

Life Cycle Assessment (LCA) of Rubber Modified Asphalt

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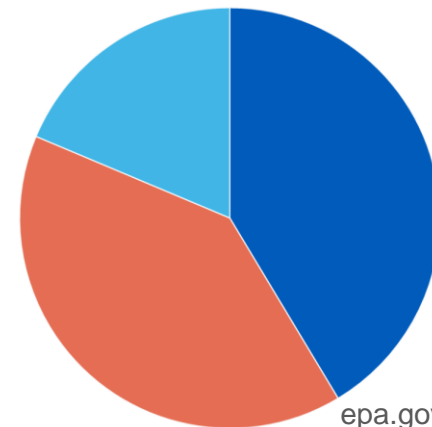
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A Problem?

- 270 million tires generated in US annually (~20 million in NY)
- By weight, 6.5 million tons of tires (~2% of total US municipal solid waste generation)
- Majority (60%) burned or landfilled

Tire Waste Pathways



- Combusted With Energy Recovery (41%)
- Recycled (40%)
- Landfilled (19%)

A Solution? Rubber Modified Asphalt (RMA)

- Bituminous paving mixture with crushed rock aggregate and crumb rubber
- Can consume up to 2,000 tires per lane mile, 0.5-5% of total asphalt mass
- Renewed interest due to advances in rubber shredding, allowing fine particles
- Some states (CA, AZ) embrace; others (NY) do not



“Innovation for Elastomer-Modified Asphalts”, Vestenamer, Evonik

LCA allows comparisons to business as usual.

Conventional Asphalt

- Unmodified bituminous paving mixture
- Used for lower traffic paving applications
- RMA performs equally with as much as 50% less thickness than conventional

Polymer Modified Asphalt (PMA)

- Bituminous paving mixture modified with poly(styrene-butadiene-styrene)
- Used for higher traffic paving applications
- RMA performs equally or slightly better than PMA

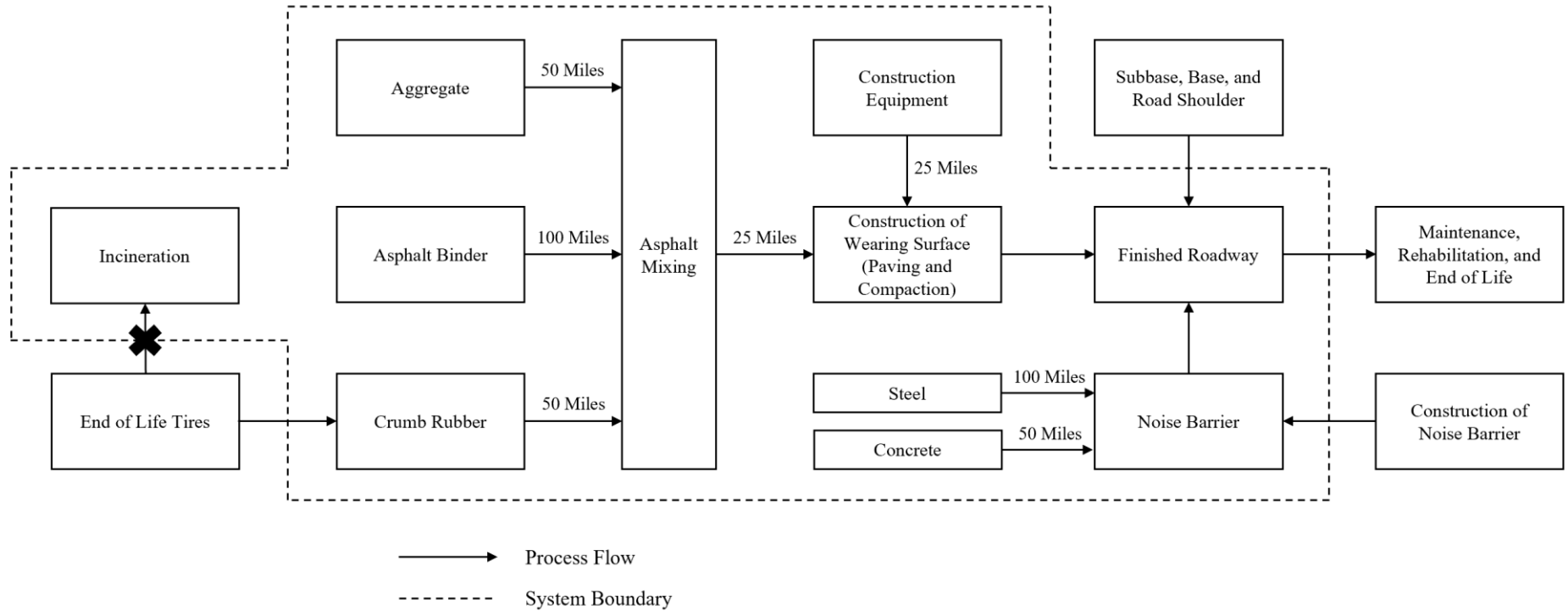
What Pavement Engineers are saying about RMA...

- Improved mechanical performance
- Comparable (or better) maintenance schedule
- Reduced vehicle road noise
- Improved ride quality
- Enhanced skid resistance (safety)
- Darker wearing surface

No published LCA considers modern RMA production and performance benefits.

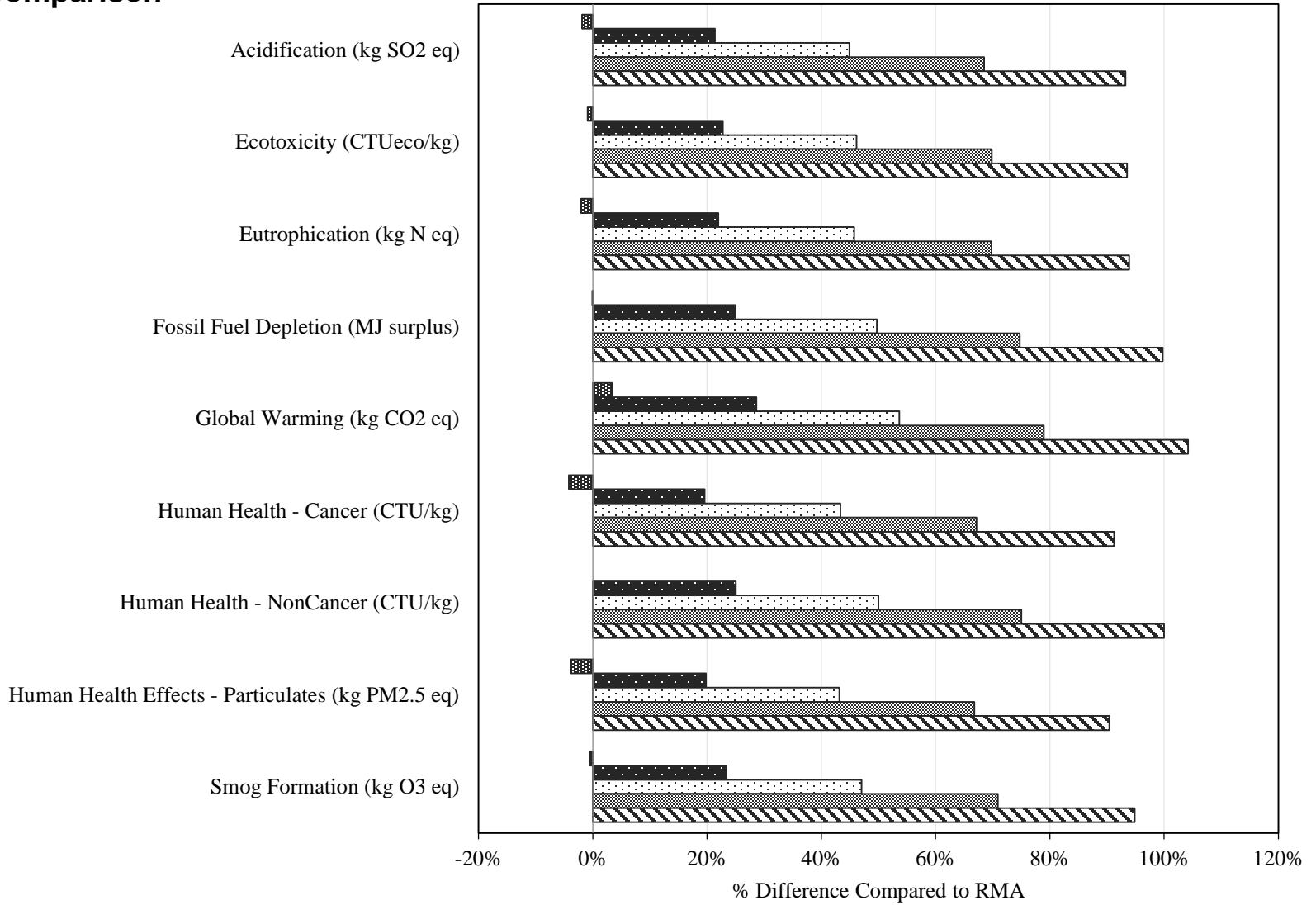
- Diversion of waste from incineration/landfill streams
- Reduced reliance on materials from fossil fuels
- Decreased material usage (RMA vs. Conventional Asphalt)
- Indirect benefits (e.g., noise reduction)

Boundary Conditions for LCA Study



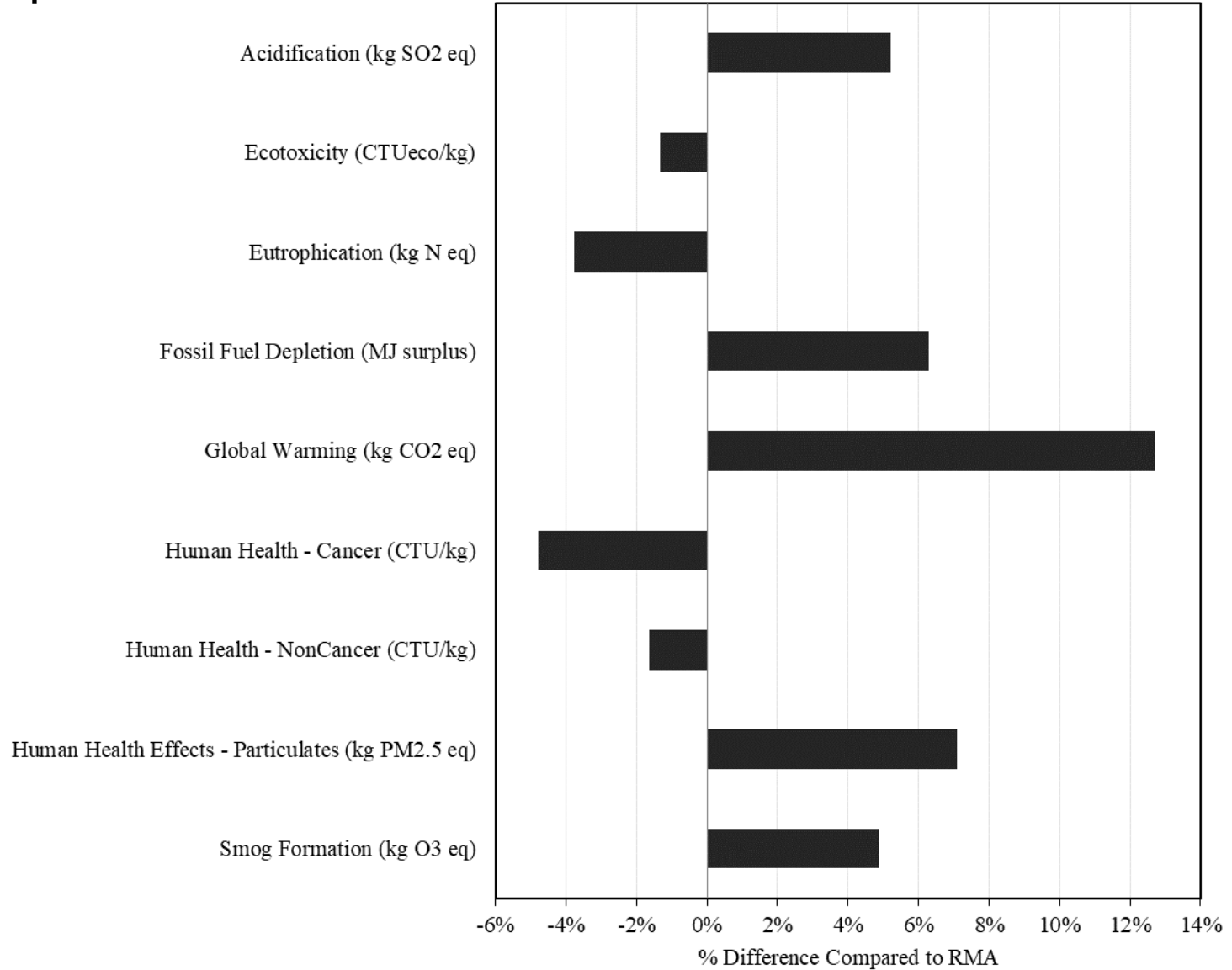
Mix Design	Aggregate Fraction	Asphalt Binder Fraction	Binder Additives
RMA	95 wt% of asphalt mix	5 wt% of asphalt mix	Crumb Rubber [10 wt% of asphalt binder]
PMA			Poly(styrene-butadiene-styrene) (SBS) [3.5 wt% of asphalt binder]
Conventional Asphalt			None

Conventional Asphalt Comparison

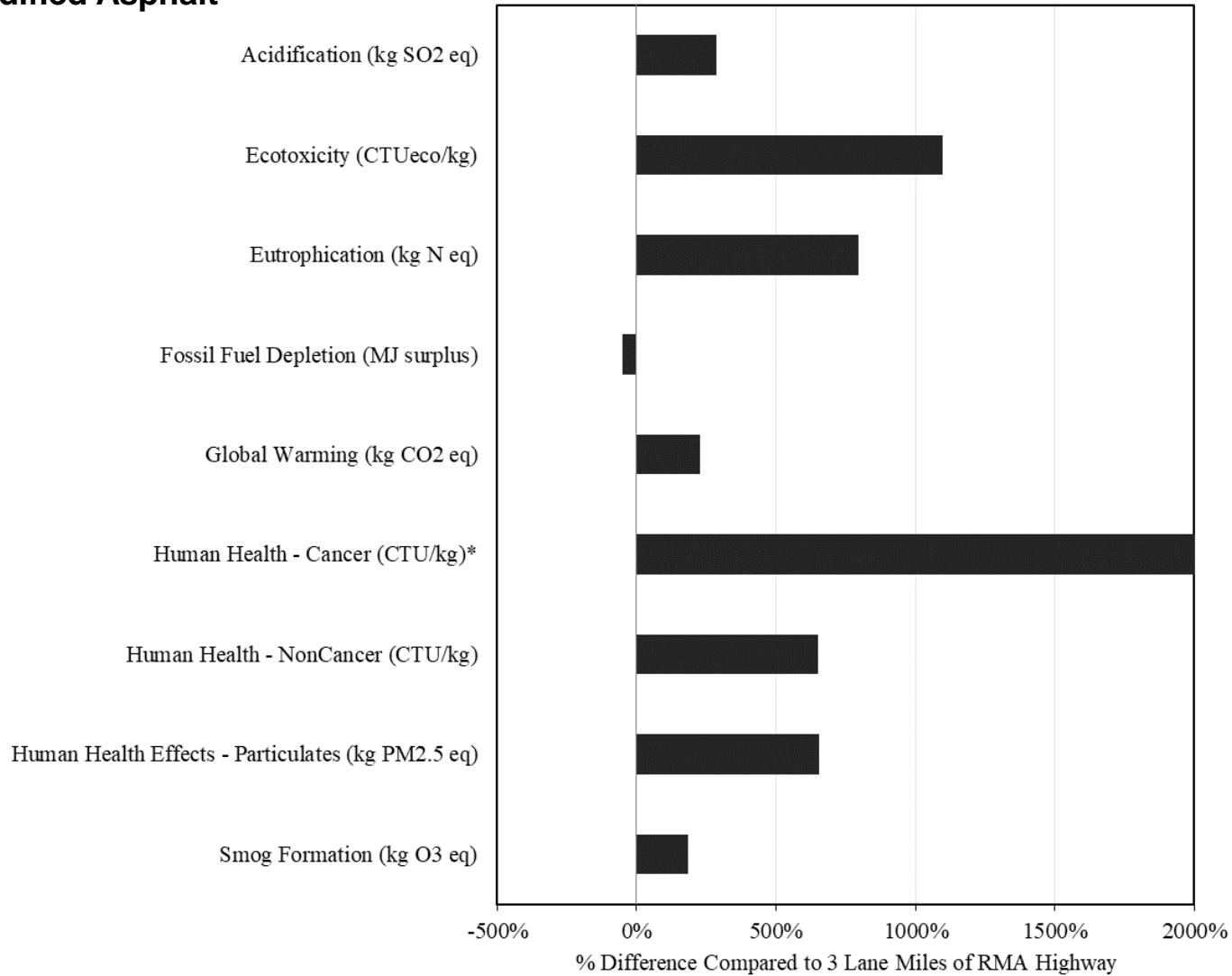


Equal Thickness
 12.5% Thicker
 25% Thicker
 37.5% Thicker
 50% Thicker

Polymer Modified Asphalt Comparison



Acoustic Benefits Linked to Polymer Modified Asphalt

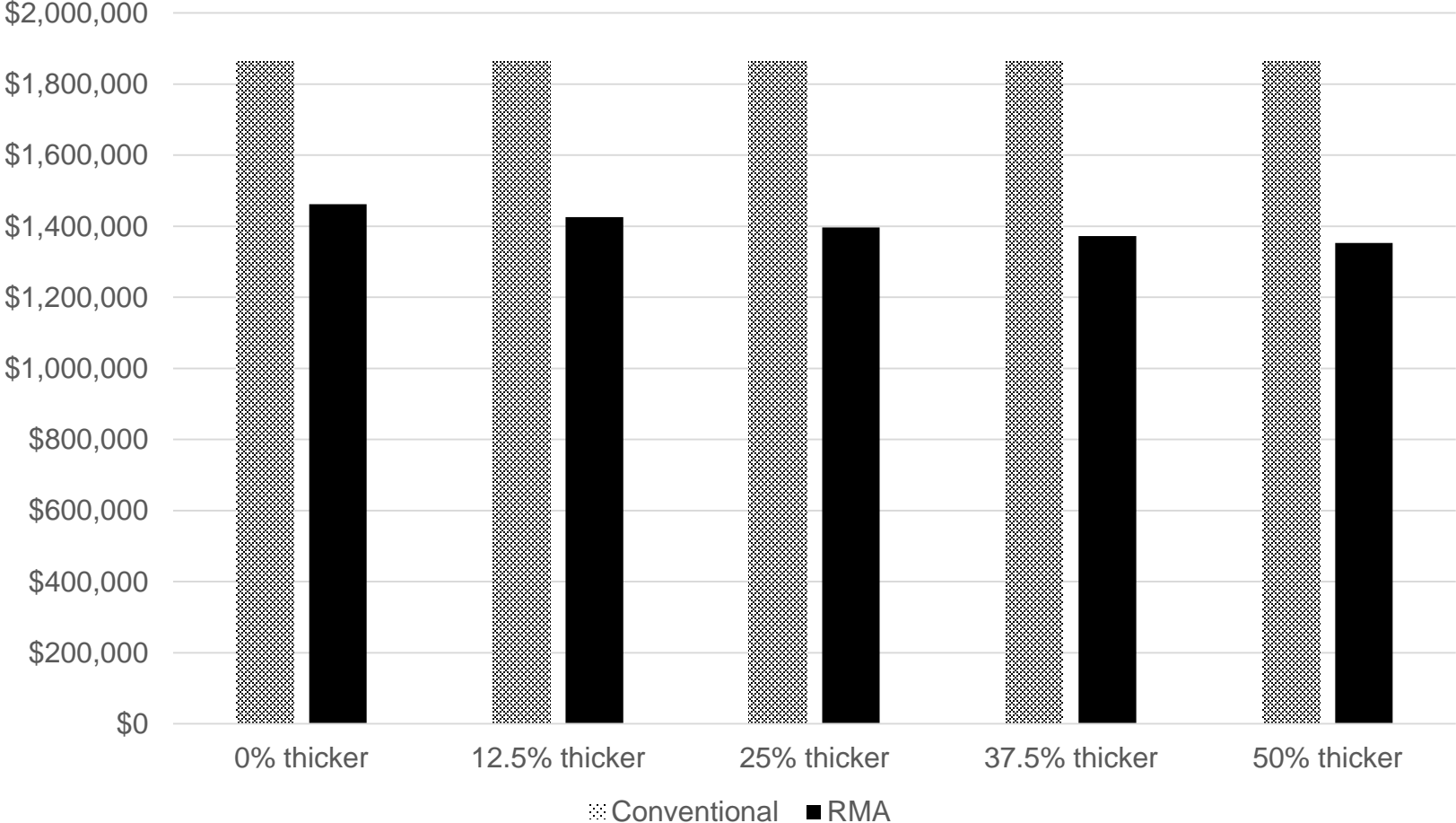


- Equivalent 6 ft tall concrete noise barrier considered (~5 dB insertion loss)
 - Resource intensive concrete = large life cycle savings

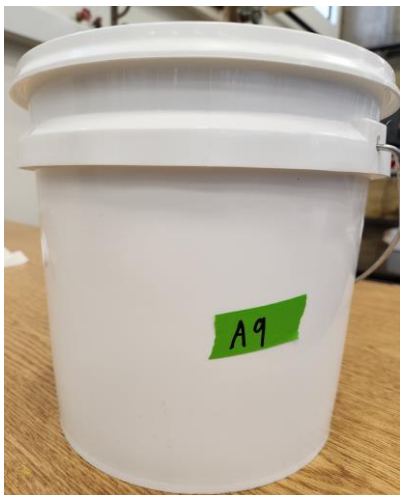
LCA Conclusions

- Substantial potential for environmental impact when replacing conventional asphalt with less thick RMA
- Based purely on pavement, life cycle impact of PMA and RMA are comparable; small carbon emission improvement for RMA
- Indirect benefits of RMA, especially reduced concrete in noise barriers, can generate outsized life cycle improvements

Life Cycle Cost – Conventional (Net Present Value)



Chemical Leaching from Tire Derived Products



EPA LEAF Method 1315

Processing & Analysis:
Chemical Analysis
Conductivity
pH
RedOx Potential



Thank You!

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