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DATE: SEPTEMBER 23, 2008
TO: DAVID KNOWLTON, PE, CITY OF SALEM
FROM: GARY HEBERT, PE, PTOE AND RICK AZZALINA, PE
RE: SALEM, MA - RECOMMENDED IMMEDIATE ACTION AND FOLLOW-UP
LAFAYETTE STREET SAFETY IMPROVEMENTS

MEMORANDUM

This follows up on information and meetings held during the last few months, including a Neighborhood Committee meeting held on September 22, 2008.

Background Information:

The Lafayette Street safety study extends between Raymond Avenue and the Forest River Bridge, a linear distance of approximately 1,300 feet, ending in the vicinity of the Marblehead line. This segment of Lafayette Street has been the site of several crashes involving serious injuries and/or fatalities. The most severe crashes have tended to occur during the late night hours, and tend to involve excessive speeding and utility poles, either on the same side as the direction of travel or opposite to the direction of travel.

This memorandum recommends implementation of a two-phased strategy – Phase 1 - Immediate Action (signs and markings) and Phase 2 - Geometric Improvements that the City of Salem (with an option to retain existing road geometry vs. enhance super elevation in two specific locations within the study area).

Due to accuracy issues with the available orthophoto mapping of the study area, early on FST recommended that the study area be surveyed to provide us with better information; the City concurred and provided a supplement to allow a full survey be undertaken of the study area involving geometry only, not property line data. Completed in March, the survey has been used to more clearly identify potential improvement options and to clarify recommended strategies.

Recommended Phase I Immediate Action Plan

All signs and pavement markings shall be installed in accordance with recommendations contained in the Manual on Uniform Traffic Control Devices (US Department of Transportation, 2003 Edition).

Install high-visibility signs and pavement markings through the study area

Recommended signs and pavement markings to be undertaken are illustrated on attached Figures 1A (plan view) and 1B (sign summary sheet). Particular attention should be given to alerting motorists to the curves and the multiuse path crossing, which has substantial use during the summer months.

Signs/Flashing Signal/Enforcement

Modifications to existing signs are recommended, with a particular emphasis on warning signs and object markers. Recommended warning signs include sharp curve and 'SLOW' delineation with the recommended speed for the sharpest horizontal curve at 25 miles per hour.

- The addition of large chevron signs in each direction and curve warning signs are recommended to delineate the curve more dramatically than the prior warning signs.

Lastly, object markers should be affixed to all major obstructions within the right of way (i.e., utility poles). However, per the City of Salem Tree Warden's directive, object markers are to be placed in front of, not affixed to, trees. Signs should be mounted at heights specified in the Manual on Uniform Traffic Control Devices. The key point is that the chevron signs be visible from the crest of the vertical curve.

Pavement Markings

The width of the existing centerline should be increased from 12" to 18" by widening the markings in each direction to 6" and widening the gap between the markers from 4" to 6". This would entail grinding and replacing the existing centerline markings.

Additionally, directional permanent raised pavement markers (PRPM's) mounted flush with the pavement (for ease of plowing) are also recommended. Spacing of the sets of four – two in each direction – will vary from approximately 80 feet apart in advance of the curves to 50 foot spacing through the curves, where possible.

The PRPM's should be placed such that they are visible by direction. Such markings will require regular maintenance to replace the inset reflectors that can become damaged and require replacement over time. Casings are epoxied to the pavement and tend to outlast the inset reflectors, needing replacement usually when



Example of Permanent Yellow or White Raised Pavement Markers (PRPM's)

the roadway is resurfaced or reconstructed. Accomplishing this along the Lafayette Street corridor entails the installation of a total of 80 raised pavement markers. All PRPM's should be offset from the centerline and edgelines by approximately a foot in each direction. PRPM's would particularly help delineate the area better during inclement weather and at night. ¹

Edgelines at intersections should be curved, similar to existing edgelines. Except at street intersections, transverse markings are recommended in the southeast direction between Raymond Avenue and the bridge. In the southbound direction, transverse markings should be used to provide a stronger delineation of the shoulder, a more visible reduction of travel lane width and to enhance delineation of the shoulder that will continue to be used for bike travel. It is recommended a typical 5-foot corridor be provided between the curb and the edge of the area marked by transverse lines, thereby separating bike traffic from motor vehicle traffic in a more effective manner.

