Iowa DOT Climate Challenge Project

ICPA 60th Annual Workshop

Des Moines, Iowa | Feb 8 , 2024

IOWA STATE UNIVERSITY
Institute for Transportation

National Concrete Pavement Technology Center

Leif Wathne, P.E.

CP Tech Center

Talking Points

- Climate Challenge?
- Relevant to Iowa how?
- Iowa’s project details
- Progress to date
- Next steps

Climate Challenge?

- FHWA Grant Program aimed at quantifying the emissions of sustainable pavements using EPDs and LCAs

Summary

The Federal Highway Administration (FHWA) Climate Challenge provides resources to help state departments of transportation (SDOTs) or other public sector stakeholders explore the use of Life Cycle Assessments (LCAs) and Environmental Product Declarations (EPDs) as a standard practice to inform pavement material and design selection for enhancing sustainable pavement practices and quantify the emissions and impacts of those practices.

The Climate Challenge is administered by FHWA's Sustainable Pavements Program (SPP).

EPDs?


Nutrition Facts
Serving Size 1 package (61g)
Servings Per Container 1
Amount Per Serving
Calories 240 Calories from Fat 35
% Daily Value*
Total Fat 3.5g
6%
10%
4%
25%
Carbohydrate 42g 14%
Dietary Fiber less than 1g 3%
Sugars 6g
Protein 10g
Vitamin A 0% • Vitamin C 0%
Calcium 15% • Iron 4%
*Percent Daily Values are based on a 2,000
INGREDIENTS:

Environmental Product Declarations (EPDs) quantify relevant environmental information about a specific material/product

Product Category Rule (PCR)

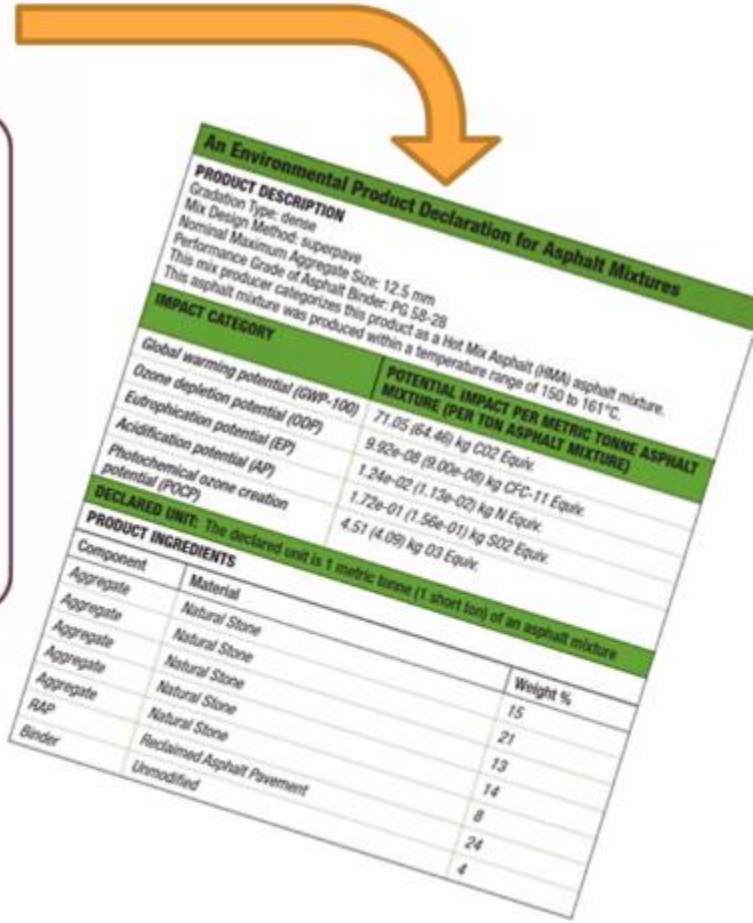
"Set of specific rules, requirements, and guidelines for developing Type III environmental product declarations for one or more categories" (ISO 14025)

Life Cycle Assessment (LCA)

"A compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle." (ISO 14040)

Environmental Product Declaration (EPD)

"Providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information" (ISO 14025)



An Environmental Product Declaration for Asphalt Mixtures

PRODUCT DESCRIPTION
Gradation Type: dense
Mix Design Method: superpave
Nominal Maximum Aggregate Size: 12.5 mm
Performance Grade of Asphalt Binder: PG 58-28
This mix producer categorizes this product as a Hot Mix Asphalt (HMA) asphalt mixture.
This asphalt mixture was produced within a temperature range of 150 to 161°C.

