APPENDIX D
HAZARDOUS MATERIALS TRANSPORTATION

This appendix provides additional detail concerning the information presented in Sections 3.2 and 4.2 of the Draft EIS. The appendix provides information on the types of hazardous materials transported by rail in the project area, the hazardous characteristics of those materials, the change in the likelihood of a hazardous materials release as a result of the proposed project, and assessment of the potential consequences of a release.

D.1 INTRODUCTION

SEA evaluated the potential impacts associated with hazardous materials transportation by identifying the types of hazardous materials transported by rail in the project area, calculating the likelihood of a release, and examining the potential consequences of a release. The following sections describe SEA's approach to this analysis. The analysis and the interpretation of the results must take into consideration the characteristics of the existing environment, in particular those of existing rail operations involving hazardous materials, in order to determine if any of the potential impacts resulting from the implementation of the Proposed Action and Alternatives would be new to the environment and to assess their significance. A new potential impact would be a type of impact that does not exist in a particular area (e.g., a potential impact associated with a new type of activity in a certain area) or a notable increase in an existing type of potential impact.

SEA used a wide range of inputs, including characteristics of the proposed or existing rail lines, volume of hazardous materials and other rail traffic, and safety statistics for various types of accidents. Some of the characteristics of the rail lines and trains used by SEA to evaluate the Proposed Action are specific to the Proposed Action, while others are based on national averages for the rail industry.

Both frequency and consequences methodologies rely on assumptions concerning some of the relevant characteristics of the Proposed Action. These assumptions are described here. The Proposed Action would involve the operation of two trains per day along a proposed 13.8-mile new alignment connecting the Bayport Loop to the existing GH&H line. (The full length of the new segments for the Proposed Action and Alternatives ranges between 12.8 and 13.8 miles depending on the alternative. For this analysis, SEA conservatively used a length of 13.8 miles for all new segments.) The trains would then travel approximately 50 miles on the GH&H line, UP East Belt, UP Terminal, UP Lafayette, and UP Baytown Subdivisions to reach BNSF's intermediate destination at the CMC Dayton Yard. The outbound train leaving the Bayport Loop would carry loaded railcars, while the inbound train, originating in the CMC Dayton Yard, would carry mostly empty railcars.

During the initial operation, the Applicants expect that an average of two trains per day with 36 railcars each would operate and that approximately 1,500 loaded railcars per year would transport hazardous materials (equivalent to 6 percent of all the railcars in each train). The future market capture projection is for an average of two trains per day with 66 railcars each with approximately 7,000 loaded railcars per year transporting hazardous materials (equivalent to

15 percent of all the railcars in each train). Because the inbound train may carry some loaded railcars, some of which may potentially be hazardous materials railcars, SEA assumed that the Applicants' annual load projections are distributed between two trains per day and that the distribution of loaded cars between the two trains has only a minor influence on the risk calculations.

D.2 TRANSPORTED HAZARDOUS MATERIALS

SEA reviewed information provided by the Applicants that identifies the specific hazardous materials that would be transported along the proposed alignment as a result of the Proposed Action. The specific hazardous materials identified at this time include ethylene oxide, propylene oxide, isobutylene, monoethanolamine, glycol ethers, ethylene glycol, and alcohols. While other materials could be transported in the future, the list already includes hazardous materials that can pose toxic inhalation hazards (e.g., ethylene oxide if it is not ignited) and hazardous materials that are highly flammable (e.g., propylene oxide). This set of hazardous materials represents the wide range of the potential hazards that can be expected from a potential release. Table D.2-1 presents a summary of the major hazards posed by these hazardous materials. Table D.2-2 presents a summary of the hazards to natural resources associated with these hazardous materials. Given the limited number of hazardous materials railcars per train, the number of railcars carrying highly hazardous materials would be even smaller. Such materials will not necessarily be on every train.

D.3 ASSESSMENT OF HAZARDOUS MATERIALS RELEASES ALONG RAIL LINE SEGMENTS

SEA evaluated the predicted frequency of hazardous materials releases on rail line segments based on the frequency of derailments, collisions, and other accidents. SEA used various inputs, including characteristics of the rail line and trains, as well as safety statistics for different types of accidents, such as derailments and collisions, for the various track classes of interest.[1] The fact that not all accidents result in hazardous materials releases is of particular importance for the proposed project, where the operating speeds will be restricted to 20 mph on the proposed new rail line. The analysis considered both project-specific details (number of trains, number of cars, route length, etc.) and track-class-specific national statistics indicating the likelihood of accidents per mile and the fraction of each type of accident that results in a derailment. The analysis resulted in a measure of the likelihood or chance of a release. Appendix C presents a discussion of SEA's analysis to determine the train length (number of cars and locomotives) that was used in various analysis, including the analysis of train accident frequency and hazardous materials release probability.

[1] SEA used safety statistics for different track classes as derived by ICF Consulting (SEA's independent third party consultant) in a recent (2001) unpublished project for the Association of American Railroads (AAR). SEA considers that these statistics provide a more reasonable estimate than would be obtained using railroad-specific data, which blend many different track classes and operating speeds, unlike the situation for the proposed project.

