APPENDIX L
GRADE CROSSING SAFETY AND DELAY ANALYSIS

L. GRADE CROSSING SAFETY AND DELAY ANALYSIS METHODOLOGY

L.1 Grade Crossing Safety Analysis Methodology

L.1.1 Assumptions for Calculations

The Surface Transportation Board's Section of Environmental Analysis (SEA) used several data sources to characterize grade crossing safety conditions, as follows:

- Information on current and future rail traffic from the Alaska Railroad Corporation (ARRC or the Applicant), as described in Chapter 2
- The Federal Railroad Administration (FRA) *Highway-Rail Crossing Inventory* for information on road and train traffic characteristics at highway/rail crossings, including the number of tracks, number of road lanes, warning devices, daily vehicle traffic volume, road paving, road classifications, and the most recent 5 years of accident history (FRA, 2007a)
- Available information on annual average daily traffic (AADT) from the Alaska Department of Transportation & Public Facilities 2005 traffic map and the Matanuska-Susitna Borough 2006 traffic map (taken from ARRC, 2008a). Where AADT was not available from agency traffic maps, aerial photography was used to identify land usage and structures. AADT values for 2012 were estimated using the available data and an annual growth rate of 0.6 percent (CDTC, 2004)
- The FRA Personal Computer Accident Prediction System to predict accident frequencies at existing grade crossings (FRA, 2007b)
- The ARRC initial estimate of train traffic of 2 trains per day (ARRC, 2008b)

L.1.2 Calculation of Accident Frequency

SEA analyzed traffic safety at existing public at-grade highway/rail crossings using the accident history from the past 5 years and calculated the potential change in the predicted accident frequency (accidents per year) resulting from the proposed action alternatives that would involve use of all or part of the existing ARRC main line between Willow and Wasilla. This calculation involved information on public at-grade crossings provided in the FRA *National Highway-Rail Crossing Inventory* (FRA, 2007a), with the exception of anticipated future train traffic and AADT information, which SEA obtained from the sources indicated above. SEA performed the calculation of predicted accident frequency using the FRA Personal Computer Accident Prediction System.

L.1.3 Calculation of Hazard Index

For new at-grade crossings that could result from the proposed action, SEA analyzed safety using a hazard index, rather than predicted accident frequency, because the predicted accident frequency approach requires historical data on past accidents at a crossing. In addition, to

provide for comparable comparison of the alternatives, SEA also calculated a hazard index for existing at-grade crossings on the main line that could be used by rail traffic on some alternatives for the proposed rail line. SEA calculated a hazard index for each crossing using the New Hampshire Method as the product of the roadway AADT, trains per day, and a crossing protection factor. The latter is defined as 1.00 for crossbuck signage, 0.90 for crossbucks with stop signs, 0.20 for crossbucks with automatic flashers, 0.11 for crossbucks with automatic flashers and gates, and zero for grade-separated crossings. Table L-1 lists calculations at each crossing.

L.2 Grade Crossing Delay Analysis Methodology

For each at-grade crossing analyzed, SEA calculated the time that a particular crossing would be blocked for each train-crossing event and estimated the average delay per vehicle at that crossing in a 24-hour period. SEA used the average delay per vehicle for at-grade crossings to determine the level of service. Level of service is also used as a qualitative measure of road and intersection operating conditions. SEA also estimated the average traffic delays for all vehicles over a 24-hour period and used the average delay per vehicle to determine level of service for each at-grade crossing based on ratings listed in Table L-2.

SEA used the following calculations to estimate traffic delay for at-grade crossings. The traffic delay at a crossing includes the time for the train to pass, and the time for any warning device to engage and disengage. For simplification purposes, it is assumed that both rail and road traffic would be uniform throughout the day.

The first step includes the calculation of gate-down time per train event (T).

$$T = T_W + \frac{L}{V}$$

Where:

T_W = Gate warning time
L = Average train length
V = Average train speed

The number of stopped vehicles delayed per day (N_V) can be calculated as follows:

$$N_V = \frac{T}{24} * N * ADT$$

Where:

N = Number of trains per day
ADT = Average daily traffic[1]
24 = Hours per day

[1] Also referred to as annual average daily traffic (AADT).