IMPACT CATEGORY	POTENTIAL IMPACT PER METRIC TONNE ASPHALT MIXTURE (PER TON ASPHALT MIXTURE)
Global warming potential (GWP-100)	71.05 (64.46) kg CO2 Equiv.
Ozone depletion potential (ODP)	9.92e-08 (9.00e-08) kg CFC-11 Equiv.
Eutrophication potential (EP)	1.24e-02 (1.13e-02) kg N Equiv.
Acidification potential (AP)	1.72e-01 (1.56e-01) kg SO2 Equiv.
Photochemical ozone creation potential (POCP)	4.51 (4.09) kg O3 Equiv.

DECLARED UNIT: The declared unit is 1 metric tonne (1 short ton) of an asphalt mixture.

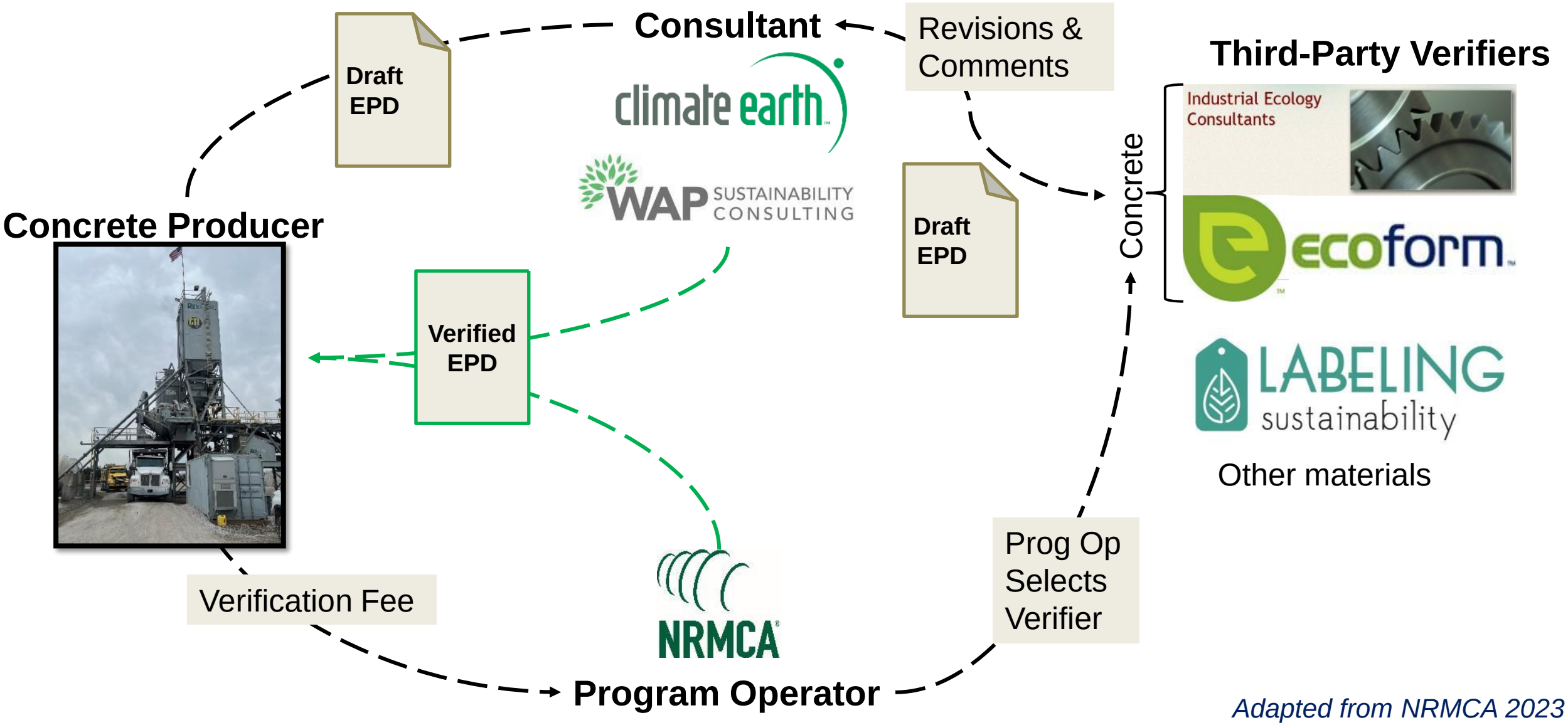
PRODUCT INGREDIENTS

Component	Material	Weight %
Aggregate	Natural Stone	15
Aggregate	Natural Stone	21
Aggregate	Natural Stone	13
Aggregate	Natural Stone	14
RAP	Reclaimed Asphalt Pavement	8
Binder	Unmodified	24
		4

RULES **MEASURE** **REPORT**

From WH Buy Clean task force, Feb 2023

EPD Verification Process



Adapted from NRMCA 2023

What do EPDs tell us?

