Agenda Item IV.1

OTTER CREEK ENGINEERING

October 5, 2021

Ms. Valerie Capels
Town Administrator
1 South Street
P.O. Box 249
Bristol, VT 05443

Subject: Town of Bristol - West Street Crosswalk Design
Basis of Design

Dear Valerie:

Enclosed is our completed Basis of Design for the West Street Crosswalk project. We have identified suitable crosswalk locations based on VTrans design criteria and the existing site conditions. I am prepared to meet with the Selectboard to discuss review and discuss our findings at their earliest convenience so that final design plans can be developed for the preferred alternative.

Thank you again for the opportunity. As always, if you have any questions, please let me know.

Regards,

Robert M. Clark, P.E.
Principal / Senior Project Engineer

1090-001

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West Street Crosswalk
Bristol, Vermont

October, 2021

1.0 Introduction / Background

Firehouse Drive was constructed in 2016 to provide access to the new Fire Station off of Vermont Routes 17 and 116 in Bristol Village (West Street). Firehouse Drive will also provide access to a commercial business park with affordable housing referred to as the Stony-Hill development. This development is currently under construction and at varying stages of project planning. A portion of the project extends a sidewalk along the east side of Firehouse Drive to West Street. The intersection of Firehouse Drive and West Street is uncontrolled. There is a stop sign on Firehouse Drive, and no controls on the West Street approaches. The Town desires a crosswalk for pedestrians to access the business park from the sidewalk network on the north side of West Street. The existing site conditions are generally depicted on the orthographic photo included as **Figure 1.**

2.0 Design Criteria and Existing Site Conditions

The type of crosswalk being considered for this project is referred to under Vermont Agency of Transportation Guidance as an uncontrolled approach. There are two options for siting a crosswalk: 1) at the intersection of Firehouse Drive or 2) a mid-block non-school crossing along West Street. The following table below includes criteria for installation and existing site conditions corresponding to the criteria. Other factors may be considered if the site conditions are not met.

VTrans Criteria for Installation:	Site Conditions:
The speed limit is 40 mph or less;	The speed limit within the project area is 30 mph. There is a speed reduction from 40 mph before on the eastbound approach.
20 or more pedestrians use the crossing per hour during the highest pedestrian volume	The Development will create new pedestrian trips and it is anticipated there will be nearly 20 or more pedestrians crossing per hour during the highest pedestrian volume.
The AADT for the roadway both directions combined exceeds 3,000 vehicles per day	According to VTrans 2020 ADDT Report, 4,167 vehicles per day per lane travel along West Street through Bristol
There is a sidewalk or adequate shoulder for use by pedestrians.	The Stoney-Hill development has a proposed sidewalk that runs along the east side of Firehouse drive. There is no sidewalk along the south side of West Street, however there is an existing sidewalk on the north side of West Street.
There is not another crosswalk across the same roadway	The closest crosswalk that crosses West Street is nearly half mile east of the proposed project site and there are no pedestrian facilities which would provide access.
Adequate site distance (equal to or exceeding the stopping site distance for the posted speed) is available in both directions	Site distance is discussed below.

3.0 Site Distance

3.1 Minimum Requirements

The VTrans Guidelines for Pedestrian Crossing Treatments (August 2019 addition) indicates the following requirements for a crosswalk at an uncontrolled intersection or mid-block non-school crossing:

Table 1 – Speed Limit vs Site Distance

Posted Speed (mph)	Required Site Distance (feet)
25	155
30	200
35	250
40	305

3.2 Stopping Site Distance Calculation

Stopping sight distance (SSD) is the minimum sight distance required for a driver to stop without colliding into an object in the roadway. Stopping site distance is the sum of the reaction time and the breaking distance. The equation is listed below:

$$SSD = vt + \frac{v^2}{2g(f \pm \frac{n}{100})}$$

Where:

v = *speed of vehicle*

- 40 mph from the west
- 30 mph from the east

t = *reaction time*

- For young drivers, this number is typically 1-2 seconds. For older drivers, the number can be as high as 3 seconds. To be conservative, we will use 3 seconds.

f = *friction coefficient*

- *Dry conditions* = *0.85*
- *Wet pavement* = *0.40*
- *Snow Conditions* = *0.22*

n = *slope*

- There is a slight positive slope from the west.
- The road is flat coming from the east.
- We will use a slope for 0% for both sides, which is considered conservative.

Table 2 - Stopping Site Distance Results for Varying Circumstances

	20 MPH	25 MPH	**30 MPH***	35 MPH	40 MPH	45 MPH
Dry Conditions (0.85)	104	135	167	202	239	278
Wet Pavement (0.40)	121	162	207	256	310	367
Snowy Conditions (0.22)	149	205	269	340	419	506
Icy Conditions (0.15)	177	249	333	427	533	649

3.3 Field Measurement of Sight Distance

Otter Creek Engineering staff measured the site distance from the east side of Firehouse drive, in both directions and along both sides of the road. The method used is as follows:

1. A point of observation was painted on the south side of West Street, at the proposed crosswalk location. Surveyor 1 crouched down on one knee with their hand resting on their knee at the 2' height.