Table L-1
Hazard Index Calculations for the Build Alternatives (page 1 of 2)

Segment	Mile Post	Road Name	Type of Crossing	Type of Protection	AADT	2012 AADT	Date of Traffic Count
Mac West	MW 5.7	S. Guernsey Road	At-Grade	Crossbucks	<100	102	Estimated
Mac East	ME 4.9	Baker Farm Road	Separated	RR over Hwy	<100	102	Estimated
	ME 9.8	W. Holstein Avenue	Separated	RR over Hwy	<100	102	Estimated
Conn 1	C1-2.4	Little Su River Road	At-Grade	Crossbucks	148	154	2005
Conn 2	C2-2.3	S. Guernsey Road	At-Grade	Crossbucks	<100	102	Estimated
Conn 3	C3-0.7	Ayrshire Avenue	At-Grade	Flashing Lights/Gates	555	579	2005
	C3-1.0	W. Carpenter Lake Road	At-Grade	Crossbucks	56	58	2005
Willow	W 19.8	W. Deshka Landing Road	At-Grade	Crossbucks	159	166	2005
	W 23.4	Willow Creek Parkway	At-Grade	Crossbucks	380	396	2005
	W 25.9	Parks Highway	Separated	Hwy over RR	NA	NA	NA
Houston	H 3.3	W. Susitna Parkway	At-Grade	Crossbucks	352	363	2007
	H 4.0	W. Papoose Twins Road	At-Grade	Crossbucks	157	164	2005
Houston South	HS 5.0	W. Millers Reach Road	At-Grade	Crossbucks	<150	154	Estimated
Big Lake	B 0.8	S. Burma Road	At-Grade	Flashing Lights/Gates	611	637	2005
	B 3.2	Homestead Road	At-Grade	Crossbucks	<100	102	Estimated
	B 5.0	Homestead Road	At-Grade	Crossbucks	<100	102	Estimated
	B 11.1	S. Larrys Lane	At-Grade	Crossbucks	<100	102	Estimated
	B 14.0	W. Hollywood Road	Separated	Hwy over RR	1426	1487	2005
	B 15.8	W. Big Lake Road	Separated	RR over Hwy	NA	NA	NA
	B 16.4	W. Calonder Way	At-Grade	Crossbucks	<50	51	Estimated
	B 16.7	W. Larae Road	At-Grade	Crossbucks	<100	102	Estimated
	B 17.1	Parks Highway	Separated	Hwy over RR	NA	NA	NA
Existing ARRC Main Line	171.3	Cheri Lake Drive	At-Grade	Flashing Lights/Gates	<200	205	Estimated
	173.0	Parks Highway	Separated	RR over Hwy	NA	NA	2006
	180.0	N. Lynx Lake Road	At-Grade	Crossbucks/Stop Signs	<100	102	Estimated
	180.8	W. Twitty Avenue / Nancy Lake Landing	At-Grade	Crossbucks/Stop Signs	<100	102	Estimated
	182.6	Parks Highway	Separated	RR over Hwy	NA	NA	2006
	185.5	Willow Station Road	At-Grade	Flashing Lights/Gates	395	412	2005
	186.9	Willow Fishhook Road	At-Grade	Flashing Lights/Gates	710	740	2005

Table L-1
Hazard Index Calculations for the Build Alternatives (page 2 of 2)