ENVIRONMENTAL IMPACTS

Declared Product:

Mix 45FN31C2C • Jeffco Plant
Description: CDOT CLASS B/D/P LOW SLUMP
Compressive strength: 4500 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	345
Ozone Depletion Potential (kg CFC-11-eq)	8.20E-6
Acidification Potential (kg SO_2-eq)	1.01
Eutrophication Potential (kg N-eq)	0.39
Photochemical Ozone Creation Potential (kg O_3-eq)	22.4
Abiotic Depletion, non-fossil (kg Sb-eq)	7.02E-5
Abiotic Depletion, fossil (MJ)	710
Total Waste Disposed (kg)	102
Consumption of Freshwater (m^3)	3.24

Product Components: natural aggregate (ASTM C33), Portland cement (ASTM C150), batch water (ASTM C1602), fly ash (ASTM C618), admixture (ASTM C494), admixture (ASTM C260)

… OF MANUFACTURE!

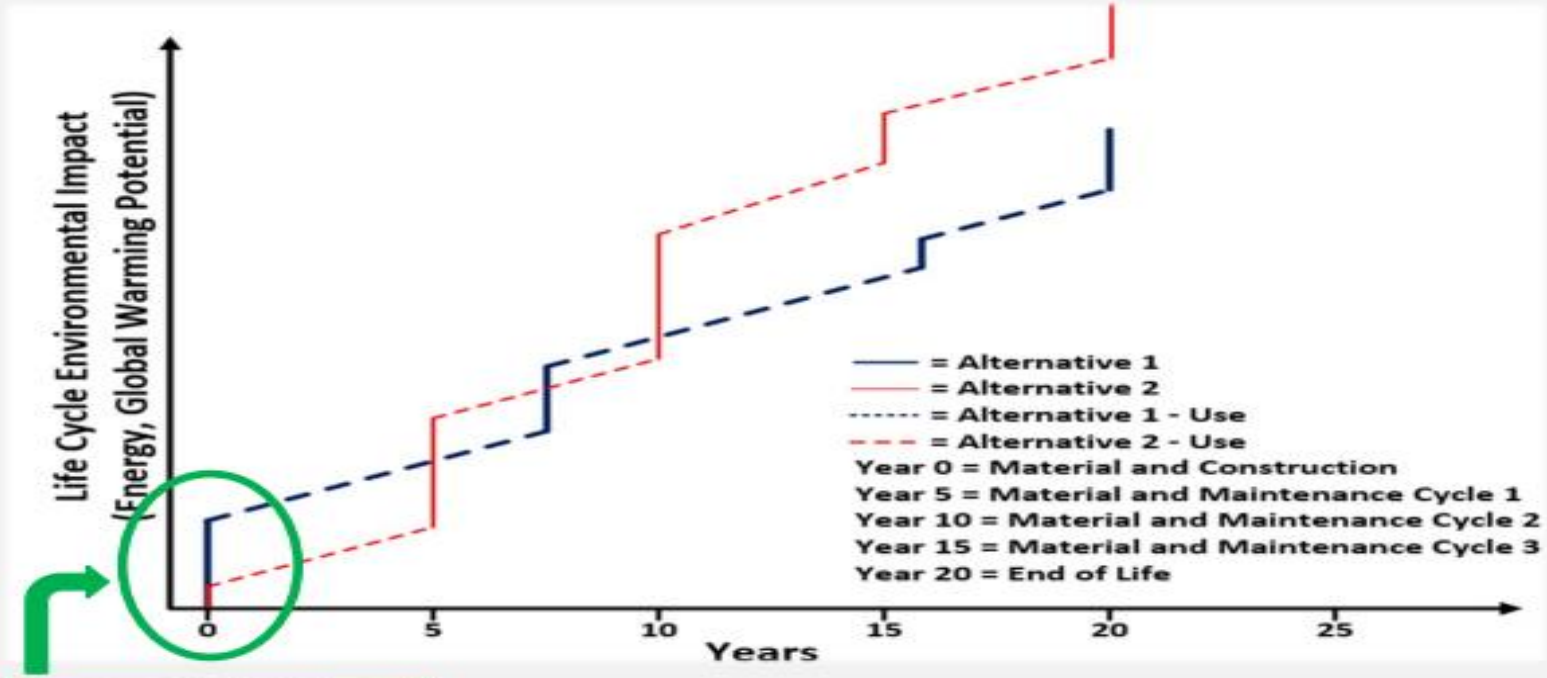
 Source: NRMCA

WHERE DO EPDS FIT IN?