2. A second surveyor walked westerly with a GPS until they were out of site. Pink flagging was placed 3.5' above the ground on the GPS pole.

3. The second surveyor walked east in the travelled lane, towards the point of observation until the first surveyor was able to see the 3.5' high flagging.

4. The second surveyor confirmed that they could see the first surveyor at 2' off the ground while their eyes were at 3.5' of the ground. Surveyor 2 recorded the location with a GPS survey instrument.

5. Steps 2 through 4 were completed for the east bound traffic to record the sight distance.

6. Steps 1 through 5 were repeated for the North side of West Street.

The results are presented in **Table 3** below:

Table 3 – Measured Site Distances

	North Side of Crosswalk	South Side of Crosswalk
East-Bound Traffic Sight Distance	418.9'	373.3'
West-Bound Traffic Sight Distance	769.5'	741.7'

The measurements collected above were at the intersection of Firehouse Drive and West Street.

3.4 Discussion

Results indicate that the measured sight distance from the east far exceeds the necessary stopping site distance of vehicles is not a design concern.

A design question for the project is whether there is adequate site distance from east-bound traffic to stop before the crosswalk. The speed limit in this area is 30 mph. **The calculations performed in the previous chart indicate that vehicles can stop in all conditions if travelling at the legal speed limit. This is the design standard accepted by the Agency of Transportation.**

Eastbound vehicles that are beginning the transition may be travelling faster than 30 mph. However, as stated previously, the calculation did not account for the uphill slope at this speed reduction which will inherently slow vehicles down quicker and utilized a conservative 3 second reaction time. When considering a more typical 2-second reaction time the stopping site distance requirements decrease for a vehicle traveling 40 mph by 60 feet.

4.0 Option for Improvement

Based on the analysis completed above, a reasonable location for the crosswalk is shown as **Figure 2** as Option 1. Since this crossing is located at the intersection of Firehouse Drive and West Street, it is desirable as it will inherently require the least amount of infrastructure (and cost) when compared to other alternatives and provide a direct line of connection for pedestrians. For this improvement, we envision the following would be provided:

4.1 Cross Walk Warning Sign

Pedestrian warning signs are installed at every crosswalk regardless of site factors. A fluorescent-yellow sign with a crosswalk symbol and an arrow pointing towards the crosswalk should be installed at each end of the crosswalk. These signs are depicted on **Figure 2.**

4.2 Drainage

Surface water within the project limits is collected in a stormdrain system on the north-side of West Street. Based on the topographic survey conducted, runoff from West Street follows the edge of the road and enters catchbasins. Based on site visits and available survey data, there does not appear to be drainage concerns within the project limits.

4.3 Cost Analysis

We understand that the Town envisions this project as a change order to the existing Stony Hill Development construction project, provided it is within the Town's budget. We have prepared a simplified engineer's opinion of construction costs for the work as outlined below in **Table 4** but would strongly encourage the Town to reach out to the Contractor (Don Weston Excavating) and solicit a quote directly for the work.

Table 4 – Engineers Opinion of Probable Cost

Option No. 1 - Traditional Crosswalk at Uncontrolled Intersection of Firehouse Drive and West Street					
Item No.	Description	Unit Quantity	Unit Cost	Total Cost	Notes
1	Crosswalk Painting	1 LS	$ 5,500.00	$ 5,500.00	Required Line Stripping
2	Crosswalk Signs	1 LS	$ 1,500.00	$ 1,500.00	Signs as indicated
3	Concrete Sidewalk	1 LS	$ 1,250.00	$ 1,250.00	Sidewalk panels on north side of West Street
4	Detectable Warning Surface	1 LS	$ 500.00	$ 500.00	Detectable Warning on north side of West Street
5	General Conditions / Miscellaneous Work	1 LS	$ 1,250.00	$ 1,250.00	PM, Bonds, Insurance, Topsoil, Seed and Mulch Disturbed Area
		Total Estimated Construction Cost =		**$10,000.00**	

5.0 Alternate Crossing Location

For comparison, an alternate crossing located east of the Firehouse / West Street intersection was considered. The site distance for eastbound traffic can be improved by extending sidewalk along the south side of West Street to the east. This option is pictorially represented on **Figure 3** as Option 2**.**

This crossing would consist of the same components as the first option but would require more concrete sidewalk be constructed. The typical cost of concrete sidewalk is $60 per linear foot. For this extension, we would estimate that the cost increase (above the costs calculated for Option 1) would be between $4,000 and $6,000 dollars, depending on the amount of additional traffic control required to complete the installation.