Table D.2-1
Characteristics of Hazardous Materials That May Be Transported on the Proposed Action

	Ethylene Oxide	Propylene Oxide	Isobutylene	Mono-ethanolamine	Glycol Ethers[a]	Ethylene Glycol	Alcohols
Natural State	Clear, colorless, volatile liquid, ethereal odor	Clear, colorless, volatile liquid, ethereal odor	Colorless gas, faint petroleum-like odor. Shipped as a liquified gas under pressure.	Colorless liquid, ammonia odor	Liquid, mild agreeable odor	Clear, colorless syrupy liquid	Clear, colorless liquid
DOT Hazard Class	Class 2, Division 3 (Poison Gas)	Class 3 or 3.1 (Flammable Liquid)	Class 2, Division 1 (Flammable Gas)	Class 8 (Corrosives)	Class 3 (Flammable Liquid)	Class 9 (Misc. Hazardous Material)	Class 3 (Flammable Liquid)
NFPA Rating[b]	Health = 3 Fire = 4 Reactivity = 3	Health = 3 Fire = 4 Reactivity = 2	Health = 2 Fire = 4 Reactivity = 1	Health = 3 Fire = 2 Reactivity = 0	Health = 2 Fire = 2 or 3 Reactivity = 0 or 1	Health = 1 Fire = 1 Reactivity = 1	[c]
Spill or Leak Considerations	Vapors heavier than air, may concentrate and displace O_2 in low-lying areas. May readily vaporize and form a gaseous cloud.	Vapors heavier than air, may concentrate and displace O_2 in low-lying areas.	Vapors heavier than air, may concentrate and displace O_2 in low-lying areas. Leaks can be liquid or vapor phase.	Vapors heavier than air, may concentrate and displace O_2 in low-lying areas.	Vapors heavier than air, may concentrate and displace O_2 in low-lying areas.	Use appropriate measures to prevent environmental damage.	Use appropriate measures to prevent ignition or environmental damage.

Table D.2-1 (continued)

	Ethylene Oxide	Propylene Oxide	Isobutylene	Mono-ethanolamine	Glycol Ethers[a]	Ethylene Glycol	Alcohols
Firefighting Considerations[d]	Flammable over wide vapor-air concentration range. Must be diluted with water in a 24:1 ratio before loses flammability. Lighter than water —undiluted flaming liquid could be scattered by water stream.	Flammable over a wide vapor-air concentration range.	Easily ignited. Flame can easily flash back to source of leak. Cylinder or tank car exposed to fire may violently rupture and rocket.	Combustible liquid and vapor. Use appropriate measures as recommended by NFPA.	Flammable. Use appropriate measures as recommended by NFPA.	N/A - Does not burn or burns with difficulty.	Flammable. Lighter than water and only slightly water soluble—flaming liquid could be scattered by water stream.
Toxicity Concerns	Vapors very toxic, irritating to eyes, skin, and respiratory system. Prolonged contact with skin may result in delayed burns.	Vapors very toxic, irritating to eyes, skin, and respiratory system. Prolonged contact with skin may result in delayed burns.	Contact with liquid can cause frostbite.	Contact hazard, can cause respiratory tract, skin, eye, and mucous membrane burns.	Use appropriate measures to prevent personnel exposure.	Use appropriate measures to prevent personnel exposure.	Use appropriate measures to prevent personnel exposure.
Polymerization Concerns	May polymerize violently with evolution of heat and rupture of container.	May polymerize violently with evolution of heat and rupture of container.	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Evacuation Distance Upon Leakage or Fire	Up to 1.1 mile, regardless of fire conditions.	Up to 0.5 mile if container exposed to flame. If no flame, evaluate by case.	Up to 1 mile if container exposed to flame. If no flame, evaluate by case.	Up to 0.5 mile if container exposed to flame. If no flame, evaluate by case.	Up to 0.5 mile if container exposed to flame. If no flame, evaluate by case.	Up to 0.5 mile if container exposed to flame. If no flame, evaluate by case.	Up to 0.5 mile if container exposed to flame. If no flame, evaluate by case.

Table D.2-1 (continued)

Table Sources
AAR. 1994. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads Bureau of Explosives. July.

NAERG-2000. 2000 North American Emergency Response Guidebook: A guidebook for first responders during the initial phase of a dangerous goods/hazardous materials incident. Developed jointly by Transport Canada (TC), the U.S. Department of Transportation (DOT), and the Secretariat of Transport and Communications of Mexico (SCT).

Michigan State University Office of Radiation, Chemical & Biological Safety (ORCBS) Webpage. www.orcbs.msu.edu/chemical/nfpa/nfpa.html

Table Notes
[a] Examples of this category include 2-butylhexanol, 2-methoxyhexanol, monomethyl ether acetate, and ethylene glycol diethyl ether.
[b] See below for an explanation of the NFPA chemical hazard rating system.
[c] The information presented in this table corresponds to the entry in AAR (1994) for "Alcohol, N.O.S." [N.O.S. is not otherwise specified]
[d] With any ignited gas, long-burning fires are possible because the source of the leak must be stopped before the fire can be extinguished. In addition, application of water as a fog is usually recommended as opposed to a water stream, requiring fire departments to possess the appropriate hose nozzle. Alcohol-based foams can be used in some cases.

Explanation of NFPA Chemical Hazard Rating System
Health
4 -- Danger. May be fatal on short exposure. Specialized protective equipment required.
3 -- Warning. Corrosive or toxic. Avoid skin contact or inhalation.
2 -- Warning. May be harmful if inhaled or absorbed.
1 -- Caution. May be irritating.
0 -- No unusual hazard.

Fire
4 -- Danger. Flammable gas or extremely flammable liquid.
3 -- Warning. Flammable liquid flash point below 100˚ F.
2 -- Caution. Combustible liquid flash point of 100˚ to 200˚ F.
1 -- Combustible if heated.
0 -- Not combustible.

