

TO: Alaska/Richardson/Steese Highways Corridor Action Plan (A/R/S CAP) Project Files

FROM: Michael Carter, EIT; Phoebe Bredlie, PE; Randy Kinney, PE, PTOE

DATE: 1 August 2023

SUBJECT: Stopping Sight Distance Analysis for Bus Stops on ARS Corridor Task 5

Executive Summary

School bus stop locations along the Alaska/Richardson/Steese Corridor (ARS Corridor) were analyzed for required sight distances to determine the effects of proposed ore hauling vehicles. 2022-2023 school year bus stop locations were supplied by officials from Alaska Gateway School District (AGSD), Delta/Greely School District (DGSD), and Fairbanks North Star Borough School District (FNSBSD). Tractor-trailer performance was determined from American Association of State Highway and Transportation Officials (AASHTO) guidelines and research in vehicle traction performance in winter conditions. Sight distance analysis methodology was from AASHTO's *A Policy on Geometric Design of Highways and Streets*, referred to as the Green Book (GB).

Analysis using AASHTO design values showed all 86 bus stop locations have stopping sight distances (SSDs) that meet current design standards on horizontal curves and vertical curves. All 12 AGSD locations have sight distances that meet current standards in snow and ice conditions. Eleven of 27 DGSD locations and 24 of 47 FNSBSD locations have sight distances in winter conditions that do not meet current standards.

Table 1: Summary of school bus stops meeting stopping sight distance standards for AASHTO and ICE conditions

District	No. Stops	Meets Design Standards	
		SSD _{AASHTO}	SSD _{ICE}
AGSD	12	12	12
DGSD	27	27	16
FNSBSD	47	47	23

Introduction of Stopping Sight Distance Analysis for Bus Stops on ARS Corridor

Bus Stops

School districts servicing rural Alaska provide bus service to students during the school year (e.g., approximately mid-August to mid-May). Routes are updated annually at the start of the school year, and as needed throughout the school year, to account for changing school demographics. As a result, bus stop locations are subject to change during the planning horizon of the Alaska/Richardson/Steese Highway Corridor Action Plan. This memo details only the supplied 2022-2023 school year bus stop locations (Figure 1) which are included as attachments to this memo.

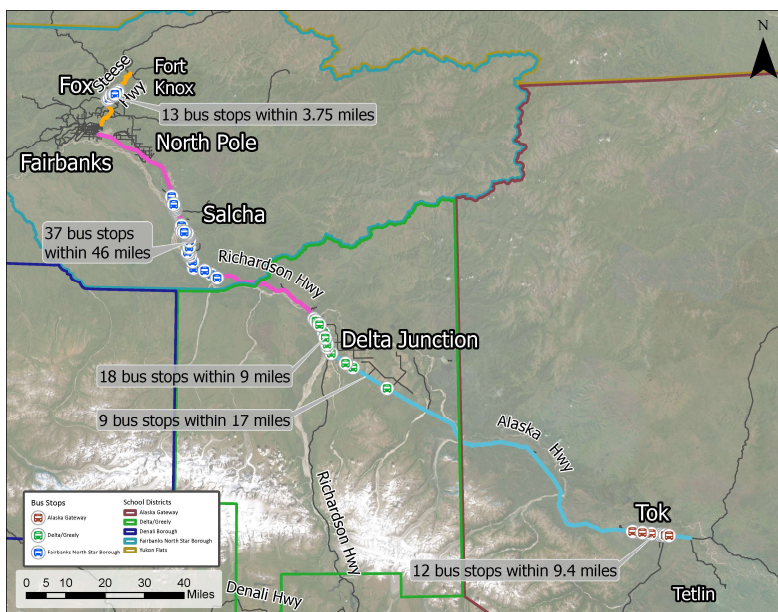


Figure 1: ARS Corridor bus stop locations

Alaska Gateway School District

Tok Transportation is contracted by AGSD to transport approximately 80 students to and from school on 5 bus routes. Along the ARS Corridor, students attending school in Tok are picked up from 12 bus stops, distributed among 3 bus routes, on the Alaska Highway. These bus stops are located at residential driveways. Daily morning and afternoon stops are scheduled in all weather conditions. Attending AGSD schools is optional when a cold weather day is called but bus service remains available. Tok Transportation buses run at temperatures down to -60 degrees Fahrenheit. Ice fog at these temperatures is common in the Tok area.

Scheduling constraints require students to cross the highway when boarding or exiting the bus. Bus drivers and students are trained in procedures to reduce crossing risks during this process. Students must not enter the roadway after the bus stops until the driver has activated all flashing lights, displayed the stop sign arm, verified traffic has completely stopped, and motioned it is safe to enter the roadway. Only kindergarten students must be accompanied by a parent during this process. It is not uncommon for younger students to complete this process with older siblings.

According to Tok Transportation only passenger vehicle drivers are known to not stop for a school bus displaying its stop sign and flashing lights. All commercial vehicles are reported to comply with the bus stop sign.

Delta/Greely School District

DGSD provides transportation to students attending elementary, junior high, and high schools in Delta Junction through a contract with First Student, Inc. Students are picked up and dropped off from 9 locations on Alaska Highway and 18 locations on Richardson Highway. These highway stops are placed at residential driveways as needed. First Student, Inc determines any policies related to bus operations and will not operate buses below -50 degrees Fahrenheit or in icy conditions. Road surfaces on Alaska and Richardson Highways are inspected to determine whether a school cancellation will be called.

Stops are scheduled in the morning and afternoon with drivers primarily stopping in the roadway but using turnouts where available. The routes are organized to allow all students to access buses from the right side so no students cross a highway. Head Start through second grade students are required to access buses with a parent present. There are no supervision requirements for older students.

In a follow up conversation on 29 June, district officials removed stops at Fleet Street, Dorshorst Road, 639 Richardson Highway, 4840 Richardson Highway, and Krebs Lane from active status.

Fairbanks North Star Borough School District

FNSBSD provides bus service to students attending elementary, middle, and high schools within the borough. 2022-2023 school year bus stop locations on the corridor include 34 stops on Richardson Highway and 13 stops on Steese Highway. No stops are located on Mitchell Expressway, Peger Road, or Johansen Expressway. New stops on rural routes are located based on requests from parents and are added to a route if the location is more than 0.10 mile from an existing stop or if it is unsafe for students to access an existing stop. New locations are visited by a district transportation supervisor to verify its accessibility by a bus. Stops are removed from a route based on driver feedback when students are no longer picked up from the location.

There is no specific district policy on locating stops to avoid students crossing the road to access the bus but on “out and back” routes students will be held on the bus until the stop is available on the right side of the road. District buses utilize turnouts where available but stops on Richardson and Steese Highways typically occur at residential driveways in the roadway. Parent or guardian supervision of students when accessing a bus is only required for special education students unless a release waiver has been signed.

Commercial vehicles are reported to comply with the displayed stop arms. Passenger vehicle drivers are the only known users to not stop when district buses display their flashing lights and stop signs.

Methodology

Stopping sight distance (SSD) calculations are based on methodology found in the GB. SSD is the combination of the time it takes for a driver to perceive and react to a hazard, the design speed of the roadway, and the deceleration rate of the vehicle. On level roadway, the SSD is computed as:

$$SSD = (1.47 \times V \times t) + 1.075 \times \frac{V^2}{a}$$

Where:

V = design speed, miles per hour (mph)

t = perception-reaction time, seconds (s)

a = deceleration rate, feet per second per second (ft/s/s)

Design values for the perception/reaction time and the deceleration rate are 2.5 seconds (s) and 11.2 feet per second per second (ft/s/s). These are conservative values; it is expected the average driver and vehicle should be reliably capable of exceeding them. Roadway grades between -3% and 3% have a small effect on braking distance and are ignored in design standards. When grades are greater than 3% or less than -3% SSD is determined using the equation:

$$SSD = (1.47 \times V \times t) + \frac{V^2}{30 \left[\left(\frac{a}{32.2} \right) \pm G \right]}$$

Where:

V = design speed, mph

t = perception-reaction time, s

a = deceleration rate, ft/s/s

G = roadway grade, feet/feet (ft/ft)

Horizontal Curve SSD

SSD on horizontal curves is controlled by any obstruction to a driver's sightline on the inside of the curve. Sight restrictions may be caused by signs, cut slopes, vegetation, buildings, or any other roadside object. Snow buildup during the winter can also restrict horizontal sightlines for drivers in shorter vehicles. Figure 2 illustrates the method to determine horizontal sight distance from the plan view for any point along the roadway, including compound curves, using a straightedge. SSD is typically measured from the middle of the traveled lane to the middle of the inside lane of the curve.

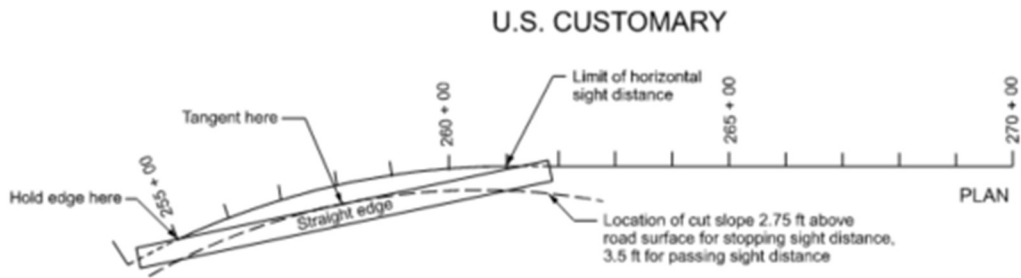


Figure 2: Green Book illustration of method for measuring horizontal sight distance (AASHTO, 2018)

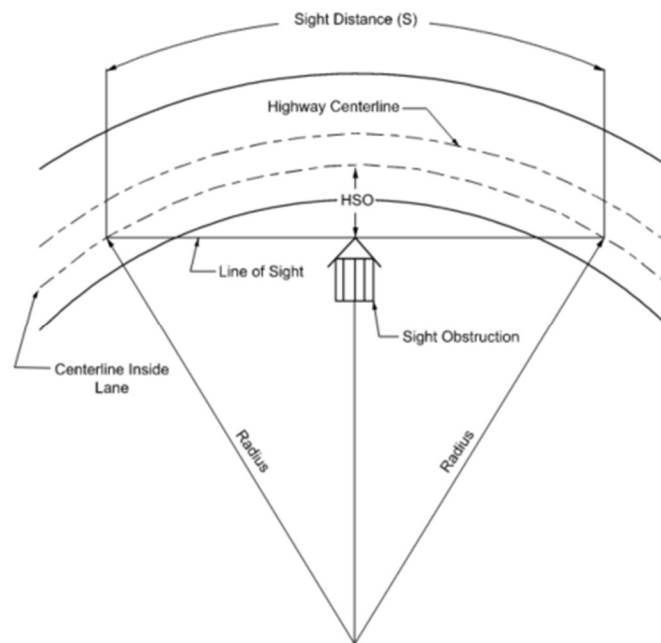


Figure 3: Green Book diagram illustrating the components of horizontal sight distance (AASHTO, 2018)

For the specific scenario when the curve length is greater than the sight distance ($L > S$) the GB provides an equation for the horizontal sight line offset (HSO):

$$HSO = R \left[1 - \cos \left(\frac{28.65 \times S}{R} \right) \right]$$

Where:

R = horizontal curve radius, ft

S = sight distance, ft

HSO is measured from the middle of the travel lane. Sight distance is set to the SSD to determine the minimum HSO required for objects.

Vertical Curve SSD

Sight distance on vertical curves is controlled by the sight line obstruction due to the vertical profile of the roadway. Figure 4 shows the process of determining SSD on crest vertical curves using the centerline profile and a straightedge.

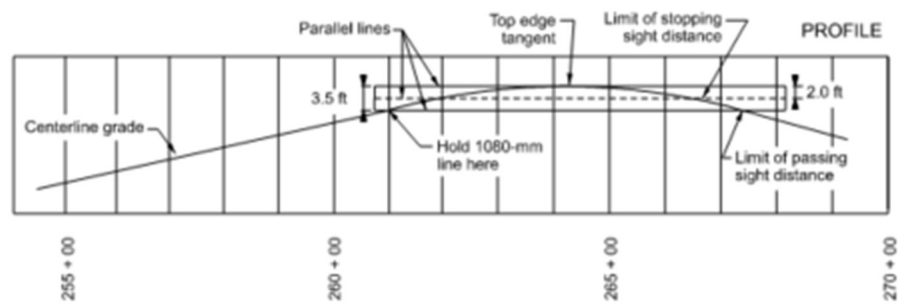


Figure 4: Green Book method for measuring vertical sight distance (AASHTO, 2018)

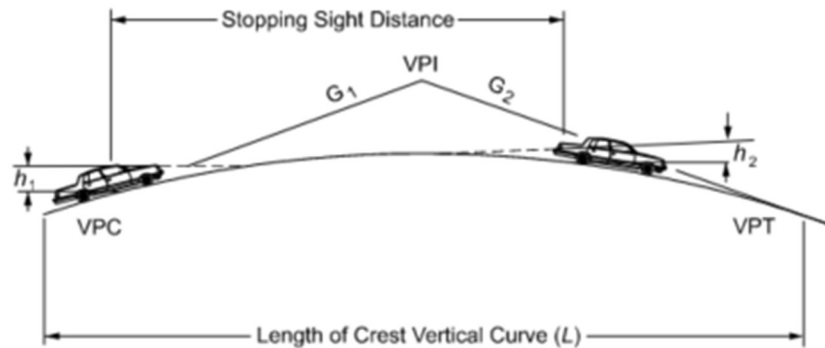


Figure 5: Green Book crest vertical curve SSD diagram (AASHTO, 2018)

The GB criteria for SSD on vertical curves is based on sight distance for crest vertical curves (**Error! Reference source not found.**) and headlight sight distance at night for sag vertical curves. There is no sight restriction in daylight on sag vertical curves. Crest vertical curve length when sight distance is less than the curve length ($S < L$) and when sight distance is greater than crest vertical curve length ($S > L$) is determined by:

$$L = \frac{A S^2}{100(\sqrt{h_1} + \sqrt{h_2})^2} \quad \text{for } S < L$$

$$L = 2S - \frac{200(\sqrt{h_1} + \sqrt{h_2})^2}{A} \quad \text{for } S > L$$

Where:

L = length of vertical curve, ft

A = algebraic difference in grades, %

S = sight distance, ft

h_1 = height of driver eye above roadway surface, ft

h_2 = height of object above roadway surface, ft

AASHTO design values for driver eye height is 3.5 ft and for the object height is 2.0 ft. A driver eye height of 7.6 ft is recommended for crest vertical curve calculations involving tractor-trailers.

Winter Snow/Ice Conditions

Design values from the current GB edition account for suboptimal road conditions (e.g., wet or dirty pavement) by using conservative design values. The design deceleration rate of 11.2 ft/s/s is the 10th percentile value for all passenger cars in dry conditions. Outdated GB versions used the tire-pavement friction factor (f) to calculate SSD but supplied no specific f values for winter conditions. Research into friction factors for vehicles on ice yielded a range of values (Figure 6) from the Society of Automotive Engineers experimentation (Navin, 1996). A friction factor of 0.1 at -10°C was determined to represent the available traction and is used in SSD for icy

conditions equation. All vehicles will experience the same friction factor on icy roads without the aid of traction devices (e.g., snow tires, chains, sanding).

$$SSD_{ICE} = (1.47 \times V \times t) + \frac{V^2}{30(f)}$$

Where:

V = design speed, mph

t = perception-reaction time, s

f = friction factor

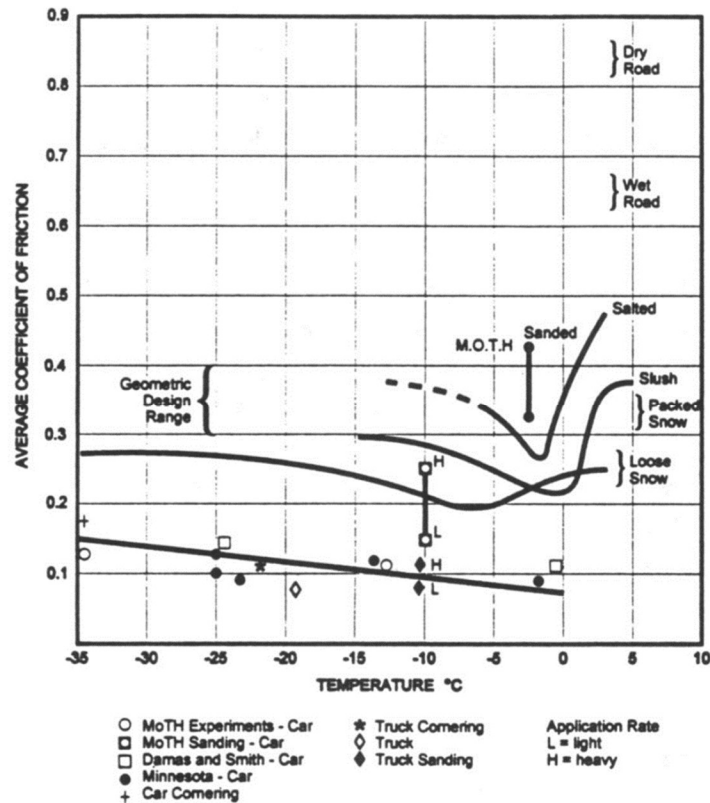


Figure 6: Coefficient of friction in winter conditions from Vehicle Traction Experiments on Snow and Ice (Navin, 1996)

Analysis

Bus stop locations were analyzed in the northbound (loaded condition) and southbound (empty condition) directions under design ($a = 11.2 \text{ ft/s/s}$) and snow/ice ($a = 3.2 \text{ ft/s/s}$) conditions for overall stopping sight distance, horizontal sight distance, and vertical sight distance. Travel speeds were set to the posted speed limit regardless of conditions. Bus stops located in pullouts or rest areas were included in the analysis with sight distances being determined from where the bus stops, regardless of turn out geometry. Providing sight distance to a bus located in a pullout ensures sight distances where the bus enters and leaves the roadway meet design standards.

SSDs for these stops were compared with sight restrictions along the curve. As an example, Figure 7 shows the AASHTO design and snow/ice SSDs in the southbound direction for the FNSBSD bus stop on Richardson Highway at Wrong Way Lane. The sightline for the design SSD of 644 ft is shown as the green chord. The green shaded area between this chord and the traveled path is free from obstructions so horizontal sight distance is acceptable. The red chord shows the sightline required for the 1656 ft SSD in snow/ice conditions. The red shaded area between the chord and the traveled path would need to be fully cleared for adequate sight distance. The blue line depicts the available right of way to the inside of the curve.



