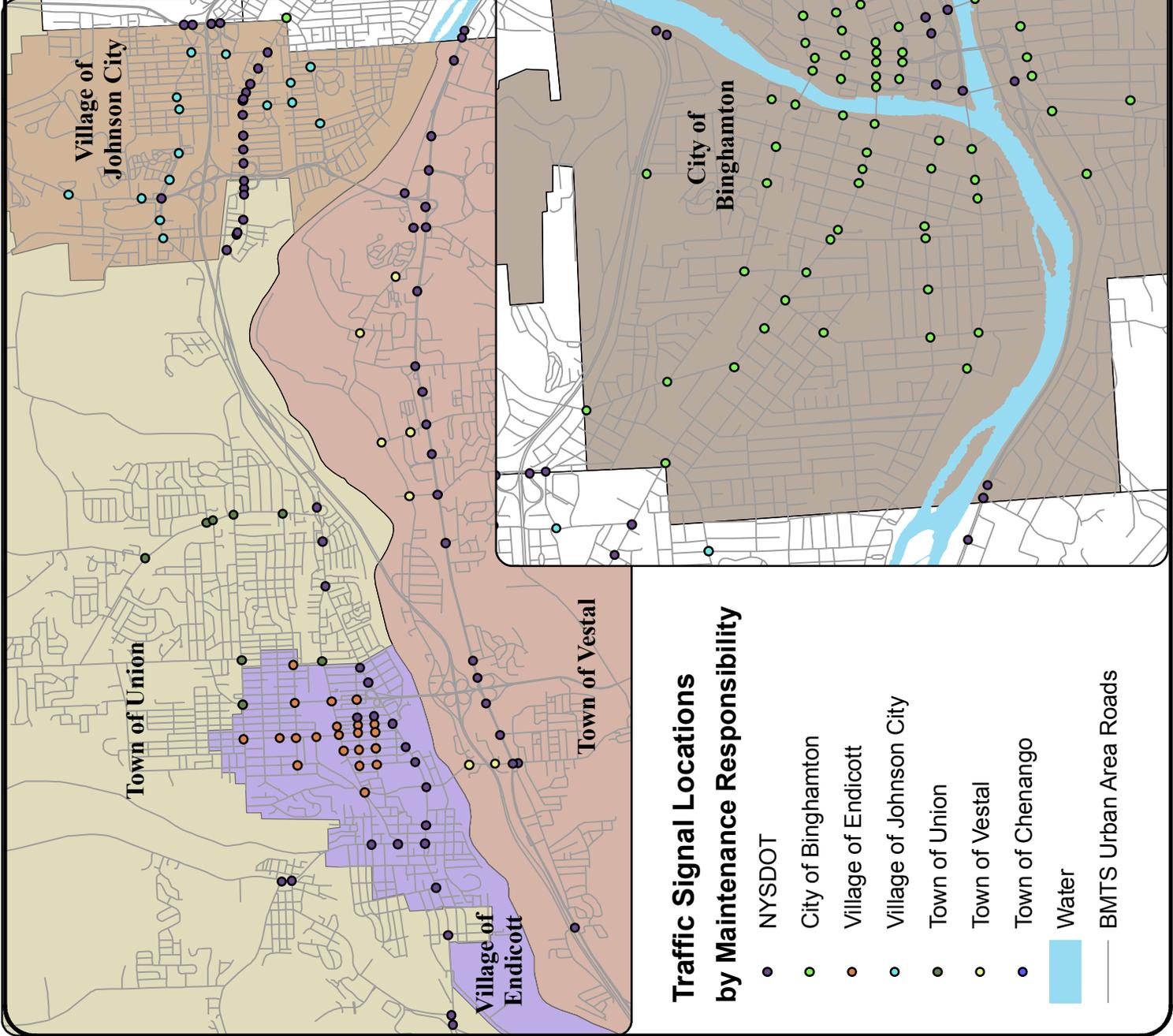
Another option instead of all municipalities consolidating into one maintenance contract would be for the Village of Endicott, Village of Johnson City and the Town of Union to combine for one signal group. Those three municipalities together maintain a total of 45 traffic signals. That number may be high enough to justify providing in-house maintenance or to at least look at the possibility of contracting out as one entity. Based on the information in Chart 2 above and the analysis that follows, this maintenance configuration would require one full-time signal mechanic and one part-time signal mechanic. The cost of these mechanics could be divided between the three municipalities based on the number of signals within each jurisdiction.

When the municipalities are reviewing or making changes to their signal maintenance procedures, this document will provide them with the necessary steps to determine the most cost effective method of maintenance.

