RESEARCH

UDOT Keeping Utah Moving

Utah Department of Transportation - Research Division
4501 South 2700 West - P.O. Box 148410 - SLC,UT 84114-8410

Report No. UT-25.16

IDENTIFYING SAFETY HOT SPOTS IN CLOSE PROXIMITY TO K-12 SCHOOLS

Prepared For:

Utah Department of Transportation
Research & Innovation Division

Final Report
November 2025

DISCLAIMER

ACKNOWLEDGMENTS

The authors acknowledge the Utah Department of Transportation (UDOT) for funding this research, and the following individuals from UDOT on the Technical Advisory Committee for helping to guide the research:

- Travis Evans – Active Transportation Safety Manager
- Todd Finlinson – Region 1 Traffic Engineer
- Geoff Dupaix – Region 2 Planning Manager
- Elise Tanner – Crash Data Analytics Manager
- Andrea Guevara – Traffic Management Division Standards Engineer
- Kristen Hoschouer – Safety Outreach Administrator
- Travis Jensen – Research Project Manager (Consultant)

TECHNICAL REPORT ABSTRACT

1. Report No. UT-25.16	2. Government Accession No. N/A	3. Recipient's Catalog No. N/A
4. Title and Subtitle Identifying Safety Hot Spots in Close Proximity to K-12 Schools		5. Report Date September 2025 6. Performing Organization Code N/A
7. Author(s) Shaunna Burbidge, PhD; Samuel Runyan, Collin Gee		8. Performing Organization Report No. N/A
9. Performing Organization Name and Address Avenue Consultants 6605 S Redwood Rd Ste 200 Taylorsville, UT 84123		10. Work Unit No. 5H094 43H 11. Contract or Grant No. 25-8503
12. Sponsoring Agency Name and Address Utah Department of Transportation 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410		13. Type of Report & Period Covered Final October 2024 to September 2025 14. Sponsoring Agency Code UT24.307

15. Supplementary Notes

Prepared in cooperation with the Utah Department of Transportation and the US Department of Transportation, Federal Highway Administration

16. Abstract

This study was conducted to help the Utah Department of Transportation (UDOT) identify and prioritize schools which have seen higher numbers of pedestrian- or bicyclist-involved crashes of school-age individuals. While UDOT's Safe Routes to School (SRTS) Program (which is called Safe Routes Utah within the state) supports safety planning and infrastructure funding, there has not been a standardized method to determine which schools are most in need of support. To address this, researchers conducted a geospatial analysis of pedestrian and bicyclist crashes involving school-age children (ages 5–17) within a 0.25-mile radius of public K–12 schools across Utah, during school travel hours. The analysis included crash records from a five-year period and incorporated school location data, infrastructure features, and whether a school had an existing SRTS plan. The results identified schools with the highest number of applicable crashes, both statewide and by UDOT region. The top two schools in each Region were selected for detailed review of crash conditions and contributing factors. Common trends included crashes at intersections involving turning vehicles and low-light visibility concerns during morning travel. Findings also revealed that many high-crash schools lack an SRTS plan, particularly high schools which are not currently required to have one. Numerous recommendations for infrastructure which can be implemented are discussed in this report. Overall crash data can effectively support school safety prioritization and offers UDOT a replicable method for identifying high-need areas, enhancing SRTS planning, and informing infrastructure investments that promote safer walking and biking routes for Utah students.

17. Key Words School Safety, Zero Fatalities, School Zones, Hot Spots, Active Transportation, Pedestrian Safety, Pedestrian Crashes, Bicycle Safety, Bicycle Crashes		18. Distribution Statement Not restricted. Available through: UDOT Research Division 4501 South 2700 West P.O. Box 148410 Salt Lake City, UT 84114-8410 www.udot.utah.gov/go/research		23. Registrant's Seal N/A
19. Security Classification (of this report) Unclassified	20. Security Classification (of this page) Unclassified	21. No. of Pages 149	22. Price N/A	

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

UNIT CONVERSION FACTORS

SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. (Adapted from FHWA report template, Revised March 2003)

LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
D&RG	Denver & Rio Grande
DOT	Department of Transportation
DUI	Driving Under the Influence
FHWA	Federal Highway Administration
HAWK	High-Intensity Activated Crosswalk
HSIP	Highway Safety Improvement Program
HVC	High Visibility Crosswalk
K-12	Kindergarten Through 12^{th} Grade Public Schools
LED	Light-Emitting Diode
MPH	Miles Per Hour
MUTCD	Manual of Uniform Traffic Control Devices
OSSLA	Overhead School Speed Limit Assemblies
RRFB	Rectangular Rapid Flashing Beacon
SNAP	Student Neighborhood Access Plan
SPF	Safety Performance Function
SRTS	Safe Routes to School
TAC	Technical Advisory Committee
TRAX	UTA Light Rail System
UDOT	Utah Department of Transportation
UGRC	Utah Geospatial Resource Center
US	United States
UTA	Utah Transit Authority

EXECUTIVE SUMMARY

The safety of students at Utah kindergarten through 12th grade schools (K-12 schools) traveling to and from school is a top priority for the Utah Department of Transportation (UDOT). With more than 675,000 students enrolled across the state, improving pedestrian and bicycle safety near schools is increasingly important as the state population grows and more road users are present. While UDOT's Safe Routes to School (SRTS) Program (which is called Safe Routes Utah within the state) supports schools in developing localized safety plans and obtaining funding for infrastructural improvements, there is currently no data-driven process to help UDOT prioritize which schools may be at highest risk or in greatest need of assistance regarding crashes impacting school-age pedestrians and bicyclists.

To help fill this gap, this research focused on identifying high-priority crash "hot spots" located near public K–12 schools across Utah. By utilizing geospatial analysis, the project team evaluated non-motorist crashes involving school-age children and teenagers occurring within a 0.25-mile radius of school facilities within timeframes most likely to see students traveling to and from school. This allowed for identification of schools which see higher numbers of these crashes, subsequently enabling UDOT to better allocate resources, provide targeted support to schools, and inform future improvements to strengthen the SRTS program.

The study utilized a comprehensive literature review of existing SRTS programs, including their benefits, implementation challenges, and known effectiveness. The literature review also examined previous research and study on non-motorist crashes near school facilities. Such background information was used in the development of project methodology, which involved collecting crash data, school location data, infrastructure attributes, and existing SRTS plan information. Crash data were filtered to include only those incidents likely to involve student travel. Criteria were based on time of day, age of persons, and travel mode; after filtering, the data was mapped using ArcGIS Pro software.

A 0.25-mile buffer was placed around each school. This buffer was then utilized to identify the total number of applicable crashes per school and summarize results both statewide and by UDOT region. In total, 984 crashes met the study's criteria. The top two schools per region with the highest crash counts were selected for further analysis, including crash characteristic review, visual mapping, and evaluation of surrounding infrastructure, to help determine what potential factors may contribute to such crashes near school facilities and constitute ‘hot spots.’ Davis High and Kaysville Jr. High (Region 1), Kearns High and West Jordan High (Region 2), Provo Peaks Elementary and Spanish Fork Jr. High (Region 3), and Dixie High and Snow Canyon Middle (Region 4) were highlighted in regional case studies.

Several key findings were identified in the analysis. These included the following:

- Crashes were most concentrated around schools in urban areas with higher roadway volumes.
- High schools made up a significant portion of top-ranking crash locations, though they are not required to have SRTS plans unless there is a school crosswalk on a state facility nearby.
- A large number of crashes involved right- or left-turning vehicles failing to yield to pedestrians or cyclists at intersections.
- Crashes during early morning hours often occurred under low-light conditions, potentially reducing driver visibility.
- While bicycles were involved more frequently than pedestrians in many locations, both modes showed safety risks in certain environments.

An additional notable finding was that several schools across the state with higher crash totals lacked SRTS plans. While not all schools (particularly high schools) are required to have SRTS plans, this may underscore the need for improved plan coverage and prioritization.

The study concludes that a data-driven prioritization process can provide a valuable tool for UDOT and its regions to identify schools in greater need of outreach, infrastructure improvements, or plan development. The recommended implementation plan includes expanding crash monitoring tools, integrating hot spot data into SRTS planning, and supporting schools (particularly those in high-crash zones) with technical resources and funding guidance.

1.0 INTRODUCTION

1.1 Problem Statement

Over 675,000 students attend Utah's K-12 schools, and their safe transportation to and from school is a priority. To facilitate this, the Utah Department of Transportation (UDOT) administers a Safe Routes to School (SRTS) Program that is called Safe Routes Utah within the state. This report will refer to this program as SRTS since that is the term most often used nationally for these programs. There are two major components to this program. The first is a funding program in which local agencies are encouraged to develop proposals and submit applications to fund infrastructure projects that they believe will help more school children walk and bike safely to school. The second component of the SRTS program includes a web-based platform where individual schools create a safe routing map for their student body, and a comprehensive plan for safety in the areas surrounding their school. Typically, school personnel (principal, faculty, etc.) are responsible for completing these plans and maps. While these individuals are aptly qualified to teach children, they likely have little to no experience or training in transportation safety and what locations should be addressed or what infrastructure or engineering solutions should be employed. The UDOT Traffic and Safety Division and the individual UDOT regions can provide outreach assistance to schools as they create their plans, but with over 1,000 public and charter schools across 42 districts, UDOT cannot provide assistance to every school. Currently there is no process in place for UDOT to prioritize resources to assist schools that have greater safety needs or higher risks for students.

1.2 Objectives

This research conducted an analysis of active transportation student-involved crashes that occurred during school travel windows using a quarter-mile buffer for public schools in Utah. The analysis was then used to identify safety hot spots in close proximity to schools using a process that examines both the number of student-involved crashes and contributing factors. This process identified priority schools by UDOT region. The highest need schools were evaluated based on their specific environmental and transportation system conditions and a set of infrastructure solutions was provided for addressing safety issues. This process allowed the

UDOT Traffic and Safety Division and the UDOT regions to quickly identify schools that may need assistance in improving their SRTS Plan or help with identifying recommendations and areas for improvement. The results of this study were also intended to help UDOT with funding prioritization for schools with the highest need based on current trends.

1.3 Scope

The scope of this study consisted of the following processes, tasks, and items.

- Project Management and Administration
  - Project management consisting of conducting a kick-off meeting with the technical advisory committee (TAC) to refine the scope, timeline, and deliverables of the research. Additionally, the research team and TAC coordinated and met regularly to provide updates and status reports on the progress of the research.
- Data Collection
  - The research team compiled an inventory of all K-12 public schools in Utah. The team then collected roadway safety data for a 0.25 mile buffer surrounding each school location. A spatially referenced database was used to consolidate the data.
- Crash Analysis
  - The project team filtered non-motorist crashes which occurred during school travel windows within the identified buffers for each school in the sample. Geospatial analysis was used to identify the schools with the highest number of such crashes.
- School Prioritization
  - The project team used the data collected to create a prioritization schema based on the number of crashes per school. Analysis identified the top schools statewide and in each UDOT region, subsequently identifying the key hot spots for student

crashes throughout the state near school facilities. Additional analysis for the top two ranked schools in each UDOT region was also conducted, identifying key locations for improvements and recommended treatments.

- Develop Conclusions
    - In this study, the research team identified conclusions and recommendations based upon observations and analyses in each of the scope items above, which assisted UDOT in better implementing the research results. This report contains an Implementation Plan created in conjunction with the UDOT TAC. This plan utilizes analysis and conclusions from the study to determine what safety improvements UDOT can make moving forward to improve pedestrian safety for students near school facilities.

1.4 Outline of Report

This document is organized by the following sections:

- Chapter 2 discusses research methods and includes a literature review.
- Chapter 3 presents collected data on public school locations and crashes around Utah.
- Chapter 4 presents a quantitative analysis of data pertaining to schools and crashes.
- Chapter 5 provides conclusions based upon data analysis.
- Chapter 6 outlines recommendations and the implementation plan.

2.0 RESEARCH METHODS

2.1 Overview

This section outlines the research methods used to examine pedestrian crash patterns near schools in Utah and background research performed on the topic. The research team conducted a literature review for the project, centered around the development of SRTS programs in Utah. The literature review explored the structure, goals, effectiveness, and implementation challenges of these programs, with a focus on both national practices and Utah-based SRTS programs. The literature review also highlights key findings from crash analysis studies performed on crashes occurring near school facilities across Utah and the US. The geospatial methodology used for this project is then discussed. This includes a review of data sources, different crash attributes used as filtering parameters, and the prioritization strategy used to identify high-risk school zones.

2.2 Literature Review

Walking to school, which was once a commonplace rite of passage in Utah and other states, now makes up only a small minority of school trips. By 2004 less than 13% of school trips were made using active modes of transportation, compared to over 50% in 1969 (Mohai, Kweon, Lee and Ard, 2011). According to Kerr et al., the main reason students no longer walk and bike to school is parental concerns about safety (Kerr et al., 2006). Due to this decline, and to improve the safety and effectiveness of walking to school for students, SRTS programs have been developed in Utah. These programs assist in funding projects which improve safety conditions around schools, such as improvements to signage, striping, active transportation infrastructure (both on and off street), traffic calming measures, etc. These projects are designed to create safer options for students walking to school, encourage more walking to school, and increase active transportation among students generally. Published literature and previous studies reveal that SRTS programs have been effective in reducing risk of injury or fatality for students that walk and bike and increasing the number of students walking and biking to school (DiMaggio et al., 2016 and McDonald et al., 2014).

The purpose and analysis of this project was not to examine SRTS programs specifically. However, identifying crash hot spots near schools in Utah would assist school administrators in focusing resources from SRTS programs more effectively on trouble spots where crashes may be more prevalent. As a result, a literature review was conducted to examine details of Utah SRTS programs currently, effectiveness of SRTS programs generally, and common challenges which may arise in SRTS implementation. The literature review also examined research on crashes near schools performed previously. The information in the literature review, combined with the analysis detailed in this report, provides a view of how SRTS programs backed by crash data can help identify and potentially mitigate safety concerns for pedestrians near schools.

2.2.1 Utah Safe Routes to School Program

According to the 2017 National Household Travel Survey (FHWA, 2019), only 10.4% of students ages 5-12 currently walk or bike to school in the US, compared to 13.7% in 2001. This is down from 48% in 1975 (Tudor-Locke, Ainsworth, and Popkin; 2001). This same dataset also showed that 80.9% of children who live “very close” to school (1/4 mile or less) walk on a usual school day (FHWA, 2019). As a result of this decline in active transportation and to improve safety for children wanting to walk or bike to school, several SRTS programs have been developed at the federal and state level. This includes the Utah SRTS program.

Since its inception, UDOT’s SRTS program has provided Utah schools with walking and biking safety resources through the Student Neighborhood Access Program (SNAP), and Utah’s SRTS program. The main goal of the Program is to assist and encourage students living within 1.5-2.0 miles to safely walk or bike to school (UDOT, 2018). The program includes both encouragement and educational programs, as well as a funding program which provides funds for construction and implementation projects. In recent years UDOT has seen great value in incorporating SRTS with other existing programs. Recently the SRTS program has begun working cooperatively with the Zero Fatalities program and Move Utah.

Through the Utah SRTS funding program, municipalities or other agencies may apply for funding of non-infrastructure (education and encouragement programs), and infrastructure projects (physical improvements - primarily new sidewalks, etc.), based on an allotment of both state and federal funds. Funding applications are screened by a review panel to determine which projects will provide the best return on investment for improving school safety. Projects are selected and funded on a 3-year rolling funding cycle through a project reimbursement program, which means that the funding recipient pays initial construction costs and is reimbursed by UDOT when the project is completed.

Within the SRTS programs, eligible infrastructure projects used to improve safety of school routes for Utah students include bike parking facilities, sign installments, on-street bike facilities, off-street bike/pedestrian facilities, crossing improvements, street striping, signals, signage, traffic calming devices, and increased placement of sidewalks. Project budgets typically range between $50,000 and $200,000. Individual SRTS improvement plans enacted through the program should work to fill in gaps or hazards identified through a school's SNAP map to create safer routes and walking options for students. The SRTS program also may work in conjunction with the Utah Safe Sidewalk program. This program provides a legislative funding source for the construction of new sidewalks adjacent to state routes where sidewalks do not currently exist and where major construction or reconstruction of the route, at that location, is not planned for ten or more years.

2.2.2 Effectiveness of SRTS Programs

While SRTS projects aim to improve safety and accessibility for students to walk and bike to school, how effective are these projects, and to what degree have they been implemented by schools and communities? The premise of the SRTS program is the net benefit to the communities relative to safety, health, and quality of life. For example, an examination of New York City's SRTS program found that the program was associated with a net social benefit of $230 million and 2,055 quality adjusted life years gained in New York City" (Muennig, Epstein, Li, and DiMaggio; 2014).

Research has also shown that students typically walk and bike more after an SRTS project has been completed in the area. A study by Boarnet et al., (2005), examined 10 sites in California where SRTS funding had been used for construction projects. The research team surveyed 1,244 parents 1-18 months after the completion of project construction and asked parents to identify whether their children walked and biked more or less frequently after the project's completion. Their analysis determined that approximately 10.6% of students walked or biked more after construction, and that the proportion of children who walked or biked more after construction was “significantly greater among children for whom the project location was along their usual route.” 15.4% of children who passed the project site on the way to school walked more following construction, compared to 4.3% of children who did not pass the project site.

A separate study of projects completed in Eugene, Oregon, determined that SRTS infrastructure improvements were associated with increases in walking and biking of 5-20% (McDonald, Yang, Abbott, and Bullock; 2013). Direct comparative analysis also indicates that SRTS programs can encourage more walking and biking. Such a study examined more than 800 schools in multiple US states with and without SRTS; findings indicated that engineering improvements combined with educational outreach for the students resulting from an SRTS program could lead to an increase in student active transportation users of 25%. (McDonald et al., 2014). Increasing the number of students walking or bicycling to school yields secondary health and wellness benefits due to increased physical activity. Buttazzoni et al., identified that walking or bicycling to school can help children achieve up to 30% of their daily recommended physical activity and are associated with increased fitness levels, reduced stress, improved mental health, and increase in positive emotions (Buttazzoni et al., 2018).

While an entire program can be examined for net benefits, it can be more difficult to determine the safety outcomes of construction projects. Since the main goal of the SRTS program is improved safety, it is important to quantify the actual impacts these projects have on student safety and not just identify changes in student walking and biking behavior (although this can often serve as a surrogate for improved perceptions of safety). Potentially dangerous environments such as busy highways or arterial roads often prevent parents from allowing their children to walk or bike to school (Timperio et al., 2006). Therefore, can projects that remove such barriers improve safety and encourage safe walking and biking? Boarnet et al. (2005) found that replacing four-way stop signs with traffic signals increased the number of children walking. However, there is a lack of evidence regarding the effectiveness and safety improvements of SRTS infrastructure projects. Dumbaugh and Frank (2006) claim that “substantive discussions of traffic safety are largely absent from the Safe Routes to School literature.” Their review of SRTS literature determined that the safety benefits of SRTS projects are largely presumed, and only raised medians and sidewalks were found to reduce pedestrian-vehicle crashes. As a result, more research to fill gaps in empirical knowledge by evaluating non-motorized safety before and after the construction of SRTS-funded infrastructure projects is needed.

2.2.3 Challenges in Implementation of SRTS Programs

A major factor regarding SRTS programs is how effectively they have been implemented. SRTS programs offer many benefits as previously discussed, with numerous studies and literature reflecting this. However, an SRTS program depends on community involvement and effort from a school in order to be successful. Past research examining the implementation of SRTS programs has identified potential challenges to program success, particularly when focusing on implementation of SRTS programs within disadvantaged communities.

Disadvantaged communities with fewer resources may also struggle to implement an SRTS program in certain cases. Without appropriate resources available to implement program structure, it is unlikely that the benefits of an SRTS program will be enjoyed by a community. Literature on this subject is somewhat more limited than projects analyzing the overall effectiveness of SRTS programs generally. An extensive study by Elliot et al., (2022), found that there is little existing evidence that SRTS funds are programmed to disadvantaged or underserved communities, that only 13 out of 51 states (including Washington, D.C.) support equitable SRTS programs, and that only 19 out of 51 states target SRTS funding specifically toward higher need communities.

This study also found that federal guides on SRTS programs may be outdated and unable to assist communities in need. A lack of government oversight on SRTS programs and lack of quality in available resources may negatively impact communities' ability to implement such programs. Elliot et al. also found that major barriers in underserved and low-income communities to implementing an SRTS program include lack of qualified individuals to run the program and apply for funding, inability to pay the community match portion of the SRTS budget, lack of staff/parent capacity, and other issues (Elliot et al., 2022). The authors suggest that SRTS and state officials should promote resources on engaging communities in these programs and analyzing what specific needs are present.

Somewhat in contrast to such research, a study on SRTS programs in California found that low-income schools were overrepresented among schools with such a program, while a similar study in Washington found mixed results, though schools with SRTS programs were typically located in areas with larger minority households and lower incomes (McDonald et al., 2013). Another study by Stewart et al., found that after implementing SRTS programs, schools in areas of six states with higher percentages of non-English-speaking or low-income households experienced active transportation increases similar to those experienced by schools in other areas with more typical demographics (2014). These mixed results perhaps indicate that when an effort is made to implement SRTS programs in low-income communities in light of particular challenges there, the program can still be successful.

A major key to the implementation of an effective SRTS program seems to be effort and ability of the school and surrounding community. Appropriate effort is essential to the successful implementation of an SRTS program and can ensure that the program will function properly despite potential barriers or challenges to its implementation. The effort to implement an SRTS program will depend on the abilities of the surrounding community and the interest shown in the program, and disadvantaged communities may face more challenges in creating an SRTS program that will improve safety and accomplish its goals (Elliot et al., 2022). Further research and study into the implementation of SRTS programs is needed to better identify challenges that school districts and communities may face in developing these programs, and examples of how to overcome such issues.

2.2.4 Utah-Based Crash Analysis Studies

Several studies have been performed in Utah which provide valuable insights into pedestrian crash patterns around public schools. One key study consisted of a systemic analysis of bicycle and pedestrian safety in Utah (Singleton et al., 2021). This analysis consisted of conducting a statewide review to identify high-risk locations and contributing environmental factors to pedestrian and bicyclist crashes near schools. The analysis utilized safety performance functions (SPFs) based upon crash frequency models and local data to identify crash risk factors. The analysis determined that wider roads with more lanes near schools and higher volumes of both vehicle and active transportation traffic tend to increase pedestrian crash risks. Roadways with more driveway accesses and a higher functional classification (e.g., non-local roads) also tended to see higher numbers of crashes. The study found that implementing traffic calming measures can help reduce these incidents overall. Median islands and similar barriers on higher speed roads are examples of infrastructure that was found to help reduce pedestrian and bike crashes.

The study "Risk Factors for Pedestrian Crashes on Utah State Highway Segments" (Rahman et al., 2023) employed both parametric and non-parametric modeling approaches (including Poisson regression and random forests) to explore crash risk factors. The study separated the influence of environmental and demographic factors in the analysis to examine different attributes associated with these factors. This study did not focus on schools specifically but did note that schools often lie in mixed-use land areas. These mixed-use land areas are trip generators for pedestrian activities, and as a result see higher levels of crashes. In addition, the study found that higher-speed roads, areas with greater minority populations, and regions with limited pedestrian infrastructure were more likely to see higher numbers of crashes. Other factors contributing to higher numbers of crashes included two-way left-turn lanes, increased number of driveways, and higher roadway volumes generally.

Another previous study conducted analysis combining crash mapping, site observations, and stakeholder input to assess pedestrian safety issues near schools and colleges (Cottrell, 2004). Notably, the study found that grade-separated pedestrian safety infrastructure is less likely to be constructed near high schools. The study also found that many crashes in Utah occurred outside designated crosswalks, emphasizing the need to improve crossing opportunities where pedestrians naturally choose to walk. The study makes numerous recommendations for safety improvement, including targeted infrastructure upgrades (e.g., enhanced crossings and pedestrian refuge islands) alongside educational outreach to better inform drivers and pedestrians of safety issues. The study also recommends that current SRTS routes be evaluated and possibly reconsidered if pedestrian crashes commonly occur on these routes.

2.2.5 US-Based Crash Analysis Studies

Additional school crash analysis literature from other locations in the US was examined. A Nebraska-based study examined data on crash rates and severity between active (e.g., flashing lights) and passive school zones by applying statistical comparisons across school areas (Wali and Khattak, 2020). The study found that active zones actually had more crashes overall. However, passive school zones saw vehicles traveling at higher speeds, and increased crash severities. The reduced crash severity in active zones is likely due to lower speed limits and the presence of crossing guards or flashing beacons. The study ultimately warns against indiscriminate use of school zones, recommending that agencies carefully assess where school zones are most needed.

A study by Clifton and Kreamer-Fults (2007) applied multivariate statistical models to crash data around public schools in Baltimore, Maryland. Their analysis process consisted of integrating multiple variables consisting of socioeconomic, land use, and road network data to analyze pedestrian-vehicle crashes at a more granular level. The study found that the presence of a driveway or turning bay at the school entryway decreases crash occurrences and injury severity. However, school recreational facilities near roadways are associated with higher crash occurrences and severities. The study found that arterial roadways and adjacent land uses (such as commercial zones) contributed to higher crash rates. Overall, the study results indicate that multiple links exist between school pedestrian crashes and the urban design of the surrounding area.

A study by DiMaggio et al. (2016) evaluated the national SRTS program to understand more about how SRTS programs impact pedestrian and bicyclist safety. The study was performed by taking crash records for school-age children and adults from 1995-2010 to compare pedestrian injury rates before and after SRTS program implementation across multiple US states. The analysis revealed approximately 23% and 20% declines in injury and fatality risk respectively among school-aged children where SRTS programs had been implemented (in comparison to adults over the same time period). The study concluded that SRTS programs had contributed to improving traffic safety for school-aged children across the country.

The Federal Highway Administration (FHWA) Guidebook (2018) provides systematic frameworks for identifying high pedestrian crash locations, including stepwise procedures for data collection, GIS-based mapping, and risk assessment. The guide discusses how the city of Los Angeles utilized a high-injury network to help prioritize SRTS project routes. This network displays where pedestrian and bicyclist severe crash incidents have occurred in the context of other variables (such as community health and equity indicators). This example highlights how crash and injury data can be utilized to prioritize and select areas where safety improvements are needed, helping to focus SRTS initiatives.

2.3 Project Methods

The project team determined that the best method of analysis for this study would be to utilize geospatial analysis to identify crashes which occur nearest to school facilities throughout Utah. To conduct this analysis, the team located and downloaded data layers related to school and crash variables for analysis. These were then used to identify schools with the most nearby crashes and identify potential hot spots for crashes near school facilities.

2.3.1 Data Collection

The first step of analysis consisted of identifying and collecting needed data. Data collected for this study consisted of the following:

- Crash Data: These were collected and filtered to retain crashes most likely to be associated with students or nearby schools over a five-year period.
    - Filtering was based on factors including age of persons involved, pedestrians involved, environmental conditions, etc.
- School Location/SRTS Plan Data: These provided an overview of where schools are located throughout the state, as well as which schools currently have a designated SRTS plan.
- Transportation Infrastructure Data: Infrastructure data helped to highlight any potential gaps in safety infrastructure which may contribute to crash issues near schools.

These datasets were loaded into an ArcGIS Pro project that allowed for spatial analysis to be conducted on the relationships between the various data types.

2.3.2 Prioritization Analysis

To examine crashes nearest to schools, the project team decided to examine all crashes (including crashes with recorded fatal and/or severe injuries) within 0.25 miles of schools. The number of students who live close to school facilities and walk to school or would otherwise be present on streets near the school during school hours will be higher within this quarter-mile distance from school facilities. Previous experience by the project team has found that fewer students will walk to school and be present on streets at greater distances than 0.25 miles. As a result, crashes within this distance from schools were examined.

This analysis shows which schools had the most applicable crashes within a 0.25-mile radius. The project team highlighted the schools with the most crashes statewide, and then the five schools with the most crashes in each UDOT region.

The final analysis steps consisted of examining attributes of crashes within 0.25 miles of the top two schools in each region. The project team examined what aspects contributed to crashes near these schools, based on crash attributes and infrastructure near the crashes. This analysis was then utilized to derive study conclusions and identify findings.

2.4 Summary

For this project, the research team reviewed the current state of student active transportation and the role of SRTS programs in improving school zone safety in Utah and the US. A review of national and Utah-based studies provided key insights into crash trends, risk factors, and the impact of infrastructure as these factors relate to SRTS programs. While this study does not focus specifically on SRTS programs, the context provided by a review of SRTS programs added useful information. The literature review also covered crash analysis studies performed for pedestrian crashes which occur near schools, including both Utah and US-based studies. Information from the literature review assisted in developing the project research approach and study methods. This study utilized geospatial analysis to identify crash hot spots within 0.25 miles of schools across Utah. This method helped identify schools with the highest number of crash incidents and allowed for a review of contributing environmental and infrastructural factors. This in turn helped the research team provide information which informed recommended safety improvements for school facilities and improved active transportation safety for students.