Figure 7: FNSBSD Richardson at Wrong Way Ln bus stop location

Minimum vertical curve lengths were calculated for the crest vertical curves and compared with sight lines determined from the roadway profile and a straight edge. For example, **Error! Reference source not found.** shows the 400 ft long crest vertical curve (algebraic difference in grades of 1.51%) north of the DGSD stop at 3636 Richardson Highway with the 1656 ft SSD and stop locations placed at the driver eye height and object height, respectively. The required sight line is marked by the red line. In this example the required sight distance is through the road profile, so the vertical curve does not meet the minimum required length for the speed. Crest vertical curves meeting the minimum curve length would have the required sightline entirely above the road profile. Analysis outcomes for each stop are listed by school district in the results section.

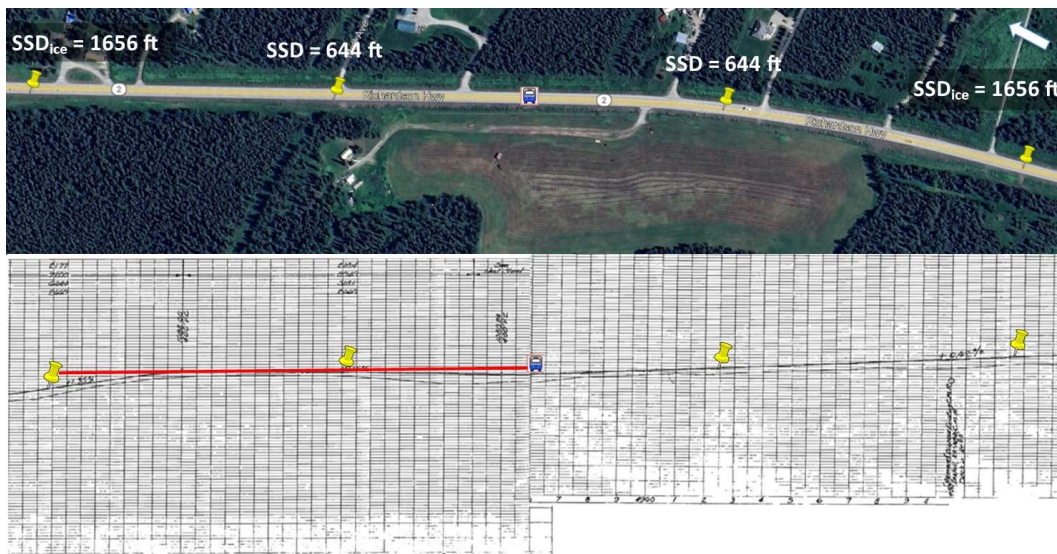


Figure 8: Plan and Vertical Profile of DGSD 3636 Richardson Highway bus stop location

Alaska Gateway School District

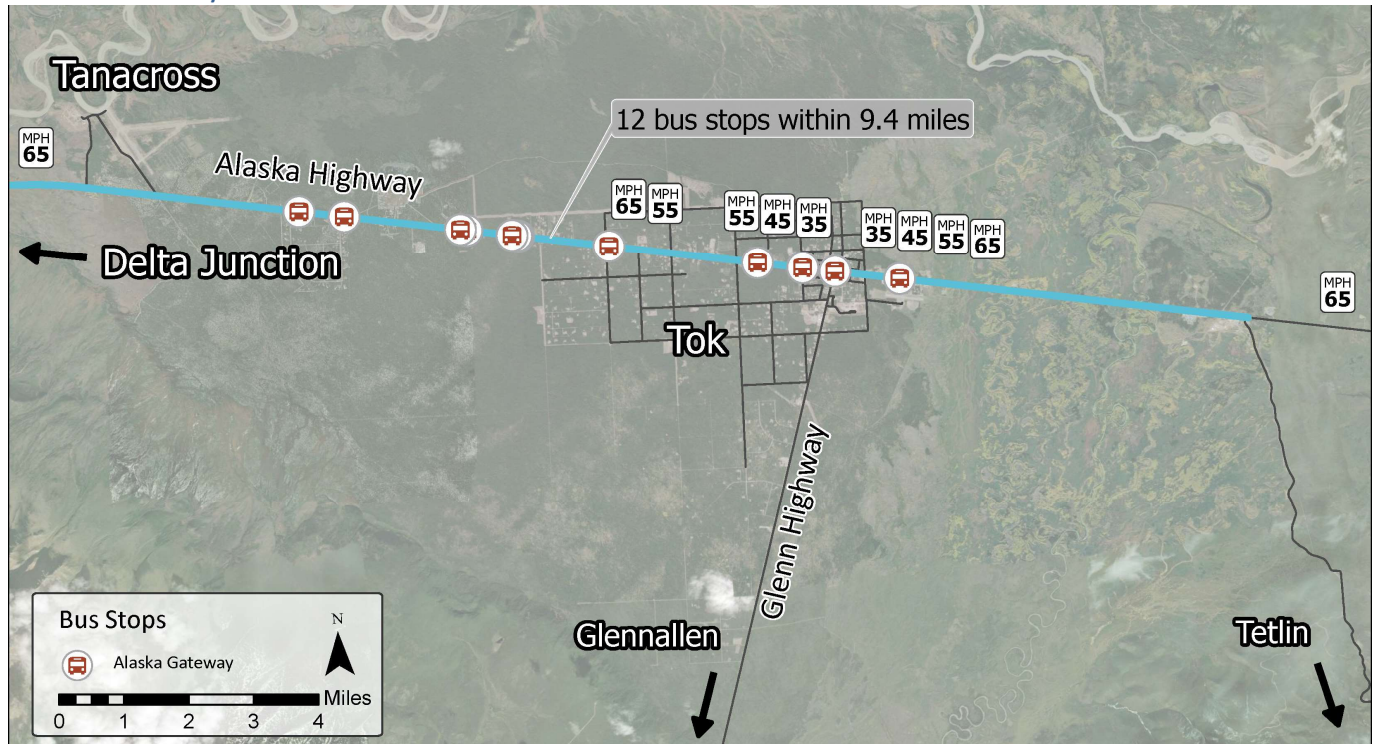


Figure 9: 2022-2023 Alaska Gateway School District bus stop locations

All 12 bus stop locations are located on roadway tangents with no horizontal sightline obstructions. There are no vertical sightline obstructions at any of the bus stop locations. Speed limits on the Alaska Highway segments containing the bus stop locations range from 35 to 65 mph.

Delta/Greely School District

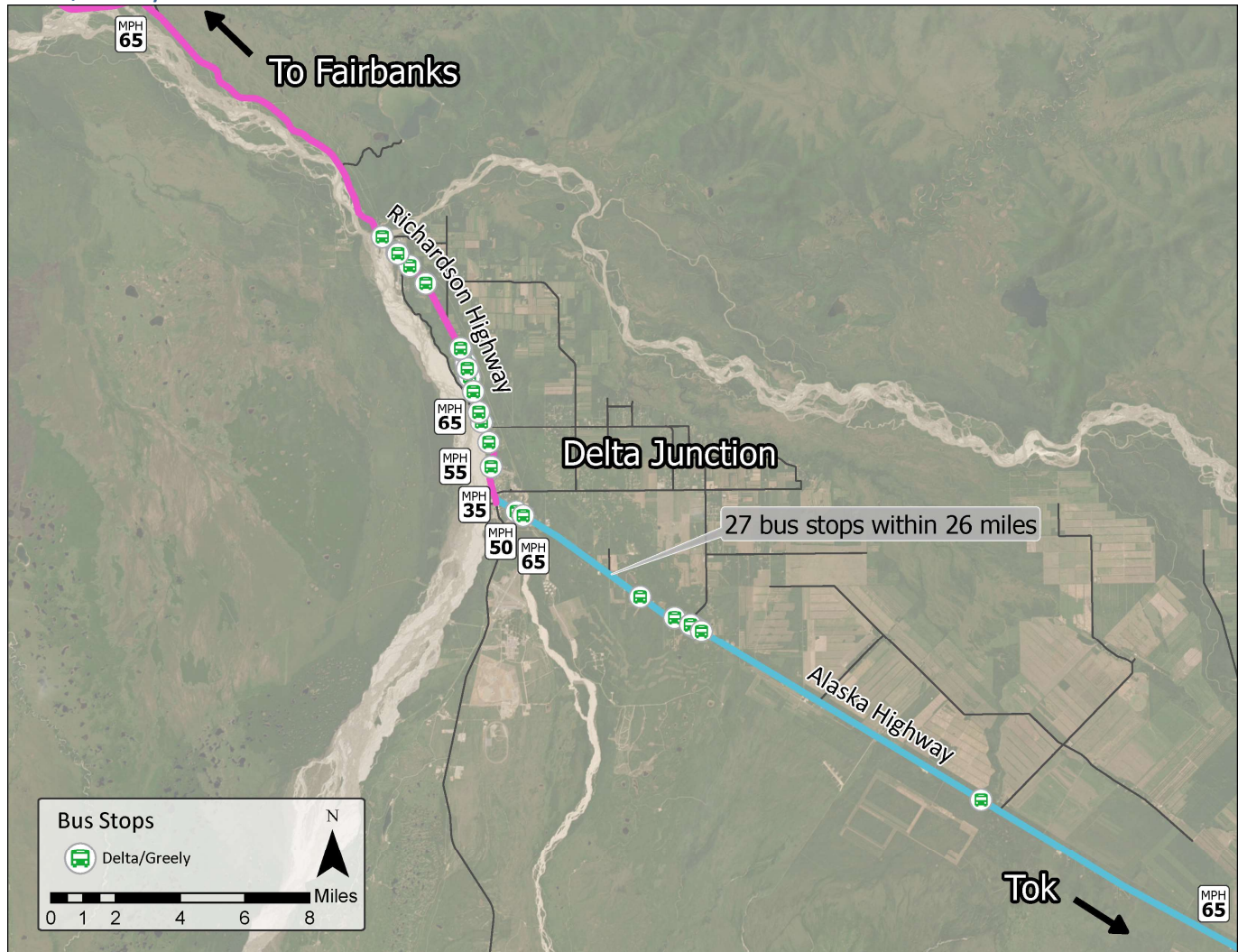


Figure 10: 2022-2023 Delta/Greely School District bus stop locations

Twenty-seven DGSD bus stops along the corridor were analyzed. Nine stops are located on Alaska Highway segments with posted speed limits of 50 to 65 mph. Eighteen stops are located on Richardson Highway segments with posted speed limits between 55 and 65 mph. All 27 stops meet SSD requirements for design conditions. Eleven of the 27 stops did not have enough sight distance available under snow/ice conditions due to vertical or horizontal sightline obstructions.

Alaska Highway at Fleet Street

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1414.3	300	north	65	400	2.9		644	1656	Vertical
		south	65	400	3.8		644	1656	Vertical

This stop is located on a 700 ft long sag vertical curve. There is 400 ft crest vertical curve (northbound grade change from 1.00% to -1.90%) immediately south and a 400 ft crest vertical curve (northbound grade change from 4.30% to 0.50%) immediately north. This location was verified by DGSD but as of a 6/29/23 DGSD communication this is no longer a bus stop.



Figure 11: DGSD Alaska Highway at Fleet Street bus stop location

Design $a = 11.2 \text{ ft/s/s}$

The stop location meets the minimum required curve lengths for tractor-trailer driver eye height. There are no horizontal sight obstructions for this stop.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Vertical curves to the north and south of this stop do not meet the minimum required lengths of 2995 ft and 2286 ft, respectively.

Recommendations

Speeds should be reduced to 35 mph for the existing 400 ft curves to meet required minimum lengths. This stop should be moved from this location if speeds are not reduced.

Alaska Highway at Theisen

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1414.4	300	north	65	400	2.9		644	1656	Vertical
		south	65	400	1.9		599	1656	Vertical

This stop located on a 400 ft crest vertical curve with the grade changing from 4.30% to 0.50% in the northbound direction. There is a 700 ft sag vertical curve (grade changes from -1.90% to 4.30%) and a 400 ft crest vertical curve (grade changes from 1.00% to -1.90%) to the south of the stop. A 400 ft sag vertical curve (grade changes from 0.50% to 1.35%) precedes a 400 ft crest vertical curve (grade changes from 1.35% to -0.50%) to the north of the stop. The bus stops in the roadway for both directions of travel.



Figure 12: DGSD Alaska Highway at Theisen bus stop location

Design $a = 11.2$ ft/s/s

Existing crest vertical curve lengths all exceed the minimum curve lengths. Northbound SSD for 11.2 ft/s/s is reduced by the 4.3% upgrade at the stop location. There are no horizontal sight obstructions for this stop.

Snow/Ice $a = 3.2$ ft/s/s

The average grade is less than 3% for SSD on snow/ice due to the longer sight distance required. The vertical curve at the stop location does not meet the minimum required length of 2995 ft. The crest vertical curve to the south does not meet the minimum required length of 2286 ft and the curve to the north does not meet the minimum required length of 1432 ft.

Recommendations

Speeds approaching this stop should be reduced to 35 mph to meet minimum crest vertical curve length requirements or the stop should be relocated.

Alaska Highway Milepost 1414.6

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1414.6	300	north	65	400	3.8		644	1656	Vertical
		south	65	400	1.9		644	1656	Vertical

This location is south of a 400 ft crest vertical curve (northbound grade change from 1.35% to -0.50%) and north of a 400 ft crest vertical curve (northbound grade change from 4.30% to 0.50%). Buses stop in both directions on the roadway.

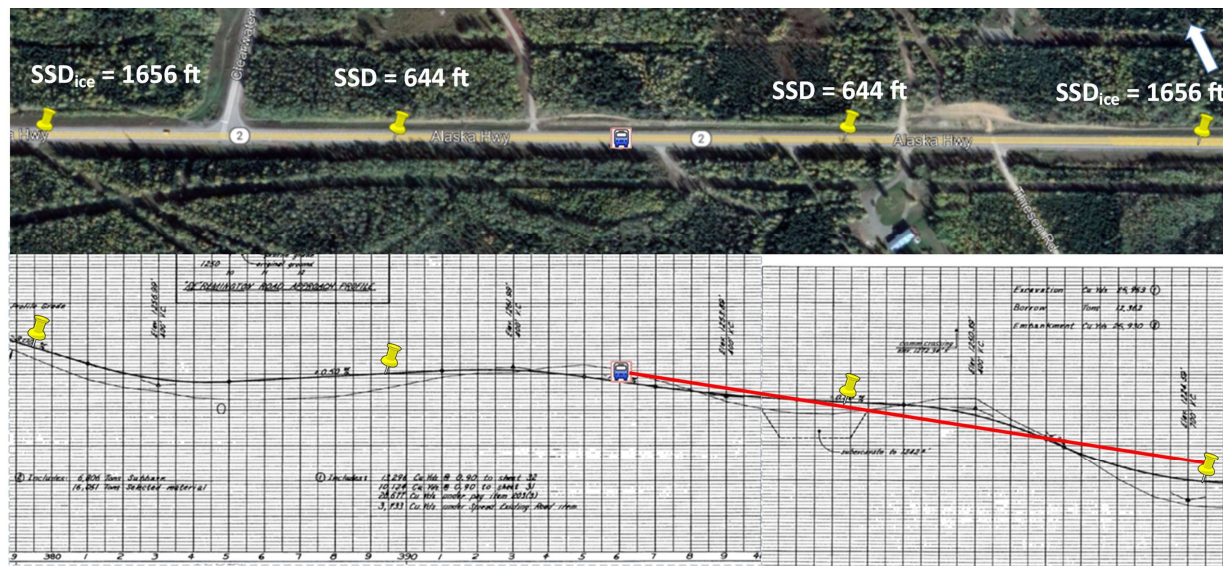


Figure 13: DGSD Alaska Highway at MP 1414.6 bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Existing crest vertical curve geometries meet the minimum required curve lengths of 0 ft and 372 ft for the curves to the north and south, respectively. There are no horizontal sight obstructions for this stop.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The 400 ft crest vertical curve to the north does not meet the minimum required length of 1432 ft. The 400 ft vertical curve to the south does not meet the required 2995 ft minimum curve length.

Recommendations

Decreasing the speed limit to 35 mph would shorten the required crest curve length to 164 ft. If the speed limit is not reduced this stop should be relocated.

Alaska Highway Milepost 1414.7

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1414.7	300	north	65	400	1.9		644	1656	Vertical
		south	65	400	3.2		644	1656	Vertical

This stop is located on a 400 ft crest vertical curve (northbound grade changes from 1.35% to -0.50%). There is a 400 ft crest vertical curve (northbound grade change from 4.3% to 0.50%) to the south and 500 ft crest vertical curve (northbound grade change 3.0% to -0.18%) to the north. It is approximately 1300 ft south of a 925 ft long horizontal curve with a radius of 2865 ft. Buses stop in both directions on the roadway.



Figure 14: DGSD Alaska Highway at MP 1414.7 bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Crest vertical curve minimum lengths are met by existing geometry. There are no horizontal sight obstructions for this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

There are no horizontal sight obstructions at this location. The crest vertical curve lengths do not meet required lengths for 65 mph. The 400 ft curve at the bus stop should be a minimum of 1432 ft long. The 400 ft vertical curve to the south should have a minimum length of 2995 ft and the 500 ft long curve to the north has a minimum required length of 2507 ft.

Recommendations

The speed limit should be reduced to 35 mph to meet minimum crest vertical curve lengths, or the stop should be relocated.

Alaska Highway at Dorshorst Rd

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
1414.9	300	north	65	925	2865		644	1656	Horizontal
		south	65	1172	2865		644	1656	Horizontal

This stop is located approximately 700 ft south of an 1172 ft horizontal curve with a radius of 2865 ft and approximately 700 ft north of a 925 ft long horizontal curve with a radius of 2865 ft. The bus stops in the roadway in both directions of travel. As of 6/29/23 DGSD communication this is no longer a stop.