Reactivity
4 -- Danger. Explosive material at room temperature.
3 -- Danger. May be explosive if shocked, heated under confinement or mixed with water.
2 -- Warning. Unstable or may react violently if mixed with water.
1 -- Caution. May react if heated or mixed with water but not violently.
0 -- Stable. Not reactive when mixed with water.

Table D.2-2
Hazards Relevant to Natural Resources Associated with Hazardous Materials That May Be Transported under the Proposed Action

Hazardous Material	Marine Pollutant [1]	Aquatic Toxicity	Living Resources (Non-human) Ranking (GESAMP)[2]	Bioaccumulation and Tainting [3]
Alcohols (including Methyl alcohol, isopropyl alcohol, n-propyl alcohol, isobutyl alcohol)	No	Harmful in high concentrations	0	0
Glycols (including dipropylene glycol, ethylene glycol, propylene glycol)	No	N/A	0	0
Ethylene oxide	No	N/A	2	0
Flammable gasses such as isobutane	No	Not harmful	N/A	N/A
Flammable liquids such as hexane, benzene, or styrene	No for all except styrene	Harmful in very low concentrations	2 -3	0 to T, liable to produce tainting of seafood
Glycol ethers	No	N/A	N/A	N/A
Isobutylene	No	Not harmful	N/A	NL
Monoethanolamine, and other ethanolamines	No	Harmful in high concentrations	1	0
Organic Acids such as formic acid maleic acid, and acetic acid	No	Harmful in high concentrations	1	0
Propylene oxide	No	N/A	2	0
Acids such as sulfuric acid	No	Harmful in very low concentrations	2	0

N/A= Data not available
NL= Not listed

1 Marine Pollutant identified by USDOT regulations 49 CFR 172.101. Commodities that are classified as marine pollutants must meet stricter packaging and labeling requirements when shipped in bulk (greater than 1,000 gallons).

2 GESAMP Hazard Profile: A composite list of hazard profiles evaluated by the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. "CHRIS 2002".

Key: Damage to Living Resources (non-human) based on a Lethal Concentration $(LC)_{50}$

	Rating	96 hr LC_{50}
0	Non-hazardous	greater than 1000 mg/l
1	Practically nontoxic	100-1000 mg/l
2	Slightly toxic	10-100 mg/l
3	Moderately toxic	1-10 mg/l
4	Highly toxic	less than 1 mg/l
5	Extremely toxic	less than 0.01 mg/l

3 Bioaccumulation and Tainting (CHRIS, 2002):

- \+ Bioaccumulated to significant extent and known to produce a hazard to aquatic life or human life.
- Z Bioaccumulated with attendant risk to aquatic organisms or human health, however, with short retention of the order of one week or less.
- T Liable to produce tainting of seafood.
- 0 No evidence to support one of the above ratings (+, Z, T).

SEA calculated the likelihood of hazardous materials releases before and after the implementation of the Proposed Action. This calculation was done for the Proposed Action, as well as for those main lines that are expected to experience an increase or a reduction in hazardous materials traffic volume resulting from the implementation of the Proposed Action.

SEA compared the predicted frequency of hazardous materials release between the scenario corresponding to the No-Action Alternative with two operating scenarios corresponding to the implementation of the Proposed Action—project initiation and future market capture projection.

D.3.1 Estimating Train Accident Likelihood – Main Line Freight Trains

This section describes the procedure used by SEA to estimate main line freight train accident rates, which is based on the procedure developed for the 2001 AAR report (see footnote 1).

- Separate accident causes as defined in the FRA accident reporting system into two types: those where accident likelihood is a function of car-miles operated, and those where accidents are proportional to train-miles operated. Car-mile accident causes include most mechanical failures of track and car components. Train-mile accident causes include most human factors-caused accidents, grade crossing collisions, and collisions with obstructions.

- Use the FRA accident database[2] to select all accidents to freight trains in main-line operation over a suitable historic period, and calculate the number of accidents that are car-mile and train-mile related.

- Divide the number of accidents by aggregate train-miles and car-miles operated in the same time period (obtained from railroad industry operations statistics) to obtain accident rates by train-mile and by car-mile for each of derailments, collisions, and other accidents. A separate analysis was carried out for each FRA track class where the data set was sufficiently large.

Separate accident rate calculations were carried out for Class I and non-Class I railroads. This required defining which railroads are Class I and which were non-Class I, using the railroad identity codes used in FRA reports. To do this correctly it was necessary to identify reports from railroads that were later merged into larger systems. Also, some Class I railroad constituents still report under their original name, although operationally they are now part of the larger system and thus have been included in Class I railroad totals.

A period from January 1, 1995 to September 30, 1999 was chosen for the historic data to be analyzed. This period is reasonably representative of current safety performance on the U.S. freight railroad system, and offers a large enough data set to provide meaningful results. September 30, 1999 was the most recent date for which data were available at the time of the analysis (early 2000). SEA considers that this data set is still valid given that there have been no significant changes in train or rail car design, or in maintenance or operating practices between 1999 and 2002.

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[2] Federal Railroad Administration, “Railroad Accident and Incident Reporting System (RAIRS)" [1995 to present].

Accidents to freight trains on main line track were selected from this data set, providing a data set of 2,936 trains in accidents on Class I railroads and 885 trains in accidents on non-Class I railroads. The definition of freight trains in main line accidents excludes accidents to passenger trains, work trains and equipment, light locomotives and cuts of cars, and accidents on yard siding and industry tracks. Grade crossing collisions reported as train accidents are included. (This is a small percentage of the overall number of grade crossing accidents as most do not involve enough damage to the train to be reportable as a train accident.)