Day or night, the PRPM's will send an immediate cue to motorists to slow down. Because this is a 'selected placement area', the national data seems to indicate this situation is one where PRPM's should have positive safety benefits -- i.e., Lafayette Street is a two-lane roadway with volumes in excess of 20,000 vehicles per day where nighttime crashes have been an issue, and where the degree of curvature is greater than 3.5. ²

A permanent variable message speed (VMS) control sign should be installed on the on the west side of Lafayette Street just north of the utility pole with the yellow flasher.

It is our understanding the City intends to purchase three such signs for its use throughout the City. As envisioned, the permanent VMS sign will give the recommended speed to motorists approaching the turn and would illuminate the speed that motorists are traveling above the safe speed for the turn, informing them to SLOW DOWN if their speed is higher than the recommended speed.

While the City could request utility companies to move existing utility poles nearest the curb to the backside of the sidewalk, the absence of good locations to relocate the poles to is

Radars Speed Signs

Radars speed signs display the speed of oncoming vehicles using highly visible LEDs to make motorists aware when they are driving at unsafe speeds. Radar speed signs have been proven to slow traffic down and are ideal for use on local roads or in school zones. Traffic Logix speed signs use a unique patented optical system that provides optimal visibility, low power consumption, and innovative vandal resistance.



Source: Traffic Logix

1 *Safety Evaluation of Permanent Raised Pavement Markers*, NCHRP # 518, Transportation Research Board, 2004.
2 Ibid.

an issue in and of itself (e.g., against hedges and stone walls or to places that would make the sidewalk non-compliant with ADA/MAAB). Similarly, the installation of guard rails, like the relocation of utility poles, is problematic in that guardrails should be placed outside of the shoulder, not within the shoulder. Along Lafayette Street, the sidewalk is so narrow that placing a guard rail on the sidewalk requires relocation of the curb line to comply with ADA sidewalk requirements. Refer ahead to the recommended follow-up plan that involves relocation of the sidewalk curb to provide room for *potential* construction of a guard rail (refer ahead to Recommended Phase II Plan).

Community Input

At a coordination meeting on September 22, 2008, local input recommended, and we concur with, the following measures for the to increase its effectiveness of the Lafayette safety improvements:

- Place the permanent radar sign in a small green space just north of the utility pole with the flashing light on it.
 - Relocate 25 sharp curve left sign to next utility pole southerly on the west side of Lafayette Street, so that motorists see it after the crest of the hill where the road turns to the left, not before where it turns to the right.
 - Place a curve right sign on the utility pole where the 25 sharp sign is to be relocated.
 - Lower the yellow flashing light above the utility pole.
 - Place a chevron on the utility pole on the east side of Lafayette Street facing southbound Lafayette Street traffic (see next page).
 - Eliminate two on-street parking spaces on the northwest corner of Lafayette Street at Raymond Avenue to provide a better transition to the vertical and horizontal curve ahead.
 - The City should seasonally trim tree branches, brush, and leaves to ensure visibility of signs.
 - Regular, increased enforcement of speed limits is essential to keep speeds down through this area. (We note that in other states, for example, in the Commonwealth of Virginia near Washington, DC, neighborhood radar photo speed enforcement has been found to be a very effective tool in reducing speeds in neighborhoods. Without the use of police officers, offenders traveling 5 miles or more of the posted speed limit are sent tickets in the mail with photos showing their actual speeds above the limit. The practice is producing major changes in neighborhoods that formerly experienced significant speeding issues. Such enforcement is currently *illegal* in the Commonwealth of Massachusetts. When or
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if such legislation is passed, we believe that many communities could benefit from this emerging tool for speed enforcement).