3.0 DATA COLLECTION

3.1 Overview

To conduct the analysis described previously, the project team utilized geospatial processing of data to identify school safety hot spots. Various datasets pertaining to school location, transportation infrastructure, and vehicle-pedestrian crashes were utilized in this analysis. This section details the project data collection process, providing context for the analysis which would be performed later.

3.2 Data Identification

The research team first identified what data would be needed to conduct an effective analysis and identify school safety hot spots. The datasets in section 3.2.1 were selected as the most relevant to the project.

3.2.1 Crash Data

The following datasets were utilized for project analysis. The data source is listed for each.

- Statewide Active Transportation Crash Data
  - Data Source: AASHTOWare Safety Database
- Utah School Location Data
  - Data Source: Utah Geospatial Resource Center (UGRC)
- SRTS Plan Data
  - Data Source: UDOT Safe Routes Database
- Transportation Infrastructure Data

  - Average Annual Daily Traffic Data
    - UDOT Data Portal
  - Highway Speed Limits
    - UDOT Data Portal
  - Crossing Location
    - UDOT Data Portal
  - Roadway Lane Counts
    - UGRC
  - Roadway Bike Lanes
    - UGRC (from the Utah Roads Dataset)

3.3 Data Collection Process

All data was downloaded and stored on an ArcGIS Pro project geodatabase. This software was then utilized to perform data analysis. The following subsections detail the data collection processes for the various data types.

3.3.1 Crash Data

Crash data was downloaded from the AASHTOWare Safety crash data website. A large amount of data and data attributes are available from crash information, so the research team utilized a series of filters to download only the data that would apply to the project analysis. The following filters were applied to the data:

- Crash Date: January 2019 – December 2023
- Time Period: 7:00 – 10:00 AM, 2:00 – 5:00 PM (periods where students are traveling to and from the school or participating in school activities)

- Pedestrian- and/or Bicyclist-involved Crashes
- Age of persons involved in the Crash: 5 to 17 years

After these filters were applied, 984 crashes were found to fit the criteria. A selection of crash attributes was downloaded with each crash, resulting in a dataset which contained each filtered crash, along with the attributes listed in table 3.1.

Table 3.1 Crash Attributes

Crash Attributes (Data Associated with Each Crash)				
Crash ID	Milepoint	Light Condition	Age	Bicycle Involved
Crash Date	Crash Severity	Weather Condition	Near-School Crashes	Mode
Crash Time	Crash Severity (Numerical Value)	Roadway Surface Condition	School	Crash Type
Year	Manner of Collision	Number of Vehicles Involved	School District	DUI Involved
Longitude	Roadway Junction Type	Route Type	Posted Speed	DUI Suspected
Latitude	Roadway Type	Crash Verified	Railroad Crossing	Alcohol Drug Suspected
Full Route Name	Roadway Description	Vehicle Type	Pedestrian Involved	Area Type

With these attributes, impacts such as weather conditions, possible Driving Under the Influence (DUI), and roadway attributes could be considered for each crash, in addition to providing information on severity and location. While some redundancy in this data may be present, it was felt to provide the most comprehensive information to the research team.

After data was downloaded and formatted into a single table, this table was imported to the ArcGIS Pro project. The crash locations were then placed on a map using the latitude and longitude data. The crash data was then ready for analysis.

3.3.2 School Location and School Plans Data

To obtain data on the location of schools throughout Utah, a dataset containing all schools was downloaded from the UGRC and placed in the ArcGIS Pro project. Some schools in Utah have existing SRTS plans, while others do not. To provide context on what schools currently have an SRTS plan, a dataset detailing existing SRTS plans by school was downloaded from the UDOT SRTS website. This dataset was then joined to the schools dataset from the UGRC according to school name. The resulting dataset contained school information, as well as information detailing which schools have an SRTS plan and which do not. It was found during this process that the school name attributes in the SRTS and UGRC datasets did not always match exactly (e.g., River Rock Elementary vs. River Rock School). In these cases, the names were manually adjusted to match so that the join could be performed properly. In addition, a UDOT regions shapefile was joined to the school data. This showed which region each school falls within, allowing for future analysis to include information on region regarding school-related crashes.

After the joins were performed, all schools which were not listed as a K-12 public school were removed from the dataset. This included all schools listed as private, pre-schools, specialty schools, online school facilities, and other school facilities included in the dataset. The project team also chose to remove charter schools from the dataset. Though these facilities are considered public schools, previous experience by the project team has found that many students at charter schools are dropped off at the facility by vehicle. Given this, it was expected that charter school facilities would not see as many students walking to school, providing rationale for removing them from analysis.

3.3.3 Transportation Infrastructure Data

Transportation infrastructure data on Average Annual Daily Traffic (AADT) and speed limits was downloaded and imported to the ArcGIS Pro project as-is. Data on crossings was derived from an intersections dataset obtained from UDOT and downloaded to the ArcGIS Pro project. This dataset contained information on the traffic control for each intersection. By extracting intersections which would likely have a marked crosswalk from this dataset, the research team derived a usable crosswalks dataset. The research team assumed that the following intersection types would have a marked crosswalk location:

- Signalized Intersections
- All-Way Stop Sign Intersection
- High-Intensity Activated Crosswalk (HAWK) Traffic Controls
- Overhead Beacon Traffic Controls
- Midblock Crossing Locations

To identify roadways where bike lanes were present, the project team utilized a similar process. A Utah Roads dataset was downloaded from the UGRC and imported to the ArcGIS Pro project. This dataset contains information on which roadway segments have a bike lane present (either on one side or both sides of the roadway) for state and local routes. The research team extracted segments with any bike lane present, and the resulting dataset provided information on bike lane locations.

3.4 Summary

The data collection and preparation processes from this study allowed for geospatial analysis of school-area pedestrian crashes in Utah. The research team identified and obtained key datasets for this purpose, which included statewide crash records, school locations, SRTS plan data, and various transportation infrastructure layers. Crash data was filtered for relevance based on several attributes (e.g., age, time of day, etc.) to identify school-related pedestrian crashes. Data attributes such as severity, roadway conditions, and contributing factors were included with the data to provide context and characteristics to the crashes. School data was refined to include only traditional K–12 public schools, while infrastructure data (including speed limits, traffic control types, bike lanes, etc.) was processed to identify relevant safety features. Data was organized and processed in ArcGIS Pro software, creating a geodatabase for spatial analysis.

4.0 DATA EVALUATION

4.1 Overview

This section presents the data evaluation process used to identify school safety hot spots based on pedestrian and bicyclist crash data near schools across Utah. The research team conducted a geospatial analysis using ArcGIS Pro to examine crashes occurring within a 0.25-mile radius of public K–12 schools. The analysis determined crash counts near each school and examined results at the statewide, district, and UDOT regional levels. Crash counts were calculated and summary statistics for the top 10 schools by crashes statewide, top 10 districts by crashes, and top five schools per UDOT region were identified. The top two schools per region were then examined more in-depth utilizing visual mapping and examination of individual crash characteristics at these schools. These findings offer insight into potential contributing factors to school-area active transportation crashes, which would assist in developing safety improvements for these areas.

4.2 Hot-Spot Prioritization Analysis Process

The research team aimed to highlight the schools with the most student-related crashes across the state of Utah. The research team prepared and mapped the school location dataset and crash dataset using ESRI ArcGIS Pro software. This software was then used to identify schools which had the most student-related crashes nearby.

The research team chose school hot spots with the most student-related crashes nearby. Crashes (including crashes with recorded severe injuries) within 0.25 miles of schools were examined. The crash data were filtered to include only crashes which likely involved a student traveling to and from school.

4.2.1 Analysis Process

After preparing and cleaning the crash and school datasets, the analysis was conducted as follows:

- All data layers were included in the same ArcGIS Pro project
- A 0.25-mile buffer was created around each school location
- The ‘Summarize Within’ tool within ArcGIS Pro was run on each buffer to provide a sum of the crashes within each school buffer
    - This tool counts the number of instances a specified data variable falls within the spatial distribution of another dataset. In this case, the tool counted the number of crashes within each school buffer
- The resulting dataset contained the number of crashes within 0.25 mile of each school

Figure 4.1 below displays a sample view of the analysis process. This view shows Snow Canyon Middle and High Schools (located in Washington County) with the 0.25-mile buffer present, along with the crash dataset used for summary analysis.

r

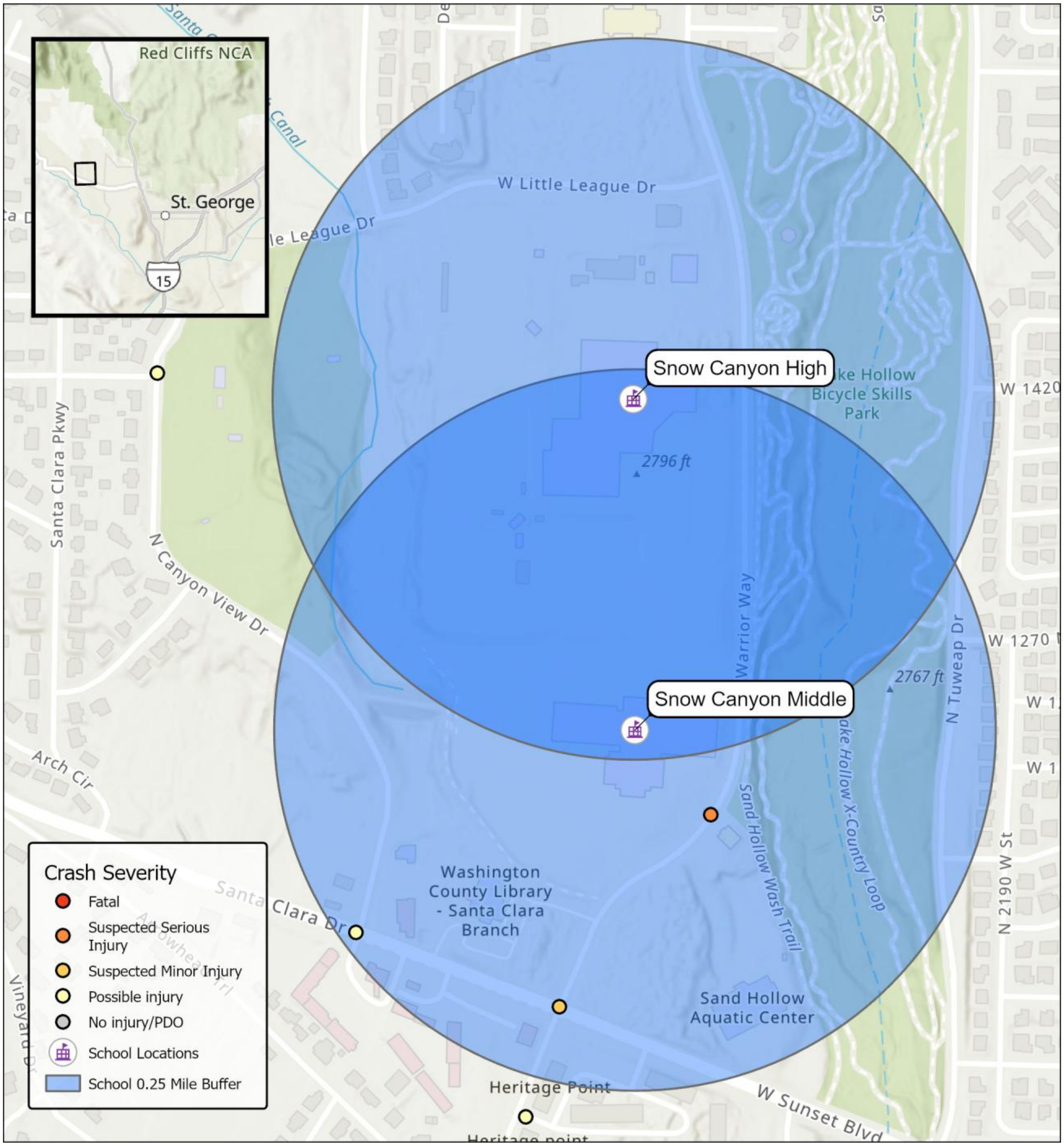

Figure 4.1 Sample View of Analysis Process

The schools with the most crashes within 0.25 miles were identified statewide. The final step of the analysis consisted of analyzing school crash results by UDOT region. Separate maps were created in the ArcGIS Pro project which divided schools by region. The school locations were then mapped and symbolized by the number of crashes within each region. Through this process, the research team was able to highlight the schools with the most student-related crashes for each UDOT region and statewide.

4.3 Statewide Results

The analysis compares schools across Utah and the respective number of crashes within 0.25 miles. Table 4.1 displays the top 10 schools statewide which had the most total crashes within 0.25 miles. The table includes the schools, associated districts, number of crashes, and whether these schools have an associated SRTS Plan.

Table 4.1 Top 10 Schools by Crashes - Statewide

School	Crashes	District	SRTS Plan
Provo Peaks Elementary School	6	Provo District	Yes
West Jordan High School	5	Jordan District	No
Kearns High School	5	Granite District	No
Magna Elementary School	4	Granite District	Yes
Bingham High School	4	Jordan District	No
Roy Elementary School	4	Weber District	No
Syracuse High School	4	Davis District	No
North Davis Jr. High School	4	Davis District	No
Davis High School	4	Davis District	No
Dixie High School	4	Washington District	No

As shown in Table 4.1, Provo Peaks Elementary School was identified as the school with the most pedestrian- and bicyclist-related crashes (six total) within 0.25 miles of the school, involving a student-aged person during the crash data period. Six of the schools in the top 10 are high schools, and only two schools in the top 10 have an SRTS plan. It is important to note that according to the Utah MUTCD, high schools are required to have an SRTS plan if they have a school crosswalk on a state facility.

4.3.1 Statewide District Results

Crashes were summed based upon school district to provide additional context to statewide data findings. Results of this analysis are shown in Table 4.2, highlighting the top 10 districts per number of crashes in the state. The number of schools in the district from the analysis is also included. Using this metric, the number of crashes per school over the study period was calculated. As seen in the table, Davis District is the leader in total crashes, but the Provo District is the total leader in crashes per school, seeing a higher ratio of crashes in comparison to the total number of schools. Overall, districts in urbanized areas with more schools saw the most crashes and crashes per school. This is most likely due to a combination of higher population, more roadways and vehicles present, higher school enrollments, and overall higher possibilities of potential conflict points and crash incidents due to these factors.

Table 4.2 Top 10 Districts by Crashes

District	Schools	Total District Crashes	Crashes Per School
Davis District	89	141	1.58
Granite District	89	128	1.44
Alpine District	86	116	1.35
Jordan District	58	92	1.59
Washington District	46	76	1.65
Canyons District	46	62	1.35
Nebo District	43	55	1.28
Salt Lake City District	38	50	1.32
Weber District	42	47	1.12
Provo District	18	42	2.33

4.4 UDOT Schools by Region Results

Based on the number of target crashes within 0.25 miles of each school, the top 5 schools were identified in each UDOT region. Table 4.3 below displays the results by UDOT region. The school district and SRTS plan status are included for each school.

Table 4.3 Top 5 Schools by Crashes Per UDOT Region

Top 2 Schools Per Region - Total Crashes			
Region 1	Crashes	District	SRTS Plan
Roy Elementary School	4	Weber District	No
Syracuse High School	4	Davis District	No
North Davis Jr. High	4	Davis District	No
Davis High School	4	Davis District	No
Kaysville Jr. High School	3	Davis District	No

Top 2 Schools Per Region - Total Crashes			
Region 2			
West Jordan High School	5	Jordan District	No
Kearns High School	5	Granite District	No
Magna Elementary School	4	Granite District	Yes
Bingham High School	4	Jordan District	No
Hillsdale Elementary School	3	Granite District	Yes
Region 3			
Provo Peaks Elementary School	6	Provo District	Yes
Lakeview Elementary School	3	Provo District	Yes
Orem Jr. High School	3	Alpine District	Yes
Centennial Elementary School	3	Alpine District	Yes
Spanish Fork Jr. High School	3	Nebo District	No
Region 4			
Dixie High School	4	Washington District	No
Snow Canyon Middle School	3	Washington District	Yes
Canyon View Middle School	3	Iron District	No
Canyon View High School	3	Iron District	No
Paradise Canyon Elementary School	2	Washington District	Yes

As seen in the table, the top schools tend to be located in more urbanized areas with larger populations. Only eight of the schools shown have an SRTS plan in place. Only 40% of the top schools in Regions 2 and 4 have an SRTS plan currently in place, while in Region 3 four of the top five have SRTS plans. In Region 1, none of the top schools have a current SRTS plan. Maps of the top schools in each region are shown in Figures 4.2 to 4.5 below. It is important to note that high schools are not required to have an SRTS plan unless a school crosswalk nearby is on a state facility.

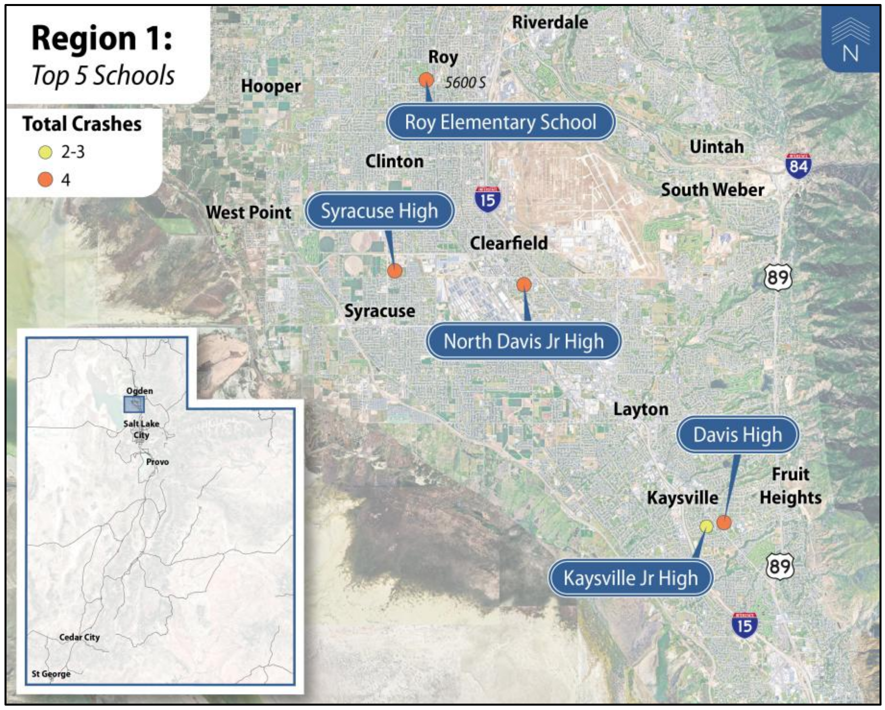

Figure 4.2 Region 1 Top Five Schools Map

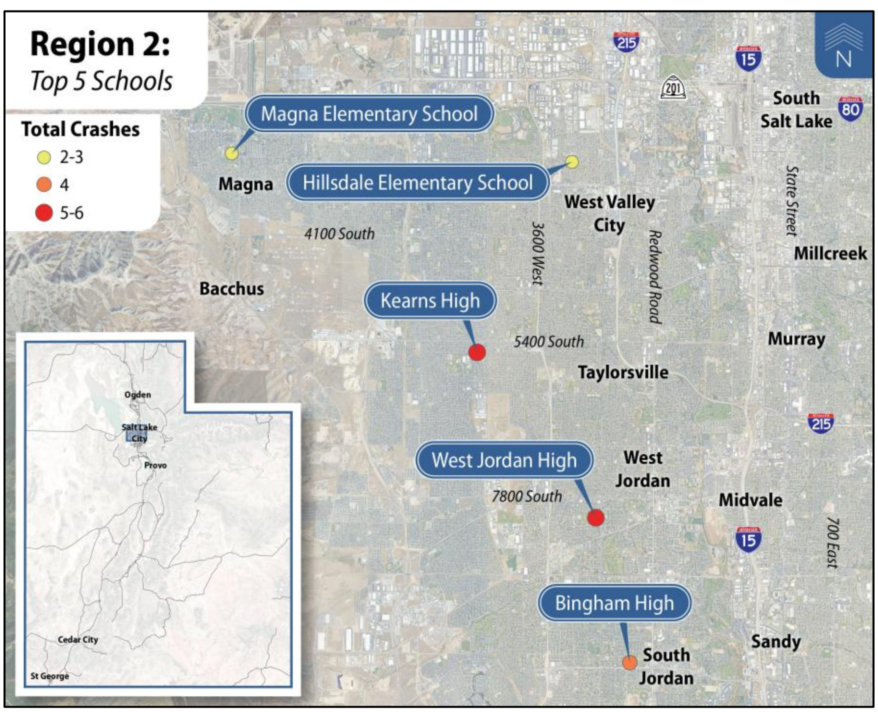

Figure 4.3 Region 2 Top Five Schools Map

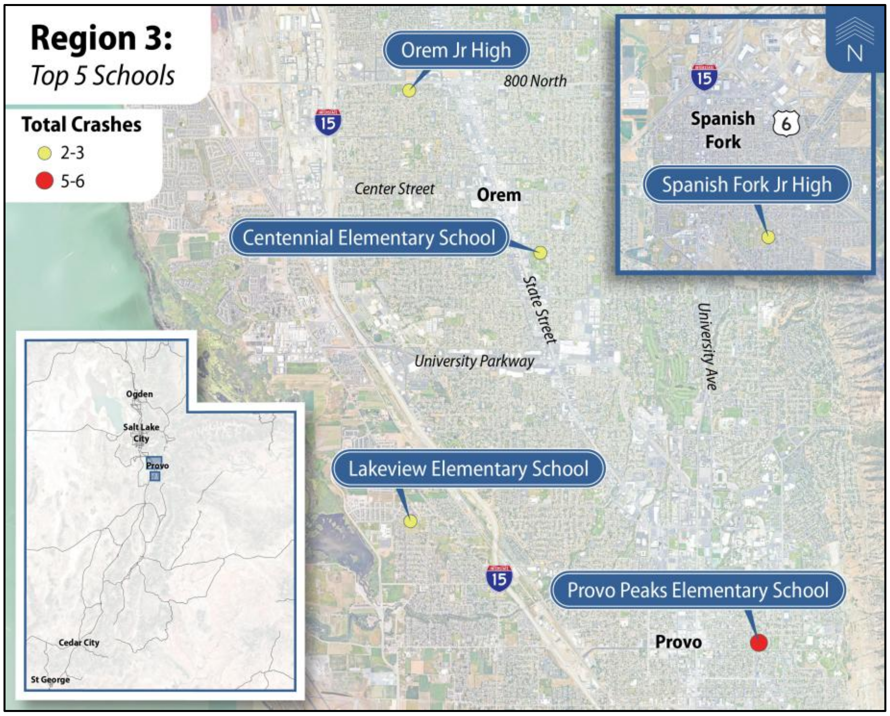

Figure 4.4 Region 3 Top Five Schools Map

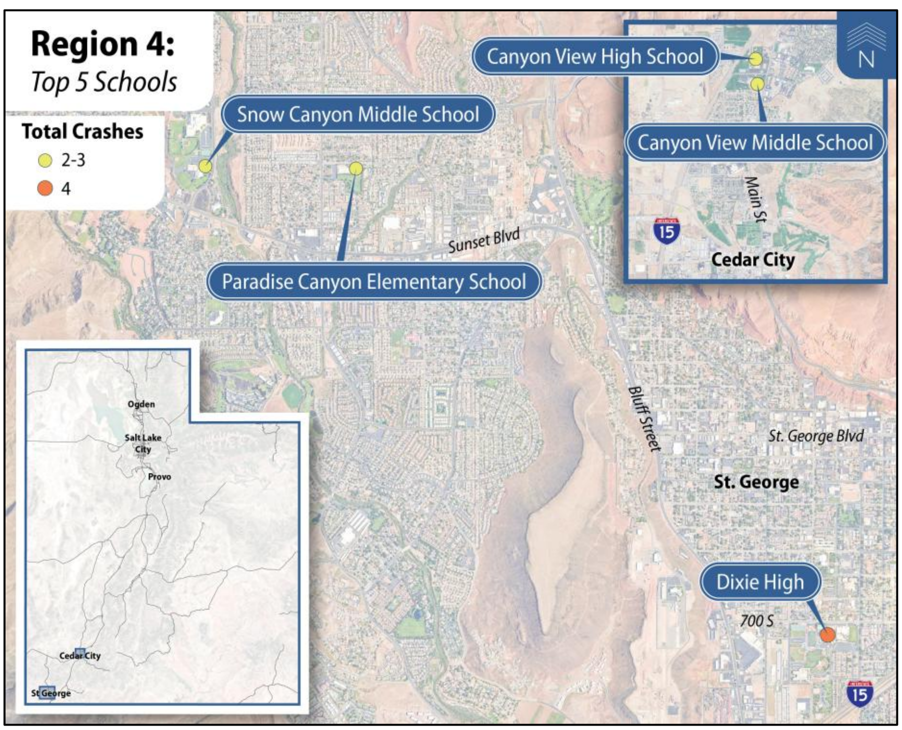

Figure 4.5 Region 4 Top Five Schools Map

4.5 Top 2 Schools Per Region Overviews

The top two schools per region with the most school-related crashes were chosen for additional observational analysis. Aerial figures of these schools and the surrounding area were created to show the location of school-related crashes within 0.25 miles of the school facilities. These aerial figures were used to determine if nearby infrastructure or facilities may contribute to potential crash risks (e.g., the presence of developments which drive higher foot traffic, infrastructure where crashes are more present, etc.). The project team also created crash reconstruction figures to analyze the contributing factors of each crash in greater detail. The following subsections highlight the results of the top two schools per region.

Note that in Table 4.3, often more than two schools have the same number of crashes (e.g., in Region 1 where the top four schools had the same number of crashes). In these cases, two schools were chosen based on crash severity, school type (e.g., choosing a high school and elementary school, to obtain a variety of school types), or areas where multiple schools were near one another with overlapping routes.

A graphic is included for each showing the position of vehicles and active transportation users for each school-related crash. Pedestrians and/or cyclists are portrayed with red icons and positioned where the collision between them and a vehicle occurred on the roadway. The bicycle symbol represents people riding scooters, skateboards, and other human-powered wheeled devices.

4.5.1 Region 1 Top Two Schools Analysis: Davis High (and Kaysville Jr. High)

Davis High School is located on Main Street (SR-273) in Kaysville. Kaysville Jr. High (which is also ranked in the top five among schools in Region 1) is located across the street from Davis High School. As seen in Figure 4.6, Davis High School is near the downtown Kaysville area, and with an AADT between 17,000 and 19,000 on Main Street there are numerous opportunities for conflicts. As shown in Figure 4.7, three out of four school-related crashes involved bicycles / scooters / skateboards, three crashes involved conflicts on the nearside of an intersection, three crashes involved a left-turning vehicle, and one crash involved multiple pedestrians.