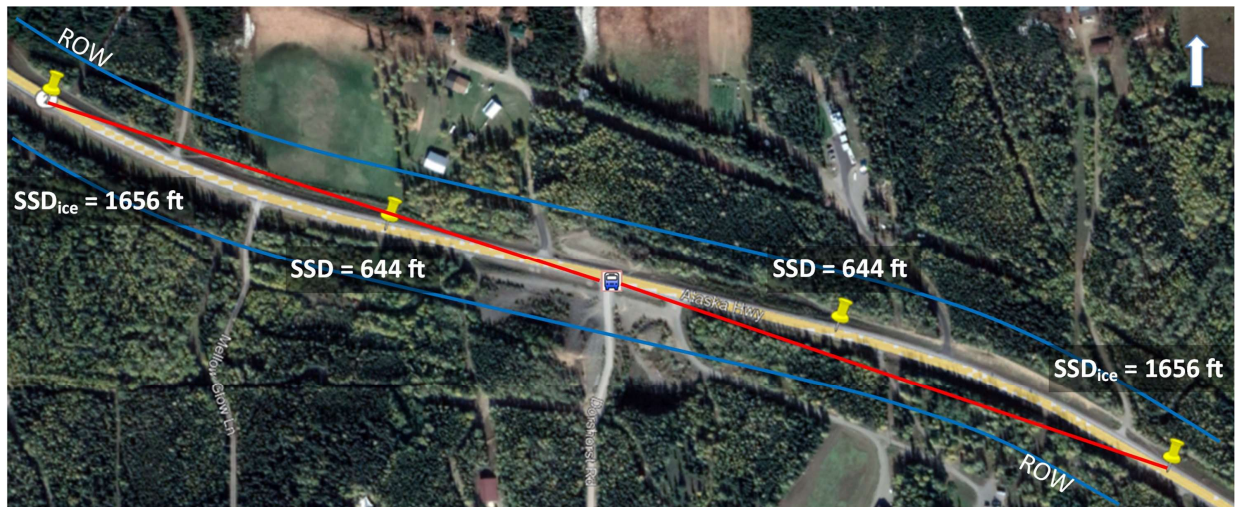


Figure 15: DGSD Alaska Highway at Dorshorst Road bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal sightline obstructions for either direction of travel. There are no vertical sight obstructions for this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound and southbound horizontal sightline is obstructed by vegetation to the inside of the curve. There are no vertical sight obstructions for this location.

Recommendations

An additional 40 ft of vegetation clearance is needed in the northbound direction and an additional 20 ft of vegetation clearance is needed in the southbound direction to meet sight distance standards at 65 mph. If no additional clearance occurs the speed limit should be reduced to 55 mph northbound and 60 mph southbound.

Alaska Highway at Bergstad Trailer Court

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1421.0	300	north	65	500	1.7		644	1656	Tangent
		south	65				644	1656	Vertical

This location is immediately south of a 500 ft crest vertical curve (northbound grade change from 0.58% to -1.10%) and 1550 ft south of a 500 ft crest vertical curve (northbound grade change from 0.07% to -0.95%). It is 1500 ft south of a 65 to 50 mph speed limit change. Buses stop on the roadway for both directions.

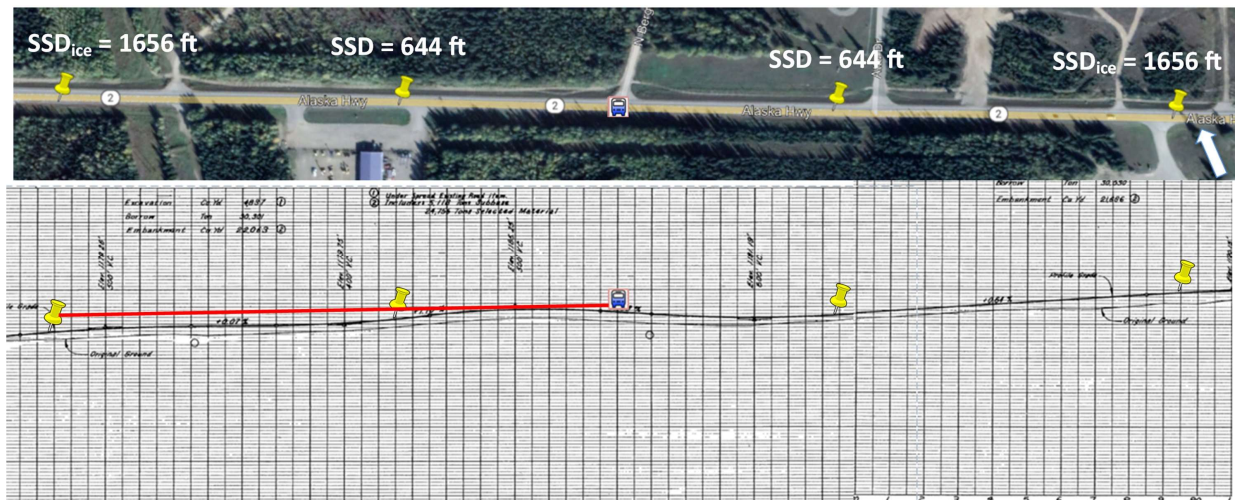


Figure 16: DGSD Alaska Highway at Bergstad Trailer Court bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no vertical or horizontal sightline obstructions for this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The 500 ft vertical curve immediately north of the stop does not meet the minimum required curve length of 1241 ft at 65 mph. The vertical curve 1550 ft north meets the minimum required curve length of 0 ft. There are no northbound vertical sight obstructions. There are no horizontal sight obstructions.

Recommendations

The southbound speed limit should be reduced to 55 mph for the vertical curve to meet the required minimum length of 363 ft or the stop should be relocated.

Alaska Highway at Med Clinic

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
1421.3	300	north	65	500	1.7		644	1656	Vertical
		south	50	500	0.9		423	1022	Vertical

This stop is located on a 500 ft crest vertical curve (northbound grade change from -0.07% to -0.95%) and is 1000 ft north of a 500 ft crest vertical curve (northbound grade change from 0.58% to -1.10%). It is located at a speed limit change from 65 to 50 mph. Buses stop on roadway in both directions of travel.

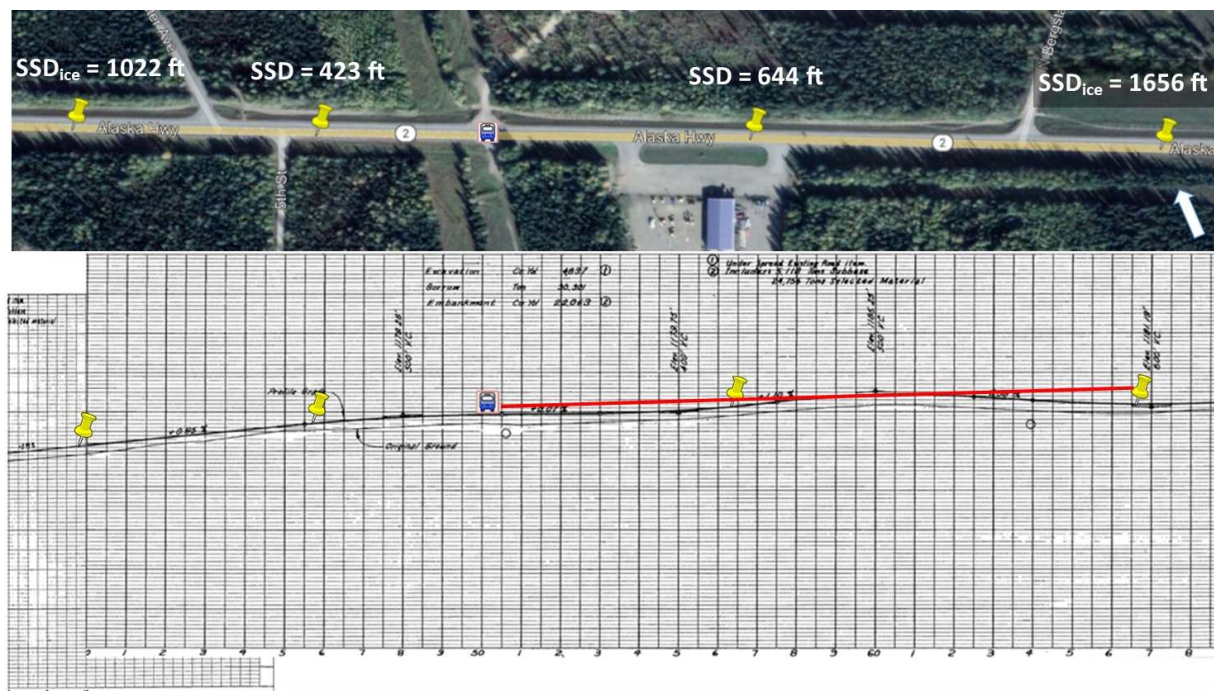


Figure 17: DGSD Alaska Highway at Med Clinic bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no vertical or horizontal sightline obstructions for this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

A minimum curve length of 0 ft is required for the 500 ft curve the stop is located on. The 500 ft curve to the south does not meet the required minimum length of 1241 ft for 65 mph. There are no horizontal sight obstructions for this location.

Recommendations

A reduced northbound speed limit of 55 mph requires a vertical curve length of 363 ft that can be met by the existing curve geometry. The stop should be relocated if the speed limit is not reduced.

3636 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
270.8	300	north	65	1335	5730	400	1.5		644	1656	Horizontal
		south	65						644	1656	Vertical

This stop is approximately 200 ft north of a 1335 ft long horizontal curve with a radius of 5730 ft. It is 1200 ft south of a 400 ft long crest vertical curve (northbound grade change from 0.16% to -1.35%). The bus stops in the northbound direction on the roadway.

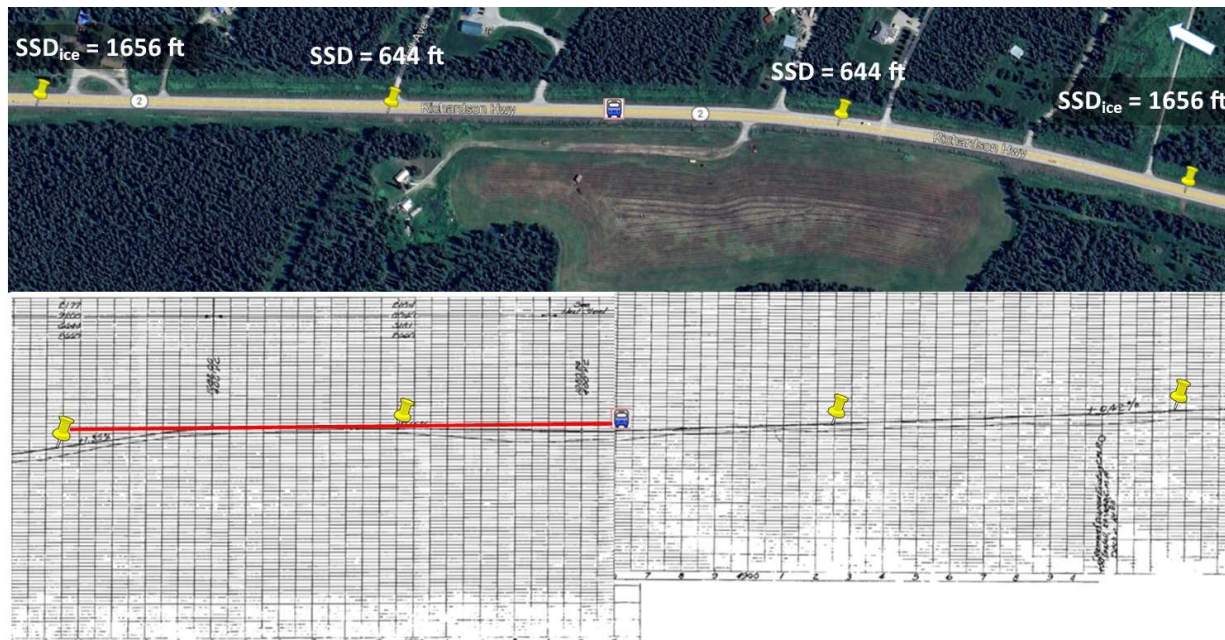


Figure 18: DGSD 3636 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sightline obstructions at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The existing roadside clearance to the inside of the curve meets current standards for horizontal sightlines. The crest vertical curve does not meet the minimum required length of 1008 ft.

Recommendations

Reducing the speed limit to 55 mph will decrease the minimum crest vertical curve length to 130 ft. The stop should be relocated if the speed limit is not reduced.

Birch Valley Duplex (Richardson Highway Milepost 270.9)

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
270.9	300	north	65	1335	5730	400	1.5		644	1656	Horizontal
		south	65						644	1656	Vertical

This stop is located 1000 ft south of a 400 ft long crest vertical curve (northbound grade change from 0.16% to -1.35%) and is 550 ft north of a 1335 ft long horizontal curve with a radius of 5730 ft. The bus stop on the roadway in the northbound direction of travel.

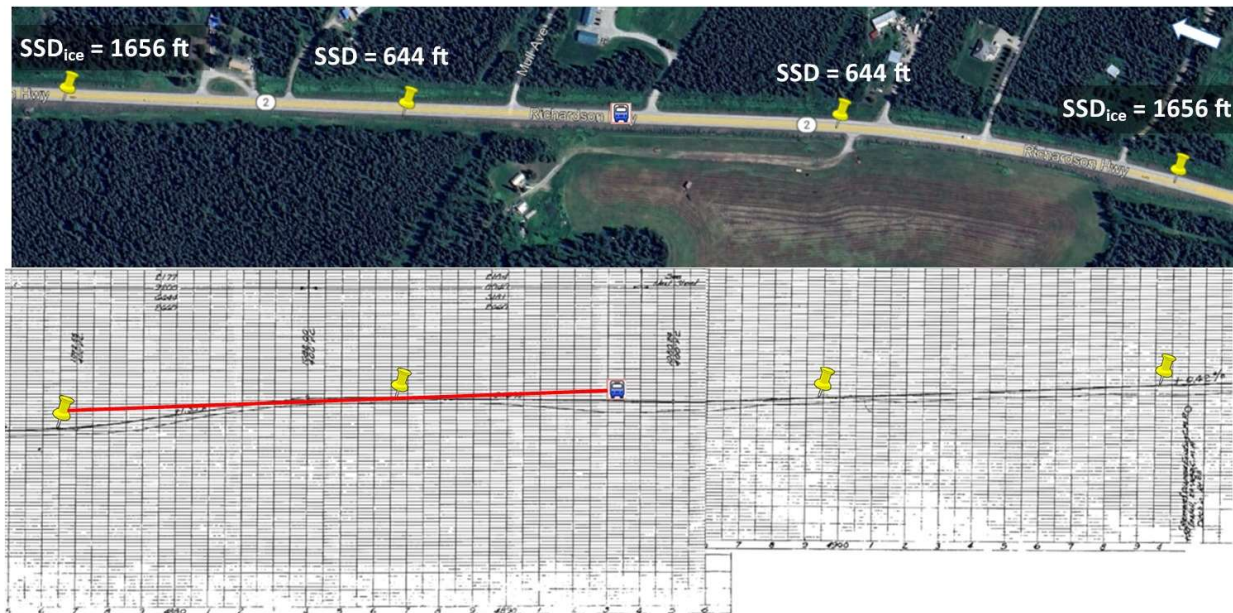


Figure 19: DGSD Richardson Highway at Birch Valley Duplex bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sightline obstructions at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

There are no horizontal sightline obstructions at this location. The 400 ft vertical curve does not meet the minimum required length of 1008 ft at 65 mph.

Recommendations

Reducing the speed limit to 55 mph would decrease the required minimum vertical curve length to 130 ft. The stop should be relocated if the speed limit is not decreased.

Richardson Highway at Krebs Lane

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
274.0	300	north	65	400	2.1		644	1656	Tangent
		south	65				644	1656	Vertical

This location is approximately 1100 ft south of a 400 ft vertical curve (northbound grade changes from 0.60% to -1.50%). The bus stops in the roadway in the northbound direction only. As of 6/29/23 DGSD communication this is no longer a stop.



Figure 20: DGSD Richardson Highway at Krebs Lane bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no sight obstructions at this location. The minimum crest vertical length required is 0 ft.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The crest vertical curve does not meet the minimum length of 1655 ft for the 65-mph speed limit. There are no horizontal sight obstructions at this location.

Recommendations

Reducing the speed limit to 50 mph would allow the current vertical curve to meet the required minimum length of 388 ft. The stop should be relocated if the speed limit is not reduced.

Richardson Highway Old Gas Station Stop at Bridge

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
275.3	300	north	65	500	10000		644	1656	Tangent
		south	65				644	1656	Horizontal

This location is on an approximate 10000 ft radius tangent just south of the Tanana River bridge off the roadway. Sight distance analysis was conducted at location of the stop.



Figure 21: DGSD Richardson Highway Old Gas Station Stop at Bridge bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sightline obstructions at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The Tanana River bridge structure significantly impacts the available horizontal sight distance for southbound approach to the bus stop location as well as the entrance and exit points to the pull out. There are no sight obstructions in the northbound direction.

Recommendations

The speed limit should be reduced to 50 mph to meet current design standards for SSD while crossing the bridge. Sight distance should be reevaluated after the existing bridge is replaced.