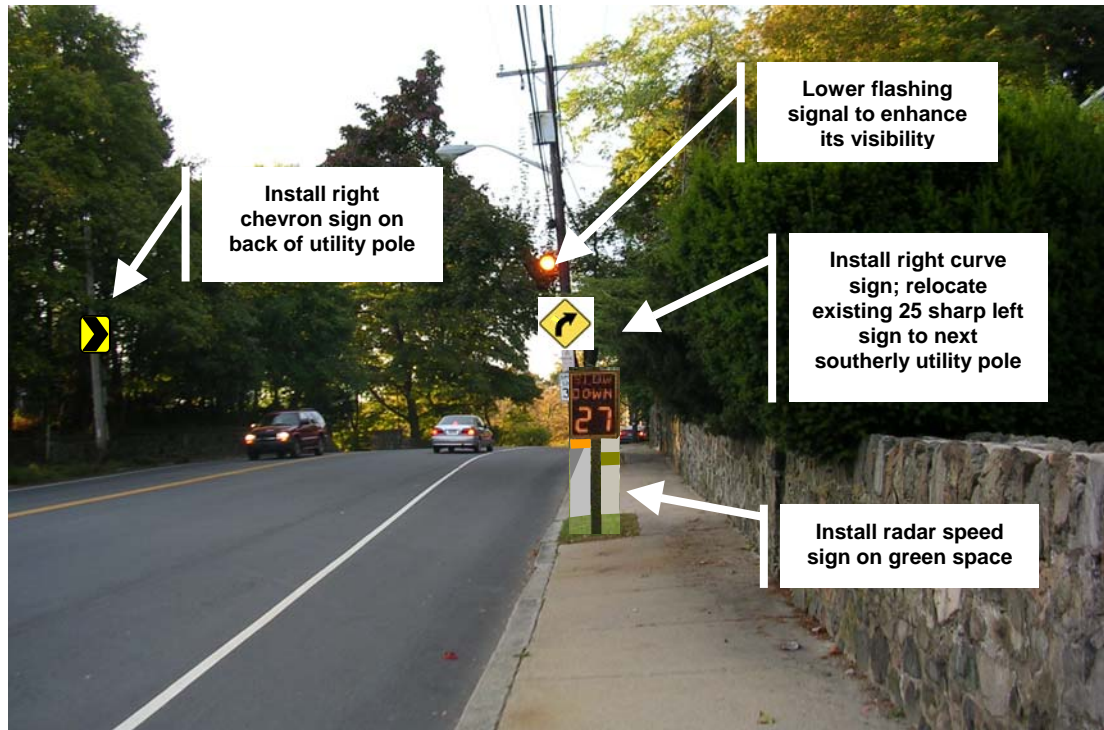
- Relocate chevron signs facing southbound traffic on Lafayette Street from stand alone poles to telephone poles (as originally done) to save poles and reduce their visual impact without negating their effectiveness.
- Enhance the visibility of the existing bikeway crossing. Consider in-pavement LED flashing lights when pedestrians are present to flash in both directions and ensure that the crosswalk is visible in both directions of travel (i.e., located on the crest of the hill). Install yellow-green signs with directional arrows pointing down and to the left at the crosswalk (Note: this could be addressed by the Lafayette Tides Project) in addition to the advance warning yellow-green signs that are in place currently.
- Request the Town of Marblehead to install a permanent radar speed sign on the approach to the curved area.



Example in-pavement crosswalk lights and automatic pedestrian detectors



Example of Enhanced Visibility Crosswalk



- Install crosswalks on Raymond Avenue, Raymond Road, Fairview Avenue, Lincoln Avenue, and Rosedale Avenue at their intersections with Lafayette Street along with stop signs and stop bars, as necessary. Separately, the City should consider measures to reduce through traffic intrusion on the Raymond Road approach to Lafayette Street including the potential for installing a supplemental (e.g., \$100 FINE FAILURE TO STOP) rectangular regulatory sign in advance of the stop sign to reduce stop sign running at this critical intersection or possibly peak period restrictions (e.g., NO THRU TRAFFIC 7-9 AM AND 4-6 PM w/ a supplemental placard 'STRICTLY ENFORCED) with regular enforcement.