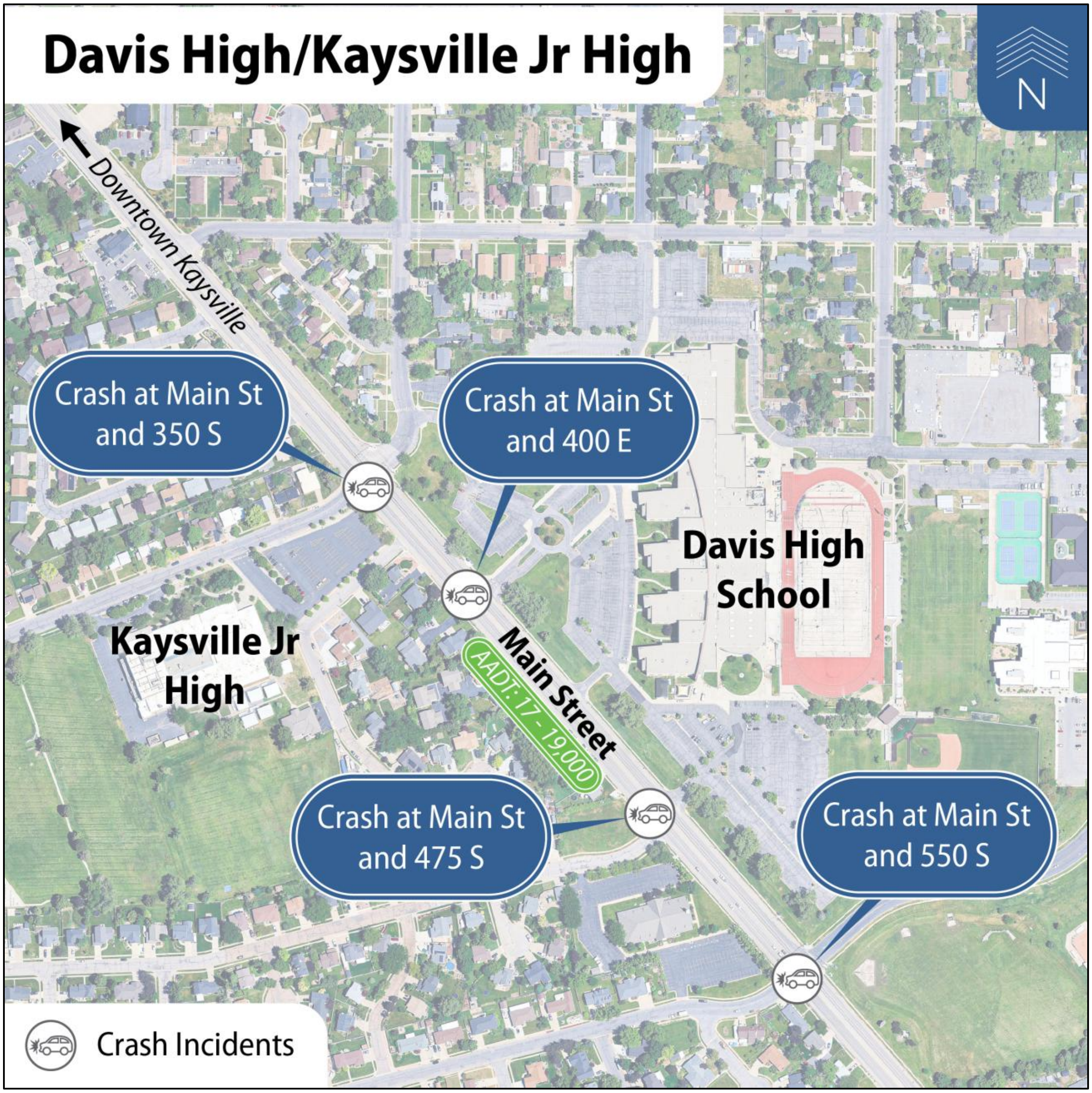

Figure 4.6 Davis High and Kaysville Jr. High Overview

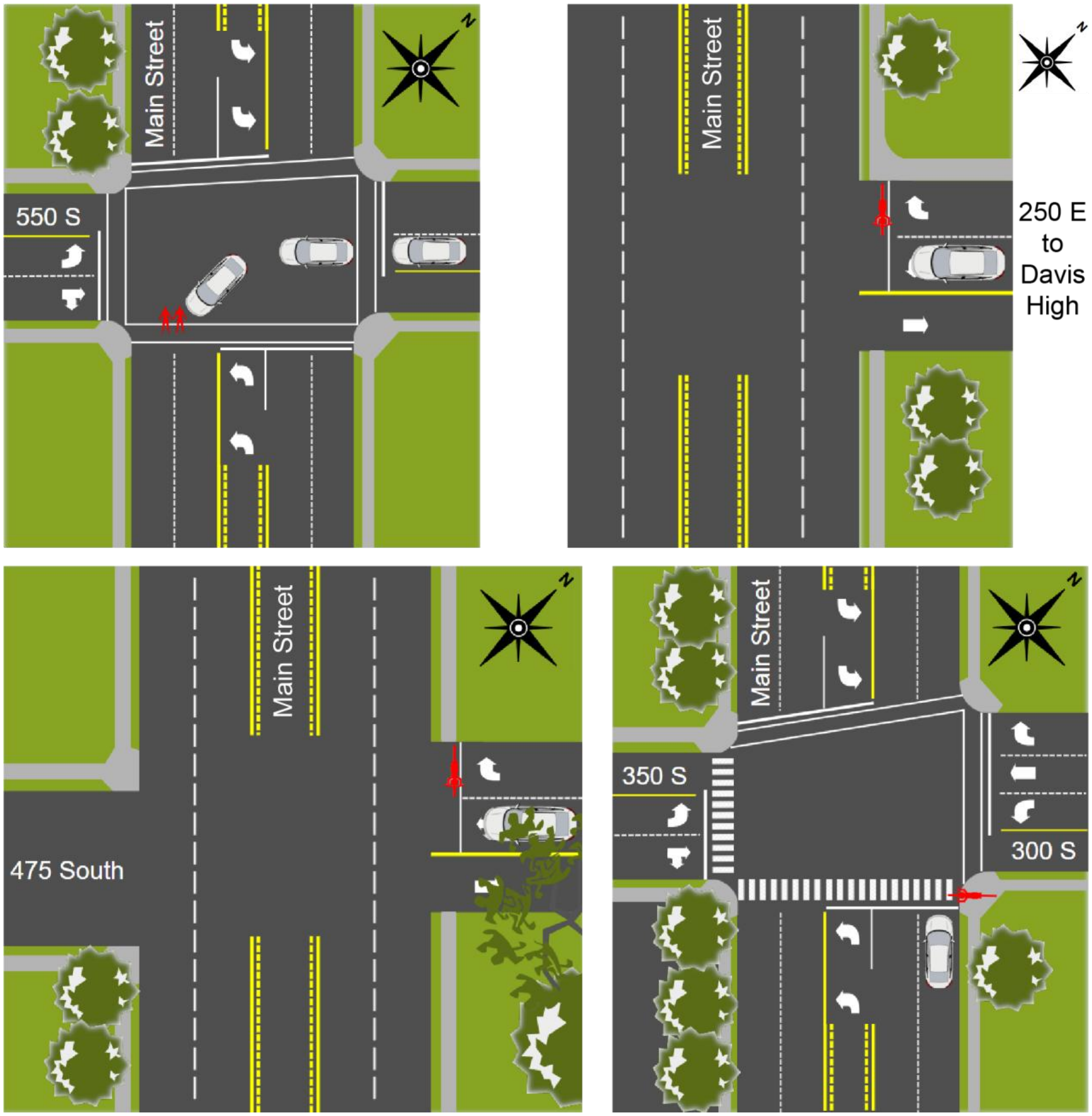

Figure 4.7 Davis High/Kaysville Jr. High Crash Diagrams

4.5.2 Region 1 Top Two Schools Analysis: Roy Elementary School

Roy Elementary School is located on 5600 South in Roy, Utah. As seen in Figure 4.8, Roy Elementary School is near the Busy Bee's Playhouse (a private day care and pre-school) and Roy Park, and with an AADT between 18,000 and 19,000 on 5600 South there are numerous opportunities for conflicts. As shown in Figure 4.9, two out of the four school-related crashes involved cyclists, all four crashes involved conflicts on the nearside of the intersection, and all four crashes involved a right-turning vehicle movement.

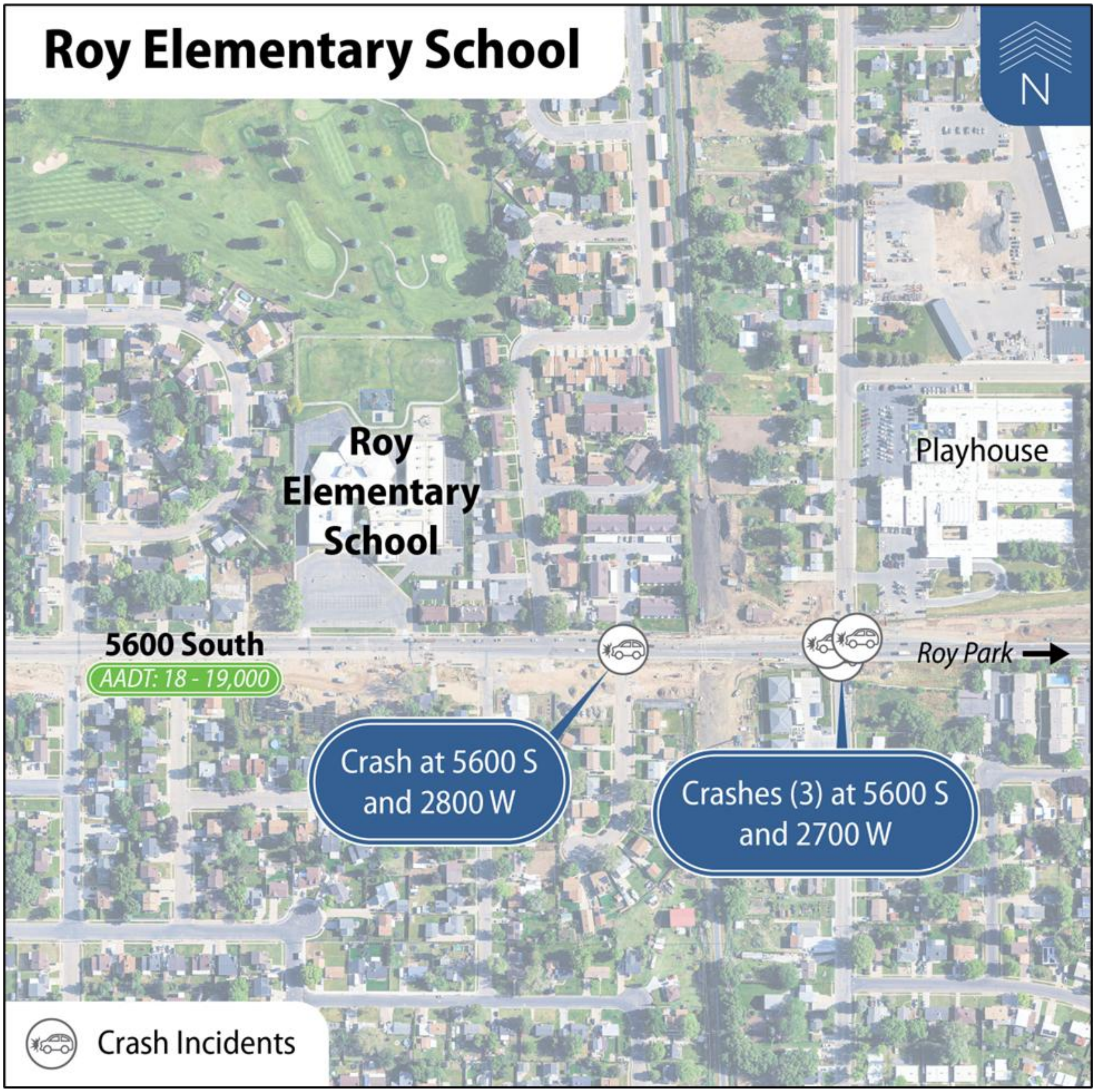

Figure 4.8 Roy Elementary School Overview

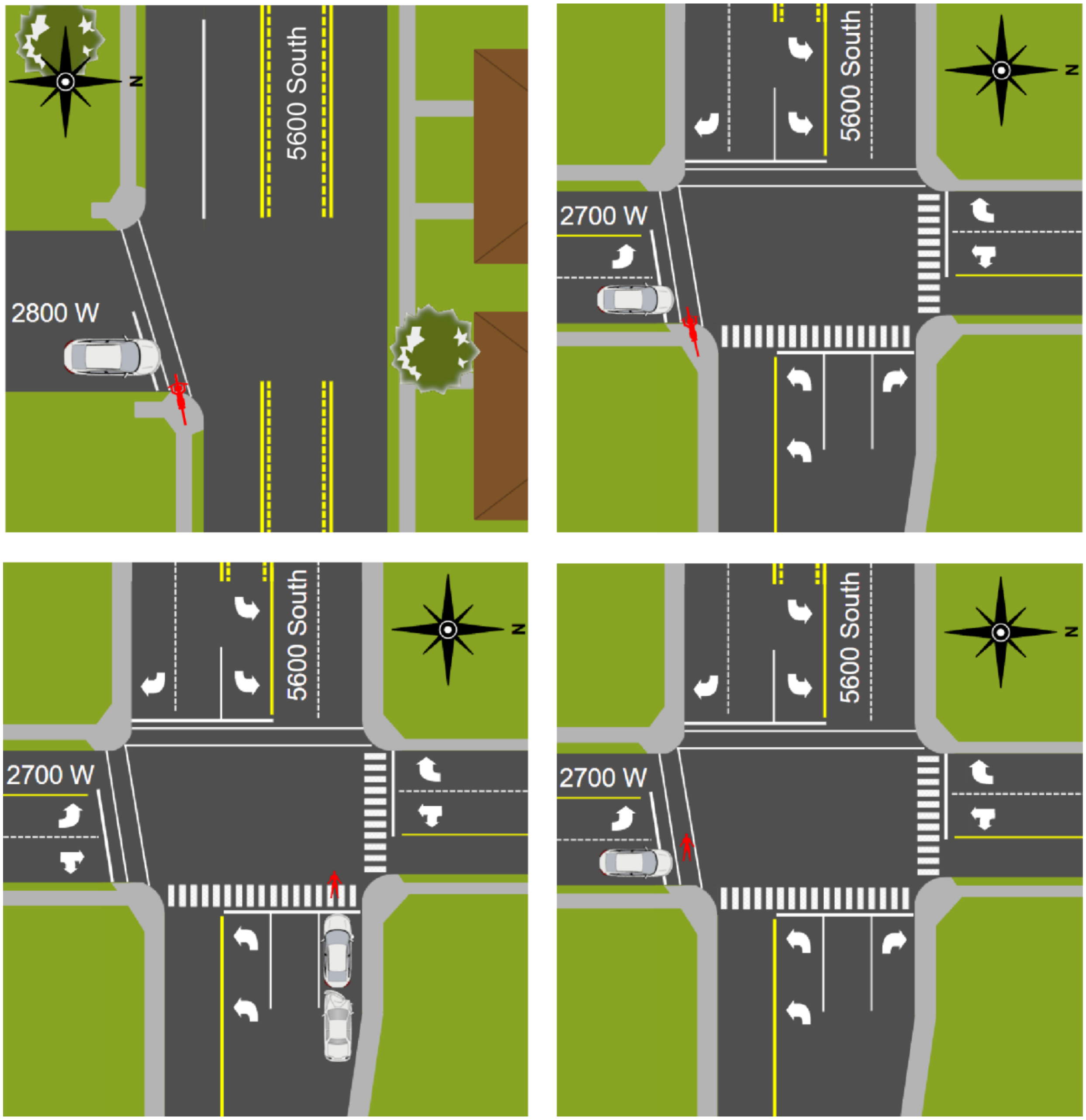

Figure 4.9 Roy Elementary School Crash Diagrams

4.5.3 Region 2 Top Two Schools Analysis: Kearns High

Kearns High School is located on Cougar Lane in Kearns, Utah. As seen in Figure 4.10, it is near the Kearns Oquirrh Recreation Center and Beehive Elementary School. As shown in Figure 4.11, one out of five school-related crashes involved bicycles/scooters/skateboards, one crash involved vehicle-to-pedestrian conflict on the nearside of an intersection, and three crashes involved a left-turning vehicle.

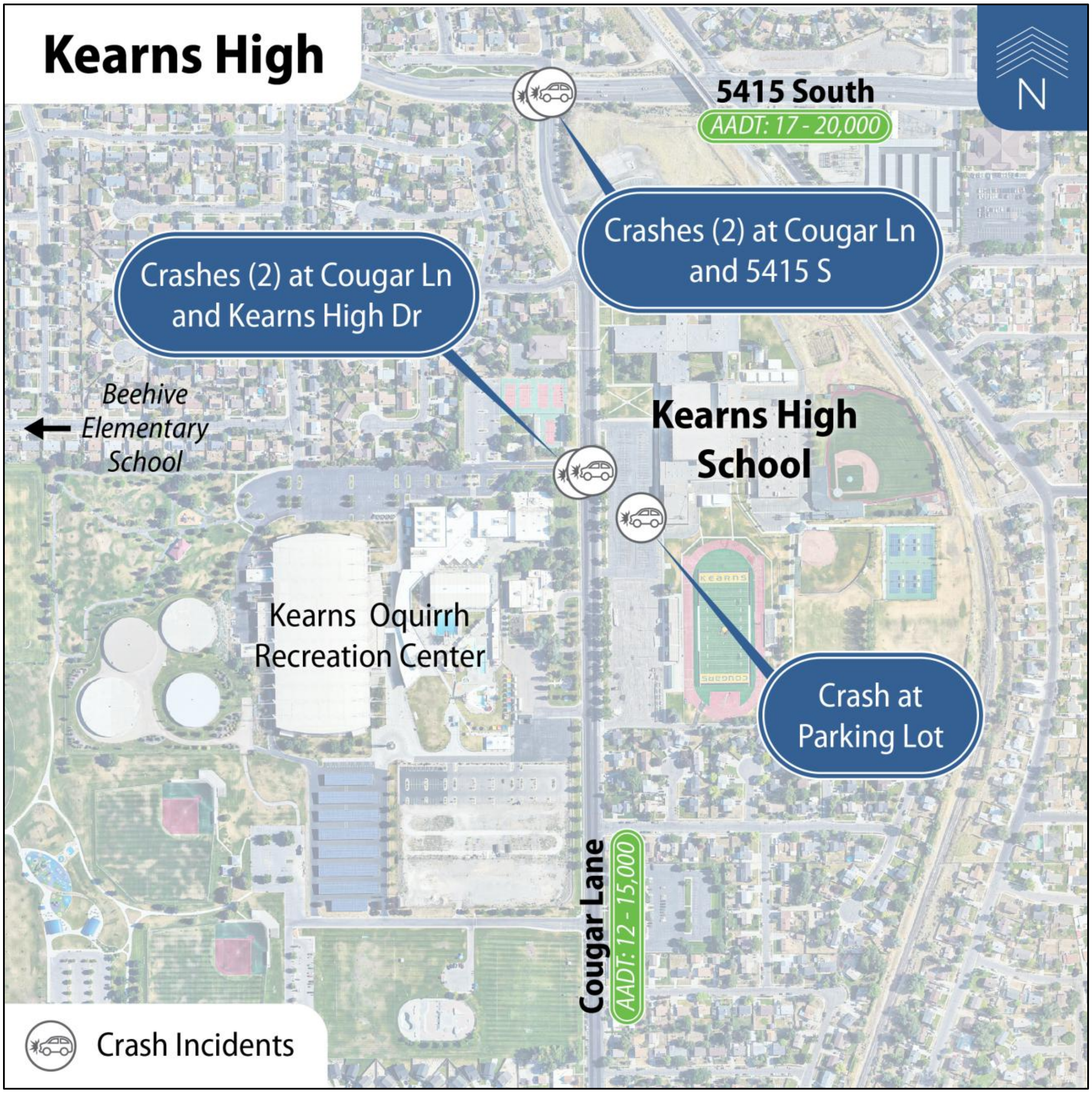

Figure 4.10 Kearns High Overview

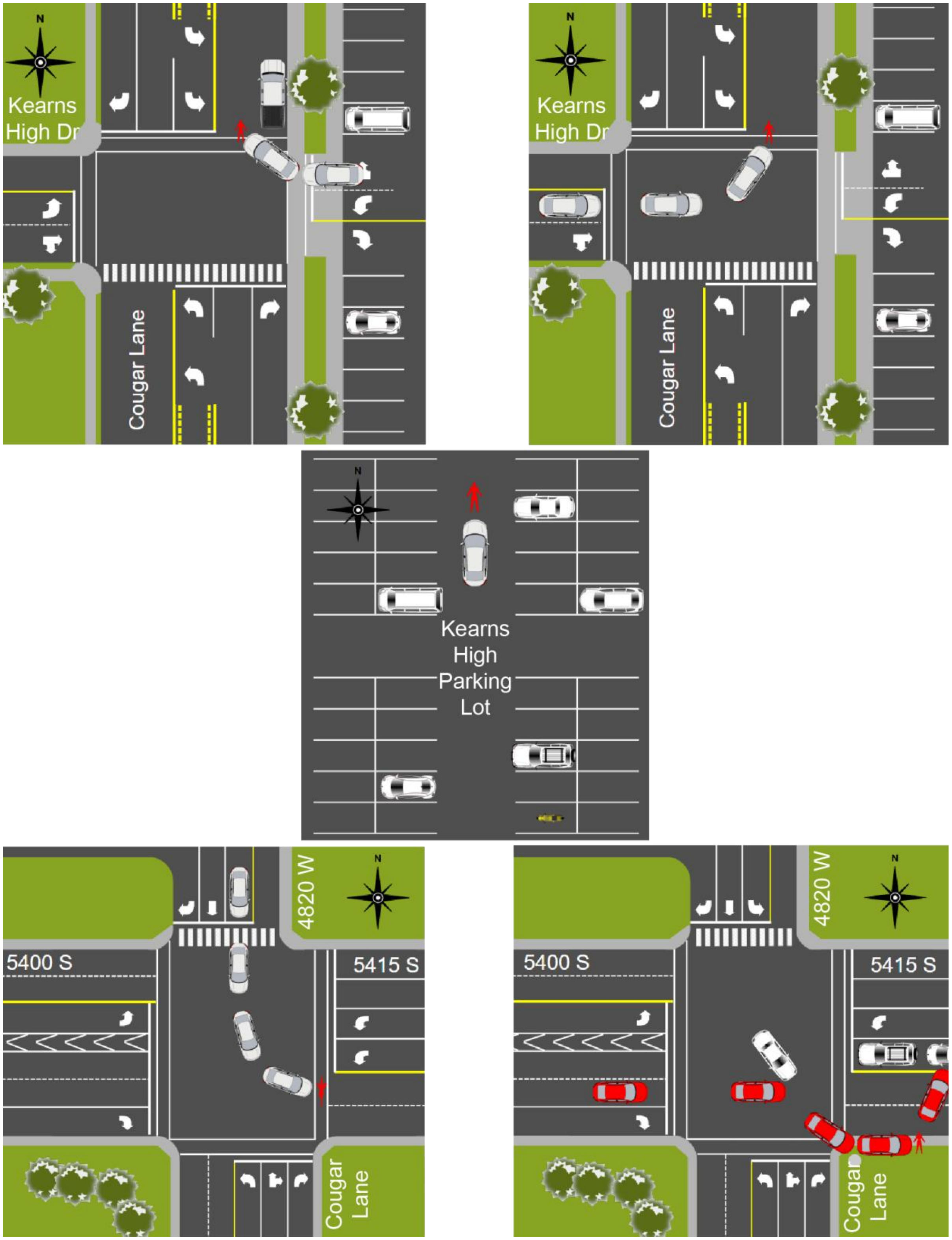

Figure 4.11 Kearns High School Crash Diagrams

4.5.4 Region 2 Top Two Schools Analysis: West Jordan High

West Jordan High School is located on 2700 West in West Jordan, Utah. As seen in Figure 4.12, West Jordan High School is near a Utah Transit Authority (UTA) TRAX (Light-Rail System) station and Joel P. Jensen Middle School. As shown in Figure 4.13, two out of five school-related crashes involved bicycles/scooters/skateboards, all five crashes involved conflicts on the nearside of an intersection, and three crashes involved wrong-way vehicles.

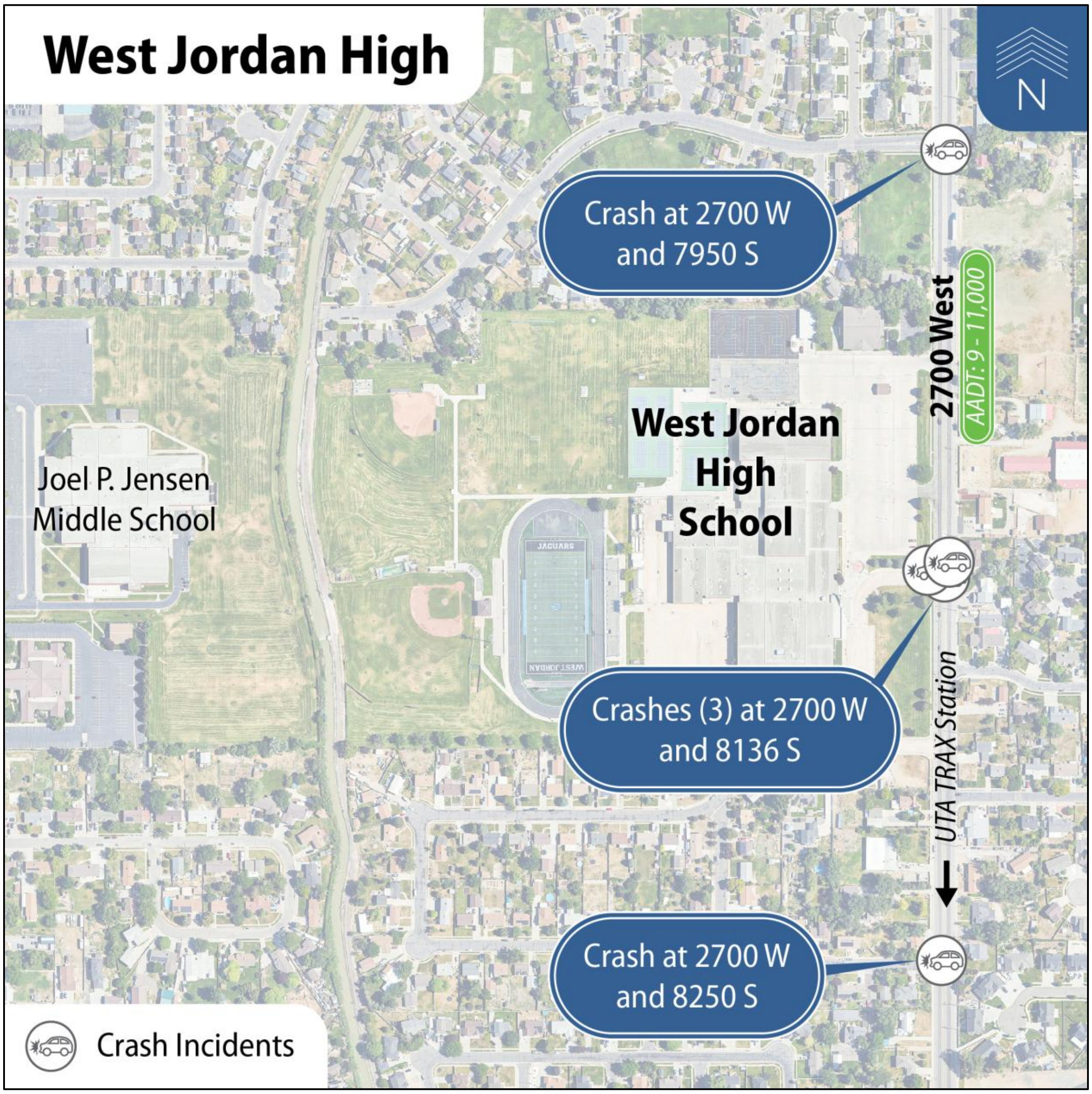

Figure 4.12 West Jordan High Overview

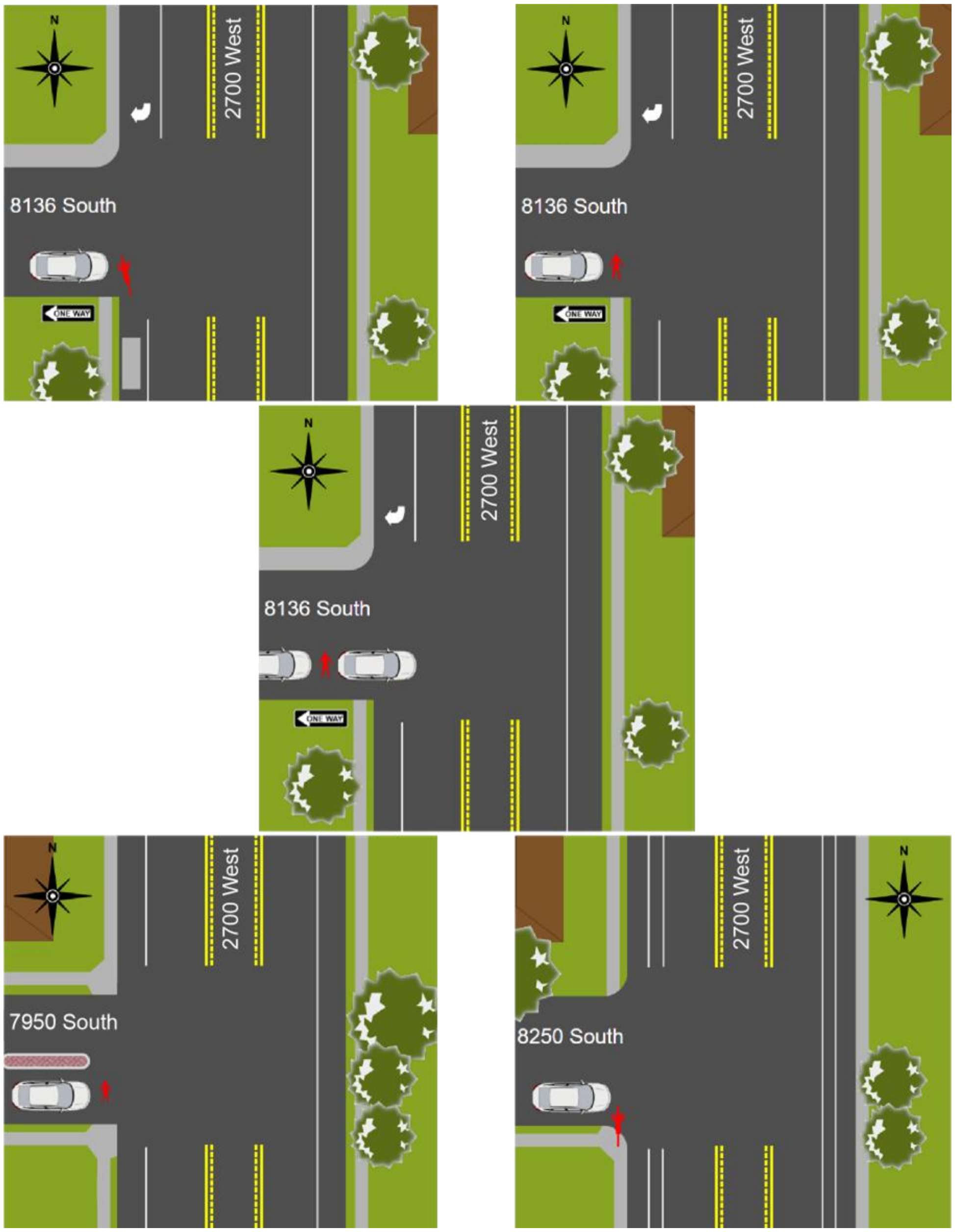

Figure 4.13 West Jordan High School Crash Diagrams

4.5.5 Region 3 Top Two Schools Analysis: Provo Peaks Elementary School

Provo Peaks Elementary School is located on Center Street in Provo, Utah. As seen in Figure 4.14, it is near downtown Provo, Brigham Young University, and Peaks Ice Arena. As shown in Figure 4.15, four out of six school-related crashes involved bicycles/scooters/skateboards, and four crashes involved conflicts on the nearside of an intersection. Provo Peaks does have an SRTS plan in place; designated SRTS routes are shown in the figure.