The selected accidents were tabulated by cause type and track class to provide the numerator in the calculation of accident rates. A similar tabulation was also prepared giving accidents in which one or more freight cars were derailed. The analysis of accidents by cause focused on accidents that potentially result in derailments of at least one railcar, even if the accident is classified differently (i.e., according to FRA regulations, a reportable accident is classified based on the initial event - e.g., a collision - although the accident may subsequently have resulted in a derailment).

The denominator in the calculation of accident rates is the exposure to potential accidents, which is the total number of train- or car-miles traveled in the same period for which the accident counts were obtained. In this case, the exposure to accidents was determined in terms of freight train- and car-miles operated over the 4.75-year period from January 1, 1995 to September 30, 1999. For Class I railroads, this information was obtained from industry statistics published by the AAR[3] up to 1997 and estimated for 1998 and 1999. The train- and car-miles were distributed among FRA track classes based on a survey performed in previous work.[4]

Information on operating miles was not available for non-Class I railroads, and approximate estimates were developed from estimated non-Class I revenue ton-miles from an ENO Foundation publication.[5] Table D.3-1 gives the resulting aggregated car- and train-miles. Table D.3-2 gives the distribution of traffic by track class.

The accident counts were divided by the exposure miles to yield car- and train-mile accident rates by track class for Class I railroads and for all track classes for non-Class I railroads. No data on the distribution of train-miles and car-miles by track class were available for non-Class I railroads. The resulting values are shown in Table D.3-3.

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[3] AAR, "Analysis of Class I Railroads" and AAR: "Railroad Ten Year Trends," periodical publications providing railroad traffic data.

[4] Report prepared by Arthur D. Little for the Inter-Industry Rail Safety Task Force, "Supplementary Report: Railroad Accident Rate and Risk Reduction Option Effectiveness Analysis and Data" [April 1996].

[5] ENO Foundation, Transportation in America 2000, with Historical Compendium 1939-1999, 18th Edition, 2001.

Table D.3-1
Estimated Aggregate Car- and Train-Miles
(January 1, 1995 – September 30, 1999)

Year	Freight Train-Miles (millions)	Freight Car-Miles (billions)
1995	458	30.38
1996	469	31.72
1997	475	31.66
1998	480 (E)	32.01 (E)
1999 (9 months)	375 (E)	25.14 (E)
Total, Class I	2,257	150.90
Estimated, non-Class I	147	7.86

E: estimated

Table D.3-2
Distribution of Traffic by Track Class (Class I Railroads)

FRA Track Class	X/1	2	3	4	5 and 6	Total*
Percent Car-miles	0.30	3.20	11.60	63.10	21.90	100
Percent Train-miles	0.30	3.30	12.10	61.80	22.60	100
Billion Car-miles	0.45	4.83	17.51	95.22	33.05	151
Million Train-miles	6.8	74.5	273.1	1,394.8	510.1	2,259

* Individual values have been rounded. Therefore, total values may vary slightly.

Table D.3-3
Regular Train Accident Rates by Track Class and Railroad Type

	Class I Railroads					Non-Class I Railroads	Fraction with Cars Derailed
	FRA Track Class	**2**	**3**	**4**	**5 and 6**		
Incidents related to car-mile travelled (per billion car-miles)	Derailments	71.0	25.0	5.5	3.3	79.8	0.98
	Collisions	0.8	0.3	0.2	0.0	0.4	0.53
	Other	1.0	0.7	0.3	0.4	0.9	0.17
Incidents related to train-mile travelled (per million train-miles)	Derailments	1.29	0.48	0.12	0.06	0.9	0.94
	Collisions	0.27	0.10	0.03	0.02	0.17	0.54
	Other	0.60	0.49	0.23	0.14	0.61	0.15

For Class 1 track, SEA used the values for Class 2 track, assuming that the low operating speeds may correspond to Class 1 track, but that the condition of the track meets the requirements for Class 2 track.

D.3.2 Frequency of Accidents on Rail Line Segments

Based on the approach described above, SEA calculated the probability of accidents associated with causes related to car-miles operated, PACCDCARS, using the values from Table D.3-3. SEA calculated PACCDCARS according to the following equation:

PACCDCARS = P Derail Car(class) * Fraction Car Derail Derail
+ P Coll Car(class) * Fraction Car Derail Coll
+ P Other Car(class) * Fraction Car Derail Other

Where:

PACCDCARS = probability of accidents associated with causes related to car-miles operated

P Derail Car(class) = probability of a derailment from causes related to car-miles operated on a particular class track

P Coll Car(class) = probability of a collision from causes related to car-miles operated on a particular class track

P Other Car(class) = probability of another type of accident from causes related to car-miles operated on a particular class track

Fraction Car Derail Derail	=	fraction of derailments from causes related to car-miles operated that result in the derailment of at least one car
Fraction Car Derail Coll	=	fraction of collisions from causes related to car-miles operated that result in the derailment of at least one car
Fraction Car Derail Other	=	fraction of other types of accidents from causes related to car-miles operated that result in the derailment of at least one car

SEA calculated the probability of accidents associated with causes related to train-miles operated, PACCDTRAINS, using the values from Table D.3-3. SEA calculated PACCDTRAINS according to the following equation:

PACCDTRAINS = P Derail Train(class) * Fraction Train Derail Derail
+ P Coll Train(class) * Fraction Train Derail Coll
+ P Other Train(class) * Fraction Train Derail Other

Where:

PACCDTRAINS	=	probability of accidents associated with causes related to train-miles operated
P Derail Train(class)	=	probability of a derailment from causes related to train-miles operated on a particular class track
P Coll Train(class)	=	probability of a collision from causes related to train-miles operated on a particular class track
P Other Train(class)	=	probability of another type of accident from causes related to train-miles operated on a particular class track
Fraction Train Derail Derail	=	fraction of derailments from causes related to train-miles operated that result in the derailment of at least one car
Fraction Train Derail Coll	=	fraction of collisions from causes related to train-miles operated that result in the derailment of at least one car
Fraction Train Derail Other	=	fraction of other types of accidents from causes related to train-miles operated that result in the derailment of at least one car

Based on the approach described above, SEA calculated the frequency of accidents associated with causes related to car-miles operated, FACCDCARS, according to the following equation:

FACCDCARS = NCARST * NTRAINS * SLENGTH * PACCDCARS

Where:

FACCDCARS	=	frequency of accidents associated with causes related to car-miles operated
NCARST	=	average number of railcars per train
NTRAINS	=	annual number of train trips on a rail line segment
SLENGTH	=	segment length (miles)

SEA calculated the frequency of accidents associated with causes related to train-miles operated, FACCDTRAINS, according to the following equation:

FACCDTRAINS = NTRAINS * SLENGTH * PACCDTRAINS

Where:

FACCDTRAINS	=	frequency of accidents associated with causes related to train-miles operated

SEA calculated the overall frequency of accidents that result in derailments associated with the different causes, ACCFREQ, according to the following equation:

ACCFREQ = FACCDCARS + FACCDTRAINS

Where:

ACCFREQ	=	overall frequency of accidents that result in derailments

For segments on which the Proposed Action would result in a direct or indirect increase or decrease in rail traffic, SEA calculated the accident frequencies based on the conditions before and after the implementation of the Proposed Action. Taking into consideration the fact that both UP and BNSF operate on several lines in the project area, SEA calculated combined accident frequency values based on the total number of trains per day on a particular segment, using an average number of railcars on those trains.

D.3.3 Overall Predicted Rate of Release of Hazardous Materials on Rail Line Segments

SEA determined the overall predicted rate of release of hazardous materials on a rail line segment as a result of an accident based on an overall predicted rate of derailments from accidents, including derailments, collisions, and other accidents. (A collision, as well as other types of accidents, may result in derailments.)

The overall predicted rate of release of hazardous materials on a rail line segment can also be described as the chance that one or more hazardous materials railcars involved in a derailment would release such materials to the environment. SEA calculated the overall predicted rate of release of hazardous materials on a rail line segment as a function of the number of hazardous materials cars per train and track class. The track class variable takes into account train speed, which influences the likelihood of release. SEA calculated the predicted rate of release of hazardous materials on a rail line segment, CHANCE, using the following equation:

CHANCE = ACCFREQ * RELEASE VALUE

Where:

CHANCE	=	overall expected rate of release of hazardous materials on a rail line segment per year
RELEASE VALUE	=	factor that takes into account the number of hazardous materials cars per train and track class (i.e., train speed), as well as an aggregate release probability for several different types of rail cars to estimate the probability of release

The potential for a hazardous materials release is a function of both the likelihood of a hazardous materials rail car (or cars) being derailed and the likelihood of one or more cars releasing in the event of a derailment. The total number of hazardous materials cars in the train, the train speed, and the train length influence the likelihood of a hazardous materials car derailing. For a given rail car having a release, the critical parameters are the type of car and the speed at the time of the accident. The release probability used in this study is an aggregate release probability, which depends on the rail car types used to handle hazardous materials on a particular train or rail line (e.g., pressurized vs. non-pressurized cars). For the Proposed Action and Alternatives, as well as for the No-Build Alternative and the No-Action Alternative, there may be a range of car types involved as the materials handled include both liquids and gases. Based on expected distributions of materials and assumptions in past SEA analyses[6], SEA used a combined release probability of 0.125 (given a hazardous materials car derailment), based on a distribution of 25% pressure cars and 75% non-pressure cars.

The methodology used by SEA to calculate the aggregate release probability draws on past peer reviewed work done for the InterIndustry Rail Safety Task Force model, where specific data for many different car types were analyzed. The release probability was adjusted for different operating speeds on different segments, and was combined with estimates of the chance of a hazardous materials car derailing on the different segments to produce the RELEASE VALUE.

SEA calculated the interval between releases on a particular rail segment by taking the reciprocal of CHANCE, as follows:

INTERVAL BETWEEN RELEASES ON A SEGMENT = 1/*CHANCE*

[6] SEA Draft Environmental Assessment, Finance Docket No. 33556, Canadian National Railway Company control Illinois Central Railroad Company (CN/IC Acquisition). SEA. November 9, 1998.

The interval between releases on a segment is essentially the average or expected time that would elapse between two successive release events on a particular rail segment.

D.3.4 Result of the Analysis of the Frequency of Release

The detailed results of the analyses conducted by SEA to determine the accident frequency (derailments per year), the frequency of release of hazardous materials (releases per year), and the intervals (years) between releases are presented in Tables D.3-4 through D.3-7. Table D.3-4 presents the predicted frequencies of release for the existing lines (i.e., UP routes between the Bayport Loop and Tower 85; and GH&H line; UP Terminal Subdivision; UP Lafayette Subdivision; and UP Baytown Subdivision). Table D.3-5 presents the predicted frequencies of release for the Proposed Action. Table D.3-6 presents the calculated frequencies of release for the No-Build Alternative. Finally, Table D.3-7 presents the calculated frequencies of release for the No-Action Alternative.