Fairbanks North Star Borough School District

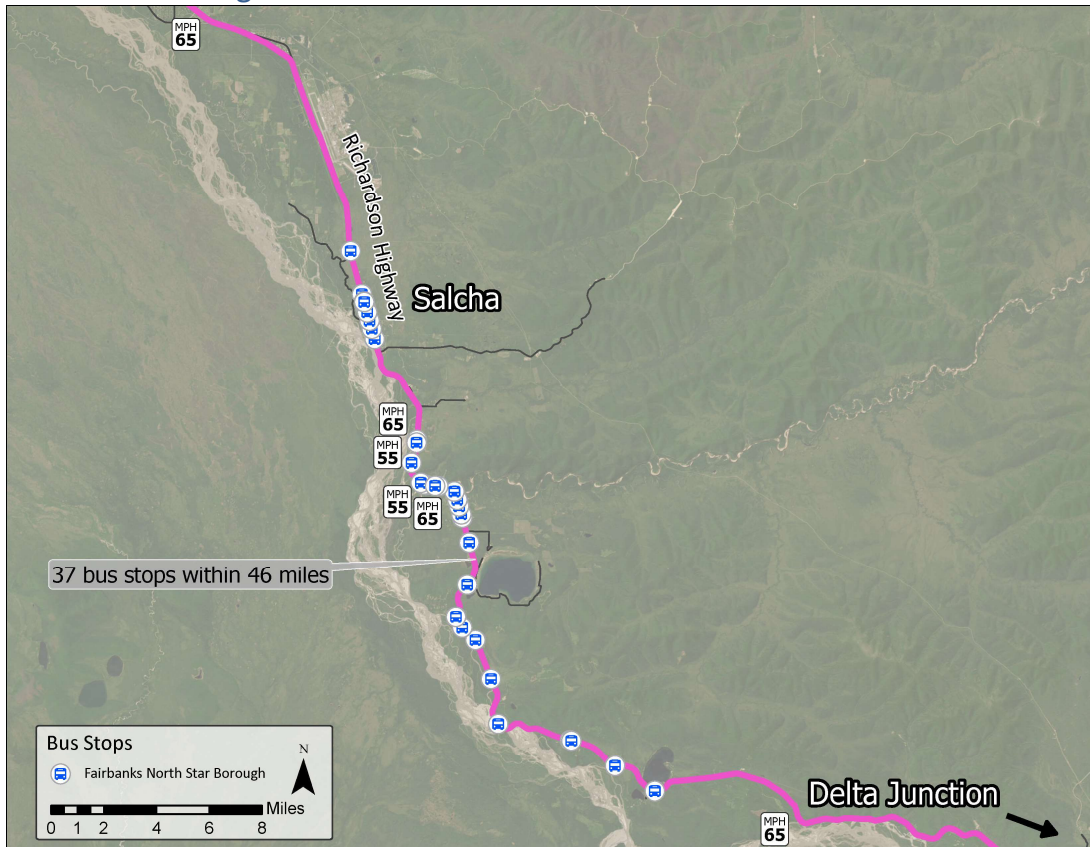


Figure 22: 2022-2023 Fairbanks North Star Borough School District bus stop locations on Richardson Highway

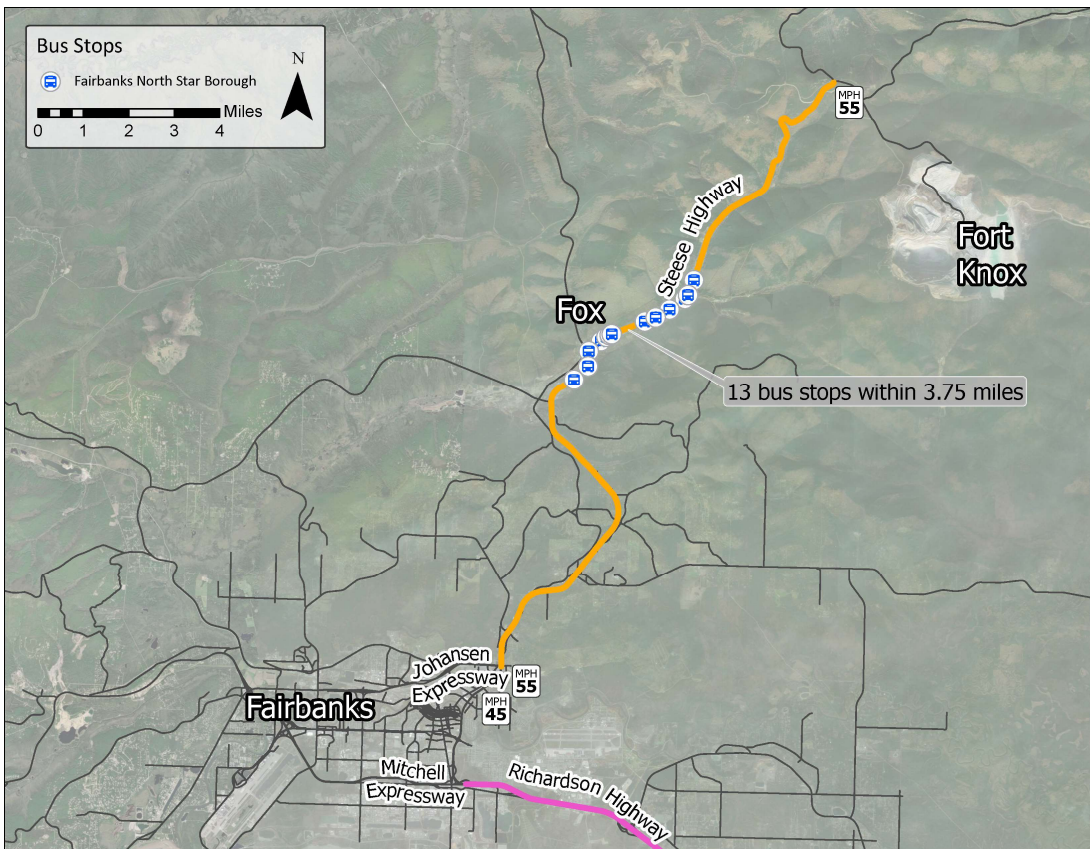


Figure 23: 2022-2023 Fairbanks North Star Borough School District bus stop locations on Steese Highway

Forty-seven FNSBSD bus stops were analyzed along the corridor. Thirty-four stops are located on Richardson Highway segments with posted speed limits between 55 and 65 mph. Thirteen stops are located on Steese Highway segments with a 55-mph posted speed limit. The 24 stops located on or near horizontal or vertical roadway geometry have had their individual analysis summarized in this section. All 47 stops meet required SSD minimums for design conditions. Twenty-four of the 47 stops did not have enough sight distance available under snow/ice conditions due to vertical, horizontal, or a combination of vertical and horizontal sightline obstructions.

Richardson Highway Birch Lake Pullout

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
306.0	300	north	65	1045	1146		644	1656	Horizontal
		south	65	1045	1146		644	1656	Horizontal

The bus stop is located at a pullout on the inside of a 1045 ft long horizontal curve with a radius of 1146 ft. The bus stops off the roadway in both directions. Sightline analysis was completed where the bus stops within the turnout. The right-of-way to the north of the pullout is limited to approximately 100 ft on each side of the roadway centerline depending on the location of Birch Lake.



Figure 24: FNSBSD Richardson Highway Birch Lake pullout bus stop location

Design $a = 11.2 \text{ ft/s/s}$

The available horizontal sight distance meets minimum required stopping sight distances in both directions.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Sightlines are obstructed by vegetation in both directions when traveling at the existing speed limit.

Recommendations

Required sight distances may be met for the 65-mph speed limit by increasing vegetation clearing in the right-of-way up to an additional 50 ft south of the stop and clearing to the lake north of the stop. The as built from highway project F-062-4(30) Silver Fox to Canyon Creek (1973) specifies to not clear the vegetative screen, labeled with the orange arrow in Figure 24, between the roadway and the lake to the north of the stop. If no additional vegetation removal were to occur, speeds should be restricted to 40 mph in both directions.

12005 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
307.9	300	north	65	1985	2292		644	1656	Horizontal
		south	65	1985	2292		644	1656	Horizontal

This stop is located on a level grade, 1985 ft long horizontal curve with a radius of 2292 ft. The bus stops in the roadway for pickups in the southbound direction. Vegetation is not currently cleared from behind the guardrail located just off the northbound shoulder leading up to the stop.

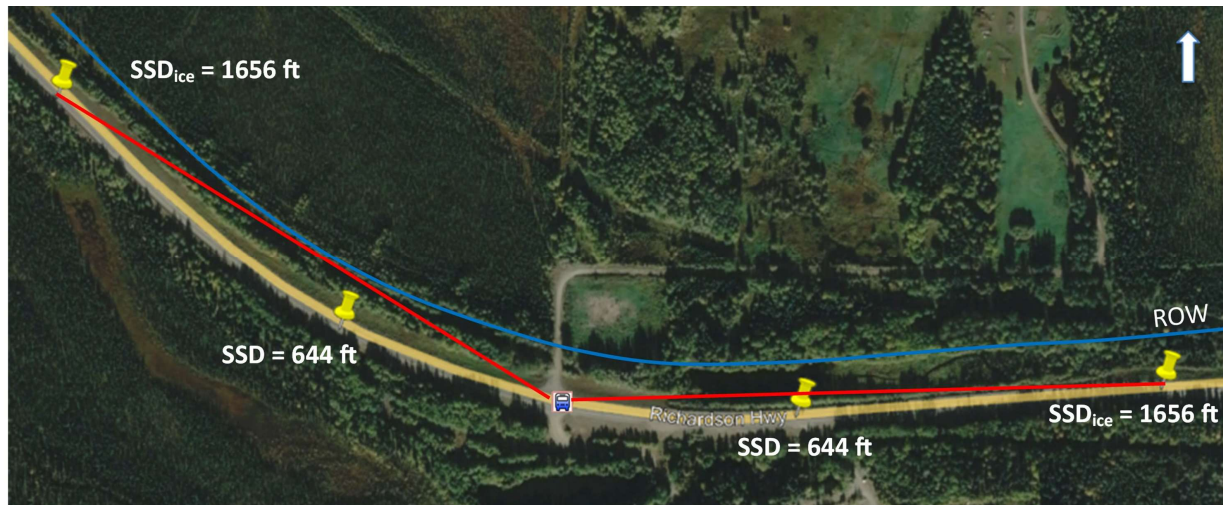


Figure 25: FNSBSD 12005 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

The available horizontal sight distance is meets current standards for the posted speed limit.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

The horizontal sightlines are obstructed in both directions of travel.

Recommendations

Vegetation clearance should be maintained at the current offset to meet design SSD requirements. To meet snow/ice SSD requirements in the northbound direction vegetation should be cleared from the inside of the curve to at least 62 ft from the roadway centerline if the speed limit of 65 mph is maintained. The southbound direction needs 135 ft of clearance. This clearance can be achieved within the existing right-of-way. With no additional vegetation clearance, the speed limit should be reduced to 40 mph northbound and 50 mph southbound at this location to meet available stopping sight distances.

11899 Richardson Highway Rest Area

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
310.0	300	north	65	2200	6.7		644	1656	Vertical
		south	65	2200	6.7		644	1656	Vertical

This stop is approximately 650 ft south of the point of intersection of a 2200 ft long crest vertical curve (2.38% to -4.33% in the northbound direction). There is a 790 ft long horizontal curve with a radius of 11460 ft to the north and a 727 ft long horizontal curve with a radius of 5730 ft to the south. This bus stop is only in the southbound direction and is off the four-lane undivided highway in a rest area turnout. Analysis was performed for the bus stop position in the turnout.

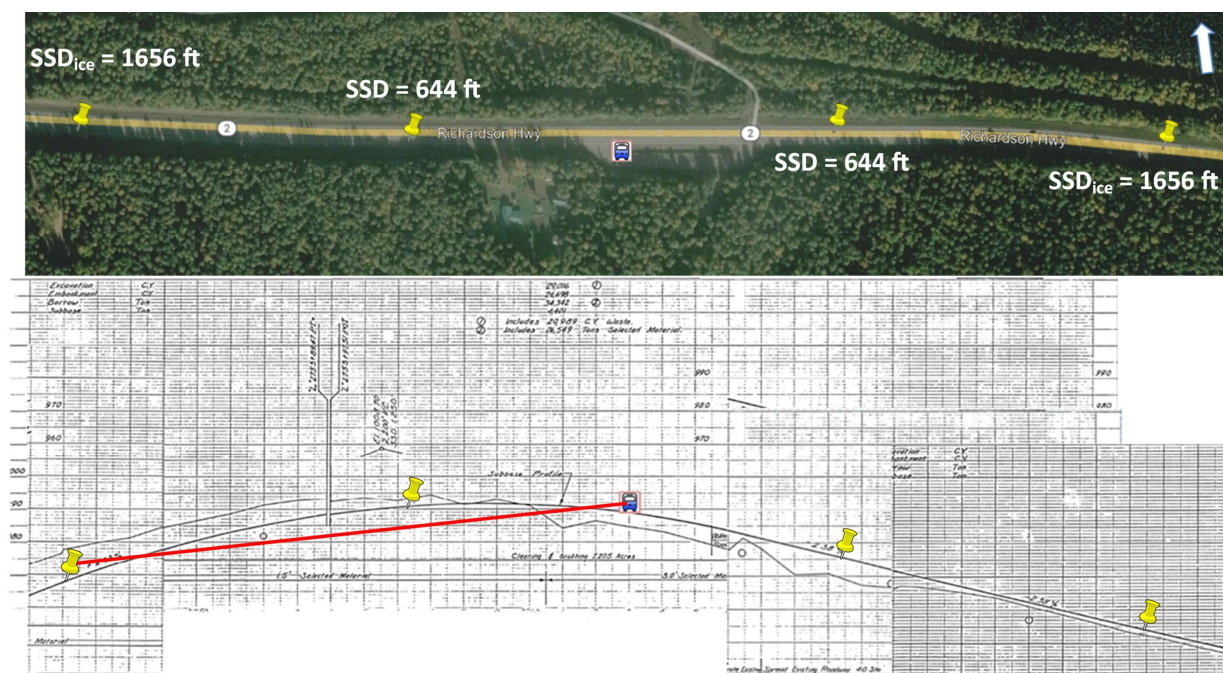


Figure 26: FNSBSD 11899 Richardson Highway rest area bus stop location

Design $a = 11.2$ ft/s/s

This stop location has no horizontal sightline restrictions and the crest vertical curve length of 2200 ft is greater than the minimum required vertical curve length of 799 ft.

Snow/Ice $a = 3.2$ ft/s/s

There are no obstructions to the horizontal sightline available at this stop. The crest vertical curve does not meet the minimum length required of 5289 ft when stopping from the speed limit of 65 mph.

Recommendations

The speed limit should be reduced to 50 mph to meet current sight distance standards, or the stop should be moved to another location.

11899 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	A, %		AASHTO	Ice	
310.1	300	north	65	2200	6.7		644	1656	Vertical
		south	65	2200	6.7		644	1656	Vertical

The bus stop is in an undivided highway passing lane segment with two northbound and two southbound lanes located 350 ft south of the point of intersection for a 2200 ft long crest vertical curve (2.38% to -4.33% grade in northbound direction). There is a 790 ft long horizontal curve with a radius of 11460 ft to the north and a 727 ft long horizontal curve with a radius of 5730 ft to the south. The bus only makes a southbound stop on the roadway.



Figure 27: FNSBSD 11899 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal sight distance restrictions for design SSDs in either direction. The 2200 ft vertical curve length exceeds the minimum required length of 799 ft at the current speed limit in both directions.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Horizontal sight distances in both directions are not impacted by the horizontal curves due in part to the additional passing lanes. The crest vertical curve does not meet the minimum crest vertical curve length of 5289 ft required when traveling at the posted speed limit.

Recommendations

The current vertical curve length does not meet the minimum length required unless the speed limit is reduced to 50 mph. The stop must be moved if the speed limit cannot be reduced.

Richardson Highway at State Pull Out T/A

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
313.1	300	north	65	2595	1528		644	1656	Horizontal
		south	65				644	1656	Tangent

This bus stop is in a turnout approximated 400 ft from the end of a 2595 ft long horizontal curve with a radius of 1528 ft. The sightline traveling northbound is restricted by a rock face and vegetation. Buses utilize the pull out traveling in both directions. Sight distances were determined from the bus stop position in the turnout.

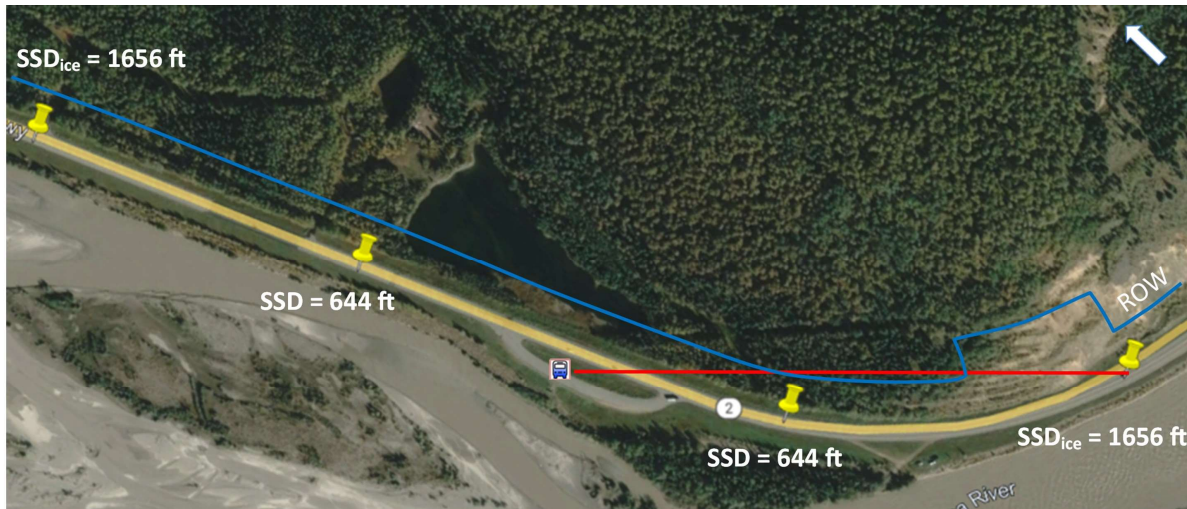


Figure 28: FNSBSD Richardson Highway at state pull out bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Available sight distances in the northbound and southbound directions meet the required SSD of 644ft at the posted speed limit.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sight distance is restricted by the rock face and vegetation. There are no southbound sight obstructions.

Recommendations

Earthwork and vegetation removal up to 25 ft beyond the existing right-of-way would be required if the 65-mph speed limit were to be maintained. Decreasing the speed limit to 50 mph would reduce the SSD to 1022 ft and require no additional clearance.

10536 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
317.4	300	north	65	781	2292		644	1656	Horizontal
				1435	1433				
		south	65	781	2292		644	1656	Horizontal

This stop is located on a 781 ft horizontal curve with a radius of 2292 ft. A 1435 ft long horizontal curve with a radius of 1435 ft begins approximately 1000 ft to the south. Only one bus stops in the northbound direction on the roadway.



Figure 29: FNSBSD 10536 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Northbound and southbound sight distances are unobstructed.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sight distance is obstructed by vegetation. Southbound sight distance is unobstructed at this location.

Recommendations

The existing 40 ft of clearance from the edge of the roadway needs to be increased to 108 ft to provide sight distance at 65 mph. Reducing the speed limit to 55 mph would provide SSD with the existing roadside clearance.

Richardson Highway at Salcha Scenic Turnout

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
317.8	300	north	65	1616	1348			4.6	596	1208	Horizontal
		south	65	1616	1348	600	2.6	-3.3	687	2375	Horizontal/Vertical

Stop is located within turnout 300 feet south of a 600 ft crest vertical curve PVI (-2.03% to -4.66% in southbound direction). The stop is on the outside of a 1617 ft long horizontal curve with a radius of 1348 ft. The speed limit is 65 miles per hour. Sight distances determined from the bus stop location in the turnout. A 1423 ft long horizontal curve with a radius of 1637 ft begins approximately 1250 ft north of the stop. Buses stop in the turnout for both directions of travel.