ABC Ready-Mix Environmental Impacts

Serving Size: 1 cubic yard of concrete mix no. 123

Global Warming Potential [kg CO_2 eq]	3.06×10^{3}
Ozone Depletion Potential [CFC-11 eq]	4.24×10^{-6}
Acidification Potential [kg SO_2 eq]	21.7
Eutrophication Potential [kg N eq]	9.25×10^{-2}
Photochemical Oxidant Creation Potential [kg O_3 eq]	30.7
TOTAL ENERGY DEMAND [MJ]:	1166
Non-renewable [MJ]	586
Renewable [MJ]	580



Supplier EPDs for materials

Product Stage			Construction Stage		Use Stage					End-of-Life Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Raw materials supply	Transport	Manufacturing	Transport	Installation	Use Stage	Maintenance	Repair	Replacement	Refurbishment	De-construction	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential

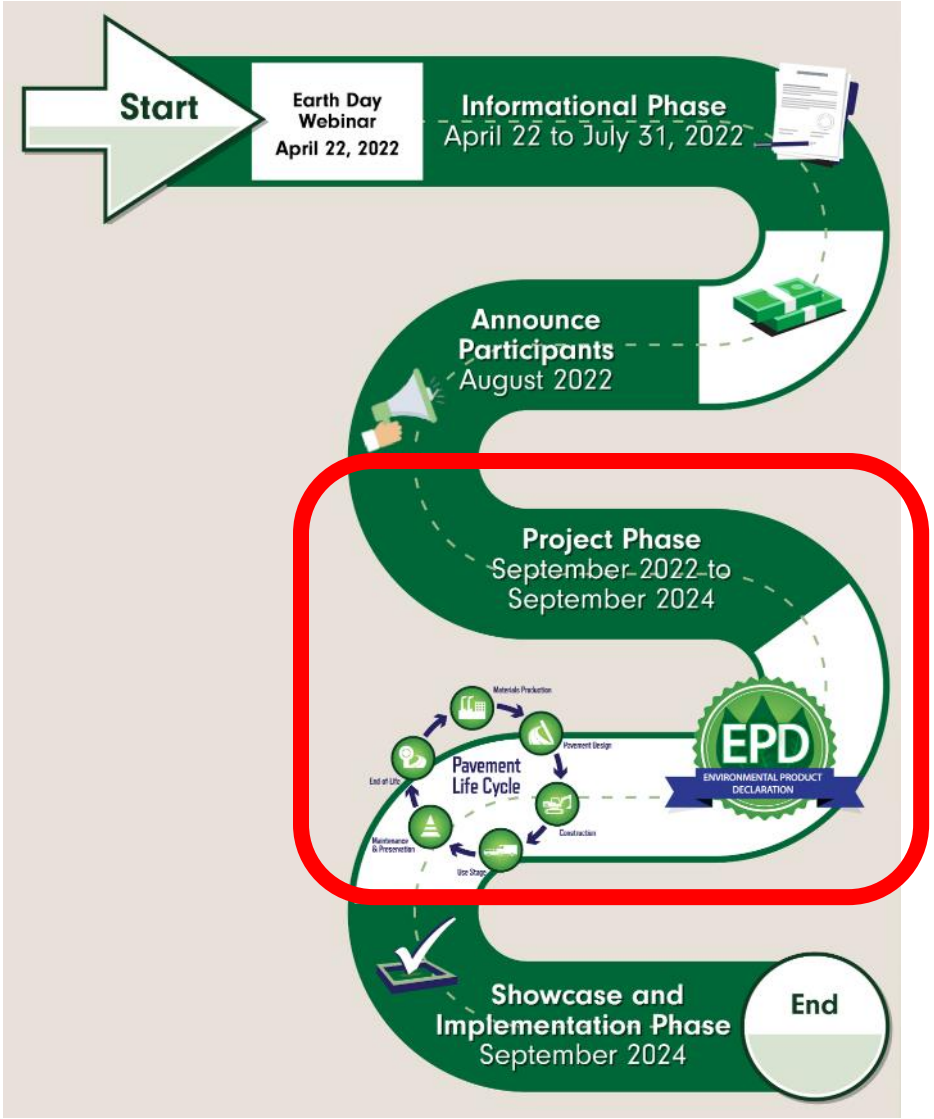
Projects

[Source: Jacquelyn Wong (CalTrans)]