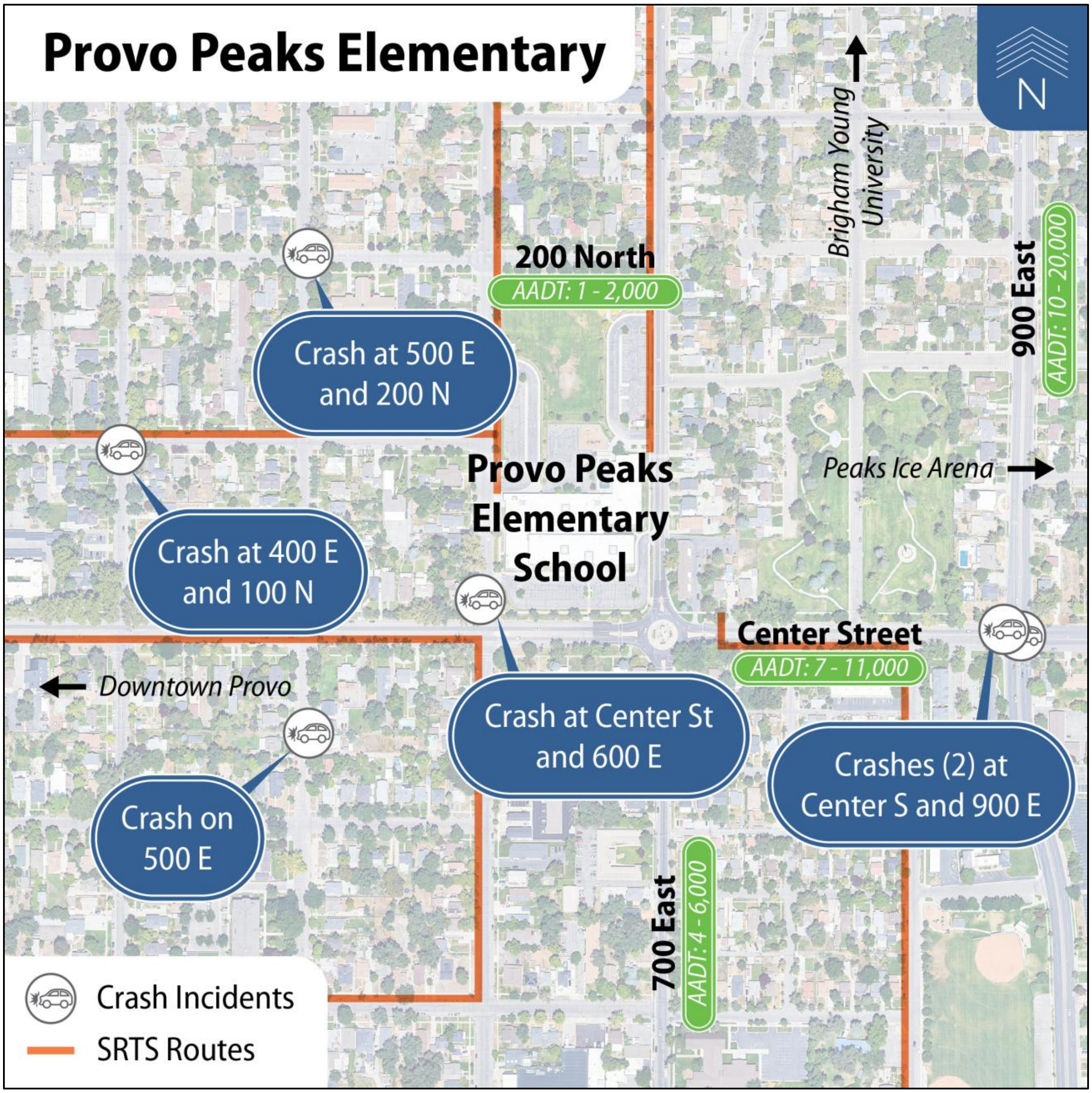

Figure 4.14 Provo Peaks Elementary Overview

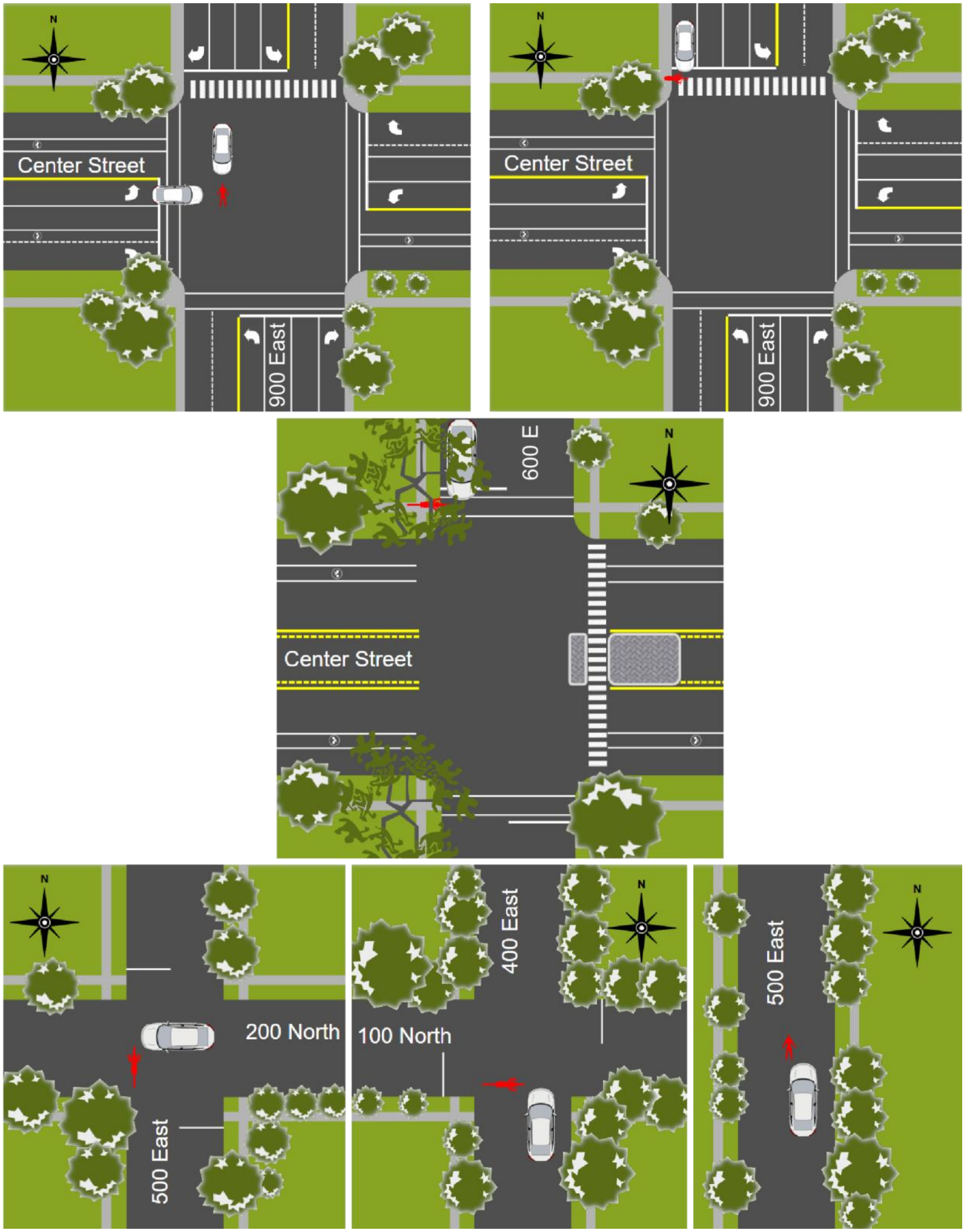

Figure 4.15 Provo Peaks Elementary School Crash Diagrams

4.5.6 Region 3 Top Two Schools Analysis: Spanish Fork Jr. High

Spanish Fork Junior High School is located on 820 East in Spanish Fork, Utah. As seen in Figure 4.16, it is near the Spanish Fork Recreation Complex and several other schools. As shown in Figure 4.17, one out of three school-related crashes involved bicycles/scooters/skateboards and one crash involved multiple pedestrians.

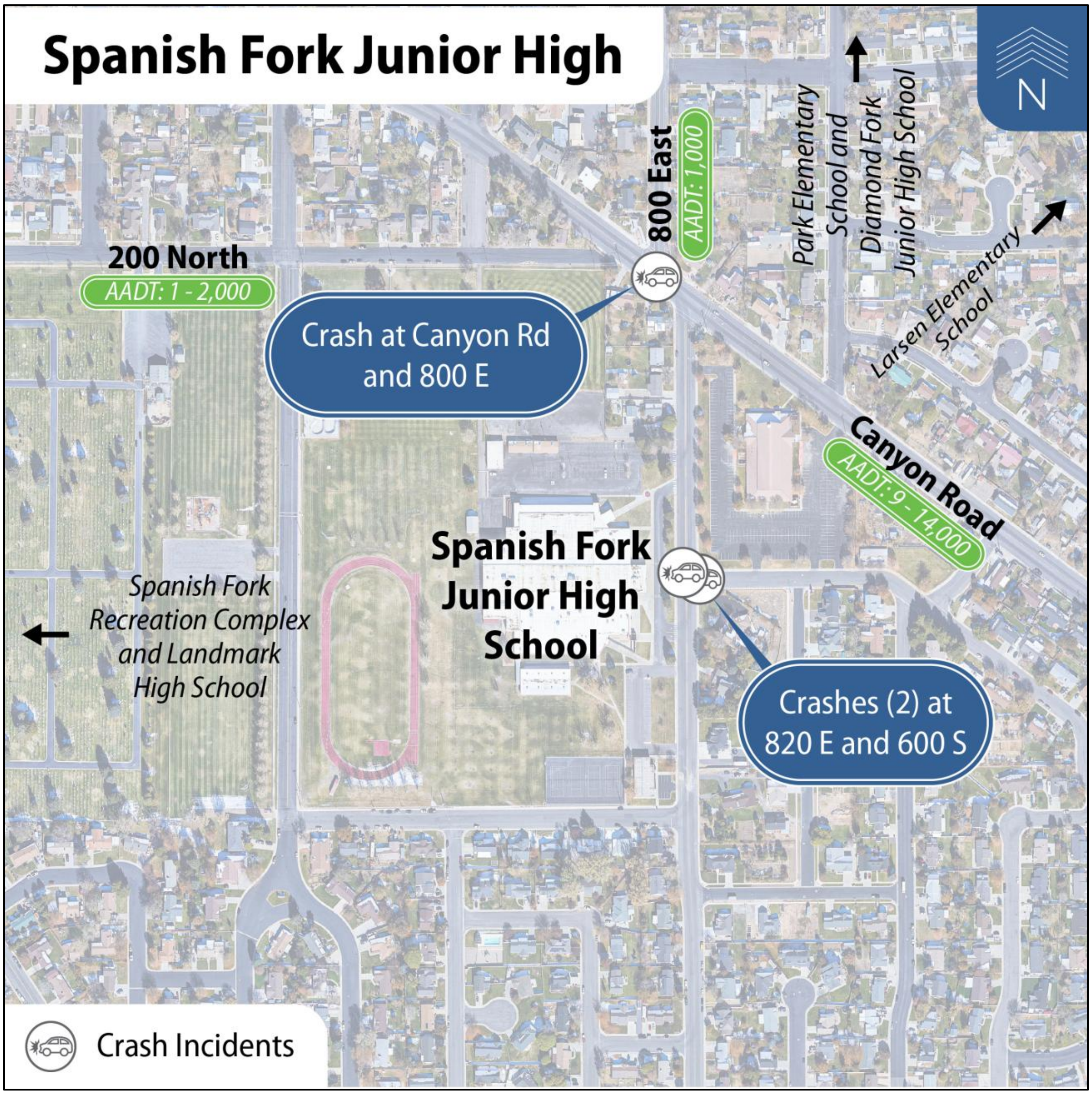

Figure 4.16 Spanish Fork Jr. High Overview

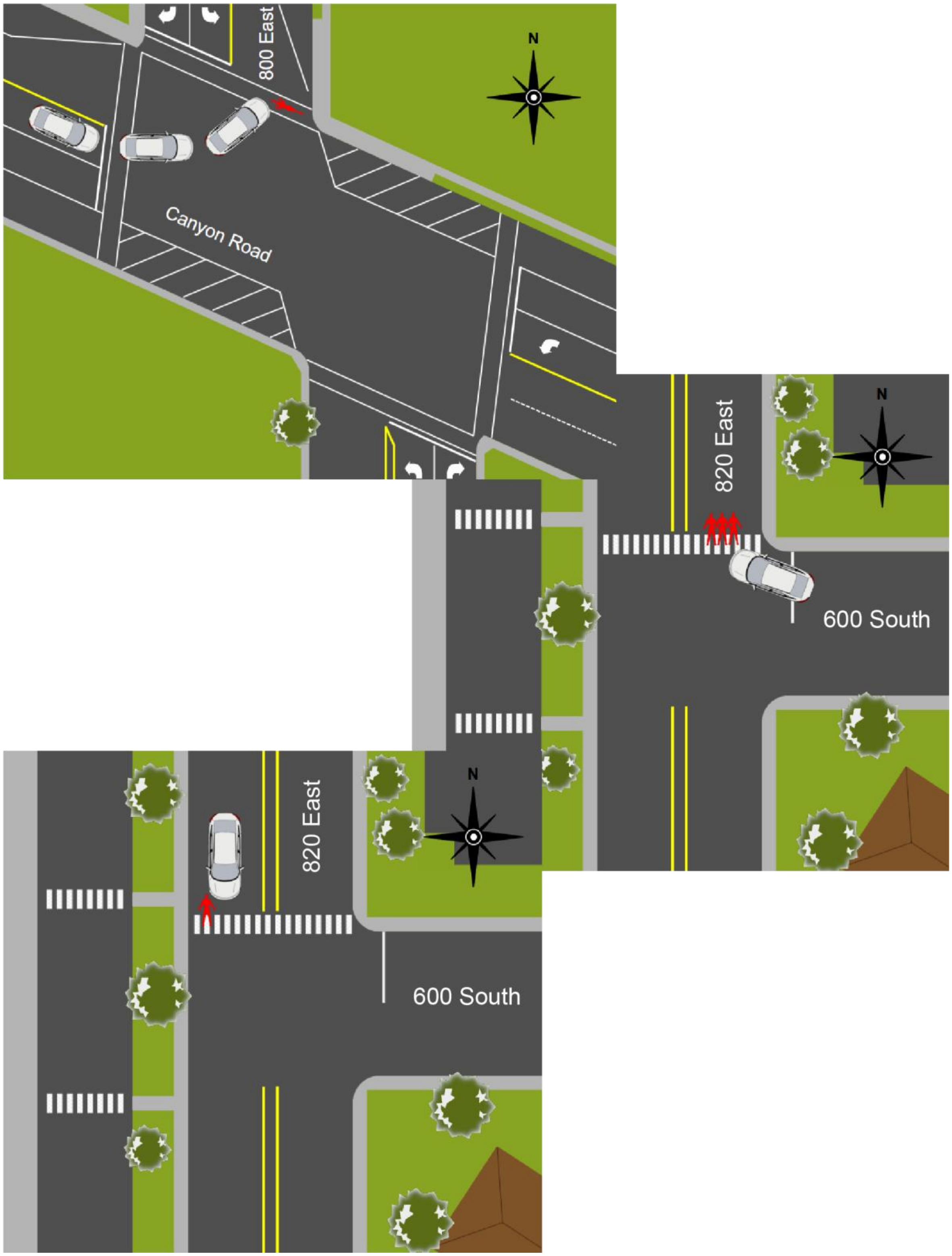

Figure 4.17 Spanish Fork Jr. High School Crash Diagrams

4.5.7 Region 4 Top Two Schools Analysis: Dixie High

Dixie High School is located on 700 South in St. George, Utah. As seen in Figure 4.18, it is near Dixie Middle School, the regional hospital, and Utah Tech University. 700 South has an AADT of between 18,000 and 21,000, creating opportunities for conflicts. As shown in Figure 4.19, three out of four school-related crashes involved bicycles/scooters/skateboards, and three crashes involved a right-turning vehicle.

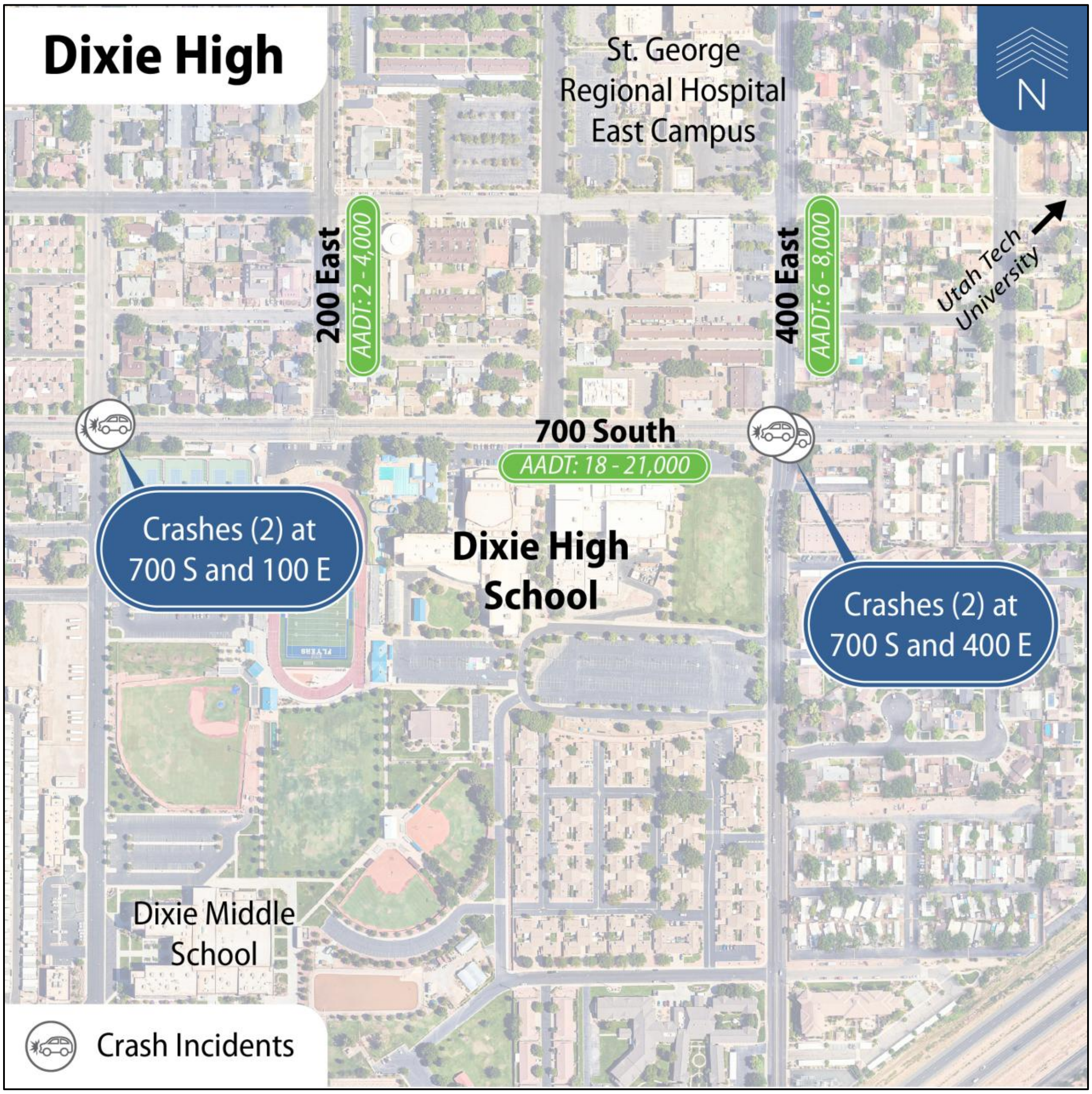

Figure 4.18 Dixie High Overview

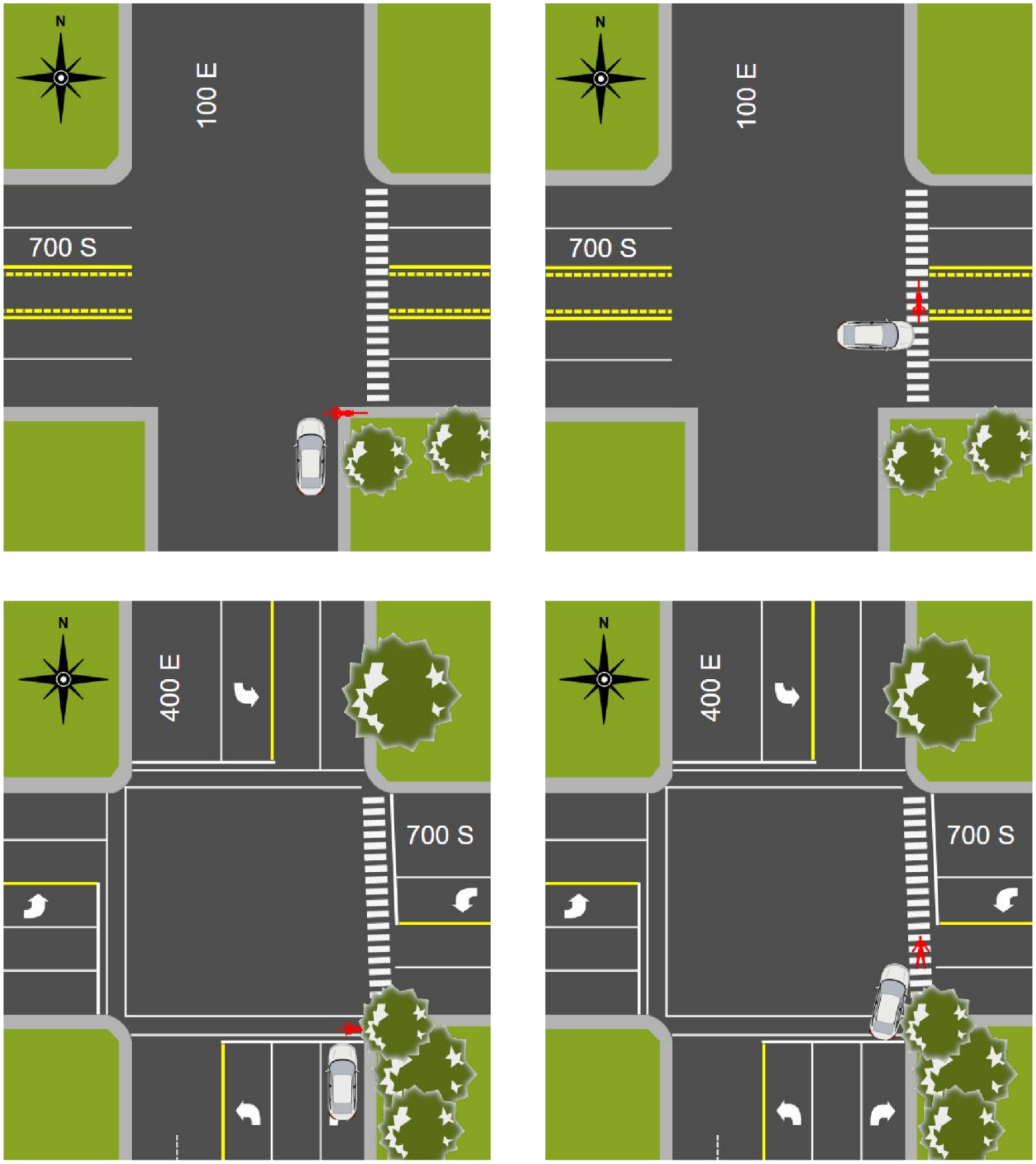

Figure 4.19 Dixie High School Crash Diagrams

4.5.8 Region 4 Top Two Schools Analysis: Snow Canyon Middle

Snow Canyon Middle School is located on Lava Flow Drive in St. George, Utah. As seen in Figure 4.20, it is near Snow Canyon High School and Sunset Boulevard which leads to downtown St. George. As shown in Figure 4.21, one out of three school-related crashes involved bicycles/scooters/skateboards, and two crashes involved left-turning vehicles. Snow Canyon does have an SRTS plan in place; designated SRTS routes are shown in the figure.