	Build Alternatives[a]															
	Mac West, Conn 1, Willow		Mac West, Conn 1, Houston, Houston North		Mac West, Conn 1, Houston, Houston South		Mac West, Conn 2, Big Lake		Mac East, Conn 3, Willow		Mac East, Conn 3, Houston, Houston North		Mac East, Conn 3, Houston, Houston South		Mac East, Big Lake	
Segment	PF	HI	PF	HI	PF	HI	PF	HI	PF	HI	PF	HI	PF	HI	PF	HI
Mac West	1.0	205	1	205	1	205	1	205	NA	NA	NA	NA	NA	NA	NA	NA
Mac East	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0
	NA	NA	NA	NA	NA	NA	NA	NA	0	0	0	0	0	0	0	0
Conn 1	1.0	309	1	309	1	309	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Conn 2	NA	NA	NA	NA	NA	NA	1	205	NA	NA	NA	NA	NA	NA	NA	NA
Conn 3	NA	NA	NA	NA	NA	NA	NA	NA	0.11	127	0.11	127	0.11	127	NA	NA
	NA	NA	NA	NA	NA	NA	NA	NA	1	117	1	117	1	117	NA	NA
Willow	1.0	332	NA	NA	NA	NA	NA	NA	1	332	NA	NA	NA	NA	NA	NA
	1.0	793	NA	NA	NA	NA	NA	NA	1	793	NA	NA	NA	NA	NA	NA
	0.0	NA	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA
Houston	NA	NA	1	725	1	725	NA	NA	NA	NA	1	725	1	725	NA	NA
	NA	NA	1	327	1	327	NA	NA	NA	NA	1	327	1	327	NA	NA
Houston South	NA	NA	NA	NA	1	307	NA	NA	NA	NA	NA	NA	1	307	NA	NA
Big Lake	NA	NA	NA	NA	NA	NA	0.11	140	NA	NA	NA	NA	NA	NA	0.11	140
	NA	NA	NA	NA	NA	NA	1	205	NA	NA	NA	NA	NA	NA	1	205
	NA	NA	NA	NA	NA	NA	1	205	NA	NA	NA	NA	NA	NA	1	205
	NA	NA	NA	NA	NA	NA	1	205	NA	NA	NA	NA	NA	NA	1	205
	NA	NA	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA	0	0
	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	0	NA
	NA	NA	NA	NA	NA	NA	1	102	NA	NA	NA	NA	NA	NA	1	102
	NA	NA	NA	NA	NA	NA	1	205	NA	NA	NA	NA	NA	NA	1	205
	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	0	NA
Existing ARRC Main Line	NA	NA	NA	NA	NA	NA	0.11	45	NA	NA	NA	NA	NA	NA	0.11	45
	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	NA	NA	NA	NA	0	NA
	NA	NA	0.9	184	0.9	184	0.9	184	NA	NA	0.9	184	0.9	184	0.9	184
	NA	NA	0.9	184	0.9	184	0.9	184	NA	NA	0.9	184	0.9	184	0.9	184
	NA	NA	0	NA	0	NA	0	NA	NA	NA	0	NA	0	NA	0	NA
	NA	NA	0.11	91	0.11	91	0.11	91	NA	NA	0.11	91	0.11	91	0.11	91
	NA	NA	0.11	163	0.11	163	0.11	163	NA	NA	0.11	163	0.11	163	0.11	163
Hazard Index:		1638		2189		2496		2139		1368		1919		2226		1729
Number of At Grade Crossings:	4		8		9		13		4		8		9		11	
Number of Separated Crossings:	1		1		1		5		3		3		3		7	

[a]PF = Crossing Protection Factor; HI = Hazard Index

Table L-2
Grade Crossings Level of Service[a]

Level of Service	Average Total Delay (seconds per vehicle)
A	<= 10
B	> 10 and <= 20
C	> 20 and <= 35
D	> 35 and <= 55
E	> 55 and <= 80
F	> 80

[a] Source: Transportation Research Board, 2001

The average delay per vehicle in a 24-hour period (D_V) is:

$$D_V = \frac{N_V}{ADT} * \frac{T * \frac{R_D}{R_D - R_A}}{2}$$

Where:

R_D = Departure rate (vehicles/lane/hour)[2]

R_A = Arrival rate, average daily traffic converted to vehicles/lane-hour

2 = Denominator to reflect that vehicles do not experience the entire time the train is blocking the grade crossing. They are assumed to arrive on average at the midpoint of the train crossing period.

Total vehicle delay (D) is the product of average delay per vehicle (D_V) and the average daily traffic (ADT).

$$D = D_V * ADT$$

Table L-3 lists the results of the grade crossing delay analysis for the proposed action.

