

# New Hampshire Route 114 at Main Street / Western Avenue



## Road Safety Audit Henniker, NH

RSA Conducted: May 10, 2013  
Final Report: February 18, 2014  
Strategy Updates: \_\_\_\_\_

## Table of Contents

1. Introduction .....	1
1.1. Objectives of Study.....	1
1.2. Background.....	1
1.3. RSA Framework.....	2
2. Existing Conditions.....	3
2.1. Geometric Conditions.....	3
2.2. Traffic Data.....	3
2.3. Crash Analysis.....	4
3. Assessment Findings.....	7
3.1. Safety Benefits of Existing Roadway Features.....	7
3.2. Identified Safety Issues and Suggestions for Improvement.....	8
4. Conclusions .....	25
5. References.....	25

### Appendixes

Appendix A: Crash Diagram .....	A-1
Appendix B: Conceptual Drawings .....	B-1
Appendix C: Conceptual Cost Estimates .....	C-1
Appendix D: Benefit-Cost Analysis .....	D-1
Appendix E: Summary of Strategies .....	E-1
Appendix F: Lane Narrowing Treatment .....	F-1

# 1. Introduction

---

## 1.1. Objectives of Study

The objective of this study was to complete a road safety audit (RSA) for the Town of Henniker, NH. The study area includes the intersection of NH 114 and Main Street / Western Avenue and the surrounding area as shown in Figure 1.



**Figure 1: Study Area**

## 1.2. Background

NH 114 is an arterial that runs north-south from Manchester, NH in the south to New London, NH in the north. NH 114 provides the major north-south route within Henniker. Western Avenue intersects NH 114 from the west and Main Street from the east to form a four-legged, two-way stop-controlled intersection. Western Avenue is the former location of Route 9 and Route 202 and is a two-lane roadway with a mix of residential and commercial uses. Main Street is also a two-lane roadway with a mix of residential and commercial uses. Main Street changes names to Old Concord Road and intersects with Route 202/Route 9 in Hopkinton in the east while Western Avenue intersects Route 202/Route 9 in Hillsborough to the west.

The Town of Henniker identified the NH 114 intersection at Main Street / Western Avenue for the RSA. As part of the RSA application, crash data for the intersection from January 2002 to November 2012 was provided. The purpose of this RSA was to identify safety issues that may be

contributing to the reported crashes and identify potential measures to mitigate these issues with a focus on pedestrians and maintaining the historic and esthetic character of the area.

The RSA was conducted by a team represented by members with expertise in planning, design, operations, and safety. The RSA team consisted of the following members:

<b>Name</b>	<b>Organization</b>
Frank Gross	Vanasse Hangen Brustlin, Inc.
Meredith Graham	Vanasse Hangen Brustlin, Inc.
Michelle Marshall	NHDOT
Trent Zanes	NHDOT
Rich Radwanski	NHDOT – District 5
Dean Williams	Central New Hampshire Region Planning Commission
Ryan Murdough	Henniker Police Department
Matthew French	Henniker Police Department
Keith Gilbert	Henniker Fire Department
Tom Yennerell	Town of Henniker
Scott Osgood	Town of Henniker
Carl Knapp	Henniker Highway Department
Peg Keeler	Henniker Community School

### **1.3. RSA Framework**

The eight-step RSA process detailed in the Federal Highway Administration’s (FHWA’s) *Roadway Safety Audit Guidelines* (FHWA, 2006) was utilized for conducting this RSA. This included a kickoff meeting with the RSA team and other stakeholders to review existing information and identify concerns, followed by a field review to verify concerns and identify other potential safety issues. Based on the field review and crash analysis, the team has suggested improvements to address the identified safety issues. The suggestions have been categorized as near-term, intermediate, long-term, and proactive improvements. Near-term improvements can typically be implemented through local maintenance forces, while intermediate and long-term improvements often require additional planning, design, and funding. Proactive improvements were identified to address potential safety issues that have not manifested in crashes. Conceptual drawings were developed for four general alternatives, and a benefit-cost analysis was conducted for each alternative. Construction costs were estimated from the NHDOT Weighted Average Unit Prices (NHDOT, 2012) and national averages. Expected benefits were based on crash modification factors (CMFs) obtained from the Highway Safety Manual (AASHTO, 2010), FHWA CMF Clearinghouse ([www.cmfclearinghouse.org](http://www.cmfclearinghouse.org)), and other related resources. Crash costs were based on the NHDOT 2013 Highway Safety Improvement Program Guidelines and FHWA Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries (FHWA-HRT-05-051).

## **2. Existing Conditions**

---

### **2.1. Geometric Conditions**

NH 114 is a two-lane, undivided road with a posted speed limit of 30 mph. The pavement width in the vicinity of Main Street/Western Avenue is variable, including 12-foot lanes, shoulders on both sides of the southbound approach, and parking lanes on both sides of the northbound approach. There is a striped centerline and edge lines on both approaches. There are nearby driveways on both approaches that provide access to residential and commercial properties. The nearby commercial properties include the Henniker Pharmacy, Citizen's Bank, Davis & Towle Insurance Group, and Gin-Gin (restaurant/bar)/Henniker Laundromat. The vertical alignment along NH 114 is varied with rolling terrain, but there is a consistent downgrade from north to south in the vicinity of the intersection. The horizontal alignment is relatively straight along this section. Discontinuous sidewalks are present on both the northbound and southbound approaches of NH 114. Striped crosswalks are present at the intersection on both approaches of NH 114. In addition to the crosswalks at the intersection, there is a midblock crossing approximately 175 feet south of the intersection.

Main Street is the westbound stop-controlled approach of the intersection. Main Street is a two-lane undivided road with a posted speed limit of 30 mph. There is white striping near the intersection to delineate an exclusive left turn lane and a shared through-right lane. On-street parking is available on both sides of Main Street with a mixture of parallel spaces and angled spaces. The vertical and horizontal alignments are flat and straight. Pedestrian amenities along Main Street include three midblock crosswalks and sidewalk along both sides. The nearest crosswalk to NH 114 on Main Street is approximately 125 feet east of the intersection.

Western Avenue is the eastbound stop-controlled approach of the intersection. Western Avenue is a two-lane undivided road with a posted speed limit of 30 mph. There is also a 20 mph posted school zone west of NH 114 for the Henniker Community School. No pavement markings are present along Western Avenue with the exception of the stop bar and crosswalk at the intersection. There are sidewalks on both sides of the roadway, but there are segments that are not continuous most notably near the Henniker Pharmacy.

### **2.2. Traffic Data**

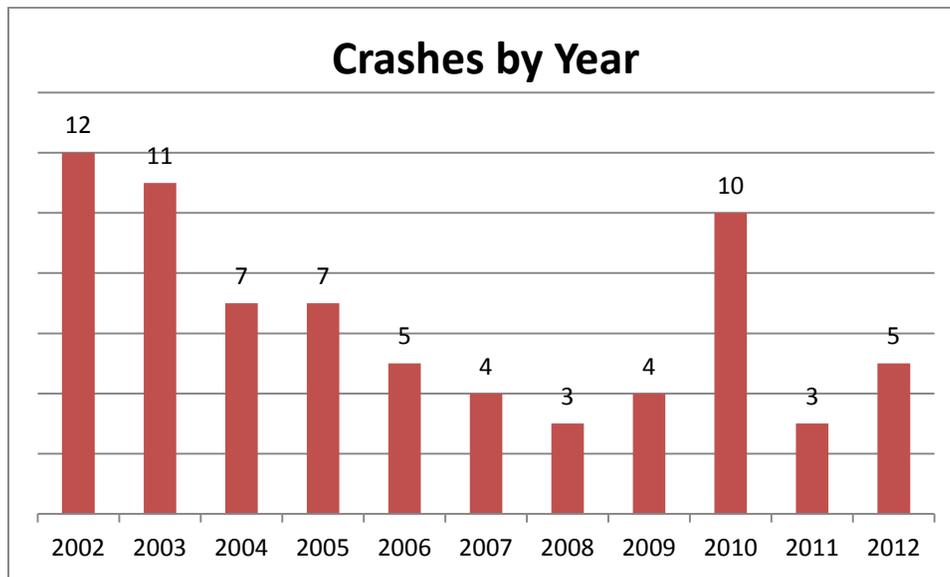
The Central New Hampshire Regional Planning Commission provided average annual daily traffic volumes for the area near the study intersection as part of the Safe Routes to School (SRTS) program being developed by the Town of Henniker. Additionally, peak hour turning movement counts were collected. The morning traffic peaked at 7:15 AM and the afternoon traffic peaked at 2:30 PM. These peak hours are influenced by the opening and closing times of the nearby Henniker Community School. The closest NHDOT permanent count station is location on NH 114 east of Mink Hill Rd in Warner approximately 2.5 miles north of the intersection with Western Avenue/Main Street. No pedestrian or bicycle traffic counts were available; however, many were

observed by the RSA team, and the majority of the pedestrians and bicyclists were students/teachers/parents traveling to/from the Henniker Community School.

### 2.3. Crash Analysis

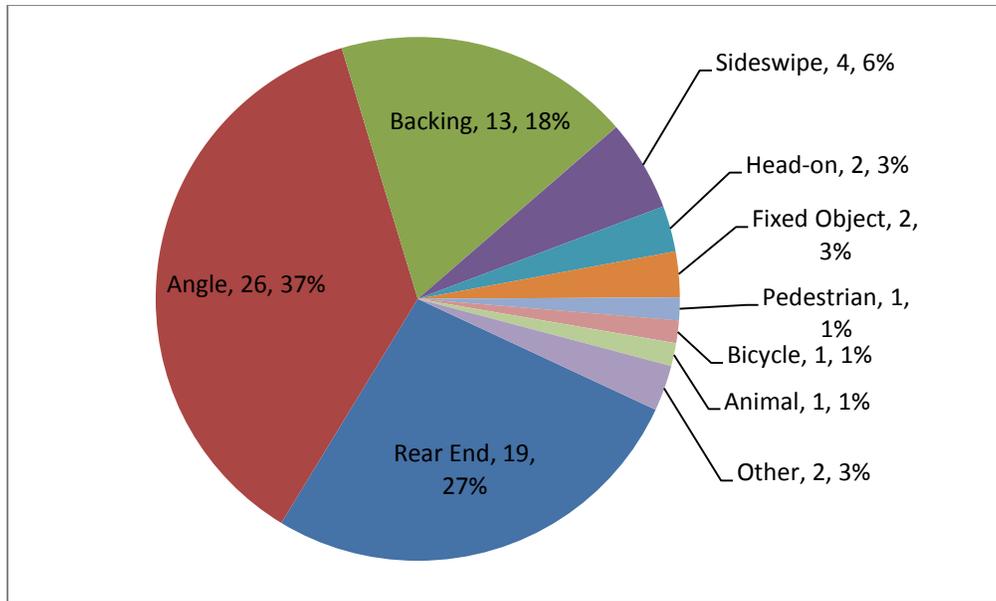
The Town of Henniker identified the intersection for the RSA. The New Hampshire Department of Transportation provided crash data for the intersection from January 2002 to November 2012. A basic crash diagram is provided in Appendix A. There were a total of 71 crashes at the intersection between January 2002 and November 2012. This section presents the results of the crash analysis by year, type, severity, weather, and time of day (day/night).

Figure 2 shows the distribution by year of the 71 identified crashes. There is a downward trend from a high of 12 crashes in 2002 through 2008 and a spike in 2010. Based on the 11 years of data, there are approximately 6.5 crashes per year on average.



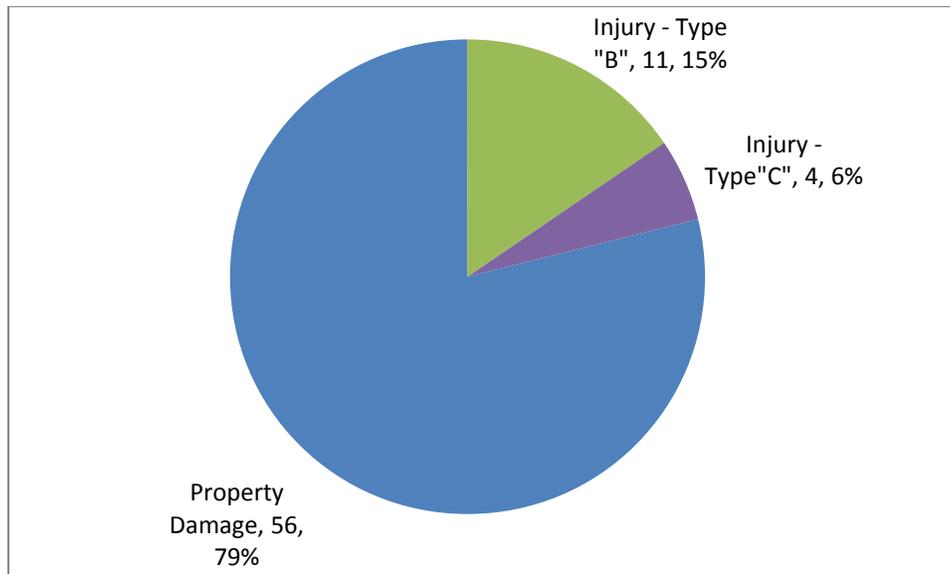
**Figure 2: Summary of Crashes by Year**

The majority of the crashes, 48 incidents, at the NH 114/Western Avenue/Main Street intersection are classified as rear end or angle crashes (68 percent). There were also a large number of backing crashes, crashes caused by a vehicle backing up generally out of a parking space with 10 crashes identified (14 percent). Figure 3 shows the distribution of reported crashes by type. There were also sideswipe crashes (4 crashes), head on crashes (2 crashes), fixed object (2 crashes), and there was one recorded crash each involving a pedestrian, a bicycle, and an animal (crash with a dog).



**Figure 3: Summary of Crashes by Type**

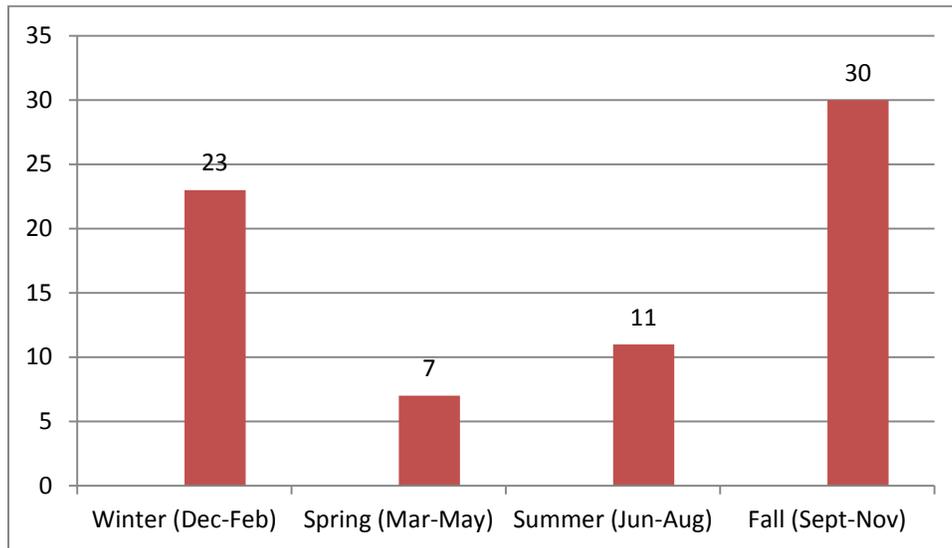
The severity of crashes at the study location was divided by property damage only (PDO) crashes (79 percent) and injury crashes (21 percent). Of the 15 injury crashes, eleven were serious (i.e., Type B severity). There were no fatalities at the intersection from 2002 to 2012.