D.4 METHOD USED TO ASSESS POTENTIAL CONSEQUENCES OF A RELEASE

SEA assessed the potential public safety consequences in the event of a hazardous materials release during rail transportation resulting from the implementation of the Proposed Action and Alternatives. An assessment of potential consequences typically involves four basic steps: (i) identification of the hazardous materials expected to be transported and their hazardous characteristics; (ii) determination of the extent of the area potentially affected; (iii) determination of the population in the area potentially affected; and (iv) assessment of the nature and magnitude of the potential consequences. Section D.1 describes the materials and their characteristics. The last three steps of the consequence assessment are summarized below.

D.4.1 Determination of the Extent of the Area Potentially Affected

SEA used the size of the Protective Action Area that would be established by emergency response personnel in the event of an accidental spill or fire involving a hazardous material as an indicator of the extent of the area potentially affected by consequences associated with such an event. The area that may be subject to protective actions is typically defined by a radial distance from the site of the release or fire and depends on a number of factors specific to the hazardous chemical released and the circumstances of the accident.[7] If there is no release and no threat of further damage (such as from an encroaching fire), there would not be an evacuation. SEA used the NAERG-2000 to determine the maximum recommended protective action distances for each rail segment analyzed, because NAERG-2000 was developed specifically for use in hazardous materials transportation and can be applied to any hazardous materials transportation accident or release. For each rail segment analyzed, SEA determined the maximum reasonably expected extent of the potentially affected area based on the maximum protective action distance for hazardous materials that are poisonous or toxic if inhaled, assuming that a large release occurs at

[7] Any containment or temporary repair measures that may be put in place shortly after the release occurs would reduce the extent of the area potentially affected. The type and extent of implementation of any measures would depend on the actual conditions under emergency response actions are conducted for a particular incident.

Table D.3-4
Calculated Frequencies of Release - Existing Lines

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/ year)	Interval Between Releases (years)
Note: Route totals presented in this table may not correspond exactly to the sum of the variables per segment due to rounding.				
UP Routes Between the Bayport Loop and Tower 85 - per Segment				
Existing Conditions - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)	2.5	0.030	0.0011	880
Project Initiation - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)		0.025	0.00070	1,400
Future Market Capture Projection - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)		0.021	0.00044	2,300
Existing Conditions - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)	3.7	0.059	0.0018	540
Project Initiation - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)		0.052	0.0020	510
Future Market Capture Projection - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)		0.046	0.0016	620
Existing Conditions - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)	1.9	0.024	0.00081	1,200
Project Initiation - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)		0.020	0.00090	1,100
Future Market Capture Projection - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)		0.017	0.00058	1,700
Existing Conditions - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)	11.6	0.22	0.019	52
Project Initiation - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)		0.20	0.020	49
Future Market Capture Projection - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)		0.18	0.018	57
Existing Conditions - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)	1.1	0.036	0.0032	310
Project Initiation - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)		0.034	0.0031	320
Future Market Capture Projection - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)		0.032	0.0027	370

Table D.3-4 (continued)

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/ year)	Interval Between Releases (years)
Existing Conditions - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)	4.4	0.089	0.0079	130
Project Initiation - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)		0.080	0.0083	120
Future Market Capture Projection - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)		0.073	0.0061	160
Existing Conditions - UP Line from Tower 30 to Tower 85	2.4	0.089	0.0012	810
Project Initiation and Future Market Capture Projection - UP Line from Tower 30 to Tower 85		0.0099	0.0014	720
Route Between the Bayport Loop and Tower 85 - Full Length				
No-Action - UP Route between Bayport Loop and Tower 85	27.6	0.46	0.036	28
Project Initiation - UP Route between Bayport Loop and Tower 85		0.42	0.037	27
Future Market Capture Projection - UP Route between Bayport Loop and Tower 85		0.38	0.030	33
UP Route Between the Tower 85 and the CMC Dayton Yard - per Segment				
Existing Conditions - UP Line from Tower 85 to Tower 87	4.7	0.23	0.020	50
Project Initiation - UP Line from Tower 85 to Tower 87		0.24	0.022	46
Future Market Capture Projection - UP Line from Tower 85 to Tower 87		0.25	0.025	41
Existing Conditions - UP Terminal and Lafayette Subdivisions (Tower 87 to Dayton Junction)	29.1	0.12	0.023	43
Project Initiation - UP Terminal and Lafayette Subdivisions		0.13	0.026	38
Future Market Capture Projection - UP Terminal and Lafayette Subdivisions		0.13	0.026	38
Existing Conditions - UP Baytown Subdivision (Dayton Junction to the CMC Dayton Yard)	2.0	0.045	0.0035	290
Project Initiation - UP Baytown Subdivision		0.051	0.0040	250
Future Market Capture Projection - UP Baytown Subdivision		0.054	0.0050	200

Table D.3-4 (continued)

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/ year)	Interval Between Releases (years)
Route Between the Bayport Loop and the CMC Dayton Yard - Full Length				
Existing Conditions - UP Line from Bayport Loop to the CMC Dayton Yard	63.4	0.86	0.082	12
Project Initiation - UP Line from Bayport Loop to the CMC Dayton Yard		0.84	0.089	11
Future Market Capture Projection - UP Line from Bayport Loop to CMC Dayton Yard		0.81	0.086	12
UP GH&H Line				
Existing Conditions - UP GH&H line – full segment	13.8	0.033	0.0032	320
Project Initiation - UP GH&H line – full segment		0.043	0.0036	280
Future Market Capture Projection - UP GH&H line – full segment		0.050	0.0071	140
Existing Conditions - UP GH&H line – short segment	11.3	0.027	0.0026	380
Project Initiation - UP GH&H line – short segment		0.035	0.0029	340
Future Market Capture Projection - UP GH&H line – short segment		0.041	0.0058	170