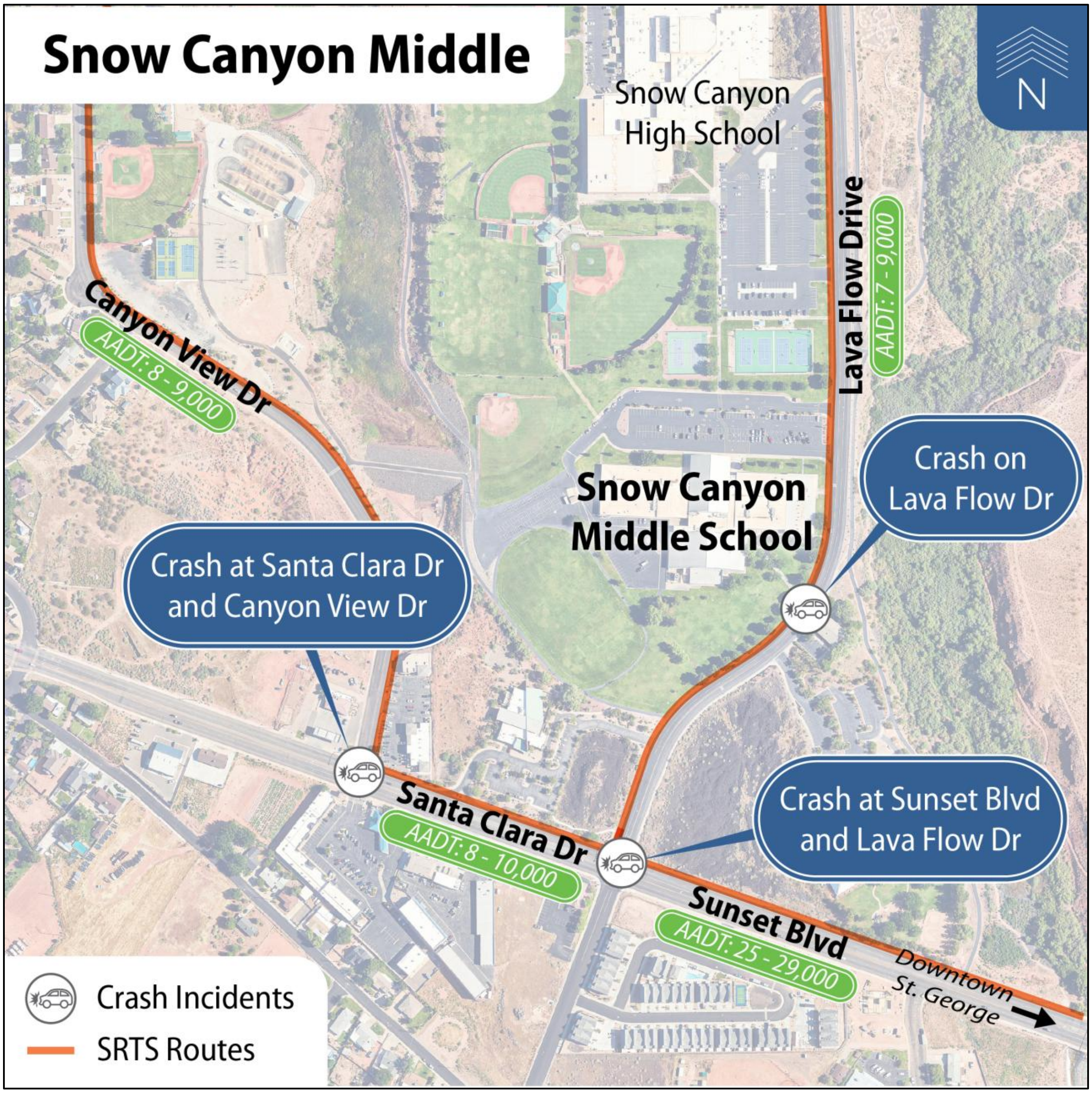

Figure 4.20 Snow Canyon Middle School Overview

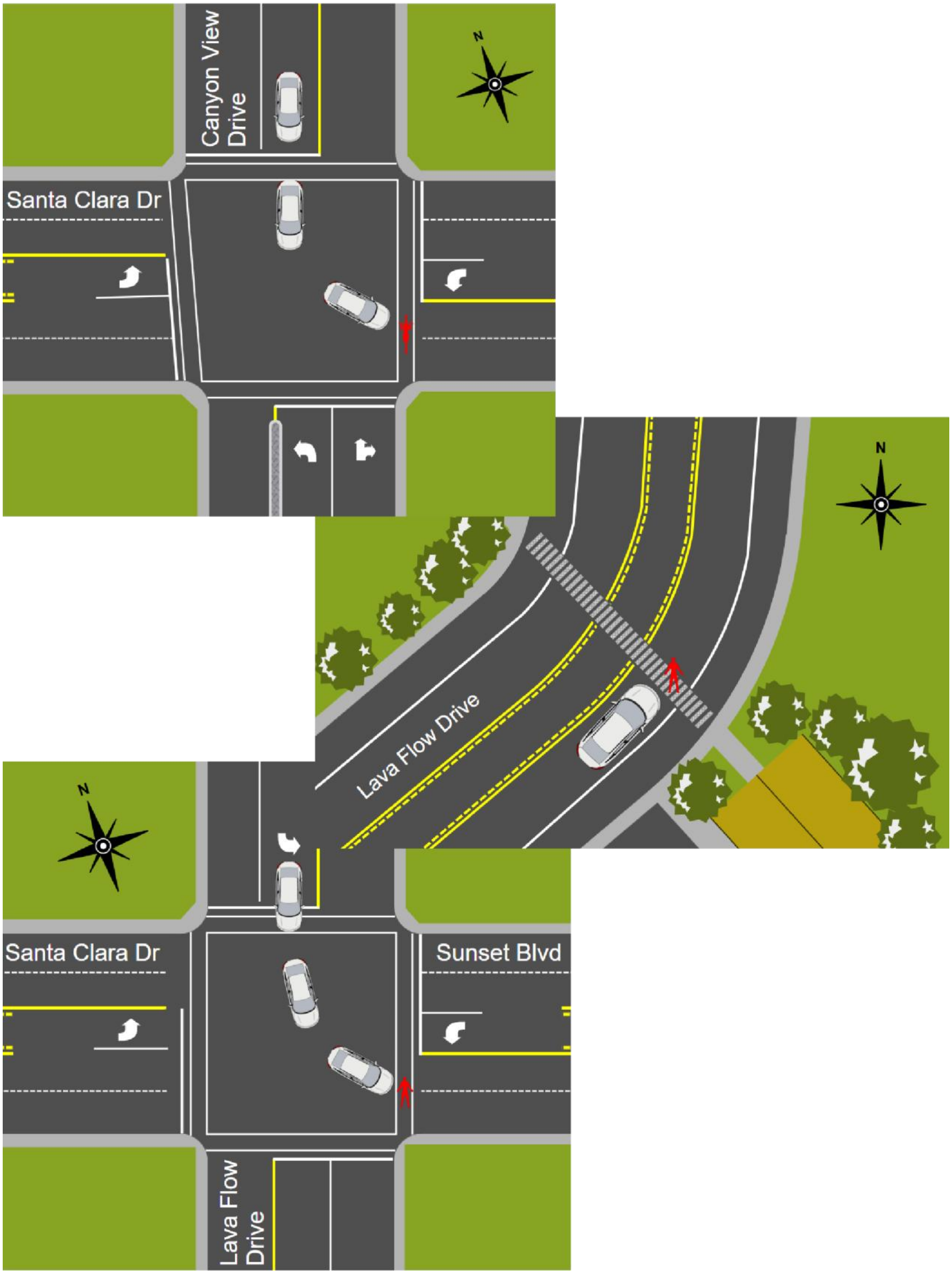

Figure 4.21 Snow Canyon Middle School Crash Diagrams

4.6 Overall Crash Observations

Taking the crash details and figures shown above, several patterns were observed which seem to correlate with common student-related crashes. Observations and potential explanations are given below:

- Many crashes involved bicycles or other modes of micromobility (represented as a bicycle in the crash figures) – This may be due to poor bicycle infrastructure and a lack of separation between bicycle paths and the roadway.
- Most crashes involved vehicle turning movements – This may be due to poor sight distances at intersections, especially for visibility of pedestrians and bicyclists.
- Crashes involving vehicles hitting a pedestrian tended to be more severe – This may be due to a lack of safe pedestrian crossings on high-speed roadways.
- Some crashes occurring in the early morning when students are traveling to school were listed as “dark” conditions – These crashes may have occurred due to poor or insufficient lighting of pedestrian paths during the winter months when sunrise is after school begins.

4.7 Summary

This section detailed the analytical approach and findings of the study. By mapping and analyzing crashes within a 0.25-mile radius of Utah’s public schools, the research team was able to identify the schools with the most active transportation crashes nearby throughout the state. Analysis results show that crashes are more typically concentrated around schools in urban areas. A number of the highest-ranking schools for crashes lack SRTS plans (which is likely in part due to the number of high schools, which do not require SRTS plans, ranking highly in crashes). The study further explored results by UDOT region, highlighting the top two schools per region and examining crash locations, characteristics, contributing factors, and surrounding infrastructure through geospatial mapping. These analyses provide valuable context for addressing pedestrian and bicyclist safety near schools and guiding future safety improvements.

5.0 CONCLUSIONS

5.1 Summary

This section will provide project recommendations based on the descriptions and evaluations of crashes shown in Chapter 4. Each location has been vetted and evaluated by a team of safety analysts using national best practices and existing crash modification factors. After identifying initial recommendations, they were then presented to each UDOT region's Planning Manager and Design Engineer for review and feedback.

5.2 Region 1- Davis High / Kaysville Junior High

All crashes identified near Davis High and Kaysville Junior High were located along Main Street (SR-273). Additionally, all crashes took place in a location where the pedestrian or cyclist would have assumed the right-of-way (at an intersection or side street crossing). In no case was the non-motorist cited for being at fault for the crash or for jaywalking. Therefore, the primary factor impacting safety along this corridor is assumed to be a lack of visibility of non-motorists and a lack of infrastructure supporting high visibility. The figures shown in Chapter 5 utilize Google Street View images of the crash locations. With each figure, a basic description of the challenges and shortcomings of the site is provided, along with a table highlighting issues and recommended countermeasures. Each table also includes a cost estimate for the recommendations based on current Utah construction costs and UDOT's approved construction standards.

Note that cost estimates do not include costs for other materials or equipment that may be needed as part of these projects. These costs may be significant, and costs for materials such as mast arms, additional lighting, etc., should be considered alongside the general cost estimates in this document. For mast arm and pole installation as part of new signage or lighting, it can be roughly estimated that each unit would cost an additional $50,000 in addition to the costs included in the remainder of this chapter.

5.2.1 Main Street (SR-273) at 350 South/200 East Intersection

The crossing at 350 South (to the west) / 200 East (to the east) is well known for high volumes of pedestrians. As seen in **Error! Reference source not found.,** Kaysville Junior High is located to the left (west) and Davis High School is located to the right (east). Many of the junior high students live east of Main Street and participate in activities, sports, and clubs at the high school before and after school. Both of these factors lead to high volumes of pedestrians crossing Main Street at this location. Students using public transit (bus) to get to both schools may also have to cross at this location, depending on which direction they travel from. There is a secondary school bus and visitor exit 120 feet east of the traffic signal. Issues and recommended countermeasures are listed in Table 5.1.

Figure 5.1 Northbound Main Street (Facing East) at 350 South/200 East

Table 5.1 350 South/200 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (100 feet ramp to ramp)	Curb extensions on south and east crossings	\$39,000-\$75,000 (\$13,000-\$25,000 per corner)
Poor or low-visibility signage	Improved high-visibility pedestrian and school signage	\$5,000-\$10,000 installed
Only permissive left turns	Upgrade signal to include protected left-turn phasing	\$12,000-\$25,000 installed
Narrow sidewalks and small queuing area for crossing	Curb extensions at intersection Replace the east sidewalk with an 8'-10' shared use path (300 South to Laurelwood Dr./600 South)	1,615 feet (whole corridor) \$13-\$28 per square foot \$170,000-\$370,000
	Total Site Cost	**\$226,000-\$480,000**

5.2.2 Main Street (SR-273) Access at 325 South

Curb extensions at this site will reduce the crossing distance and improve pedestrian visibility. Additionally, the extensions will reduce the visual field of the roadway, which will slow down vehicle traffic. Increasing pedestrian and school signage will provide improved recognition by drivers that this area is a pedestrian zone, and they need to be watching for non-motorized traffic.

As shown in Figure 5.2 below, the main vehicle entrance to Davis High School (Main Street at 325 South) features a roundabout that directs drivers to guest parking (to the north), temporary limited parking (30 minutes or less, next to the school), and faculty parking (to the south). Outside of arrival and dismissal times, this access is used primarily by school visitors. High school students use this as an exit after school, leading to a large surge in traffic volumes that converge with increased pedestrian traffic on the sidewalk. Issues and recommended countermeasures for this site are listed in Table 5.2.

Figure 5.2 Main Street (Facing East) at 325 South

Table 5.2 Main Street Access at 325 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Pedestrian crossing width	Curb extensions on both sides of the access	$26,000 - $50,000 ($13,000-$25,000 per corner)
No crosswalk	High visibility crosswalk with center ped island	$13,000-$20,000
No signage	High-visibility signage including no left turn	$2,000-$5,000 installed
Large curb radius	Curb extensions on both sides of the access Replace east sidewalk with shared use path	-Cost included above -Cost included in Table 5.1
Permissive left-turn allowed	Limit exit to right-out with median barrier	$15,000-$20,000
Proximity of traffic signal		
	Total Site Cost	**$56,000-$95,000**

Currently the pedestrian crossing width is 90 feet (ramp to ramp) while the roadway width just east of the sidewalk is only 40 feet. Adding curb extensions and a high-visibility crosswalk will bring the pedestrian crossing in line with the roadway, adding visibility, and reducing the crossing distance. Currently a permissive left turn is allowed at this location (only 325 feet downstream from an existing traffic signal) which increases conflict points and increases the yield complexity and decision making for drivers. Changing this access to a right-out only by adding signage and installing a center pedestrian median and center raised median on Main Street will reduce conflict points and improve mobility. Drivers wishing to turn left can make a U-turn at the 550 South signal or exit the parking lot via the north or south exits and turn left at the two existing signalized intersections.

5.2.3 Main Street (SR-273) Access at 425 South

The DHS entrance, located at 425 South, provides access to the main student parking lot, football stadium, and main gym through the south entrance of the school. This is the primary entrance for student parking and visitors to sporting events and other school activities. This access is also used by school buses for pick-ups and drop-offs for sports teams. This entrance is located directly across the street from a vacant lot and a church building and parking lot, shown in Figure 5.3. Issues and recommended countermeasures for this site are listed in Table 5.3.

Figure 5.3 Main Street (Facing East) at 425 South

Table 5.3 Main Street Access at 425 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Pedestrian crossing width	Curb extensions on both sides of the access Replace the east sidewalk with shared use path	$26,000 - $50,000 ($13,000-$25,000 per corner) -Cost included in Table 5.1
Limited pedestrian visibility		
Large curb radius		
No crosswalk	High-visibility crosswalk with center pedestrian island	$13,000-$20,000
No signage	High-visibility signage including no left turn	$2,000-$5,000 installed
Access not aligned with 425 South across Main Street	Limit exit to right-out with median barrier	$15,000-$20,000
Permissive left turn		
Proximity of traffic signal		
	Total Site Cost	**$56,000-$95,000**

This access is very similar to the access point at 325 South Main Street. Currently, the pedestrian crossing width is 90 feet (ramp to ramp) while the roadway width just east of the sidewalk is only 40 feet. Adding curb extensions and a high-visibility crosswalk will bring the pedestrian crossing in line with the roadway increasing visibility and reducing the crossing distance. Currently a permissive left is allowed at this location, only 325 feet downstream from an existing traffic signal, which increases conflict points and increases the yield complexity and decision making for drivers. The existing through/left travel lane is not aligned with 425 South across Main Street. This access is also located only 470 feet from the signalized intersection to the south. Eliminating the through/left lane and changing this exit to a right-out only, by adding signage and installing a center pedestrian median and center barrier on Main Street, will reduce conflict points and improve mobility. Drivers wishing to turn left can exit the parking lot via the south exit and turn left at the existing signalized intersection at 550 South.

5.2.4 Main Street (SR-273) Access at 550 South

The intersection at Main Street and 550 South (Davis Tech Drive) provides access to the Davis High School student parking lot, the school's baseball and softball fields, Davis Technical College, and Mountain High to the east. To the west, the intersection provides access to a local neighborhood. The grass area on the southeast corner of the intersection serves as a drainage basin and is regularly used for sports training and community disc golf (shown in Figure 5.4).

The Main Street roadway is 110 feet wide (curb to curb). Issues and recommended countermeasures for this site are listed in Table 5.4.

Figure 5.4 Southbound Main Street (Facing East) at 550 South

Table 5.4 Main Street at 550 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (110 feet ramp to ramp)	Curb extensions on all corners	$55,000-$100,000 ($13,000-$25,000 per corner)
Poor low-visibility signage	Improved high-visibility pedestrian and school signage	$5,000-$10,000 installed
Narrow sidewalks and small queuing area for crossing	Curb extensions at intersection Replace the east sidewalk with an 8'-10' shared use path (300 South to Laurelwood Dr./600 South)	Cost included above Cost included in table 5.1
Permissive left turns (west and eastbound)	Upgrade signal to include protected left-turn phasing	$12,000-$25,000 Installed
	Total Site Cost	**$72,000-$135,000**

Curb extensions at this site will reduce the crossing distance and improve pedestrian visibility. Additionally, the curb extensions will highlight the entrance and provide a visual transition or gateway to the school area and will reduce the visual field of the roadway, which will slow down vehicle traffic. Increasing pedestrian and school signage will also provide improved recognition by drivers that this area is a pedestrian zone and alert them of the need to watch for non-motorized traffic.

Additional corridor improvements include replacing the existing standard sidewalk on the east side of Main Street with an 8 to10-foot wide shared-use path for pedestrians, cyclists, and others. This would remove the non-motorists from the vehicle right-of-way and provide a safe multi-modal area. There is a significant setback along most of the corridor which would provide space for this improvement without the need to purchase additional right-of-way. Likewise, it would maintain the character of the existing greenspace. The cost estimates include extending the path from 300 South to Laurelwood Drive (600 South). As discussed above for both midblock access locations, it is also recommended that center lane barriers be installed on Main Street to eliminate the ability to turn left out of the high school. This will provide access management, reduce conflict points, and move left-turning traffic to the signalized intersections at the north and south ends of the school corridor.

5.3 Region 1- Roy Elementary

Most crashes identified near Roy Elementary occurred at the signalized intersection located at 5600 South (SR-97) at 2700 West and involved students crossing on the south and east side of the intersection. One additional crash occurred as a student on a bike attempted to cross 2800 West on the south side of 5600 South. A review of the crashes determined that the primary factor impacting safety along this corridor is failure to yield by vehicles turning right, and a lack of infrastructure enhancing visibility for non-motorists. The pick-up and drop-off lane for the school is accessed on the east side of the school parking lot from 5600 South. Vehicles are directed to exit the school parking lot from the west side of the parking lot. A midblock crosswalk controlled by a HAWK beacon is located on 5600 South approximately 30 feet east of the school parking entrance.

5.3.1 5600 South (SR-97) at 2700 West

The intersection at 5600 South (SR-97) and 2700 West is located approximately 1,000 feet from the school entrance, as seen in Figure 5.6. The northeast corner of the intersection is home to the Heritage Park Healthcare and Rehabilitation Service, Roy Park (and baseball field), and the Roy Park Maintenance and Public Works facilities. The northwest and southeast corners are both vacant lots, and the southwest corner consists of an apartment/townhome development.

The northbound/southbound intersection approaches (on 2700 West) consist of a permissive left-turn lane and a combined through/right turn lane. The roadway width is 45 feet, and the crossing distance (ramp to ramp) is 75 feet (Figure 5.5**).**

The eastbound/westbound intersection approaches (on 5600 South) consist of a permissive left-turn lane, a through lane, and a right turn lane. The roadway width is 55 feet, and the crossing distance (ramp-to-ramp) is 75 feet (Error! Reference source not found.). 5600 South east of 2700 West includes a significant slope along a 1,000-foot segment between the intersection and a railroad bridge. Additionally, the Denver and Rio Grande (D&RG) Rail Trail crosses 5600 South approximately half-way between 2700 West and 2800 West. Issues and recommended countermeasures for this site are listed in Table 5.5.

Figure 5.5 2700 West at 5600 South (SR-97)

Table 5.5 5600 South (SR-97) at 2700 West: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Pedestrian visibility	Curb extensions on 2 corners (NW and SE)	$26,000-$50,000 ($13,000-$25,000 per corner)
Large curb radius		
Inadequate signage	High-visibility signage	$2,000-$5,000 installed
Right-turn pocket	Create right-turn slip lanes for eastbound and westbound traffic with a pedestrian island Consider "No Right on Red" signage for north and southbound traffic	$100,000-$250,000
	Total Site Cost	**$128,000-$305,000**

Adding curb extensions on the northwest and southeast corners will reduce the crossing distance of the roadway and improve pedestrian visibility. High visibility signage is also recommended at this location to alert motorists that they are entering a school area and that students and non-motorists will be present. As most crashes at this intersection involved right-turning vehicles failing to yield, creating right-turn slip lanes for east- and westbound traffic will reduce potential conflicts and allow drivers and pedestrians to more easily see each other. This will also reduce pedestrian exposure in the roadway and reduce the complexity of the intersection by breaking it into manageable parts. It will also narrow the visual field of the roadway which will slow traffic, particularly westbound traffic as vehicles accelerate downhill from the rail bridge.

5.3.2 5600 South (SR-97) at 2800 West

It should be noted that there are two roadways designated as 2800 West. The northbound leg of 2800 West is approximately 130 feet to the east of the southbound leg of 2800 West. This evaluation is focused on the southbound leg of 2800 South (Figure 5.6 5600 South (SR-97) at Southbound 2800 West

). The southbound leg is located approximately 160 feet from Roy Elementary school's drop-off/pick-up entrance and 120 feet from the HAWK crossing on 5600 South. The roadway provides direct access to 5600 South from a large residential neighborhood to the south. The east and west corner parcels are both vacant lots (as of 7/2023). There is a stop sign and an existing standard crosswalk east/west, however there is currently no sidewalk on the east side of 2800 West. The crossing distance is 60 feet (ramp to ramp) while the roadway width is 30 feet (curb to curb). Eastbound 5600 South has a striped right-turn pocket approximately 65 feet long located between the HAWK crossing and southbound 2800 West. Issues and recommended countermeasures for this site are listed in Table 5.6.

Figure 5.6 5600 South (SR-97) at Southbound 2800 West

Table 5.6 5600 South (SR-97) at Southbound 2800 West: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Pedestrian visibility	Curb extensions on both corners	$26,000-$50,000 ($13,000-$25,000 per corner)
Low visibility crossing	Upgrade crosswalk to school crosswalk standards and striping	$750-$2,000 installed
No signage	Add high-visibility school zone signage	$2,000 installed
Right-turn pocket	Eliminate the right-turn pocket on the eastbound approach	--
	Total Site Cost	**$28,750-$54,000**

Adding curb extensions on the east and west sides of the roadway will square up the intersection and reduce the crossing distance for students. Additionally, it will slow vehicles approaching the stop sign on 2800 West and encourage drivers to yield near the existing HAWK crossing. Likewise, striping a standard school crosswalk will increase visibility and adding high-visibility school and pedestrian signage will visually remind drivers they are in a school area. It is also recommended that UDOT and Roy City consider prohibiting left (westbound) turns from 2800 West during drop-off and pick-up times due to the proximity to the HAWK crossing.

It is noteworthy that UDOT is currently installing a shared-use path on the north side of 5600 South from the D&RG Rail Trail to the rail bridge to the east. This will promote safety by allowing pedestrians and cyclists to access local trails and destinations while remaining separated from traffic and the vehicle right-of-way.

5.4 Region 2 – Kearns High

Kearns High School is located on Cougar Lane (4800 West) to the south of 5400 South (SR-173). Most crashes identified near KHS cluster around two locations: the intersection of 5415 South and Cougar Lane, and directly in front of the school on Cougar Lane. There was also a reported non-motorized crash in the school parking lot. The Kearns Oquirrh Recreation Center is located directly across Cougar Lane from the high school. This site is home to a large community recreation center, several baseball and soccer fields (Oquirrh Park), tennis and pickleball courts, a skate park, and the Utah Olympic Oval. This site serves as a major traffic draw for the area producing moderate AADT on Cougar Lane (12,000-15,000).

5.4.1 Charlotte Avenue (Cougar Lane) at 5400 South (SR-173)

As shown in Figure 5.6 5600 South (SR-97) at Southbound 2800 West

, the intersection at 5400 South (SR-173) allows permissive left turns for northbound and southbound traffic, while westbound traffic is provided with protected left turns (eastbound traffic features both types). There is a modest hill on the south side of the intersection between the high school and 5400 South. There are residential subdivisions west of the intersection, with a frontage road-type access on the north side. This frontage road could potentially create access management issues for Charlotte Avenue, as it is located just 45 feet from the intersection. Any vehicle turning right off the frontage road attempting to queue to the left-turn lane at the signal would be required to cross two travel lanes. On the southeast corner is a vacant lot with large trees that could potentially obscure a northbound driver's view of the intersection. A residential home sits on the northeast corner with a rail access road located between the house and 5400 South.

Both student-involved crashes at this location were the result of a left-turning vehicle coming southbound through the intersection. In one case, the driver of the left-turning vehicle struck a cyclist in the crosswalk as the rider was traveling northbound. In the second case, the driver of the left-turning vehicle hit an eastbound traveling vehicle, which caused the second vehicle to travel up onto the southeast sidewalk striking a pedestrian. Table 5.7 identifies the key issues for this location, with countermeasures to improve safety.

Figure 5.7 Cougar Lane at 5400 South (SR-173)

Table 5.7 5400 South (SR-173) at Cougar Lane: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Permissive left turns (north and southbound)	Upgrade signal to include protected left-turn phasing	$12,000-$25,000 installed
Lack of non-motorist visibility	Install a right-turn slip-lane and concrete median on the southeast corner	$50,000-$100,000
	Install high-visibility crosswalk on east leg of 5400 South with center pedestrian island	$13,000-$20,000
	Increase pedestrian and school signage	$2,500-$5,000
Northbound bike lane visibility	Improve striping and contrast from KHS to intersection (approx. 1,000 feet)	$50,000 (thermoplastic striping) – $80,000 (4-foot green lane)
	Total Site Cost	**$127,500-$230,000**

Upgrading the existing signal to incorporate protected left-turn phasing for north and southbound traffic will improve safety by eliminating permissive turns. Often, when making a permissive left turn, drivers will focus on judging the gap of oncoming traffic rather than yielding to non-motorists. When drivers make a permissive turn on a green light, they typically accelerate into the turn to clear the intersection as quickly as possible. This becomes dangerous if there is a non-motorist crossing in the opposing crosswalk on a green signal. The driver turning left may not see the non-motorist in the crosswalk until it is too late to brake. Providing only protected left turns during school travel hours will eliminate these types of conflicts by only allowing left turns when pedestrians are safely stopped with a “don’t walk” or red signal.

Another major issue at this location is the lack of pedestrian visibility. 5400 South is a very busy roadway with high traffic volumes. Currently the intersection design does not communicate to drivers that there will be non-motorists present and crossing. Adding more signage identifying the area as a school/pedestrian/cyclist zone will enhance the environment and increase driver awareness. Additionally, installing a high-visibility crosswalk with a center pedestrian refuge island on the east leg of the intersection will improve visibility and provide visual clues to drivers that they should be watching for non-motorists. It is also recommended that a slip lane be installed for northbound vehicles turning right onto 5400 South eastbound. This will reduce the crossing distance for non-motorists by further segmenting the roadway and providing a buffer for those waiting to cross. It will also provide a narrower channel for northbound vehicles turning left onto eastbound 5400 South, improving yielding behavior and slowing traffic.

5.4.2 Cougar Lane and Kearns High School

As seen in Figure 5.9, the front entrance to Kearns High School on Cougar Lane is located directly across from the entrance to the Kearns Oquirrh Recreation Center entrance. This entrance also provides access to the Utah Olympic Oval and other recreational facilities. Although the location is signalized, it operates like a midblock signal. The Kearns parking lot serves as the east leg of the intersection, with the rec center entrance acting as the west leg. The signal currently allows permissive left turns, and parking is prohibited on both sides of the street. There are additional exits from the high-school parking lot 100 feet to the north and 300 feet to the south. The number of access points contributes to risk for non-motorists as there are more potential conflict areas along the corridor.

Both student-involved non-motorist crashes that occurred at this location involved a pedestrian being struck by a vehicle as the pedestrian was traveling west across the north leg of the intersection. Table 5.8 provides key issues and countermeasures for this site.

Figure 5.8 Cougar Lane at KHS Entrance

Table 5.8 Cougar Lane at Kearns High School: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Turning vehicles	Upgrade signal to include protected Left-turn phasing	$12,000-$25,000 installed
	Add “yield to pedestrians on red” signage	$5,500-$10,000
	Install high-visibility raised school crosswalks on north and south legs across Cougar Lane	$20,000-$30,000 (both sides)
	Increase pedestrian and school signage	$2,500-$5,000
	Enhance northern school exit with curb extension and “right-turn only,” and “do not enter, exit only” signage	$7,000-$15,000
Northbound bike lane visibility	Improve striping and contrast from KHS to intersection (approx. 1,000 feet)	$50,000 (thermoplastic striping) – $80,000 (4-foot green lane)
	Total Site Cost	**$97,000-$165,000**

Upgrading the signal to include protected left-turn phasing during school commute hours will reduce risk and conflict by only allowing left turns when pedestrians are stopped by a “do not walk” or red signal. As described previously, permissive left-turning vehicles introduce increased risk for pedestrians and cyclists. Adding “yield to pedestrians on red” signage will remind drivers to watch for pedestrians and cyclists when turning through the crosswalk area.

A possible strategy for this intersection includes raised crosswalks. Raised school crosswalks across both the north and south leg of the intersection will improve visibility for pedestrians, while also lowering driver speeds through the area. Combined with improved signage this will signal to drivers that they are in a pedestrian and cycling area and should be watching for and always yielding to non-motorists. Roadway speeds would need to be lowered significantly for such measures, likely to 25 miles per hour (MPH).

The north exit of the school parking lot currently is striped to allow only right-turning vehicles to exit. This location should be enhanced with a curb extension through the striped area narrowing the exit and should be appropriately signed as “right-turn only” facing the parking lot and “no entrance, exit only” signage facing the street. Additionally, the left-turn arrows currently striped on the roadway at this entrance should be removed to avoid driver confusion.

Finally, it is recommended that the entire corridor be enhanced by improving the visibility and contrast of the existing bike lane. This can be accomplished by new thermoplastic striping and signage or enhanced green paint from KHS to 5400 South.

While one of the KHS student-involved crashes occurred in the parking lot, this report will not identify recommendations for improving parking lot safety. It is, however, recommended that the school administration identify opportunities for educating students on proper safety and behavior when walking and driving in the school parking lot.