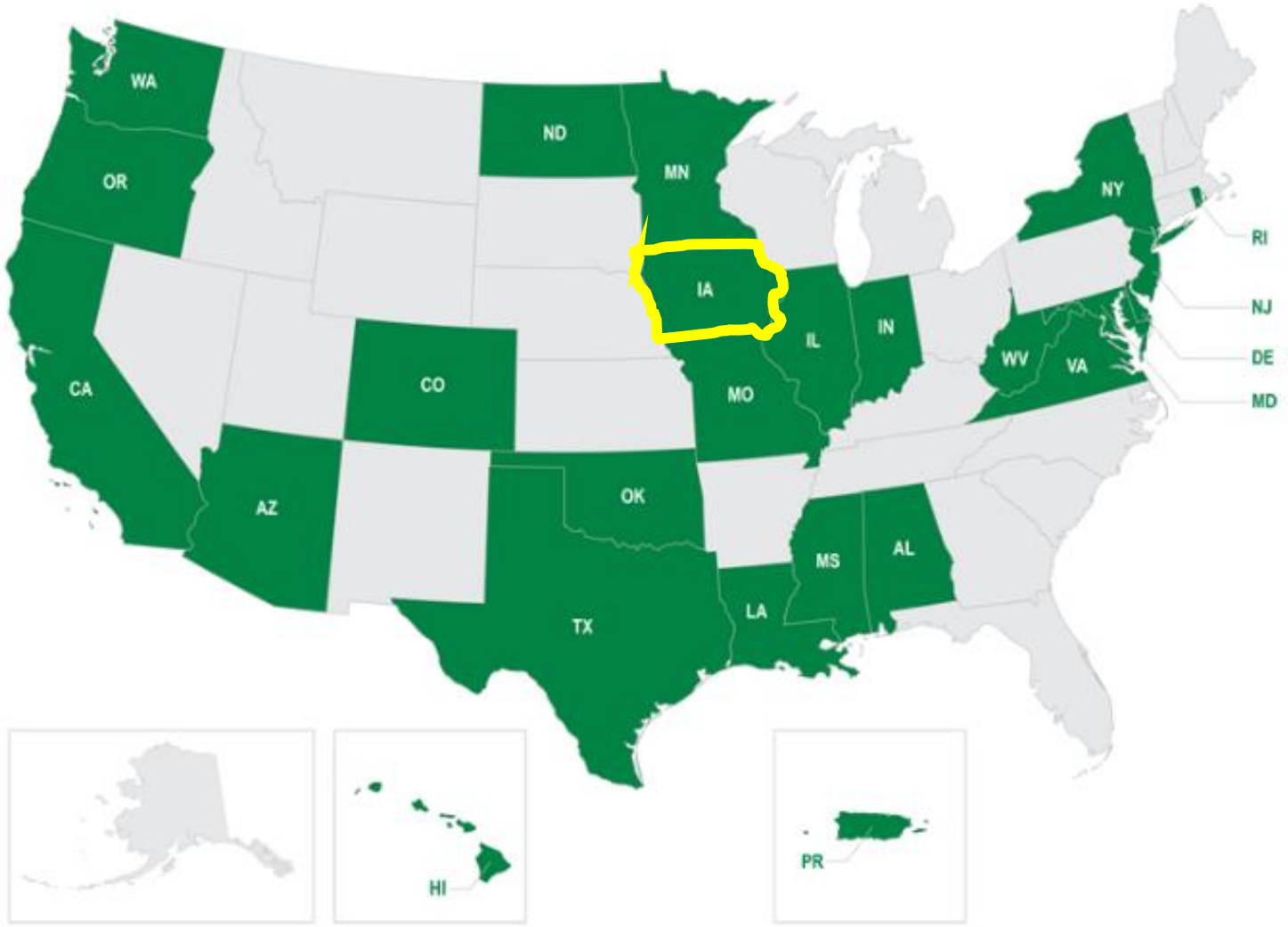
FHWA's Climate Challenge Process

What Is the Process?

1. Informational Phase
2. Project Phase
3. Showcase and Implementation Phase



Who applied…?



- FHWA's Climate Challenge identified more than 35 projects from 27 agencies, providing $7.1 million to 25 state departments of transportation.
- IADOT won a $312K grant, led by CP Tech Center.