Table D.3-5
Calculated Frequencies of Release – Proposed Action

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/year)	Interval Between Releases (years)
Note: Route totals presented in this table may not correspond exactly to the sum of the variables per segment due to rounding.				
Proposed Action and Alternatives - New Construction per Segment				
Project Initiation - Proposed Action and Alternatives - New Construction – West of Bayport Rail Terminal (BRT) Yard	7.6	0.022	0.00072	1,400
Future Market Capture Projection - Proposed Action and Alternatives - New Construction – West of BRT Yard		0.034	0.0035	290
Project Initiation - Proposed Action and Alternatives - New Construction – East of BRT Yard	6.2	0.019	0.00061	1,600
Future Market Capture Projection - Proposed Action and Alternatives - New Construction – East of BRT Yard		0.028	0.0029	340
Proposed Action and Alternatives - New Construction Full Length				
Project Initiation - Proposed Action and Alternatives - New construction, full length	13.8	0.041	0.0013	750
Future Market Capture Projection - Proposed Action and Alternatives - New construction, full length		0.062	0.0064	160
Proposed Action and Alternative 1C - Route between Bayport Loop and CMC Dayton Yard				
Existing Conditions - Proposed Action and Alternative 1C - Route between Bayport Loop and CMC Dayton Yard	65.8	0.44	0.051	20
Project Initiation - Proposed Action and Alternative 1C - Route between Bayport Loop and CMC Dayton Yard		0.51	0.058	17
Future Market Capture Projection - Proposed Action and Alternative 1C - Route between Bayport Loop and CMC Dayton Yard		0.56	0.071	14

Table D.3-5 (continued)

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/year)	Interval Between Releases (years)
Proposed Action - Alternatives 2B/2D - Route between Bayport Loop and CMC Dayton Yard				
Existing Conditions - Proposed Action - Alternatives 2B/2D - Route between Bayport Loop and CMC Dayton Yard	63.3	0.43	0.051	20
Project Initiation - Proposed Action - Alternatives 2B/2D - Route between Bayport Loop and CMC Dayton Yard		0.51	0.058	17
Future Market Capture Projection - Proposed Action - Alternatives 2B/2D - Route between Bayport Loop and CMC Dayton Yard		0.55	0.069	14

Table D.3-6
Calculated Frequencies of Release – No-Build Alternative

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/year)	Interval Between Releases (years)
Note: Route totals presented in this table may not correspond exactly to the sum of the variables per segment due to rounding.				
No-Build Alternative per Segment				
Existing Conditions - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)	2.5	0.030	0.0011	880
Project Initiation and Future Market Capture Projection - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)		0.032	0.00078	1,300
Existing Conditions - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)	3.7	0.059	0.0018	540
Project Initiation and Future Market Capture Projection - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)		0.063	0.0023	430
Existing Conditions - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)	1.9	0.024	0.00081	1,200
Project Initiation and Future Market Capture Projection - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)		0.026	0.00088	1,100
Existing Conditions - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)	11.6	0.22	0.019	52
Project Initiation and Future Market Capture Projection - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)		0.23	0.024	42
Existing Conditions - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)	1.1	0.036	0.0032	310
Project Initiation and Future Market Capture Projection - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)		0.037	0.0034	290
Existing Conditions - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)	4.4	0.089	0.0079	130
Project Initiation and Future Market Capture Projection - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)		0.093	0.0082	120

Table D.3-6 (continued)

Segment/Route	Length (mi)	Accident Frequency (derailments/ year)	Release Frequency (releases/year)	Interval Between Releases (years)
Existing Conditions - UP between Tower 30 and Tower 85	2.4	0.0089	0.0012	810
Project Initiation and Future Market Capture Projection - UP between Tower 30 and Tower 85		0.0099	0.0014	720
Existing Conditions - UP East Belt between Tower 85 and Tower 87	4.7	0.23	0.020	50
Project Initiation - UP East Belt between Tower 85 and Tower 87		0.24	0.022	46
Future Market Capture Projection - UP East Belt between Tower 85 and Tower 87		0.25	0.025	41
Existing Conditions - UP Terminal and Lafayette Subdivisions between Tower 87 and Dayton Junction	29.1	0.12	0.023	43
Project Initiation - UP Terminal and Lafayette Subdivisions between Tower 87 and Dayton Junction		0.13	0.026	38
Future Market Capture Projection - UP Terminal and Lafayette Subdivisions between Tower 87 and Dayton Junction		0.13	0.026	38
Existing Conditions - UP Baytown Subdivision between Dayton Junction and the CMC Dayton Yard	2.0	0.045	0.0035	290
Project Initiation - UP Baytown Subdivision between Dayton Junction and the CMC Dayton Yard		0.051	0.0040	250
Future Market Capture Projection - UP Baytown Subdivision between Dayton Junction and the CMC Dayton Yard		0.054	0.0050	200
No-Build Alternative – Between Bayport Loop and CMC Dayton Yard - Full Length				
Existing Conditions - No-Build Alternative	63.4	0.86	0.082	12
Project Initiation - No-Build Alternative		0.91	0.093	11
Future Market Capture Projection - No-Build Alternative		0.93	0.097	10