5.5 Region 2 – West Jordan High

West Jordan High lies on 2700 West (also known as Jaguar Drive) in West Jordan City. This road has a moderate AADT of 9 - 11,000. Joel P. Jensen Middle School is located directly west of the West Jordan High School facilities. A UTA TRAX Line crosses Jaguar Drive in an east-west direction south of the school, with a TRAX station located at the crossing. The immediate area around the school is largely residential; some commercial properties lie farther to the north. Five crashes occurred in the vicinity of the school area; three of the crashes were clustered immediately in front of the school at the intersection of 2700 West and 8136 South (which is a small road providing direct access to the school front and parking lot). Two other crashes were reported, one each at the intersections of 2700 West with 7950 S and 8250 South.

5.5.1 2700 West and 7950 South

As shown in Figure 5.9, the intersection at 7950 South is a T-intersection, where cars turn from 2700 West to 7950 South, and pedestrians cross 7950 South along 2700 West. The intersection includes a median island on 7950 South, which splits eastbound traffic turning onto 2700 West from westbound traffic coming from 2700 West. Traffic approaching 2700 West is controlled by a stop sign. There is not a marked pedestrian crossing across 7950 South. There is also no sign for pedestrians or noting the nearby school area. The median island sits back roughly 15 feet from the area where pedestrians cross 7950 South and cannot serve as a pedestrian refuge island. The island itself is low due to many layers of asphalt overlays on the roadway, providing minimal vertical deflection to traffic. The sidewalk corners at the intersection do not extend into the roadway to any degree, providing limited space for pedestrians to wait at the intersection, and potentially decreasing pedestrian visibility. The crash involved at this intersection involved a vehicle on 7950 South approaching 2700 West eastbound and striking a pedestrian who was crossing 7950 South. Table 5.9 below lists the key issues and recommended countermeasures, along with potential costs.

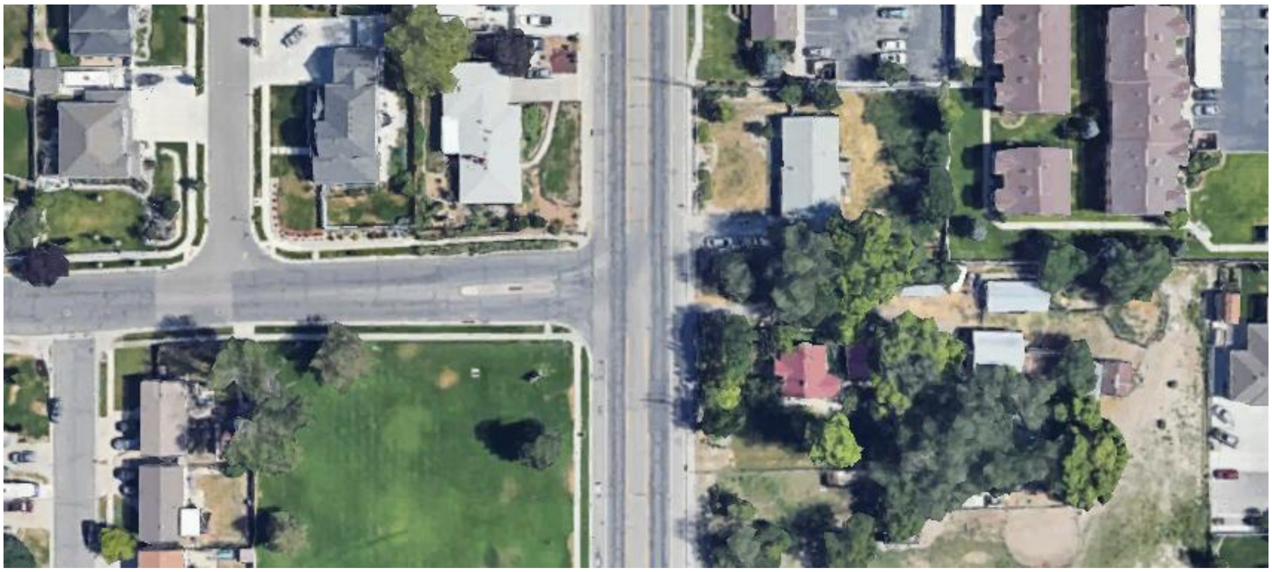

Figure 5.9 2700 West and 7950 South

Table 5.9 2700 West and 7950 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Median setback and low visibility	Rebuild concrete median on 7950 South. Ensure new median serves as a ped refuge island for the crosswalk.	$30,000 - $60,000
Lack of non-motorist visibility	Install high-visibility crosswalk on 7950 South.	$13,000-$20,000
	Curb extensions on both corners	$26,000-$50,000 ($13,000-$25,000 per corner)
Lack of signage	Increase pedestrian and school signage	$2,500-$5,000
	Total Site Cost	**$71,500-$135,000**

Rebuilding the concrete median will help provide a refuge island for pedestrians and help slow down vehicles by preventing them from being able to drive onto the median. It should be noted that the median became level with the pavement due to many years of asphalt overlays on the roadway. The city should diligently repair structural issues with their roadways rather than using persistent asphalt overlays to prevent such issues and to reduce maintenance costs from structural damage. Installing a high visibility crosswalk, curb extensions, and pedestrian and school signage should also draw awareness to pedestrians and alert vehicles to drive carefully around turns.

5.5.2 2700 West and 8136 South

As seen in Figure 5.10, 8136 South is a dedicated access road for West Jordan High, which provides access to the school front and parking lot area and serves as a pickup/drop-off area. The road runs south from the intersection on 2700 West to 8200 South. A right-turn only lane directs southbound traffic on 2700 West onto 8136 South. Several signs mark this road as a bus-only route from 7:00 AM to 3:00 PM, however other resources note this route as a general drop-off area, potentially confusing drivers on when they can access the road and when they can't.

8136 South contains a one-way lane, with traffic entering it from 2700 West. However, the entire roadway is not one-way, leading to potential confusion for drivers entering or existing 8136 South. The three crashes involved at this location included drivers striking pedestrians (two of the three crashes) and a bicyclist (one of three crashes) when driving out of 8136 South onto 2700 West. One of the pedestrian crashes also involved a pedestrian crossing between waiting vehicles; there is no marked pedestrian crosswalk at this location, potentially impacting pedestrian visibility. Converting the entire roadway to a one-way road would help to eliminate some of this confusion, and direct traffic to enter 8136 South and exit on 8200 South to the south. Issues and recommended countermeasures for this site are listed in Table 5.10.

Figure 5.10 2700 West and 8136 South

The sidewalk corner on the north side of 8136 South is set far back to provide access for the right-turn-only lane, increasing the distance pedestrians must cross. A final note is that a midblock crossing across 2700 West is located just north of the 8136 South intersection. It is likely that numerous pedestrians and bicyclists pass through the 8136 South intersection area either before or after using this midblock crossing. Table 5.10 below displays countermeasures for the issues at this intersection.

Table 5.10 2700 West and 8136 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Confusion on one-way lane and traffic direction on 8136 South	Utilize signage and striping to convert 8136 South into a one-way-only road running from the entrance on 2700 West to the exit on 8200 South nearby	$8,000 - $12,000
Lack of non-motorist visibility	Install high-visibility crosswalk on 8136 South.	$13,000-$20,000
	Curb extensions on both corners	$26,000-$50,000 ($13,000-$25,000 per corner)
	Total Site Cost	**$47,000-$82,000**

5.5.3 2700 West and 8250 South

As seen in Figure 5.11 below, the intersection of 2700 West and 8250 South is a T-intersection. Eastbound traffic approaching 2700 West is controlled by a stop sign. There is no pedestrian crosswalk across 8250 South, and no signs noting the presence of pedestrians or the nearby school area. The sidewalk ending at the north end of 8250 South does not feature an ADA ramp but simply ends at the curb. Both sidewalk corners are set back from the roadway, decreasing pedestrian visibility. Another feature of this area is that there are several trees and significant vegetation which potentially obscures pedestrians as they approach the intersection, making pedestrian visibility the key issue at this intersection. The crash recorded at this location consisted of an eastbound vehicle on 8250 South striking a bicyclist who was headed north toward the school area across 8250 South. Table 5.11 below displays countermeasures and associated costs for the issues at this location.

Figure 5.11 2700 West and 8250 South

Table 5.11 2700 West and 8250 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Lack of non-motorist visibility	Install high-visibility crosswalk on 7950 South.	$13,000-$20,000
	Curb extensions on both corners	$26,000-$50,000 ($13,000-$25,000 per corner)
Lack of signage	Increase pedestrian and school signage	$2,500-$5,000
	Total Site Cost	**$41,500-$75,000**

5.6 Region 3 – Provo Peaks Elementary

Crashes around Provo Peaks Elementary School were not concentrated in a specific area, but two of the crashes occurred at the intersection of Center Street and 900 East. All but one of the crashes involved vehicle collisions with pedestrians or cyclists where the non-motorist would have assumed the right-of-way. In no cases were the non-motorists cited for traffic violations or jaywalking, which indicates poor pedestrian visibility and a lack of infrastructure promoting pedestrian visibility in these areas. The figures in this section provide street view images of the crash locations. Included with each figure is a basic description of the challenges and shortcomings of the site and a table highlighting issues and recommended countermeasures. Each table also includes a cost estimate for the recommendations based on current Utah construction costs and UDOT's approved construction standards.

5.6.1 400 East and 100 North

400 East and 100 North are low-speed streets with posted speed limits of 25 MPH. However, as seen in Figure 5.12, the widths of these streets are not conducive to low speeds. The streets are approximately 45 feet wide, which equates to about 6 or 7 vehicle widths. Also, despite this being a residential neighborhood, 400 East and 100 North act as through routes for traffic, increasing opportunities for conflicts. There is also no signage warning of bicycles in the area. This lack of signage may have contributed to the bicycle-related crash at this intersection. Issues and recommended countermeasures for this site are listed in Table 5.12.

Figure 5.12 400 East and 100 North

Table 5.12 400 East/100 North: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (45 feet ramp to ramp)	Curb extensions on all crossings or 20-foot roadway narrowing	$52,000-$100,000 ($13,000-$25,000 per corner) Or 1.16 miles (both corridors) $250,000-$500,000per mile $290,000-$580,000
Lack of bicycle infrastructure and wide perceived roadway width	Bike lanes	1.16 miles (both corridors) $20,000-$100,000 per mile $23,000-$116,000
Lack of bicycle signage	Improved high-visibility bicycle and school signage	$5,000-$10,000 installed
	Total Site Cost	**$80,000-$706,000**

Curb extensions or roadway narrowing will reduce the visual field of the roadway, which will slow down vehicle traffic. They will also reduce the crossing distance and improve pedestrian visibility. Increasing bicycle and school signage will help increase awareness for drivers of possible active transportation users in the area. Bike lanes signal drivers to watch for cyclists and can reduce the perceived width of the roadway, which will slow down vehicle traffic.

While it is more expensive, roadway narrowing can have many benefits besides safety. These include providing a more comfortable walking environment or striping the sides of the road to mark on-street parking. However, it can make turning movements for heavy vehicles difficult or impractical. Alternative truck routes may need to be provided if roadway narrowing is implemented, or truck aprons should be installed at corners to allow heavy trucks to navigate narrower streets.

5.6.2 500 East Between 100 South and Center Street

500 East is a low-speed street with a posted speed limit of 25 MPH. However, the width of this street is not conducive to low speeds. As seen in Figure 5.14, the street is approximately

45 feet wide, which equates to about six or seven vehicle widths. Also, despite this being a residential neighborhood, 500 East acts as a through route for traffic, increasing opportunities for conflicts. Issues and recommended countermeasures for this site are listed in Table 5.13.

Figure 5.13 500 East Between 100 South and Center Street (northbound)

Table 5.13 500 East Between 100 South and Center Street: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (45 feet ramp to ramp)	20-foot roadway narrowing or Bike lanes	1.27 miles (whole corridor) $250,000-$500,000 per mile $318,000-$635,000 Or $20,000-$100,000 per mile $25,000-$127,000
	Total Site Cost	**$25,000-$635,000**

Roadway narrowing will reduce the visual field of the roadway, which will slow down vehicle traffic. It will also reduce the crossing distance and improve pedestrian visibility. Bike lanes signal drivers to watch for cyclists and can reduce the perceived width of the roadway, which will slow down vehicle traffic.

While expensive, roadway narrowing can have many benefits besides safety, including providing a more comfortable walking environment or designating the sides of the road for parking. However, it can make turning movements for heavy vehicles difficult or impractical. Alternative truck routes may need to be provided if roadway narrowing is implemented, or truck aprons should be installed at corners to allow heavy trucks to navigate narrower streets.

5.6.3 Center Street and 600 East

As seen in Figure 5.15, the intersection of Center Street and 600 East is on the southwest corner of Provo Peaks Elementary School and includes a school crosswalk on the east leg of the intersection. 600 East is a low-speed street with a posted speed limit of 25 MPH. However, the width of this street is not conducive to low speeds. The street is approximately 45 feet wide, which equates to about 6 or 7 vehicle widths. Also, despite this being a residential neighborhood, 600 East acts as a through route for traffic, increasing opportunities for conflicts. There is also no signage warning of bicycles or school-related traffic on the southbound approach which may have contributed to the bicycle-related crash at this intersection. Issues and recommended countermeasures for this site are listed in Table 5.14.

Figure 5.14 Center Street and 600 East

Table 5.14 Center Street/600 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (45 feet ramp to ramp)	Curb extensions on north and east crossings or 20-foot roadway narrowing	$26,000-$50,000 ($13,000-$25,000 per corner) Or 1.01 miles (both corridors) $250,000-$500,000 per mile $253,000-$505,000
Lack of bicycle infrastructure and wide perceived roadway width	Bike lanes	1.01 miles (both corridors) $20,000-$100,000 per mile $20,000-$101,000
Lack of bicycle and school signage	Improved high-visibility bicycle and school signage	$5,000-$10,000 installed
	Total Site Cost	**$51,000-$616,000**

Curb extensions or roadway narrowing will reduce the visual field of the roadway, which will slow down vehicle traffic. They will also reduce the crossing distance and improve pedestrian visibility. Increasing bicycle and school signage will provide improved recognition by drivers that this area is a pedestrian zone, and they need to be watching for non-motorized traffic. Bike lanes signal drivers to watch for cyclists and can reduce the perceived width of the roadway, which will slow down vehicle traffic.

While it is more expensive, roadway narrowing can have many benefits besides safety including providing a more comfortable walking environment or designating the sides of the road for parking. However, it can make turning movements for heavy vehicles difficult or impractical. Alternative truck routes may need to be provided if roadway narrowing is implemented, or truck aprons should be installed at corners to allow heavy trucks to navigate narrower streets.

5.6.4 Center Street and 900 East

As seen in Figure 5.15, the intersection of Center Street and 900 East is a signalized intersection with a school crosswalk on the north leg. Center Street has a moderate AADT of 7 -

11,000 with a posted speed limit of 30 MPH and 900 East has a higher AADT of 10 – 20,000 with a posted speed limit of 35 MPH. This means there are more opportunities for dangerous conflicts on 900 East, where the student-related crashes occurred. The student-related crashes here involved turning vehicles. Each approach to the intersection uses permissive-protected left-turn phasing which could have contributed to these crashes. Also, it can be difficult for right-turning vehicles to see approaching pedestrians. Curb extensions can help make pedestrians more visible but may require lane reductions on some intersection approaches. Issues and recommended countermeasures for this site are listed in Table 5.15.

Figure 5.15 Center Street and 900 East

Table 5.15 Center Street/900 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (75 feet ramp to ramp) and poor pedestrian visibility	Curb extensions on north crossing	$26,000-$50,000 ($13,000-$25,000 per corner)
Poor low-visibility signage	Improved high-visibility pedestrian and school signage	$5,000-$10,000 installed
Only protected-permissive left turns	Upgrade signal to include protected-only left-turn phasing	$12,000-$25,000 installed
	Total Site Cost	**$43,000-$85,000**

Curb extensions at this site will reduce the crossing distance and improve pedestrian visibility. Additionally, the extensions will reduce the visual field of the roadway, which will slow down vehicle traffic. Increasing pedestrian and school signage will signify to drivers that the area is a pedestrian zone, and they need to be alert for active transportation users.

5.6.5 500 East and 200 North

As seen in figure 5.17, 500 East and 200 North are low-speed streets with posted speed limits of 25 MPH. However, the widths of these streets are not conducive to low speeds. The streets are approximately 45 feet wide, which equates to about 6 or 7 vehicle widths. Also, despite this being a residential neighborhood, 500 East and 200 North function as through routes for traffic, increasing opportunities for conflicts. There is also no signage warning of bicycles in the area which may have contributed to the bicycle-related crash at this intersection. Issues and recommended countermeasures for this site are listed in Table 5.16.

Figure 5.16 500 East and 200 North

Table 5.16 500 East/200 North: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (45 feet ramp to ramp)	Curb extensions on all crossings or 20-foot roadway narrowing	\$52,000-\$100,000 (\$13,000-\$25,000 per corner) Or 1.89 miles (both corridors) \$250,000-\$500,000 per mile \$470,000-\$945,000
Lack of bicycle infrastructure and wide perceived roadway width	Bike lanes	1.89 miles \$20,000-\$100,000 per mile \$38,000-\$189,000
Lack of bicycle signage	Improved high-visibility bicycle and school signage	\$5,000-\$10,000 installed
	Total Site Cost	**\$95,000-\$1,144,000 (500 East costs included in Table 5.13)**

Curb extensions or roadway narrowing will reduce the visual field of the roadway, which will slow down vehicle traffic. They will also reduce the crossing distance and improve pedestrian visibility. Increasing bicycle and school signage will provide improved recognition by drivers that this area is a pedestrian zone, and they need to be watching for non-motorized traffic. Bike lanes signal drivers to watch for cyclists and can reduce the perceived width of the roadway, which will slow down vehicle traffic.

While expensive, roadway narrowing can have many benefits besides safety including providing a more comfortable walking environment or designating the sides of the road for parking. However, it can make turning movements for heavy vehicles difficult or impractical. Alternative truck routes may need to be provided if roadway narrowing is implemented, or truck aprons should be installed at corners to allow heavy trucks to navigate narrower streets.

5.7 Region 3 – Spanish Fork Jr. High

Spanish Fork Jr. High lies off 800 East south of Canyon Road in Spanish Fork City. Canyon Road features a moderate AADT (9 – 14,000 AADT), but other roads in the vicinity of the school have lower AADTs and are primarily residential areas. Several other schools lie near

Spanish Fork Jr. High, including elementary schools and another junior high to the east and north, and Landmark High School to the west. A recreation center is located to the west. All student-related crashes identified near Spanish Fork Jr. High occurred on 800 East (to the north) / 820 East (to the south). Additionally, all crashes took place in a location where the pedestrian or cyclist would have assumed the right-of-way. In no case was the non-motorist cited for being at fault for the crash or for jaywalking. Therefore, the primary factor impacting safety along this corridor is assumed to be a lack of visibility of non-motorists and a lack of infrastructure supporting high visibility.

5.7.1 820 East and 600 South

As seen in Figure 5.18, the crossing on the north leg of the intersection of 820 East and 600 South is a school crosswalk which leads directly to Spanish Fork Jr. High. As such, a significant portion of students traveling on foot would be expected to cross at that location. Also, crash reports indicate that crashes occurred during dark conditions and there is only one streetlight on the opposite side of the intersection from the crosswalk. This streetlight also doesn’t appear to have a directed beam which would be helpful for illuminating the crosswalk. 820 East and 600 South are low-volume residential streets, so they may also be viable for roadway narrowing. 820 East is 50 feet wide which can be narrowed to slow drivers down and make them more alert to pedestrians. Issues and recommended countermeasures for this site are listed in Table 5.17.

r

Figure 5.17 820 East and 600 South

Table 5.17 820 East/600 South: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (50 feet ramp to ramp)	Curb extensions on north crossing or 25-foot roadway narrowing	$26,000-$50,000 ($13,000-$25,000 per corner) Or 0.24 miles (820 East corridor) $250,000-$500,000 per mile $59,000-$119,000
Poor low-visibility signage	Improved high-visibility pedestrian and school signage	$5,000-$10,000 installed
Inadequate street lighting	Improved street lighting	$20,000-$50,000 installed
	Total Site Cost	**$51,000-$179,000**

Curb extensions or roadway narrowing will reduce the visual field of the roadway, which will slow down vehicle traffic. They will also reduce the crossing distance and improve pedestrian visibility. Increasing pedestrian and school signage will provide improved recognition by drivers that this area is a pedestrian zone, and they need to be watching for non-motorized traffic. Improved street lighting will allow drivers to see pedestrians more clearly under dark conditions.

While expensive, roadway narrowing can have many benefits besides safety including providing a more comfortable walking environment or designating the sides of the road for parking. However, it can make turning movements for heavy vehicles difficult or impractical. Alternative truck routes may need to be provided if roadway narrowing is implemented, or truck aprons should be installed at corners to allow heavy trucks to navigate narrower streets.

5.7.2 Canyon Road and 800 East

As shown in Figure 5.18, the intersection of Canyon Road and 800 East (to the north) / 820 East (to the south) is a skewed intersection which leads to visibility issues for turning vehicles. It also includes an offset for the northbound and southbound approaches, which can be hazardous. This intersection could be realigned and have vehicle movements restricted to help improve safety. If movements are restricted, alternative routes may need to be identified. However, 800 East has a very low traffic volume and could be restricted, turning the current layout into a three-leg intersection with Canyon Road and 820 East. Issues and recommended countermeasures for this site are listed in Table 5.18.

Figure 5.18 Canyon Road and 800 East

Table 5.18 Canyon Road/800 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width (60-80 feet ramp to ramp)	Curb extensions on all crossings	$52,000-$100,000 ($13,000-$25,000 per corner)
Lack of pedestrian signage	Improved high-visibility pedestrian and school signage	$5,000-$10,000 installed
Skewed and misaligned approaches	Realignment / restriction and reconstruction	$500,000-$3,000,000 installed
	Total Site Cost	**$557,000-$3,110,000**

Curb extensions at this site will reduce the crossing distance and improve pedestrian visibility. Additionally, the extensions will reduce the visual field of the roadway, which will slow down vehicle traffic. Increasing pedestrian and school signage will provide improved recognition by drivers that this area is a pedestrian zone, and they need to be watching for non-motorized traffic. Realigning or restricting the intersection can reduce conflict points and improve visibility for turning vehicles.

5.8 Region 4 – Dixie High

Dixie High School lies south of the St. George Regional Hospital off 700 South and 400 East. Dixie Middle School is located directly to the southwest, while Utah Tech University is located farther away to the northeast. 700 South features a moderate AADT of 18,000-21,000, while 400 East features a lower AADT of 6,000-8,000. The area is largely residential, but the high school complex is large and features numerous recreational fields and areas. Several commercial properties are nearby, and JC Snow Park is directly to the south. 700 South is also one of the few corridors that provides access across (under) I-15 to the east. Four student-involved crashes were recorded near Dixie High School at two separate locations. Two crashes occurred at the intersection of 700 South and 400 East, while two others occurred at the intersection of 700 South and 100 East. All four crashes occurred while students were crossing at a marked crosswalk.

5.8.1 700 South and 400 East

As seen in Figure 5.20, north and southbound 400 East both feature one through lane in each direction, and a dedicated permissive left-turn lane. Northbound 400 East also features a right-turn lane. The east and westbound directions feature one through lane and one permissive dedicated left-turn lane. The roadway has a wide shoulder. Signage identifies “no on-street parking” along 700 South, however, many of the signs are obscured by the park strip trees. There is a school crosswalk on the east intersection approach, which may not be an appropriate location, given that there is not a connecting crosswalk on the south approach to access the school. Overall, the roadway environment does not provide an indication that drivers should be aware of the presence of a school or the potential for a large number of pedestrians. Issues and recommended countermeasures for this site are listed in Table 5.19.

Figure 5.19 700 South and 400 East

Table 5.19 700 South and 400 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Low-visibility signage	Install high-visibility signage for “no-parking,” and pedestrian and school crossings	$10,000-$15,000 installed
No environmental indicators of school environment	Install curb extensions on east and west approaches to provide traffic calming and identify the school area	$52,000-100,000 ($13,000-$25,000 per corner)
School crosswalk location	Move the school crosswalk to the west approach or add a second school crossing to the south approach	$1,500-$4,500
	Total Site Cost	**$63,500-$119,500**

5.8.2 700 South and 100 East

At 700 South and 100 East, as seen in Figure 5.21, north and southbound travel is controlled with stop signs, while east/west traffic is free flow. There is a school crosswalk on the east approach. However, there is no signage or signalization to stop traffic, just a school crossing sign with an arrow to the crosswalk. The roadway on the northbound approach is about 45 feet wide, while the southbound approach is 60 feet wide. There are no environmental indicators to indicate that this is a school zone, and 700 South has a moderate AADT of 18 – 21,000 which can make crossing for students very difficult. Some form of traffic control, such as a rectangular rapid flashing beacon (RRFB) may be necessary on 700 South to improve the pedestrian experience. Issues and recommended countermeasures for this site are listed in Table 5.20.

Figure 5.20 700 South and 100 East

Table 5.20 700 South and 100 East: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Roadway width misaligned north and southbound (60 feet to the north and 45 feet to the south)	Curb extensions on north and south approach or 35-foot roadway narrowing to the north and 20-foot roadway narrowing to the south	$52,000-100,000 ($13,000-$25,000 per corner) Or 1.60 miles (100 East Corridor) $250,000-$500,000 per mile $400,000-$800,000
No environmental indicators of school environment	Curb extensions on east approach at school crosswalk	$26,000-$50,000 ($13,000-$25,000 per corner)
	High visibility school and pedestrian signage	$10,000-$15,000 installed
No traffic control at school crossing	RRFB with push button actuator	$10,000-$20,000
	Total Site Cost	**$98,000-$885,000**

Narrowing the northbound approach as it reaches the intersection will reduce the crossing distance and better align the intersection through the southbound approach. It will also slow approaching traffic. Installing curb extensions on the east leg will also reduce the crossing distance to the school, while providing visual cues that it is a school/pedestrian environment. Improving signage and adding an RRFB on that same crossing will further highlight the presence of pedestrians and encourage drivers to slow down through this area.

5.9 Region 4 – Snow Canyon Middle School

Snow Canyon Middle School is located on Lava Flow Drive (2400 West) on the border of St. George and Santa Clara in Washington County. It is located directly south of Snow Canyon High School, with downtown St. George to the east. Lava Flow Drive features a lower AADT of 7 – 9,000. Directly to the south of the school is Sunset Boulevard, which features a higher AADT of 25 – 29,000. The area features a mix of residential and commercial land use. Notably, several areas near the school include open spaces between developments, with several walking trails nearby. Three crashes occurred in the area involving student-age individuals, all in separate locations. One crash occurred at the intersection of Lava Flow Drive and Sunset

Boulevard, one occurred at a midblock location on Lava Flow Drive at a pedestrian crossing near the school, while another occurred at the intersection of Santa Clara Drive and Canyon View Drive (note: Santa Clara Drive is the continuation of Sunset Boulevard after crossing westward into Santa Clara).

5.9.1 Santa Clara Drive and Canyon View Drive

As seen in Figure 5.22, Canyon View Drive provides secondary access to Snow Canyon Middle School by way of a pedestrian/bicycle access path about 900 feet north of this intersection. This access encourages the broader use of this route for pedestrian and bicycle travel. Also, Canyon View Park is on the east side of Canyon View Drive about 1/3 mile north of the intersection and 900 feet from the access path. The park has baseball and softball fields, pickleball and tennis courts, sand volleyball, and a BMX track, which serve as community amenities and destinations for non-motorized travel. The intersection is unique, as the southbound approach enters from the parking lot of a strip mall. Land use for all four corners is commercial, including a bank, gas station, and other general commercial properties. The student crash at this intersection involved a cyclist crossing the east leg in a marked crosswalk (northbound) being hit by a permissive left-turning vehicle. The ramp-to-ramp crossing distance for this leg is 100 feet, compared to the roadway width of 80 feet (curb-to-curb). Issues and recommended countermeasures for this site are listed in Table 5.21.

Figure 5.21 Santa Clara Drive and Canyon View Drive

Table 5.21 Santa Clara Drive and Canyon View Drive: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Only permissive left turns	Upgrade signal to include protected-only left-turn phasing	$12,000-$25,000 installed
Crossing distance and poor visibility	Curb extensions on east approach with high visibility crosswalk	$26,000-$50,000 ($13,000-$25,000 per corner)
No signage or recognition of school or recreation area	High visibility school and pedestrian signage	$10,000-$15,000 installed
Very narrow bike lane on Canyon View	Remove gutter-side striping on the east bike lane	$2.50-$5 per foot x 140 feet $350-$700
	Total Site Cost	**$48,350-$90,700**

Installing protected left-turn signal phasing will eliminate the potential conflict between left-turning vehicles and non-motorists in the crosswalk. Additionally, adding curb extensions will reduce the non-motorist crossing distance and improve visibility of pedestrians and cyclists, particularly children. Improving signage to alert drivers to the presence of school-aged children will increase visibility while encouraging drivers to slow down and watch for children in the area. Lastly, removing the gutter-side striping from the east bike lane on Canyon View Dr. will widen the existing bike lane from 3 feet to over 5 feet, providing a more comfortable experience for cyclists.