Placing overhead utilities underground is an aesthetic long-term option for Lafayette Street. Unfortunately, street lighting poles would need to remain in place, so there would still be potential hazards through the curve unless they were replaced with breakaway poles. Overhead utility to underground relocations are very costly and require a long-term commitment with increased utility bills for affected customers. Such an action should normally only be taken within the context of other potential needs for placing utilities underground at other locations within the City of Salem and requires the concurrence of the public (Citywide) who would be paying the utility relocation costs.

The estimated construction cost of the Recommended Immediate Action Plan is \$32,000 (see attached Engineers Preliminary Cost Estimate).

Recommended Phase II Plan

When funding becomes available, and pending a review of safety impacts following implementation of the 'Immediate Action' plan, it is recommended the City consider follow-up curb adjustments to modify the geometry of the Lafayette Street curve under a Phase II Plan, if anticipated speed reductions on Lafayette Street do not occur.

This would be accomplished by narrowing the paved cross section to reduce travel speeds through the area and to increase the distance between traveling motor vehicles and the utility poles. The existing paved cross section is approximately 50 feet in width. The proposed 'road diet' would involve creating a typical paved section of 31 feet for two 12-foot travel lanes, one with a 5-foot shoulder that can be used by bicyclists and the other with a 2-foot lane offset, a curbed/grassed area, and a 5-foot shoulder adjacent to the sidewalk curb that would remain. An illustration of the proposed new curb lines on the Recommended Follow-up Plan will be submitted in the near future.

As noted at our meeting last month, there are two possibilities for the Recommended Phase II Plan, one with super-elevation at two defined locations and one retaining the existing roadway cross-slopes. If the features of the Phase I Immediate Action Plan end up reducing design travel speeds enough – i.e., to a target 85th percentile speed of less than 30 miles per hour -- the super-elevated plan may not be needed. The 85th percentile speed, typically considered to be the design speed, is the speed at which 85 % of all vehicles using the road are traveling at or below. Given that Lafayette Street was recently repaved, if the two areas cited for potential super-elevation at the meeting are required due to continued speeding following full implementation of the Phase I Immediate Action Plan, super elevation changes will be confined to the two locations cited. A cost differential with and without the super-elevation will be included as part of the Follow-up Plan and the potential super-elevation areas will be highlighted. The primary drawback of super elevation is that it tends to increase speeds through the super-elevated areas. This is why a normal roadway crown works for design speeds under 30 miles per hour.

The Recommended Follow-up Plan will be as compatible as possible with the Immediate Action Plan. Whether or not the super elevation is needed or undertaken, it is assumed the PRPM's and signage will generally be retained. The Recommended Follow-up Plan will require removal of the transverse markings called for in the Immediate Action Plan and retention of the shoulders adjacent to

the future curb on Lafayette Street at a width sufficient for bicycle travel plus grass or very low-lying shrubs adjacent to a narrowed travel way.

Ultimately, with the relocated southerly curb of Lafayette Street as part of the Recommended Follow-up Plan, the green space added to Lafayette Street will increase the distance between the paved travel way area and the utility poles, making it more difficult for motorists to run-off-road than might otherwise occur in the northeast direction toward the Town of Marblehead.

Additionally, with the modified curb line the installation of a wood guardrail between the bike lane and the travel way would be possible, should measured travel speeds recorded by the new VMS sign continue to exceed the target 85th percentile speed of 30 miles per hour through the Lafayette Street curves. There are many ways to address the hazards of utility poles located directly adjacent to the roadway, as is one of the key issues with the Lafayette Street curve.



Example of utility pole at Lafayette Street at curb line

A recent National Cooperative Highway Research Program report³ cites numerous potential approaches to reducing utility pole related crashes and the approximate time required for implementation. FST reviewed the list of potential measures and we find that one of the most realistic and effective ways to reduce the potential for collisions would be to adjust the curb alignment such that ultimately utility poles will be located well off the curb edge, rather than at it, as existing (see below for a photo of the issue).

