

Appendix A5 Probability Assessment of Traffic Accident

1.0 Traffic Accident and Release

Three credible accident scenarios were assessed in this study. They are:

- Scenario 1: Collision of two vehicles (Crash)
- Scenario 2: Roll over into a ditch or down an embankment
- Scenario 3: Roll over directly into a river (considered the most extreme environmental accident)

To assess the probabilities and potential consequences associated with these scenarios, it was considered that a spill into a river is the most serious environmental event. As such, the impact assessment examined a release of materials into the water at a river crossing.

2.0 Accident Scenarios

Accident statistics are presented and used to derive estimates of probability of events occurring that could result in spills to the environment. As yellowcake is transported in DOT-approved sealed drums, there are a number of events that must occur for a spill to occur. Much of the discussion that follows therefore applies to the assessment of the probability of a spill of the yellowcake.

In simple terms, several events need to occur at the same time for a release of yellowcake to occur. The probability and severity of damage to a drum in an accident is a function of the severity of the accident, the form and amount of force applied to the drum and the ability of the drum to withstand these forces. The potential for a release and the corresponding size of a release can then be described symbolically as the product of conditional probabilities:

$$\text{Frequency of a release} = [\text{Frequency of an accident}] \times [\text{conditional probability of damage to the container}] \times [\text{conditional probability that container ruptures}]$$

The spill to a river, with the potential transport downstream of spilled material, represents the worst case accident scenario from an environmental perspective. While the roll-over and head-on collision represent more likely accident scenarios, releases from these accidents could be easily contained unless the accident occurred in or near a water body or during an extreme rainfall event.

Accident statistics reported for the United States were reviewed in selecting appropriate statistics to use in the current assessment. The U.S. DOT (2007) statistical data for hazardous material transportation in 2007 showed that the frequency of accidents involving hazardous material transport on all roads and rural roads were 0.136 and 0.051 accidents per million ton-miles, respectively. The same statistics indicate that the frequency of rollovers and truck crashes during transportation of hazardous materials were 6.7×10^{-4} and 8.1×10^{-4} accidents per million ton-miles, respectively.

The yellowcake will be transported from the mill to Port Hope, Ontario Canada (1950 miles). Using these data combined with the accident statistics, the truck transportation frequency, and transportation distance, the frequency of rollover and truck crashes along the haul route for yellowcake were estimated to equal 5.1×10^{-4} and 6.2×10^{-4} per year, respectively, as determined by the calculations below:

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The ore will be transported from the mine sites to the mill (<60 miles). Using these data combined with the accident statistics, the truck transportation frequency, and transportation distance, the frequency of rollover and truck crashes along the haul route were estimated to equal 7.5×10^{-3} and 9.1×10^{-3} per year, respectively, as determined by the calculations below:

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- Ton-miles / year = Trucks per year * length of route (miles) * Truck load (tons)
- For yellowcake:

$$\text{Ton-mile/year} = 15 \text{ trips per year} * 1950 \text{ miles} * 26 \text{ ton} = 7.6 \times 10^5 \text{ ton-mile/yr}$$

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- For ore:

$$\text{Ton-mile/year} = 7200 \text{ trips per year} * 60 \text{ miles} * 26 \text{ ton} = 1.1 \times 10^7 \text{ ton-mile/yr}$$

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- For yellowcake:

$$\text{Frequency of rollover} = 6.7 \times 10^{-4} * \frac{7.6 \times 10^5}{1,000,000} = 5.1 \times 10^{-4} \text{ per year}$$

$$\text{Frequency of crash} = 8.1 \times 10^{-4} * \frac{7.6 \times 10^5}{1,000,000} = 6.2 \times 10^{-4} \text{ per year}$$

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- For ore:

$$\text{Frequency of rollover} = 6.7 \times 10^{-4} * \frac{1.1 \times 10^7}{1,000,000} = 7.5 \times 10^{-3} \text{ per year}$$

$$\text{Frequency of crash} = 8.1 \times 10^{-4} * \frac{1.1 \times 10^7}{1,000,000} = 9.1 \times 10^{-3} \text{ per year}$$

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The U.S. DOT reported that in 2007 only 8 out of 17,000 hazardous material transportation accidents involved radioactive material. It should be noted that the statistics presented above do not address specific issues related to an accident occurring at stream or river crossings or adjacent to nearby lakes. Factors that affect accidents at bridge crossings include:

- Low visibility in foggy conditions increases the risk of an accident at bridge crossings, as they are normally narrower than other parts of the road. Bridges do not have shoulders and typically the clearance of trucks from the side of the bridge is low.
- Accidents on bridges normally involve a fall with higher probability of damage compared with accidents that occur along other parts of the road.
- Presence of structural materials such as steel structures, rebar and other reinforcement steels can puncture containers during an accident.