Table D.3-7
Calculated Frequencies of Release – No-Action Alternative

Segment/Route	Length (mi)	Accident Frequency (derailments of hazardous materials cars/year)	Release Frequency (releases/year)	Interval Between Releases (years)
Note: Route totals presented in this table may not correspond exactly to the sum of the variables per segment due to rounding.				
No-Action Alternative				
No-Action Alternative - UP Bayport Loop Industrial Lead (South End of Loop - Part 1)	2.5	0.030	0.0011	880
No-Action Alternative - UP Bayport Loop Industrial Lead (North End of Loop - Part 2)	3.7	0.059	0.0018	540
No-Action Alternative - UP Bayport Loop Industrial Lead (from North End of Loop to Strang Yard - Part 3)	1.9	0.024	0.00081	1,200
No-Action Alternative - UP Strang Subdivision along SH 225 (Strang Yard to Pasadena J. - Part 1)	11.6	0.22	0.019	52
No-Action Alternative - UP Strang Subdivision along SH 225 (Pasadena J. to Sinco J. - Part 2)	1.1	0.036	0.0032	310
No-Action Alternative - UP Strang Subdivision along SH 225 (Sinco J. to Tower 30 - Part 3)	4.4	0.089	0.0079	130
No-Action Alternative - UP between Tower 30 and Tower 85	2.4	0.0089	0.0012	810
No-Action Alternative – Between Bayport Loop and Tower 85 - Full Length				
No-Action Alternative - Bayport Loop to Tower 85 - Full Length	27.6	0.46	0.036	28

nighttime.[8] Since not all materials are toxic or have the same potential consequences, this is a very conservative approach.

SEA assumed that the same maximum protective action distances are applicable throughout the project area. This assumption recognizes that the most hazardous materials associated with the Proposed Action could be carried on any of the rail lines in the project area. SEA considers this assumption reasonable for the purposes of the EIS, because it is based on information about the hazardous materials originating in the Bayport Loop.

D.4.2 Determination of the Population in the Area Potentially Affected Along a Particular Rail Segment

For the purposes of the assessment of potential health consequences, SEA identified the most densely populated area for the Proposed Action and Alternatives, including the No-Action Alternative, using a GIS integration routine. Using adjusted 2000 U.S. Census data, SEA calculated the total population that lives within a circle with a radius equal to the maximum protective action distance, based on the set of hazardous materials, for that particular segment in the most densely populated area. The analysis took into consideration all the Census blocks located within the circle of interest. The use of a circle as the shape of the protective action area is a simplifying assumption that leads to a very conservative estimate. In the event of an actual incident, the wind would cause the hazardous material vapor cloud (if the hazardous material released has generated such a cloud) to disperse downwind in more of an elliptical or cigar shape. In the event of an accident, any isolation measures are expected to be limited to the immediate vicinity of the release and there may also be a larger protective action zone. The actual shape and size of this larger protective action zone would be determined on a case-by-case basis, depending on the actual conditions at the time of the release (i.e., nature of the hazardous material and weather conditions, as well as the locations of potentially affected persons). A circle thus recognizes uncertainty in the wind direction at the time of the release and results in a very conservative estimate of potential exposures.

D.4.3 Assessment of the Nature and Magnitude of the Potential Consequences

The population located in the vicinity of the site of a hazardous materials release would potentially be impacted to various degrees. They may experience no adverse effect at all if the release is a liquid with no extended toxic hazards and there is no ignition, and thus no fire. If there is a fire or toxic hazard present, they may need to leave the area; could be exposed to irritating levels of smoke or toxic vapor; or could experience minor or serious injuries. Emergency response actions and guidance are designed to help minimize the number of serious impacts, particularly those that occur at least a short time after the release or accident. SEA used the population within the area potentially affected by a hazardous materials release as an

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[8] Atmospheric conditions tend to be more stable at night; this condition tends to support the development of larger areas of concern as less air is mixed in to dilute the released vapors. SEA considers that the use of this condition in the analysis yields a conservative assessment of the extent of the potentially affected area.

indicator of the magnitude of the consequences of such an event, recognizing that the magnitude of consequences could be quite variable.

SEA assumed that a release of hazardous materials into the environment as a result of a rail accident potentially would lead to human exposure of a relatively short duration. The duration of a release is limited by the volume in the railcar. Also, the emergency response teams on the scene would contain and clean up any release within a relatively short time as a result of knowing the exact point of release and the timely implementation of existing local, state, and Federal clean-up regulations. This would minimize the potential for groundwater contamination, limit the extent of any soil contamination, and allow for the proper management of surface water contamination. For surface water, appropriate management actions depend on the material and the resources affected, but might include, but not be limited to, cleaning up the spill and temporarily restricting the use of the water body. Thus, the potential for longer-term impacts through unrecognized soil or water contamination would be minimized.

Therefore, SEA's analysis focused on acute toxicity (i.e., toxicity typically associated with short-term exposure, which results in toxic effects that are typically experienced immediately or within days of exposure), rather than on chronic toxicity (i.e., toxicity typically resulting from repeated or long-term exposure, which results in toxic effects that are usually detected after months or years of exposure). SEA also considered the bioaccumulation potential in the aquatic environment. For flammables, SEA considered the population located within the area potentially impacted by a fire.

In general terms, if protective actions have not yet been implemented, the potential consequences of a hazardous materials release depend on the nature and quantity of the actual materials released. If protective actions are implemented promptly, the population within the protective action zone would be affected in terms of temporary restrictions on their activities while an evacuation is in effect, but serious health effects would be minimized. Those subject to exposures before the emergency response actions could be implemented or those not following recommended precautions and guidance might still experience serious effects.