It should be noted that crossing Firehouse Drive prior to crossing West Street was not considered as it would reduce the site distance for eastbound traffic on West Street.

6.0 Crosswalk Enhancement Considerations

The VTrans Guidelines for Pedestrian Crossing Treatments (August 2019 addition) provides guidance on crosswalk enhancements which may be appropriate based on several factors including the design speed of the highway, number of lanes, and Average Annual Daily Traffic (AADT). In some cases, marked crossings and signage is not sufficient to provide an adequate level of safety. **Table 5** below is taken directly from the VTrans guidance document and indicates that a marked crosswalk alone may be appropriate based on the speed and traffic volumes identified. It has been reduced to reflect the AADT range appropriate for this location.

Table 5 – Appropriateness of marked crosswalks

Roadway Type	3000 ≤ AADT ≤ 9,000		
	≤ 30 MPH	35 MPH	40 MPH
2 Lanes			
3 Lanes			
4 or more Lanes <u>with</u> Raised Median			
4 or more Lanes <u>without</u> Raise Median			

	Marked Crosswalk alone may be appropriate
	Additional crosswalk enhancements should be included
	Additional crosswalk enhancements must be included, a marked crosswalk alone is not appropriate

Table 6 is also from VTrans Guidelines for pedestrian crossing treatments, which outlines what enhancements may be appropriate.

Table 6 – Crosswalk Enhancements to Consider

RoadwayType	3000 ≤ AADT ≤ 9,000		
	≤ 30 MPH	**35 MPH**	**40 MPH**
2 Lanes	**In-street sign**	**In-street sign**	**In-streetsign, RRFB**
3 Lanes	Ped Refuge	Ped Refuge	Ped Refuge,AYL, RRFB
4 or more Lanes with Raised Median*	AYL	AYL	AYL, RRFB
4 or more lanes without raised median	Ped Refuge, AYL	Ped Refuge, AYL	Ped Refuge,AYL, RRFB, PHB

The guidance documents also suggest engineering judgement be utilized for each individual location. Given local concerns of vehicle speed and pedestrian safety, it is reasonable to consider crosswalk enhancement options in this location. **Table 6** suggests that in-street signs may be used for a 30 mph design speed, and that Rectangular Rapid Flashing Beacons (RRFBs) can be considered at a design speed of 40 mph. The following is a brief discussion on both:

6.1 In Street Pedestrian Signs

An in-street pedestrian sign is a basic enhancement that may be added to crosswalks to enhance their visibility. The use of in-street pedestrian signs shall be in accordance with the standards outlined on page 24 of the VTrans guidelines for Pedestrian Crossing Treatments, and be placed in the roadway at the crosswalk location, either on the centerline or on the lane line. They should not be post-mounted on either side of the roadway.

It is important to note that the sign legend shall refer to Yield rather than Stop consistent with Vermont state law, and that the sign shall not be placed in the crosswalk itself.

The sign support shall be designed to bend over and bounce back to its normal position if struck by a vehicle and should not be paired with the use of reflectorized cones or barrels.

In this location, the use of the in-street sign may be appropriate. We estimate the cost to be $750 each to add this enhancement.

6.2 Rectangular Rapid Flashing Beacons (RRFBs)

Rectangular Rapid Flashing Beacons (RRFBs) can be installed and utilized to increase sight distance and decrease reaction time. At this location, a RRFB will increase the stopping sight distance when traveling from the west. Since there is a horizontal curve on West Street, the north side of the street is visible before the south side of the street. If an RRFB were to be installed on both sides of the road, a driver will be able to see the flashing beacon on the north side of the road before seeing the pedestrian on the south side of the road. This will increase the stopping site distance to 419' feet for pedestrians traveling in either direction. It should be noted however that the overuse of RRFBs in the roadway environment could decrease not only the effectiveness of RRFBs but those crossings without RRFBs. RRFBs should be limited to locations with the most critical safety concerns.

We estimate that the additional cost to install RRFBs in this location is $5,000 and given the Stony Hill Development and surrounding uses, it is our opinion that an RRFB could be an appropriate enhancement in this location.