[2] Based on the *Highway Capacity Manual* (Transportation Research Board, 2001), departure rates (in vehicles/lane-hour) are the following: highways (1,800), arterials (1,400), collectors (900), and local roads (700).

Table L-3
Delay at At-Grade Highway/Rail Crossings

Segment	Crossing ID	Street	Average Daily Traffic in Both Directions (Veh/Day)	Number of Daily Trains (including loaded and empty)		Number of Vehicles Delayed Per Day (vehicles/day)		Average Delay Per Stopped Vehicle (min/vehicle)		Average Delay Per Vehicle in a 24-Hour Period (sec/vehicle)		Total Delay in a 24-Hour Period (min)	
				No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action	No Action	Proposed Action
Mac West	MW 5.7	S. Guernsey Road	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
Conn 1	C1-2.4	Little Su River Road	154	-	2.0	-	0.4	-	1.0	-	2.0	-	0.4
Conn 2	C2-2.3	S. Guernsey Road	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
Conn 3	C3-0.7	Ayrshire Avenue	579	-	2.0	-	1.5	-	1.0	-	2.0	-	1.5
	C3-1.0	W. Carpenter Lake Road	58	-	2.0	-	0.2	-	1.0	-	2.0	-	0.2
Willow	W 19.8	W. Deshka Landing Road	166	-	2.0	-	0.4	-	1.0	-	2.0	-	0.4
	W 23.4	Willow Creek Parkway	396	-	2.0	-	1.1	-	1.0	-	2.0	-	1.0
Houston	H 3.3	W. Susitna Parkway	363	-	2.0	-	1.0	-	1.0	-	2.0	-	0.9
	H 4.0	W. Papoose Twins Road	164	-	2.0	-	0.4	-	1.0	-	2.0	-	0.4
Houston South	HS 5.0	W. Millers Reach Road	154	-	2.0	-	0.4	-	1.0	-	2.0	-	0.4
Big Lake	B 0.8	S. Burma Road	637	-	2.0	-	1.7	-	1.0	-	2.0	-	1.7
	B 3.2	Homestead Road	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
	B 5.0	Homestead Road	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
	B 11.1	S. Larrys Lane	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
	B 16.4	W. Calonder Way	51	-	2.0	-	0.1	-	1.0	-	2.0	-	0.1
	B 16.7	W. Larae Road	102	-	2.0	-	0.3	-	1.0	-	2.0	-	0.3
Existing ARRC Main Line	171.3	Cheri Lake Drive	205	11.0	13.0	3.0	3.6	1.0	1.0	0.9	1.0	2.9	3.5
	180.0	N. Lynx Lake Road	102	11.0	13.0	1.5	1.8	1.0	1.0	0.9	1.0	1.5	1.7
	180.8	W. Twitty Avenue / Nancy Lake Landing	102	11.0	13.0	1.5	1.8	1.0	1.0	0.9	1.0	1.5	1.7
	185.5	Willow Station Road	412	11.0	13.0	6.1	7.2	1.0	1.0	0.9	1.0	5.9	7.0
	186.9	Willow Fishhook Road	740	11.0	13.0	10.9	12.9	1.0	1.0	0.9	1.0	10.7	12.7
Totals by Alternative													
Mac West, Conn 1, Willow			819			-	2	-	1.0	-	0.2	-	2
Mac East, Conn 3, Willow			1,199			-	3	-	1.0	-	0.2	-	3
Mac West, Conn 1, Houston, Houston North			2,140			20	26	1.0	1.0	0.5	0.7	20	25
Mac East, Conn 3, Houston, Houston North			2,521			20	27	1.0	1.0	0.5	0.6	20	26
Mac West, Conn 1, Houston, Houston South			2,294			20	26	1.0	1.0	0.5	0.7	20	26
Mac East, Conn 3, Houston, Houston South			2,674			20	27	1.0	1.0	0.4	0.6	20	27
Mac West, Conn 2, Big Lake			2,865			23	31	1.0	1.0	0.5	0.6	22	30
Mac East, Big Lake			2,660			23	30	1.0	1.0	0.5	0.7	22	29

L.3 References

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