Thus, additional safety measures may be warranted at bridge crossings to reduce the probability of accident events occurring. Such measures include adequate lighting, signs, reduced speed limits, and appropriate guard rails.

3.0 Length of Roadway Exposed to Water

Accidents close to water bodies were considered critical events due to their potential to release contaminants to the aquatic environment. The probability of an accident occurring close to a water body is a function of the proximity of water along the roadway and the overall travel distance. The methodology used to calculate the length of haul road in proximity to water, referred to as the Effective Exposed Length, is described in this section.

It was estimated that if a vehicle were to leave the roadway, the forward momentum would carry it a distance equivalent to the braking distance on a normal road surface (i.e., rocks, trees and topography would serve to decelerate the vehicle). For an A-train truck, this is assumed to be equivalent to approximately 262 ft. It was assumed that any streams with a width greater than 7 ft would be sufficient to stop the forward momentum of an out-of-control vehicle. Thus, if a vehicle were to leave the roadway within 262 ft of a stream crossing wider than 7 ft, the vehicle would come to a complete stop in the stream. Therefore, for streams that are greater than 7 ft wide, the Effective Exposed Length of the roadway would be the stream's width plus an additional 262 ft.

For streams narrower than 7 ft, it was assumed that a vehicle would have sufficient momentum to "jump" the stream. In such a case, a stream's Effective Exposed Length would be equivalent to the width of the stream. For the purposes of this investigation, an additional 16.5 ft was added to each side of the stream to account for the "flood-plain" of the streams. For example, if a stream is 3 ft wide, it was assumed that a spill within 16.5 ft of either side of the stream would end up entering the stream. In this particular case, the Effective Exposed Length of the roadway would be 36 ft. Table A5.1 summarizes the Effective Exposed Lengths of all ecologically significant stream crossings.

Table A5.1 Effective Exposed Length for Stream Crossings – Yellowcake Shipments to Metropolis, Illinois

Width of Crossing (ft)	Number of Crossings	Additional Width per Crossing (ft)	Effective Exposed Length for all Crossings (ft)
7	5600	5600	5600
16	4170	4170	4170
33	1770	1770	1770
66	6888	6888	6888
98	7920	7920	7920
131	3930	3930	3930
164	3834	3834	3834
197	2754	2754	2754
230	984	984	984
328	1770	1770	1770
492	1508	1508	1508
656	5508	5508	5508
1312	3148	3148	3148
1640	3804	3804	3804
Total Effective Exposed Stream Crossings			53588

To calculate the risk of a spill occurring in water, the possibility of a vehicle going off the road and travelling perpendicular to the roadway was also considered. It was assumed that in the event of an accident, a vehicle would travel in a perpendicular direction one-half of the distance travelled parallel to the roadway before coming to a stop. In the case of an accident involving a train carrying yellowcake, the spill would have to occur directly into the stream, as the material is handled in a dry state. The Effective Exposed Length for the yellowcake assessment therefore was adjusted to reflect the portion of the transportation route where there is a risk of release to a water body without consideration of the flood plain of the streams. As indicated in Table A5.1, the overall width of crossings for all stream crossings is 53,588 ft (0), of which approximately 5,000 ft is the width of the Rend Lake River, Kanakakee River, and Niagara River crossings. The road also has major crossings with Mississippi River and branches of the Missouri River with two crossings width of about 1300 ft and two crossing widths of about 660 ft each.

Therefore, the total Effective Exposed Length attributed to stream crossings and bodies of water located adjacent to the roads is 36100 ft (10.2 miles). These distances were used in the analysis of the frequency of a truck rollover and crash that could result in a spill of yellowcake into one of the water bodies along the haul road between Piñon Ridge and the Metropolis conversion facility.

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Total rollover and crash frequency = $5.1 \times 10^{-4} + 6.2 \times 10^{-4} = 1.1 \times 10^{-3}$ per year
Adjusting for the exposed length = $7.9 \times 10^{-4} \times \frac{10.2}{1950} = 5.8 \times 10^{-6}$ per year

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Assuming the same fraction of the haul road is exposed to water bodies, the frequency of rollover and crash for hauling the ore can be calculated as follows:

Total rollover and crash frequency = $7.5 \times 10^{-3} + 7.5 \times 10^{-3} = 1.7 \times 10^{-2}$ per year
Adjusting for the exposed length = $1.7 \times 10^{-2} \times \frac{6.8}{1357} = 8.3 \times 10^{-5}$ per year

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