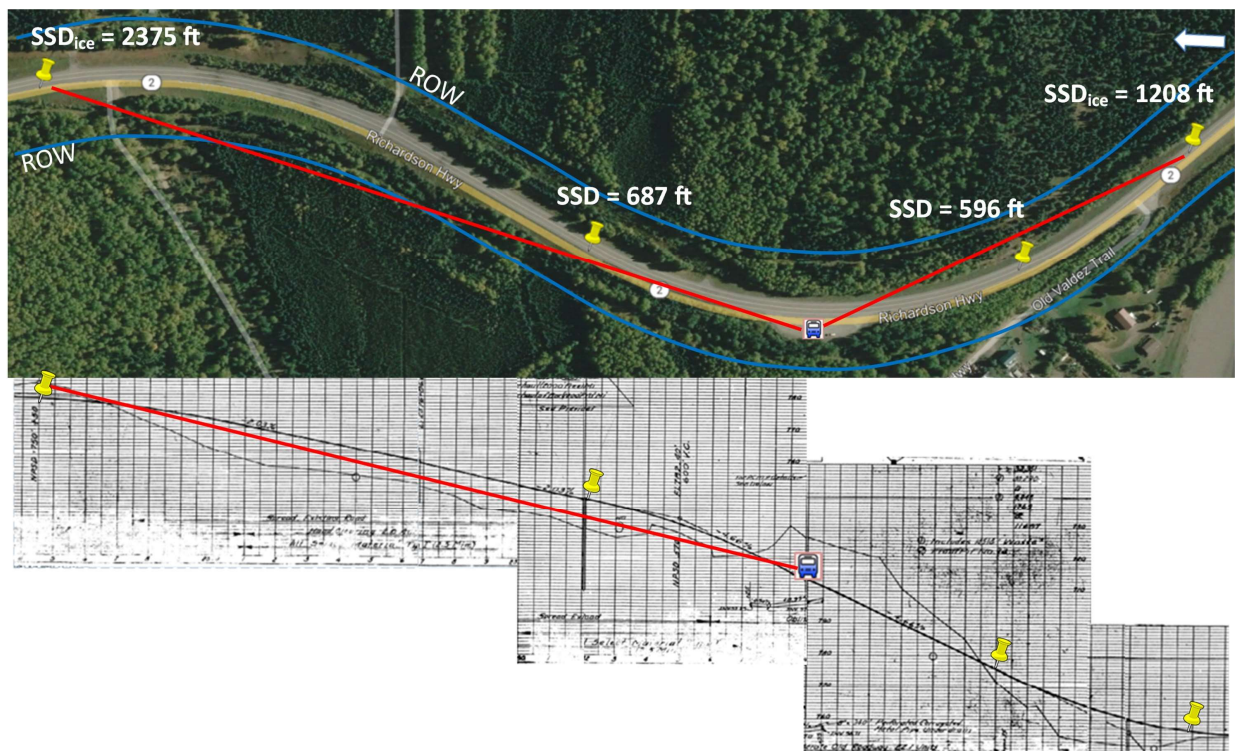


Figure 30: FNSBSD Richardson Highway at Salcha Scenic Turnout bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Northbound and southbound horizontal sight distances meet current standards with the existing right-of-way vegetation clearance. The 600 ft southbound crest vertical curve (-2.03% to -4.66% grade) just prior to the stop meets the minimum crest vertical curve length of 51 ft.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Available horizontal sight distance in both directions is do not meet current standards when traveling at the 65-mph posted speed limit. The crest vertical curve does not meet the minimum required length of 4270 ft for the posted speed limit.

Recommendations

Northbound horizontal sight restrictions from vegetation should be cleared up to 100 ft from the road centerline, within the existing right-of-way, to maintain the posted speed limit. Southbound sight restrictions would require clearing approximately 50 ft beyond existing right-of-way to maintain 65 mph. The posted speed limit should be reduced to 40 mph to meet vertical sight distance requirements. The southbound SSD would be reduced to 957 ft resulting in a minimum vertical curve length of 591 ft. Horizontal sight distances at 40 mph would provide SSD with no additional roadside clearance.

Richardson Highway at Wrong Way Lane

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
316.7	300	north	65	1468	1637		644	1656	Horizontal
		south	65	1468	1637		644	1656	Horizontal

The stop is located on a level grade, 1468 ft long horizontal curve with a radius of 1637 ft. The stop is in the roadway for both directions of travel.



Figure 31: FNSBSD Richardson Highway at Wrong Way Lane bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Northbound and southbound sight distances meet current standards at the posted speed limit.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sightlines are unobstructed. Southbound sight distance is obstructed by vegetation to the inside of the curve.

Recommendations

Vegetation would require clearing at least 30 ft beyond the right-of-way to meet southbound sight distance requirements while maintaining the current speed limit. Southbound sight distance would be met for existing vegetation clearance by decreasing the speed limit to 45 mph, resulting in an SSD of 845 ft.

Richardson Highway at Salcha Dr South

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
319.3	300	north	65	993	2865		644	1656	Tangent
		south	65				644	1656	Horizontal

This stop is located on a tangent 600 ft south of a 993 ft long horizontal curve with a radius of 2865 ft. The bus stops in both directions on the roadway.

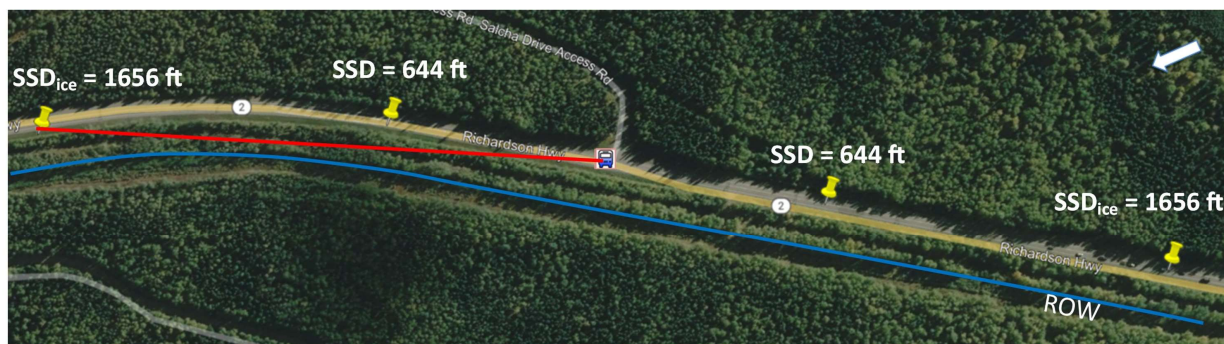


Figure 32: FNSBSD Richardson Highway at Salcha Drive South bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no sight obstructions with current right-of-way clearance in both directions for the posted speed limit of 65 mph.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Available sight distance in the southbound direction does not meet required SSD due to vegetation on the inside of the horizontal curve. There are no obstructions to the northbound SSD at the current speed limit.

Recommendations

Up to an additional 60 ft of vegetation, fully inside of the existing right-of-way, needs to be cleared to meet required SSD at 65 mph. The southbound speed limit should be reduced to 50 mph to provide the required sight distance with no additional roadside clearance.

9207 Richardson Highway LDS Church

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
322.8	300	north	65	1558	1637		644	1656	Tangent
		south	65				644	1656	Horizontal

The bus stop is located on a tangent approximately 1000 ft south of a 1558 ft long horizontal curve with a 1637 ft radius. Student pick up and drop off occur within the roadway for both directions of travel.



Figure 33: FNSBSD 9207 Richardson Highway LDS Church bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no sight obstructions in either direction at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Available sight distance meets the required SSD in the northbound direction at the posted speed limit. Vegetation to the inside of the curve obstructs the southbound sightline from the required SSD.

Recommendations

Up to an additional 20 feet of vegetation will need to be cleared from the inside of the curve to maintain the current speed limit. The speed limit should be reduced to 60 mph if no additional vegetation is cleared.

Richardson Highway at Salcha Marine

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
323.1	300	north	65	1558	1637	1000	3.2		644	1656	Horizontal
		south	65	1558	1637				644	1656	Horizontal/Vertical

This bus stop is located on a 1558 ft long horizontal curve with a 1637 ft radius. A 1000 ft long crest vertical curve (1.59% to -1.59% grade change in the southbound direction) is located at the bridge crossing the Salcha River approximately 1450 ft north of the stop. Buses stop in both directions on the roadway.

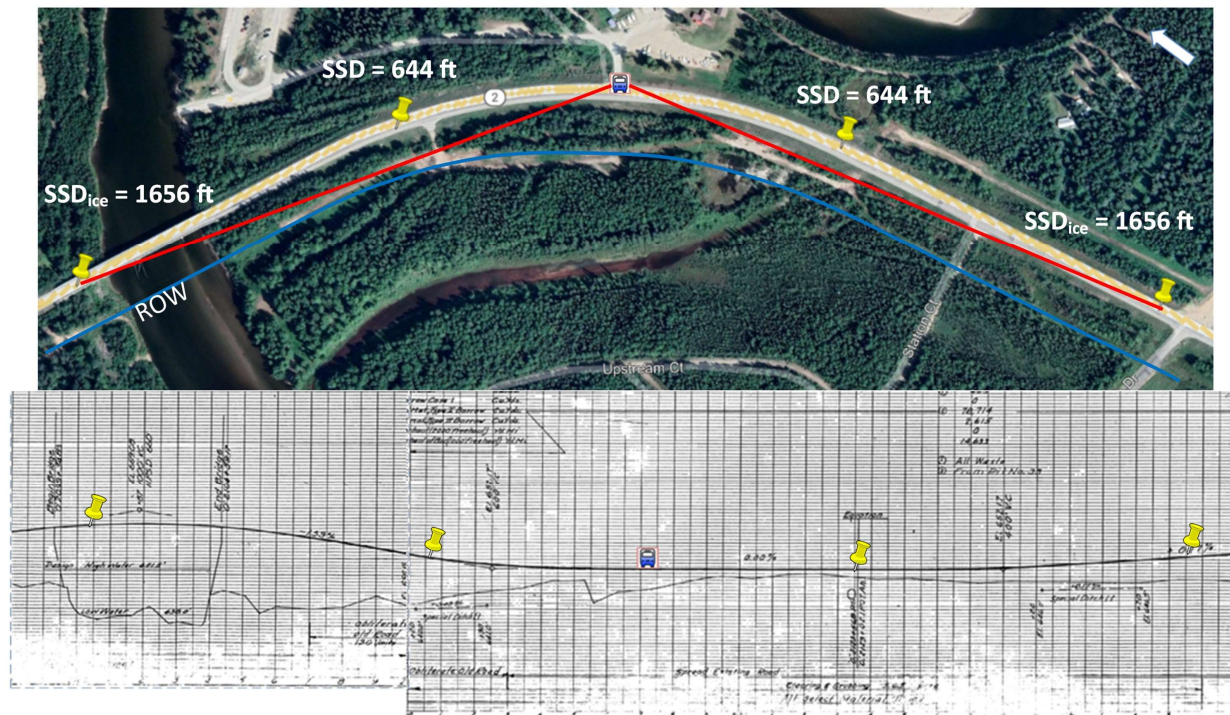


Figure 34: FNSBSD Richardson Highway at Salcha Marine bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sightline obstructions for either direction at the current speed limit of 65 mph.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

SSD in both directions is not met by available sight distances at 65 mph. The required vertical curve length of 2506 ft at 65 mph is not met by the 1000 ft crest vertical curve but the vertical sight distance is unobstructed at for the SSD and bus stop locations.

Recommendations

Up to 30 ft of additional vegetation clearance on the inside of the horizontal curve is required in the northbound direction to maintain the 65-mph speed limit. An additional 60 ft of clearance is required to the inside of the curve in the southbound direction. The speed limit should be reduced to 45 mph to meet SSD requirements for existing vegetation levels.

The vertical sight distance limitation would be removed by reducing the speed limit to 45 mph. The SSD location would move towards the bus stop to the south side of the crest the vertical curve. The required vertical curve length would decrease to 595 ft, less than the available 1000 ft.

8835 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
323.8	300	north	65	792	1637	400	1.6		644	1656	Horizontal
		south	65						644	1656	Vertical

This bus stop is located approximately 700 ft north of a 794 ft horizontal curve with a radius of 2865 ft. A 400 ft long crest vertical curve (1.70% to 0.08% change of grade in the southbound direction) is located 600 feet north of the stop. The bus stops at this location in both directions within the roadway.

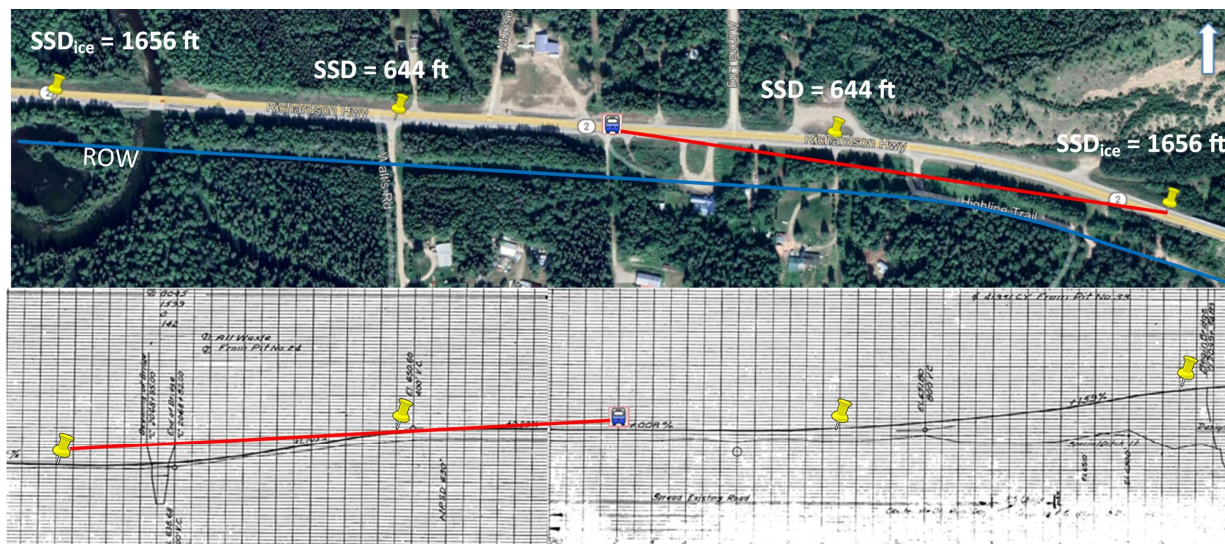


Figure 35: FNSBSD 8835 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Horizontal and vertical sight distances meet current standards for the posted speed limit.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound horizontal sight distance is obstructed by vegetation to the inside of the curve. There are no horizontal sight obstructions in the southbound direction. The crest vertical curve does not meet the minimum length of 1164 ft required for a 65 mph. There are no vertical sight obstructions in the northbound direction.

Recommendations

An additional 20 ft of vegetation clearance is required to the inside of the horizontal curve to meet northbound sight distance requirements at 65 mph. Reducing the speed limit to 60 mph will meet the minimum SSD with no additional roadside clearance.

The stop should be moved to a different location due to the vertical curve length not meeting current standards unless the speed limit is reduced. A 55-mph speed limit would reduce the minimum crest vertical curve length to 286 ft which would be met by the current vertical geometry.

8810 Richardson Highway at Walts Road

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
323.9	300	north	65	794	2865	400	1.8		644	1656	Horizontal/Vertical
		south	65	2096	2865	400	1.8		644	1656	Horizontal/Vertical

This stop is located on a 400 ft long crest vertical curve (1.70% to 0.08% change of grade in the southbound direction). It is 1350 ft north of a 794 ft long horizontal curve with a radius of 2865 ft. One daily stop is made in the southbound direction.



Figure 36: FNSBSD 8810 Richardson Highway at Walts Road bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal sight obstructions at this location. The vertical curve length is greater than the required minimum length of zero feet.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Horizontal sight lines are not obstructed for either direction of travel. Vertical sightlines to the bus stop location are not obstructed from the SSD locations but the minimum vertical curve length of 1164 ft for 65 mph is not met by the existing 400-foot vertical curve length.

Recommendations

Reducing the speed to 55 mph would decrease the required minimum vertical curve length to 286 ft to allow for SSD when approaching the curve.

Richardson Highway at Old Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
324.3	300	north	55	2096	2865		492	1217	Horizontal
		south	55	2096	2865		492	1217	Horizontal

This stop is located on a 2096 ft long horizontal curve with a radius of 2865 ft. Buses stop in the roadway in each direction of travel. The speed limit changes 550 ft south of the stop location.

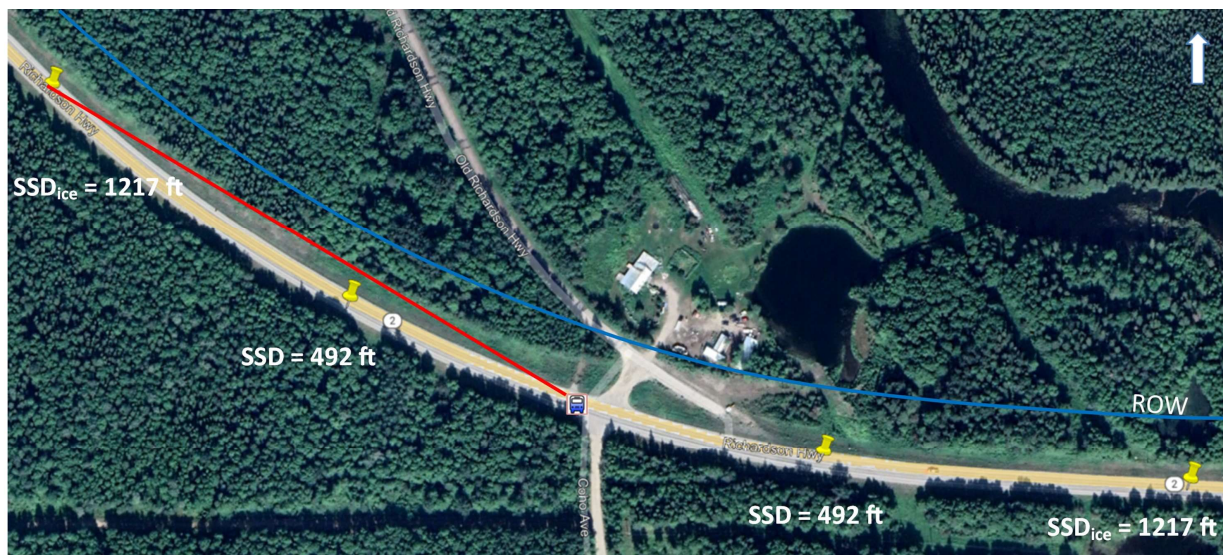


Figure 37: FNSBSD Richardson Highway at Old Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Available horizontal sight distance exceeds the required SSD of 492 ft for both directions of travel.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound horizontal sightlines are unobstructed. The southbound horizontal sightline is obstructed by vegetation to the inside of the turn.