**Figure 4: Crashes by Severity**

There is a high seasonal impact on the crashes. There were 30 crashes (42 percent) reported in the fall months (September through November), followed by 23 crashes (32 percent) in the winter months (December through February). The remaining 18 crashes are divided among the spring and summer months. With New England College's campus located in Henniker, mostly south of the

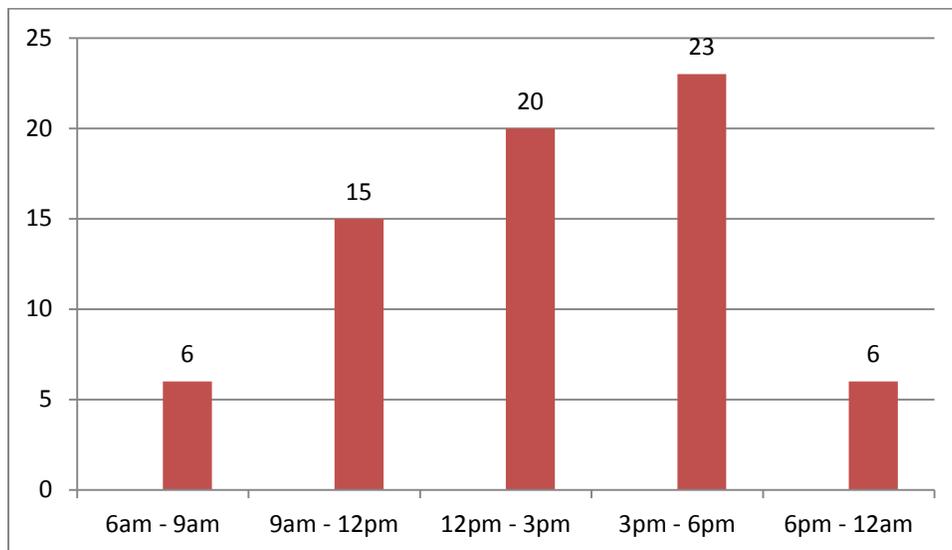
Contoocook River, it is expected that the presence of college students and their general unfamiliarity with the area in the fall may be a contributing factor of this seasonal trend.



**Figure 5: Crashes by Season**

While season appears to play a role in crashes at the study intersection, weather does not appear to play as large of a role. Of the 71 crashes at the intersection, the majority of crashes, 53 (75 percent), occurred under clear and dry conditions. There were 11 crashes that occurred under wet roadway conditions and 6 occurred under snow/slush conditions.

There was a notable time of day pattern as shown in Figure 6. There were no crashes during the early morning hours (12 am – 6 am), but crashes steadily increase throughout the day, peaking during the PM peak traffic period. While the greatest number of crashes occurred between the hours of 3 pm and 6 pm, the greatest traffic volumes occur in the morning.



**Figure 6: Crashes by Time of Day**

### 3. Assessment Findings

---

#### 3.1. Safety Benefits of Existing Roadway Features

There are notable benefits provided by existing roadway features that are described below:

- **Positive Attitude and Multi-Agency Collaboration** – Throughout the course of the RSA process, the Town of Henniker (Administrator, Selectmen, Community School, community members, law enforcement, and fire department), Central New Hampshire Region Planning Commission, and New Hampshire Department of Transportation provided support and were open to suggestions to enhance safety and improve communication and collaboration. This attitude will help to maintain a long-term commitment to improving safety for residents and guests of the Town.
- **Accessibility to Businesses** – The adjacent businesses have good access from the street, which is important to maintain for the types of businesses (i.e., high customer turnover).
- **Presence and Maintenance of Pavement Markings** – Pavement markings enhance guidance, particularly at night, delineating the lanes, edge of roadway, and intersection. Centerline and edge line pavement markings are installed along NH 114. Pavement markings are also provided on the westbound approach (Main Street) to delineate the left-turn lane and shared thru/right-turn lane. All pavement markings were in relatively good condition, which indicates that they are well-maintained.
- **Sidewalks, Pedestrian Refuge Island, Crosswalks, and Pedestrian Signs** – There are sidewalks provided from every direction. This helps to improve mobility and provides pedestrians with a separate facility, which limits exposure to vehicles. There is a pedestrian refuge island on the northbound approach of NH 114. This reduces exposure between pedestrians and vehicles by reducing the effective crossing distance. In this case, pedestrians can cross the right-turn lane and then wait on the island as they identify a suitable gap to cross the remaining lanes. There are also crosswalks on three of the four approaches to the intersection and pedestrian warning signs. These features help to alert drivers of the potential presence of pedestrians and inform pedestrians of the desired crossing locations.
- **Crossing Guard** – A crossing guard is present before and after school to help all pedestrians and bicyclists across the street, particularly children.
- **Driver Compliance** – Drivers tend to approach the intersection with caution and yield to pedestrians. Driver yielding behavior appeared to improve when pedestrians were crossing in groups and before/after school when the crossing guard was present.
- **Courteous Drivers on Minor Roads** – There were limited aggressive driving maneuvers observed from drivers on the minor roads. These drivers must stop at the STOP sign and identify suitable gaps on the mainline while watching for pedestrians, bicyclists, and other vehicles from the opposing minor road.
- **Enforcement** – The level of enforcement has been adequate to maintain speeds and address driver behavior issues at and near the intersection.

### 3.2. Identified Safety Issues and Suggestions for Improvement

Despite the existing safety measures to improve road safety at the intersection, four general issues were identified by the RSA team. The RSA team prioritized the issues based upon their perceived importance in the study area and also provided a qualitative assessment of the relative risk. This assessment is based on the expected crash frequency and severity. Expected crash frequency is qualitatively estimated on the basis of expected exposure (i.e., how many road users will likely be exposed to the identified safety issue) and probability (i.e., how likely is it that a collision will result from the identified issue). Expected crash severity is qualitatively estimated on the basis of factors such as anticipated speeds, expected collision types, and the likelihood that vulnerable road users will be exposed. These two risk elements (frequency and severity) are then combined to obtain a qualitative risk assessment on the basis of the matrix shown in Table 3.1.

**Table 3.1 Crash Risk Assessment Matrix**

Frequency Rating	Severity Rating			
	Minor	Moderate	Serious	Fatal
Frequent	Moderate-High	High	Highest	Highest
Occasional	Moderate	Moderate-High	High	Highest
Infrequent	Low	Moderate	Moderate-High	High
Rare	Lowest	Low	Moderate	Moderate-High

The prioritized list of issues is summarized in Table 3.2 with a qualitative risk assessment. The issues are discussed in further detail following Table 3.2 along with the RSA Team’s suggestions to correct or mitigate the identified issues. Conceptual drawings are provided in Appendix B and cost estimates for those alternatives are provided in Appendix C. Appendix D provides a benefit-cost analysis for suggested intermediate and long-term improvements that are associated with crashes during the study period. Appendix E provides a complete summary of suggested improvements.

**Table 3.2 Summary of Potential Safety Issues**

Identified Issues	Expected Crash Frequency	Expected Crash Severity	Qualitative Risk Assessment
Design of Pedestrian Facilities	Frequent	Serious/Fatal	Highest
Design and Operation of Intersection	Frequent	Moderate	High
Lack of Access Management	Occasional	Minor	Moderate
Maintenance and Drainage Issues	Infrequent	Minor	Low

## ISSUE 1: DESIGN OF PEDESTRIAN FACILITIES

### 1.1 Lack of Continuity and Connectivity of Sidewalks

The presence of sidewalks has been shown to reduce pedestrian-vehicle crashes. Sidewalks help to reduce potential conflicts by separating pedestrians and motorists. The RSA team noted that there is a lack of continuity and connectivity of sidewalks near the intersection. Formal sidewalks end and lead into parking areas with no clearly defined paths for pedestrians and vehicles, which increases the potential for pedestrian-vehicle conflicts. This is a particular concern due to the proximity of the school and college; school children and college students walk through this area to get to/from class. Specific locations of concern include the following:

- Sidewalk along north side of Western Avenue leads into bank parking lot.
- Sidewalks along south side of Western Avenue and the west side of the NH 114 northbound approach lead into Pharmacy parking lot. While there is a private sidewalk along the storefront of the Pharmacy, there is no connection to the adjacent public sidewalks.
- Sidewalk along the north side of Main Street ends at Rush Road. There is no sidewalk on the north side of Main Street between Rush Road and NH 114, and the crosswalk leads into the guide wire of a utility pole and a flower garden.
- Sidewalk along west side of the NH 114 southbound approach ends approximately 300 feet prior to the intersection. Pedestrians continue along the shoulder and across the bank parking area.

The RSA Team also noted the lack of differentiation between the roadway and sidewalk in some locations. Specifically, the sidewalk is asphalt and blends with the roadway along Western Avenue and Rush Road.



View of sidewalk along north side of Western Avenue looking west toward Henniker Community School. Photo shows the sidewalk leading into the bank parking lot.



View of sidewalk along south side of Western Avenue looking east toward intersection. Photo shows the sidewalk leading into a crosswalk and then into Pharmacy parking lot.



View of sidewalk along west side of NH 114 looking north toward intersection. Photo shows the sidewalk leading into the Pharmacy parking lot.



View of NH 114 looking south toward intersection. Photo shows the lack of continuity between the intersection and the sidewalk to the north.

The following is a list of potential mitigation measures related to these issues:

#### *Near-Term*

- 1.1.1 Determine right-of-way and ownership of property surrounding the intersection.
- 1.1.2 Connect private sidewalk along the storefront of the Pharmacy to existing public sidewalks in both directions using colored pavement or stamped pavement to help differentiate between the sidewalk and parking lot. There is the question of potential liability if the adjacent public sidewalks are connected to the private sidewalk and this should be cleared with the Pharmacy owner first.
- 1.1.3 Review and consider existing Safe Routes to School (SRTS) plans in the development of alternatives.

#### *Intermediate*

- 1.1.4 Redesign Main Street to narrow the cross-section of the travel way and create room for a sidewalk and shoulder along the north side between Rush Road and NH 114. The redesign would involve the elimination of the exclusive left-turn lane and convert the remaining lane to a shared through/right/left. Any modifications to the geometry of the intersection should consider the turning radius of large trucks (WB-62). Some of the local truck drivers have commented that the current intersection is too narrow and any further lane width or curb radius reduction will make it very difficult to navigate. Based on a review of the current and proposed intersection geometry, the following table provides a summary of the curb radii in comparison to the accommodation of a WB-62 truck. Note that the measurements are based on an aerial image, which made it difficult to identify the edge of pavement for the existing condition. Also, the large truck radii assume no encroachment into additional lanes, and this was done with an acetate turning and radius template. During the final design, there could be further refinements that would change the information in the following table.

<b>Location</b>	<b>Existing Radius (ft)</b>	<b>Concept 2 Proposed Radius (ft)</b>	<b>Radius to Accommodate WB-62 (ft)</b>	<b>Notes</b>
NW Radius: Bank Parcel	20'	18'	25' + 70' (Compound)	Approximately 200 SF impact to the landscaping
NE Radius: "Gin-Gin" Parcel	15'	20'	45'	Approximately 50 SF impact to the restaurant parking lot
SW Radius: Pharmacy Parcel	15'	20'	30'	WB-62 turning radius increases the radius slightly, however with off-tracking an additional parking space could be lost on NH 114.
SE Radius: Slip Lane	20'	40'	40'	No significant change to the proposed concept

- 1.1.5 An alternative to the redesign of Main Street is to simply shift the centerline (and approach lanes) to the south and redesign the Gin-Gin parking lot to provide a sidewalk. This would involve improvements to the curb line and removal of the flower garden.
- 1.1.6 If the approach width on Main Street is narrowed and a sidewalk is installed in the northeast corner of the intersection, then consider installing a crosswalk from the island on the northbound approach of NH 114 to the northeast corner.
- 1.1.7 Eliminate the parking space between the Grange and the Pharmacy to make room for a sidewalk and continue the existing sidewalk east to the old real-estate office.
- 1.1.8 Continue the sidewalk north of the intersection on the west side of NH 114 to connect with the intersection (on Bank side).
- 1.1.9 Connect the sidewalk on the north side of Western Avenue with the intersection. There is a need to consider the delivery activities behind the Pharmacy (loading dock).

## 1.2 Location and Design of Crosswalks

The placement and design of crosswalks has a direct impact on safety. Crosswalks help to increase driver awareness of pedestrians and also inform pedestrians about the desired crossing locations. The RSA team noted the following potential safety issues related to the location and design of crosswalks near the intersection.

- Crosswalks leading into driveways/parking lots, which increases the potential for pedestrian-vehicle conflicts.
- Skewed crosswalks (i.e., not perpendicular to sidewalks) and limited use of curb extensions (i.e., bump-outs) increase the length of the crossing, which increases pedestrian exposure to potential conflicts.
- While there is an existing crosswalk on Western Avenue in front of the school, there are several students crossing Western Avenue near the Grange where there is no crosswalk. Based on input from the RSA team, there is breakfast served here in the morning and this is where the majority of students are crossing.



View of crosswalk along north side of Main Street looking west toward intersection. Photo shows the crosswalk leading into the Gin-Gin parking lot.



Aerial view of crosswalk on NH 114 just to the south of the intersection. Image shows the skew of the crosswalk.

The following is a list of potential mitigation measures related to these issues:

### *Intermediate*

- 1.2.1 Realign crosswalks to meet new sidewalks and reduce crossing distances.
- 1.2.2 Consider installing bump-outs at crosswalks to reduce crossing distances. This is a potential maintenance concern and any curb extensions should be well-marked and conveyed to the respective maintenance departments (Town and/or District).
- 1.2.3 Construct a bump-out with crosswalk in front of the Grange to clearly identify the preferred crossing location for pedestrians walking to school. The bump-out will reduce the crossing distance and a crosswalk will help to alert drivers of the potential for pedestrian crossings.

## ISSUE 2: DESIGN AND OPERATION OF INTERSECTION

### 2.1 Wide Intersection

The width of the intersection can impact safety. Wide intersections increase crossing distances for pedestrians, which increases exposure to potential conflicts. It is also more difficult for motorists to navigate wide intersections, particularly those with limited delineation. The RSA Team noted that the Western Avenue and Main Street approaches are excessively wide, which contributes to the following issues:

- The wide approaches increase the crossing distance for pedestrians, which increases exposure.
- The approach on Main Street operates as two lanes (one shared lane for through and right-turn movements, and one exclusive left-turn lane). The traffic volumes on Main Street are the lowest of all approaches and do not likely warrant an exclusive left-turn lane. The two-lane design also creates sight distance issues for drivers when vehicles queue side-by-side.
- The wide approach on Western Avenue allows drivers to pull alongside each other. The RSA Team observed drivers using the shoulder as a right-turn lane, where vehicle #2 pulls to the right of vehicle #1 waiting at the stop bar and makes a right-turn. When vehicles queue side-by-side, it obstructs the sight distance for both drivers. This is also a concern for potential conflicts with drivers entering/exiting parking spaces adjacent to the approach.



View of Main Street looking west toward the intersection. Photo shows the wide approach with limited delineation.



View of Western Avenue looking east toward the intersection. Photo shows the wide approach with no delineation.

The following is a list of potential mitigation measures related to these issues:

#### *Near-Term*

- 2.1.1 Paint a centerline and edgeline near the intersection to better define the approach on Western Avenue.

### *Intermediate*

- 2.1.2 Consider the potential to eliminate the last parking space on the south side of Western Avenue and west side of NH 114 to install a curb extension (bump-out) for pedestrians. This will reduce the crossing distance and help to eliminate right-turn sneakers.
- 2.1.3 Redesign Main Street to narrow the cross-section. The redesign would involve the elimination of the exclusive left-turn lane and convert the remaining lane to a shared left/through/right.

### *Long-Term*

- 2.1.4 Consider the potential to eliminate the northbound right-turn slip-lane on NH 114. This would narrow the cross-section, which may help to reduce speeds and would shorten the crosswalks. It may also benefit the left-turn movements from Main Street. The turning radius of heavy vehicles is a potential concern and needs to be considered in the redesign.
- 2.1.5 Consider alternative traffic control options, including a traffic signal and/or a roundabout. There is some evidence that flashing beacons may cause confusion for drivers on the minor road. Specifically, the minor road drivers may assume a 4-way stop condition when the intersection operates as a 2-way stop. Based on a review of the crash data from 2002 – 2012, there were 16 angle crashes that resulted from a failure to yield right-of-way.

## 2.2 Lack of Pavement Markings on Western Avenue

Pavement markings define lanes and shoulders and help drivers to navigate their desired vehicle path. Other than a stop bar and crosswalk, there are no pavement markings on the Western Avenue approach near the intersection. This creates driver confusion, particularly at night, and leads to undesirable maneuvers. The RSA Team observed drivers pulling alongside each other, where vehicle #2 pulls to the right of vehicle #1 waiting at the stop bar to make a right-turn. When vehicles queue side-by-side, it obstructs the sight distance of both drivers.



View of Western Avenue looking east toward the intersection. Photo shows the wide approach with no delineation.



View of Western Avenue looking north from Pharmacy parking lot. Photo shows two vehicles queued side-by-side on Western Avenue (obstructing each other's view).

The following is a list of potential mitigation measures related to these issues:

### *Near-Term*

- 2.2.1 Paint a centerline and edgeline near the intersection to better define the approach on Western Avenue.
- 2.2.2 Continue the edgeline around the corner from NH 114 southbound onto Western Avenue to better define the corner and turn from NH 114.

## 2.3 Lack of Control for Northbound Right-Turn Lane

Traffic control devices such as stop and yield signs help to define the right-of-way between potential conflicting movements. The northbound right-turn lane on NH 114 is designed as a slip lane and does not have a traffic control device to assign right-of-way.



View of NH 114 looking north toward the intersection. Photo shows the right-turn slip-lane with no traffic control.

The following is a list of potential mitigation measures related to these issues:

### *Near-Term*

2.3.1 Install a yield sign for the right-turn slip lane on the northbound approach.

### *Long-Term*

2.3.2 Consider the potential to eliminate the northbound right-turn slip-lane on NH 114.

## 2.4 Intersection Skew

Intersection skew has been shown to have a negative impact on safety and also impacts traffic operations such as turning movements for large vehicles. The skew of this intersection is not severe, but does create issues related to lane alignment. For example, the northbound approach lane on NH 114 is not aligned with the receiving lane.



Aerial view of intersection obtained from Google Earth. Image shows the relative skew of the intersection.



View of NH 114 looking north toward the intersection. Photo shows the unaligned lanes on the northbound and southbound approaches.

The following is a list of potential mitigation measures related to these issues:

### *Intermediate*

- 2.4.1 During the next restriping project, consider modifying the striping plan to better align the approach and receiving lanes.

### *Long-Term*

- 2.4.2 Consider realigning the intersection approaches so they intersect at a 90 degree angle.

## 2.5 Downgrade on Southbound Approach of NH 114

The downgrade along the southbound approach of NH 114 is contributing to speeding on this approach. Based on feedback from members of the RSA Team, speeding is not a major issue at the intersection, but speeds north of the intersection exceed the posted speed limit (average speed is 35 mph compared to the posted speed of 30 mph).

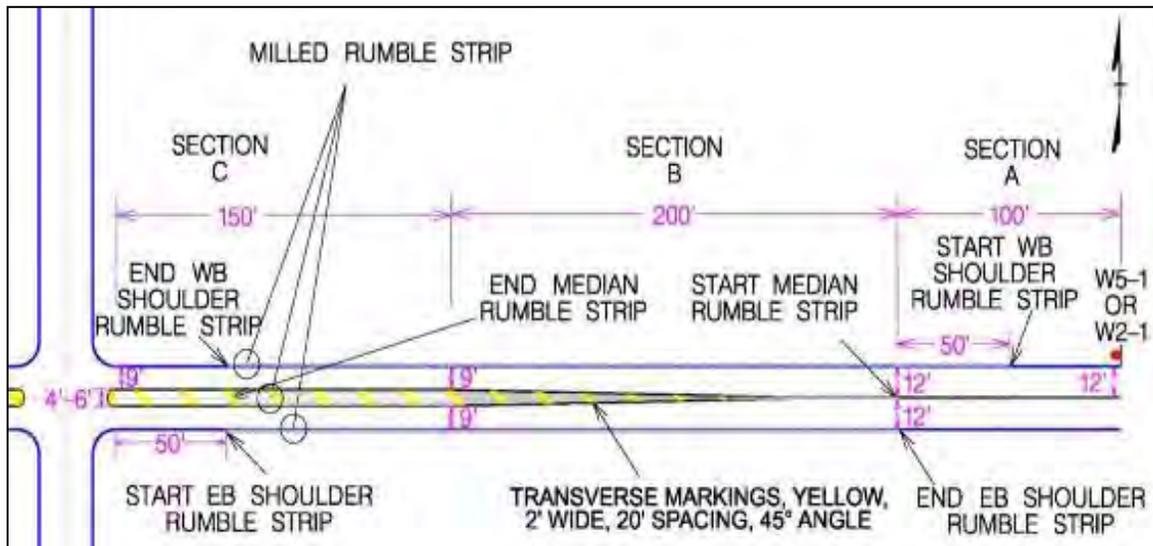
The following is a list of potential mitigation measures related to these issues:

### *Near-Term*

- 2.5.1 Conduct speed study (or review recent speed study if available) to consider speed-reduction measures on the southbound approach of NH 114 (north of the intersection).

### *Intermediate*

- 2.5.2 Consider installing speed feedback signs or other speed-reduction strategies such as narrowing the effective cross-section using pavement markings on the southbound approach of NH 114. The following is an example of a strategy to narrow the effective cross-section. While the concept drawing below includes the use of rumble strips, this may be an undesirable feature for this particular location due to the noise. Additional details for this strategy are provided in Appendix F.



## ISSUE 3: LACK OF ACCESS MANAGEMENT

### 3.1 On-Street Parking Near Intersection

On-street parking provides convenient access to businesses, but can also create safety issues such as added conflicts during parking maneuvers and sight distance issues near the intersection. The RSA Team noted the following safety issues related to on-street parking:

- Parking lots and on-street parking are provided along each approach to the intersection. Vehicles are parked along the road and in some cases all the way to the corner of the intersection. Parked cars near the intersection create sight distance issues as do delivery trucks that park along NH 114. The RSA Team also noted parking issues along Rush Road.
- There are a variety of parking options, including off-street parking lots, parallel parking spaces, and pull-in-back-out parking spaces. Based on a review of crashes from 2002 – 2012, there appears to be an issue with the pull-in-back-out parking spaces at the Pharmacy. Specifically, there have been several incidents involving a vehicle backing from a parking space into another vehicle either on Western Avenue or NH 114. The back-out parking is also a concern for pedestrians and bicyclists as the sidewalks along the south side of Western Avenue and the west side of NH 114 feed into the back of the cars parked along the Pharmacy.
- The RSA Team also observed vehicles parked in unmarked spaces along the intersection approaches. This adds to the overall congestion around the intersection and creates additional sight obstructions.



View of Western Avenue looking east toward intersection. Photo shows students walking from the Henniker Community School to the Pharmacy (the current layout forces them to cross behind a parked car and into the parking lot).



View of the Gin-Gin parking lot looking west toward Western Avenue. Photo shows a parked car obstructing the crosswalk.

The following is a list of potential mitigation measures related to these issues:

### *Near-Term*

- 3.1.1 Conduct a parking study (or review recent study) to inventory the existing spaces and determine the number of parking spaces needed to serve the businesses adjacent to the intersection.
- 3.1.2 Better define the parking at businesses at the intersection and along Rush Road.
- 3.1.3 Eliminate parking spaces at the corner of the intersection to improve visibility of pedestrians and intersection sight distance. This should be based on the local ordinance or Uniform Vehicle Code (UVC), but common restrictions include:
  - No parking within 20 feet of a crosswalk at an intersection.
  - No parking within 30 feet upon the approach to any flashing signal, stop sign, yield sign, or traffic-control signal located at the side of a roadway.
- 3.1.4 Consider angled back-in parking in place of the current pull-in-back-out parking at the Pharmacy. There may be a need for a pilot study to test the feasibility and acceptance of the design. There are also concerns about the current lack of delineation on Western Avenue and the potential for drivers to back onto the sidewalk or into the structure of the Pharmacy. If angled back-in parking is pursued, there is a need to better channelize drivers on Western Avenue toward the center of the roadway and install some type of bollards along the back of the parking spaces to protect the sidewalk and building.

### *Intermediate*

- 3.1.5 Create an access management policy to support future decisions and requests for access permits. The following website provides a useful tool for visualizing the potential impacts of access points and related roadway characteristics: <http://teachamerica.com/cve/>.

### 3.2 Design and Location of Access Points

The design and location of access points have been shown to impact safety as well as the operational performance of an intersection. The RSA Team noted the following safety issues related to the design and location of access points near the intersection:

- Many of the businesses adjacent to the intersection have multiple access points. The number of potential conflicts is directly related to the number of access points, and conflicts increase as the number of access points increase.
- Many of the access points near the intersection are relatively wide. As the width of an access point increases, the exposure to pedestrians and bicyclists increases. Wide openings also allow vehicles to enter and exit at relatively high speeds compared to narrow access openings. Wide openings may promote undesirable parking maneuvers such as parking in the entrance to the business; the RSA Team observed this at the bank and the Gin-Gin restaurant.
- There are access points within the functional area of the intersection. The American Association of State Highway and Transportation Officials' (AASHTO's) *A Policy on Geometric Design of Highways and Streets* indicates that driveways should not be located within the functional area of an intersection, which includes the storage length for turn lanes and adequate maneuvering space to enter these lanes.



View of NH 114 looking south toward the intersection. Photo shows the wide access points for the Gin-Gin and Citizens Bank that are located in close proximity to the intersection.



View of NH 114 looking north from left-turn lane on Main Street. Photo shows the undefined parking lot at the Gin-Gin and how vehicles in the parking lot can limit sight distance for drivers on Main Street.

The following is a list of potential mitigation measures related to these issues:

#### *Near-Term*

- 3.2.1 Begin conversations with the Bank to redesign the parking, close one of the access points, and add parallel parking along the southbound approach of NH 114 if the adjacent access point is closed.

- 3.2.2 Begin conversations with the Gin-Gin to redesign the parking. There may be the potential to add parallel parking spaces along NH 114.

*Intermediate*

- 3.2.3 Consider eliminating the access point that is closest to the intersection on the east side of the northbound approach (driveway between the Marian B Towle and St. George buildings). This driveway currently operates as part of a one-way couplet where this driveway is one-way out and another nearby driveway is one-way in. The advantage of closing this driveway is that it will help to reduce potential conflicts with pedestrians and eliminate access points near the functional area of the intersection. The drawback is that the alternate access point that is currently one-way in is relatively narrow and steep.

## ISSUE 4: MAINTENANCE AND DRAINAGE ISSUES

### 4.1 Maintenance of Lighting

Lighting helps to improve visibility at night and has other potential benefits such as improved security. Intersection lighting helps to improve driver awareness of the presence of an intersection and helps to illuminate pedestrians within the intersection area. The RSA Team noted that the cobra head light closest to the intersection is not working. There are also several security-level lights throughout the area and the RSA Team noted two lights (one near the bank and another near the grange) that are not working because they are not connected to a power source.



View of intersection at night looking south from Citizen Bank parking lot. Photo shows the unlit lamp for the security-level light in the bank parking lot.



View of intersection looking east from Western Avenue toward Main Street. Photo shows the unlit cobra head light along Main Street.

The following is a list of potential mitigation measures related to these issues:

#### *Near-Term*

- 4.1.1 Replace the bulb in the cobra-head light at the intersection.
- 4.1.2 Connect the two security-level lights to a power source. One option is the power supply to the Grange.

## 4.2 Low Drop Inlets

Adequate drainage is critical to the surface friction of the road during wet-weather conditions. There appears to be adequate drainage near the intersection based on limited observations during wet-weather conditions and input from the RSA Team. There were, however, a few potential issues noted by the RSA Team, including the following:

- The gutters on the Pharmacy drain into the parking lot and crosswalks. There is the potential for this design to create icy conditions for pedestrians.
- The drop inlet near the bank is too low. This creates a potential hazard for bicyclists.
- Right-turn vehicles from Main Street to NH 114 are driving over the drop inlet in that corner and creating maintenance issues.



View of drainage system at Pharmacy. Photo shows how the down-spout drains into the parking lot.



View of Western Avenue looking north from the Pharmacy parking lot. Photo shows the rough condition of a catch basin.

The following is a list of potential mitigation measures related to these issues:

### *Near-Term*

- 4.2.1 Begin conversations with the Pharmacy to explain the potential safety and liability issues related to their current drainage design. The drainage could be rerouted to feed into the planters.

### *Intermediate*

- 4.2.2 Review the current condition of drainage structures and rehabilitate as necessary during the next repaving project.

## 4. Conclusions

---

There were four major safety issues identified during the RSA, including:

- Design of Pedestrian Facilities
- Design and Operation of Intersection
- Lack of Access Management
- Maintenance and Drainage Issues

Suggestions for improvements have been identified and are described in the report. The suggestions have been categorized as near-term, intermediate, and long-term improvements. Four alternatives were prepared based on the suggested improvements. Conceptual drawings for those alternatives are provided in Appendix B and corresponding cost estimates are provided in Appendix C. Appendix D provides a benefit-cost analysis for suggested intermediate and long-term improvements that are associated with crashes during the study period. Appendix E provides a complete summary of suggested improvements.

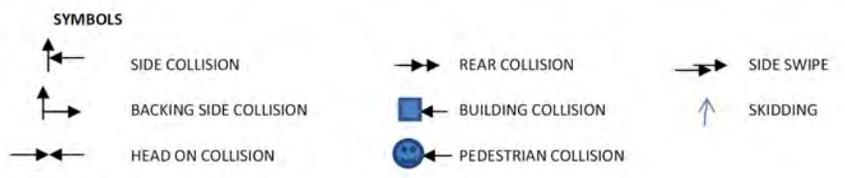
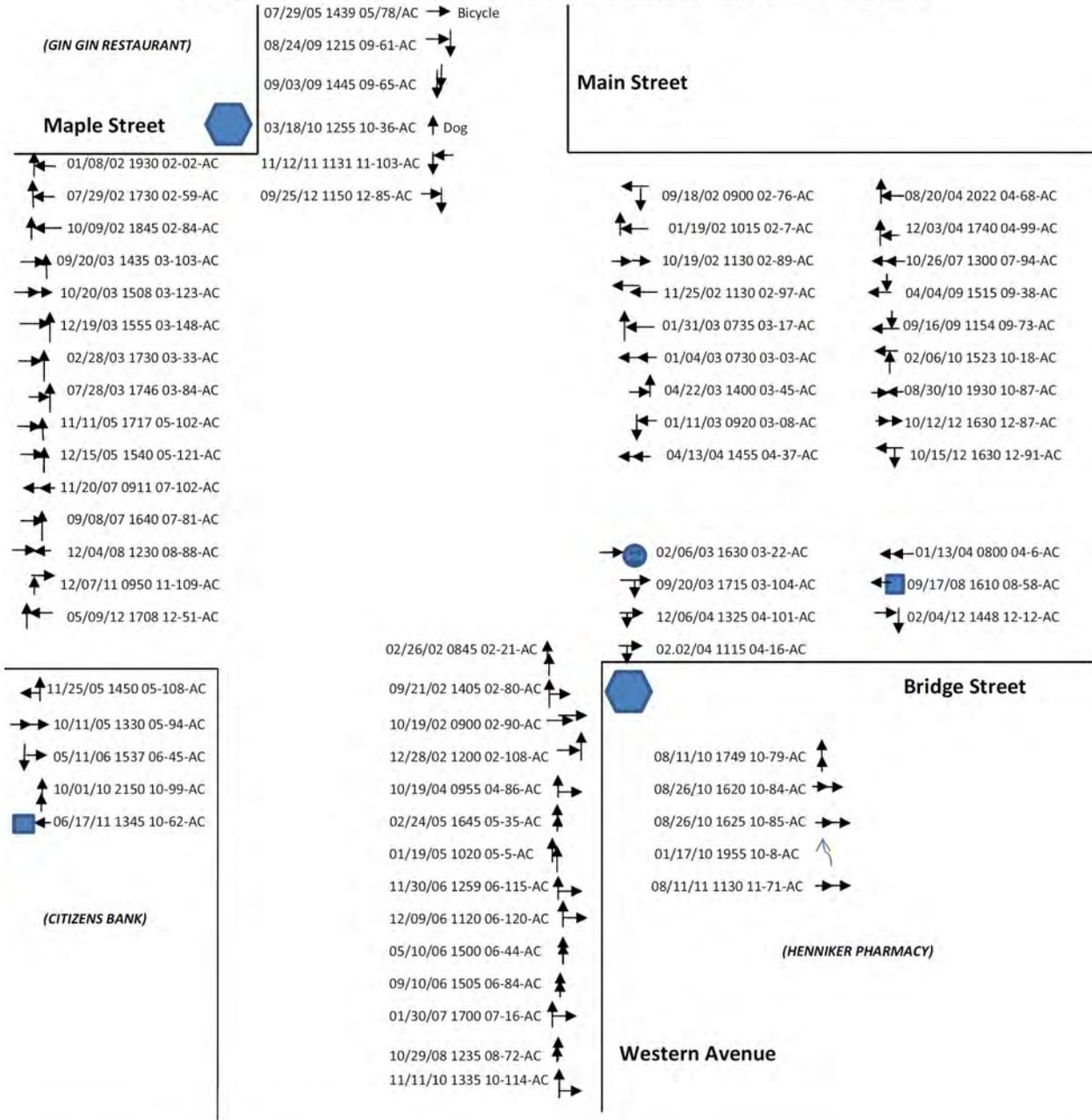
## 5. References

---

1. American Association of State Highway and Transportation Officials (AASHTO). *A Policy on the Geometric Design of Highways and Streets*, Washington, DC, 2004.
2. American Association of State Highway and Transportation Officials (AASHTO). *Highway Safety Manual, 1<sup>st</sup> Edition*, Washington, DC, 2010.
3. Council, F., Zaloshnja, E., Miller, T., and Persaud, B. *Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries*. Publication FHWA-HRT-05-051, Federal Highway Administration, McLean, VA, 2005. Available online at: <http://www.fhwa.dot.gov/publications/research/safety/05051/>.
4. Crash Modification Factors (CMF) Clearinghouse. Federal Highway Administration. Available online at: [www.cmfclearinghouse.org](http://www.cmfclearinghouse.org)
5. Federal Highway Administration, *Road Safety Audit Guidelines*, Report No. FHWA-SA-06-06, Washington, DC, 2006.
6. New Hampshire Department of Transportation (NHDOT). *Highway Safety Improvement Program Guidelines*, 2013.
7. New Hampshire Department of Transportation (NHDOT). *Weighted Average Unit Prices*, 2012.

# Appendix A: Crash Diagram

HENNIKER, NH Motor Vehicle Crash Analysis January 1, 2002 through November 12, 2012



## Appendix B: Conceptual Drawings

Conceptual drawings are included in Appendix B to help determine the feasibility of the RSA Team’s suggestions, and to estimate potential impacts and construction costs. Section 3: Assessment Findings provides a detailed discussion of the safety issues identified by the RSA team and potential mitigation strategies for each issue. The concepts can aid in visualizing these suggestions as well as the potential benefits and impacts.

### *Existing Conditions*

The existing conditions for NH 114 (Bridge Street), Main Street, and Western Avenue roadways are described in Section 2 of this report.

### *Design Criteria/Controls*

The following table presents the design criteria and controls assumed for the layout of the concepts.

<b>Design Speed</b>	30 mph, Posted Speed. As noted within the RSA report, Western Avenue is within a school zone and posted at 20 mph near the school.
<b>Typical Section</b>	All roadways: 11’ Travel Ways, 4’ Shoulders Roundabout: 100’ inscribed diameter (125’ typical for large vehicles) with 15’ circulatory roadway See Figures B.1, B.2, and B.3 for additional width information
<b>Landscaping</b>	Landscaping should be considered within the Concept 2 and 3 to address property impacts.
<b>Drainage &amp; Stormwater Treatment</b>	Concepts 1 and 2 drainage design would likely include connection into existing drainage systems. Concept 3 would require a greater effort to design and construct closed drainage systems and potentially water quality pre-treatment structures. Cost estimates have included the potential scope of drainage improvements. Drainage concerns were noted in Issue 4.2, which can be addressed with short term maintenance activities and within each of the Concepts provided.
<b>Environment</b>	No environmental review was conducted for the RSA or concept development.
<b>Right-of-Way</b>	Limited existing research was provided for the RSA and concept development. The NH 114 N leg was based on 1800’s 3-4 Rod (49.5’-66’) width, NH 114 S leg was based on the 1998 Bridge Street Project Plans, Main Street is 1800’s 4 Rod (66’) width, and Western Avenue is assumed to be prescriptive and from tax map information. Below are descriptions of potential right-of-way needs for each concept.  Concept 1 – Sidewalk Improvements <ul style="list-style-type: none"> <li>• Fee taking or permanent sidewalk easement along Western Ave, Main St. and NH 114 are needed for the sidewalks.</li> <li>• Temporary easements are needed for construction of the sidewalk and driveways for the project, and retaining walls on NH 114N and Western Ave.</li> <li>• Concept 1 does not impact the Western Ave. parking for the Pharmacy, but it does impact Pharmacy parking on NH 114. Some of this parking is within the right-of-way today and warrants further discussion.</li> </ul> Concept 2 – Streetscape Improvements <ul style="list-style-type: none"> <li>• Fee taking or permanent sidewalk easement along Western Ave, Main St. and NH 114 are needed for the sidewalks.</li> <li>• Temporary easements are needed for construction of the sidewalk and driveways for the project, and retaining walls on NH 114N and Western Ave.</li> <li>• Concept 2 maintains the Pharmacy parking, however places the sidewalk outside the existing ROW. A fee taking or permanent sidewalk easement is needed. Some of this parking is within the right-of-way today and warrants further discussion.</li> </ul>

	<p>Concept 3 – Roundabout Improvements</p> <p><b>Right-of-Way</b></p> <ul style="list-style-type: none"> <li>• Fee taking – two parcels at intersection. (Chen Henniker LLC, and Yi-Teng Investments LLC) The building / business on the Yi-Teng Investments LLC parcel will need to be removed. Relocation benefits will need to be considered for the Yi-Teng Investments LLC parcel.</li> <li>• Fee taking or permanent sidewalk easement along Western Avenue and NH 114 are needed for the sidewalks.</li> <li>• Temporary easements are needed for construction of the sidewalk and driveways for the project, and retaining walls on NH 114N and Western Avenue.</li> <li>• Similar to Concept 2, a fee taking or permanent sidewalk easement is needed for the sidewalk and parking along the Pharmacy frontage.</li> </ul> <p>Concept 4 – Grass Panel and Pavement Markings</p> <ul style="list-style-type: none"> <li>• Fee taking or a permanent easement along Main St. is needed for the grass panel construction.</li> </ul> <p>Additional notes; the project is located within the center of the Town of Henniker and New England College. Consideration is needed in each concept for the possible permanent or temporary relocation of business signs (Richardson Office Park, Citizens Bank and Coca-Cola sign), existing landscaping and personal property impacts. Furthermore, review of the existing flashing beacon and its easements may be required.</p>
<b>Traffic Control Plan (TCP)</b>	TCP was not evaluated for the RSA or concept development. However, the scope of Concepts 1 & 2 with curb line adjustments will accommodate existing traffic flows easier than Concept 3, which requires greater construction efforts with horizontal realignment and anticipated vertical alignment adjustments. A local roadway detour for this intersection was not evaluated; however, could be difficult to accommodate existing traffic and trucks.
<b>Utilities</b>	No utility review was conducted for the RSA or concept development. Aerial and underground utilities are present within this area, which would require greater efforts to accommodate Concept 3.
<b>Survey</b>	No survey was conducted for the RSA or concept development.
<b>Lighting</b>	Ornamental and street lighting is found within existing conditions and was noted as Issue 4.1 in the RSA report. Lighting design was not conducted for the RSA or concept development.
<b>Soils</b>	No geotechnical review was conducted for the RSA or concept development.
<b>Accidents</b>	See the RSA report and Appendix A for Crash data.
<b>Traffic</b>	Traffic information was received for the purpose of the RSA, however no analysis or review was performed to establish lane usage and layout for the RSA or concept development.
<b>Estimate</b>	See Appendix C for Conceptual Construction Costs.
<b>Funding</b>	Highway Safety Improvement Program Funding is considered for this project.
<b>Coordination with other Work</b>	The Town of Henniker has applied for Safe Routes to School Projects within the Town.

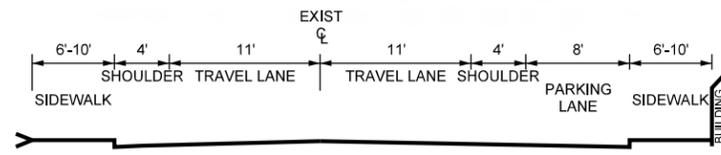
### *Conceptual Designs and Considerations*

As noted above, the alternatives provided are conceptual representations of mitigation strategies highlighted in Section 3. The concepts are two-dimensional sketches overlaid on aerial photography without horizontal and vertical alignments; therefore actual footprint could be different as design continues. The primary focus of the concepts is to address sidewalk connectivity and continuity, as well as addressing parking concerns and access management. The four concepts are presented below in Figures B.1 – B.4.

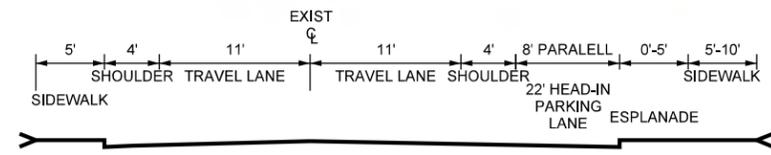
## B.1 Concept 1: Sidewalk Improvements, Intermediate/Long Term

Concept 1 involves the reconstruction of the sidewalk along NH 114 (Bridge Street) and a “road diet” along Western Avenue and Main Street. The road diet is achieved by reducing the pavement width, better defining existing sidewalks, and adding new sidewalks with vertical curb for separation of roadway and pedestrian facilities. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
NH 114 (Bridge Street)	Reconstruct sidewalk with curb north of Citizen Bank and add new sidewalk. Narrow curb return to reduce length of crosswalk.	Poor sidewalk condition with no curb or sidewalk along Citizen Bank frontage.	1.1, 1.2, 3.1, and 3.2.
	Redefine parking to create back-in parking along the Pharmacy.	Head-in/Back-out parking.	3.1
	Install stop or yield control for right-turn lane. Expand pedestrian refuge island by narrowing Main Street.	Uncontrolled right-turn slip-lane to Main Street.	1.2, 2.1, and 2.3
Western Avenue	Reduce pavement width by constructing bulb-outs and new sidewalk along the approach.	Wide cross-section and no sidewalks on north or south side between Town buildings and intersection.	1.1, 1.2, and 2.1 Addresses connectivity for north sidewalk; however, to preserve head-in parking at Pharmacy, pedestrians are forced to cross at the mid-block crossing to the west.
	Construct bulb-out on southwest corner.	Length of crosswalks and parking within the functional area of the intersection.	1.2, 2.1, and 3.1
	Add pavement markings to delineate the roadway near the intersection.	No pavement markings.	2.1 and 2.2
Main Street	Eliminate one lane (WB) and narrow cross-section by constructing new sidewalk.	Wide cross-section (3-lane section) and no sidewalk between Rush Road and NH 114 (along Gin-Gin parcel).	1.1, 1.2, 2.1, and 3.2



NH 114



WESTERN AVE / MAIN ST

**VHB** Vanasse Hangen Brustlin, Inc.

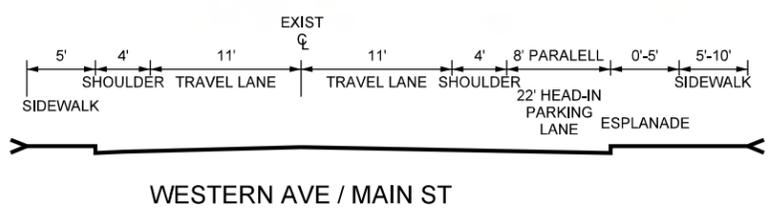
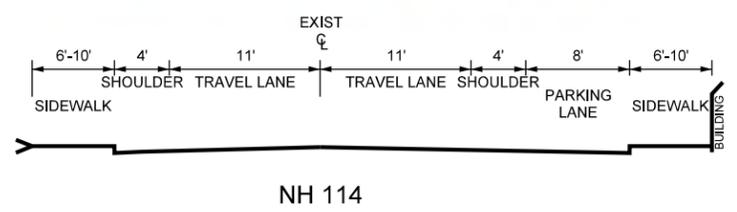
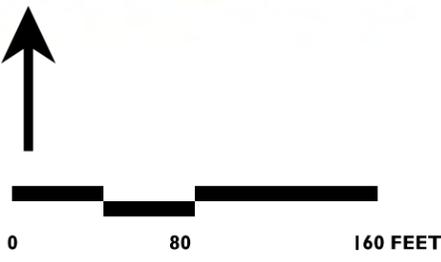
**Figure B.1**  
**Alternative 1**

Henniker, NH

## B.2 Concept 2: Streetscape Improvements, Intermediate/Long Term

Concept 2 incorporates the elements of Concept 1 with the addition of a landscaped sidewalk along the Pharmacy parcel to address parking concerns and improve sidewalk connectivity along the south side of Western Avenue. In addition, the width of the NH 114 northbound approach is reduced with new curb and sidewalk on the southeast corner to enhance existing pedestrian accommodations while allowing for larger vehicle movements to Main Street. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
NH 114 (Bridge Street)	Narrow cross-section on the NH 114 northbound approach and provide stop or yield control for right-turn lane.	Wide cross-section and uncontrolled right-turn slip-lane to Main Street.	1.2, 2.1, 2.3 There was a suggestion to eliminate the right-turn slip-lane; however, this would create issues for larger vehicle movements.
Western Avenue	Construct a landscaped sidewalk and curbed head-in parking along the north side of the Pharmacy.	Lack of connectivity for pedestrians along the south side of Western Avenue.	1.1, 1.2, 2.1, 3.1 Addresses the connectivity issue that is not addressed in Concept 1. Fee acquisition or permanent easements as well as maintenance agreements will be needed for landscaping.
Main Street	Narrow cross-section by expanding sidewalk and installing bulb-outs along south side of Main Street.	Wide cross-section and length of crosswalks.	1.1, 1.2, 2.1, and 2.2
Rush Road	Curb and sidewalk improvements along Rush Road.	Lack of continuity and connectivity.	1.1



**VHB** Vanasse Hangen Brustlin, Inc.

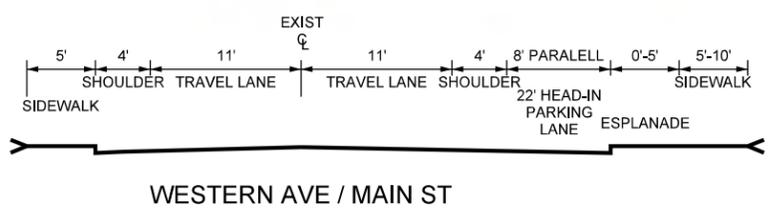
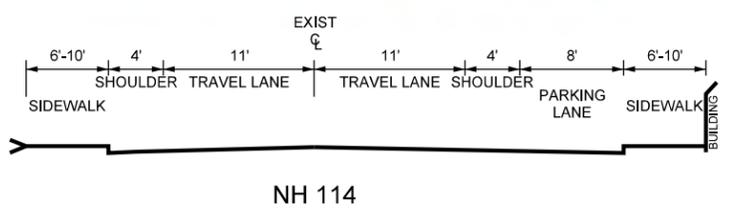
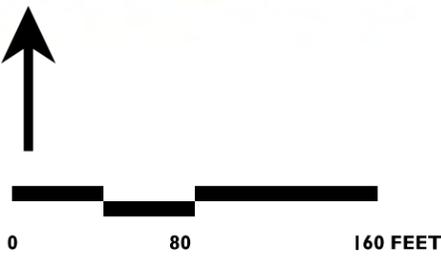
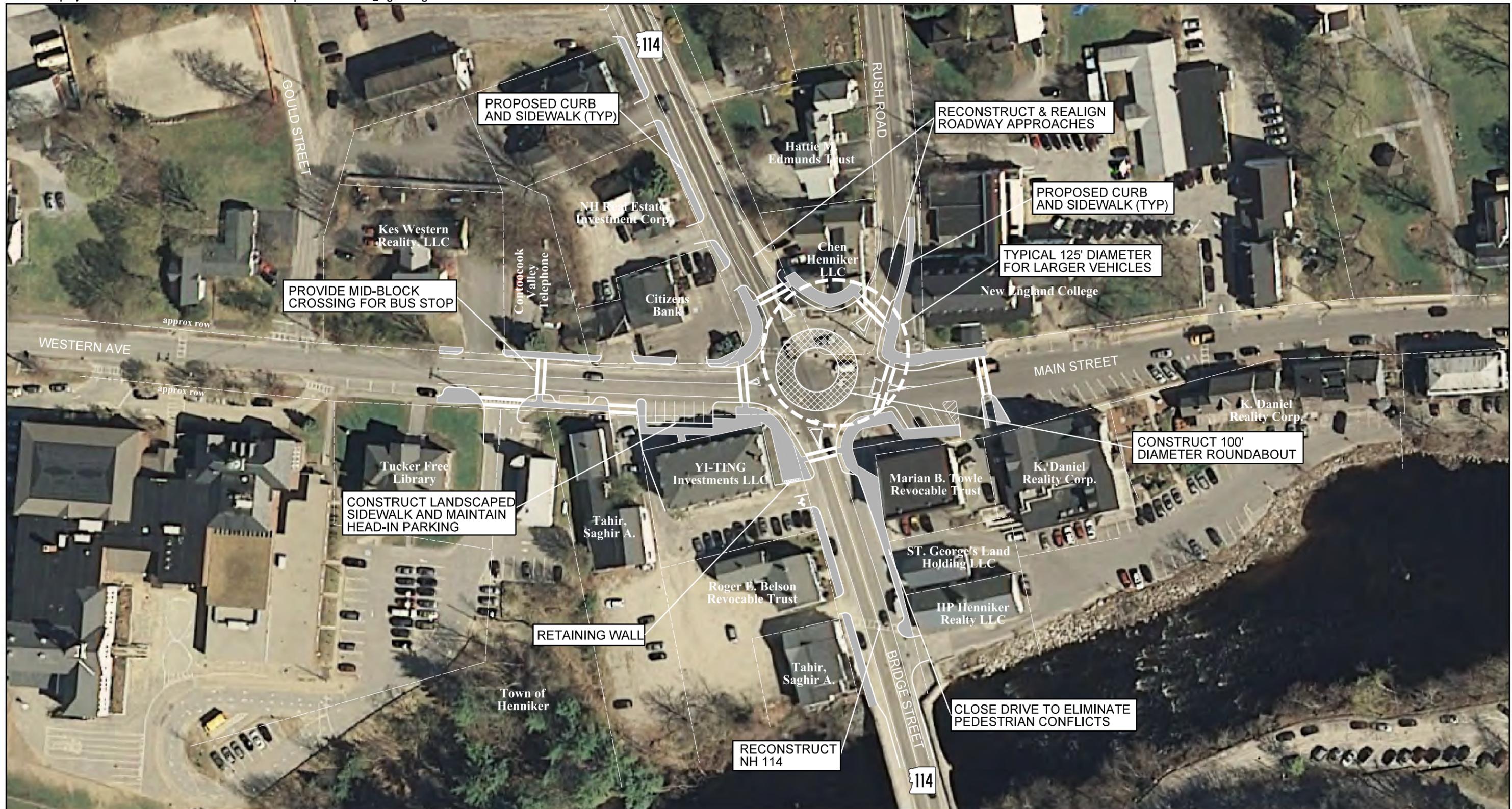
**Figure B.2**  
**Alternative 2**

Henniker, NH

### B.3 Concept 3: Roundabout Improvements, Long Term

Concept 3 incorporates the elements of Concept 2 with the addition of a roundabout. The roundabout helps to address intersection skew and roadway alignment concerns, driver behavior and speed issues, and lane use issues. A roundabout is a major long-term project that requires fee acquisition of one parcel (Gin-Gin Restaurant) and permanent impacts for sidewalk and parking on the Pharmacy parcel. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
NH 114 (Bridge Street)	Realignment to reduce speeds and align with the layout of the roundabout.	Speeds on southbound approach of NH 114 and intersection alignment.	2.3, 2.4, 2.5, 3.1, and 3.2
Intersection	Construct roundabout.	Wide cross-section, length of crosswalks, uncontrolled right-turn slip-lane to Main Street, intersection skew, speed on southbound approach, and on-street parking within functional area of intersection.	1.1, 1.2, 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, and 3.2 It is anticipated that the southbound approach of NH 114 will need to be vertically adjusted, increasing costs and property impacts. Roundabout will eliminate on-street parking along NH 114 at the Pharmacy.
Main Street	Reduce pavement width and realignment to match layout of the roundabout.	Wide cross-section (3-lane section) and driver behavior (gap acceptance).	1.2, 2.1, 2.4
Rush Road	Realignment to match the layout of the Roundabout.	Parking along Rush Road.	3.1, 3.2 Requires fee acquisition of the Gin-Gin Restaurant.



**VHB** Vanasse Hangen Brustlin, Inc.

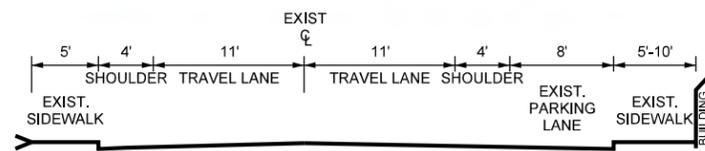
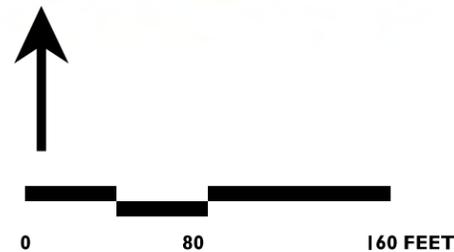
**Figure B.3**  
**Alternative 3**

Henniker, NH

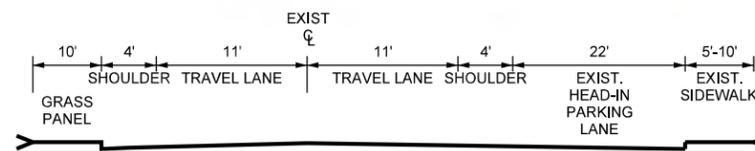
#### B.4 Concept 4: Grass Panel and Pavement Markings, Intermediate

Concept 4 incorporates the “road diet” concept along Main Street. A road diet is achieved by reducing the pavement width on Main Street, eliminating the right-turn lane, and creating a raised grass panel with vertical curb adjacent to the Gin-Gin Restaurant parcel. The following table provides a summary of the proposed strategies, safety concerns, and related issues from Section 3.

Roadway	Proposed Strategies	Safety Concerns	Related Issues/Notes
NH 114 (Bridge Street)	Delineate travel lanes with new pavement markings.	Intersection skew and poor lane alignment through intersection of Main Street and Western Ave.	2.1, 2.4
	Install stop or yield control for right-turn lane. Expand pedestrian refuge island by narrowing Main Street.	Uncontrolled right-turn slip-lane to Main Street.	2.3
Main Street	Eliminate one lane (WB) and narrow cross-section by constructing new grass panel.	Wide cross-section (3-lane section).	2.1



NH 114



MAIN ST

**VHB** Vanasse Hangen Brustlin, Inc.

**Figure B.4**  
**Alternative 4**

Henniker, NH

## Appendix C: Conceptual Cost Estimates

Conceptual cost estimates are provided for each of the three concepts. NHDOT's Weighted Average Unit Costs were used to establish project unit costs and quantities calculations were performed for the major items in each concept.

The following assumptions were made in the development of cost estimates for each concept:

### Concept 1:

1. No major reconstruction of pavement structure. Construction includes saw cut and curb/sidewalk construction with final wearing course (inlay/overlay) for construction limits.
2. Sidewalk Construction – 2” bituminous sidewalk and 6” crushed gravel. Concrete Sidewalk to meet ADA and construct curbed ramps was a percentage of the sidewalk cost.

### Concept 2:

1. No major reconstruction of pavement structure. Construction includes saw cut and curb/sidewalk construction with a final wearing course (inlay/overlay) for the construction limits.
2. Sidewalk Construction – 2” bituminous sidewalk and 6” crushed gravel. Concrete Sidewalk to meet ADA and construct curbed ramps was a percentage of the sidewalk cost.

### Concept 3:

1. Full box reconstruction for realignment of each roadway leg; Full pavement structure includes 6” pavement, 8” crushed gravel, 8” gravel, & 8” sand.
2. Beyond the realigned roadway segments construction consists of pavement inlay/overlay and sidewalk construction similar to Concepts 1 & 2.
3. Roundabout construction (lump sum) includes landscaping, curbing, truck apron, and islands.

### Concept 4:

1. No major reconstruction of pavement structure. Construction includes saw cut and curb/grass panel construction with a hand method pavement for the grass panel construction limits.
2. Remove conflicting existing pavement markings and re-stripe intersection. Add yield control signage for right-turn NH 114 North to Main Street.

The following table provides a summary of Construction Costs, which are detailed in the following sections. NHDOT will review and provide Right-of-Way and Preliminary Engineering Costs:

Cost Components	<u>Concept 1</u>	<u>Concept 2</u>	<u>Concept 3</u>	<u>Concept 4</u>
Conceptual Construction Cost	\$123,000	\$320,000	\$1,100,00	\$15,000
Right-of-Way				
Preliminary Engineering				
Total	TBD	TBD	TBD	TBD

## C.1 Concept 1: Sidewalk Improvements

CONSTRUCTION COST ESTIMATE						
PROJECT : NH 114 at Main Street		DATE PREPARED: 6/25/2013			<b>Henniker RSA</b> <b>NH 114 at Main Street</b>  <b>Alternative 1 - Sidewalk Improvements</b> <b>(Short/Near Term)</b>	
LOCATION : Henniker, NH		ESTIMATED BY: JMA				
STATE PROJECT NO.		CHECKED BY: MLG				
FEDERAL PROJECT NO.		ESTIMATE TYPE: Conceptual Cost Estimate				
ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
<b>MATERIAL ITEMS (ROADWAY)</b>						
1	201.1 CLEARING AND GRUBBING (F)	A		\$8,000	0.00	\$0
2	203.1 COMMON EXCAVATION	CY		\$8	490	\$3,920
2.1	203.2 ROCK EXCAVATION	CY	ASSUME 5% OF COMMON EXCAVATION	\$30	25	\$735
2.2	203.6 EMBANKMENT-IN-PLACE (F)	CY	ASSUME 5% OF COMMON EXCAVATION	\$10	25	\$245
2.4	206.1 COMMON STRUCTURE EXCAVATION					
2.5	206.19 COMMON STRUCTURE EXCAVATION EXPLORATORY					
2.6	206.2 ROCK STRUCTURE EXCAVATION	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			\$698
2.7	207.3 UNCLASSIFIED CHANNEL EXCAVATION					
3	304.1 SAND	CY		\$19	0	\$0
3	304.2 GRAVEL (F)	CY		\$23	0	\$0
3	304.3 CRUSHED GRAVEL (F)	CY		\$25	20	\$500
4	403.1105 HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON		\$70	0	\$0
4	403.12 HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	10% OF HBP MACH. COST	\$100	120	\$12,000
4	403.99 TEMPORARY BITUMINOUS PAVEMENT	TON	0% OF MACHINE METHOD QUANTITY	\$60	0	\$0
4	411.43 PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON		\$70	0	\$0
4	417 COLD PLANING BITUMINOUS SURFACES (F)	SY		\$5	0	\$0
5	417.412 RUMBLE STRIPS, 12" WIDE	LF		\$5	0	\$0
6	606.14 BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF		\$18	0	\$0
6	606.141 BEAM GUARDRAIL (CURVED W/ CRT POSTS)					
6	606.1452 BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			\$0
6	606.147 BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
6	606.84 ANCHOR FOR CURVED GUARD- RAIL W/ CRT POSTS					
7	608.12 2" BITUMINOUS SIDEWALK	SY		\$13	700	\$9,100
8	608.24 CONCRETE SIDEWALK (F)	SY		\$40	120	\$4,800
8	609.01 STRAIGHT GRANITE CURB	LF		\$17	1270	\$21,590
8	609.02 CURVED GRANITE CURB	LF	5% OF STRAIGHT CURB QUANTITY	\$30	64	\$1,920
8.1	609.21 STRAIGHT GRANITE SLOPE CURB	LF		\$13	0	\$0
8.2	609.811 BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY	\$5	0	\$0
8.3	609.5 RESET GRANITE CURB	LF	10% OF TOTAL GRANITE CURB QUANTITY	\$7	133	\$933
9	628.2 SAWED BITUMINOUS PAVEMENT	LF	LENGTH OF CURB	\$2	1467	\$2,934
10	214 FINE GRADING	LS	20% OF TOTAL SUB BASE COST			\$100
<b>SUBTOTAL A</b>						<b>\$57,555</b>
<b>MISCELLANEOUS ITEMS (ROADWAY)</b> (SAMPLE ITEMS BELOW)						
12	FILL ABANDONED PIPE	CY				
12	CLEARING FOR FENCE LINES (F)	A				
12	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
12	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
12	REMOVAL OF GUARDRAIL (F)	LF				
12	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
12	Geotextile fabrics	SY				
12	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
12	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
12	DROP INLET SEDIMENT TRAP OUTLET	EA				
12	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
12	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
12	CONCRETE STAIRS	U				
12	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
12	DELINEATORS WITH POST	EA	USE 10% OF SUBTOTAL "A" COST			
12	STEEL WITNESS MARKERS, BOUNDS	EA				
12	SAWED PAVEMENT	LF				
12	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
12	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
12	LOAM & HUMAS	CY				
12	FERTILIZER	TON				
12	GRASS SEED, TYPE 82	LB				
12	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
12	TURF ESTABLISHMENT	SY				
12	BARK MULCH MATERIAL	CY				
12	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	\$				
12	FIELD OFFICE TYPE & LAB	MON				
12	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
<b>MISCELLANEOUS COST SUBTOTAL</b>						<b>\$5,756</b>
<b>SUBTOTAL B</b>						<b>\$63,311</b>
<b>DRAINAGE COSTS</b> (SAMPLE ITEMS BELOW)						
13	STONE FILL, CLASS B,C,D	CY				
13	PIPE	LF				
13	STEEL END SECTIONS	EA				
13	CATCH BASINS	U				
13	DRAINAGE MANHOLES	U				
13	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	CONSIDER			
13	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	10% RECONST NON URBAN			
13	UNDERDRAIN FLUSHING BASINS	EA	15% NEW NON URBAN			
13	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	20% FULL DEPTH RECONSTRUCT URBAN			
13	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF	20% NEW URBAN			
13	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF	25% COMPLEX URBAN			
<b>DRAINAGE COST SUBTOTAL</b>						<b>\$3,165.55</b>
<b>SUBTOTAL C</b>						<b>\$66,476</b>
<b>PERMANENT TRAFFIC CONTROL</b> (SAMPLE ITEMS BELOW)						
13.1	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE \$600/LF	\$600	0	\$0
13.1	OVERHEAD SIGN STRUCTURES SPAN	EA	USE \$800/LF	\$800	0	\$0
60	TRAFFIC SIGNALS	EA	USE \$150K/ INTERSECTION	\$150,000	0	\$0
60	TRAFFIC SIGNAL COORDINATION	EA	USE \$50K/ ADDITIONAL INTERSECTION	\$50,000	0	\$0
65	LIGHT POLES AND BASES ( est 2/300 feet)	EA	USE \$4500/ POLE	\$4,500	0	\$0
<b>PERMANENT TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$0</b>
<b>SUBTOTAL D</b>						<b>\$66,476</b>
<b>TEMPORARY TRAFFIC CONTROL</b> (SAMPLE ITEMS BELOW)						
70	UNIFORMED OFFICERS WITH VEHICLE		USE 1.5 TIMES MAINT OF TRAFFIC COST			\$6,000
71	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			\$1,800
73	MAINTENANCE OF TRAFFIC	UNIT		\$4,000	1	\$4,000
74	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	USE 5% OF SUBTOTAL D	\$20	0	\$0
<b>MISCELLANEOUS TRAFFIC CONTROL</b>						
75	PORTABLE CHANGEABLE MESSAGE SIGN-					
75	TRAILER-MOUNTED SPEED LIMIT SIGN					
75	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 55% OF MAINTENANCE OF TRAFFIC			\$2,200
75	IMPACT ATTENUATION DEVICE					
<b>MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL</b>						<b>\$2,200</b>
<b>TEMPORARY TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$14,000</b>
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL</b>						
80	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
80	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
80	SILT FENCE	LF				
80	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U	USE 30% OF DRAINAGE COST			\$950
80	MONITORING EROSION AND SEDIMENT CONTROL	HR				
80	TEMPORARY PROJECT WATER POLLUTION CONTROL	\$				
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL SUBTOTAL</b>						<b>\$950</b>
<b>SUBTOTAL E</b>						<b>\$81,426</b>
<b>ADDITIONAL ITEMS OF CONSIDERATION</b>						
20	ITS			\$0	0	\$0
30	RETAINING WALLS	SF	USE \$50/SF	\$50	0	\$0
30	SOUND WALL	SF	USE \$25 /SF	\$25	0	\$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 10% OF SUBTOTAL E			\$8,143
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	\$100,000	0	\$0
	LANDSCAPING		ASSUME \$20.65/LF	\$20.65	390	\$6,195
	UTILITY ADJUSTMENTS		ASSUME \$1000/LF	\$0	0	\$0
	STRUCTURES			\$0	0	\$0
<b>ADDITIONAL ITEMS COST SUBTOTAL</b>						<b>\$14,338</b>
<b>SUBTOTAL F</b>						<b>\$95,764</b>
<b>MOBILIZATION</b>						<b>\$7,661</b>
<b>CONTINGENCIES</b>						<b>\$9,576</b>
<b>CONSTRUCTION SUBTOTAL</b>						<b>\$113,001</b>
<b>CONSTRUCTION ENGINEERING</b>						<b>\$9,040</b>
<b>CONSTRUCTION TOTAL</b>						<b>\$123,000</b>

**C.2 Concept 2: Streetscape Improvements**

CONSTRUCTION COST ESTIMATE						
PROJECT : NH 114 at Main Street		DATE PREPARED: 6/25/2013			<b>Henniker RSA</b> <b>NH 114 at Main Street</b> <b>Alternative 2 - Intersection and Streetscape Improvements (Mid/Long Term)</b>	
LOCATION : Henniker, NH		ESTIMATED BY: JMA				
STATE PROJECT NO.		CHECKED BY: MLG				
FEDERAL PROJECT NO.						
ESTIMATE TYPE: Conceptual Cost Estimate						
ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
<b>MATERIAL ITEMS (ROADWAY)</b>						
1	201.1 CLEARING AND GRUBBING (F)	A		\$8,000	0.00	\$0
2	203.1 COMMON EXCAVATION	CY		\$8	830	\$6,640
2.1	203.2 ROCK EXCAVATION	CY	ASSUME 5% OF COMMON EXCAVATION	\$30	42	\$1,245
2.2	203.6 EMBANKMENT-IN-PLACE (F)	CY	ASSUME 5% OF COMMON EXCAVATION	\$10	42	\$415
2.4	206.1 COMMON STRUCTURE EXCAVATION					
2.5	206.19 COMMON STRUCTURE EXCAVATION EXPLORATORY					
2.6	206.2 ROCK STRUCTURE EXCAVATION	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			\$1,183
2.7	207.3 UNCLASSIFIED CHANNEL EXCAVATION					
3	304.1 SAND	CY		\$19	0	\$0
3	304.2 GRAVEL (F)	CY		\$23	0	\$0
3	304.3 CRUSHED GRAVEL (F)	CY		\$25	40	\$1,000
4	403.1105 HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON		\$70	660	\$46,200
4	403.12 HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	10% OF HBP MACH. COST			\$4,620
4	403.99 TEMPORARY BITUMINOUS PAVEMENT	TON	0% OF MACHINE METHOD QUANTITY	\$60	0	\$0
4	411.43 PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON		\$70	0	\$0
4	417 COLD PLANING BITUMINOUS SURFACES (F)	SY		\$5	300	\$1,500
5	417.412 RUMBLE STRIPS, 12" WIDE	LF		\$5	0	\$0
6	606.14 BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF		\$18	0	\$0
6	606.141 BEAM GUARDRAIL (CURVED W/ CRT POSTS)					
6	606.1452 BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			\$0
6	606.147 BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
6	606.84 ANCHOR FOR CURVED GUARD- RAIL W/ CRT POSTS					
7	608.12 2" BITUMINOUS SIDEWALK	SY		\$13	1440	\$18,720
8	608.24 CONCRETE SIDEWALK (F)	SY		\$40	300	\$12,000
8	609.01 STRAIGHT GRANITE CURB	LF		\$17	2280	\$38,760
8	609.02 CURVED GRANITE CURB	LF	5% OF STRAIGHT CURB QUANTITY	\$30	114	\$3,420
8.1	609.21 STRAIGHT GRANITE SLOPE CURB	LF		\$13	0	\$0
8.2	609.811 BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY	\$5	0	\$0
8.3	609.5 RESET GRANITE CURB	LF	10% OF TOTAL GRANITE CURB QUANTITY	\$7	239	\$1,676
9	628.2 SAWED BITUMINOUS PAVEMENT	LF	SUBSIDIARY TO PAVEMENT OVERLAY			\$0
10	214 FINE GRADING	LS	20% OF TOTAL SUB BASE COST			\$200
<b>SUBTOTAL A</b>						<b>\$134,159</b>
<b>MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)</b>						
12	FILL ABANDONED PIPE	CY				
12	CLEARING FOR FENCE LINES (F)	A				
12	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
12	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
12	REMOVAL OF GUARDRAIL (F)	LF				
12	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
12	Geotextile fabrics	SY				
12	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
12	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
12	DROP INLET SEDIMENT TRAP OUTLET	EA				
12	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
12	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
12	CONCRETE STAIRS	U				
12	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
12	DELINEATORS WITH POST	EA	USE 10% OF SUBTOTAL "A" COST			
12	STEEL WITNESS MARKERS, BOUNDS	EA				
12	SAWED PAVEMENT	LF				
12	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
12	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
12	LOAM & HUMAS	CY				
12	FERTILIZER	TON				
12	GRASS SEED, TYPE 82	LB				
12	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
12	TURF ESTABLISHMENT	SY				
12	BARK MULCH MATERIAL	CY				
12	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	\$				
12	FIELD OFFICE TYPE & LAB	MON				
12	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
12	MISCELLANEOUS COST SUBTOTAL					\$13,416
<b>SUBTOTAL B</b>						<b>\$147,574</b>
<b>DRAINAGE COSTS (SAMPLE ITEMS BELOW)</b>						
13	STONE FILL, CLASS B,C,D	CY				
13	PIPE	LF				
13	STEEL END SECTIONS	EA				
13	CATCH BASINS	U				
13	DRAINAGE MANHOLES	U				
13	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	CONSIDER			
13	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA	10% RECONST NON URBAN			
13	UNDERDRAIN FLUSHING BASINS	EA	15% NEW NON URBAN			
13	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF	20% FULL DEPTH RECONSTRUCT URBAN			
13	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF	20% NEW URBAN			
13	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF	25% COMPLEX URBAN			
13	DRAINAGE COST SUBTOTAL					\$22,136.16
<b>SUBTOTAL C</b>						<b>\$169,711</b>
<b>PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
13.1	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE \$600/LF	\$600	0	\$0
13.1	OVERHEAD SIGN STRUCTURES SPAN	EA	USE \$800/LF	\$800	0	\$0
60	TRAFFIC SIGNALS	EA	USE \$150K/ INTERSECTION	\$150,000	0	\$0
60	TRAFFIC SIGNAL COORDINATION	EA	USE \$50K/ ADDITIONAL INTERSECTION	\$50,000	0	\$0
65	LIGHT POLES AND BASES ( est 2/300 feet)	EA	USE \$4500/ POLE	\$4,500	0	\$0
<b>PERMANENT TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$0</b>
<b>SUBTOTAL D</b>						<b>\$169,711</b>
<b>TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
70	UNIFORMED OFFICERS WITH VEHICLE		USE 1.5 TIMES MAINT OF TRAFFIC COST			\$13,500
71	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			\$4,050
73	MAINTENANCE OF TRAFFIC	UNIT		\$9,000	1	\$9,000
74	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	USE 5% OF SUBTOTAL D	\$20	0	\$0
<b>MISCELLANEOUS TRAFFIC CONTROL</b>						
75	PORTABLE CHANGEABLE MESSAGE SIGN-					
75	TRAILER-MOUNTED SPEED LIMIT SIGN					
75	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 55% OF MAINTENANCE OF TRAFFIC			\$4,950
75	IMPACT ATTENUATION DEVICE					
<b>MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL</b>						<b>\$4,950</b>
<b>TEMPORARY TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$31,500</b>
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL</b>						
80	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
80	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
80	SILT FENCE	LF				
80	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U	USE 30% OF DRAINAGE COST			\$6,641
80	MONITORING EROSION AND SEDIMENT CONTROL	HR				
80	TEMPORARY PROJECT WATER POLLUTION CONTROL	\$				
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL SUBTOTAL</b>						<b>\$6,641</b>
<b>SUBTOTAL E</b>						<b>\$207,851</b>
<b>ADDITIONAL ITEMS OF CONSIDERATION</b>						
20	ITS			\$0	0	\$0
30	RETAINING WALLS	SF	USE \$50/SF	\$50	0	\$0
30	SOUND WALL	SF	USE \$25 /SF	\$25	0	\$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 10% OF SUBTOTAL E			\$20,785
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	\$100,000	0	\$0
	LANDSCAPING		ASSUME \$20.65/LF	\$20.65	895	\$16,623
	UTILITY ADJUSTMENTS		ASSUME \$1000/LF	\$0	0	\$0
	STRUCTURES			\$0	0	\$0
<b>ADDITIONAL ITEMS COST SUBTOTAL</b>						<b>\$37,408</b>
<b>SUBTOTAL F</b>						<b>\$245,260</b>
<b>MOBILIZATION</b>						<b>\$19,621</b>
<b>CONTINGENCIES</b>						<b>\$24,526</b>
<b>CONSTRUCTION SUBTOTAL</b>						<b>\$289,407</b>
<b>CONSTRUCTION ENGINEERING</b>						<b>\$23,153</b>
<b>CONSTRUCTION TOTAL</b>						<b>\$320,000</b>

### C.3 Concept 3: Roundabout Improvements

CONSTRUCTION COST ESTIMATE						
PROJECT : NH 114 at Main Street		DATE PREPARED: 6/25/2013			<b>Henniker RSA</b> <b>NH 114 at Main Street</b> <b>Alternative 3 - - Roundabout and Streetscape Improvements (Mid/Long Term)</b>	
LOCATION : Henniker, NH		ESTIMATED BY: JMA				
STATE PROJECT NO.		CHECKED BY: MLG				
FEDERAL PROJECT NO.						
ESTIMATE TYPE: Conceptual Cost Estimate						
ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
<b>MATERIAL ITEMS (ROADWAY)</b>						
1	201.1 CLEARING AND GRUBBING (F)	A		\$8,000	0.00	\$0
2	203.1 COMMON EXCAVATION	CY		\$8	3760	\$30,080
2.1	203.2 ROCK EXCAVATION	CY	ASSUME 5% OF COMMON EXCAVATION	\$30	188	\$5,640
2.2	203.6 EMBANKMENT-IN-PLACE (F)	CY	ASSUME 5% OF COMMON EXCAVATION	\$10	188	\$1,880
2.4	206.1 COMMON STRUCTURE EXCAVATION					
2.5	206.19 COMMON STRUCTURE EXCAVATION EXPLORATORY					
2.6	206.2 ROCK STRUCTURE EXCAVATION	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			\$5,358
2.7	207.3 UNCLASSIFIED CHANNEL EXCAVATION					
3	304.1 SAND	CY		\$19	580	\$11,020
3	304.2 GRAVEL (F)	CY		\$23	930	\$21,390
3	304.3 CRUSHED GRAVEL (F)	CY		\$25	1070	\$26,750
4	403.1105 HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON		\$70	1660	\$116,200
4	403.12 HOT BITUMINOUS PAVEMENT, HAND METHOD	TON	10% OF HBP MACH. COST			\$11,620
4	403.99 TEMPORARY BITUMINOUS PAVEMENT	TON	0% OF MACHINE METHOD QUANTITY	\$60	0	\$0
4	411.43 PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON		\$70	0	\$0
4	417 COLD PLANING BITUMINOUS SURFACES (F)	SY		\$10	300	\$3,000
5	417.412 RUMBLE STRIPS, 12" WIDE	LF		\$5	0	\$0
6	606.14 BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF		\$18	0	\$0
6	606.141 BEAM GUARDRAIL (CURVED W/CR POSTS)					
6	606.1452 BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			\$0
6	606.147 BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
6	606.84 ANCHOR FOR CURVED GUARD- RAIL W/CR POSTS					
7	608.12 2" BITUMINOUS SIDEWALK	SY		\$13	1860	\$24,180
8	608.24 CONCRETE SIDEWALK (F)	SY		\$40	280	\$11,200
8	609.01 STRAIGHT GRANITE CURB	LF		\$17	2820	\$47,940
8	609.02 CURVED GRANITE CURB	LF	5% OF STRAIGHT CURB QUANTITY	\$30	141	\$4,230
8.1	609.21 STRAIGHT GRANITE SLOPE CURB	LF		\$13	370	\$4,810
8.2	609.811 BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY	\$5	0	\$0
8.3	609.5 RESET GRANITE CURB	LF	10% OF TOTAL GRANITE CURB QUANTITY	\$7	333	\$2,332
9	628.2 SAWED BITUMINOUS PAVEMENT	LF	SUBSIDIARY TO PAVEMENT OVERLAY			\$0
10	214 FINE GRADING	LS	20% OF TOTAL SUB BASE COST			\$11,832
<b>SUBTOTAL A</b>						<b>\$335,232</b>
<b>MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)</b>						
12	FILL ABANDONED PIPE	CY				
12	CLEARING FOR FENCE LINES (F)	A				
12	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
12	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
12	REMOVAL OF GUARDRAIL (F)	LF				
12	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
12	Geotextile fabrics	SY				
12	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
12	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
12	DROP INLET SEDIMENT TRAP OUTLET	EA				
12	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
12	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
12	CONCRETE STAIRS	U				
12	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
12	DELINEATORS WITH POST	EA	USE 10% OF SUBTOTAL "A" COST			
12	STEEL WITNESS MARKERS, BOUNDS	EA				
12	SAWED PAVEMENT	LF				
12	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
12	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
12	LOAM & HUMAS	CY				
12	FERTILIZER	TON				
12	GRASS SEED, TYPE 82	LB				
12	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
12	TURF ESTABLISHMENT	SY				
12	BARK MULCH MATERIAL	CY				
12	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	\$				
12	FIELD OFFICE TYPE & LAB	MON				
12	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
12	MICELLANEOUS COST SUBTOTAL					\$33,523
<b>SUBTOTAL B</b>						<b>\$368,755</b>
<b>DRAINAGE COSTS (SAMPLE ITEMS BELOW)</b>						
13	STONE FILL, CLASS B,C,D	CY				
13	PIPE	LF				
13	STEEL END SECTIONS	EA				
13	CATCH BASINS	U				
13	DRAINAGE MANHOLES	U				
13	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF	CONSIDER 10% RECONST NON URBAN 15% NEW NON URBAN 20% FULL DEPTH RECONSTRUCT URBAN 20% NEW URBAN 25% COMPLEX URBAN			
13	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA				
13	UNDERDRAIN FLUSHING BASINS	EA				
13	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF				
13	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
13	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
<b>DRAINAGE COST SUBTOTAL</b>						<b>\$55,313.23</b>
<b>SUBTOTAL C</b>						<b>\$424,068</b>
<b>PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
13.1	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE \$600/LF	\$600	0	\$0
13.1	OVERHEAD SIGN STRUCTURES SPAN	EA	USE \$800/LF	\$800	0	\$0
60	TRAFFIC SIGNALS	EA	USE \$150K/ INTERSECTION	\$150,000	0	\$0
60	TRAFFIC SIGNAL COORDINATION	EA	USE \$50K/ ADDITIONAL INTERSECTION	\$50,000	0	\$0
65	LIGHT POLES AND BASES ( est 2/300 feet)	EA	USE \$4500/ POLE	\$4,500	0	\$0
<b>PERMANENT TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$0</b>
<b>SUBTOTAL D</b>						<b>\$424,068</b>
<b>TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
70	UNIFORMED OFFICERS WITH VEHICLE		USE 1.5 TIMES MAINT OF TRAFFIC COST			\$31,950
71	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			\$9,585
73	MAINTENANCE OF TRAFFIC	UNIT		\$21,300	1	\$21,300
74	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	USE 5% OF SUBTOTAL D	\$20	0	\$0
<b>MISCELLANEOUS TRAFFIC CONTROL</b>						
75	PORTABLE CHANGEABLE MESSAGE SIGN-					
75	TRAILER-MOUNTED SPEED LIMIT SIGN					
75	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 55% OF MAINTENANCE OF TRAFFIC			\$11,715
75	IMPACT ATTENUATION DEVICE					
<b>MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL</b>						<b>\$11,715</b>
<b>TEMPORARY TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$74,550</b>
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL</b>						
80	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
80	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
80	SILT FENCE	LF				
80	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U	USE 30% OF DRAINAGE COST			\$16,594
80	MONITORING EROSION AND SEDIMENT CONTROL	HR				
80	TEMPORARY PROJECT WATER POLLUTION CONTROL	\$				
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL SUBTOTAL</b>						<b>\$16,594</b>
<b>SUBTOTAL E</b>						<b>\$515,212</b>
<b>ADDITIONAL ITEMS OF CONSIDERATION</b>						
20	ITS			\$0	0	\$0
30	RETAINING WALLS	SF	USE \$50/SF	\$50	0	\$0
30	SOUND WALL	SF	USE \$25 /SF	\$25	0	\$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 5% OF SUBTOTAL E			\$25,761
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	\$100,000	0	\$0
	LANDSCAPING		ASSUME \$20.65/LF	\$20.65	1375	\$28,394
	ROUNDAABOUT		ASSUME \$300,000/SINGLE LANE ROUNDAABOUT	\$275,000.00	1	\$275,000
	UTILITY ADJUSTMENTS			\$0	0	\$0
	STRUCTURES		ASSUME \$1000/LF	\$0	0	\$0
<b>ADDITIONAL ITEMS COST SUBTOTAL</b>						<b>\$329,154</b>
<b>SUBTOTAL F</b>						<b>\$844,366</b>
<b>MOBILIZATION</b>						<b>\$67,549</b>
<b>CONTINGENCIES</b>						<b>\$84,437</b>
<b>CONSTRUCTION SUBTOTAL</b>						<b>\$996,352</b>
<b>CONSTRUCTION ENGINEERING</b>						<b>\$79,708</b>
<b>CONSTRUCTION TOTAL</b>						<b>\$1,100,000</b>

## C.4 Concept 4: Grass Panel and Pavement Markings

CONSTRUCTION COST ESTIMATE						
PROJECT : NH 114 at Main Street		DATE PREPARED: 2/12/2014			<b>Henniker RSA</b> <b>NH 114 at Main Street</b>  <b>Alternative 4 - Grass Panel and Pavement Markings (Short/Near Term)</b>	
LOCATION : Henniker, NH		ESTIMATED BY: JMH				
STATE PROJECT NO.		CHECKED BY: JAR				
FEDERAL PROJECT NO.		ESTIMATE TYPE: Conceptual Cost Estimate				
ITEM NO	ITEM DESCRIPTION	UNIT	NOTE	UNIT PRICE	QUANTITY	TOTAL COST
<b>MATERIAL ITEMS (ROADWAY)</b>						
1	201.1 CLEARING AND GRUBBING (F)	A		\$8,000	0.00	\$0
2	203.1 COMMON EXCAVATION	CY		\$8	40	\$320
2.1	203.2 ROCK EXCAVATION	CY		\$30	0	\$0
2.2	203.6 EMBANKMENT-IN-PLACE (F)	CY	ASSUME 5% OF COMMON EXCAVATION	\$10	25	\$250
2.4	206.1 COMMON STRUCTURE EXCAVATION					
2.5	206.19 COMMON STRUCTURE EXCAVATION EXPLORATORY					
2.6	206.2 ROCK STRUCTURE EXCAVATION	LS	ADD 15% OF TOTAL COST of COM. EXC. & ROCK EXC. COST			\$48
2.7	207.3 UNCLASSIFIED CHANNEL EXCAVATION					
3	304.1 SAND	CY		\$19	0	\$0
3	304.2 GRAVEL (F)	CY		\$23	0	\$0
3	304.3 CRUSHED GRAVEL (F)	CY		\$25	8	\$200
4	403.1105 HOT BITUMINOUS PAVEMENT, MACHINE METHOD	TON		\$70	0	\$0
4	403.12 HOT BITUMINOUS PAVEMENT, HAND METHOD	TON		\$100	8	\$800
4	403.99 TEMPORARY BITUMINOUS PAVEMENT	TON		\$60	0	\$0
4	411.43 PLANT MIX SURFACE TREAT- MENT (ASPHALT CEMENT 3/8")	TON		\$70	0	\$0
4	417 COLD PLANING BITUMINOUS SURFACES (F)	SY		\$5	0	\$0
5	417.412 RUMBLE STRIPS, 12" WIDE	LF		\$5	0	\$0
6	606.14 BEAM GUARDRAIL (STANDARD SECTION- WOOD POSTS)	LF		\$18	0	\$0
6	606.141 BEAM GUARDRAIL (CURVED W/ CRT POSTS)					
6	606.1452 BEAM GUARDRAIL (TERMINAL UNIT TYPE ELT)	LS	ADD 40% OF COST OF GUARD RAIL			\$0
6	606.147 BEAM GUARDRAIL (TERMINAL UNIT TYPE G-2)					
6	606.84 ANCHOR FOR CURVED GUARD- RAIL W/ CRT POSTS					
7	608.12 2" BITUMINOUS SIDEWALK	SY		\$13	0	\$0
7	608.24 CONCRETE SIDEWALK (F)	SY		\$40	0	\$0
8	609.01 STRAIGHT GRANITE CURB	LF		\$17	95	\$1,615
8	609.02 CURVED GRANITE CURB	LF		\$30	90	\$2,700
8.1	609.21 STRAIGHT GRANITE SLOPE CURB	LF		\$13	0	\$0
8.2	609.811 BITUMINOUS CURB, TYPE B (4" REVEAL)	LF	25% OF GUARD RAIL QUANTITY	\$5	0	\$0
8.3	609.5 RESET GRANITE CURB	LF		\$7	0	\$0
9	628.2 SAWED BITUMINOUS PAVEMENT	LF		\$2	185	\$370
10	214 FINE GRADING	LS	20% OF TOTAL SUB BASE COST			\$40
<b>SUBTOTAL A</b>						<b>\$3,643</b>
<b>MISCELLANEOUS ITEMS (ROADWAY) (SAMPLE ITEMS BELOW)</b>						
12	FILL ABANDONED PIPE	CY				
12	CLEARING FOR FENCE LINES (F)	A				
12	REMOVAL OF EXISTING PIPE 0-24" DIAMETER	LF				
12	REMOVAL OF CATCH BASINS, DROP INLETS, AND MANHOLES	EA				
12	REMOVAL OF GUARDRAIL (F)	LF				
12	CRUSHED GRAVEL FOR SHOULDER LEVELING /DRIVES	CY				
12	Geotextile fabrics	SY				
12	ADJUSTING CATCH BASIN DROP INLET GRATE AND FRAMES	EA				
12	ADJUSTING MANHOLE COVERS AND FRAMES	EA				
12	DROP INLET SEDIMENT TRAP OUTLET	EA				
12	CHAIN LINK FENCE WITH VINYL-COATED STEEL FABRIC 6' HIGH	LF				
12	POST ASSEMBLIES FOR CHAIN LINK FENCE, 6 FT. HIGH	EA				
12	CONCRETE STAIRS	U				
12	RETROREFLECTIVE BEAM GUARDRAIL DELINEATOR	EA				
12	DELINEATORS WITH POST	EA				
12	STEEL WITNESS MARKERS, BOUNDS	EA				
12	SAWED PAVEMENT	LF				
12	DETECTABLE WARNING PAVERS (SIDEWALK RAMPS)					
12	THERMOPLAS. & PAINT PAVE. MARKING,	LF				
12	LOAM & HUMAS	CY				
12	FERTILIZER	TON				
12	GRASS SEED, TYPE 82	LB				
12	SLOPE STABILIZATION & CHANNEL STABILIZATION	SY				
12	TURF ESTABLISHMENT	SY				
12	BARK MULCH MATERIAL	CY				
12	ON-THE-JOB TRAINING OF UNSKILLED WORKERS	\$				
12	FIELD OFFICE TYPE & LAB	MON				
12	TRAFFIC SIGN TYPE A,B,C,AA,BB,CC	SF				
12	MICELLANEOUS COST SUBTOTAL					\$364
<b>SUBTOTAL B</b>						<b>\$4,007</b>
<b>DRAINAGE COSTS (SAMPLE ITEMS BELOW)</b>						
13	STONE FILL, CLASS B,C,D	CY				
13	PIPE	LF				
13	STEEL END SECTIONS	EA				
13	CATCH BASINS	U				
13	DRAINAGE MANHOLES	U				
13	RECONSTRUCTING CATCH BASINS & DROP INLETS	LF				
13	WATER REPELLENT FOR EXISTING CB'S AND DI'S	EA				
13	UNDERDRAIN FLUSHING BASINS	EA				
13	18" AGGREGATE UNDERDRAIN TYPE 2, WITH 6" PIPE	LF				
13	24" AGGRE UND. TYPE 2, WITH OPTION PIPE	LF				
13	6" PIPE UNDERDRAIN (CON- TRACTORS OPTION)	LF				
<b>DRAINAGE COST SUBTOTAL</b>						<b>\$1,202.19</b>
<b>SUBTOTAL C</b>						<b>\$5,209</b>
<b>PERMANENT TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
13.1	OVERHEAD SIGN STRUCTURES CANTELEVER	EA	USE \$600/LF	\$600	0	\$0
13.1	OVERHEAD SIGN STRUCTURES SPAN	EA	USE \$800/LF	\$800	0	\$0
60	TRAFFIC SIGNALS	EA	USE \$150K/ INTERSECTION	\$150,000	0	\$0
60	TRAFFIC SIGNAL COORDINATION	EA	USE \$50K/ ADDITIONAL INTERSECTION	\$50,000	0	\$0
65	LIGHT POLES AND BASES ( est 2/300 feet)	EA	USE \$4500/ POLE	\$4,500	0	\$0
<b>PERMANENT TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$0</b>
<b>SUBTOTAL D</b>						<b>\$5,209</b>
<b>TEMPORARY TRAFFIC CONTROL (SAMPLE ITEMS BELOW)</b>						
70	UNIFORMED OFFICERS WITH VEHICLE		USE 1.5 TIMES MAINT OF TRAFFIC COST			\$1,500
71	FLAGGERS		USE 30% OF UNIFORMED OFFICER COST			\$450
73	MAINTENANCE OF TRAFFIC	UNIT		\$1,000	1	\$1,000
74	PORTABLE CONCRETE BARRIER FOR TRAFFIC CONTROL	LF	USE 5% OF SUBTOTAL D	\$20	0	\$0
<b>MISCELLANEOUS TRAFFIC CONTROL</b>						
75	PORTABLE CHANGEABLE MESSAGE SIGN-					
75	TRAILER-MOUNTED SPEED LIMIT SIGN					
75	TRUCK-MOUNTED IMPACT ATTENUATOR, TEST LEVEL 2		USE 55% OF MAINTENANCE OF TRAFFIC			\$550
75	IMPACT ATTENUATION DEVICE					
<b>MISCELLANEOUS TRAFFIC CONTROL SUBTOTAL</b>						<b>\$550</b>
<b>TEMPORARY TRAFFIC CONTROL COST SUBTOTAL</b>						<b>\$3,500</b>
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL</b>						
80	HAY BALES FOR TEMPORARY EROSION CONTROL	EA				
80	RYEGRASS FOR TEMPORARY EROSION CONTROL	LB				
80	SILT FENCE	LF				
80	EROSION AND SEDIMENT CONTROL STORMWATER MGMT PLAN	U				
80	MONITORING EROSION AND SEDIMENT CONTROL	HR				
80	TEMPORARY PROJECT WATER POLLUTION CONTROL	\$				
<b>EROSION, SEDIMENT &amp; POLLUTION CONTROL SUBTOTAL</b>						<b>\$361</b>
<b>SUBTOTAL E</b>						<b>\$9,070</b>
<b>ADDITIONAL ITEMS OF CONSIDERATION</b>						
20	ITS			\$0	0	\$0
30	RETAINING WALLS	SF	USE \$50/SF	\$50	0	\$0
30	SOUND WALL	SF	USE \$25 /SF	\$25	0	\$0
	MISCELLANEOUS (fuel adjust,alterations)		USE 10% OF SUBTOTAL E			\$907
	WATER QUALITY - STORMWATER BMPs		DRAINAGE BASINS AREAS (INCLUDED IN SITE)	\$100,000	0	\$0
	LANDSCAPING		ASSUME \$20.65/LF	\$20.65	80	\$1,652
	UTILITY ADJUSTMENTS		ASSUME \$1000/LF	\$0	0	\$0
	STRUCTURES			\$0	0	\$0
<b>ADDITIONAL ITEMS COST SUBTOTAL</b>						<b>\$2,559</b>
<b>SUBTOTAL F</b>						<b>\$11,629</b>
<b>MOBILIZATION</b>						<b>\$930</b>
<b>CONTINGENCIES</b>						<b>\$1,163</b>
<b>CONSTRUCTION SUBTOTAL</b>						<b>\$13,722</b>
<b>CONSTRUCTION ENGINEERING</b>						<b>\$1,098</b>
<b>CONSTRUCTION TOTAL</b>						<b>\$15,000</b>

**C.5 Supplemental Cost Information**

**CONCEPTUAL COST ESTIMATE  
HENNIKER - NH 114**

CALC'D BY: JMA  
CHCK'D BY: MLG  
REV BY: JMH

SECTION	TYPICAL ID	LENGTH FEET	QUANTITIES PER 1000 LF									
			Common Excavation	Hot Bituminous Pavement	Crushed Gravel	Gravel	Sand	Beam Guardrail	Slope Curb (Median)	Vertical Curb	2" Sidewalk	6" Conc. Sidewalk (Median)
<b>Alternative 1</b>												
NH 114 N		400	0	0	0	0	0	0	0	0	0	0
NH 114 S		100	0	0	0	0	0	0	0	0	0	0
Western Ave.		300	0	0	0	0	0	0	0	0	0	0
Main Street		165	0	0	0	0	0	0	0	0	0	0
Landscaping			0	0	0	0	0	0	0	0	0	0
<b>SUBTOTALS</b>		965	0	0	0	0	0	0	0	0	0	0
<b>TOTALS</b>		970	0	0	0	0	0	0	0	0	0	0
<b>Alternative 2</b>												
NH 114 N		400	0	0	0	0	0	0	0	0	0	0
NH 114 S		340	0	0	0	0	0	0	0	0	0	0
Western Ave.		300	0	0	0	0	0	0	0	0	0	0
Main Street		165	0	0	0	0	0	0	0	0	0	0
Rush Ave.		160	0	0	0	0	0	0	0	0	0	0
<b>SUBTOTALS</b>		1365	0	0	0	0	0	0	0	0	0	0
<b>TOTALS</b>		1370	0	0	0	0	0	0	0	0	0	0
<b>Alternative 3</b>												
NH 114 N		175	0	0	0	0	0	0	0	0	0	0
NH 114 N - Reconstruct	B	100	3341	1140	1050	870	940	0	0	800	560	0
NH 114 S		100	0	0	0	0	0	0	0	0	0	0
NH 114 S - Reconstruct	E	250	4200	1450	2100	1640	1920	0	0	800	1450	0
Western Ave.		300	0	0	0	0	0	0	0	0	0	0
Main Street		165	0	0	0	0	0	0	0	0	0	0
Rush Ave.	B	460	3341	1140	1050	870	940	0	0	800	560	0
<b>SUBTOTALS</b>		1550	10882	3730	4200	3380	3800	0	0	2400	2570	0
<b>TOTALS</b>		1550	10890	3730	4200	3380	3800	0	0	2400	2570	0
<b>Alternative 4</b>												
Main Street		165	0	0	0	0	0	0	0	0	0	0
<b>SUBTOTALS</b>		165	0	0	0	0	0	0	0	0	0	0
<b>TOTALS</b>		170	0	0	0	0	0	0	0	0	0	0

Common Excavation	Hot Bituminous Pavement	HBP - Hand Method	Crushed Gravel	Gravel	Sand	Beam Guardrail	Slope Curb (Median)	Vertical Curb	2" Sidewalk	6" Conc. Sidewalk (Median)
110	0	41	4	0	0	0	0	331	181	12
100	0	19	3	0	0	0	0	298	129	36
130	0	45	4	0	0	0	0	425	182	24
100	0	15	5	0	0	0	0	213	199	47
50	0	0	0	0	0	0	0	0	0	0
490	0	120	15	0	0	0	0	1267	691	119
<b>490</b>	<b>0</b>	<b>120</b>	<b>20</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1270</b>	<b>700</b>	<b>120</b>
<b>Alternative 2</b>										
110	183	55	4	0	0	0	0	331	181	12
260	189	56	11	0	0	0	0	739	542	36
220	151	64	8	0	0	0	0	580	345	102
240	133	31	9	0	0	0	0	628	371	130
		0	0	0	0	0	0			12
830	656	206	32	0	0	0	0	2278	1439	292
<b>830</b>	<b>660</b>	<b>210</b>	<b>40</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>2280</b>	<b>1440</b>	<b>300</b>
<b>Alternative 3</b>										
110	183	55	4	0	0	0	0	331	181	12
334	114	0	105	87	94	0	0	80	56	0
260	189	56	11	0	0	0	0	739	542	36
1050	363	0	525	410	480	0	0	200	363	0
220	151	64	8	0	0	0	0	580	345	102
240	133	31	9	0	0	0	0	628	371	130
1537	524	0	400	432	0	0	368	258	0	0
3751	1657	206	1062	929	574	0	368	2816	1858	280
<b>3760</b>	<b>1660</b>	<b>210</b>	<b>1070</b>	<b>930</b>	<b>580</b>	<b>0</b>	<b>370</b>	<b>2820</b>	<b>1860</b>	<b>280</b>
<b>Alternative 4</b>										
65	0	8	8	0	0	0	0	185	0	0
65	0	8	8	0	0	0	0	185	0	0
<b>70</b>	<b>0</b>	<b>10</b>	<b>10</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>190</b>	<b>0</b>	<b>0</b>

## Appendix D: Benefit-Cost Analysis

### D.1 Near-Term Strategies

Near-term improvements are those that are lower cost and can generally be done with maintenance staff. For example, sign replacements are an inexpensive strategy and can generally be done as part of routine maintenance. As such, detailed benefit-cost analyses were not conducted for near-term improvements. Near-term strategies are summarized in Appendix E.

### D.2 Proactive Strategies

The report identified proactive strategies that are not necessarily related to any crashes experienced in the 11-year study period (1/2002 – 11/2012). Instead, these strategies are suggested based on field observations of potential safety issues. A benefit-cost analysis was not conducted for proactive measures because they are not directly related to any crashes experienced in the study period. Proactive strategies are summarized in Appendix E.

### D.3 Intermediate Strategies

Detailed benefit-cost analyses were conducted for intermediate strategies that are associated with crashes reported during the study period. The following table presents a summary of the analyses.

Concept	Issue(s)	Intermediate Strategies	Target Crashes	Benefit	Cost	B/C Ratio
1, 2	1.1, 2.1	Redesign Main Street to narrow cross-section and create room for sidewalk and shoulder (eliminate exclusive left-turn lane and convert remaining lane to thru/right/left).	Angle <sup>1</sup>	\$76,860	\$123,000	0.62
1, 2, 3	1.1, 1.2, 2.1	Install bump-outs at crosswalks and install crosswalk from refuge island to northeast corner.	All crashes	\$954,574	\$320,000	2.98
4	2.1	Eliminate one lane (WB) and narrow cross-section on Main Street by constructing new grass panel.	Angle <sup>1</sup>	\$76,860	\$15,000	5.12
N/A <sup>2</sup>	2.5	Install speed feedback signs on southbound approach of NH 114.	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>
N/A <sup>2</sup>	2.5	Implement lane narrowing “effect” through striping and rumble strips on southbound approach of NH 114.	All crashes	\$371,348	\$30,000	12.38
			Fatal/Injury	\$146,385	\$30,000	4.88
			Angle <sup>1</sup>	\$188,744	\$30,000	6.29
			Rear-end	<b>-\$69,025</b>	<b>\$30,000</b>	<b>-2.30</b>
N/A <sup>2</sup>	3.1	Create an access management policy to support future decisions and requests for access permits.	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>
N/A <sup>2</sup>	4.2	Review current condition of drainage structures and rehabilitate as necessary during next repaving project.	Wet road	\$100,481	\$15,000	6.70

1. Angle crashes include turning-related crashes.

2. N/A = not applicable because a crash modification factor is not available for this strategy.

#### D.4 Long-Term Strategies

Detailed benefit-cost analyses were conducted for long-term strategies that are associated with crashes reported during the study period. The following table presents a summary of the analyses.

Concept	Issue(s)	Long-Term Strategies	Target Crashes	Benefit	Cost	B/C Ratio
3	2.1	Convert from two-way stop control to single lane roundabout.	All crashes	\$1,692,284	\$1,020,000	1.66
N/A <sup>2</sup>	2.1	Convert from two-way stop control to traffic signal (if warrant is met).	All crashes	\$1,135,169	\$100,000	11.35
			Angle <sup>1</sup>	\$745,253	\$100,000	7.45
			Left-turn	\$268,023	\$100,000	2.68
			Rear-end	<b>-\$159,672</b>	<b>\$100,000</b>	<b>-1.60</b>
N/A <sup>2</sup>	2.1, 2.3	Eliminate northbound right-turn slip-lane.	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>	N/A <sup>2</sup>
N/A <sup>2</sup>	2.4	Realign intersection approaches to intersect at 90 degree angle.	All crashes	\$262,596	\$250,000	1.05

1. Angle crashes include turning-related crashes.

2. N/A = not applicable because a crash modification factor is not available for this strategy.

## Appendix E: Summary of Strategies

Appendix E provides a summary of suggested strategies. This can form the basis of the formal response letter (Step 7 of the FHWA RSA Process). The objective of the formal response letter is to document the decisions made by the project owner/design team with respect to the RSA findings. The response identifies those strategies that will be implemented and the responsible party. The response should also note any strategies that will not be implemented and why. The following are examples of why a strategy may not be selected:

- The strategy is not within the scope of the project.
- The strategy would lead to mobility, environmental, or other non-safety related issues.
- The strategy is not cost-effective and other alternatives will be explored.

### E.1 Near-Term Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1.1	1.1.1 Determine right-of-way and ownership of property surrounding intersection.			
1.1	1.1.2 Connect private sidewalk along storefront of Pharmacy to existing public sidewalks in both directions using colored pavement or stamped pavement.			
1.1	1.1.3 Review and consider existing Safe Routes to School (SRTS) plans.			
2.1, 2.2	2.1.1, 2.2.1 Paint centerline and edgeline near intersection to better define approach on Western Avenue.			
2.2	2.2.2 Continue edgeline around corner from NH 114 onto Western Avenue to better define corner and turn from NH 114.			
2.3	2.3.1 Install yield sign for right-turn slip lane on northbound approach.			
2.5	2.5.1 Conduct speed study (or review recent speed study if available) to consider speed-reduction measures on southbound approach of NH 114.			
3.1	3.1.1 Conduct parking study (or review recent study) to inventory existing spaces and determine number of parking spaces needed to serve adjacent businesses.			

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
3.1	3.1.2 Better define parking at businesses near intersection and along Rush Road.			
3.1	3.1.3 Eliminate parking spaces at corner of intersection to improve visibility of pedestrians and intersection sight distance.			
3.1	3.1.4 Implement angled back-in parking at Pharmacy with channelization on Western Avenue and bollards along back of parking spaces.			
3.2	3.2.1 Begin conversations with Bank to redesign parking, close one of the access points, and add parallel parking along southbound approach of NH 114.			
3.2	3.2.2 Begin conversations with Gin-Gin to redesign parking.			
4.1	4.1.1 Replace bulb in cobra-head light at intersection.			
4.1	4.1.2 Connect two security-level lights to a power source.			
4.2	4.2.1 Begin conversations with Pharmacy to explain potential safety and liability issues related to current drainage design.			

## E.2 Intermediate Proactive Strategies

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1.1	1.1.5 Shift centerline (and approach lanes) south and redesign Gin-Gin parking lot to provide sidewalk.			
1.1	1.1.7 Eliminate parking space between Grange and Pharmacy and continue existing sidewalk east to old real-estate office.			
1.1	1.1.8 Connect existing sidewalk on west side of NH 114 (north of intersection) to intersection.			
1.1	1.1.9 Connect sidewalk on north side of Western Avenue to intersection.			
1.2	1.2.1 Realign crosswalks to meet new sidewalks.			
1.2	1.2.3 Construct bump-out with crosswalk in front of Grange building.			
2.4	2.4.1 Modify striping plan to better align approach and receiving lanes during next restriping project.			
3.2	3.2.3 Eliminate access point closest to intersection on east side of northbound approach (driveway between Marian B Towle and St. George buildings).			

### E.3 Intermediate Strategies Associated with Crashes in the Study Period

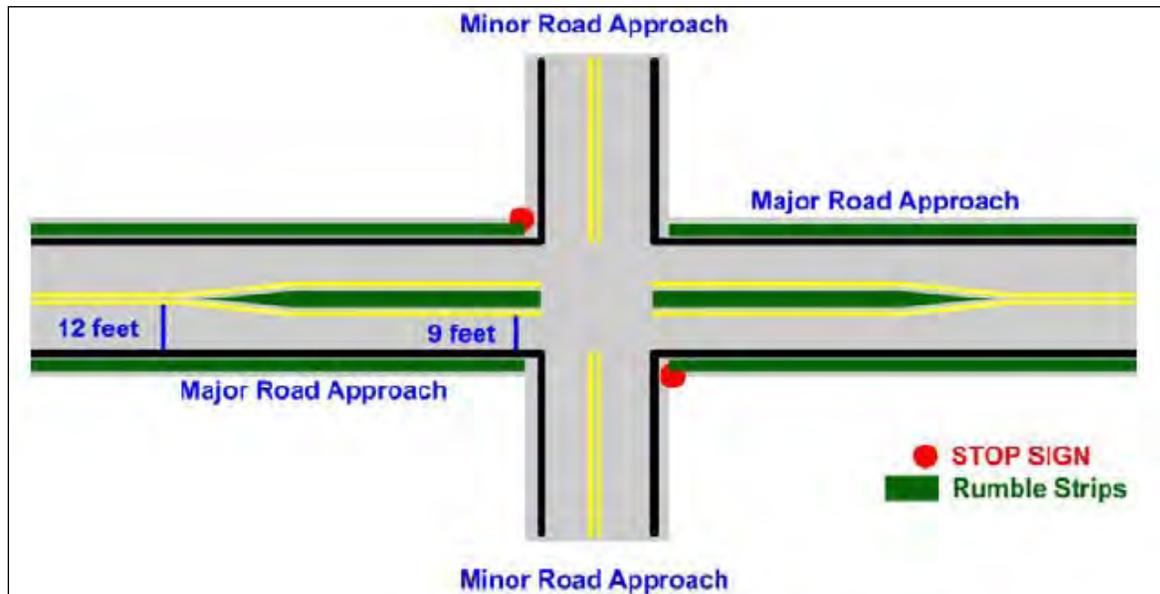
Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
1.1, 2.1	1.1.4, 2.1.3 Redesign Main Street to narrow cross-section and create room for sidewalk and shoulder (eliminate exclusive left-turn lane and convert remaining lane to thru/right/left).			
1.1	1.1.6 Install crosswalk from refuge island to northeast corner if approach width on Main Street is narrowed.			
1.2, 2.1	1.2.2, 2.1.2 Install bump-outs at crosswalks.			
2.5	2.5.2 Install speed feedback signs on southbound approach of NH 114.			
2.5	2.5.2 Implement lane narrowing “effect” through striping and rumble strips on southbound approach of NH 114.			
3.1	3.1.5 Create an access management policy to support future decisions and requests for access permits.			
4.2	4.2.2 Review current condition of drainage structures and rehabilitate as necessary during next repaving project.			

### E.4 Long-Term Strategies Associated with Crashes in the Study Period

Issue(s)	Strategy	Responsible Stakeholder		Status / Comments
		Implementation	Maintenance	
2.1, 2.3	2.1.4, 2.3.2 Eliminate northbound right-turn slip-lane.			
2.1	2.1.5 Convert from two-way stop control to traffic signal (if warrant is met).			
2.1	2.1.5 Convert from two-way stop control to roundabout.			
2.4	2.4.2 Realign intersection approaches to intersect at 90 degree angle.			

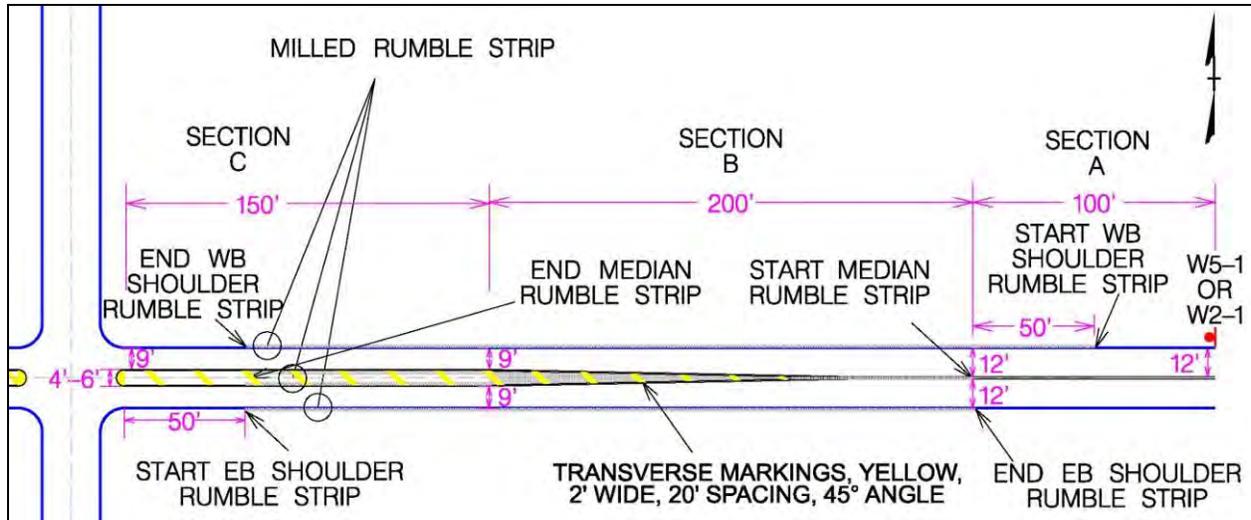
## Appendix F: Lane Narrowing Treatment

The following lane narrowing concept features the introduction of rumble strips on the outside shoulders and in a painted yellow median on the major road approaches. The objective is to induce drivers on the major road to reduce approach speeds at intersections by effectively reducing the lane width. There is greater potential for effectiveness on intersections of high-speed roadways; however, the treatment can be applied to intersections with lower posted speeds.



The installation of this concept is relatively low cost. While Pennsylvania spent between \$50,000 and \$70,000, the installations in other States were much less expensive. Based on data from the remaining States, the implementation costs for the lane narrowing concept ranged from \$10,000 to \$30,000 per intersection, excluding construction costs unrelated to the concept implementation.

A typical design template for the lane narrowing concept is shown below. For this scenario, lane widths on the major road are reduced from 12 ft to 9 ft, as measured from the inside edges of the pavement markings. The effective lane width after implementation is 10 ft, as measured from the inside edges of the rumble strips. The design template shows three distinct sections (A, B, and C). Prior to the lane narrowing, appropriate signing is placed at the beginning of section A to warn motorists of the upcoming taper or intersection. The end of section A corresponds with the beginning of section B (i.e., the lane taper). Section B gradually transitions from a median width of 0 ft to the full width of the median at the end of the section. Section C carries the full width of the median for 150 ft up to the intersection, but the rumble strips end 50 ft prior to the intersection. Table A.1 indicates the lengths of each section based on the posted speed of the roadway. For example, if the posted speed of the major road is 55 mph, then the lengths of sections A, B, and C would be 100 ft, 200 ft, and 150 ft, respectively.



**Table C.1. Section Lengths**

Speed (mi/h)	Section A (ft)	Section B (ft)	Section C (ft)
45– 55	100	200	150
60	150	200	150

The safety and operational performance was investigated at nine sites after the implementation of this strategy. For all vehicles, the mean speed was reduced by 3.5 mph with a standard deviation of 0.36. The mean reduction in the 85th-percentile speed was even greater (4.5 mph) with a standard deviation of 0.25. Overall, there appears to be a reduction in the crash rate for total, fatal/injury, and angle crashes after implementing the lane narrowing concept. The crash rate for rear-end crashes increases in the after period. While the after period is relatively short for many of the sites, there is some consistency in the increase in rear ends. A Wilcoxon Signed-Rank Test was used to determine whether or not the change in crash rate was significant for total crashes and for fatal/injury crashes (i.e., fatal plus injury). For total crashes, the results are statistically insignificant. For fatal/injury crashes, the results are statistically significant at the 95 percent confidence level, which leads to the conclusion that fatal/injury crashes were reduced after the lane narrowing concept was implemented. CMF = 0.69 (all crashes). CMF = 0.80 (fatal/injury crashes). CMF = 0.58 (angle crashes). CMF = 1.54 (rear-end crashes).<sup>1</sup>

Further detail can be found in FHWA Publication No.: FHWA-HRT-08-063, *Two Low-Cost Safety Concepts for Two-Way STOP-Controlled, Rural Intersections on High-Speed Two-Lane, Two-Way Roadways*. <http://www.fhwa.dot.gov/publications/research/safety/08063/index.cfm>

<sup>1</sup> CMF Clearinghouse: [http://www.cmfclearinghouse.org/study\\_detail.cfm?stid=198](http://www.cmfclearinghouse.org/study_detail.cfm?stid=198)