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Communities Planning Together

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TECHNICAL MEMORANDUM

TO: Joe Colangelo, Dean Pierce; Town of Shelburne
FROM: Sai Kumar Sarepalli, P.E.; CCRPC
DATE: 09/10/2015
RE: Bay Road Traffic Data Collection & One-Lane Underpass Evaluation

Traffic Data Collection

As per the discussion with the Town Manager, Roadway Foreman and residents at a meeting on October 23, 2014, CCRPC staff installed 2 Automated Traffic Recorders (ATRs) along Bay Road to collect traffic volume, axle and speed data. Figure 1 shows the study area and ATR locations:

Figure 1: Study Area, Underpass and ATR Locations

The ATR locations on Bay Road are at approximately 0.3 miles west of the intersection with Shelburne Road (Location A) and 0.15 miles east of Yacht Haven Dr. (Location B). Data were collected from October 29, 2014 to November 5, 2014 and can be found in Table 1.

Table 1: Volume, Axle and Speed Data:

	Location A	**Location B**
85th Percentile Speed (mph)	42 mph – Eastbound 43 mph – Westbound	39 mph – Eastbound 39 mph – Westbound
Posted Speed Limit (mph)	35	35
Average Annual Daily Traffic (AADT)	2,456	2,523
Trucks and buses	4.0% - Eastbound 5.1% - Westbound	5.5% - Eastbound 5.0% - Westbound

A windshield reconnaissance survey was conducted by CCRPC staff to identify safety related issues, roadway characteristics, limited sight distance locations and roadside safety hazards.

Summary of Windshield Survey

1. The roadway width along Bay Road between Shelburne Road and the railroad underpass varies between 22 ft and 24 ft, whereas, the roadway width between the underpass and the boat ramp access varies between 20 ft and 22 ft.
2. Shoulders are not marked along the road. Narrow gravel shoulders are available for pedestrians; however they do not provide adequate room between pedestrians and vehicular traffic.
3. The roadway width under the railroad bridge was measured to be 20 ft wide which poses a safety hazard when multiple vehicles and/or users are present.
    a. Several scratches and scuff marks were observed, especially on southern abutment, indicating insufficient roadway width.
4. Sight distance is limited on the eastern side of the underpass due to a horizontal curve and roadway gradient. This is especially troublesome for westbound vehicles in detecting pedestrians or another vehicle present in the underpass.
5. A 25 mph warning sign is posted at the narrow section of road on the eastern side of the underpass.

One-lane Underpass Evaluation

Due to concerns identified in the windshield survey and through conversations with municipal staff, the feasibility of reducing the underpass to one-lane travel way was evaluated. By converting the underpass to one lane, the potential for vehicle conflicts will be eliminated and the remaining width could be used to better accommodate pedestrians and bicyclists. Due to the limited sight distance east of the underpass it was determined that the use of YIELD signs would not be appropriate and STOP control would be necessary. Figure 2 below shows the location and geometry of Bay Road at the underpass.

Figure 2: Railroad underpass and Bay Road Geometry

Stopping Sight Distance

CCRPC staff measured stopping sight distance at the underpass on May 21, 2015. Stopping sight distance is the distance required for drivers to stop safely after sighting an object or obstacle such as a broken tree stump or sign on the travel way. The American Association of State Highways and Transportation Officials (AASHTO) developed recommended safe stopping sight distances, based on design speeds, in its Policy on Geometric Design of Highway and Streets commonly known as the AASHTO Green Book. As noted earlier, the posted speed limit on Bay Road is 35 mph whereas the 85th percentile speed from traffic data collected within the study area on Bay Road varies between 39 mph and 43 mph. Therefore, it was determined that desired sight distance for westbound and eastbound approaches to the underpass would be based on design speeds of 45 mph and 40 mph, respectively. The following table illustrates the recommended stopping sight distances with respect to design speeds and grades.