Recommendations

Field inspection should be conducted at this location to verify available sight lines. It is recommended to remove an additional 5 ft of vegetation on the inside of the curve. Excessive vegetation growth between maintenance would likely obstruct the required sightline if the current clearance offset remained unchanged.

8750 Richardson Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
324.5	300	north	55	2096	2865		492	1217	Horizontal
		south	55	2096	2865		492	1217	Horizontal

This stop is located on a 2096 ft long horizontal curve with a radius of 2865 ft. The bus stops on the roadway in both directions of travel.

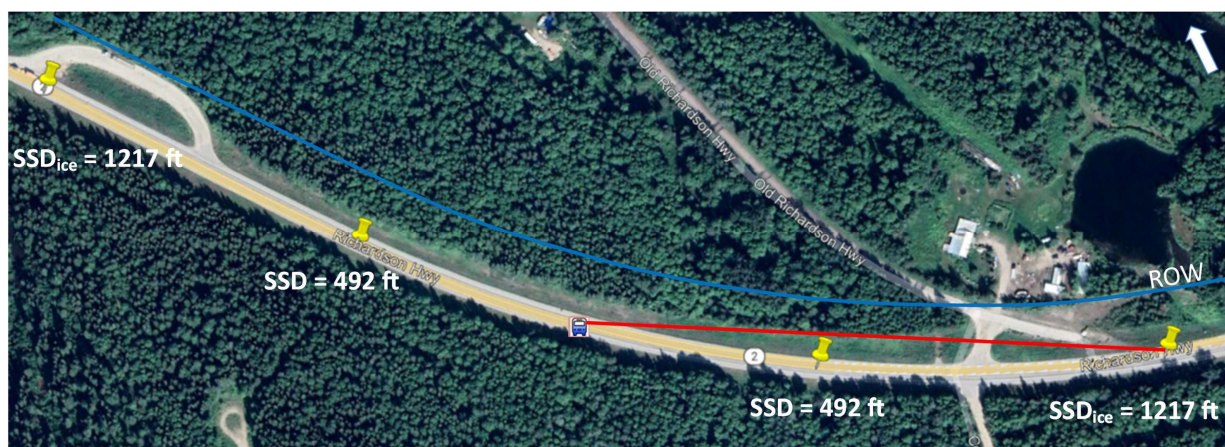


Figure 38: FNSBSD 8750 Richardson Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no obstructions to horizontal or vertical sightlines in either direction.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound horizontal sightlines are obstructed by vegetation to the inside of the curve. There are no southbound sight obstructions.

Recommendations

It is recommended to increase vegetation clearance by five feet to ensure required sightlines are met between maintenance clearing or to decrease the speed limit to 50 mph.

Richardson Highway at Salcha ES Drive

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft	Length, ft	A, %		AASHTO	Ice	
325.4	300	north	55	1856	1791	1600	2.4		492	1217	Horizontal/Vertical
		south	55	533	2292				492	1217	Horizontal

This stop is located 200 ft north of a 1600 ft long crest vertical curve (1.21% to -1.19% grade change in the northbound direction). An 1856 ft long horizontal curve with a radius of 1791 ft lies 700 ft to the south and a 530 ft long horizontal curve with a radius of 2292 ft is 50 ft north. Buses stop in both directions. The sight distance analysis was completed at the supplied location on the roadway.

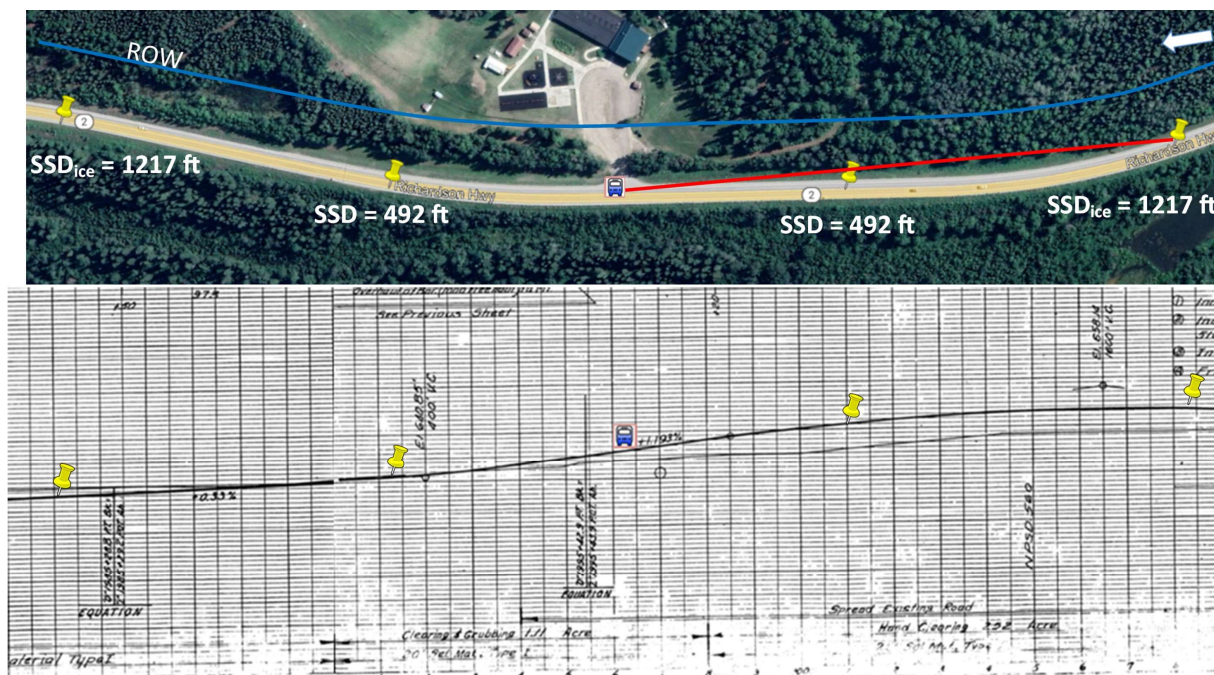


Figure 39: FNSBSD Richardson Highway at Salcha ES Drive bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal sight obstructions. The existing vertical curve length is above the minimum required length of zero feet. The vertical curve point of intersection is approximately 550 ft south of the required SSD point and does not obstruct sight distance.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sight distance is obstructed by vegetation on the inside of the curve. The existing crest vertical curve length of 1600 ft exceeds the minimum required length of 984 ft.

Recommendations

Clearing an additional 10 ft of vegetation to the inside of the horizontal curve will allow sight distances to meet standards at the current speed limit. Reducing the speed limit to 50 mph will remove the horizontal sightline obstruction with no additional vegetation clearance.

2126 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
10.7	330	north	55	1473	1146		492	1217	Tangent
		south	55				492	1217	Horizontal

This stop is located approximately 150 ft from a 1473 ft long horizontal curve with a radius of 1146 ft. A bus stops in both directions on the roadway.



Figure 40: FNSBSD 2126 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sight obstructions for this stop location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

There are no sight obstructions in the northbound direction. Southbound horizontal sightlines are obstructed by vegetation and an embankment to the inside of the horizontal curve. There are no vertical sight obstructions.

Recommendations

Additional vegetation clearance on the inside of the horizontal curve to the right-of-way if the 55-mph speed limit were maintained. Reducing the speed limit to 45 mph would allow sight distance to meet current standards with existing roadside clearance. The stop should be relocated if the speed limit is not reduced.

2303 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
11.4	200	north	55	750	2600		492	1217	Tangent
		south	55				492	1217	Horizontal

This stop is located approximately 600 ft south of a 750 ft long horizontal curve with a radius of 2600 ft. Buses stop on the roadway in both directions of travel.

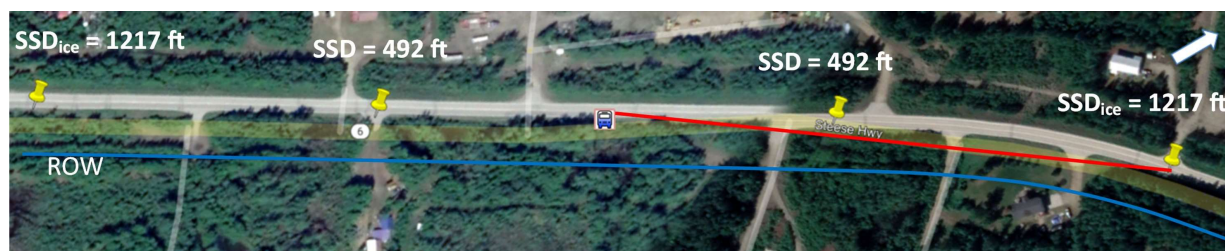


Figure 41: FNSBSD 2303 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sight obstructions for this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound horizontal sightlines are unobstructed. Southbound sightlines are obstructed by vegetation to the inside of the horizontal curve.

Recommendations

Up to an additional 25 feet of vegetation will need to be cleared to meet current standards for sight distance if the 55-mph speed limit is maintained or the stop should be relocated. The speed limit should be reduced to 45 mph if roadside clearance is maintained to current levels.

2324 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
11.6	200	north	55	750	2600		492	1217	Horizontal
		south	55	750	2600		492	1217	Horizontal

This stop is on a 750 ft long horizontal curve with a radius of 2600 ft. Buses stop on the roadway in both directions of travel.



Figure 42: FNSBSD 2324 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

No vertical or horizontal sightline obstructions are present in either direction.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

No sightline obstructions are present in the northbound direction. Vegetation in the inside of the curve restricts sightline in the southbound direction.

Recommendations

The speed limit may remain unchanged if up to an additional 10 ft of vegetation is cleared from within the existing right-of-way to the inside of the curve. The speed limit should be reduced to 45 mph if there is no additional roadside clearance provided.

2343 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
11.7	200	north	55	750	2600		492	1217	Horizontal
		south	55				492	1217	Tangent

This stop is on a 750 ft long horizontal curve with a radius of 2600 ft. Buses stop on the roadway in both directions of travel.

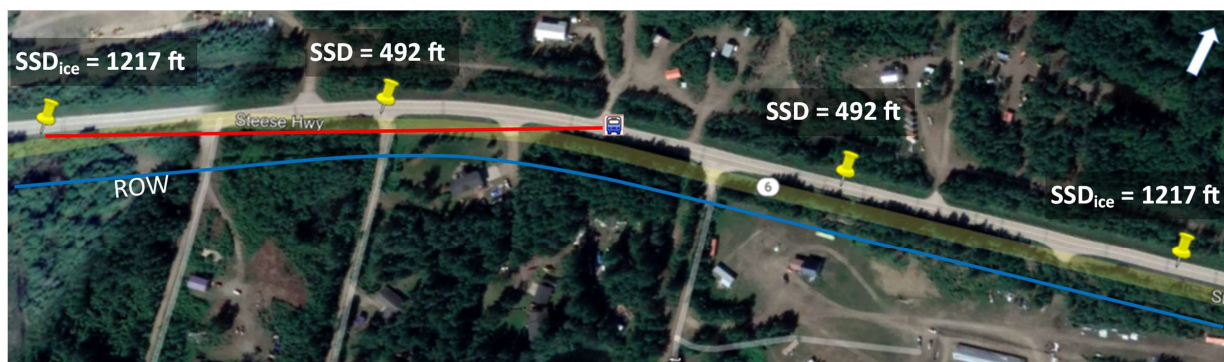


Figure 43: FNSBSD 2343 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

No horizontal or vertical sightline obstructions are present for this stop.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Vegetation on the inside of the curve obstructs the sightline in the northbound direction. There are no southbound sight obstructions for this location.

Recommendations

Up to 25 ft of additional clearance would be needed if the speed limit were to remain unchanged for horizontal sight distance to meet current design standards. SSD for a reduced speed of 40 mph would meet sight distance standards with the current vegetation clearance offset.

Steese Highway at Gunner Lane

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
11.7	200	north	55	750	2600		492	1217	Horizontal
		south	55				492	1217	Tangent

This stop is located approximately 300 ft north of a 750 ft long horizontal curve with a radius of 2600 ft. Buses stop on the roadway in both directions.

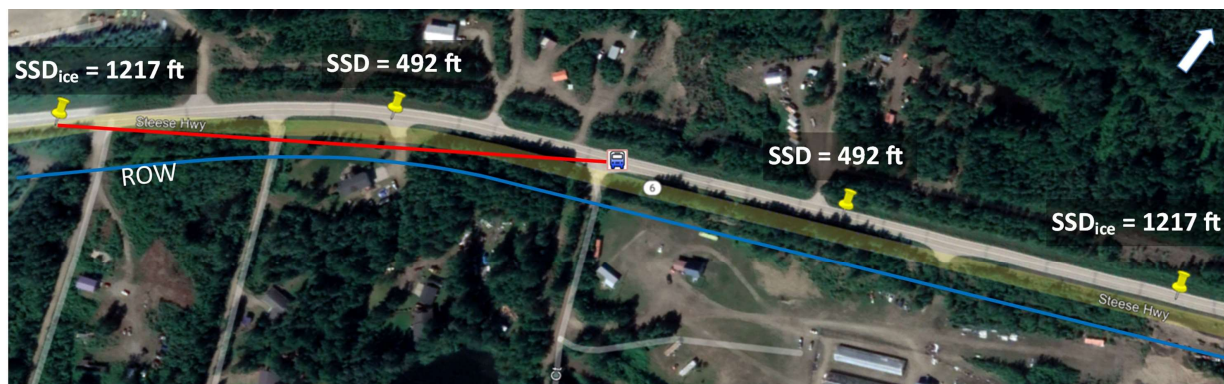


Figure 44: FNSBSD Steese Highway at Gunner Lane bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sight obstructions in either direction.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Horizontal sightlines are obstructed by vegetation on the inside of the curve in the northbound direction. There are no southbound sight restrictions.

Recommendations

Up to an additional 20 ft of vegetation clearance to the inside of the horizontal curve would be required to maintain the current speed limit. Reducing the speed limit to 40 mph would provide enough sight distance with no additional roadside clearance.

2505 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
12.7	200	north	55	850	2600		492	1217	Tangent
		south	55				492	1217	Horizontal

This stop is approximately 400 ft south of an 850 ft long horizontal curve with a radius of 2600 ft. Buses stop on the roadway in both directions of travel.

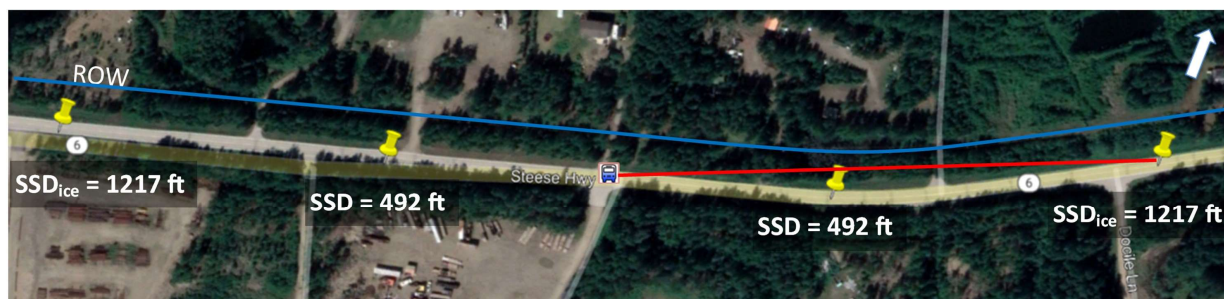


Figure 45: FNSBSD 2505 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sight line obstructions at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sightlines are unobstructed. Vegetation on the inside of the curve obstructs sightlines in the southbound direction.

Recommendations

An additional 20 ft of vegetation clearance would be required for sight distance to meet current standards for the existing speed limit. The speed limit should be reduced to 40 mph with roadside clearance is not changed.

2605 Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
13.5	200	north	55	1980	3300		492	1217	Horizontal
		south	55	1980	3300		492	1217	Horizontal

This location is on a 1980 ft long horizontal curve with a radius of 3300 ft. One bus stops in the southbound lane on the roadway. There is no northbound stop.



Figure 46: FNSBSD 2605 Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

Horizontal and vertical sightlines meet current design standards at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Northbound sightlines meet current standards for this location. The southbound horizontal sightline is obstructed by vegetation to the inside of the horizontal curve.

Recommendations

An additional 40 ft of clearance is required for the 55-mph speed limit to be maintained. If clearance is not increased the speed limit should be reduced to 45 mph to meet current sight distance standards.

2641 Steese Highway/Old Steese Highway

Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Grade Values that are <-3% and >+3%	SSD, ft		Sight Distance Check
				Length, ft	Radius, ft		AASHTO	Ice	
13.6	200	north	55	1980	3300		492	1217	Horizontal
		south	55	1980	3300		492	1217	Horizontal

This stop is located on a 1980 ft long horizontal curve with a radius of 3300 ft. Buses stop on the roadway in both directions of travel.



Figure 47: FNSBSD 2641 Steese Highway/Old Steese Highway bus stop location

Design $a = 11.2 \text{ ft/s/s}$

There are no horizontal or vertical sight obstructions at this location.

Snow/Ice $a = 3.2 \text{ ft/s/s}$

Vegetation to the inside of the curve obstructs sightlines in both directions.

Recommendations

An additional 20 ft of clearance is required in the northbound direction and an additional 25 ft is required in the southbound direction in order to maintain the 55-mph speed limit. Northbound speed should be reduced to 45 mph and southbound speed should be reduced to 40 mph if no additional roadside clearance takes place.

