

The Sustainability of Our Asphalt Binders, Mixtures and Pavements

2023 Alaska Asphalt Paving Summit

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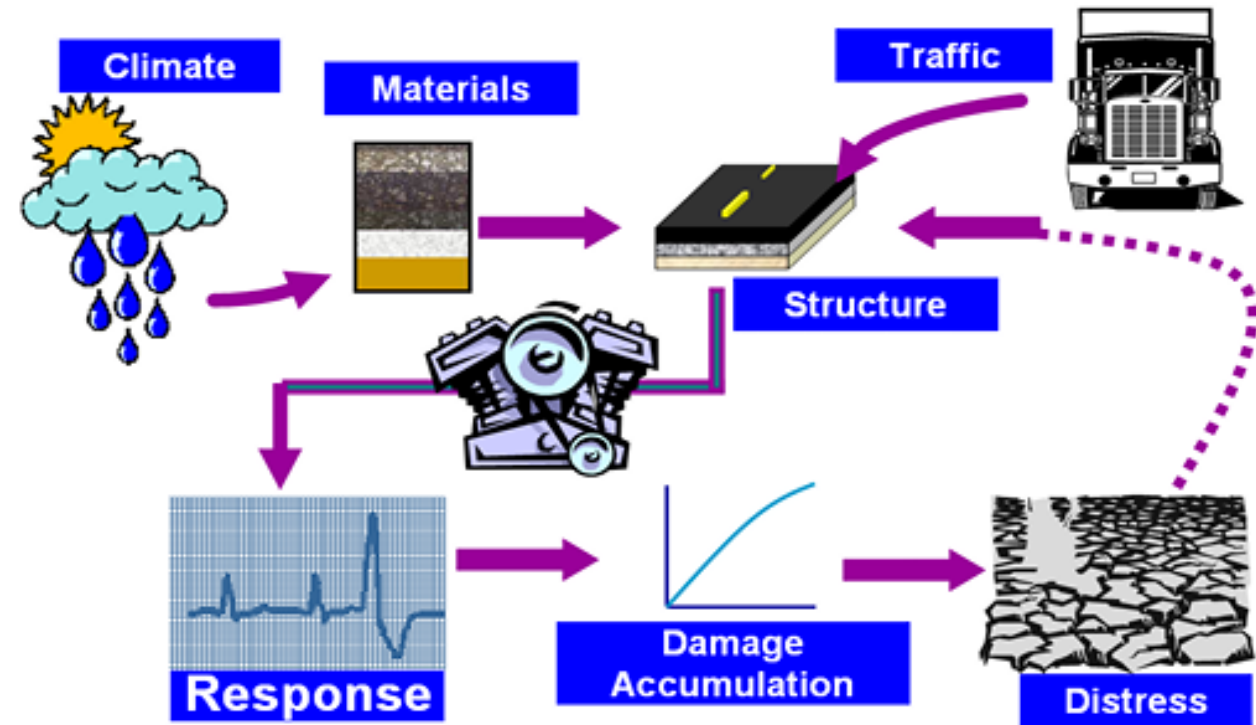
- *“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”*
 - *World Commission on Environment and Development (1987)*
- What does Sustainability mean to you?

Pavement Sustainability: The Four Pillars (FHWA, 2015)



1. Performance

- *Achieve the engineering goals for which they have been constructed*
- Pavement Design
 - Carry expected traffic volumes
 - Through expected service life
 - Maintained level of serviceability
- Material Specifications



2. Environmental

- *Preserve and (ideally) restore surrounding ecosystems*
- Energy consumption
- Global Warming Potential (GWP)
- Green House Gas (GHG) Emissions



3. Economic

- *Use financial, human and environmental resources economically*
- Costs Associated with
 - Construction
 - Maintenance
 - Rehabilitation
 - Preservation
- Best Practice
 - Life Cycle Costs Analysis
- Other Costs
 - Vehicle Operating Costs
 - Crash Costs

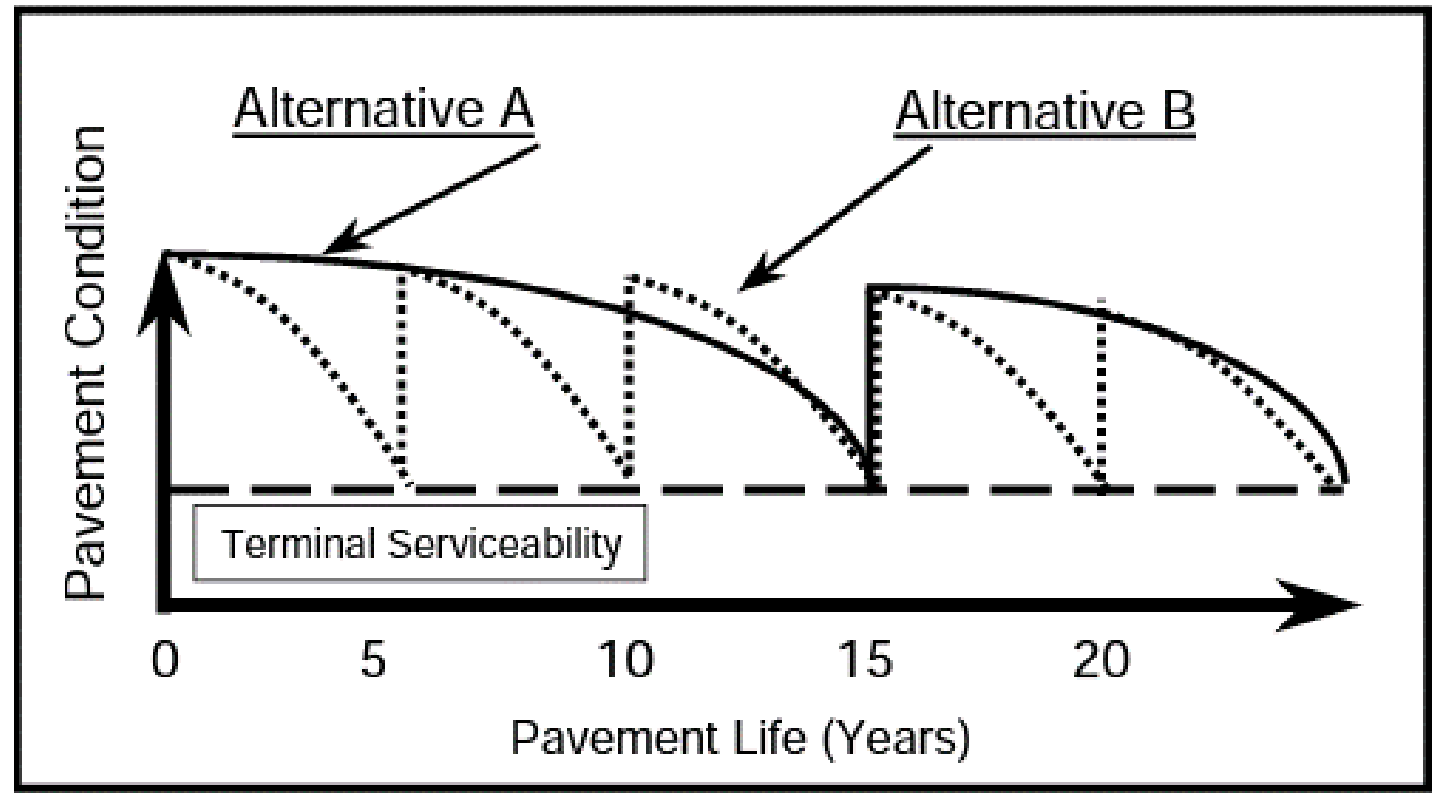


Figure 2.2. Performance curve versus rehabilitation strategy.

From: FHWA: Life Cycle Costs Analysis in Pavement Design

4. Social

- *Meet human needs such as health, safety, equity, employment, comfort and happiness*
- Equity
- Safety
- Smoothness
- Vehicle Operating Costs
- Crash Costs
- Aesthetics
- Access
- Mobility



Save Lives

Better coordinated work zone scheduling can reduce the number of work zone-related crashes by providing alternate routes that allow motorists to avoid work zones altogether.



Save Money

An optimized renewal programming schedule can reduce the agency's expenditures on mitigation strategies.



Save Time

Careful planning and scheduling of work zones can mitigate or avoid some work zone delays.

Why does sustainability feel different now?

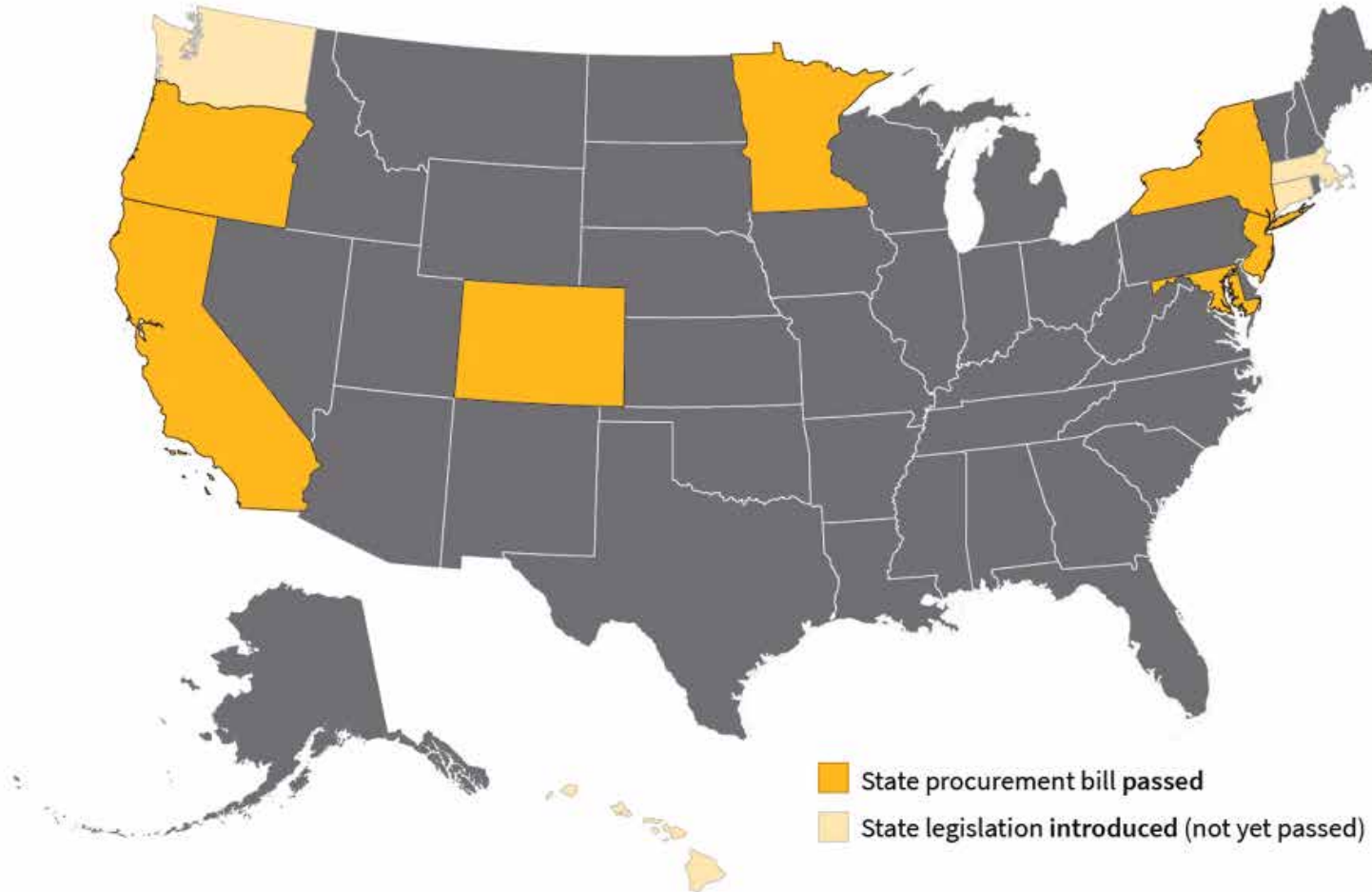
- We have historically promoted sustainability efforts
 - Performance
 - Energy Consumption
 - Recycling
 - Pavement Design
 - Safety
- We are now being asked to keep score
 - And Improve!
- Accountability is key



Green Public Procurement

Policies and Methods

Buy Clean Policies at the State Level



Information collected from state legislative websites.

• Which sections relate to low carbon construction materials?

IRA Section	Agency	Funding	Purpose	Funds obligation deadline
60503	GSA Federal Buildings Fund	\$2.15B	To acquire and install materials/products for use in the construction or alteration of buildings that have substantially lower levels of embodied GHG emissions (<i>as determined by EPA</i>)	9/30/26
60506	DOT FHWA	\$2B	To reimburse or provide incentives (up to 2% of incremental costs) to eligible recipients for the use of construction materials/products that have substantially lower levels of embodied GHG emissions (<i>as determined by EPA</i>)	9/30/26
60116	EPA	\$100M	For administrative costs to develop (<i>with GSA and DOT-FHWA</i>) a program to identify and label construction materials/products that have substantially lower levels of embodied GHG emissions, based on EPDs and determinations by State agencies, as verified by EPA.	9/30/26
60112	EPA	\$250M	Grants and technical assistance to businesses, states, tribes and nonprofit organizations to support the development, enhanced standardization and transparency, and reporting criteria for EPDs for construction materials/products that include measurements of the embodied GHG emissions across all life cycle stages	9/30/31
50161	DOE	\$5.812B	For financial assistance for advanced technology retrofits for US industrial or manufacturing facilities that produce iron, steel, steel mill products, aluminum, cement, concrete, glass, and other energy intensive industrial processes	
	DOE	\$10B	For the 48C tax credit to expand clean technology manufacturing	
30002	HUD	\$837.5M	For direct loans and grants to improve climate resilience of affordable housing, including low- emission building materials/processes	
70006	FEMA		May provide financial assistance for costs associated with low-carbon materials	

- Environmental Product Declarations (EPDs) are the current state of the art for representing third-party verified environmental impacts of products
- Based on ISO Standards 14025 (2006), 21930 (2017)/ EN 15804
- LEED v.4 led adoption of EPDs
 - Up to two points available in its green building rating system
 - Most impact in vertical infrastructure products



Nutrition Label

Nutrition Facts	
Serving size	1 potato (148g/5.2oz)
Amount per serving	110
Calories	
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 0mg	0%
Total Carbohydrate 26g	9%
Dietary Fiber 2g	7%
Total Sugars 1g	
Includes 0g Added Sugars	0%
Protein 3g	
Vitamin D 0mcg	0%
Calcium 20mg	2%
Iron 1.1mg	6%
Potassium 620mg	15%
Vitamin C 27mg	30%
Vitamin B ₆ 0.2mg	10%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

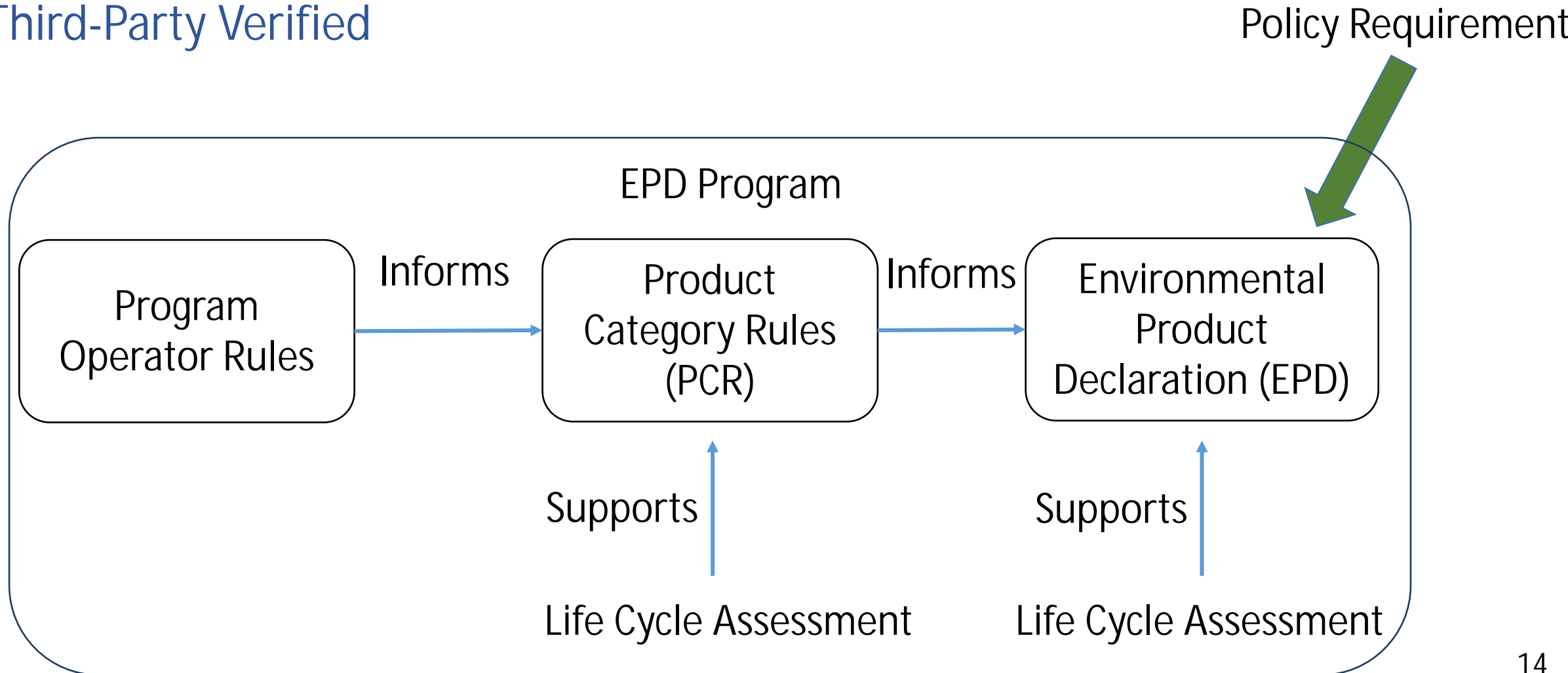
Environmental Product Declaration

Declared Unit: 1 short ton of asphalt mixture

PARAMETER	UNIT	A1
Global Warming Air, incl. Biogenic Carbon	[kg CO ₂ -Equiv.]	17.7
Ozone Depletion Air	[kg CFC 11-Equiv.]	3.72e-09
Acidification	[kg SO ₂ -Equiv.]	0.104
Eutrophication	[kg N-Equiv.]	0.00624
Smog Air	[kg O ₃ -Equiv.]	1.89
Abiotic Depletion for Fossil Resources	[MJ surplus energy]	MND*

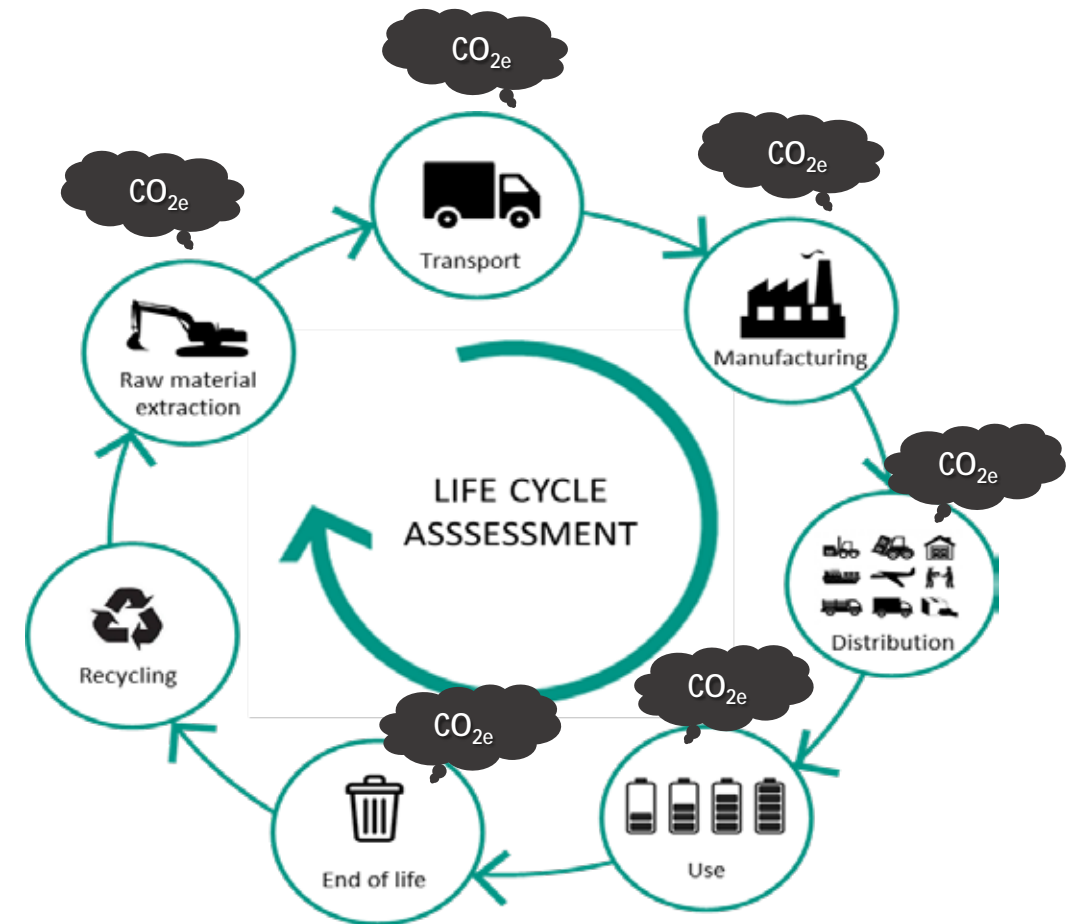
EPD Program: Overview

- Multiple Stakeholders: Program Operator, PCR Committee, Review Panel
- Consensus-Based
- Third-Party Verified



What is Life Cycle Assessment (LCA)?

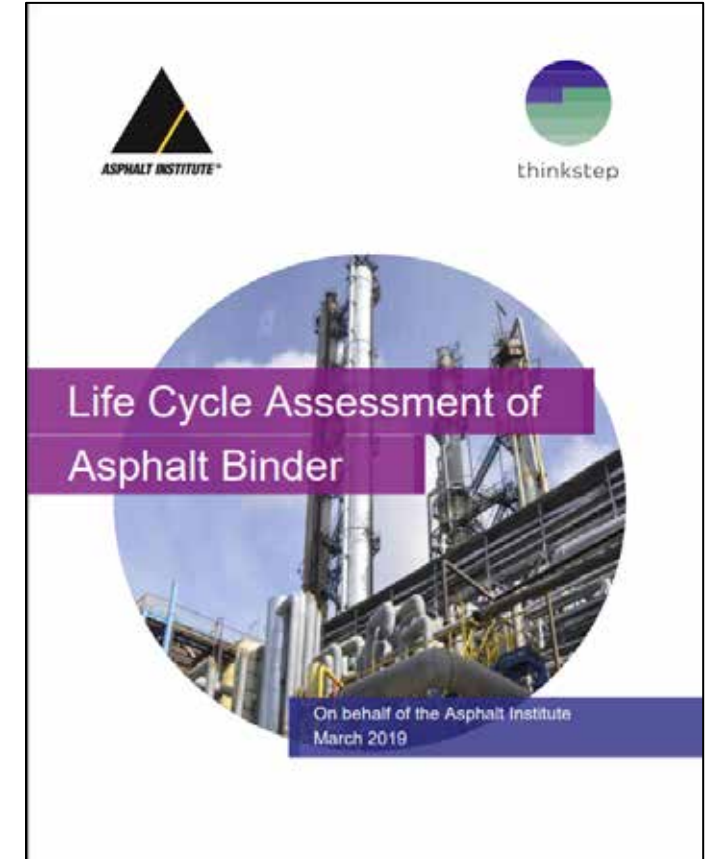
- A systematic analysis of the potential environmental impacts of products during their entire life cycle.
- LCCA is a financial accounting, LCA is a eco-accounting
- ISO Standards 14040 and 14044
- This example shows “cradle to grave” LCA



Industry Initiatives on Environmental Sustainability

EPDs for Asphalt Binder: Previous Efforts

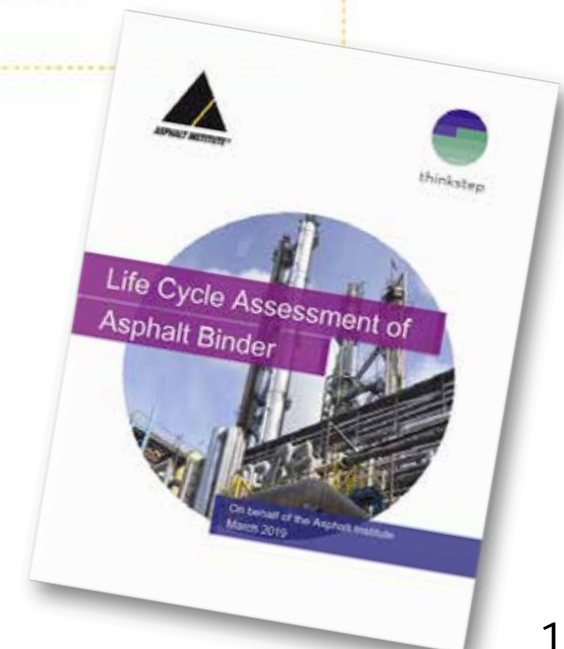
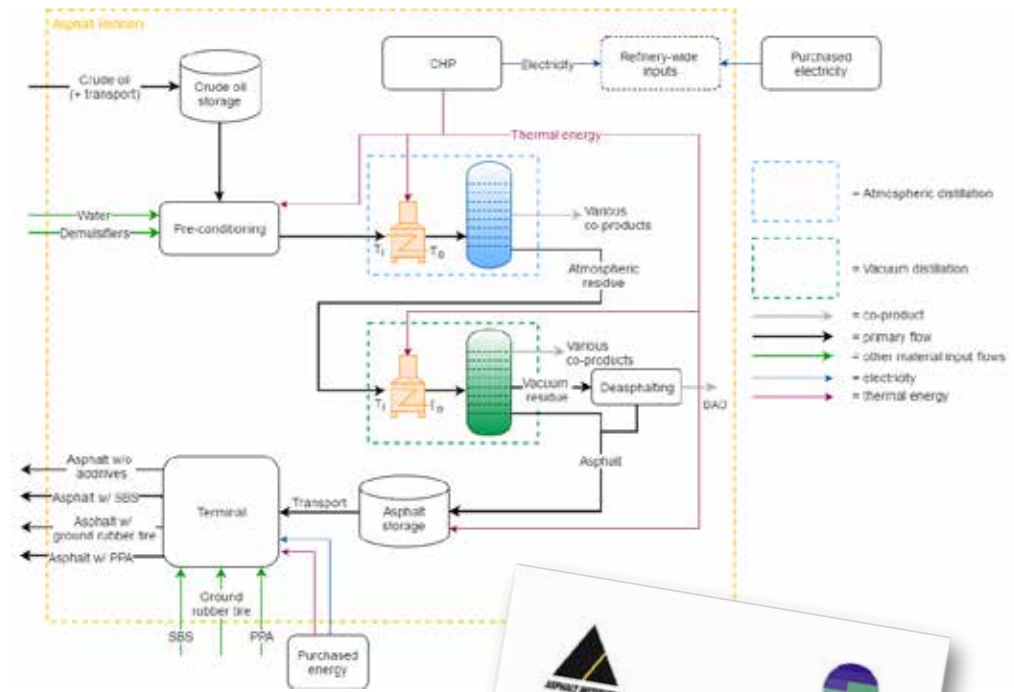
- Existing Cradle to Gate Industry Average LCA for Asphalt Binder
 - Published in 2019
 - Started in 2016
 - Contracted with Thinkstep, now Sphera
 - Collected “Foreground” (process) data from 12 refineries and 10 terminals
 - Used Sphera’s “Gabi” for background data
 - Declared Unit: 1 kg of Asphalt Binder
 - Without additives
 - SBS Modified
 - GTR Modified
 - PPA Modified
- Feeds into NAPA’s Mixture EPD Tool



EPDs for Asphalt Binder: Current Efforts

EPD Taskforce provided path forward for:

- Developing Product Category Rules (PCR) for asphalt binder using third-party Program Operator
 - Process includes including relevant external stakeholders
- Update AI's current Life Cycle Assessment (LCA) on asphalt binders in North America that was published in 2019
 - Collect new foreground data from volunteer member company refineries and terminals (NDAs in place)
 - Incorporate newer background datasets
- Developing Environmental Product Declaration (EPD) web-based tool for product or facility specific EPDs
 - Support "Buy-Clean" policies
 - Will support NAPA's EPD tool on mixtures



EPD for Asphalt Mixtures

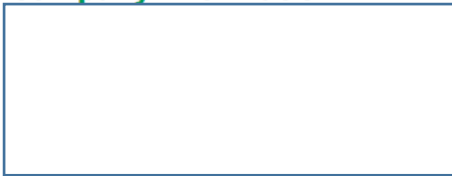
- Program Operator - NAPA
- PCR –Committee Info and Review
 - Completed in 2022
 - www.asphaltpavement.org/uploads/documents/EPD_Program/NAPA_PCR_AsphaltMixtures_v2.pdf
- Asphalt Mixtures LCA
 - Published in 2016, updated in 2021
 - www.asphaltpavement.org/uploads/documents/EPD_Program/LCA_final.pdf
- Independent Verification
 - LCA, PCR and EPD Tool
- Emerald Eco-label EPD Tool
 - <https://asphaltep.org/>

DECLARED PRODUCT	221731, an asphalt mix.
DECLARATION OWNER	
PROGRAM OPERATOR	 <p>National Asphalt Pavement Association 6406 Ivy Lane, Suite 350 Greenbelt, MD, 20770 Toll-free: (888) 468-6499 www.asphaltpavement.org/epd</p>
LCA AND EPD TOOL DEVELOPER	 <p>Benjamin Ciavola, Ph.D., Trisight 322 Sheldon Ave. Ste. 14, Houghton, MI 49931 http://trisightengineering.com</p>
INDEPENDENT VERIFIERS	 <p>John Beath Environmental, LLC The data and declarations produced by the EPD tool was externally, independently verified in accordance with ISO14025, ISO21930, and the referenced PCR. Trisha Montalbo https://goaspha.lt/3u7MIqk</p>
PRODUCT CATEGORY RULE	 <p>Product Category Rules (PCR) for Asphalt Mixtures, version 2.0 National Asphalt Pavement Association 6406 Ivy Lane, Suite 350 Greenbelt, MD, 20770 Toll-free: (888) 468-6499 www.asphaltpavement.org/epd</p>
PCR REVIEW	 <p>PCR confirmed by PCR Review Panel Led by Joep Meijer, TheRightenvironment https://goaspha.lt/3NJbyVx</p>

EPD Example – HMA Asphalt



Company Information



Product Description

This EPD reports the potential environmental impacts and additional environmental information for an asphalt mixture, which falls under the United Nations Standard Products and Services Code 30111509. Asphalt mixtures are typically incorporated as part of the structure of a roadway, parking lot, driveway, airfield, bike lane, pedestrian path, railroad track bed, or recreational surface.



Gradation Type: Not Reported
 Mix Design Method: superpave
 Nominal Maximum Aggregate Size: 0.375 inches
 Performance Grade of Asphalt Binder: PG 58-28
 Customer [Project/Contract] Number: Not Reported

This mix producer categorizes this product as a Hot Mix Asphalt (HMA) asphalt mixture. This asphalt mixture was produced within a temperature range of 143 to 163°C (290.0 to 325.0°F). Energy and environmental impacts are based on a plant's average performance over a 12-month period and are not adjusted for mix-specific production temperatures.

Product Ingredients

The product ingredients as identified in the mix design are provided in the table below.

TABLE 1. PRODUCT INGREDIENTS

COMPONENT	MATERIAL	WEIGHT %
Aggregate	Natural Stone	24
Aggregate	Natural Stone	19
Aggregate	Natural Stone	14
RAP	Reclaimed Asphalt Pavement	38
Binder	Unmodified	4

TABLE 3. ENVIRONMENTAL IMPACT SUMMARY TABLE

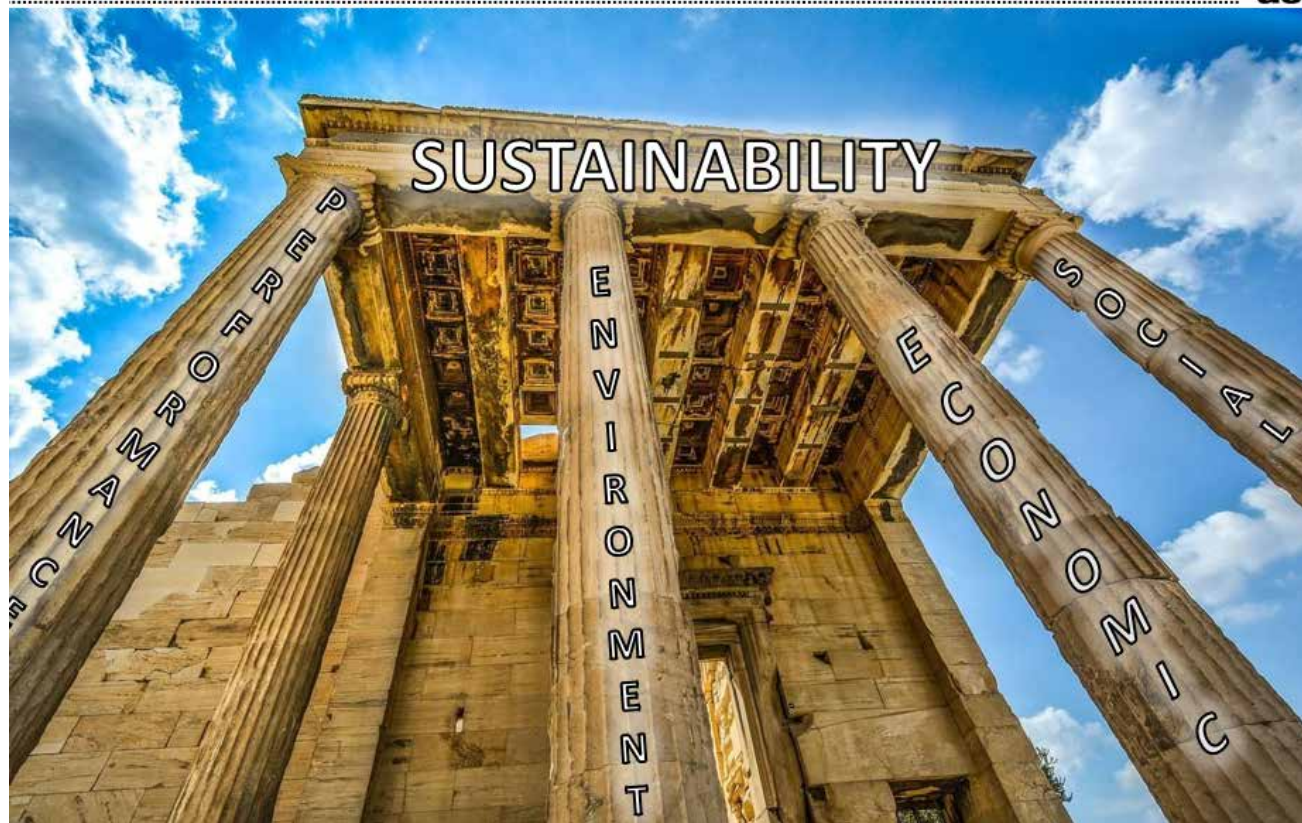
IMPACT CATEGORY	POTENTIAL IMPACT PER METRIC TONNE ASPHALT MIXTURE (PER TON ASPHALT MIXTURE)
Global warming potential (GWP-100)	48.05 (43.59) kg CO2 Equiv.
Ozone depletion potential (ODP)	5.29e-08 (4.80e-08) kg CFC-11 Equiv.
Eutrophication potential (EP)	9.34e-03 (8.48e-03) kg N Equiv.
Acidification potential (AP)	1.17e-01 (1.06e-01) kg SO2 Equiv.
Photochemical ozone creation potential (POCP)	2.84 (2.58) kg O3 Equiv.

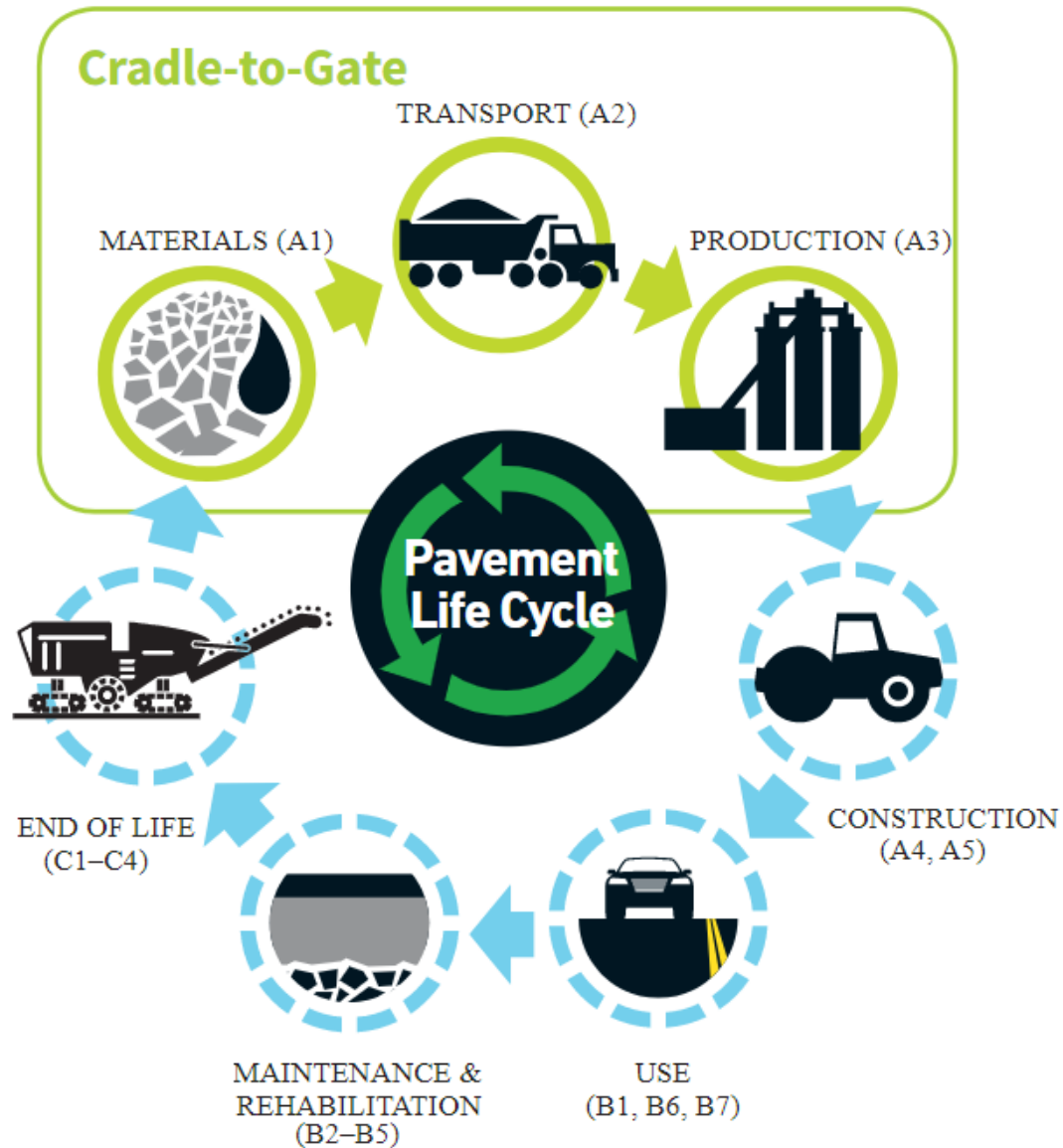
GWP from HMA EPDs will be used in benchmarking mixtures with Buy Clean policies;

Concerns with Green Public Purchasing Initiatives:

- Equivalent functionality (same performance) for comparison for EPDs
- Uniform performance-based specifications across all agencies for construction of pavements
- Scope for benchmark establishment is cradle to gate
- No feedback loop with design, maintenance and asset management divisions of agencies

- How do our asphalt binders, mixtures and pavements contribute to the overall sustainability?



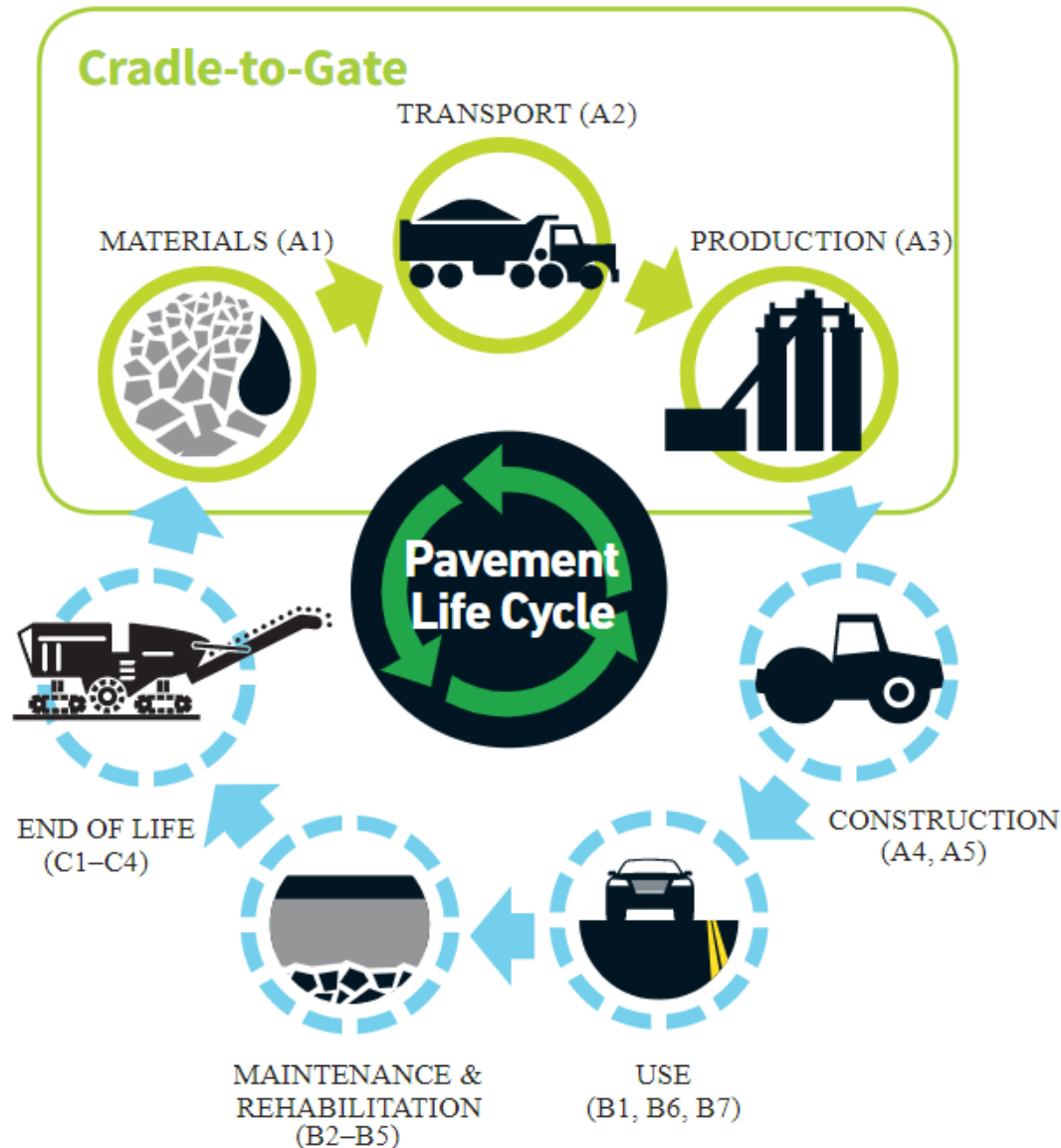


- Currently, the focus is on “Cradle to Gate of Materials” (A1- A3)

Considerations for Path Forward

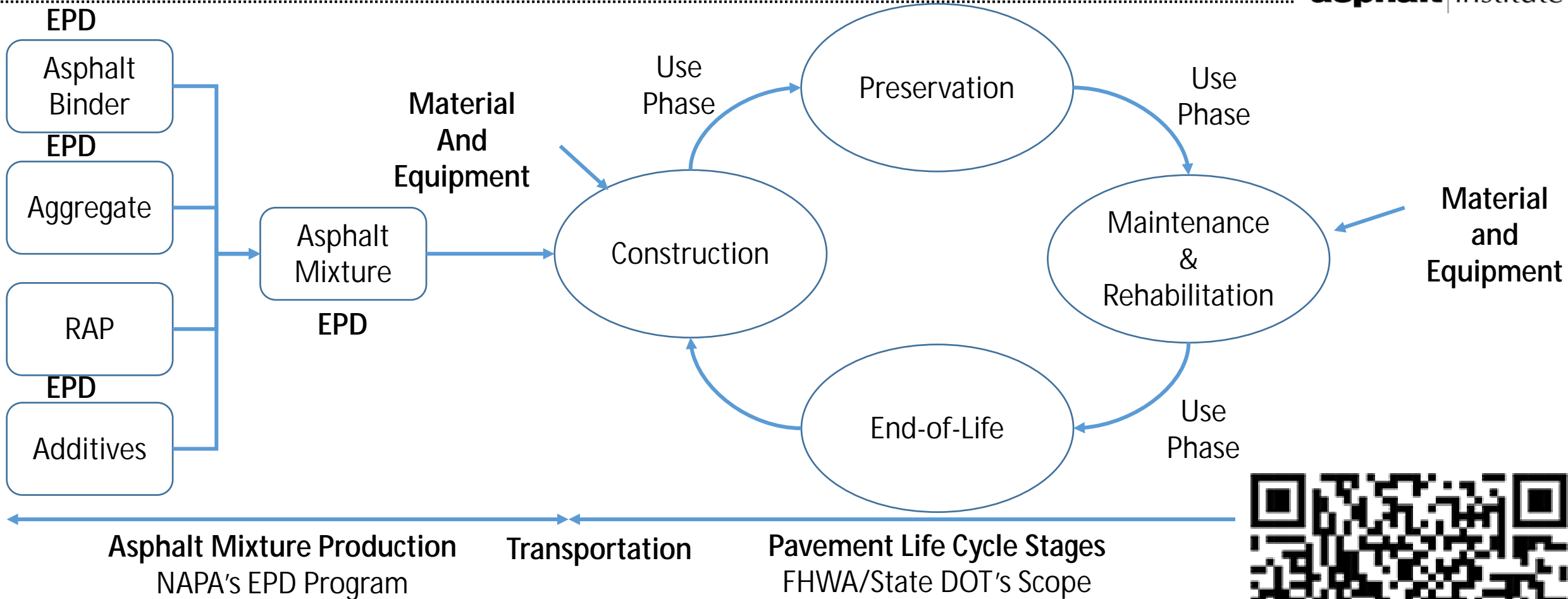
- Which option is more “sustainable”?
- Context Dependent
 - Material Cradle to Gate
 - Cradle to Grave





- Need to consider and plan for “Cradle to Grave” (A1 – C4)
- How will construction impact Pavement LCA (A4 – A5)
- The use phase (B1 - B7)
- Maintenance and Rehab based on performance (B2 – B5)
- How do we account for “End of Life?” (C1-C4)
- How do we include all stakeholders?

Pavement-Level EPDs with Diligence and Accountability



[Link to an article on Pavement PCR](#)

Guidance on "Who and What Level should Pavement PCR be developed?"

Next in the line: ["Can All LCAs be Considered as EPDs?"](#)



- Pavement-level EPD Process will need to be standardized
 - Involve multiple stakeholders
 - Program Operators, PCR Committee
 - Consensus Based and Third-Party Plus Public Verified
 - Accountability is key
 - Functional unit
 - *Example: A* lane-mile of a pavement structure serving *B* amounts of traffic under *C* climatic conditions for *X* years of service life
 - Cradle to Gate EPDs mostly use “Declared Unit” only
 - Example: Short ton or kilogram



*IR 275 in Hamilton County
APA Perpetual by Performance Award
www.Driveasphalt.org*

Holistic Pavement Sustainability

- Incorporate principles of “Service Life Planning” (ISO 15686)
 - Meet or Exceed a Structure’s Design Life
 - Quality Assurance Improvements
 - Use Stage Performance: Structural Condition Evaluation
- Innovative Contracting Mechanisms
 - “Buy-Clean” to “Design-Build-Operate-Preserve-Maintain Clean”
 - Transition to “Low-Carbon” Pavement Systems
- Data Quality Improvement = Systemic Improvement
 - Improving existing Pavement Management Systems
 - Feedback loop between PMS with Procurement and Design

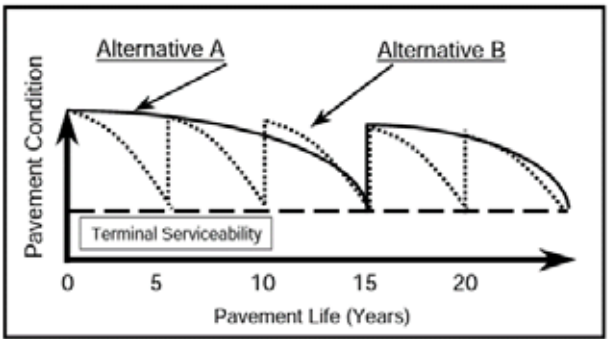
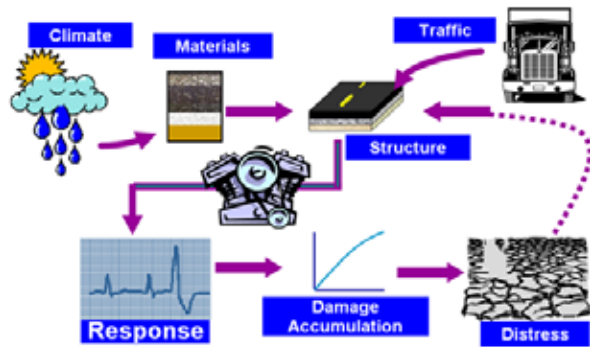
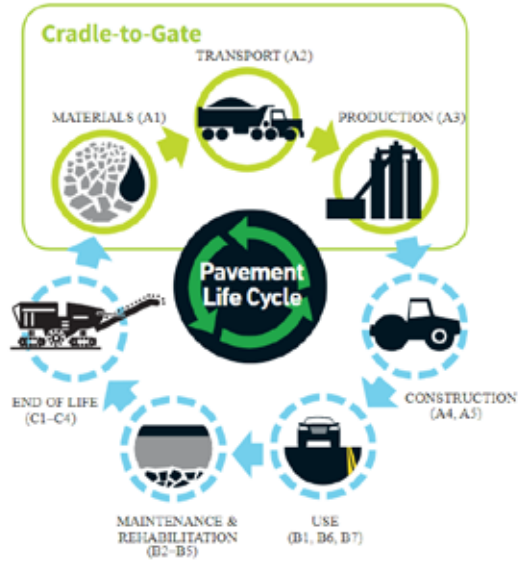


Figure 2.2. Performance curve versus rehabilitation strategy.



Balance

- Needed when evaluating projects/ processes between the pillars
- Priorities and “Trade-Offs”
- Priorities need to be established as part of the ultimate goal of a project
 - “You cannot do everything, you must pick priorities”
- Context dependent



Trade-Offs: Materials Strategy Example

- Research sponsored by IDOT, conducted by Illinois Center for Transportation
- SMA is durable and stable with proven long service life
- Problem: Local aggregates difficult to meet SMA aggregate requirements
 - Requires importing from other states
- Objective: determine if IDOT can use locally available aggregates in SMA
 - Reduce cost and environmental impact of SMA production
 - Without compromising resistance to pavement rutting or cracking
- Reducing costs will lead to more SMA usage
- Widespread SMA use will lead to:
 - Less frequent rehabilitation
 - Fewer traffic interruptions for construction
 - Substantial cost savings



Illinois Center for Transportation
University of Illinois at Urbana-Champaign

I ILLINOIS

Local Aggregate Utilization in Stone-Matrix Asphalt (SMA)

Javier J. García Mainieri
Imad L. Al-Qadi

December 14, 2021
IAAP Aggregate Policy Seminar



"Where Excellence and Transportation Meet"

2

Why Sustainability and Why Now?

- Opportunities
 - Business
 - Innovation
 - Specifications and Design
 - Education
- Establish Priorities
 - Legislation and agencies provide context
- Improve quality of life
 - For our industry
 - For the public we serve
- Let's do it for next generations



Future Woman of Asphalt



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