Table 2: Stopping Sight Distance on Grades

Design Speed (mph)	Stopping Sight Distance (ft)						
	Level	Downgrades			Upgrades		
	0%	3%	6%	9%	3%	6%	9%
15	80	80	82	85	75	74	73
20	115	116	120	126	109	107	104
25	155	158	165	173	147	143	140
30	200	205	215	227	200	184	179
35	250	257	271	287	237	229	222
40	305	315	333	354	289	278	269
45	360	378	400	427	344	331	320
50	425	446	474	507	405	388	375
55	495	520	553	593	469	450	433
60	570	598	638	686	538	515	495

Source: Policy on Geometric Design of Highway and Streets, AASHTO

CCRPC staff measured stopping sight distance from the underpass in both eastbound and westbound travel directions. A STOP sign on a temporary pole was used to measure the sight distance from the height of a driver's eye (3.5 ft from the travel surface). Figure 3 shows the available stopping sight distance in both directions from the underpass.

Figure 3: Stopping Sight Distance at the Underpass

Based on the field observation and 2 ft contours generated from LIDAR (available at Vermont Center for Geographic Information (VCGI)), the westbound direction exhibits a downgrade that varies between 2% and 3.5%, whereas on the eastbound direction varies between 0% and 1.2%. As per the AASHTO's guidelines, the recommended stopping sight distance for a roadway with a 3% downgrade and design speed of 45 mph is 378 ft.

It is evident from field measurements that eastbound motorists approaching the underpass have adequate stopping sight distance (more than 400 ft) to see and react to a temporary STOP sign located at the underpass and come to a safe stop. Westbound motorists approaching the underpass have a stopping sight distance of approximately 350 ft. This distance is inadequate based on the previously discussed design speed of 45 mph requiring 378 ft for a 3% downgrade. The combination of horizontal and vertical alignment of roadway and obstructions within the driver's line of sight are the contributing factors in limiting the stopping sight distance for westbound motorists. This deficiency can be remedied with an appropriately placed Stop Ahead sign. Sight distance pictures are provided in the Appendix.

Stop Sign Analysis

To understand the traffic impacts of a stop controlled one-lane underpass, CCRPC staff developed a traffic simulation model for the PM peak hour. Average vehicle delay (seconds) and maximum queue lengths were extracted from the model results.

The average delay per vehicle for eastbound and westbound traffic from the simulation model was 9.1 seconds and 8.5 seconds, respectively. The maximum queue lengths reported from the simulation model were approximately 5 vehicles (78 to 90 ft) on each approach. The queue length and average vehicle delay report is provided in the Appendix.

Recommendations

Based on field observations, stopping sight distance evaluation, AASHTO guidelines and results from the traffic simulation model, a short-term pilot project for approximately 6 months is recommended at the underpass on Bay Road. The purpose of the pilot project is to evaluate travel conditions and safety of all users as well as receive public input on the proposed changes. The following improvements should be included in the pilot study:

1. Convert 2-lane road section under the railroad bridge to a minimum of 14 ft wide single travel lane and provide a separated pedestrian path of a minimum of 5 ft wide along the northern abutment (lake side) by installing a physical barrier system (concrete barrier, or bollards or railing) that conforms to the FHWA crash test requirements.
2. Install STOP signs on both approaches at the underpass. The actual STOP sign and STOP bar locations shall be determined in the field.
3. Install a Stop Ahead (W3-1) warning sign supplemented by an advisory plaque "400 feet ahead" at 400 ft from the proposed STOP sign location on westbound approach. See the proposed pilot study sign layout attached in the Appendix.

4. Install a New Traffic Pattern Ahead (W23-2)

on both approaches for the duration of the pilot study. The actual sign location shall be determined in the field. See the proposed sign layout attached in the Appendix.

5. Coordinate with the railroad company and install a Low Clearance sign (W12-2)

on both sides of the bridge deck.

The following recommendations should be considered to improve safety of all users along Bay Road.

1. Relocate the existing low clearance warning sign (11' Underpass) on eastbound and westbound approaches such that motorists are informed about low clearance in advance prior to reaching the pilot study area. See the proposed sign layout attached in the Appendix.
2. Given the residential land use along Bay Road, different alternatives for pedestrian facilities within the study area should be evaluated through a scoping study.
3. Install a permanent radar speed feedback sign approximately 100 ft west of Ti Haul Recreational path crossing on Bay Road.
4. Install an In-Street sign (R1-6) "State Law Yield to Pedestrians Within Crosswalk" at the Ti Haul Recreational path crossing on Bay Road during high pedestrian activity period (from April to November).