7.0 Permits Required

The crosswalk options considered under this report do not require any permits or approvals to be installed. This portion of Vermont State Routes 116 /17 is under the operational control of the Town of Bristol in this area. We would recommend that you review any installation with the Traffic Operations Unit of the Vermont Agency of Transportation. Contact information is provided below:

Ian Degutis, P.E., P.T.O.E.
Traffic Operations Engineer
Phone: (802) 371-8827
Ian.degutis@vermont.gov

8.0 Next Steps

Otter Creek Engineering has completed a limited topographic survey of the project limits sufficient to complete final design which could be issued as part of a change order to the sitework portion of the Stony Hill Development project. We offer the following recommendations:

1. The Selectboard authorizes the design of a preferred crosswalk location with desired crosswalk enhancements.

2. OCE completes design plans and provides to Don Weston Excavating for cost estimating.

3. If within budget, the Town authorizes the work as part of a change order to the Stony Hill Development project.

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TOWN OF BRISTOL
WEST STREET
CROSSWALK

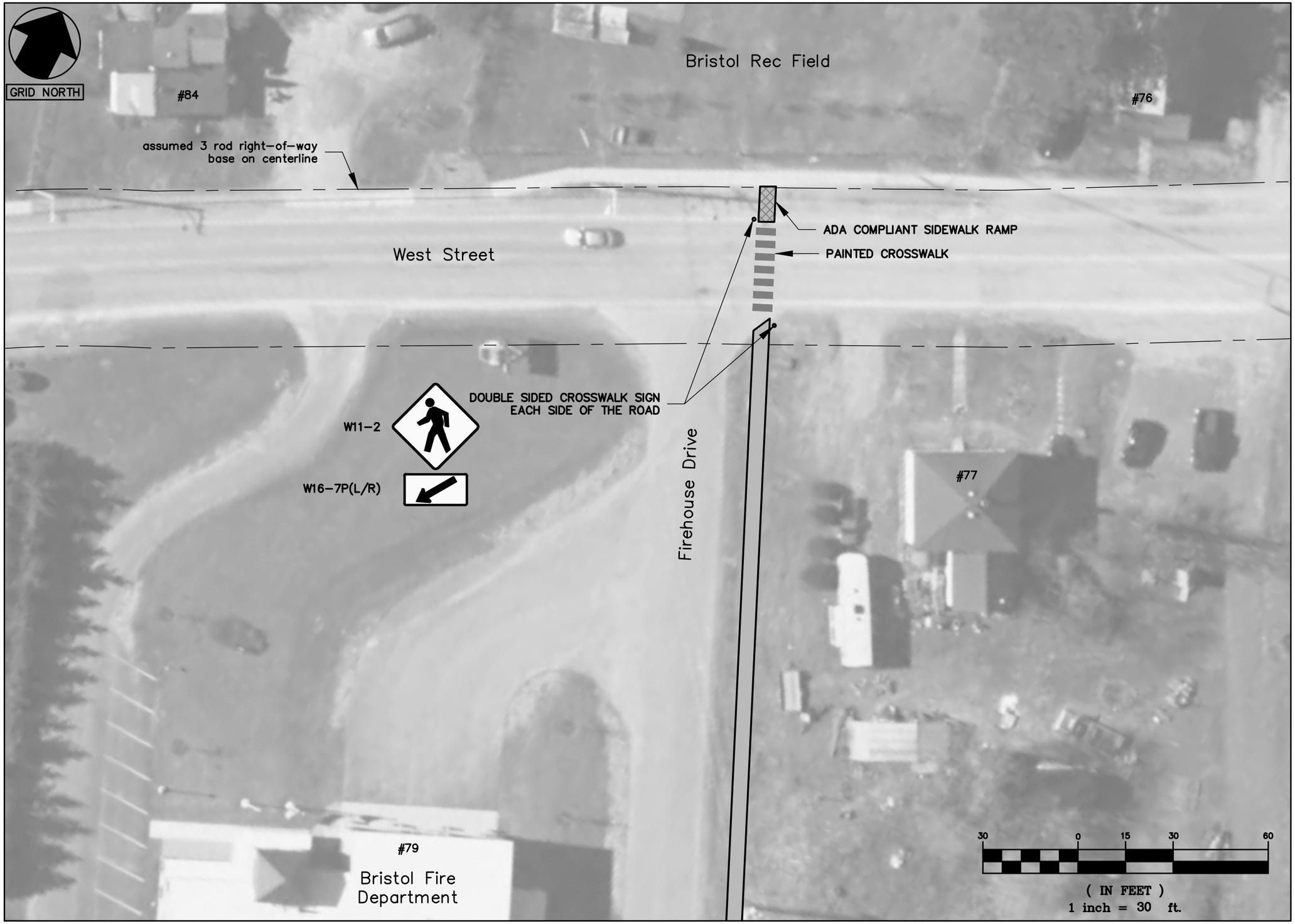
BRISTOL, VERMONT

DATE ISSUED:	10/1/2021
DRAWN BY:	RR
CHECKED BY:	RC
SCALE:	1"=30'
PROJECT NO.:	1090.001

TITLE:
EXISTING
CONDITIONS
SITE PLAN

FIGURE NO.
1

REF. DRAWING:



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TITLE:
CROSSWALK
OPTION 1

FIGURE NO.
2

REF. DRAWING:

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CROSSWALK

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TITLE:
CROSSWALK
OPTION 2

FIGURE NO.
3

REF. DRAWING: