Riverside Middle School

Traffic & Pedestrian Safety Study

Prepared for

City of Watertown & Watertown Unified School District

August 2016

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1 Executive Summary

The purpose of this study is to identify traffic and pedestrian safety improvements at the Riverside Middle School (RMS) campus in Watertown, WI, as well as along the adjacent city streets. This report contains background information, traffic crash data, traffic and pedestrian field observations, a parent traffic safety survey summary, staff, local business and stakeholder comments and concerns, and safety recommendations.

A total of 26 crashes were reported between January 2011 and April 2016 on the city streets adjacent to Riverside Middle School. Of the 26 crashes, 15 (58%) occurred during school arrival (7:00 AM – 8:00 AM) and dismissal (3:00 PM – 4:00 PM) periods. The remaining 11 crashes occurred during off-peak or weekend hours. Of the 15 crashes reported during school arrival and dismissal periods, 10 (67%) involved vehicles striking a fixed object or were sideswipe crashes. The fixed object crashes all involved vehicles colliding with a parked car in the parallel or angle parking on Hall Street, or a parked car on E Main Street. The sideswipe crashes occurred on the one-way driveway or on Hall Street. There was also one crash involving a pedestrian. In this crash, a vehicle had stopped on E Main Street to allow a group of students to cross E Main Street at the one-way school driveway and cemetery entrances. The group of students had finished crossing, but one student turned around to walk back towards the school when the driver began moving forward, striking the student. This is the only reported injury crash within the study area.

Parent survey, staff, and local stakeholder comments focused primarily on traffic flow and pedestrian safety concerns within the student drop-off/pick-up area and the surrounding streets. Problems identified from the study include inadequate pedestrian facilities, insufficient signage and pavement markings, and uncontrolled traffic flow and operation.

Based on the analysis of existing conditions, a set of recommendations was developed to improve Riverside Middle School traffic and pedestrian safety. The recommendations are divided into short-range low cost improvements and intermediate range improvements that require greater budget and design considerations.

1.1 Short Range Recommendations

<u>Riverside Middle School Campus</u>

1. Construct a sidewalk along the south side of the one-way school driveway from the main school entrance to its intersection with E Main Street.
2. Construct a raised pedestrian crosswalk on the one-way driveway to the new sidewalk identified in Improvement 1 above.
3. Convert the angle parking on Hall Street to ‘back-in’ only angle parking.

<u>City Streets</u>

1. Add sidewalks and pedestrian crosswalks to surrounding area streets and intersections.
2. School area crosswalks should be upgraded to the ‘continental-style’ pavement marking to increase driver awareness of pedestrian crossing locations.
3. Install additional school crossing signs at selected intersections.
4. Install a stop sign on the southwestbound approach of E Main Street at its intersection with Hall Street, along with ‘Do Not Block Intersection’ signing.

5. Install a solar powered school zone speed feedback sign on westbound E Main Street east of its intersection approach to Oak Hill Court.
6. Install a mid-block crosswalk on Boughton Street near Hidde Drive with pedestrian refuge islands for students crossing Boughton Street from the RMS Athletic Field.
7. Install Rectangular Rapid Flashing Beacons (RRFB) at the crosswalks: a) on E Main Street at its intersection with the one-way school driveway entrance; b) at the new mid-block pedestrian crossing on Boughton Street; and c) on the Hall Street crosswalks near the west parking lot driveway and the one-way driveway exit.
8. Install pavement markings to include roadway center lines and left-turn lanes with directional arrows to the southbound approach of Hall Street at E Main Street and the southwest approach of E Main Street to Summit Avenue. This requires the use of appropriate advance warning signage.
9. Install 'Do Not Block Intersection' pavements markings and signage on Hall Street at the west parking lot entrances, and remove on-street parallel parking in these zones.

1.2 Long Range Recommendations

Riverside Middle School Campus

1. Construct a new parking lot and drop-off area on the north side of the RMS property, with access on Boughton Street at the Hidde Street intersection.

City Streets

1. Redesign the E Main Street intersection with the one-way driveway school entrance and cemetery roadways. It is recommended that the Roundabout Option (Design Concept 3) be implemented as a long-term safety improvement. Roundabouts have been proven to provide the safest intersection control, as well as safely accommodate pedestrians and calm traffic speeds. Additional detailed engineering will need to be conducted for a roundabout design to ensure it does not disrupt any cemetery graves, minimizes adjacent property right-of-way needs, and is acceptable to the Oak Hill Cemetery Association to cul-de-sac one of the roadways that currently intersect E Main Street.

   If the detail design indicates that it is not feasible to construct a roundabout at this intersection, then it is recommended to implement Option 2, which involves realigning the school driveway entrance and the north curb of E Main Street to the south, removing the uncontrolled open space near the cemetery entrances. This option includes installation of a crosswalk and pedestrian refuge island on the E Main Street west leg of the intersection, along with the installation of rectangular rapid flashing pedestrian actuated beacons.

2 Riverside Middle School Background

Riverside Middle School (RMS) is a public school serving grade levels six to eight, in Watertown, WI. It is located on Hall Street between Doctors Court and Boughton Street. The Oak Hill Cemetery is located directly east of the school property, separated by a fence. The Rock River is located immediately to the west of Hall Street.

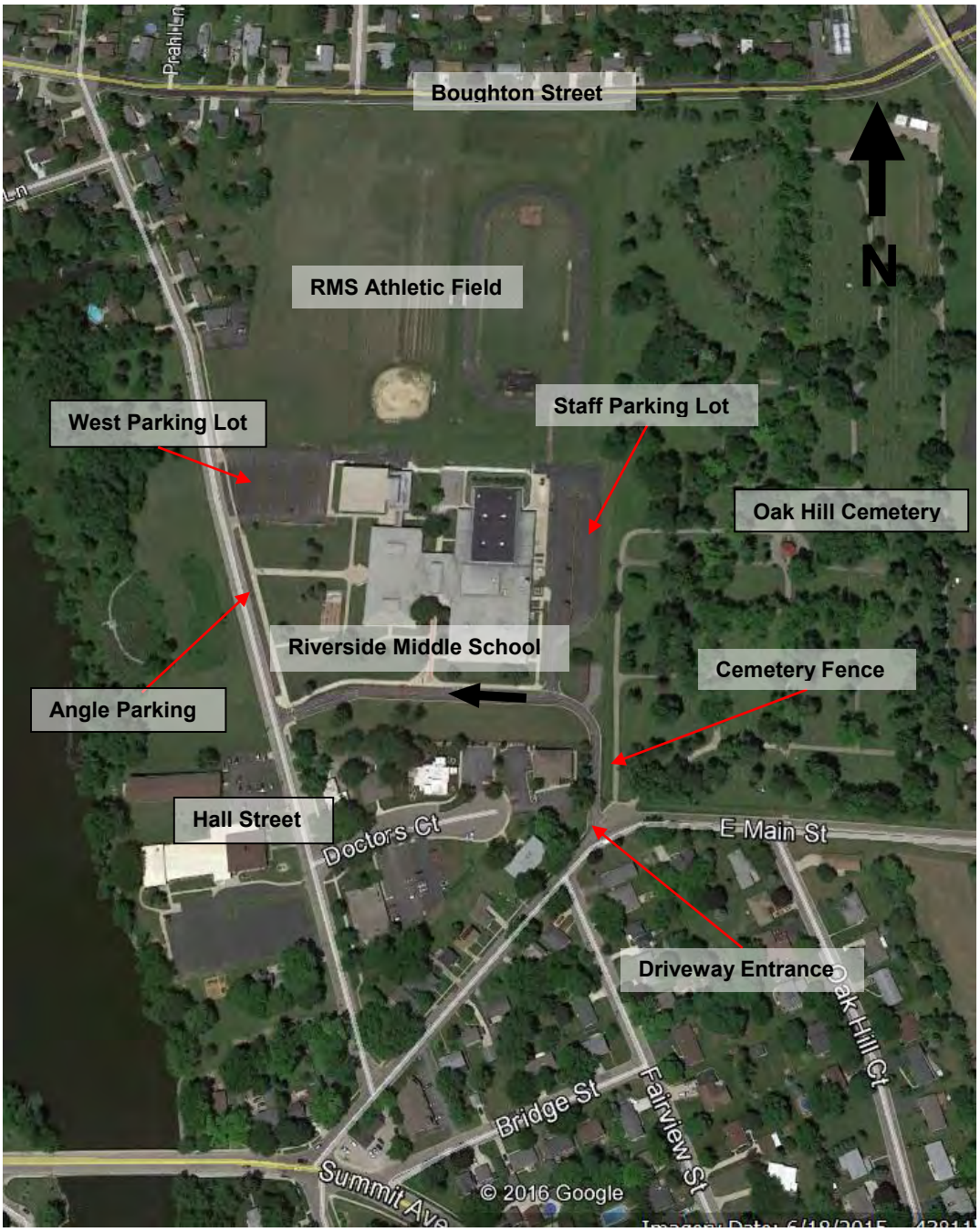
The main entrance road to the school operates as a one-way, westbound driveway, running along the south side of the school building. The driveway entrance is on E Main Street, which

runs parallel to Doctors Court. Traffic turns from E Main Street into the driveway, heading north along the cemetery, and then turns west to run along the south side of the school. The driveway exits onto Hall Street, north of Doctors Court. The driveway also provides access to the staff parking lot, which is located along the east side of the building, adjacent to the cemetery property. A second school parking lot is located on the west side of the building, with two driveways on Hall Street, north of the one-way driveway exit. This parking lot serves as a shared playground and school bus staging area. Angle parking is permitted on the east side of Hall Street, between the one-way driveway exit and the northern driveway of the west parking lot. On-street parallel parking is permitted on the west side of Hall Street. Along the north side of the school is an athletic field, with a track and baseball diamond. Boughton Street runs along the north side of the field.

Refer to Figure 1 for an aerial photograph of the RMS Campus.

RMS classes currently begin at 7:57 AM and dismiss at 3:16 PM. There are approximately 800 students enrolled at the school. Students arrive at and leave campus by three primary transportation modes: 1) bus, 2) walk/bike, or 3) private automobile. The RMS Campus also serves as the hub for the school bus company; buses pick up students from other Watertown schools and meet at RMS, where the students transfer to different buses based on where they live.

Figure 1: Riverside Middle School Campus



3 Existing Conditions

There are three directions from which the school can be accessed: 1) the driveway entrance on E Main Street; 2) Hall Street from the south at the intersection with E Main Street; and 3) Hall Street from the north at the intersection with Boughton Street. This school traffic/pedestrian safety study evaluated all three streets, as well as several selected intersections within the

study area, and the one-way driveway, for geometrics, operation, safety, and signing and markings.

3.1 One-Way Driveway

The one-way driveway begins as two lanes at E Main Street, while heading north along the cemetery property. When it turns west to approach RMS, it widens to accommodate two travel lanes and a student drop-off/pick-up parking lane. The right lane, adjacent to the school, is designated as the parking lane and serves as the drop-off and loading area during student arrival and dismissal time periods. At the west end of the driveway, the parking lane merges back into a traffic lane, with the two lanes separating into a left-turn lane and a right-turn lane. A sidewalk runs along the north side of the driveway from Hall Street to the entrance of the staff parking lot. No sidewalks are constructed on the south side of the driveway, or along the northbound segment of the driveway by the cemetery. Figure 2 shows the geometrics and configuration of the one-way driveway.

Most motorists will use the right lane upon entering the driveway, and wait their turn to pull up to the sidewalk to drop off or pick up their child. Some drivers will use the left lane and stop in the travel lanes to drop off or pick up their child. This double parking results in drivers being required to weave in and out of the travel and parking lanes, and students weaving between cars to reach the school property. The parking spaces on the western end of the driveway are less utilized than those on the east end, as drivers do not have adequate space to weave across traffic to access the left-turn lane to Hall Street. During arrival and dismissal periods, traffic back-ups can build up at the driveway stop signs, as drivers wait for gaps in traffic to enter Hall Street.

Figure 2: One-Way Driveway

3.2 E Main Street

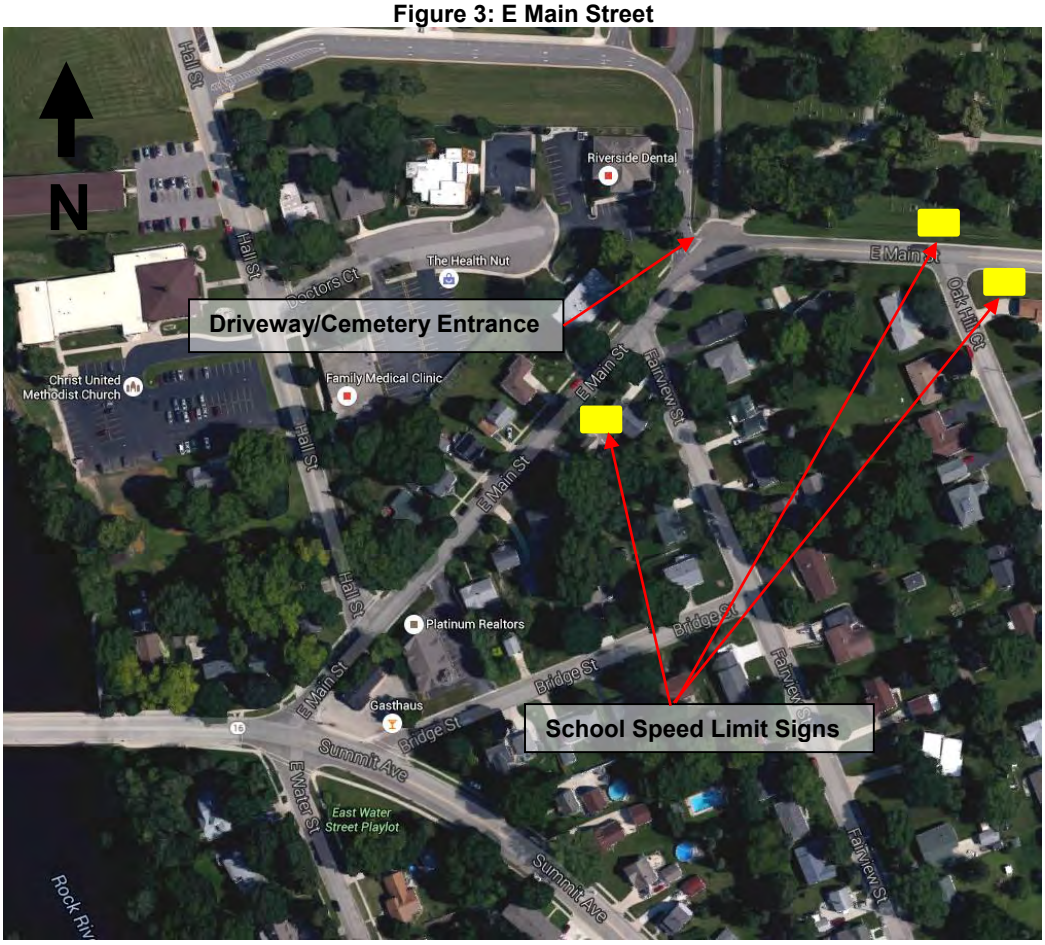
E Main Street is a two-lane street south of Riverside Middle School that runs primarily east-west. However, the street has several bends, and the segment directly south of the school, from the Summit Avenue intersection to the Oak Hill Court intersection, runs northeast-southwest. Intersections with Hall Street and with Fairview Street are both located within the segment, and the RMS one-way driveway entrance and the two Oak Hill Cemetery entrances

are located east of the Fairview Street intersection, at the start of another bend on the street. The section of E Main Street between Hall Street and the school/cemetery entrances is also on a vertical curve; the driveway entrances have poor driver sight distance due to the combination of the horizontal and vertical curvatures of the roadway.

Parking is allowed on the north side of E Main Street. The south side of the street is residential. The north side of the street is also residential on the west end, but one of the Doctor's Court businesses is provided direct building access to E Main Street. Sidewalk is constructed on the north side of E Main Street, but not the south side. The posted speed limit is 25 mph but two "School Speed Limit 15 MPH When Children Are Present" signs are located on the south side of the street for eastbound drivers and one is located on the north side for westbound drivers. Figure 3 shows the E Main Street segment with sign locations.

During school arrival and dismissal periods, parents use E Main Street to access the one-way driveway, as well as Hall Street. Additionally, some parents drop off and pick up their students along E Main Street or Fairview Street, rather than wait in the school driveway queue. Students walk along E Main Street and the driveway to access the school. Because there are no crosswalks and very few sidewalks, many students walk through the street and between parked cars.

Figure 3: E Main Street



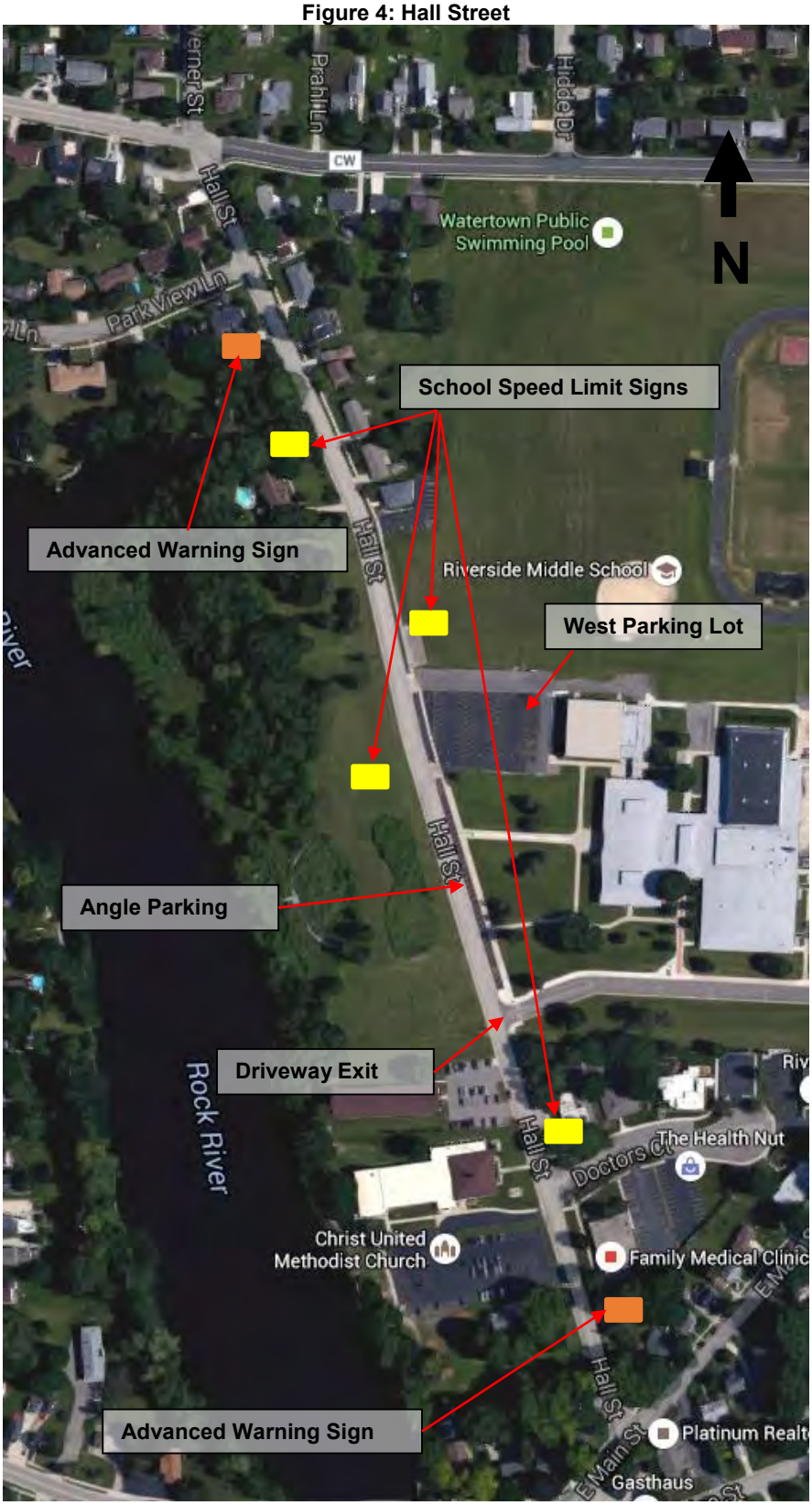
3.3 Hall Street

Hall Street is a two-way street that runs north-south along the west side of Riverside Middle School. Within the study area, there are four intersections on Hall Street, as well as several driveways and parking lot entrances. The intersections include Boughton Street, Parkview Lane, Doctors Court, and E Main Street. All of the intersections are three-leg intersections, with the exception of the Boughton Street intersection. The north end, near Boughton Street and Parkview Lane, has multiple driveways to private residences. The west parking lot for RMS has two driveways on the east side of Hall Street. The one-way driveway exits to Hall Street south of the parking lot entrances. Two driveway entrances to a church and an apartment building are located on the west side of Hall Street, across from the Doctors Court intersection. Additional private residence driveways are located on Hall Street between Doctors Court and E Main Street.

Angle parking is provided along the east side of Hall Street from Doctors Court to the northern entrance of the RMS west parking lot. Parallel parking is permitted along the rest of the east side of the street and along the entire west side of the street, with the exception of directly across from the one-way driveway exit. A sidewalk is constructed along the east side of Hall Street from Boughton Street to E Main Street. No sidewalk is available on the west side of the street. The speed limit on Hall Street is 25 mph except during school. Four “School Speed Limit 15 MPH When Children Are Present” signs are located on Hall Street near the school, two for each direction of travel. Additionally, school advanced warning signs are located on the east side of the street, near Doctors Court, and the west side of the street, near Parkview Lane. Figure 4 shows the Hall Street geometrics and various sign locations.

All traffic leaving the RMS campus must use Hall Street, as the one-way driveway exit and both entrances to the west parking lot are on Hall Street. During school arrival and dismissal periods, parents use Hall Street to drop off and pick up their students in the angle parking on the east side of the street. Some parents also park in the southbound parallel parking along the west side of the street. Anyone dropping off or picking up on the one-way driveway also uses Hall Street when leaving the school driveway. Buses dropping off and picking up students use the west parking lot, which they access via Hall Street. During the afternoon dismissal period, RMS is the school bus hub for the city. All buses leave the campus together, creating a convoy out of the parking lot and onto Hall Street.

Figure 4: Hall Street



3.4 Boughton Street

Boughton Street is a two-lane street that runs east-west along the north side of Riverside Middle School. The primary intersection within the study area is at Hall Street. The other intersection is with Hidde Drive, which provides access to the neighborhood north of the school. Driveways to private residences are located along the north side of Boughton Street, and on the south side of the street near the intersection with Hall Street. A driveway to the Oak Hill Cemetery is also located at the east end of Boughton Street, on the south side.

Parking is allowed on both sides of the street. Sidewalk is constructed on the south side of the street, but not the north side. The speed limit for the street is 25 mph. No school speed limits signs are installed along the street, but an advanced warning school sign is located at the east end of the street on the north side and two school zone crossing signs are located at the Hall Street intersection. Additionally, an in-street "State Law Yield to Pedestrians" regulatory sign and a pedestrian warning sign are located on Boughton Street outside of the study area, just west of the intersection with Parkview Lane. Figure 5 shows the Boughton Street geometrics and various sign locations.

During school arrival and dismissal periods, parents use Boughton Street to access Hall Street and HWY 16 to the east. Parents do not typically drop students off on Boughton Street. However, some students who walk and/or bike to school will use the field on the north side of the school to get to Boughton Street, crossing Boughton Street mid-block to access the adjacent residential neighborhood.

Figure 5: Boughton Street

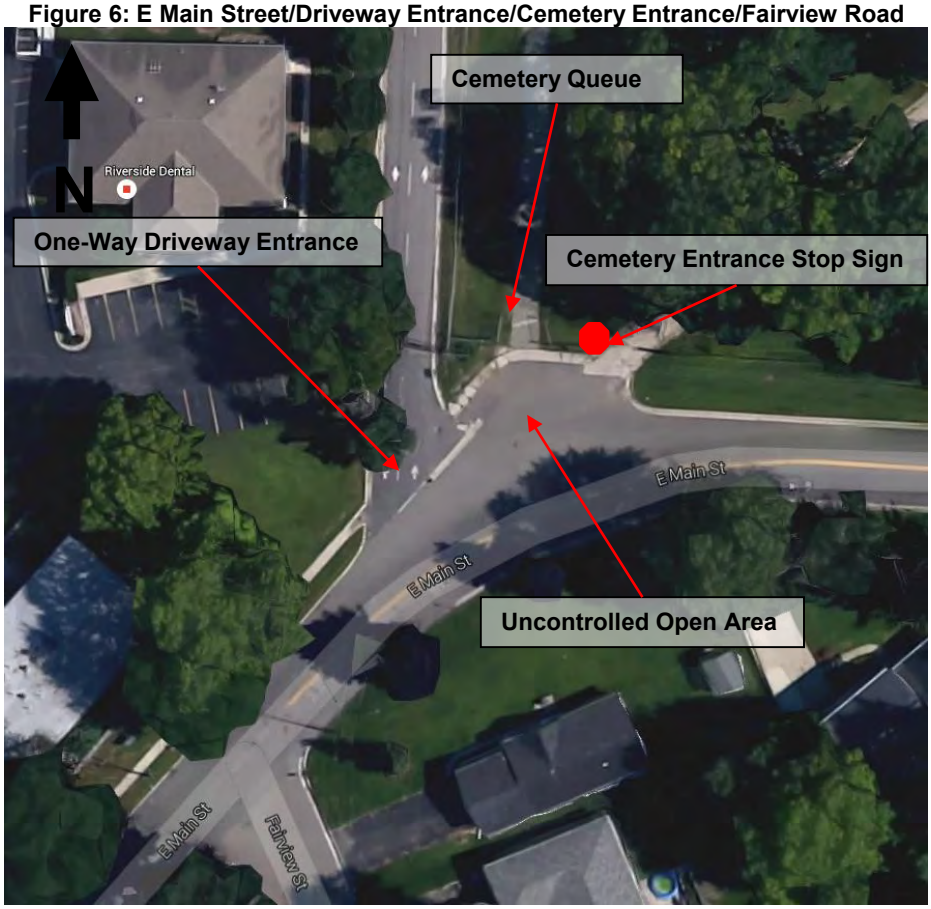
3.5 Intersection: E Main Street/Driveway Entrance/Cemetery Entrance/Fairview Road

The one-way RMS driveway entrance on E Main Street is directly adjacent to the Oak Hill Cemetery access point. The cemetery access points accommodate both entering and exiting traffic. The school and cemetery driveways are located on the combination horizontal and

vertical curve on E Main Street. The E Main Street cross section widens at the intersection, creating an uncontrolled open area. Because these access points are driveways, rather than a traditional intersection, traffic operation through the intersection is not well controlled, efficient, or safe, particularly during school day arrival and dismissal periods. A stop sign to control traffic is located on the north cemetery entrance, but no other traffic control is present at the intersection. Fairview Street also connects with E Main Street on the south side immediately west of the school and cemetery entrances. Traffic movements often conflict with the movements in and out of the school and cemetery access points. No crosswalks are marked at the intersection, as the sidewalk on the west side of E Main Street ends at the intersection, rather than extending east beyond the cemetery entrances. Figure 6 shows the intersection geometrics and traffic control.

Before and during school arrival and dismissal periods, parents will turn from E Main Street into the one-way driveway. Due to the roadway curve, driver visibility can be poor for those making turning movements. Additionally, many parents will use the uncontrolled open area adjacent to the cemetery entrances to drop off and pick up their students, as well as turn around. Parent vehicles will also queue up on the cemetery drive, adjacent to the fence separating the school and cemetery properties, and exit the cemetery into the uncontrolled open space to turn onto E Main Street, or make a U-turn into the school driveway. Fairview Street is also used as a staging area for parents to wait for students. Students who walk to and from school along E Main Street from the east and students who are dropped off or picked up on E Main Street, Fairview Street, or in the cemetery will walk through the intersection, frequently cutting in front of vehicles.

Figure 6: E Main Street/Driveway Entrance/Cemetery Entrance/Fairview Road

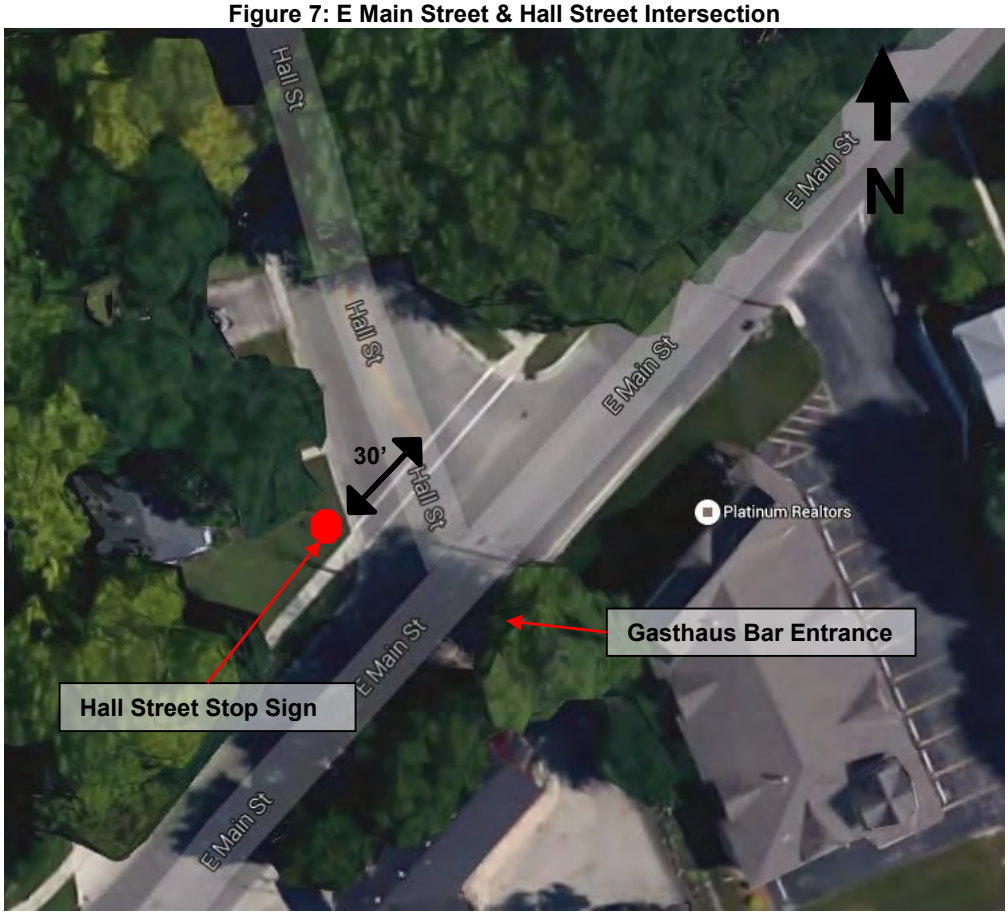


3.6 Intersection: E Main Street & Hall Street

The intersection of Hall Street and E Main Street is a partial stop-sign controlled, three-legged intersection, with a stop sign on Hall Street. A private driveway to the Gasthaus Bar is located directly across from the Hall Street approach to E Main Street. Because the segment of E Main Street intersected by Hall Street runs northeast-southwest, the Hall Street approach is skewed from E Main Street. The Hall Street approach cross-section widens at the intersection to accommodate the roadway skew, providing approximately 50 feet of pavement width; the roadway center line pavement marking is offset so that the approach is approximately 30 feet wide, while the receiving lane for vehicles turning onto Hall Street from E Main Street is approximately 20 feet wide. A crosswalk is marked on the Hall Street approach for pedestrians walking along the northwest side of E Main Street. No crosswalks are available for crossing E Main Street at this intersection. Figure 7 shows the intersection configuration and traffic control.

The Hall Street and E Main Street intersection is the primary intersection on the route to leave Riverside Middle School to the south. During school arrival and dismissal periods, a queue can extend on Hall Street back to the west parking lot entrances. Although the Hall Street approach is not marked as two lanes, because of the wide cross-section, space is available for a left-turn lane and a right-turn lane. Many drivers will move to the left or right of the approach lane to allow other vehicles to pull up to the intersection, thus alleviating some of the congestion. However, because it is not marked specifically as two lanes, some drivers will stop in the center of the lane, allowing for only one vehicle to arrive at the intersection at a time, which creates increased driver delay and vehicle queueing.

Figure 7: E Main Street & Hall Street Intersection



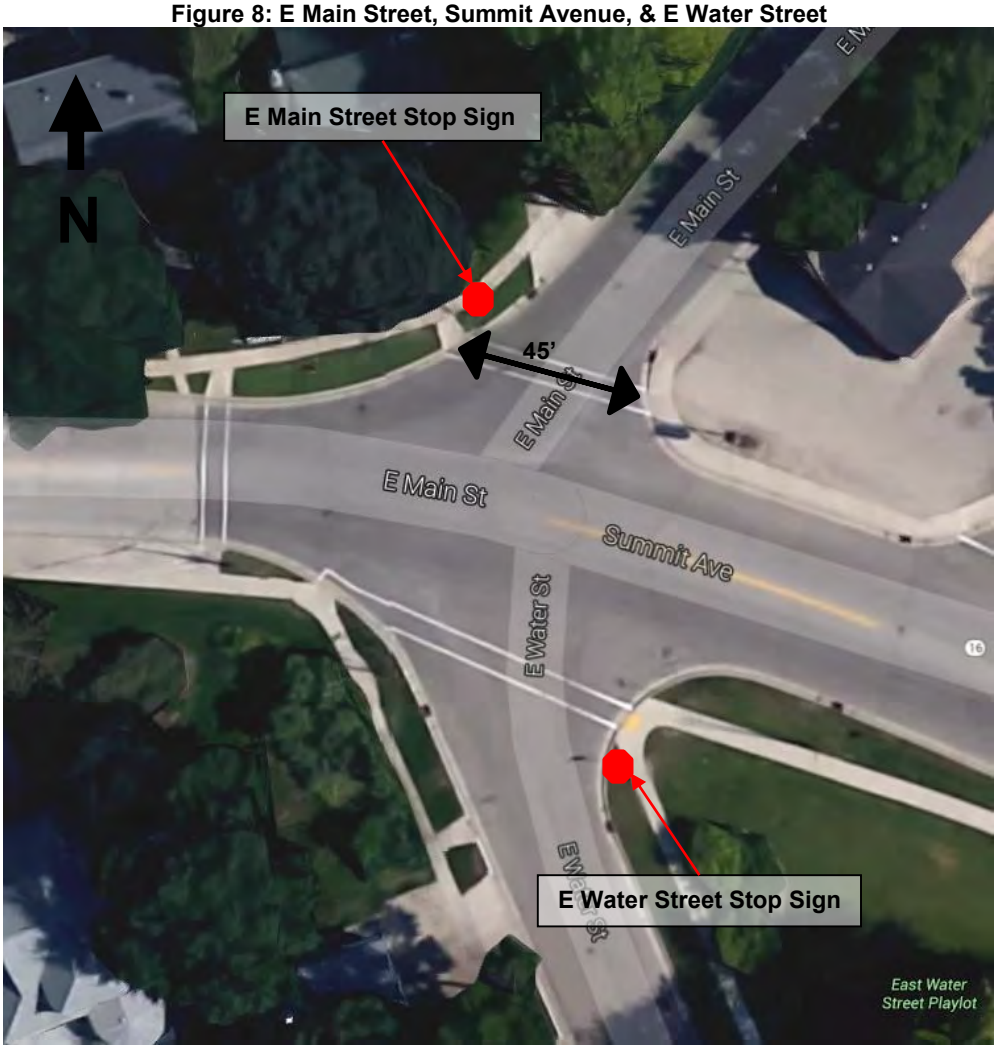
3.7 Intersection: E Main Street and Summit Avenue

The intersection of E Main Street, Summit Avenue, and E Water Street is a partial stop sign controlled, four-legged intersection. Due to the proximity of the Rock River and the bend in the E Main Street alignment, the geometry at the intersection is unique. Summit Avenue is located on the east approach. The west approach and the north approach are both E Main Street. Because E Main Street turns northeast, the north approach is skewed toward the east. Similarly, because the Rock River curves east, the south approach, E Water Street, is skewed to the east. Stop signs are located on the E Water Street southeast approach and the E Main Street northeast approach. The west E Main Street and east Summit Avenue approaches are not stop sign controlled.

The cross-section of the northeast leg of E Main Street at the intersection is approximately 45 feet wide to accommodate the roadway skew. There is no center line pavement marking delineating the intersection approach lane from the receiving lane. The cross section of the southeast leg of E Water Street at the intersection is approximately 60 feet wide to accommodate the roadway skew. As with the northeast leg, there is no center line pavement marking delineating the intersection approach lane from the receiving lane. Crosswalks are marked on all intersection approaches except for the west Summit Avenue approach. Figure 8 shows the intersection geometrics and traffic control.

The E Main Street and Summit Avenue intersection is heavily used by drivers leaving Riverside Middle School to the west and southeast. During school arrival and dismissal periods, a queue can extend northeast on E Main Street, impacting operation at the E Main Street and Hall Street intersection. Although the approach is not marked as two lanes, because of the wide cross-section, space is available for a shared through/left-turn lane and a separate right-turn lane. Many drivers will move to the left or right of the approach lane to allow other vehicles to pull up to the intersection, thus alleviating some of the congestion and queuing. However, because it is not marked specifically as two lanes, some drivers will stop in the center of the lane, allowing for only one vehicle to arrive at the intersection at a time which creates increased driver delay and vehicle queueing.

Figure 8: E Main Street, Summit Avenue, & E Water Street



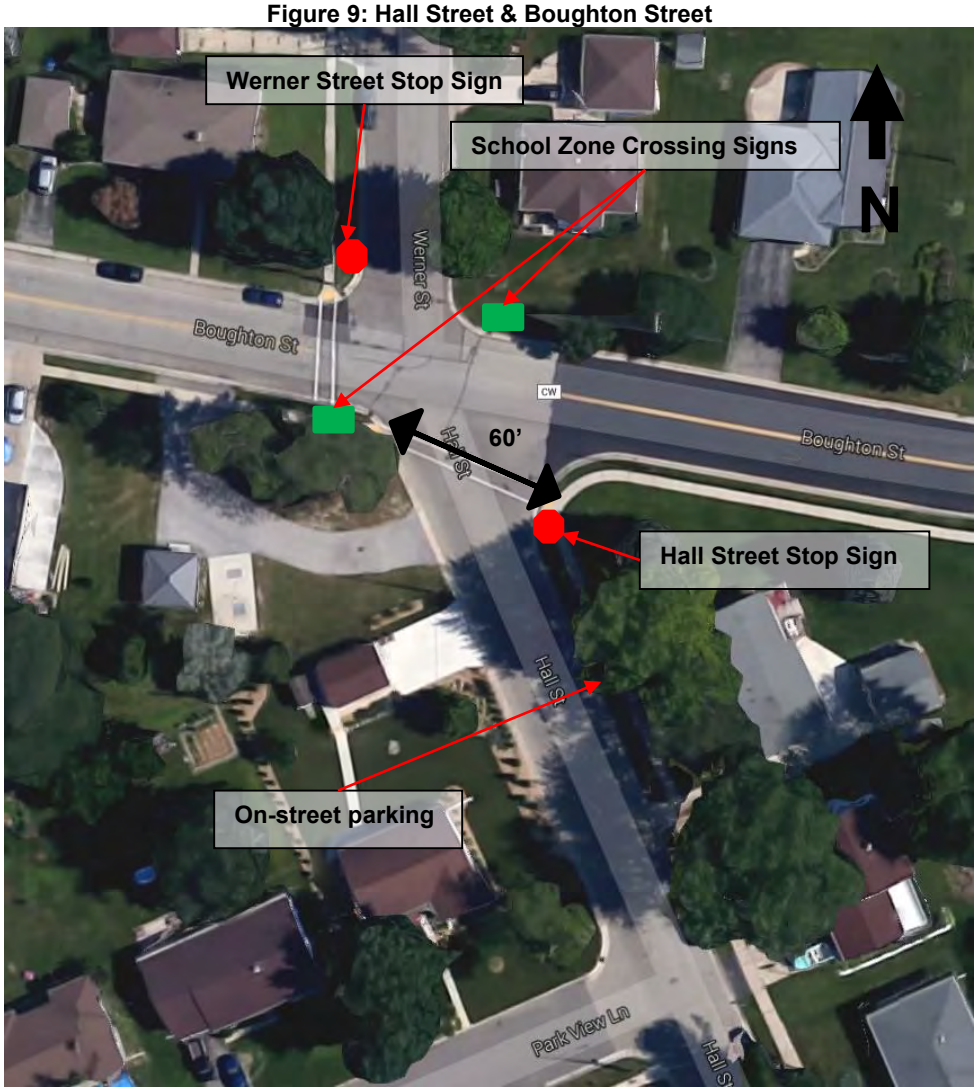
3.8 Intersection: Hall Street and Boughton Street

The intersection of Hall Street and Boughton Street is a partial stop sign controlled, four-legged intersection. The east and west legs are Boughton Street. Hall Street ends at the south approach of the intersection, and the north leg is Werner Street. Stop signs are located on the Hall Street and Werner Street approaches. Because Hall Street runs on a slight north-south angle, the south leg is skewed slightly to the east. Additionally, there is a small vertical curve on Boughton Street. The combination of the skew and the curve can reduce driver visibility, particularly for the northbound approach.

The cross-section of Hall Street at the intersection is approximately 60 feet wide to accommodate for the roadway skew. There is no center line pavement marking delineating the intersection approach lane from the receiving lane. Crosswalks are marked on the Hall Street approach and the west Boughton Street approach. School crossing zone signs are also located on both Boughton Street approaches. These signs should be located on both sides of the crosswalk, for both directions of travel, for a total of four sign faces. Figure 9 shows the intersection geometry, various sign location, and traffic control.

The Hall Street and Boughton Street intersection is the primary intersection on the route to leave Riverside Middle School to the north. During the school arrival and dismissal periods, a queue can extend south on Hall Street reaching back to the west parking lot entrances. Although the Hall Street approach is not marked as two lanes, because of the wide cross-section, space is available for a left-turn lane and a separate right-turn lane. However, because parking is allowed on the east side of Hall Street in front of the private residences, vehicles must stay in a single lane until arriving at the intersection. This has the effect of increasing intersection queuing. Additionally, many students who walk to and from school along Boughton Street will cross Hall Street at the Parkview Lane intersection to avoid the Boughton Street intersection. Because there is no crosswalk at the Parkview Lane intersection, drivers have to navigate around students crossing the street at random locations.

Figure 9: Hall Street & Boughton Street

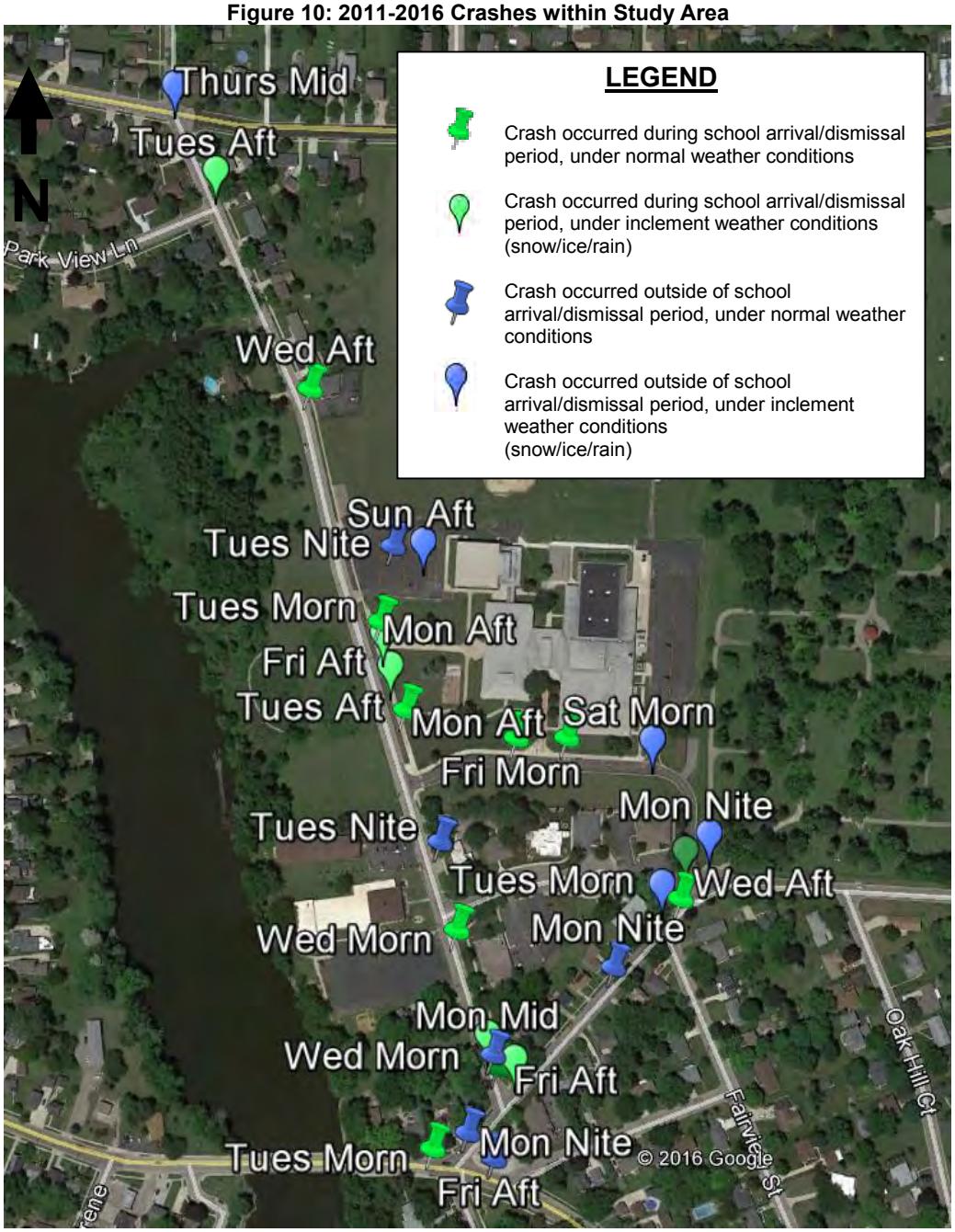


3.9 Traffic Crash History

A traffic safety analysis of the study street segments and intersections indicates that a total of 26 traffic crashes were reported between January 2011 and April 2016. Figure 10 shows the locations of the crashes. As shown on Figure 10, green-colored crashes occurred during school

arrival and dismissal periods, on weekdays between 7:00 and 8:00 AM and between 3:00 and 4:00 PM. Blue-colored crashes occurred during the non-school arrival and dismissal periods, or on weekends. Pin symbols represent crashes that occurred under normal weather/roadway conditions, and balloon symbols represent crashes that occurred under inclement weather/roadway conditions, including snow, ice, and rain. A review of the crash locations shown on Figure 10 indicates the crashes are distributed throughout the study area street network without evidence of a particular hot spot that would require special safety mitigation improvements.

Figure 10: 2011-2016 Crashes within Study Area



Of the 26 crashes, 15 (58%) occurred during school arrival (7:00 AM – 8:00 AM) and dismissal (3:00 PM – 4:00 PM) periods, as shown in Figure 11. The remaining 11 crashes occurred during off-peak or weekend hours. Of the 15 crashes reported during school arrival and dismissal periods, 10 (67%) involved vehicles striking a fixed object or were sideswipe crashes. The fixed object crashes all involved vehicles colliding with a parked car in the parallel or angle parking on Hall Street, or a parked car on E Main Street. The sideswipe crashes occurred on the one-way driveway or Hall Street. There was also one crash involving a pedestrian. In this crash, a vehicle had stopped on E Main Street to allow a group of students to cross E Main Street at the one-way school driveway and cemetery entrances. The group of students had finished crossing, but one student turned around to walk back towards the school when the driver began moving forward, striking the student. This is the only reported injury crash in the entire study area. Table 1 and Table 2 summarize crash data for the study area.

Figure 11: 2011-2016 Crashes during School Arrival and Dismissal Periods

Table 1: Collision Patterns for Crashes during School Arrival and Dismissal Periods

Year	Collision Pattern					Total
	Rear-End	Fixed Object	Sideswipe	Right Angle / Left Turn	Bike / Ped	
2011	0	0	1	0	0	**1**
2012	0	3	2	2	0	**7**
2013	0	1	0	0	0	**1**
2014	2	1	1	0	0	**4**
2015	0	0	0	0	1	**1**
2016	0	1	0	0	0	**1**
Total	**2**	**6**	**4**	**2**	**1**	**15**

Of the 11 crashes that did not occur during school arrival or dismissal periods, four were rear-ends at the intersections, and four were collisions with fixed objects/parked cars.

Table 2: Collision Patterns for Crashes outside of School Arrival and Dismissal Periods

Year	Collision Pattern					Total
	Rear-End	Fixed Object	Sideswipe	Right Angle / Left Turn	Bike / Ped	
2011	0	0	0	1	0	**1**
2012	1	0	0	0	0	**1**
2013	0	1	0	0	0	**1**
2014	1	1	1	0	0	**3**
2015	0	0	0	1	0	**1**
2016	2	2	0	0	0	**4**
Total	**4**	**4**	**1**	**2**	**0**	**11**

4 Traffic Circulation and Pedestrian Field Observations

Ayres Associates engineering staff conducted several field observation studies during school arrival and dismissal time periods. Ayres Associates staff, along with City staff, participated in a school bus ride-along on February 23, 2016 during the afternoon route. Additionally, staff observed the afternoon dismissal period on Wednesday, March 16, 2016, and the morning arrival and afternoon dismissal periods on May 12, 2016. Weather conditions for all three observation days were clear. The temperature during the February bus ride-along observation was approximately 35 degrees Fahrenheit. The temperature for the March field observation was approximately 50 degrees Fahrenheit, with heavy winds. The temperature for the May field observations was approximately 70 degrees Fahrenheit, overcast during the morning and sunny in the afternoon.

4.1 School Bus Ride-Along Field Observations

Because the school bus system operates as a shuttle service for the afternoon routes, with RMS as the bus 'hub' for all school buses, stops are made at several schools along the afternoon route. On the ride-along, the first stop after leaving the bus company was at Schurz Elementary School. After picking up several students from Schurz, the bus travelled to Webster Elementary School to pick up more students. From Webster, the route continued to the Boughton Street Apartment Complex east of HWY 16. Several students were dropped off at the complex, where parents were waiting to pick them up. The next stop on the route after the

apartment complex was RMS. Many of the other school buses make similar stops at multiple schools before arriving at RMS. All of the buses meet at the middle school in the west parking lot after making their earlier route stops. RMS students waiting to board the buses also wait inside of the circle of buses under school staff supervision until their particular bus arrives. Once all of the students board the appropriate buses, all buses exit the parking lot in convoy onto Hall Street to take students home.

When approaching the RMS west parking lot on Hall Street, buses have to turn onto Hall Street from Boughton Street or E Main Street. The Boughton Street intersection can have reduced driver sight vision of oncoming traffic due to the skew of the approaches combined with the curvature of the roadway. Additionally, due to parallel parking on Hall Street, buses also experience difficulty navigating the roadway, particularly when attempting to turn into the school parking lot. There are several cases of collisions between buses and parked vehicles in the safety analysis. The first bus to leave the parking lot to head north on Hall Street typically exits from the southern driveway, and stops at the northern driveway to block traffic, allowing the rest of the buses to convoy out of the parking lot. This practice is fairly common at other school system and provides a safe traffic condition. Because the Hall Street intersections with E Main Street and Boughton Street are both partial-stop sign controlled, with stop signs on Hall Street, and traffic is heavy due to buses and parents picking up students, traffic back-ups on Hall Street from both directions can extend back to the west parking lot. Figure 12 and Figure 13 show the traffic congestion conditions on Hall Street as a bus approaches the west parking lot. Figure 14 shows the convoy of buses leaving the parking lot, navigating around vehicles waiting in the queue on Hall Street, as well as parked vehicles and pedestrians.

Figure 12: Northbound Hall St Queue Viewed from Southbound Bus

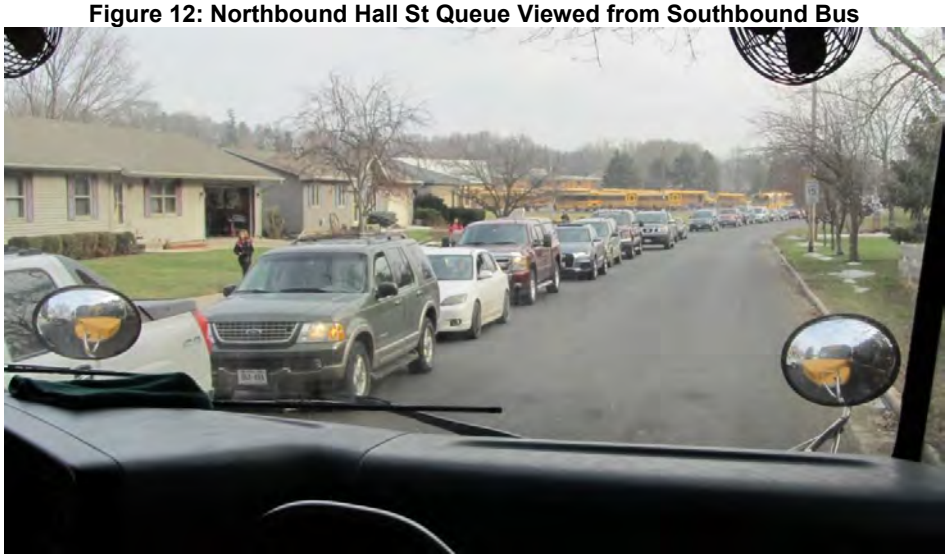


Figure 13: Bus Movements Impeded by Traffic Queue & Parked Vehicles

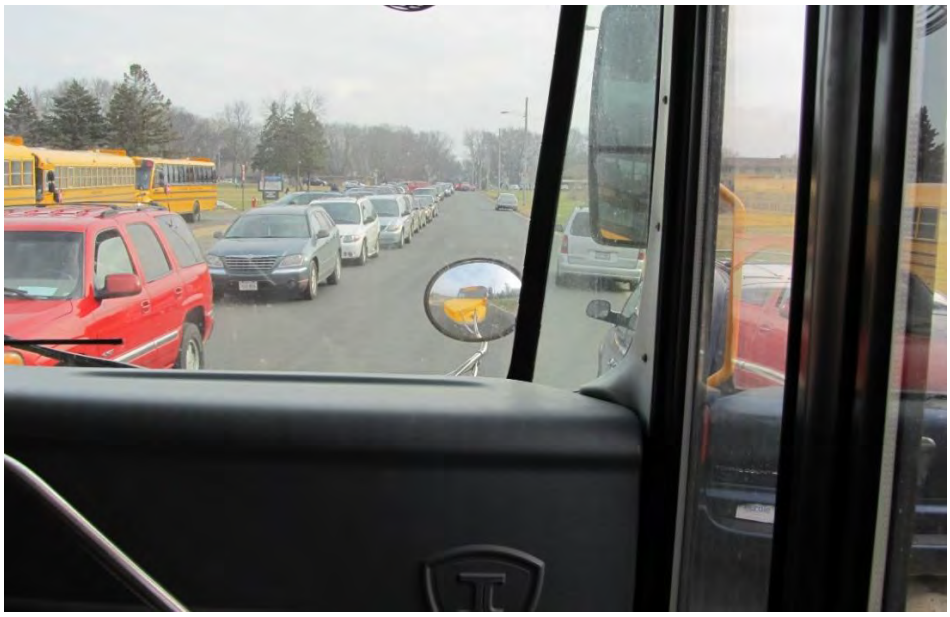


Figure 14: Bus Caravan Exiting RMS West Parking Lot

4.2 School Arrival Field Observations

Students begin arriving at school around 7:00 AM. Only a side building entrance located on the one-way driveway is open for students to use before 7:30 AM. Students who walk to school access the school from all directions; some come from Boughton Avenue and Parkview Lane, walking down Hall Street, or cutting across the RMS Athletic field. Others come from the west end of E Main Street, accessing the school from Hall Street. Sidewalks are available for these routes. Other students come from the east on E Main Street or through the cemetery, accessing the school from the one-way driveway. No sidewalk is available for students coming from these directions. Students walk on the grass or in the street. There are no crosswalk markings across the driveway for students to get from one side to the other. Figure 15 shows various students as they walk or bike to school from E Main Street, Fairview Street, and the

cemetery. They walk on grass, in the street, and around vehicles, creating unnecessary safety conflicts.

Figure 15: Students Walking/Biking on E Main St/One-Way Driveway during School Arrival Period

Similarly, parents dropping their children off do so primarily on the one-way driveway in front of school or on Hall Street near the angle parking. When dropping off in the one-way driveway, parents queue up in the right lane waiting their turn to pull up to the sidewalk in front of the main school building entrance. The queue can extend back to the driveway entrance intersection with E Main Street. Some drivers will use the travel lanes to pull into the spots on the west end of the driveway and other drivers will stop in the travel lanes to drop off their children. Additionally, some students exit their vehicles on the left side, directly into the travel lanes, rather than on the right, onto the sidewalk. The combination of all of these practices creates safety conflicts, congestion, and driver/pedestrian confusion, as vehicles have to navigate around each other, as well as students, to exit the driveway. Additionally, drivers will sometimes park and talk to their children or allow their children to sit in the car during cold weather conditions before entering the school building. This adds to driver delay and vehicle queueing.

Drivers also drop students off on Hall Street in the angle parking area. Pulling into and backing up out of the angle parking spaces can create queuing and safety problems. In general, Hall Street can become quite chaotic as it serves several purposes: some drivers use it as a drop off and turn around location, while others use it as a street to arrive at and leave the school grounds. This operation is exacerbated during inclement weather, such as cold temperatures, snow, or rain. Fewer students walk to school under these conditions, and the number of vehicles navigating the roadways increases. Additionally, if snow banks are located along the curbs, buses and vehicles have less room to maneuver around parked vehicles. Figure 16 shows parents dropping students off from the driveway center lane, students exiting vehicles

Figure 16: Vehicles and Students Navigating One-Way Driveway during School Arrival Period

into traffic while focused on cell phones, and multiple vehicles navigating the one-way driveway to avoid other vehicles and students.

4.3 School Dismissal Field Observations

The school dismissal bell rings at 3:16 PM each day, with all students released from school at that time. Parents who pick up their children each day typically arrive at school between 3:00 and 3:30 PM, with some arriving even before 3:00 PM. Parents will queue up on the one-way driveway and in the cemetery driveway along the fence, and park on E Main Street, on Fairview Drive, and on Hall Street.

Students exit the building from several different doorways, depending on how they get home from school. Students who get picked up on the one-way driveway, E Main Street, in the cemetery, or on Fairview Street typically exit from the main front entrance. Students continuing to the driveway entrance to access the cemetery, E Main Street and Fairview Street cross the one-way driveway and walk through the grass on the far side of the school, around the fence separating school property from businesses on Doctors Court and through the Doctors Court properties. Some students will also walk through the open space at the school and cemetery driveway entrances, across E Main Street through yards and driveways on Fairview Street, and up E Main Street to the east. There are no crosswalk markings or sidewalks in this area, which results in students cutting in front of cars and crossing mid-block, frequently while distracted with cell phones or headphones.

The driveway and cemetery entrances are uncontrolled, so drivers use it for several purposes. Some enter the school driveway, while others enter or exit the cemetery. This space is also used by drivers turning around, or waiting to pick up students. Vehicle paths frequently conflict as drivers make a variety of untraditional turning movements in the space, navigating around each other and pedestrians. Figure 17 shows snapshots of the afternoon dismissal period: students crossing the driveway, students crossing the street in front of vehicles, students walking through yards and on streets, parents navigating the driveway entrances, parents queued on the one-way driveway and the cemetery driveway, and parents parked in front of the cemetery entrance, on E Main Street, and on Fairview Street.

Leaving the one-way driveway onto Hall Street can be similarly chaotic and uncontrolled. As with the morning arrival periods, drivers have to navigate around other vehicles and students to get to Hall Street. A queue can build up on the driveway due to the traffic queue on Hall Street. Parents also use Hall Street to pick up students, so the traffic on Hall Street is congested with drivers waiting in queue to turn onto E Main Street or Boughton Street, as well as drivers waiting for students in the angle parking area and turning around. The southbound queue on Hall Street depends on the queue on E Main Street as southwestbound vehicles wait to turn at the intersection with Summit Avenue and E Water Street. The queue on E Main Street can extend back towards Fairview Street, which then impacts the queues on Hall Street and the one-way driveway. Additionally, drivers have to wait for students walking home who use the crosswalks at these intersections, or that cross Hall Street mid-block. The school buses also exit the west parking lot onto Hall Street shortly after 3:30 PM, adding to the congestion. As with the morning arrival period, the queues and delay are more significant with inclement weather as fewer students walk and the number of vehicles increases. During the winter months, the available roadway widths for turning movements and lane changes can be reduced if snow banks are located along the curbs. Figure 18 shows queues on each of the streets surrounding the school during the dismissal periods.

Figure 17: Students Walking on One-Way Driveway/E Main Street/Fairview Street during School Dismissal Period

Figure 18: Queues on E Main Street, One-Way Driveway, and Hall Street during School Dismissal Period

5 Local Stakeholder Concerns

In addition to the field observations, Ayres Associates engineers met with local businesses adjacent to the school and conducted an electronic survey of RMS parents.

5.1 Oak Hill Cemetery Association

Ayres Associates engineers met with Oak Hill Cemetery board members and groundskeepers on May 12, 2016. RMS is built on property that previously belonged to the cemetery. The cemetery has maintained its relationship with the school by allowing parents to wait on the cemetery drive adjacent to the fence separating the cemetery from the school property. "No Parking" signs are posted along the drives throughout the cemetery, but staff is lenient about enforcing it during the school dismissal periods. Although it is a private drive, parents will also drive through the cemetery to avoid Hall Street, using the E Main Street driveway and the north end driveway on Boughton Street.

At times, driving behavior through the cemetery can be aggressive. The paved drive where parents queue is very narrow and does not provide space for two-way traffic. When two vehicles approach each other from opposite directions on the roadway, one frequently "gets pushed off" the drive, driving over grass and grave sites. Similarly, vehicles do not provide space for cemetery maintenance vehicles to pass. Cemetery staff have reported instances of verbal altercations with motorists who want to get through, as well as instances where motorists will drive across graves to pass a blocked off drive. Drivers frequently speed on the drives, which are not designed for high speeds, but rather as private drives to access graves. During winter, some vehicles have slid into the fence if they are travelling too fast down the cemetery hills while approaching the queue where parents are waiting to pick up students. Figure 19 shows the parked vehicle queues on the cemetery drive, from E Main Street and from inside the cemetery. The "No Parking" sign is rarely enforced.

Figure 19: Queues on Cemetery Drive Adjacent to School and "No Parking" Sign

The cemetery would like to continue cooperating with the school, providing parents and students with access to the cemetery, but they hope to find a solution that allows the cemetery staff to work safely and also maintains the respect and dignity of those buried in the cemetery.

5.2 Facilitated Healing Clinic – Doctors Court

Facilitated Healing Clinic is located in the southeast corner of the Doctors Court cul-de-sac. It is the only business on the street to have direct building access on both Doctors Court and E Main Street. The Riverside Dental facility is located adjacent to the one-way driveway, with the remaining businesses located on the north side of Doctors Court, with a fence separating their

properties from RMS. The Facilitated Healing Clinic does not have a parking lot; they have several angle parking spots in the Doctors Court cul-de-sac. However, the entrance to the clinic is located up a flight of stairs, and there is no ADA accessible entrance near the parking spaces. The ADA accessible entrance is located on E Main Street, so clients will park in the on-street parking on E Main Street.

During the school dismissal periods, Facilitated Healing Clinic clients are frequently unable to find parking due to all of the parents waiting for their children on E Main Street and Fairview Street. Additionally, students will walk through the Riverside Dental and Facilitated Healing lawns to avoid walking in the street, and sometimes sit on the stone planter wall that is part of the clinic landscaping while waiting to be picked up. The clinic would like to maintain parking near the ADA accessible entrance at all times, and also maintain a professional appearance outside of the facility without students loitering around the property. Figure 20 shows the ADA accessible entrance on E Main Street, along with the stone wall where students will sit and the RMS driveway entrance.

Figure 20: Facilitated Healing Clinic ADA Accessible Entrance on E Main Street

5.3 Watertown Police Department – RMS Liaison

The Watertown Police Department appoints an officer to serve as a liaison with Riverside Middle School. One of the officer liaison's duties is to patrol the school during student arrival and dismissal periods. The liaison also provides parents with a letter outlining school arrival drop-off and dismissal pick-up procedures. The letter explains that double parking in the one-way driveway is prohibited. Parking is allowed along the curb, as long as buses are not parked in front of the school. It states that the west parking lot is not available for parking during the school dismissal period. The "No Parking" zones on the city streets, as well as several private parking lots where public parking is prohibited, are called out as well. The letter also discusses the agreement with the cemetery allowing parking along the fence, but asks that parents not block passage of any cemetery traffic. Finally, it suggests that parents use Hall Street, Parkview Lane, and Boughton Street for drop-off and pick-up, due to the lack of crosswalks on E Main Street near the driveway entrance.

During field observations, the officer liaison expressed concern over a lack of compliance with the procedures outlined in the letter to parents. Double parking is a common occurrence, as is parking in the open space between the cemetery driveways, which is mentioned as a "No Parking" zone in the letter. Additionally, there are safety concerns with the lack of sidewalks and crosswalks on and surrounding the one-way driveway. Finally, a significant amount of driver and pedestrian distraction is common. Drivers are focused on their own children, or weaving around other vehicles, rather than looking for students who might walk into the middle of the road. Similarly, students are frequently focused on cell phones or music and headphones, rather than on safely crossing the street.

5.4 Parent Survey

Ayres Associates engineers developed an online electronic survey that was emailed to all Riverside Middle School parents in May 2016 asking them to provide information regarding how their child arrives at and departs from school on a usual day. In addition to arrival and dismissal routines, parents were asked to identify traffic and pedestrian safety issues and offer any safety improvement recommendations. Approximately 290 survey responses were received.

5.4.1 School Arrival Routines

Parents were asked to identify how children typically arrive at school.