APPENDIX A

Map of locally owned traffic signals versus NYSDOT owned traffic signals by municipality

BMTS Urban Area Signals



Traffic Signal Locations by Maintenance Responsibility

- NYSDOT
- City of Binghamton
- Village of Endicott
- Village of Johnson City
- Town of Union
- Town of Vestal
- Town of Chenango
- Water
- BMTS Urban Area Roads

APPENDIX B

Current Local Procedures for Signal Maintenance

Current Local Procedures of Signal Maintenance

	Number of signalized intersections (non-flashing)	Yearly Maintenance Schedule	LED Status	Maintenance: In-house or Contract out	Insurance Coverage for maintenance providers	Cost	Signal Malfunction Response	Power Outage Response
City of Binghamton	82	Clean lens, change yellows	All reds and greens	In-house	City of Binghamton	salary and wages of employee	1) Single bulb out - regular workday hours, 2) On flash - regular workday hours, major intersection, immediate response 3) No indications - immediate response	portable stop signs
Town of Chenango	1			Yearly maintenance contract with NYSDOT		\$1,260		
Town of Union	9	clean filter, check timing	All	Contract out, use Village of JC lift trucks	Town of Union	\$50 per hour per man	Single bulb out or flash immediate to 24 hour response. All out immediate to 4 hour response.	portable stop signs
Town of Vestal	8	Clean signal lenses, preventative maintenance on signal cabinets, check detectors where applicable, check wiring in cabinet, check head alignment of signal heads, check RAM sheets	All reds and greens	Technically part-time Vestal Employees, use Vestal equipment for maintenance, on-call, as needed,	Town of Vestal	Yearly: 8 intersections x \$375/intersection = \$3,000 Trouble Call Fee: \$50 per hour per man	1) Single bulb out - regular workday hours, multiple bulbs out (same indication - 24 hours) 2) On flash - regular workday hours except during holiday weekends 3) No indications - immediate response (within 4 hours)	police direction, have generator but don't use unless a large power outage
Village of Endicott	21	more reactionary than proactive due to staffing.	9 intersections have LED bulbs, 12 do not. Have purchased LED bulbs for all signals for replacement after burnout	Have own bucket truck, 3 full-time Village of Endicott employees, each with different duties, maintenance, traffic, and electrical	Village of Endicott	salary and wages of employees		
Village of Johnson City	15	Clean lens, check timing	8 intersections have LED.	Have own lift truck for in-house bulb replacements. Contract out for yearly maintenance and timing issues.	Village of JC	2 men at \$2,500/yr. Total is \$5,000/yr.	Bulb(s) out, in-house called in after hours. Timing or other issues, contract employees called out.	Flip down stop signs, portable generators

APPENDIX C

Sample Preventive Maintenance Checklist

Sample Preventive Maintenance Program Checklist

VEHICULAR SIGNAL HEADS

- Clean and inspect all visors; replace those that are cracked or broken. Tighten all screws securing visors to the signal head.
- Clean and inspect all lenses; replace those that are damaged.
- Inspect traffic signal housing for cracks or damage.
- Check terminal block connections.
- Check gaskets and mounting hardware; retighten as necessary.
- Check head alignment relative to lanes they serve.
- Check safety chains.
- Relamp all incandescent signals.
- Relamp all sealed beams for programmed signal heads.
- Clean reflectors on inside of signal housing (applies only to incandescent fixtures).
- Note serial numbers and/or date of manufacture for LED modules.
- Clear any obstructions (such as branches) that block visibility.
- Check underclearances for span wire mounted signals; adjust height as necessary.
- Check bushings on cable outlet and universal hangers; replace as necessary.
- Check for cracked and/or damaged mounting brackets.
- Clean back plates and check for cracks and/or missing screws.

PEDESTRIAN SIGNAL HEADS

- Clean and inspect all visors.
- Clean and inspect all lenses.
- Inspect signal housing for cracks or damage.
- Check terminal block connections.
- Check gaskets and mounting hardware; retighten as necessary.
- Check head alignment relative to the crosswalks they serve.
- Relamp incandescent bulb (if any) with correct wattage bulb.
- Clean reflectors on inside of signal housing (applies only to incandescent fixtures).
- Note serial numbers and/or date of manufacture for LED modules.

PEDESTRIAN PUSHBUTTONS

- Check housing for damage or signs of vandalism; replace as necessary.
- Check for tightness.
- Verify operation.
- Check accompanying sign; repair or replace as necessary.

SIGNAL POLES AND MAST ARMS

- Check anchorage.
- Check tightness of mounting hardware.
- Check that each pole is electrically bonded.
- Re-tighten bolt covers.
- Check poles for plumbness; shim or adjust as necessary.
- Check mast arm alignment.
- Check pole and/or arms for warping or other damage; note deficiencies.
- Replace missing pole base access doors.
- Check paint condition and/or corrosion.
- Clear drainage holes in pole bases, if present.
- Check for missing pole caps and mast arm end caps; replace as required.
- Check condition of grout at pole bases, if applicable.
- Check condition of varmint screen at pole bases, if applicable.