Upon request, CCRPC staff could assist the Town in developing an implementation plan for the pilot study and gather traffic data, queue lengths and travel conditions at the underpass and evaluate before and after conditions.

Appendix

Queuing and Blocking Report
Baseline 8/7/2015

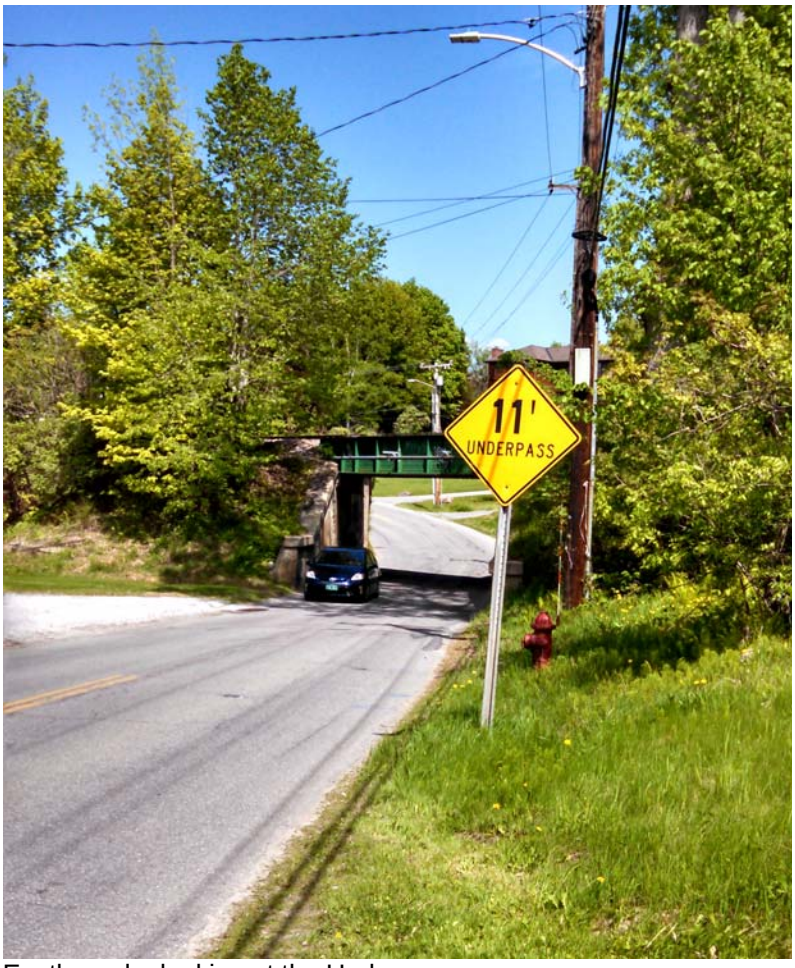
Intersection: 6: Bay Road

Movement	EB	WB
Directions Served	T	T
Maximum Queue (ft)	90	78
Average Queue (ft)	51	41
95th Queue (ft)	88	72
Link Distance (ft)	556	549
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

SimTraffic Performance Report
Baseline 8/7/2015

6: Bay Road Performance by approach

Approach	EB	WB	All
Denied Delay (hr)	0.0	0.0	0.0
Denied Del/Veh (s)	0.0	0.0	0.0
Total Delay (hr)	0.3	0.2	0.4
Total Del/Veh (s)	9.1	8.5	8.8
Stop Delay (hr)	0.1	0.1	0.2
Stop Del/Veh (s)	4.2	4.1	4.2