- 84% of students get dropped off in a private vehicle (parent or carpool)
- 6% of students walk or bike to school
- 10% of students ride the bus

Of the students who walk or bike, 58% come from the north along Boughton Street, 16% come from E Main Street from the west, and 26% come from E Main Street from the east, using the one-way driveway.

Of the students who arrive by vehicle, 76% get dropped off on the one-way driveway, 21% get dropped off on Hall Street, and 3% get dropped off in the cemetery or Fairview Street. This suggests that 97% of parents dropping students off each day use Hall Street. 89% of the parents dropping students off in vehicles arrive between 7:20 and 8:00 AM and 57% of parents dropping students off do not feel that available parking is sufficient during the school arrival period.

The following problems were identified as presenting unsafe conditions during the school arrival period by at least 30% of respondents.

- The E Main Street and Hall Street Intersection
- The E Main Street intersection with the school driveway entrance
- Dropping off on the one-way driveway
- Exiting the one-way driveway
- Lack of sidewalks and crosswalks
- Other parents

Other unsafe conditions that were identified include the Hall Street intersection with Boughton Street, the school bus parking lot, and the lack of bike lanes.

5.4.2 School Dismissal Routines

Parents were asked to identify how children typically leave school.

- 70% of students get picked up in a private vehicle (parent or carpool)
- 16% of students walk or bike home
- 14% of students ride the bus

Of the students who walk or bike, 33% leave to the north along Boughton Street, 39% leave on E Main Street heading west, and 28% leave on E Main Street heading east, using the one-way driveway.

Of the students who leave by vehicle, 27% get picked up on the one-way driveway, 37% get picked up on Hall Street, and 36% get picked up on E Main Street, Fairview Street, or the cemetery entrances. This suggests that 64% of parents picking students up each day use Hall Street. 76% of the parents arrive at the school between 3:00 and 3:30 to pick up students and 76% also feel there is not sufficient parking during the school dismissal period.

The following problems were identified as presenting unsafe conditions during the school arrival period by at least 40% of respondents.

- The E Main Street and Hall Street Intersection
- The E Main Street intersection with the school driveway entrance
- Picking up/waiting on the one-way driveway
- Exiting the one-way driveway
- Lack of sidewalks and crosswalks

Other unsafe conditions that were identified include the Hall Street intersection with Boughton Street, the school bus parking lot, vehicles waiting on E Main Street and Fairview Street, vehicles waiting on Hall Street, and the lack of bike lanes.

5.4.3 Parent Concerns and Recommendations

The final two questions were free responses asking parents to identify any general safety concerns and offer any recommendations. The two questions, along with a summary of the responses, follow:

1. Of any of the previously mentioned problems, or one not yet mentioned, what do you feel is the biggest traffic safety problem at Riverside Middle School?

    - Congestion
    - Lack of organization/control/flow
        - Left-turn lanes
    - Lack of crosswalks/crossing guards
    - Double-parking/Lack of parking
    - Speeding on one-way driveway
    - Dropping students off on the wrong side of one-way driveway
    - Not pulling up to the front spaces on the one-way driveway (no room to cross to make left turn)
    - Students not following rules (bike/ped)
        - Jay-walking at Parkview Lane, Boughton Street, Fairview Street/Cemetery

    - Darting in front of cars
    - Walking in road against traffic flow
    - Not paying attention – cell phones, ear buds, etc.
- Bus Hub/Buses leaving parking lot/blocking traffic on Hall Street
- No visibility leaving west parking lot due to angle parking on Hall Street
- General law-breaking/impatience/road rage of other drivers
- Cell Phones/Other distractions
- Not enough law-enforcement presence

2. Please describe any solutions you feel would improve traffic safety at Riverside Middle School.
    - Change traffic control at Hall Street and E Main Street intersection
        - Roundabout
        - Traffic Signal
    - Channelize left turn lanes (pavement markings) at Hall Street and E Main Street intersection, E Main Street and Summit Avenue intersection, and Hall St and Boughton Street intersection
    - Prohibit left turns at Hall Street and E Main Street intersection and E Main Street and Summit Avenue intersection
    - Crosswalks at all intersections/crossing guards
    - Increased signage for pedestrian awareness/rapid flashing beacons
    - School speed zone flashing feedback signs
    - Add speed bumps on E Main Street and Hall Street
    - Reduce one-way driveway to one lane for channelization
    - No parking in one-way driveway in front of school
    - Sidewalks along school one-way driveway
    - Pedestrian bridge over one-way driveway
    - Prevent drivers from entering one-way driveway
    - Make driveway a two-way road
    - Add a driveway completely circling school
    - Add a driveway on north side of school
    - Add a path/sidewalk through north field along the cemetery for students crossing at Boughton mid-block
    - Create more parking
    - Widen Hall Street
    - Buy the houses on Hall Street and E Main Street to create more space for vehicles
    - Add bike lanes
    - Increased police presence to improve compliance and increase citations
    - A traffic safety program for students – one-time video/speech/program to increase student awareness/education
    - Staggered release times for each grade level
    - Staggered release exits for each grade level
    - Staggered release by travel type – bus students get released before others
    - Prohibit cell phones
    - Relocating bus hub to a different school
    - Increase bus service coverage so fewer students need to be driven to school
    - Swap bus and pick-up locations (buses on driveway, pick up in west parking lot)

Overall, the parents were primarily concerned with improving pedestrian safety, traffic flow, and parking. Responses were similar regardless of how students arrive at and leave school each day. Several of the solutions mentioned by parents have been incorporated into the

recommendation improvements. Others are cost prohibitive or could create new challenges. For example, purchasing homes and increasing police presence have high costs associated with them. Staggering student release times or school exits locations based on grade level could be challenging for parents with multiple children in different grades. Still others are worth considering at a later time. Creating a traffic safety program for students as a school assembly or workshop could be beneficial.

6 Recommendations & Improvements

There are a series of actions that could be implemented to enhance traffic and pedestrian safety in the vicinity of Riverside Middle School. The actions are separated into low cost short-term and longer term improvements. Some improvements focus on the Riverside Middle School property, while others target the city streets surrounding the school. Cost estimates are included with each improvement, and detailed cost estimates for all improvements are included at the end of the report.

6.1 Short Range Improvements

6.1.1 Riverside Middle School Property

1. The first improvement action focusing on the school property involves construction of a sidewalk along the south side of the one-way student drop-off/pick-up driveway between the E Main School entrance and the E Main Street intersection. In addition, the sidewalk on the north side of the driveway should be extended from the staff parking lot entrance to the E Main Street intersection. All sidewalks should be constructed with a minimum 5 foot width and separate curb lawn area. If a curb lawn area between the sidewalk and street is not provided the sidewalk should be a minimum of 7 feet wide. Cost estimates for the sidewalk are expected to be approximately $17,500.

2. In order to access the new sidewalk constructed along the south side of the one-way driveway, a raised pedestrian crosswalk should be added to the driveway. Figure 21 illustrates a typical raised crosswalk design. From field observations, it was determined that most students cross the driveway near the north side of the school building, by the staff parking lot. Students walking south to Hall Street followed the sidewalk on the north side of the driveway and crossed the driveway exit at the existing crosswalk. As a result, adding a crosswalk just north of the main entrance can be expected to create a safer student crossing by increasing driver awareness of the student crossing location, as well as calm traffic entering the student drop-off/pick up area. Cost estimates for a single raised crosswalk are approximately $1,500.

Figure 21: Raised Crosswalk Design

Source: SRTS Guide, saferoutesinfo.org

3. The final low-cost improvement action on RMS property involves changing the existing angle parking on Hall Street to back-in angle parking. Back-in angle parking creates a safer traffic condition as the vision of parked car drivers as they attempt to back into a traffic lane is not obscured by UV darkened windows and/or large parked pick-up trucks in adjacent spaces. The back-in parking maneuver is easy and very similar to a parallel parking maneuver. Back-in angle parking should make it safer and easier for drivers to see northbound traffic on Hall Street to exit their parking space. Costs estimates for this improvement involve new signing, which is expected to cost $100-$200.

6.1.2 City Streets

1. Sidewalks and crosswalks should also be constructed on the streets and intersections surrounding the Riverside Middle School property. E Main Street should have sidewalk constructed on both sides of the street east of the school and cemetery driveway entrances. The sidewalk on the north side of E Main Street will require construction of a retaining wall due to the steep slope of the cemetery property down to the roadway. The cost estimate for this segment of sidewalk, including the retaining wall, is approximately $27,500. The west side of Hall Street should also have sidewalk added, which is expected to cost approximately $61,600, due to the length of Hall Street. Finally, in order to maintain connectivity with E Main Street east of the driveway entrance, sidewalk on the south side of E Main Street between Fairview Street and Summit Avenue could be added. The cost estimate for this segment of sidewalk is approximately $20,000.

2. Crosswalks should be marked with 'Continental' style pavement markings, as shown on Figure 22. Studies have shown that 'Continental' style crosswalk markings are the most visible to motorists and sight-impaired pedestrians. All existing school area crosswalks should be updated with the 'Continental' pavement marking design. In addition, the following intersection approaches are recommended for new crosswalks:

    - West leg of E Main Street/School Driveway Entrance intersection*
    - South leg of Fairview Street/E Main Street intersection
    - East leg of E Main Street/Hall Street intersection**
    - West leg of Summit Avenue/E Main Street intersection
    - North leg of Hall Street/School Driveway Exit intersection*+
    - North leg of Hall Street/West Parking Lot Entrance*+
    - North leg of Hall Street/Boughton Street intersection

- East leg of Hall Street/Boughton Street intersection

*Requires installation of rectangular rapid flashing beacons.
**Requires installation of a new stop sign on westbound E. Main Street at its intersection with Hall Street.
+Requires installation of a raised crosswalk similar to the crosswalk on the one-way driveway.

The total cost estimate to update and add all of the recommended 'Continental' style crosswalks is approximately $3,500.

Figure 22: 'Continental-Style' Crosswalk Pavement Marking

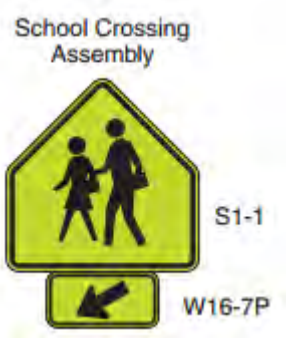
Source: Federal Highway Administration

3. Consideration should be given to installing a mid-block crosswalk on Boughton Street near Hidde Street, as numerous students were observed to walk through the RMS athletic field to cross Boughton Street. This new crossing should be designed with a median pedestrian refuge island and rectangular rapid flashing beacons to create a safe crossing for students and increase driver awareness of the existing pedestrian activity. The 'Continental' Style crosswalk is estimated to cost approximately $350. The median refuge island cost estimate is approximately $5,000, and the rectangular rapid flashing beacon cost estimate is approximately $7,750.

4. In addition to the above sidewalk and crosswalk pedestrian safety enhancement actions, it is also recommended to update the existing school zone signage in compliance with the standards set forth in the *Manual of Uniform Traffic Control Devices*. As shown on Figure 23, there are currently two School Zone Warning signs on Hall Street, one on Boughton Street and one on Summit Avenue. In addition, there are four 15 MPH School Zone Speed Limit signs on Hall Street, and four 15 MPH School Zone Speed Limit signs on E Main Street. There are also two school zone crossing signs at the Boughton Street and Hall Street intersection. School Zone Warning signs should be added to E Main Street, particularly near the intersections with Hall Street and with the school driveway entrance. With the addition of crosswalks at the intersections, school zone crossing signs should be added to each side of the crosswalks, for both directions of travel, for a total of four sign faces per crosswalk, and Yield to Pedestrians signs (MUTCD R1-6) should be added to the approaches of the crosswalks to improve compliance. An example of these signs are shown in Figure 24. One of these signs is already located on Boughton Street on the eastbound approach to Parkview Lane. The total cost estimate to add all recommended crosswalk and school zone warning signing is approximately $4,000.

Figure 23: Existing School Zone Signage

Figure 24: School Crossing In-Street and Yield to Pedestrians Crosswalk Signs



Source: MUTCD 2009 Edition Chapter 2B

5. Rectangular Rapid Flashing Beacons (RRFB) provide additional pedestrian crosswalk safety by alerting motorists of pedestrian crossing activity. The beacons are placed on both sides of the street, and the LEDs flash in a wig-wag pattern when activated by a pedestrian, alerting drivers to yield to any pedestrians in the crosswalk. Rectangular rapid flashing beacons should be installed at: 1) the new crosswalk on E Main Street at the RMS one-way driveway intersection; 2) the proposed mid-block pedestrian crossing on Boughton Street at the Hidde Street intersection; and 3) the two proposed pedestrian crosswalks on Hall Street in the vicinity of the school angle parking area. As previously mentioned, the cost estimate for a single rectangular rapid flashing beacon is $7,750. To install four of the beacons, the total cost estimate is $31,000.

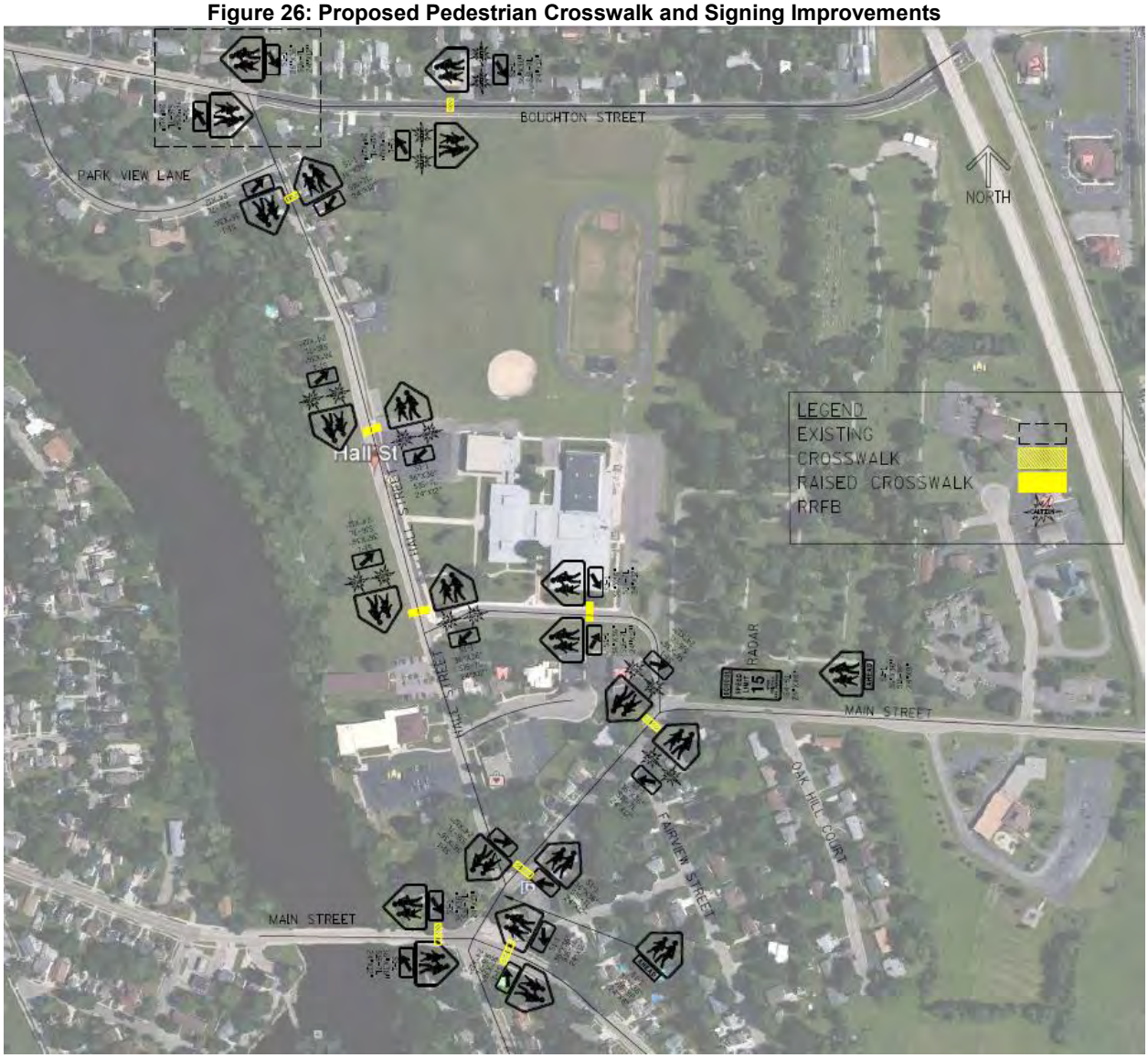
Figure 25: Rectangular Rapid Flashing Beacon (IA-11) with W11-2 sign and W16-7p plaque

Source: MUTCD IA-11 Interim Approval Memo

6. It is also recommended that a solar powered school zone speed feedback sign be installed on westbound E Main Street east of its intersection approach to Oak Hill Court. A school zone speed feedback sign is expected to cost approximately $6,000.

Figure 26 shows the proposed locations of the recommended crosswalks, raised crosswalks, school zone ahead signs, school zone crossing signs, RRFB locations, and radar speed feedback signs. It should be noted that each of the school zone crossing signs should be double-sided to alert drivers in both directions of travel.

Figure 26: Proposed Pedestrian Crosswalk and Signing Improvements



7. It is recommended that a stop sign be installed on the westbound approach of E Main Street at the intersection with Hall Street. Westbound traffic on E Main Street currently blocks southbound traffic on Hall Street due to the queuing that occurs at the intersection with Summit Avenue during school dismissal time. Installation of a stop sign should allow westbound traffic on E Main Street and southbound traffic on Hall Street to follow the 'Rules of the Road' by allowing Hall Street traffic to enter the E Main Street traffic stream. This recommendation includes installation of 'Do Not Block Intersection' signs on the E Main Street westbound approach to the intersection. The cost estimate for the stop sign and related 'Do Not Block Intersection' signs is $50-$100.

8. Another low-cost, short-term improvement involves enhancing existing intersection pavement markings. In addition to the previously recommended crosswalk markings, it is also recommended to install a yellow center line, solid white lane lines, and directional arrows on the intersection approaches of E Main Street with Hall Street and with Summit Avenue. This improvement requires the installation of appropriate advance lane use

signing. At both intersections, the street cross-section width allows for two traffic lanes on the southbound approach, due to the skewed alignment of the approaches. Currently with no lanes, some drivers tend to wait in the middle of the intersection approach, preventing other vehicles from passing them. Adding a left turn lane and a shared through/right turn lane on the Hall Street southbound approach at the intersection with E Main Street and the E Main Street westbound approach at the intersection with Summit Avenue should improve peak traffic operation by allowing through and right turn vehicles to avoid delays created by vehicles waiting to turn left. The left turn lane on E Main Street at the Summit Avenue intersection can be expected to reduce the queuing on E Main Street. The impact of reducing queuing on the E Main Street approach to Summit Avenue can reduce the queue on Hall Street at the intersection with E Main. Likewise, a shorter queue on Hall Street can have impacts on reducing the queuing on the RMS one-way exit driveway queue, as well as at the angle parking area along Hall Street and the western school bus staging area parking lot access point. The cost estimate for all necessary pavement markings, including stop bars, lane arrows, and lane lines, is approximately $1,300 if paint is used, and $1,700 if epoxy is used.

9. It is recommended to add pavement markings to Hall Street at the entrances to the west parking lot prohibiting drivers from blocking the entrances while queued up from the intersection. This recommendation includes installation of 'Do Not Block Driveway' signs on the Hall Street approaches to each driveway entrance. This will provide buses with gaps to enter and exit the parking lot. On-street parallel parking should also be prohibited on the west side of Hall Street within the pavement marking area. Figure 27 shows an example of the proposed markings and signage. The cost estimate for appropriate pavement markings and signage is approximately $200 if paint is used and $400 if epoxy is used.

Figure 27: Example of 'Do Not Block Intersection' Pavement Marking/Signage

Source: 'Roads Bike Newton' – Newtown, MA, bikenewtown.org

6.2 Long Range Improvements

There are several long-range improvements that can be implemented. These are expected to be more costly since they involve development of design plans and construction.

6.2.1 RMS Property

A recommended long-range improvement involves constructing a new parking lot or student drop-off/pick-up turn around location using the RMS athletic field, with access on Boughton Street at the intersection with Hidde Street, as shown on Figure 28. This improvement would provide parents with an additional location to drop-off or pick-up students, reducing the traffic congestion and conflicts on Hall and E Main Streets. The parking lot could be designed to include a drop-off/pick-up driveway, as well as parking spaces for anyone requiring more time. Pavement markings delineating circulation patterns, designated parking areas, and crosswalks should be included in the new entrance to provide controlled and efficient traffic flow and improved safety. Although this action increases traffic conflicts on Boughton Street it should reduce traffic conflicts at all other study intersections surrounding the Riverside Middle School. Estimated construction costs for this alternative are approximately $191,500.

Figure 28: Proposed Drop-Off/Pick-Up Location with Boughton Street Access Point

6.2.2 City Streets

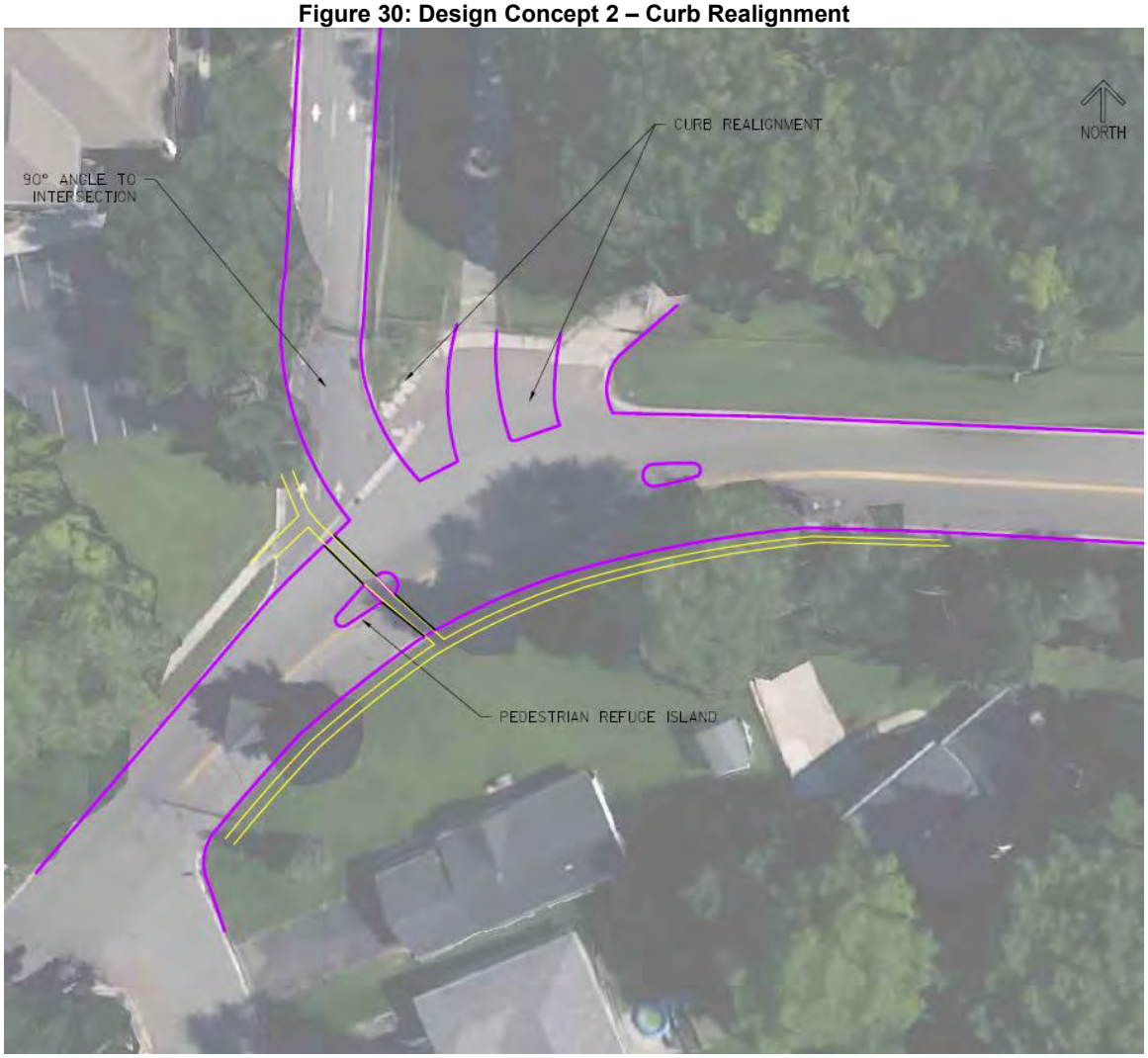
A long-range city street improvement involves redesigning the E Main Street intersection with the school driveway and the cemetery driveways. Existing traffic operation at this intersection is uncontrolled, which creates many conflicting vehicle paths and maneuvers. Adding sidewalks and crosswalks to the existing intersection should improve pedestrian safety, but redesigning the entire intersection to create a more controlled flow should provide a greater impact on improving safety as well as traffic operation. Three intersection improvement options have been developed for this intersection.

1. Design Concept One involves realigning the RMS one-way driveway entrance to intersect E Main Street at an angle closer to 90 degrees, as shown in Figure 29. This option can be expected to reduce the intersection traffic conflict area, reduce speeds of vehicles entering the school driveway and create an enhanced pedestrian crossing location. As previously mentioned, the crosswalk should have appropriate signage, Rectangular Rapid Flashing Beacons, and have 'continental' style markings. Estimated construction costs for this alternative are approximately $209,600. The RRFB and crosswalk costs are not included here, as they have been discussed previously.

Figure 29: Design Concept 1 – Driveway Entrance at 90 Degrees

2. Design Concept Two involves realigning the north side of the E Main Street roadway to eliminate the paved open roadway space near the cemetery driveway, as shown on Figure 30. This option has a benefit of channelizing traffic flow/reducing traffic conflicts and prohibiting drivers from turning around in the open area. Under this option, median pedestrian refuge crosswalk islands should be constructed on E Main Street to increase student pedestrian safety and calm traffic speeds on E Main Street. As with Design Concept One, the crosswalk should have appropriate signage, Rectangular Rapid Flashing Beacons, and have 'continental' style markings. Estimated construction costs for this alternative are approximately $213,700 and do not include RRFBs or crosswalks.

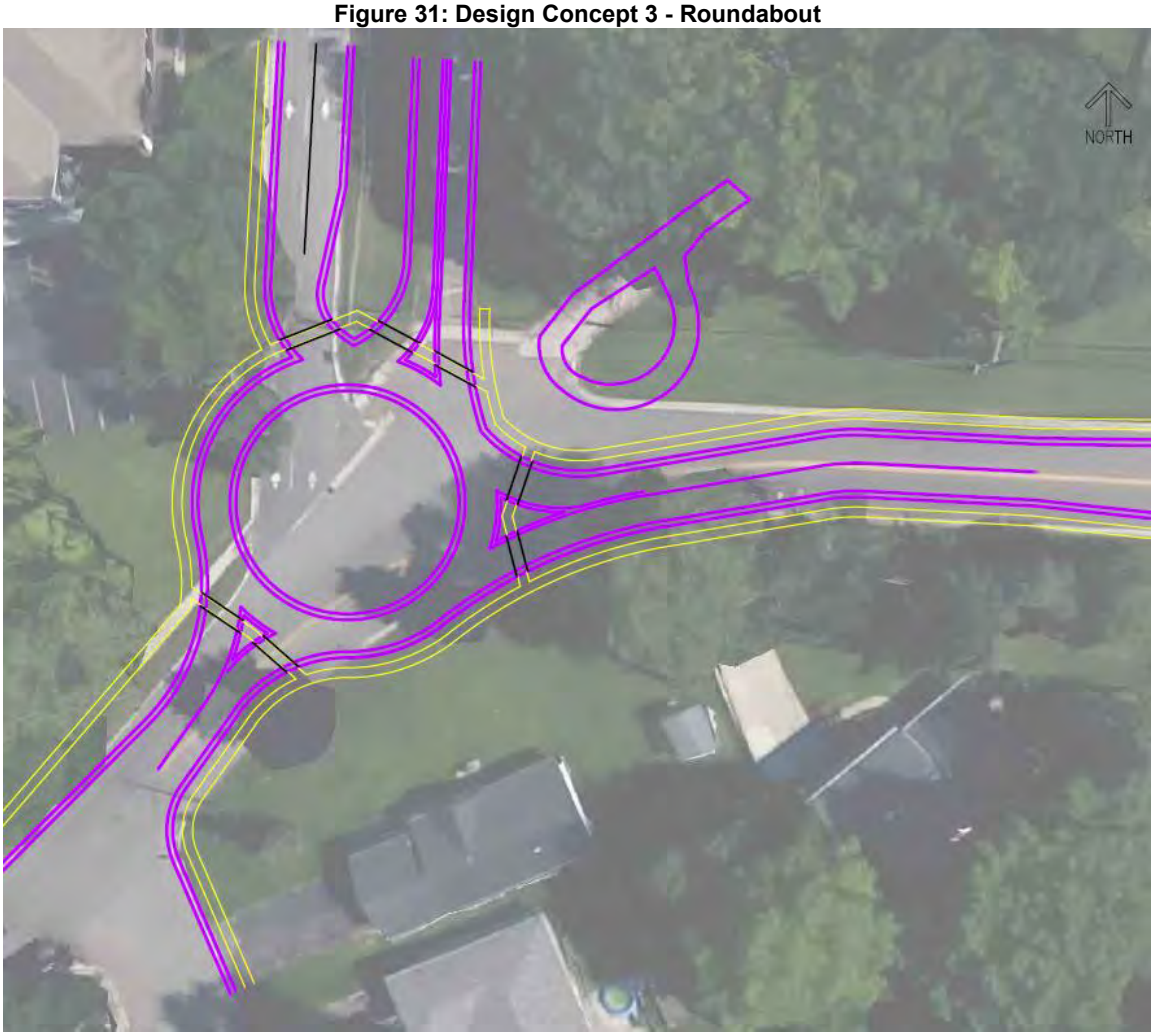
Figure 30: Design Concept 2 – Curb Realignment



3. Design Concept Three involves constructing a roundabout at the intersection, as shown in Figure 31. Roundabouts slow traffic speeds and channelize turning movements to reduce the number of intersection conflict points and have been shown to provide safe pedestrian crosswalk conditions. Roundabouts have been proven to provide the safest intersection control as well as safely accommodate pedestrians and calm traffic speeds. Additional detailed engineering will need to be conducted for a roundabout design to ensure it does not disrupt any cemetery graves, minimizes adjacent property right-of-way needs, and that it is acceptable to the Oak Hill Cemetery Association to cul-de-sac

one of the roadways that intersection with E Main Street. Estimated construction costs for this alternative are approximately $482,800.

Figure 31: Design Concept 3 - Roundabout



Based on the safety impacts of the three intersection construction improvements, it is recommended to construct Option 3. If the detailed design indicates that it is not feasible to construct a roundabout at this intersection, then it is recommended to implement Option 2.

7 Conclusions

The City of Watertown and the Watertown Unified School District requested that a traffic and pedestrian safety study be conducted at the Riverside Middle School Campus. School traffic and pedestrian operating conditions during student arrival and dismissal time periods, along with the surrounding streets and intersections, were evaluated. This included an inventory of the existing signage and pavements markings. A safety analysis reviewing the study area's crash history was also completed. Ayres Associates staff conducted several field observation studies, met with local stakeholders, and conducted an electronic survey for parents to complete regarding their children's travel routines and their traffic safety concerns. From the field observations and input from stakeholders, it was determined that the primary issues are a lack of controlled traffic flow and inadequate pedestrian facilities. A range of improvement actions

were recommended, including short-range, low cost improvements and longer-term more expensive improvements, for both the Riverside Middle School property and the surrounding city streets.

Short Range Safety Improvement Recommendations

1. Construct a sidewalk along the south side of the one-way school driveway from the main school entrance to its intersection with E Main Street.
2. Construct a raised pedestrian crosswalk on the one-way driveway to the new sidewalk identified in Improvement 1 above.
3. Convert the existing angle parking on Hall Street to 'back-in' only angle parking.
4. Add sidewalks and pedestrian crosswalks to surrounding area streets and intersections.
5. School area crosswalks should be upgraded to the 'continental-style' pavement marking to increase driver awareness of pedestrian crossing locations.
6. Install additional school zone crossing signing at selected intersections.
7. Install a stop sign on the southwestbound approach of E Main Street at its intersection with Hall Street, along with 'Do Not Block Intersection' signing.
8. Install a solar powered school zone speed feedback sign on westbound E Main Street east of its intersection approach to Oak Hill Court.
9. Install a mid-block crosswalk with pedestrian refuge islands on Boughton Street near Hidde Drive for students crossing Boughton Street from the RMS Athletic Field.
10. Install Rectangular Rapid Flashing Beacons (RRFB) at the crosswalks: 1) on E Main Street at its intersection with the one-way school driveway entrance; 2) at the new mid-block crossing on Boughton Street; and 3) on the Hall Street crosswalks near the west parking lot driveway and the one-way driveway exit.
11. Install pavement markings to include roadway center lines and left-turn lanes with directional arrows to the south approach of Hall Street at E Main Street and the southwest approach of E Main Street to Summit Avenue. This requires the use of appropriate advance warning signage.
12. Install 'Do Not Block Intersection' pavements markings and signage on Hall Street at the west parking lot entrances, and remove on-street parallel parking in these zones.

Long Range Safety Improvement Recommendations

1. Construct a new parking lot and drop-off area on the north side of the RMS property, with access on Boughton Street at Hidde Street.
2. Redesign the E Main Street intersection with the one-way driveway school entrance and cemetery roadways. It is recommended that the Roundabout (Option #3) be implemented as a long-term safety improvement. If the detail design indicates it is not feasible to construct a roundabout at this intersection it is then recommended to implement Option 2 which involves realigning the school driveway entrance and the north curb of E Main Street to the south.

Appendix A: Cost Estimates

AYRES ASSOCIATES

RIVERSIDE MIDDLE SCHOOL ESTIMATE

8/8/2016

	COST
PARKING LOT	$191,500
SIDEWALK	$139,150
DRIVEWAY ENTRANCE AT 90 DEGREES	$209,600
CURB REALIGNMENT	$213,700
ROUNDABOUT	$482,800
SIGNING	$41,000
PAVEMENT MARKINGS	$15,150

SIDEWALK

LOCATION	SIDEWALK SF	WALL SF	EXCAV CY	BASE COURSE TONS	TOTAL COST
The south side of the one-way driveway	3000		83	74	$17,204
E Main Street East of the driveway entrances, both sides	3100	300	86	77	$27,377
E Main Street between driveway entrance and Summit Avenue, south side	3500		97	86	$20,071
West side of Hall Street between E Main Street and Boughton Street	10750		299	265	$61,647
ITEM TOTAL	20350	300	565	502	
UNIT PRICE	$5.00	$32.00	$14.00	$14.00	
COST	$101,800	$9,600	$8,000	$7,100	$126,500
MISC ITEMS				10%	$12,650
				TOTAL	**$139,150**

PAVEMENT MARKINGS

LOCATION	Quanity	Units	Unit Price	Total Price
Lane Lines (Lane Separation and Do Not Block Intersection Markings) - Paint	500	LF	$0.75	$375.00
Lane Lines (Lane Separation and Do Not Block Intersection Markings) - Epoxy	500	LF	$2.00	$1,000.00
Lane Arrows - Left turn at Hall St, Left turn at E Main Street	2	EACH	$200.00	$400.00
Stop Bars - E Main Street and Hall Street, E Main Street and Summit Avenue	75	LF	$10.00	$750.00
Contentinental Crosswalks - 10 new/updated crosswalks	500	LF	$7.00	$3,500.00
Median Refuge Islands - Boughton Street	1	EACH	$5,000.00	$5,000.00
Raised Crosswalk - 1 on driveway, 2 on Hall Street	3	EACH	$1,500.00	$4,500.00
TOTAL COST, with Epoxy Lane Lines				$15,150.00

SIGNING

SIGN	Quanity	Units	Unit Price	Total Price
School Crossing and Arrow Assembly	36	EACH	$100.00	$3,600.00
School Zone and Ahead Sign Assembly	2	EACH	$100.00	$200.00
Stop Sign	1	EACH	$50.00	$50.00
Back-In Only Signs - Hall Street	3	EACH	$50.00	$150.00
Speed Feedback Radar Sign	1	EACH	$6,000.00	$6,000.00
Rectangular Rapid Flashing Beacon	4	EACH	$7,750.00	$31,000.00
Total Cost				$41,000.00

PARKING LOT

ITEM	QTY	UNIT	UNIT PRICE	TOTAL
HMA PAVEMENT	794	TONS	$68.00	$54,000
1 1/4" BASE COURSE	1553	TONS	$14.00	$21,800
CURB AND GUTTER	2080	LF	$15.00	$31,200
EXCAVATION	3105	CY	$14.00	$43,500
		SUBTOTAL		$150,500
STORM SEWER	10%			$15,100
RESTORATION/E.C.	5%			$7,600
MARKING/SIGNING	2%			$3,100
MOBILIZATION	5%			$7,600
MISC ITEMS	5%			$7,600
TOTAL				**$191,500**

DRIVEWAY ENTRANCE

ITEM	QTY	UNIT	UNIT PRICE	TOTAL
HMA PAVEMENT	805	TONS	$68.00	$54,800
1 1/4" BASE COURSE	2350	TONS	$14.00	$32,900
CURB AND GUTTER	1009	LF	$15.00	$15,200
5" SIDEWALK	913	SF	$5.00	$4,600
EXCAVATION	2663	CY	$15.00	$40,000
SOD	416	SY	$5.00	$2,100
		SUBTOTAL		**$149,600**
REMOVALS	5%			$7,500
STORM SEWER	10%			$15,000
RESTORATION/E.C.	5%			$7,500
MARKING/SIGNING	5%			$7,500
TRAFFIC CONTROL	5%			$7,500
MOBILIZATION	5%			$7,500
MISC ITEMS	5%			$7,500
TOTAL				**$209,600**

CURB REALIGNMENT

ITEM	QTY	UNIT	UNIT PRICE	TOTAL
HMA PAVEMENT	746	TONS	$68.00	$50,800
1 1/4" BASE COURSE	2302	TONS	$14.00	$32,300
CURB AND GUTTER	1255	LF	$15.00	$18,900
5" SIDEWALK	1337	SF	$5.00	$6,700
EXCAVATION	2746	CY	$15.00	$41,200
SOD	443	SY	$5.00	$2,300
		SUBTOTAL		**$152,200**
REMOVALS	5%			$7,700
STORM SEWER	10%			$15,300
RESTORATION/E.C.	5%			$7,700
MARKING/SIGNING	5%			$7,700
TRAFFIC CONTROL	5%			$7,700
MOBILIZATION	5%			$7,700
MISC ITEMS	5%			$7,700
TOTAL				**$213,700**

ROUNDABOUT

ITEM	QTY	UNIT	UNIT PRICE	TOTAL
HMA PAVEMENT	1164	TONS	$68.00	$79,200
1 1/4" BASE COURSE	3563	TONS	$14.00	$49,900
CURB AND GUTTER	3263	LF	$15.00	$49,000
CURB AND GUTTER RAB	297	LF	$20.00	$6,000
5" SIDEWALK	7282	SF	$5.00	$36,500
CONCRETE TRUCK APRON	302	SY	$50.00	$15,100
EXCAVATION	4101	CY	$15.00	$61,600
SOD	788	SY	$5.00	$4,000
WALL MODULAR BLOCK	1350	SF	$32.00	$43,200
		SUBTOTAL		$344,500
REMOVALS	5%			$17,300
STORM SEWER	10%			$34,500
RESTORATION/E.C.	5%			$17,300
MARKING/SIGNING	5%			$17,300
TRAFFIC CONTROL	5%			$17,300
MOBILIZATION	5%			$17,300
MISC ITEMS	5%			$17,300
TOTAL				**$482,800**