SPAN WIRE SIGNAL INSTALLATIONS

- Check condition of strain vises, if applicable.
- Visually inspect each upper and lower tether span wire for damage or deterioration.
- Visually inspect each upper and lower tether span wire for excess sag; adjust as necessary.
- Inspect all connecting span wire hardware; tighten or replace as necessary.
- Inspect guy anchors for proper attachment and/or damage.
- Visually inspect pole condition for cracks and/or checks (wood poles); note any deficiencies.

CONDUIT SYSTEM AND JUNCTION BOXES

- Check grounding bushings on rigid metallic conduit; replace as necessary.
- Inspect junction box covers for cracks or misalignment; replace as necessary.
- Check proper seating of junction and splice box covers.
- Check grounding; secure all straps and rod connections.
- Check above ground conduit for damage; replace damaged and/or missing conduit straps.
- Clear debris and/or overgrowth around junction box.
- Visually inspect junction box covers for cracks and/or other damage; replace covers, as necessary.
- Clear lip of junction box cover to ensure proper seating of cover; tighten cover bolts if present.
- Check junction boxes for proper grade; note any deficiencies.

TRAFFIC SIGNAL CABLE

- Check all splices in each traffic signal pole base; resplice as necessary using waterproof connectors or splice kits.
- Visually check the condition of the traffic signal cable for dry rot, nicks, cuts, or other damage to the outer jacket insulation; perform resistance and continuity tests, if required.
- Check all overhead cables and connections.
- Check to ensure cable is not rubbing against cable outlet (free-swinging, end-mounted signals only).

VEHICLE DETECTION—LOOPS

- Verify operation of areas of detection.
- Measure each loop for resistance (R), inductance change DL%, and loop quality (Q).
- Visually inspect loop installation; reseal sawcut trench, if necessary.
- Check loop detector splices.
- Re-tune loop detector amplifiers at the cabinet.
- Check that all loop leads are properly tagged.

VEHICLE DETECTION—CAMERAS

- Verify operation of areas of detection.
- Check video camera positioning.
- Check video camera mounting hardware.
- Inspect camera head for damage.
- Clean camera lens.
- Verify operation of video processor at cabinet.
- Update card firmware, if applicable.
- Verify camera cables are labeled for identification.

OVERHEAD STREET NAME SIGNS

- Clean sign faces.
- Check mounting hardware; tighten as necessary.

UNINTERRUPTIBLE POWER SOURCE (BATTERY BACK-UP)

- Verify automatic transfer switch operation.
- Verify incoming line voltage.
- Verify DC output to batteries.
- Verify AC output on inverter.
- Check electrical connections.
- Test system via simulated power outage at cabinet.
- Record events and run times either saved on UPS unit manually or uploaded to laptop.

CONTROLLER AND METER CABINETS

- Vacuum cabinet interior.
- Change cabinet filter.
- Check operation of fan and thermostat.
- Check operation of cabinet light and switch; replace if necessary.
- Check and tighten all terminal connections.
- Verify operation of detector panel relays.
- Check police functions.
- Lubricate hinges and locks.
- Check cabinet door gaskets.
- Check neutral and grounding bus.
- Check conditioning of incoming line voltage.
- Test circuit breakers.
- Check GFCI receptacle on power distribution panel; replace if necessary.
- Seal all conduit.
- Verify that all spare conductors are landed on spare terminal blocks or taped off.
- Verify all cables are tagged or otherwise identified.
- Seal around cabinet base with silicone caulking.

CONTROLLER ASSEMBLY

- Note and record make, model, firmware version and serial number for controllers, conflict monitors and other major components.
- Scan conflict monitor for logged events; note any entries.
- Perform conflict monitor test; place copy in cabinet.
- Run internal diagnostic routine on the controller.
- Verify input timing versus approved timing, including coordination and time-of-day parameters.
- Upload controller timing and parameters via laptop; place copy in cabinet.
- Check yellow change and all-red clearance intervals against current design standards for duration.
- Check pedestrian clearance times against current design standards for duration.
- Verify vehicle and pedestrian calls.
- Check preemption function for firehouses, if applicable.
- Check confirmation/telltale light for preemption, if applicable; relamp if needed.
- Check programming and operation of time clocks (school zone flashers only).
- Verify correct date, time and DST function for controller (intersections only).
- Verify communication with master controller, if applicable.
- Place cabinet wiring diagram(s) in cabinet, if missing.
- Place user and/or programming manuals in cabinet, if missing.