Results

Alaska Gateway School District AASHTO and ICE Summary

2022-2023 Bus Stop Location	Highway	Milepost	Meets Design Standards	
			SSD _{AASHTO}	SSD _{ICE}
Alaska Hwy MP 1319.13	Alaska	1313.2	Yes	Yes
Alaska Hwy MP 1319.2	Alaska	1314.2	Yes	Yes
Alaska Hwy MP 1319.9	Alaska	1314.7	Yes	Yes
Alaska Hwy MP 1320	Alaska	1315.4	Yes	Yes
Alaska Hwy MP 1321.8	Alaska	1317.7	Yes	Yes
Alaska Hwy MP 1319.1	Alaska	1319.1	Yes	Yes
Alaska Hwy MP 1319.13	Alaska	1319.13	Yes	Yes
Alaska Hwy MP 1319.2	Alaska	1319.2	Yes	Yes
Alaska Hwy MP 1319.9	Alaska	1319.9	Yes	Yes
Alaska Hwy MP 1320	Alaska	1320.0	Yes	Yes
Alaska Hwy MP 1321.8	Alaska	1321.8	Yes	Yes
Alaska Hwy MP 1322.5	Alaska	1322.5	Yes	Yes
Meets Standards/Total:			12/12	12/12

Delta/Greely School District AASHTO and ICE Summary

			Meets Design Standards	
2022-2023 Bus Stop Location	Highway	Milepost	SSD _{AASHTO}	SSD _{ICE}
Silver Fox	Alaska	1404.2	Yes	Yes
Alaska Hwy @ Fleet Street	Alaska	1414.3	Yes	No
Alaska Hwy @ Theisen	Alaska	1414.4	Yes	No
Alaska Hwy MP 1414.6	Alaska	1414.6	Yes	No
Alaska Hwy MP 1414.7	Alaska	1414.7	Yes	No
Alaska Hwy @ Dorhorst Rd	Alaska	1414.9	Yes	No
Alaska Hwy MP 1416.5	Alaska	1416.5	Yes	Yes
Bergstad Trailer Crt	Alaska	1421.0	Yes	No
Med Clinic on Ak Hwy	Alaska	1421.3	Yes	No
DOT pull out	Richardson	267.0	Yes	Yes
Green Acres	Richardson	267.8	Yes	Yes
Richardson Hwy Apartments	Richardson	268.8	Yes	Yes
2880 Richardson Hwy	Richardson	269.3	Yes	Yes
3146 Richardson Hwy	Richardson	270.0	Yes	Yes
3370 Richardson Hwy	Richardson	270.2	Yes	Yes
3720 Richardson Hwy	Richardson	270.3	Yes	Yes
639 Richardson Hwy	Richardson	270.4	Yes	Yes
3636 Richardson Hwy	Richardson	270.8	Yes	No
Birch Valley Duplex	Richardson	270.9	Yes	No
4840 Richardson Hwy	Richardson	273.2	Yes	Yes
Old Gas station stop at Bridge	Richardson	275.3	Yes	No
McAfee Dr	Richardson	273.6	Yes	Yes
Probert St	Richardson	272.7	Yes	Yes
Kreb Lane	Richardson	274.0	Yes	No
Sandra St	Richardson	272.0	Yes	Yes
Rebecca Lane	Richardson	271.9	Yes	Yes
Spengler Rd	Richardson	269.4	Yes	Yes
Meets Standards/Total:			27/27	16/27

Fairbanks North Star Borough School District AASHTO and ICE Summary – Richardson Highway Stops

2022-2023 Bus Stop Location	Highway	Milepost	Meets Design Standards	
			SSD _{AASHTO}	SSD _{ICE}
BIRCH LAKE PULLOUT No Intersection	Richardson	306.0	Yes	No
12005 Richardson Hwy	Richardson	307.9	Yes	No
11899 RICHARDSON HWY REST AREA	Richardson	310.0	Yes	No
11899 Richardson hwy	Richardson	310.1	Yes	No
State Pull Out T/A on Richardson Hwy	Richardson	313.1	Yes	No
11161 Richardson Hwy	Richardson	314.8	Yes	Yes
Richardson @ Wrong Way Ln	Richardson	316.7	Yes	No
10536 Richardson Hwy	Richardson	317.4	Yes	No
Salcha Scenic Turnout	Richardson	317.8	Yes	No
Richardson Hwy @ Salcha Dr South	Richardson	319.3	Yes	No
9581 Richardson Hwy	Richardson	321.0	Yes	Yes
9199 Richardson Hwy	Richardson	322.1	Yes	Yes
9163 Richardson Hwy	Richardson	322.2	Yes	Yes
Richardson Hwy @ Price Dr	Richardson	322.5	Yes	Yes
Richardson Hwy @ Harry Lucke Trl	Richardson	322.6	Yes	Yes
9207 Richardson Hwy LDS Church	Richardson	322.8	Yes	No
Salcha Marine	Richardson	323.1	Yes	No
8835 Richardson Hwy	Richardson	323.8	Yes	No
8810 Richardson Hwy/Walts rd	Richardson	323.9	Yes	No
8830 Richardson Hwy/Munson Slough	Richardson	324.3	Yes	Yes
Richardson Hwy @ Old Richardson Hwy	Richardson	324.3	Yes	No
8750 Richardson Hwy	Richardson	324.5	Yes	No
Richardson Hwy @ Salcha ES Dr	Richardson	325.4	Yes	No
Richardson Hwy @ Starkeyville Ln	Richardson	326.2	Yes	Yes
8263 Richardson Hwy	Richardson	326.3	Yes	Yes
Richardson Hwy @ Snow White Ct	Richardson	330.9	Yes	Yes
Richardson Hwy @ Bullwinkle Ct	Richardson	331.3	Yes	Yes
Richardson Hwy @ Grieme Rd/Tom Bear Trl	Richardson	331.7	Yes	Yes
Richardson Hwy @ Maggie Dr	Richardson	332.0	Yes	Yes
Richardson Hwy @ Pit Run Ct	Richardson	332.2	Yes	Yes
Richardson Hwy @ Paula Ct (Knotty Shop)	Richardson	332.41	Yes	Yes
6550 Richardson Hwy	Richardson	332.42	Yes	Yes
Richardson Hwy @ Howell Rd/Cleveland Ave	Richardson	332.7	Yes	Yes
5972 Richardson Hwy	Richardson	334.3	Yes	Yes
Meets Standards/Total:			34/34	18/34

Fairbanks North Star Borough School District AASHTO and ICE Summary – Steese Highway Stops

			Meets Design Standards	
2022-2023 Bus Stop Location	Highway	Milepost	SSD _{AASHTO}	SSD _{ICE}
2010 Steese Hwy	Steese	10.3	Yes	Yes
2126 Steese Hwy	Steese	10.7	Yes	No
Steese Hwy @ Old Steese Hwy/Elliot Hwy	Steese	11.1	Yes	Yes
2303 Steese Hwy	Steese	11.4	Yes	No
2324 Steese Hwy	Steese	11.6	Yes	No
2343 Steese Hwy	Steese	11.67	Yes	No
Steese Hwy @ Gunner Ln	Steese	11.7	Yes	No
2465 Steese Hwy	Steese	12.4	Yes	Yes
2505 Steese Hwy	Steese	12.7	Yes	No
2541 Steese Hwy	Steese	13.1	Yes	Yes
2605 Steese Hwy (only To School)	Steese	13.5	Yes	No
2641 Steese Hwy/Old Steese Hwy	Steese	13.6	Yes	No
2755 Steese Hwy	Steese	14.0	Yes	Yes
Meets Standards/Total:			13/13	5/13

Alaska Gateway School District – AASHTO Results

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Alaska Hwy MP 1313.2	1313.2	300	north	35					246		
			south	35				246			
Alaska Hwy MP 1314.2	1314.2	300	north	35					246		
			south	35				246			
Alaska Hwy MP 1314.7	1314.7	300	north	35					246		
			south	35				246			
Alaska Hwy MP 1315.4	1315.4	300	north	55					492		
			south	55				492			
Alaska Hwy MP 1317.7	1317.7	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1319.1	1319.1	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1319.13	1319.13	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1319.2	1319.2	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1319.9	1319.9	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1320.0	1320	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1321.8	1321.8	300	north	65					644		
			south	65				644			
Alaska Hwy MP 1322.5	1322.5	300	north	65					644		
			south	65				644			

Alaska Gateway School District – ICE Results

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{ICE}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Alaska Hwy MP 1313.2	1313.2	300	north	35					540		
			south	35				540			
Alaska Hwy MP 1314.2	1314.2	300	north	35					540		
			south	35				540			
Alaska Hwy MP 1314.7	1314.7	300	north	35					540		
			south	35				540			
Alaska Hwy MP 1315.4	1315.4	300	north	55					1217		
			south	55				1217			
Alaska Hwy MP 1317.7	1317.7	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1319.1	1319.1	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1319.13	1319.13	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1319.2	1319.2	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1319.9	1319.9	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1320.0	1320	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1321.8	1321.8	300	north	65					1656		
			south	65				1656			
Alaska Hwy MP 1322.5	1322.5	300	north	65					1656		
			south	65				1656			

Delta/Greely School District – AASHTO Results

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD ^{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Silver Fox MP 1404.2	1414.2	300	north	65						644	
			south	65						644	
Alaska Hwy @ Fleet Street MP 1414.3	1414.3	300	north	65			400	2.9		644	
			south	65			400	3.8		644	
Alaska Hwy @ Theisen MP 1414.4	1414.4	300	north	65			400	2.9	4.3	599	
			south	65			400	1.9		644	
Alaska Hwy MP 1414.6	1414.6	300	north	65			400	3.8		644	
			south	65			400	1.9		644	
Alaska Hwy MP 1414.7	1414.7	300	north	65			400	1.9		644	
			south	50			400	3.2		644	
Alaska Hwy @ Dorhorst Rd MP 1414.9	1414.9	300	north	65	925	2865				644	
			south	65	1172	2865				644	
Alaska Hwy MP 1416.5	1416.5	300	north	65						644	
			south	65						644	
Bergstad Trailer Crt MP 1421	1421.0	300	north	65						644	
			south	65			500	1.7		644	
Med Clinic on Ak Hwy MP 1421.3	1421.3	300	north	65			500	1.7		644	
			south	50			500	1.0		423	
DOT pull out MP 267	267.0	300	north	55						492	
			south	55						492	
Green Acres MP 267.8	267.8	300	north	55						492	
			south	55						492	
Richardson Hwy Apartments MP 268.8	268.8	300	north	65						644	
			south	65						644	
2880 Richardson Hwy MP 269.3	269.3	300	north	65						644	
			south	65						644	

Delta/Greely School District – AASHTO Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
			south	65						644	
3370 Richardson Hwy MP 270.2	270.2	300	north	65						644	
			south	65						644	
3720 Richardson Hwy MP 270.3	270.3	300	north	65						644	
			south	65						644	
639 Richardson Hwy MP 270.4	270.4	300	north	65						644	
			south	65						644	
3636 Richardson Hwy MP 270.8	270.8	300	north	65	1335	5730				644	
			south	65			400	1.5		644	
Birch Valley Duplex MP 270.9	270.9	300	north	65	1335	5730				644	
			south	65			400	1.5		644	
4840 Richardson Hwy MP 273.2	273.2	110	north	65						644	
			south	65						644	
Richardson Hwy at Krebs Ln	274.0	300	north	65						644	
			south	65			400	2.1		644	
Old Gas station stop at Bridge MP 275.3	273.5	300	north	65						644	
			south	65	500	10000				644	
McAfee Dr MP 273.6	273.6	100	north	65						644	
			south	65						644	
Probert St MP 272.7	272.7	100	north	65						644	
			south	65						644	
Sandra St MP 272	272.0	300	north	65						644	
			south	65						644	
Rebecca Lane MP 271.9	271.9	300	north	65						644	
			south	65						644	
Spengler Rd MP 269.4	269.4	183	north	65						644	
			south	65						644	

Delta/Greely School District – ICE Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{ICE}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
3146 Richardson Hwy MP 270	270.0	100	north	65						1656	
			south	65							1656
3370 Richardson Hwy MP 270.2	270.2	300	north	65						1656	
			south	65							1656
3720 Richardson Hwy MP 270.3	270.3	300	north	65						1656	
			south	65							1656
639 Richardson Hwy MP 270.4	270.4	300	north	65						1656	
			south	65							1656
3636 Richardson Hwy MP 270.8	270.8	300	north	65	1335	5730				1656	
			south	65			400	1.5			1656
Birch Valley Duplex MP 270.9	270.9	300	north	65	1335	5730				1656	
			south	65			400	1.5			1656
4840 Richardson Hwy MP 273.2	273.2	110	north	65						1656	
			south	65							1656
Richardson Hwy at Kreb Ln	274.0	300	north	65						1656	
			south	65			400	2.1			1656
Old Gas station stop at Bridge MP 275.3	273.5	300	north	65						1656	
			south	65	500	10000					1656
McAfee Dr MP 273.6	273.6	100	north	65						1656	
			south	65							1656
Probert St MP 272.7	272.7	100	north	65						1656	
			south	65							1656
Sandra St MP 272	272.0	300	north	65						1656	
			south	65							1656
Rebecca Lane MP 271.9	271.9	300	north	65						1656	
			south	65							1656
Spengler Rd MP 269.4	269.4	183	north	65						1656	
			south	65							1656

Fairbanks North Star Borough School District – AASHTO Results

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
BIRCH LAKE PULLOUT No Intersection	306.0	300	north	65	1045	1146				644	
			south	65	1045	11469					644
12005 Richardson Hwy	307.9	300	north	65	1985	2292				644	
			south	65	1985	2292					644
11899 RICHARDSON HWY REST AREA	310.0	300	north	65			2200	6.7		644	
			south	65			2200	6.7			644
11899 Richardson hwy	310.1	300	north	65			2200	6.7		644	
			south	65			2200	6.7			644
State Pull Out T/A on Richardson Hwy	313.1	300	north	65	2595	1528				644	
			south	65							644
11161 Richardson Hwy	314.8	300	north	65						644	
			south	65							644
Richardson @ Wrong Way Ln	316.7	300	north	65	1468	1637				644	
			south	65	1468	1637					644
10536 Richardson Hwy	317.4	300	north	65	781	2292				644	
					1435	1433					644
			south	65	781	2292					644
Salcha Scenic Turnout	317.8	300	north	65	1616	1348			4.6	596	
			south	65	1616	1348	600	2.6	-3.3		687
Richardson Hwy @ Salcha Dr South	319.3	300	north	65						644	
			south	65	993	2865					644
9581 Richardson Hwy	321.1	300	north	65						644	
			south	65							644
9199 Richardson Hwy	322.1	300	north	65						644	
			south	65							644
9163 Richardson Hwy	322.2	300	north	65						644	
			south	65							644

Fairbanks North Star Borough School District – AASHTO Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD ^{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Richardson Hwy @ Price Dr	322.5	300	north	65						644	
			south	65							
Richardson Hwy @ Harry Lucke Trl	322.6	300	north	65						644	
			south	65							
9207 Richardson Hwy LDS Church	322.8	300	north	65						644	
			south	65	1558	1637					
Salcha Marine	323.1	300	north	65	1558	1637				644	
			south	65	1558	1637	1000	3.2			
8835 Richardson Hwy	323.8	300	north	65	792	2865				644	
			south	65			400	1.6			
8810 Richardson Hwy/Walts rd	323.9	300	north	65	2096	2865	400	1.6		644	
			south	65	2096	2865	400	1.6			
8830 Richardson Hwy/Munson Slough	324.3	300	north	55						492	
			south	55							
Richardson Hwy @ Old Richardson Hwy	324.3	300	north	55	2096	2865				492	
			south	55	2096	2865					
8750 Richardson Hwy	324.5	300	north	55	2096	2865				492	
			south	55	2096	2865					
Richardson Hwy @ Salcha ES Dr	325.4	300	north	55	1856	1791	1600	2.4		492	
			south	55	533	2292					
Richardson Hwy @ Starkeyville Ln	326.2	300	north	55						492	
			south	55							
8263 Richardson Hwy	326.3	300	north	55						492	
			south	55							
Richardson Hwy @ Snow White Ct	330.9	300	north	65						644	
			south	65							
Richardson Hwy @ Bullwinkle Ct	331.3	300	north	65						644	
			south	65							

Fairbanks North Star Borough School District – AASHTO Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <- 3% and >+3%	SSD _{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Richardson Hwy @ Grieme Rd/Tom Bear Trl	331.7	300	north	65						644	
			south	65						644	
Richardson Hwy @ Maggie Dr	332.0	300	north	65						644	
			south	65						644	
Richardson Hwy @ Pit Run Ct	332.2	300	north	65						644	
			south	65						644	
Richardson Hwy @ Paula Ct (Knotty Shop)	332.4	300	north	65						644	
			south	65						644	
6550 Richardson Hwy	332.4	300	north	65						644	
			south	65						644	
Richardson Hwy @ Howell Rd/Cleveland Ave	332.7	300	north	65						644	
			south	65						644	
5972 Richardson Hwy	334.3	300	north	65						644	
			south	65						644	
2010 Steese Hwy	10.3	330	north	55						492	
			south	55						492	
2126 Steese Hwy	10.7	330	north	55						492	
			south	55	1473	1146				492	
Steese Hwy @ Old Steese Hwy/Elliot Hwy	11.1	330	north	55						492	
			south	55						492	
2303 Steese Hwy	11.4	200	north	55						492	
			south	55	750	2600				492	
2324 Steese Hwy	11.6	200	north	55						492	
			south	55	750	2600				492	
2343 Steese Hwy	11.7	200	north	55	750	2600				492	
			south	55						492	
Steese Hwy @ Gunner Ln	11.7	200	north	55	750	2600				492	
			south	55						492	

Fairbanks North Star Borough School District – AASHTO Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{AASHTO}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
2465 Steese Hwy	12.4	200	north	55						492	
			south	55							
2505 Steese Hwy	12.7	200	north	55						492	
			south	55	850	2600					
2541 Steese Hwy	13.1	200	north	55						492	
			south	55							
2605 Steese Hwy (only To School)	13.5	200	north	55	1980	3300				492	
			south	55	1980	3300					
2641 Steese Hwy/Old Steese Hwy	13.6	200	north	55	1980	3300				492	
			south	55	1980	3300					
2755 Steese Hwy	14.0	200	north	55						492	
			south	55							

Fairbanks North Star Borough School District – ICE Results, Continued

2022-2023 Bus Stop Location	Milepost	Right of Way Width, ft	Traveled Direction	Speed Limit, mph	Horizontal Curve		Crest Vertical Curve		Grade Values that are <-3% and >+3%	SSD _{ICE}	Sight Distance Constraint
					Length, ft	Radius, ft	Length, ft	A, %			
Richardson Hwy @ Price Dr	322.5	300	north	65						1656	
			south	65							1656
Richardson Hwy @ Harry Lucke Trl	322.6	300	north	65						1656	
			south	65							1656
9207 Richardson Hwy LDS Church	322.8	300	north	65						1656	
			south	65	1558	1637					1656
Salcha Marine	323.1	300	north	65	1558	1637				1656	Horizontal
			south	65	1558	1637	1000	3.2			1656
8835 Richardson Hwy	323.8	300	north	65	792	2865				1656	Horizontal
			south	65			400	1.6			1656
8810 Richardson Hwy/Walts rd	323.9	300	north	65	2096	2865	400	1.6		1656	Vertical
			south	65	2096	2865	400	1.6			1656
8830 Richardson Hwy/Munson Slough	324.3	300	north	55						1217	
			south	55							1217
Richardson Hwy @ Old Richardson Hwy	324.3	300	north	55	2096	2865				1217	
			south	55	2096	2865					1217
8750 Richardson Hwy	324.5	300	north	55	2096	2865				1217	Horizontal
			south	55	2096	2865					1217
Richardson Hwy @ Salcha ES Dr	325.4	300	north	55	1856	1791	1600	2.4		1217	Horizontal
			south	55	533	2292					1217
Richardson Hwy @ Starkeyville Ln	326.2	300	north	55						1217	
			south	55							1217
8263 Richardson Hwy	326.3	300	north	55						1217	
			south	55							1217
Richardson Hwy @ Snow White Ct	330.9	300	north	65						1656	
			south	65							1656
Richardson Hwy @ Bullwinkle Ct	331.3	300	north	65						1656	
			south	65							1656