5.9.2 Lava Flow Drive (2400 West) North of Sunset Boulevard

Lava Flow Drive (2400 West) provides vehicle and non-motorist access to both Snow Canyon High School and Snow Canyon Middle School. As seen in Figure 5.23, approximately 1,000 feet north of Sunset Blvd., there is a mid-block crossing connecting the middle school to an LDS Seminary building. The crossing is marked with a school crosswalk and pedestrian signage. Just south of this crossing is a vehicle access to the Sand Hollow Aquatic Center parking lot, and to the north are the Snake Hollow and St. George Bike Parks along with a multi-use trail. This crossing provides the only marked crosswalk across Lava Flow Drive between Sunset Blvd and Pioneer Parkway (a distance of approximately 1.25 miles). Also, this crossing is along a roadway curve, which may reduce pedestrian visibility as vehicles travel southbound. The student crash at this intersection involved a pedestrian crossing in the marked crosswalk being hit by a vehicle traveling northbound. The ramp-to-ramp crossing distance for this leg is 70 feet, compared to the roadway width of 50 feet (curb-to-curb). Issues and recommended countermeasures for this site are listed in Table 5.22.

Figure 5.22 Lava Flow Drive North of Sunset Boulevard

Table 5.22 Lava Flow Drive North of Sunset Boulevard: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Low-visibility signage	High-visibility school and pedestrian signage	$10,000-$15,000 installed
Unexpected mid-block crossing location	RRFB with push button actuator	$10,000-$20,000
Wide crossing distance	Bulb-outs on both sides of the roadway	$26,000-$30,000 ($13,000-$15,000 per side)
No traffic calming	Install high-visibility raised school crosswalk	$10,000-$15,000
	Total Site Cost	**$56,000-$80,000**

Installing high-visibility pedestrian and school signage along the corridor to the north and south will alert drivers to the likely presence of non-motorists at this location. Adding bulb-outs will reduce the crossing distance to just over 30 feet, which will limit the conflict zone for pedestrians and cyclists while also making students more visible to drivers before they cross. Adding a raised crosswalk will provide traffic calming by slowing vehicles driving around the corner; if this strategy is implemented, speed limits will need to be lowered near the crosswalk area, likely to 25 MPH. Lastly, the crossing is not used consistently throughout the day, which means drivers do not have a predetermined window of when to expect non-motorist traffic. Therefore, it is recommended to install an RRFB with a button actuator. This will allow students and non-motorists to activate the signal as needed, alerting drivers to their presence.

5.9.3 Sunset Boulevard/Santa Clara Drive and Lava Flow Drive

Lava Flow Drive (2400 West) provides vehicle and non-motorist access to both Snow Canyon High School and Snow Canyon Middle School. As seen in Figure 5.24, the north corners are both vacant parcels, while the southwest parcel features a restaurant and the southeast parcel consists of residential townhomes. The student crash at this intersection involved a cyclist crossing in a marked crosswalk being hit by a permissive left-turning vehicle. The ramp-to-ramp crossing distance for this leg is 95 feet, compared to the roadway width of 75 feet (curb-to-curb). Issues and recommended countermeasures for this site are listed in Table 5.23.

Figure 5.23 Sunset Boulevard/Santa Clara Drive and Lava Flow Drive

Table 5.23 Santa Clara Drive and Lava Flow Drive: Issues and Countermeasures

Key Issues	Recommended Countermeasure	Estimated Cost
Only permissive left turns	Protected-only left-turn phasing	$12,000-$25,000 installed
Crossing distance and poor visibility	Curb extensions on east approach with high-visibility crosswalk	$26,000-$50,000 ($13,000-$25,000 per corner)
No signage or recognition of school or recreation area	High-visibility school and pedestrian signage	$10,000-$15,000 installed
	Total Site Cost	**$48,000-$90,000**

Installing signal phasing that provides protected left turns will eliminate the potential conflict between left-turning vehicles and non-motorists in the crosswalk. Adding curb extensions will reduce the non-motorist crossing distance to 60 feet and improve visibility of pedestrians and cyclists, particularly children. Additionally, improving signage to alert drivers to the presence of school-aged children will increase visibility and encourage drivers to slow down and be on guard for children in the area.

5.10 Limitations and Challenges

The recommendations suggested in this report are ultimately subject to UDOT approval. UDOT personnel should review these potential projects to confirm their placement and feasibility at each location.

6.0 RECOMMENDATIONS AND IMPLEMENTATION

6.1 Recommendations

This section will give a detailed description of each countermeasure described in Chapter 5. Pictures showing examples of the countermeasures, design guidelines, and estimated installation costs are included. For countermeasures which would normally require a warrant, it is still recommended for safety reasons regardless of whether the warrant would be met.

6.1.1 Curb Extensions

Curb extensions, also called bulb-outs, extend the sidewalk and reduce the width of the roadway. They include midblock curb extensions, known as pinch points or chokers (Figure 6.1); intersection curb extensions (Figure 6.2); and bus stop curb extensions, known as bus bulbs (Figure 6.3). Some curb extensions may include cut-throughs for bicyclists (Figure 6.4), and others may include truck aprons to allow heavy trucks to make wider turns (Figure 6.5).

Figure 6.1 Midblock Curb Extension (also known as pinch point or choker)

Figure 6.2 Intersection Curb Extensions (seen from an aerial perspective)

Figure 6.3 Bus Stop Curb Extension

Figure 6.4 Curb Extension with Cut-Throughs for Bicyclists

Figure 6.5 Curb Extension with Truck Apron

Curb extensions cue drivers to slow down and force them to take safer turns at intersections. They can also be used to shorten the distance of crosswalks in the roadway to make pedestrian crossings safer and more comfortable. Sometimes curb extensions are combined with raised crosswalks to slow vehicles as shown in Figure 6.6. Curb extensions cost an estimated $13,000 to $25,000 per corner in Utah.

Figure 6.6 Curb Extension with Raised Crosswalk

6.1.1.1 Truck Aprons

Due to frequent heavy vehicle use, it may not always be possible to install a traditional curb extension. In these cases, truck aprons combined with curb extensions allow trucks to mount the curb for wider turns if needed. These should be designed in a way that vehicles cannot comfortably mount the curb at high speeds to discourage most drivers from using the truck apron and to prevent dangerous turns at high speeds. Figure 6.7 shows an example of a truck apron for a right-turn curve.

Figure 6.7 Curb Extension with Truck Apron – Right-Turn Curve

6.1.2 High-Visibility Signage

Street signs communicate the rules of the road and warn drivers of potential dangers. They can be applied for a wide variety of pedestrian safety purposes, including restricting turning movements at intersections with poor pedestrian visibility, or alerting drivers of pedestrian activity. Street signs should be highly visible by using reflective paint and following standards from the MUTCD. While signage implementation may vary significantly depending on scope, it is typically estimated to cost $2,000 to $5,000 to install.

6.1.2.1 High-Visibility School and Pedestrian Signage

Chapter 7 of the Utah Manual on Uniform Traffic Control Devices (MUTCD) includes detailed guidelines on signage for school zones. These include standards for high-visibility signage such as Overhead School Speed Limit Assemblies (OSSLA) (sign SS5-1a) as shown in Figure 6.8. Overhead signage is more visible than signage next to the road which can be blocked by trees, vehicles, or other obstructions. A variety of highly reflective signage can also be used to warn drivers of school crossings, school bus stops, and reduced speed school zones. Highly visible signage such as this can greatly improve pedestrian safety near schools by warning drivers of the presence of schoolchildren. High-visibility pedestrian and school signage, especially OSSLAs, are estimated to cost $5,000 to $10,000 to install in Utah, not including the cost of the mast arm to which the signage is mounted.

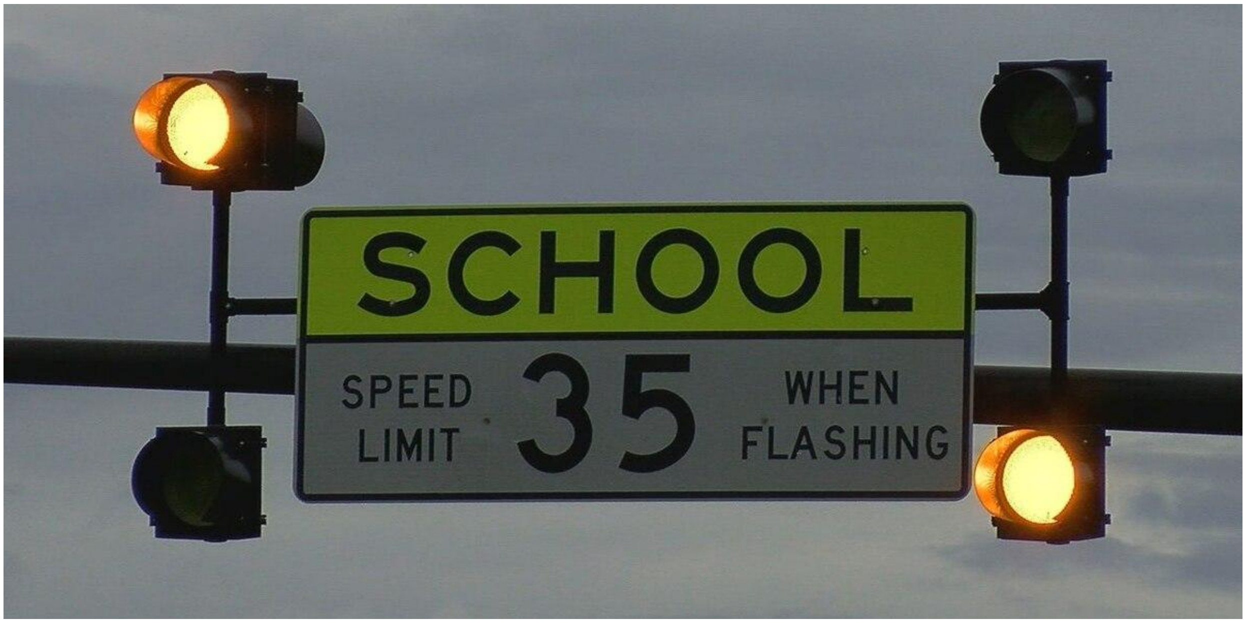

Figure 6.8 Overhead School Speed Limit Assemblies (OSSLA) Sign SS5-1a

6.1.3 Right-Turn Slip Lane - with Ped Island

Right-turn slip lanes may be implemented at intersections with a designated right-turn lane. They are often used to improve the turning radius for right-turning vehicles, but the inclusion of a pedestrian island makes them advantageous for pedestrians as well. As shown in Figure 6.9, this design allows right-turning vehicles to traverse the crosswalk before entering traffic, which simplifies driver workload and allows them to yield to pedestrians more effectively. The pedestrian island also shortens the crosswalk distance for pedestrians into two smaller crosswalks instead of one long crosswalk**.** Figure 6.10 and Figure 6.11 show examples of some right-turn slip lanes with various designs highlighting their flexibility and utility.

A good slip lane design for pedestrian safety should include a short radius which forces turning vehicles to slow down and pay attention to pedestrians. It should also include an amply-sized pedestrian island to make pedestrians feel comfortable, and a well-placed crosswalk to make sure turning drivers are focused on pedestrians and not merging with traffic. In Utah, the estimated cost to install a right-turn slip lane is $100,000 to $250,000.

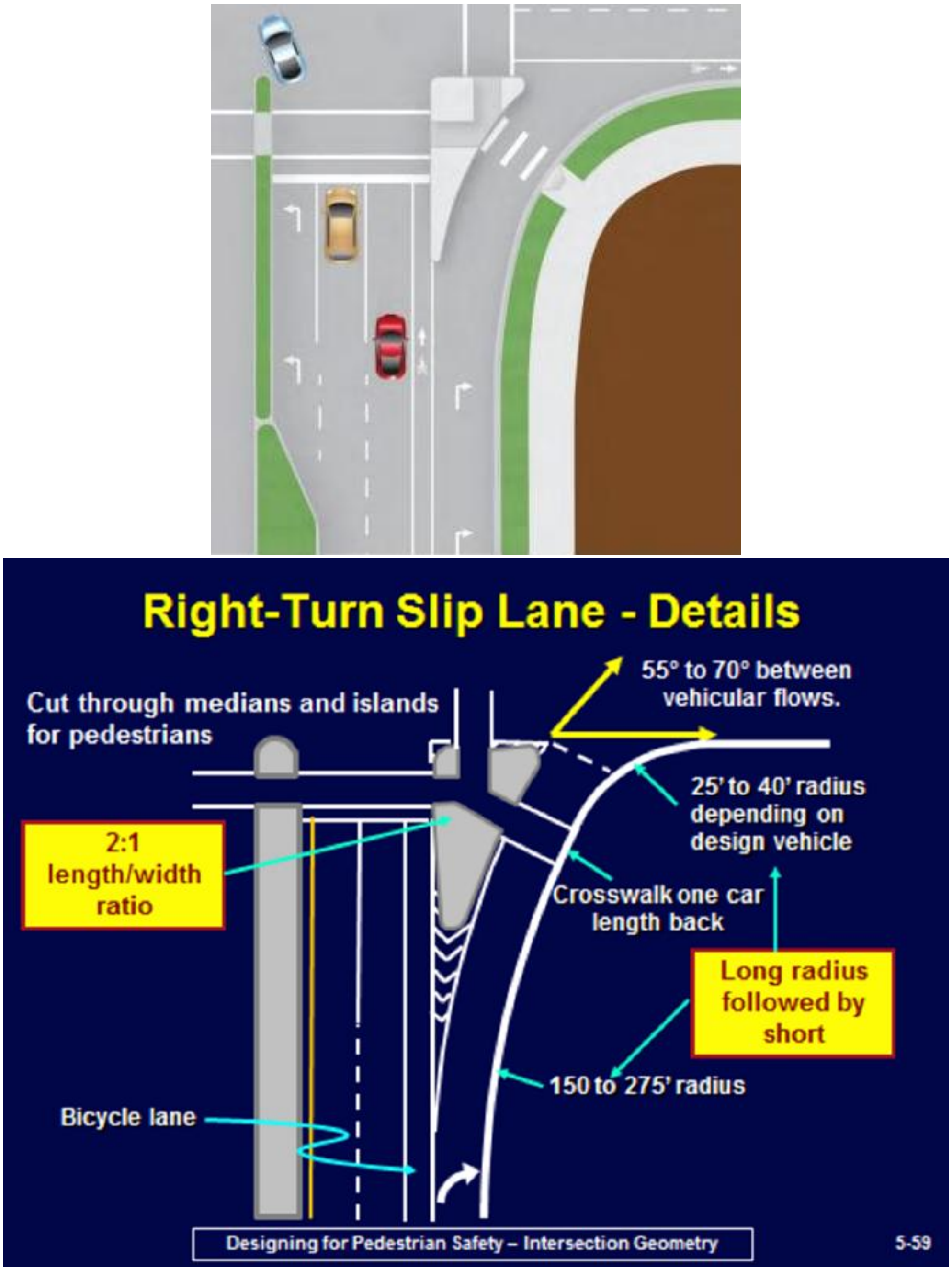

Figure 6.9 Right-Turn Slip Lane Aerial View Example (Top) and Slip Lane Details (Bottom)

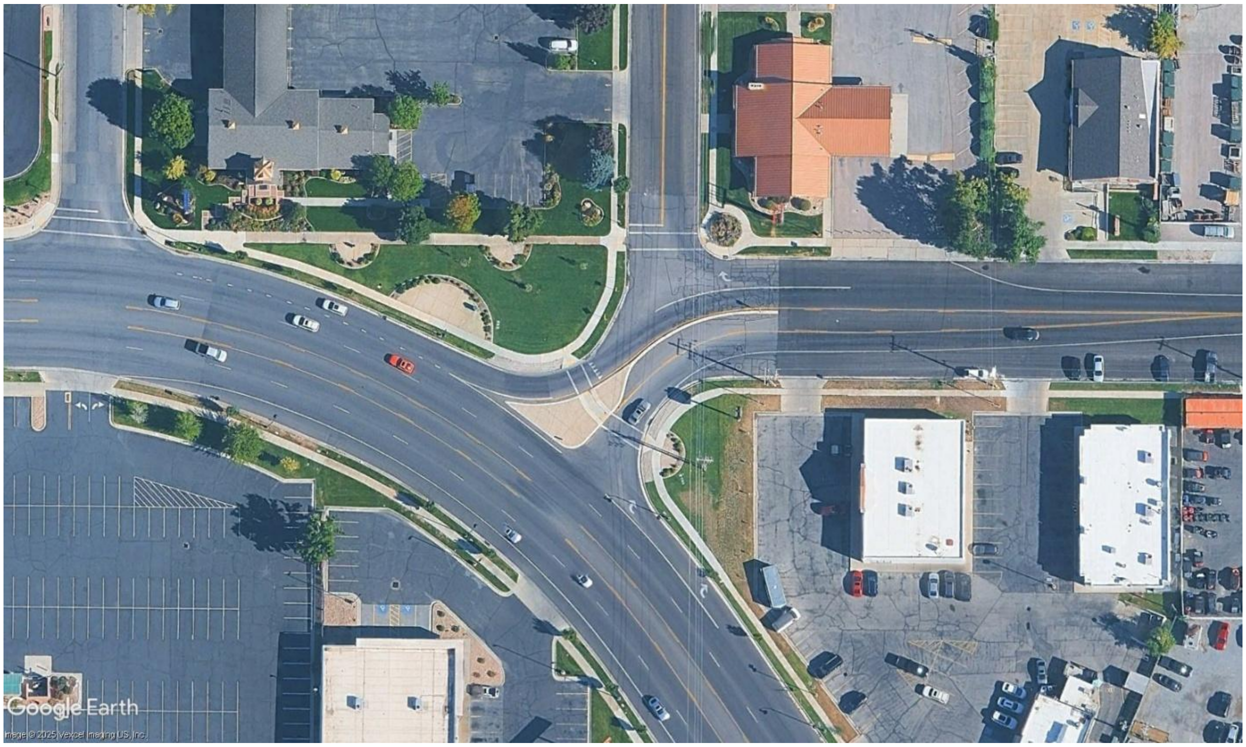

Figure 6.10 Right-Turn Slip Lane Aerial View Example 1

Figure 6.11 Right-Turn Slip Lane Aerial View Example 2

6.1.4 Protected Left-Turn Phasing

Left turns at signalized intersections are often a source of conflicts, especially for unprotected or protected-permissive left-turn phasing. During an unprotected left turn, the turning vehicle must watch opposing traffic to find an acceptable gap in traffic. During this time, pedestrians in the crosswalk often go unnoticed, creating an opportunity for dangerous conflicts. Protected phasing ensures there will be no conflicting through traffic while the left-turning vehicle moves through the intersection, thereby allowing them to watch for pedestrians. It should also ensure that pedestrians will not be in the crosswalk (unless they are jaywalking) when vehicles are turning left. While protected left-turn phasing is often implemented to improve the operation at a signalized intersection with high left-turning volume, it can be worthwhile to implement for safety reasons even if there are few operational benefits or it degrades traffic operations. The cost to change left-turn phasing to protected phasing is negligible if the hardware already exists but may cost between $12,000 to $25,000 to install in Utah otherwise. Figure 6.12 shows an example of a left-turn signal head used for protected left-turn phasing.

Figure 6.12 Left-Turn Signal Head and Sign for Control Over Left-Turn Phasing

6.1.5 Shared-Use Path

A shared-use path is a trail or sidewalk used by pedestrians, cyclists, and other forms of active transportation which separates these vulnerable road users from vehicle traffic. Shared-use paths come in a wide variety of forms and may be completely separated from the roadway such as in Figure 6.13 or directly adjacent to the roadway such as in Figure 6.14. Figure 6.15 shows an example of a shared-use path along the Provo River Trail in Utah.

Shared-use paths are beneficial to pedestrian safety since they separate pedestrians and cyclists from the roadway area and create a more comfortable walking environment. Some cities may regulate design standards for shared-use paths, but they are very flexible and simple to install otherwise. In Utah, their cost ranges from $13 to $28 per square foot. This cost does not include the cost of right-of-way acquisition, which will increase the total cost of the pathway.

Figure 6.13 Shared-Use Path Separated from Roadway

Figure 6.14 Shared-Use Path Adjacent to Roadway

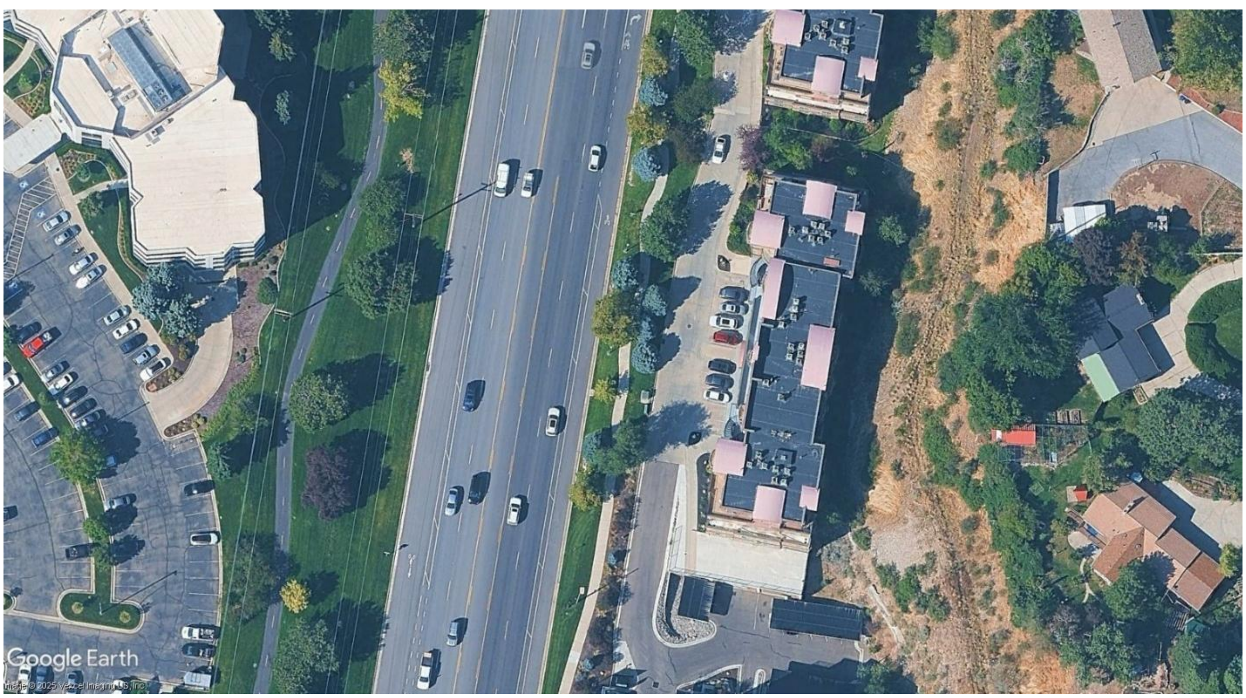

Figure 6.15 Shared-Use Path Example – Provo River Trail

<u>6.1.6 High-Visibility Crosswalk</u>

High-visibility crosswalks (HVCs) use patterns which are more recognizable to drivers and pedestrians (i.e., bar pairs, continental, and ladder). See Figure 6.16 through Figure 6.18 for examples of these crosswalk patterns and potential designs. HVCs should use inlays or thermoplastic tape instead of paint or brick to make them highly reflective. Lighting at HVCs is also vital and should illuminate pedestrians in a way that provides positive contrast, meaning light falls on pedestrians but not behind them allowing them to stand out to drivers. Signage and pavement markings telling drivers to “STOP” or “YIELD” to pedestrians along with a STOP or YIELD bar, also help improve the visibility of HVCs.

Figure 6.16 High-Visibility Crosswalk (Bar Pair/Piano Key Design)

Figure 6.17 High Visibility Crosswalk (Continental/Zebra Design)

Figure 6.18 High-Visibility Crosswalk (Ladder-Style Design with Sharks Teeth)

6.1.6.1 Center Pedestrian Island

In addition to HVCs, center pedestrian islands (also known as pedestrian refuge islands) enhance pedestrian experience and safety at crosswalks. Pedestrian islands are built in the middle of the roadway, giving pedestrians a place to wait if there is oncoming traffic and narrowing the roadway to encourage drivers to slow down at crosswalks. Examples of crosswalks with center pedestrian islands are shown in Figure 6.19 through Figure 6.21. An HVC with a center pedestrian island is estimated to cost $13,000 to $20,000 to install in Utah.

Figure 6.19 HVC and Center Median Island Example 1

Figure 6.20 HVC and Center Median Island Example 2

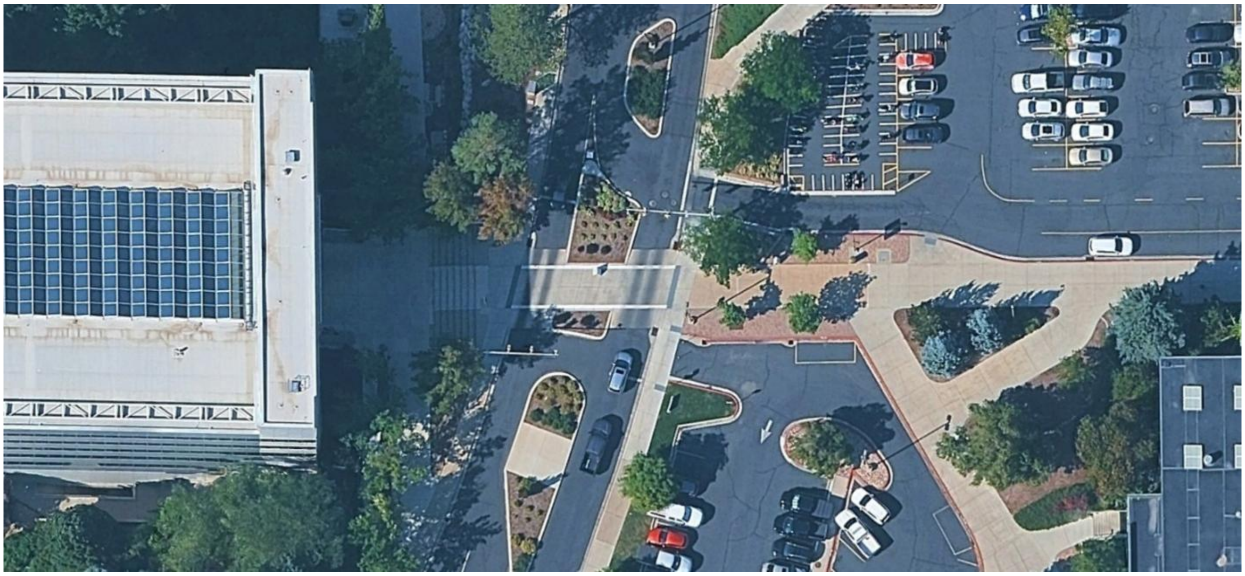

Figure 6.21 HVC and Center Median Island Example 3 (Aerial View)

6.1.6.2 School Crosswalk

Some crosswalks are specifically designed for paths to school as part of UDOT's SRTS program. Under this program, schools outline safe paths for students to take on the way to school. If these paths include a crosswalk, that crosswalk should be designed as a school crossing according to MUTCD Chapter 7. School crosswalks should be designed as HVCs and should include specific signage and pavement markings. Figure 6.22 through Figure 6.24 show examples of school crosswalks. The cost to upgrade an existing crosswalk to a school crosswalk in Utah, excluding a center pedestrian island, is estimated as $750 to $2,000.

Figure 6.22 School Crosswalks at Yield-Controlled 4-Way Intersection

Figure 6.23 School Crosswalk Providing Access to School Facilities at T-Intersection

Figure 6.24 School Crosswalk at Signalized 4-Way Intersection

6.1.7 Median Barrier

Median barriers in urban environments near schools are typically a raised curb with landscaping. Landscaped median barriers reduce the perceived width of the roadway, which promotes slower driving speeds. Barriers also prevent left turns from driveways along the road, creating “right-in-right-out" scenarios. By limiting the allowable movements at driveways, drivers can pay more attention to pedestrians. They also will not be required to cross multiple lanes of traffic to make left turns, a dangerous scenario for drivers and pedestrians. In some cases, a median barrier may be used in places where pedestrian crossings are observed to provide a refuge island for pedestrians. Alternatively, fencing may be installed along the median barrier to prevent pedestrians from attempting to cross at dangerous locations.

A large portion of vehicle-to-pedestrian crashes near schools observed in this study involved a vehicle turning from a driveway onto a busier road which distracted them from an approaching pedestrian. Thus, median barriers may be an effective way to improve pedestrian safety near schools in Utah. Figure 6.25 through Figure 6.27 show examples of landscaped median barriers. While landscaping costs can vary significantly, the cost to install a landscaped median barrier in Utah is between $95 to $190 per foot. Figure 6.28 shows an example of a fenced median barrier. Fenced median barriers have a similar cost for installation (typically ranging from $90 to $180 per square foot) but would have fewer maintenance requirements than landscaped medians.

Figure 6.25 Landscaped Median Barrier with Pedestrian Walkway and Benches

Figure 6.26 Landscaped Median Barrier Example on 4-Lane Residential Road

Figure 6.27 Landscaped Median Barrier Example (Aerial View)

Figure 6.28 Fenced Median Barrier Example

6.1.8 No Right-Turn Light-Emitting Diode (LED) Blank-Out Lane Control (MUTCD Sign R3-1)

LED blank-out road signs are designed to alert motorists to changing traffic patterns. Signs are designed with narrow-angle, high performance LEDs for superior readability. Automatic photo-dimming adjusts LED brightness to ambient lighting conditions, and the message disappears when turned off. Figure 6.29 and Figure 6.30 show examples of LED blank-out road signs. In Utah, installation costs are approximately $5,500 to $12,000 per sign.

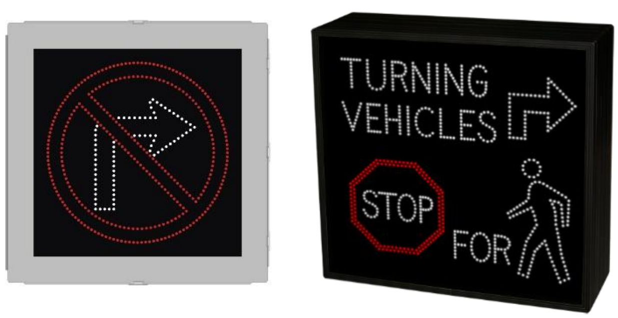

Figure 6.29. No Right-Turn LED Blank-Out Lane Control Sign Examples

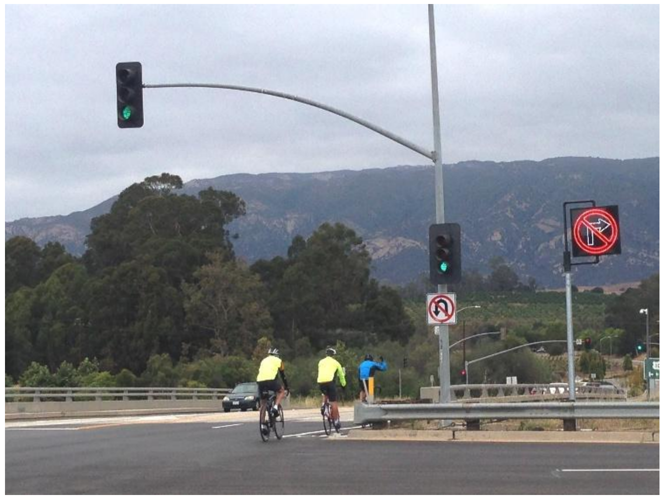

Figure 6.30 No Right-Turn LED Blank-Out Lane Control Sign at Intersection

6.1.9 Roadway Narrowing

Whereas curb extensions narrow the roadway at intersections and midblock crossings, roadway narrowing extends along an entire corridor. Reducing the width of the roadway influences drivers to lower vehicle speeds and increases driver awareness. This allows drivers to pay more attention to pedestrians and reduces the risk of high-speed collisions with pedestrians. Figure 6.31 "Road Narrows" Sign Example

through Figure 6.34 show a "Road Narrows" sign and examples of narrow roads. It is estimated to cost $250k to $500k per mile to narrow an existing roadway in Utah. It should be noted that striping can be used to create a perceived narrowing of the road, but this is not the same as narrowing the road and is not what roadway narrowing means in this case.

Figure 6.31 "Road Narrows" Sign Example

Figure 6.32 Narrow Road Example in Residential Area with "Shared Street" Sign

Figure 6.33 Narrow Road Example in Residential Area

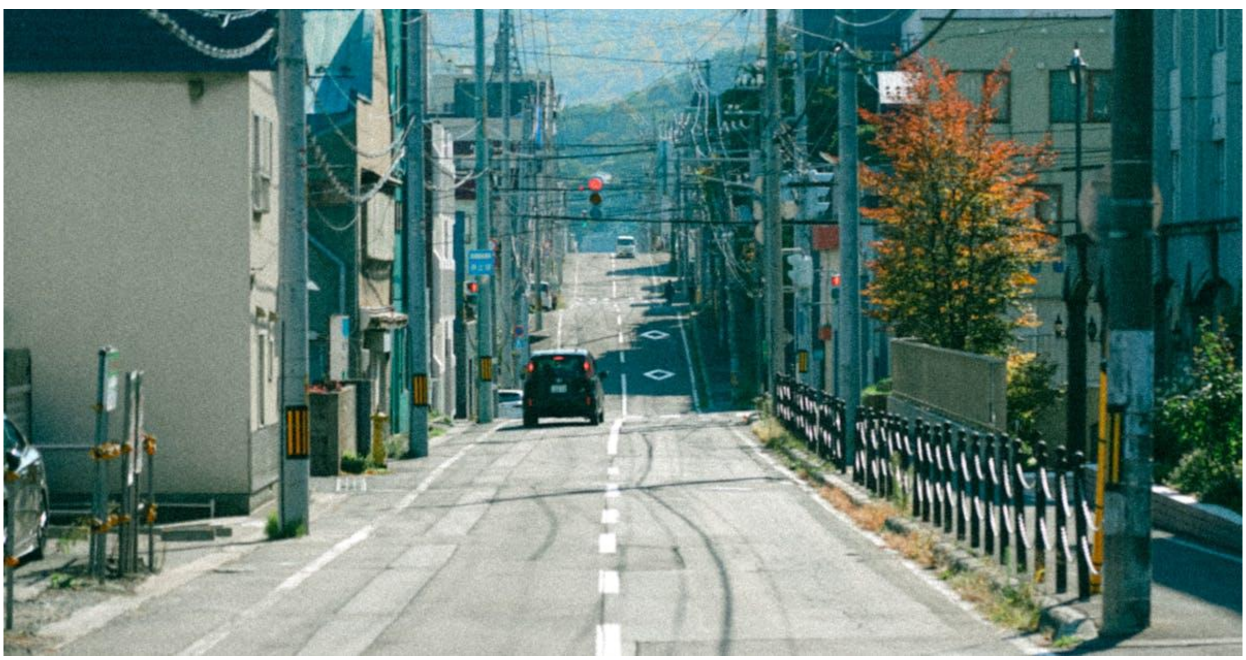

Figure 6.34 Narrow Road Example in Urban Area

6.1.10 Bike Lanes

Bike lanes are used to indicate to drivers that they must share the road with cyclists. This can improve safety for cyclists who already use the road. Bike lanes can also create a perceived narrowing of the road which influences drivers to travel at slower speeds.

There are several kinds of bike lanes including shoulder bike lanes (Figure 6.35), median bike lanes (Figure 6.36), and separated bike lanes (Figure 6.37). Median and separated bike lanes should include a barrier separating them from vehicle traffic but can also be created by striping alone. For bike lanes without barriers using striping and signage alone, it is estimated to cost $20k to $100k per mile to install bike lanes in Utah.

Bike lane markings can just be painted white stripes with bicycle symbols, or they can include green filled-in lane markings or thermoplastic striping. These options differ significantly in cost with thermoplastic striping costing approximately $264,000 per mile and 4-ft-wide green bike lane paint costing approximately $422,000 per mile. Despite the extra expense, these improvements can help make bike lanes more visible and increase the perceived sense of roadway narrowing, causing vehicles to slow down.

Figure 6.35 Roadway with Shoulder Bike Lane

Figure 6.36 Roadway with Median Bike Lane

Figure 6.37 Roadway with Separated Bike Lanes

6.1.11 Street Lighting

A significant portion of severe vehicle-to-pedestrian crashes occur at night or during dark conditions due to poor visibility. Some of these crashes can be mitigated with well-implemented street lighting. Rather than focusing solely on the quantity of light produced by street lighting, it is best to ensure street lighting creates contrast at pedestrian crossings. The crossing area should be well-lit with a dark background, concentrating light directly at the crossing location. Note that street lighting is relevant to schools as some students walk to school early in the morning before the sun rises.

Figure 6.38 and Figure 6.39 show examples of street lighting for pedestrians. It is estimated to cost $25,000 to $50,000+ to install street lighting at a crosswalk in Utah.

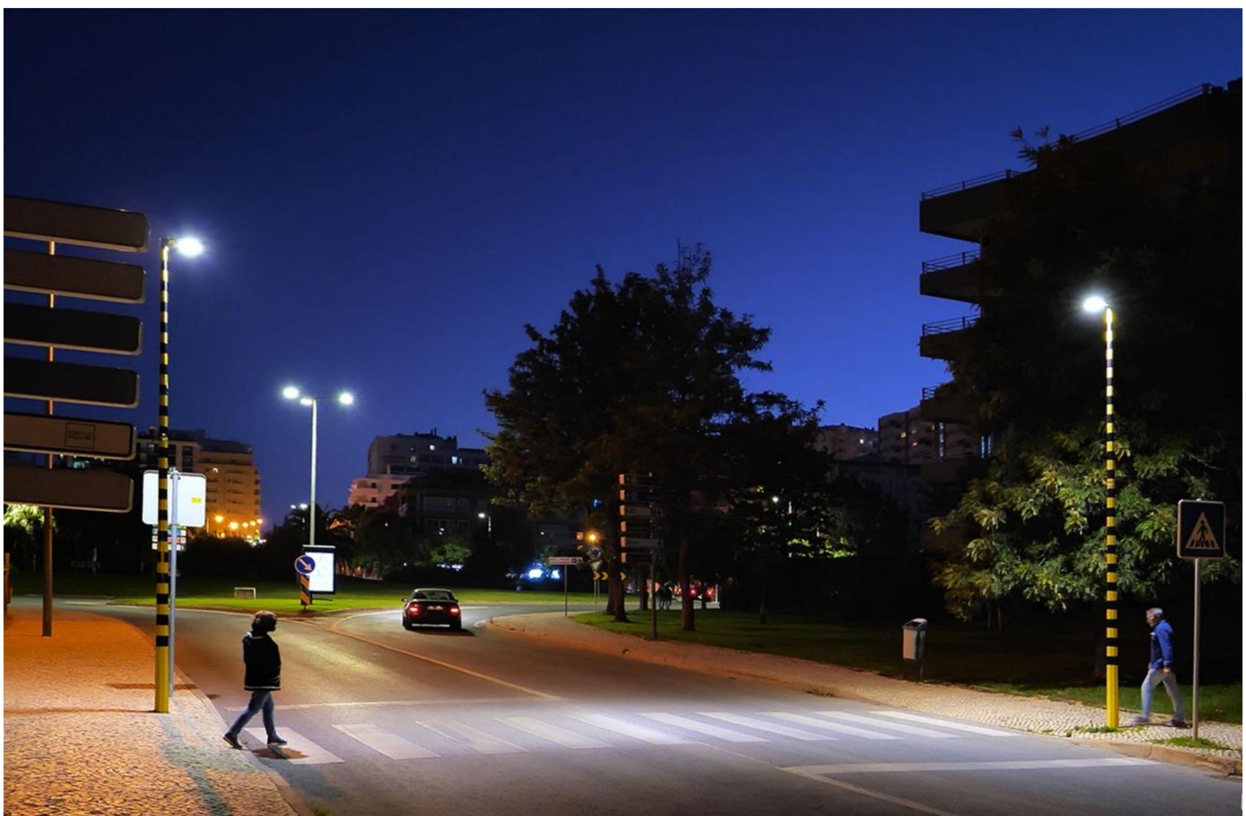

Figure 6.38 Pedestrian Street Lighting with Crosswalk (Example 1)

Figure 6.39 Pedestrian Street Lighting with Crosswalk (Example 2)

6.1.12 Intersection Reconstruction

Skewed intersections or intersections with misaligned approaches can degrade pedestrian visibility, particularly for turning vehicles. In some cases, it may be worthwhile to reconstruct an intersection to improve alignment. Reconstructing an intersection can also be a good opportunity to improve pedestrian facilities such as sidewalks, crosswalks, and curb extensions. Alternatively, a poorly aligned intersection can be reconstructed to restrict vehicle movements, improve pedestrian, and bicycle movements, and reduce vehicle speeds.

Figure 6.40 and Figure 6.41 show examples of intersection realignments, and Figure 6.42 shows an example of restricting vehicle movements at an intersection. It is estimated to cost between $500,000 and $3,000,000 to reconstruct an intersection in Utah. Costs vary widely depending on the need to reconstruct utilities, acquire right-of-way, and the size of the intersection.

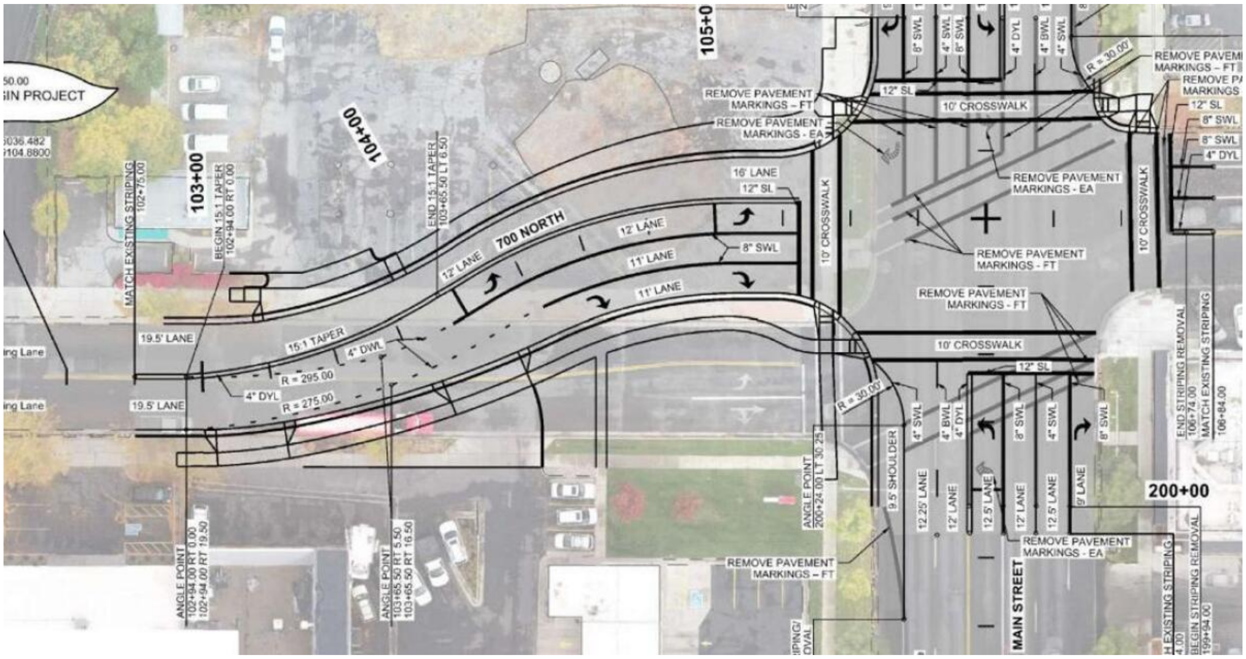

Figure 6.40 Intersection Realignment (Example 1)

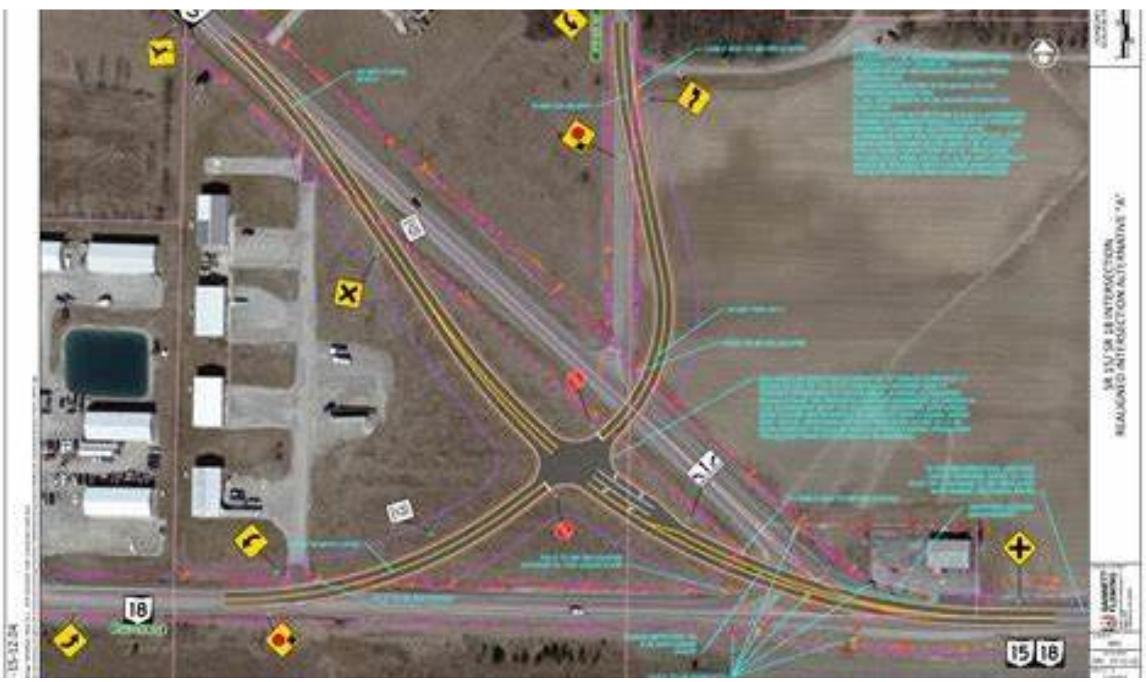

Figure 6.41 Intersection Realignment (Example 2)

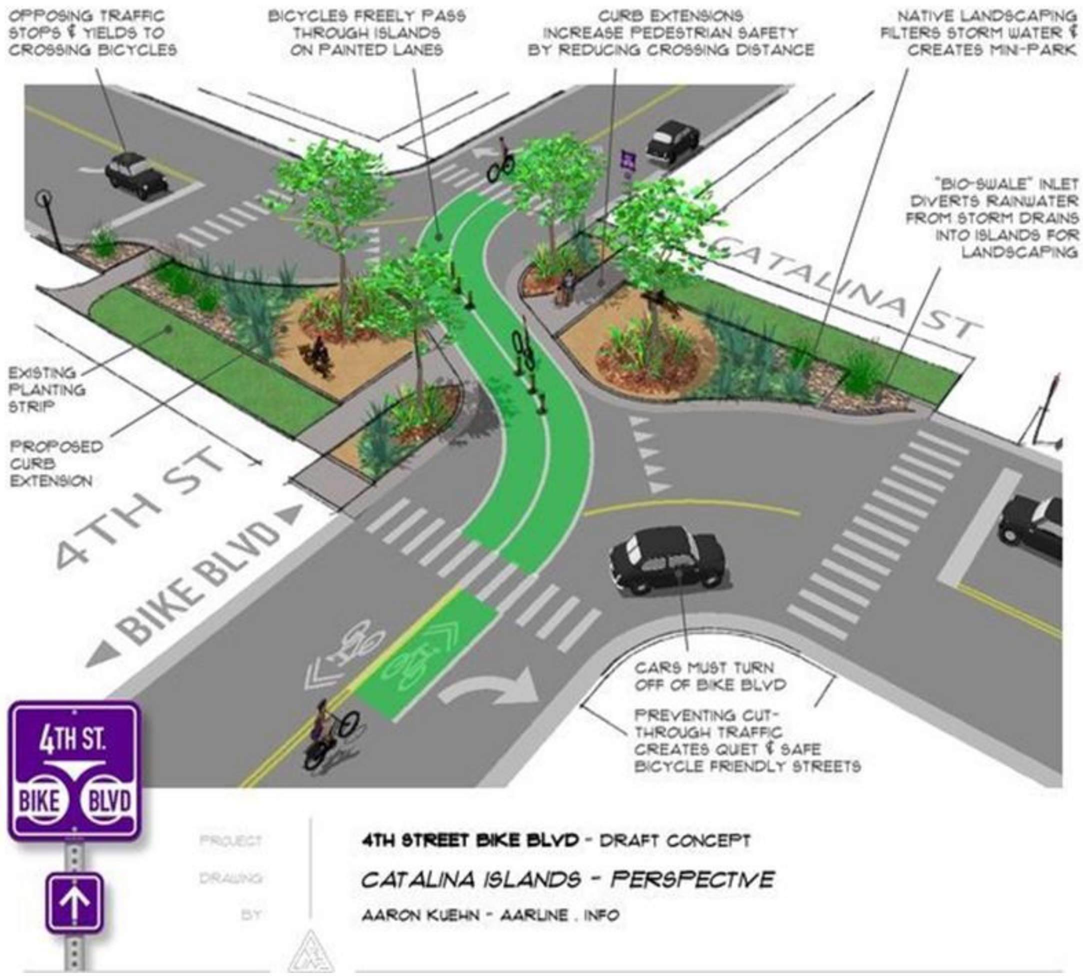

Figure 6.42 Intersection Design Featuring Vehicle Movement Restrictions

6.1.13 RRFB with Push-Button Actuator

RRFBs include pedestrian warning signs with rectangular flashing LED beacons on each side of the road next to a crosswalk. They may be used at midblock crosswalks or uncontrolled intersection crosswalks to require vehicles to stop or yield when a pedestrian activates a push button. This can be useful for crossings with periodic, high pedestrian volumes, such as school crossings during school peak hours. According to the FHWA, RRFBs are particularly effective at multilane crossings with speed limits less than 40 MPH. When possible, they should be installed in the median of a roadway if there is a pedestrian refuge island, rather than the far side of the roadway. They may also be installed with an overhead mast for longer crossings.

Figure 6.43 to Figure 6.45 show examples of RRFBs installed at different crosswalks, including crosswalks with a median pedestrian refuge island and an overhead mast. It is estimated to cost $10,000 to $20,000 to install an RRFB in Utah, although costs may be higher for installing an overhead mast or a median refuge island.

Figure 6.43. RRFB Installed at a Short Crosswalk

Figure 6.44. RRFB Installed with a Median Island

Figure 6.45. RRFB Installed with an Overhead Mast

6.2 Implementation Plan

Based on the analysis conclusions described in this report and input from the TAC and the UDOT Project Champion, the following implementation plan has been identified to support UDOT's Expanding Opportunities for All and All Users mindset.

1. Identify a process for working cooperatively with local jurisdictions to promote safety improvements on local roads. This may include assistance in identifying funding sources for design and construction (Safe Routes Utah grants, UDOT's Highway Safety Improvement Program (HSIP), UDOT's Safe Sidewalks Program, etc.).

2. Conduct cost/benefit analysis of each major project to promote integration and prioritization of Safe Routes projects within the HSIP Program.

3. Work with the highest risk schools to ensure that a Safe Routes Utah plan is in place for the school that includes realistic recommendations for safety improvements. For schools without a current plan, work with school and community members and other appropriate partners to create a plan.

4. For all recommendations located on State Routes:

    a. Identify any upcoming projects along the corridor that could complement or allow for construction of the recommended improvements.

    b. Coordinate with UDOT region engineers and planning managers to integrate recommendations into their planning efforts.

    c. Identify the potential for using region contingency funds or Safe Sidewalk funds to implement recommended improvements.

    d. Coordinate all efforts with UDOT region staff and the local jurisdiction.

REFERENCES

Boarnet, M.G., C.L. Anderson, K. Day, T. McMillan, and M. Alfonzo. (2005a). Evaluation of the California Safe Routes to School Legislation. American Journal of Preventive Medicine. 28(22), 134-140.

Buttazzoni, A. N., Coen, S. E., and J. A. Gilliland. (2018). Supporting active school travel: A qualitative analysis of implementing a regional safe routes to school program. Social Science & Medicine. 212. 181-190. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0277953618303848

Clifton, K. J., & Kreamer-Fults, K. (2007). An examination of the environmental attributes associated with pedestrian–vehicular crashes near public schools. Accident Analysis & Prevention, 39(4), 708–715. https://doi.org/10.1016/j.aap.2006.11.003

Cottrell, W. D. (2004). Evaluating and improving pedestrian safety in Utah. Upper Great Plains Transportation Institute. https://www.ugpti.org/resources/reports/downloads/mpc04-157.pdf

Dumbaugh, E., and L. Frank. (2006). Traffic and Safety and Safe Routes to Schools: Synthesizing the empirical evidence. Paper presented at the 85th Annual Meeting of the Transportation Research Board.

DiMaggio, C., Frangos, S. and G. Li. (2016). National Safe Routes to School program and risk of school-age pedestrian and bicyclist injury. Annals of Epidemiology. 26(6). 412-417. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1047279716300837

Elliot, L. D., Lieberman, M., Rovniak, L. S., Bose, M., Holmes, L. M., and M. Bopp. (2022). What are States Doing to Encourage Safe Routes to School Programming in Disadvantaged Communities? Findings From a U.S. Mixed-Methods Survey. Transportation Research Record: Journal of the Transportation Research Board. Available at: https://doi.org/10.1177/03611981221140363

Federal Highway Administration. (2018). Guidebook on identification of high pedestrian crash locations (FHWA-SA-17-106). U.S. Department of Transportation. https://www.fhwa.dot.gov/publications/research/safety/17106/17106.pdf

FHWA. (2019). Children's Travel to School. FHWA NHTS Brief. Available at: https://nhts.ornl.gov/assets/FHWA_NHTS_%20Brief_Traveltoschool_032519.pdf

Heelan, K. A., Unruh, S. A., Combs, H. J., Donnelly, J. E., Sutton, S., and B. M. Abbey. (2008). Walking to School: Taking Research to Practice. Journal of Physical Education, Recreation & Dance. 79(6). 26-41. Available at: https://doi.org/10.1080/07303084.2008.10598197

McDonald, N.C., Y. Yang, S.M. Abbott, and A.N. Bullock. (2013). Impact of the Safe Routes to School Program on Walking and Biking: Eugene, Oregon study. Transport Policy. 29, 243-248. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0967070X13000942

McDonald, N. C., Steiner, R. L., Lee, C., Smith, T. R., Zhu, X., and Y. Yang. (2014). Impact of the Safe Routes to School Program on Walking and Bicycling. Journal of the American Planning Association. 80(2). 153-167. Available at: https://doi.org/10.1080/01944363.2014.956654

McDonald, N. C., Barth, P. H., and R. L. Steiner. (2013). Assessing the Distribution of Safe Routes to School Program Funds, 2005–2012. American Journal of Preventive Medicine. 45(4). 401-406. Available at: https://doi.org/10.1016/j.amepre.2013.04.024

Mohai, P., Kweon, B., Lee, S., and Ard, K. J. (2011). Air pollution around schools affects student health and performance. Health Affairs, 852-862.

Muennig, P.A., M. Epstein, G. Li, and C. DiMaggio. (2014). The Cost Effectiveness of New York City's Safe Routes to School Program. American Journal of Public Health. 104(7): 1294-1299.

Programs. American Journal of Health Promotion. 28(3) suppl. Available at: https://doi.org/10.4278/ajhp.130430-QUAN-210

Rahman, R.., Saheli, M, V., & P. A. Singleton. (2023). Risk factors for pedestrian crashes on Utah state highway segments: Results from parametric and non-parametric approaches controlling for pedestrian exposure. ResearchGate. https://www.researchgate.net/publication/368572871

Singleton, P. A., Rahman, M. R., and S. Burbidge. (2022). Systemic analysis of bicycle and pedestrian safety in Utah. Utah Department of Transportation. https://rosap.ntl.bts.gov/view/dot/62355/dot_62355_DS1.pdf

Stewart, O., Moudon, A. V. and C. Claybrooke. (2014). Multistate Evaluation of Safe Routes to School Programs. American Journal of Health Promotions. 28(3 Suppl):S89-96 https://pubmed.ncbi.nlm.nih.gov/24380471/

Timperio, A. D. Crawford, A. Telford, and J. Salmon. (2003). Perceptions about the Local Neighborhood and Walking and Cycling Among Children. Preventive Medicine. 38(1), 39-47.

Tudor-Locke, C., B.E. Ainsworth, and B.M. Popkin. (2001). Active Commuting to School: An overlooked source of children’s physical activity? Sports Medicine. 31:309-313.

UDOT. (2018). UDOT Safe Routes to School Program. Available at: https://www.udot.utah.gov/main/f?p=100:pg:0:::1:T,V:1388

Wali, B., & Khattak, A. (2020). Harnessing ambient sensing & naturalistic driving systems to understand links between driving volatility and crash propensity in school zones: A generalized hierarchical mixed logit framework. arXiv preprint arXiv:2010.12017. https://arxiv.org/abs/2010.12017