EVALUATION OF LAFAYETTE STREET NARROWING OPTIONS CONSIDERED

There are at least four options for the horizontal geometry of narrowing Lafayette Street:

Volume 8: A Guide for Reducing Collisions Involving Utility Poles, NCHRP 500, (AASHTO, 2004).

- Option 1) Create grass strips without curbing and retain the Phase I bike lane;
- Option 2) Create grass strips with curbing on the roadside; flush on the bike side and retain the Phase I bike lane;
- Option 3) Create grass strips with curbing on all sides and retain the Phase I bike lane;
- Option 4) Narrow the road with curbing and greenspace; cyclists ride in the a relocated and slightly wider Phase I bike lane adjacent to the travel lane.

After a reviewing the pros and cons of each of the above options with several FST engineers, FST's recommended preferred option for Phase II would be Option 4), possibly with the super-elevation modifications if the desired reduction in travel speeds does not occur with the Phase I implementation. Options 1)-3) reflect the notion of trying to make the Phase II Option as consistent as possible with the Immediate Action Plan for the bike lane location. With the bike lane cutout is eliminated under the Phase II plan, there are two sub-options, the curb could be retained as shown in the photo above with a secondary curb and grass strip or the sidewalk could be reconstructed and the existing curbing removed, a more costly approach.

Option 1) is the least preferred, as it creates a potential slippery zone in the curve, the grass would be torn up in the winter plowing, and would likely be least effective of the options considered at reducing nighttime crashes. Its advantages are that it is more aesthetic than 2) or 3), and the least costly of the Follow-up options considered.

Of Options 2) and 3), Option 2) is better, if retention of the bikelane cutout created with the immediate action plan is locally preferred. It would produce a grass buffer with steep grades ranging from 10% to nearly 20% in some areas. Both Options 2) and 3) will create maintenance headaches for City, will be potentially confusing to motorists, but keep the southbound cyclists further away from motor vehicles compared to the Phase II plan. Option 3) creates more hazards for the cyclists due to curbing on both sides, but is easier to mow/maintain and probably more aesthetic than Option 2).

The preferred Phase II plan, while it places the southbound cyclists closer to the motor vehicles, it further *assumes the other traffic calming measures will tend to slow travel speeds of the cars and trucks on Lafayette Street*. The pros of filling with grass are aesthetics (it creates a far more 'normal' urban design look), more greenspace, drainage is easier, it may be less confusing to motorists, while best addressing the utility pole locational issues. The preferred Phase II plan is less costly than Options 2) or 3) due to the curbing/drainage requirements.

With the preferred Phase II plan, cyclists do have an option of the nearby multiuse path to stay off Lafayette Street. With Phase II, the proposed shoulders on both



Safety Recommendations
Salem Lafayette Street
September 23, 2008
Page 10 of 10

sides of Lafayette Street are sufficient to accommodate bike travel in accordance with State and Federal guidelines. Costly super elevation enhancements may not be needed if traffic slows effectively with Phase I enhancements.

It is important to reiterate that if the Phase I Immediate Action Plan is found to be successful at reducing travel speeds to below 30 mph, Phase II modifications will not be needed and we believe that of the other three Options considered, only Option 2) is feasible, should the City wish to explore it further as an alternative to the preferred Phase II Plan attached.

The estimated construction cost of the Recommended Phase II follow-up Plan ranges from \$141,000 with minimal sidewalk enhancements (see attached Engineers Preliminary Cost Estimate) to \$212,000 with sidewalk enhancements. Guard rail is not assumed in these estimates.

The City recently placed a highly visible mobile speed sign at the crest of the vertical curve. Following input received at the September 22 meeting, this is the preferred location for the permanent radar speed detection sign to be placed. Ideally, another radar speed sign would be placed on the Town of Marblehead westbound approach to the area as well to slow traffic in both directions.

Please feel free to contact FST with any questions on this memo or its findings.

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Attachments: Phase I Immediate Action Plan – Signs and Pavement Markings
Phase II Plan
Sign Summary Sheet
Immediate Action Plan/Phase II Plan Cost Estimates