Citations

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American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, Washington DC, 2018

Attachments

Table 2: Fairbanks North Star Borough School District bus stop locations on corridor

2022-2023 Bus Stop Location	Highway	Milepost
BIRCH LAKE PULLOUT No Intersection	Richardson	306.0
12005 Richardson Hwy	Richardson	307.9
11899 RICHARDSON HWY REST AREA	Richardson	310.0
11899 Richardson Hwy	Richardson	310.1
State Pull Out T/A on Richardson Hwy	Richardson	313.1
11161 Richardson Hwy	Richardson	314.8
Richardson @ Wrong Way Ln	Richardson	316.7
10536 Richardson Hwy	Richardson	317.4
Salcha Scenic Turnout	Richardson	317.8
Richardson Hwy @ Salcha Dr South	Richardson	319.3
9581 Richardson Hwy	Richardson	321.0
9199 Richardson Hwy	Richardson	322.1
9163 Richardson Hwy	Richardson	322.2
Richardson Hwy @ Price Dr	Richardson	322.5
Richardson Hwy @ Harry Lucke Trl	Richardson	322.6
9207 Richardson Hwy LDS Church	Richardson	322.8
8835 Richardson Hwy	Richardson	323.8
8810 Richardson Hwy/Walts Rd	Richardson	323.9
8830 Richardson Hwy/Munson Slough	Richardson	324.3
Richardson Hwy @ Old Richardson Hwy	Richardson	324.3
8750 Richardson Hwy	Richardson	324.5
Richardson Hwy @ Salcha ES Dr	Richardson	325.4
Richardson Hwy @ Starkeyville Ln	Richardson	326.2
8263 Richardson Hwy	Richardson	326.3
Richardson Hwy @ Snow White Ct	Richardson	330.9
Richardson Hwy @ Bullwinkle Ct	Richardson	331.3
Richardson Hwy @ Grieme Rd/Tom Bear Trl	Richardson	331.7
Richardson Hwy @ Maggie Dr	Richardson	332.0
Richardson Hwy @ Pit Run Ct	Richardson	332.2
Richardson Hwy @ Paula Ct (Knotty Shop)	Richardson	332.41
6550 Richardson Hwy	Richardson	332.42
Richardson Hwy @ Howell Rd/Cleveland Ave	Richardson	332.7
5972 Richardson Hwy	Richardson	334.3
Richardson Hwy @ Slayden/Rentals St	Richardson	353.3
2010 Steese Hwy	Steese	10.3
2126 Steese Hwy	Steese	10.7
Steese Hwy @ Old Steese Hwy/Elliot Hwy	Steese	11.1
2303 Steese Hwy	Steese	11.4
2324 Steese Hwy	Steese	11.6
2343 Steese Hwy	Steese	11.67
Steese Hwy @ Gunner Ln	Steese	11.7

2465 Steese Hwy	Steese	12.4
2505 Steese Hwy	Steese	12.7
2541 Steese Hwy	Steese	13.1
2605 Steese Hwy (only To School)	Steese	13.5
2641 Steese Hwy/Old Steese Hwy	Steese	13.6
2755 Steese Hwy	Steese	14.0

Table 3: Delta/Greely School District bus stop locations on corridor

2022-2023 Bus Stop Location	Highway	Milepost
Silver Fox MP 1404.2	Alaska	1404.2
Alaska Hwy @ Fleet Street MP 1414.3	Alaska	1414.3
Alaska Hwy @ Theisen MP 1414.4	Alaska	1414.4
Alaska Hwy MP 1414.6	Alaska	1414.6
Alaska Hwy MP 1414.7	Alaska	1414.7
Alaska Hwy @ Dorhorst Rd MP 1414.9	Alaska	1414.9
Alaska Hwy MP 1416.5	Alaska	1416.5
Bergstad Trailer Crt MP 1421	Alaska	1421
Med Clinic on Ak Hwy MP 1421.3	Alaska	1421.3
DOT pull out MP 267	Richardson	267
Green Acres MP 267.8	Richardson	267.8
Richardson Hwy Apartments MP 268.8	Richardson	268.8
2880 Richardson Hwy MP 269.3	Richardson	269.3
3146 Richardson Hwy MP 270	Richardson	270
3370 Richardson Hwy MP 270.2	Richardson	270.2
3720 Richardson Hwy MP 270.3	Richardson	270.3
639 Richardson Hwy MP 270.4	Richardson	270.4
3636 Richardson Hwy MP 270.8	Richardson	270.8
Birch Valley Duplex MP 270.9	Richardson	270.9
4840 Richardson Hwy MP 273.2	Richardson	273.2
Old Gas station stop at Bridge MP 273.5	Richardson	273.5
McAfee Dr MP 273.6	Richardson	273.6
Probert St MP 272.7	Richardson	272.7
Sandra St MP 272	Richardson	272
Rebecca Lane MP 271.9	Richardson	271.9
Spengler Rd MP 269.4	Richardson	269.4

Table 4: Alaska Gateway School District bus stop locations on corridor

2022-2023 Bus Stop Location	Highway	Milepost
Alaska Hwy MP 1313.2	Alaska	1313.2
Alaska Hwy MP 1314.2	Alaska	1314.2
Alaska Hwy MP 1314.7	Alaska	1314.7
Alaska Hwy MP 1315.4	Alaska	1315.4
Alaska Hwy MP 1317.7	Alaska	1317.7
Alaska Hwy MP 1319.1	Alaska	1319.1
Alaska Hwy MP 1319.13	Alaska	1319.13
Alaska Hwy MP 1319.2	Alaska	1319.2
Alaska Hwy MP 1319.9	Alaska	1319.9
Alaska Hwy MP 1320	Alaska	1320.0
Alaska Hwy MP 1321.8	Alaska	1321.8
Alaska Hwy MP 1322.5	Alaska	1322.5

TO: Alaska-Richardson-Steese Highways Corridor Action Plan (ARS CAP) Project Files

FROM: Ron Martindale, Randy Kinney, PE, PTOE

DATE: 7/19/2023

SUBJECT: School Bus Stop Safety: Speed, Signage, Cell Networks
Task 6C

Executive Summary

Information Transportation Service (ITS) technologies can be deployed to increase the safety of roadways. Equipment capable of transmitting and receiving information can be equipped to roadside hardware, school buses, and commercial vehicles to communicate with each other or within a larger network. Information regarding location of vehicles and inclement weather conditions can be communicated to drivers increasing safety at school bus stops.

Introduction of Subject Matter

During winter snow and ice conditions road friction is reduced: the distance required for a vehicle to stop is greater.

Additional snow-plow maintenance and graveling is not considered in this memorandum. Maintenance would increase stopping sight distance by increasing available road surface friction. Maintenance work of this nature already occurs along the corridor: further analysis would revolve around frequency of maintenance during Winter.

The author instead provides communication mediums to convey vehicular location data and weather data that when presented to a driver can reduce the distance needed to respond to a stopped bus to within stopping sight distance for the vehicle.

The communication mediums considered overcome the physical limitations of sight in the stopping sight distance equation by providing a credible safe speed or approximating vehicular position at a given time. None of the presented mediums are both as fast and accurate as visual verification of a stopped vehicle by eyesight or line of sight sensors.

No Action Alternative: State Law 13 AAC 02.275(a-e)

Per Alaska Administrative Code 13 AAC 02.275(a) regarding basic rules and maximum limits:

- (a) No person may drive a vehicle at a speed greater than is reasonable and prudent considering the traffic, roadway, and weather conditions.

A licensed driver with line of sight to a stopped school bus or adverse weather condition is more likely to obey the law and drive at a reduced speed.

This law does not provide any additional information to the driver beyond their assessment of their current surroundings and will be considered the no action alternative.

See Communication Medium: Variable Speed Limit Signs for State Law that provides additional information to the driver by way of engineering study and variable posted speed limits.

Communications Medium: School Bus Stop Ahead Signs & Timetables

Public notice indicating route times of buses paired with roadside signs indicating a bus stop is ahead can provide drivers with the approximate location of stopped buses. Worst case weather conditions can be displayed as static signs on the side of the road. This communication medium places the burden of determining likelihood of bus location and adverse road condition on the driver and is only as accurate as the bus drivers' ability to keep schedule. When a driver, after computing likelihood of bus location and weather conditions, believes either to be credible, they are more likely to reduce their speed. Stopping sight distance is proportional to speed: as driver speed decreases upstream of a bus stop the distance required to stop decreases.

Communications Medium: Variable Speed Limit Signs (VSLs)

Variable speed limit signs (VSLs) can be installed to reduce speeds prior to proposed bus stops.

FHWA's publication no. FHWA-HRT-21-053, adapted below, shows a benefit-cost overview of VSLs [1, pg. 6]:

BENEFIT-COST STUDIES ON VSLs

VSL implementations generate preferential system benefits of traffic efficiency and safety (FHWA 2017). Reported benefits of VSL systems include the following (USDOT 2016):

- Reduced crashes and crash severity.
- Smoother traffic flow and less delay.
- Safer speeds in work zones.
- Reduced travel times.
- Reduced bottlenecks.
- Ability to tie into road weather information system data.

WYDOT estimated VSL systems generate \$4.7 million in safety benefits per year on high volume routes (WYDOT 2012). This 2008 estimation was based on the values for crash costs and crash severity distributions in the Highway Safety Manual (AASHTO 2010). Maintenance expense (infrastructure repair and replacement) is a considerable cost of VSL systems. Operations, staffing, evaluation, and end-of-life replacement costs should be considered along with installation cost when deploying VSLs.

In Wyoming across the Elk Mountain corridor (I-80) a VSL system built around managing speeds in adverse weather conditions was constructed. A crash modification factor (CMF) of 0.66 for total crashes was computed from an interrupted time series and estimated with logistic segmented regression with generalized estimating equations [1, Table 9]. The Benefit-to-Cost ratio of installing the Wyoming VSLs on I-80 is computed to be 9.05 indicating the installation and adjustment of speeds by WYDOT staff and Highway Safety Patrol staff yielded larger benefits than costs [1, pgs. 31-32].

VSLs can be advisory, or they can be enforced maximum speed limits from an engineering & traffic study.

Per 13 AAC 02.280(c):

(c) A maximum speed limit may be effective at all times or at times indicated by the signs required by [an engineering and traffic investigation described in] (a) of this section. **Limits may be established for different times of day, different types of vehicles, varying weather conditions, and other factors bearing on safe speeds** [emphasis added]. The limits are effective when posted upon fixed **or variable** signs [emphasis added].

Per 13 AAC 02.275(b) the maximum posted speed limit controls:

(b) Except when a special hazard exists that requires a lower speed for compliance with (a) of this section, the limits specified in this subsection are the maximum lawful speeds throughout the state, and no person may drive a vehicle at a speed in excess of these maximum limits, **unless otherwise posted** [emphasis added]:

- (1) 15 miles per hour in an alley;
- (2) 20 miles per hour in a business district;
- (3) 25 miles per hour in a residential district; or
- (4) 55 miles per hour on any other roadway.

Per 13 AAC 02.275(e) and 13 AAC 02.280(c) a variable maximum posted speed limit is enforceable under Alaska State Law.

Ensuring drivers comply with reduced speeds is paramount to a VSL system that reduces crashes. Researchers in the State of Washington along I-90 near Snoqualmie Pass found the average speed of drivers at sites with variable speed limit signage decreased. This reduction in mean speed is qualified with an increase in speed deviation: “This is not surprising, since drivers can be expected to obey VSLs to different degrees, thereby increasing speed deviation” [3, pg. 15]. The authors found potential safety issues with their implementation of VSLs. “[Drivers] accelerate more quickly beyond the VSL zone when the speed limit is reduced than when the speed limit is not reduced to compensate for their slower speed. Compensatory behavior like this could increase accident frequencies in the area between the [VSL] sites and reduce or negate the safety benefits of lower mean speeds when a reduced speed is posted.” [3, pgs. 19-20].

Credibility of speed limits is a consideration when varying a speed limit sign. As noted by Attorney Margaret Hines: “... some static speed limits have low levels of compliance, which may be improved by implementing limits that are more responsive to the situation and therefore are more credible. In some other situations, the static speed limit may become too high for changing conditions, and a variable limit provides information and safety to motorists.” [4, pg. 3].

Regarding parameters influencing the speed limit on a variable speed limit sign: “Using VSL, agencies can take into account a variety of conditions such as traffic volume, operating speeds, weather information, sight distance, and roadway surface conditions when posting speed limits. This data is typically transmitted to a transportation management center (TMC) and analyzed automatically with an algorithm or reviewed by agency personnel who make decisions about the speed limit.” [2, pg. 3].

The State of Alaska Department of Transportation and Public Facilities (AKDOT&PF) in Northern Region has a traffic operations management center suited for the task of interconnecting the corridor from Farmer’s Loop Road thru Fairbanks to the Gaffney Road, Airport Way, Richardson Highway, Steese Expressway intersection. See Communications Medium: Private Cellular Band for potential interconnection with cellular throughout the remainder corridor.

Regarding using environmental data from Road Weather Information Systems (RWIS) to vary speed limits: “Nevada DOT’s VSL relies on data from two separate RWIS stations. Once an RWIS measures a 30 mi/h wind gust, the VSL on US-395 is activated to reduce speeds. The VSL signs do not display normal operating speeds until neither RWIS measures a wind gust of 30 mi/h or more for 30 minutes.” [2, pg. 24].

The State of Alaska owns RWIS infrastructure. See <https://roadweather.alaska.gov/gis> for the existing State of Alaska road weather information system sites. See Communications Medium: Private Cellular Band for networks the State of Alaska uses to receive information from RWIS sites.

Communication Medium: Private Cellular Band

Vehicle to network communications on a cellular band can locate stopping school buses and present them to commercial truck drivers even when lacking line of sight. A driver alerted to a stopping vehicle outside of normal stopping sight distance is provided additional reaction time in the stopping sight distance equation. Where drivers understand and comply with an accurate and credible alert, the driver can reduce speeds to within stopping sight distance.

Benefit-cost data has not yet been collected for this novel implementation of warning drivers of stopping school busses and adverse weather conditions via new private transponders or existing state infrastructure and cellular agreements.

Cellular Long Term Evolution Network (LTE) and phone applications currently exist for presenting similar information to a minority of the traveling public [5]. Privately owned phone applications such as Waze are currently used to identify roadside hazards: The Waze website at time of writing displays HAAS Alert and their Safety Cloud offering within their case study [6].

Further conversation with HAAS Alert indicated school bus stop heading data could be used to alert ore haul drivers of school busses coming to a stop. The requirements would be cellular network coverage (the author assumes LTE from the context of the conversation) a transponder in a school bus, and a transponder in a commercial vehicle. Transponders would require access to a GPS network and access to a cellular network to provide the location and heading of vehicles to notify commercial drivers of stopping school busses visually and/or audibly [7].

Examples of private cellular providers in Alaska are GCI Communications Incorporated and AT&T Incorporated. These corporations own cellular sites that transmit and receive on bands outside the 30 MHz of 5.9GHz spectrum allocated for Intelligent Transportation Systems. The private providers mentioned own most existing cellular sites along the Alaska Richardson-Steese Highways Corridor.

Review of AT&T's online cellular coverage map at time of writing indicates LTE coverage through the corridor: <<https://www.att.com/maps/wireless-coverage.html>>.

Review of GCI's online cellular coverage map at time of writing indicates lack of LTE coverage through the corridor: <<https://www.gci.com/mobile/coverage-map>>.

The State of Alaska currently uses Long Term Evolution (LTE) band communications sourced from the discussed private providers to communicate with its Regional Weather Information System (RWIS) and Message Signs located along the corridor. Phone applications such as Alaska 511 are updated by way of database by AKDOT&PF construction staff and maintenance personnel. Updates currently include construction events and road condition information. The phone implementations of Alaska 511 incorporate and uses this data to identify accidents, closures, and weather condition: <<https://511.alaska.gov/about/faq>>.

The author believes it is feasible to provide weather information to a commercial truck driver as well via cellular phone and new software implementation. It should be noted phone application implementations of Alaska 511 can access GPS data. An algorithm and application interface for using this data to alert Alaska 511 users of stopping school buses has not yet been implemented.

Communication Medium: Cellular Band 5.895-5.925 GHz

Vehicle to network to vehicle communications on a cellular band federally licensed for intelligent transportation services can resolve relative vehicular positions and present them to drivers. If a network of towers capable of overcoming line of sight obstructions were constructed with cellular site equipment supporting a 5.9 GHz band: vehicles could communicate their positions to one another with transponder and receiver technologies on a federally exclusive band.

The US Federal Communications Commission (FCC) allocated electromagnetic frequencies within the 5.9 GHz band for ITS use in 1999 [8]. The intent of regulating these frequencies for ITS use was to provide a safety band [9]. Communications on this band, such as vehicle to vehicle as well as vehicle to network, do not share or otherwise interfere with private providers as a safety feature [9].

The FCC in 2021 reduced the band available from 75 MHz to 30 MHz (5.850-5.925 GHz to 5.895-5.925 GHz) [10].

The author is not aware of Municipal, Borough or State infrastructure using this cellular band in Alaska. Under this assumption, use of this band would require new cellular equipment owned and operated by agencies heavily involved in the distribution of ITS such as the State of Alaska Department of Transportation and Public Facilities (AKDOT&PF).

Funding Mechanisms

The Federal Government by way of the Infrastructure Investment and Jobs Act provides grant opportunities for transportation safety programs to prevent roadside deaths.

In particular, Title 23, Chapter 4, Subsection (h)(2-4) United States Code provides up to an 80% match to "deploy digital alert technology" and "increas[e] visibility of stopped vehicles" [11].

According to NPR \$11 billion is set aside for transportation safety programs as of 2021 [12].

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