Eastbound – looking at the Underpass

Westbound – looking at the Underpass from 250 ft

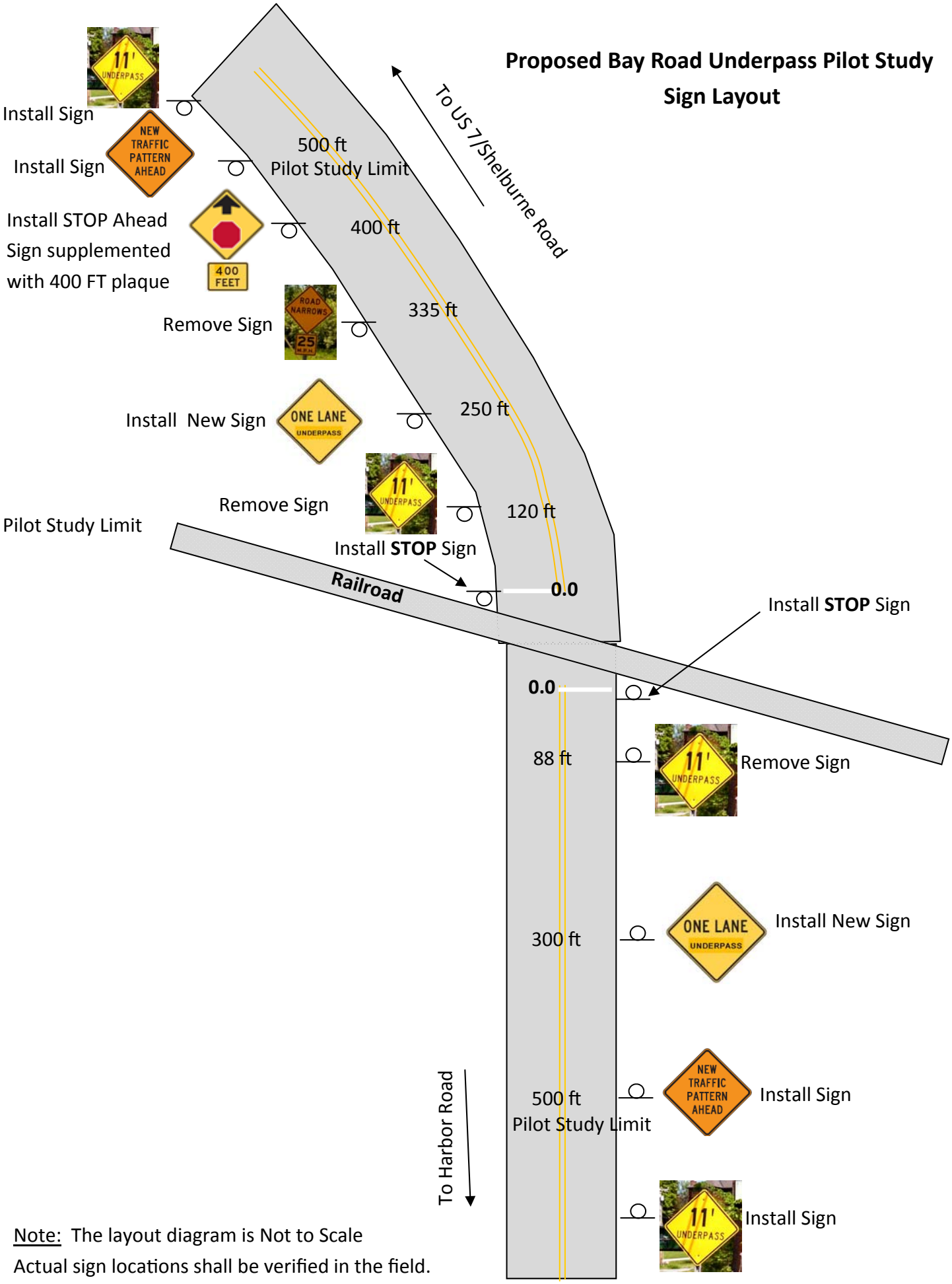
Westbound – looking at the Underpass from 300 ft

Westbound – looking at the Underpass from 350 ft

Westbound – looking at the Underpass from 400 ft

Southern Abutment showing scuff marks

Proposed Bay Road Underpass Pilot Study Sign Layout



Note: The layout diagram is Not to Scale
Actual sign locations shall be verified in the field.