Relevance to Iowa?

Federal legislative efforts related to EPDs…

- $250 Million for Environmental Product Declarations (EPD) Assistance
- $100 Million for **Low-Embodied Carbon** Labeling for Construction Materials
- $2.15 Billion for Use of **Low-Carbon** Buildings
- $2 Billion for **Low-Carbon Transportation** Grants

$4.5B

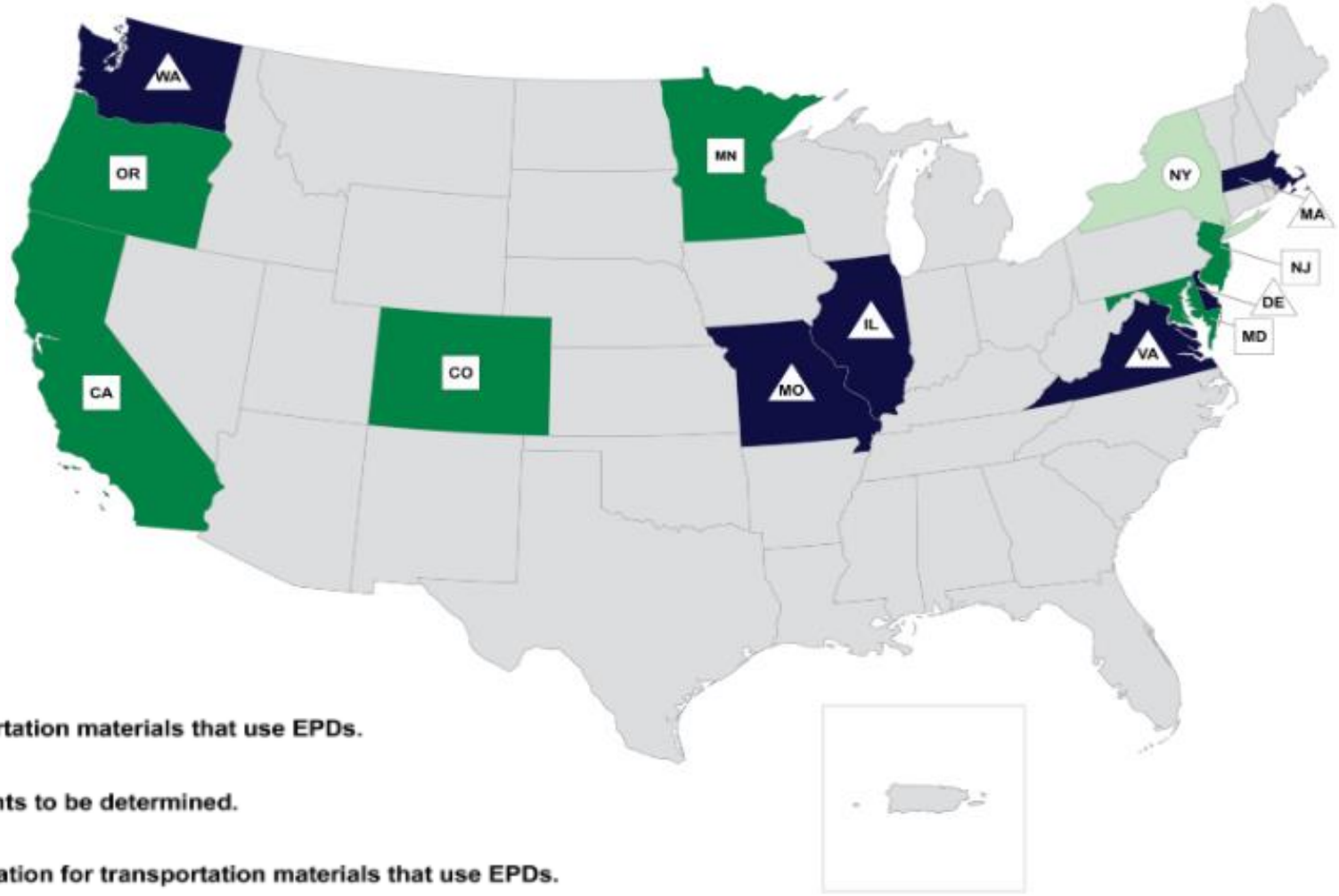
2022 Inflation Reduction Act

Relevance to Iowa?

- **State initiatives** ➔
- EDC 7 technology

https://www.fhwa.dot.gov/innovation/everydaycounts/

- Enhance understanding
- Opportunity to prepare…



Talking Points

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Iowa DOT

Contact Information:
Todd Hanson
✉:*todd.hanson@iowadot.us*

Use of EPDs and LCA to quantify emissions and associated impacts of material and design decisions to enhance sustainable pavement practices in Iowa

Project Goals:

(1) **Understand what is involved in requiring contractors to use EPDs and informing sustainable decision-making.**
(2) **Establish strategies to collect EPDs, implement LCA, and reduce impacts of pavements through changes in materials, design, and maintenance.**
(3) **Provide training/workshop to Iowa contractors and Iowa DOT Staff.**
(4) **Develop a state-of-the-art estimates of embodied emissions, use phase emissions, end-of-service emissions, and use phase excess fuel use and costs.**

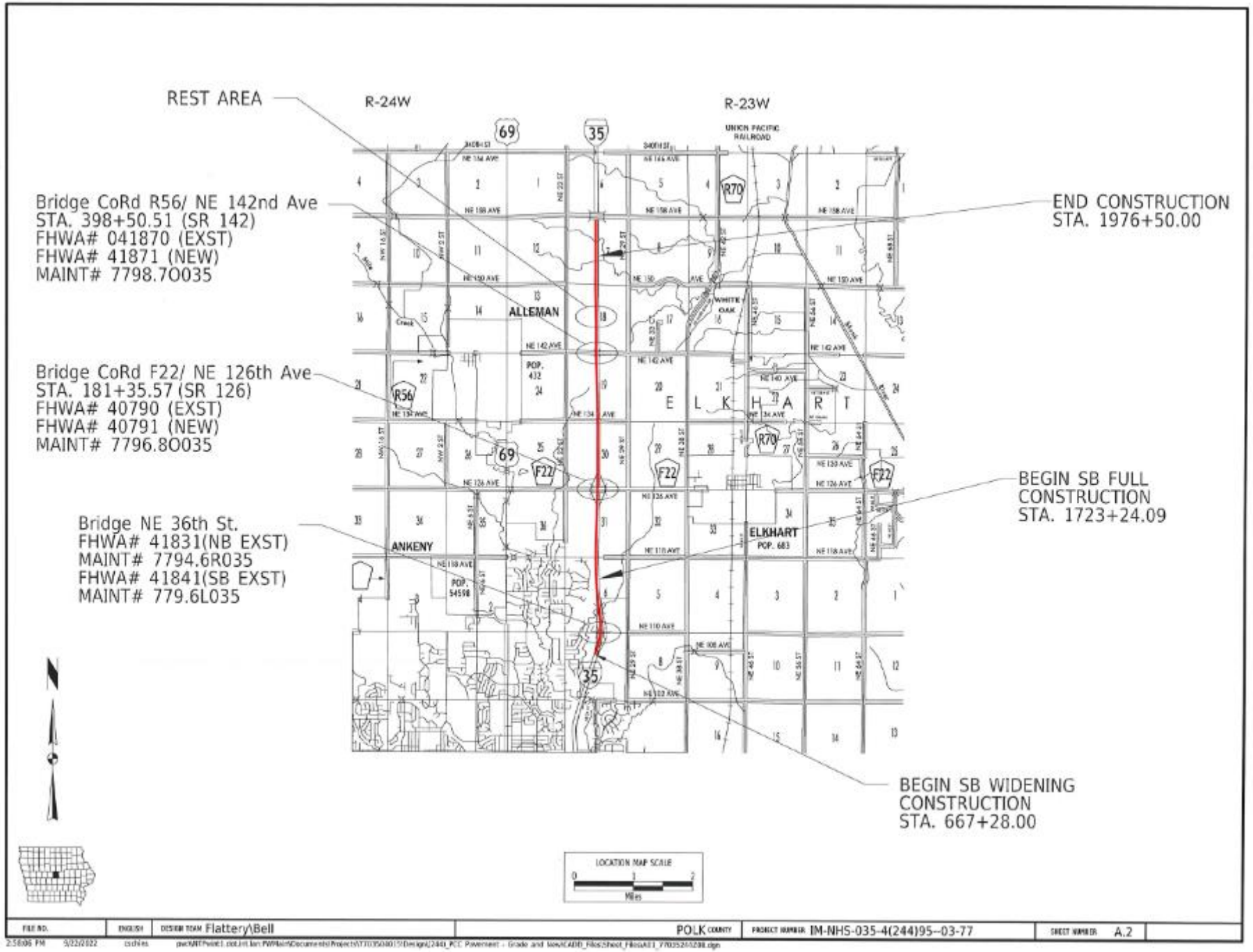
Project Tasks:

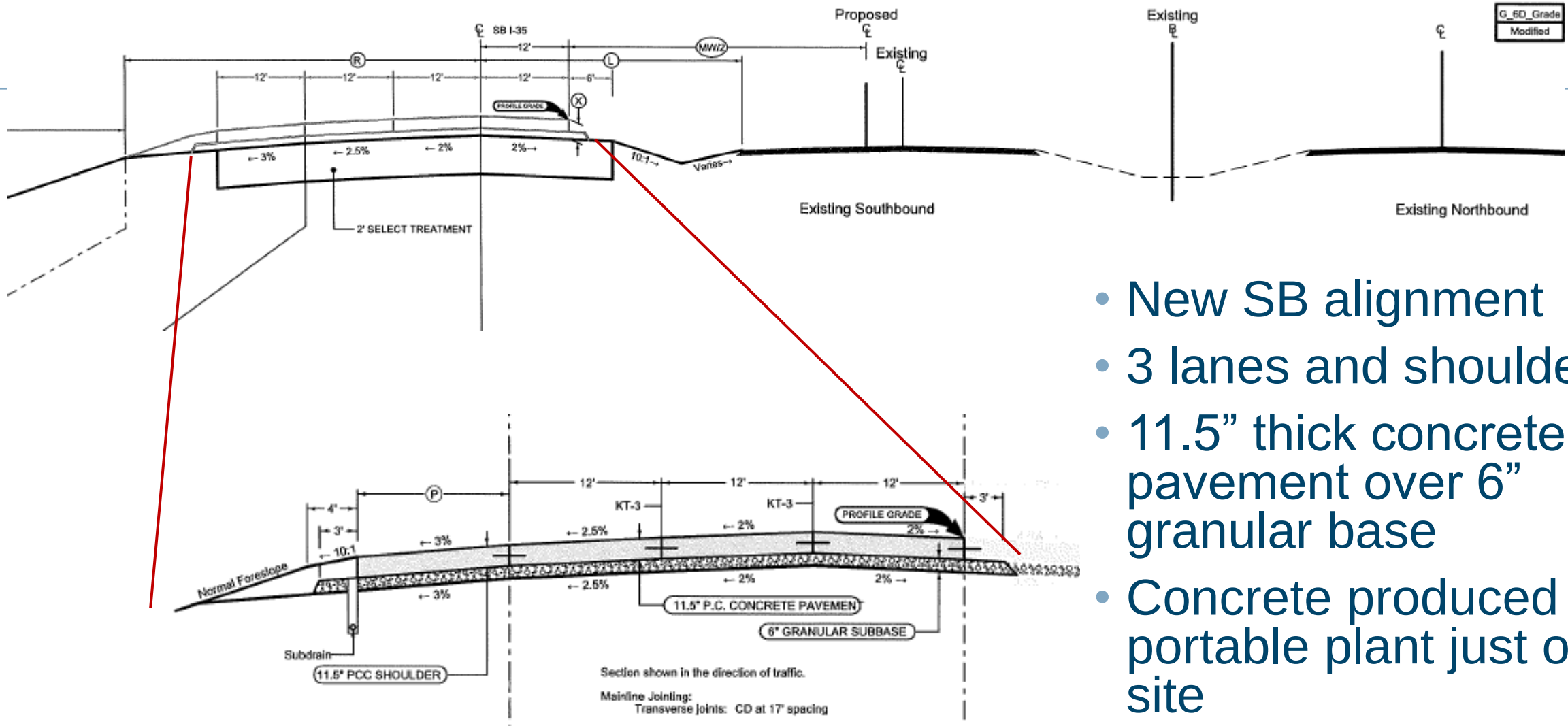
- Establish what type of adjustments will be necessary to adequately capture portable plants
- **Enable Iowa DOT and Iowa paving industry to better understand the level of effort required to generate EPDs**
- Identify areas where improvements in data collection, education and training are needed to facilitate possible routine EPD generation in the future.
- **Inform a benchmarking analysis of current Iowa DOT concrete paving operations**.
- Enhance Iowa DOT understanding of the complete life cycle impacts (including use-phase) associated with pavement assets and inform improved decision-making in the pavement arena to lower the GHG emissions associated with Iowa's pavement assets.

Project Details

IM-NHS-035-4(244)95--03-77

- I-35 southbound
  - Between Huxley and Ankeny
- New alignment
- ~4.8 miles
- 2023/24 construction seasons



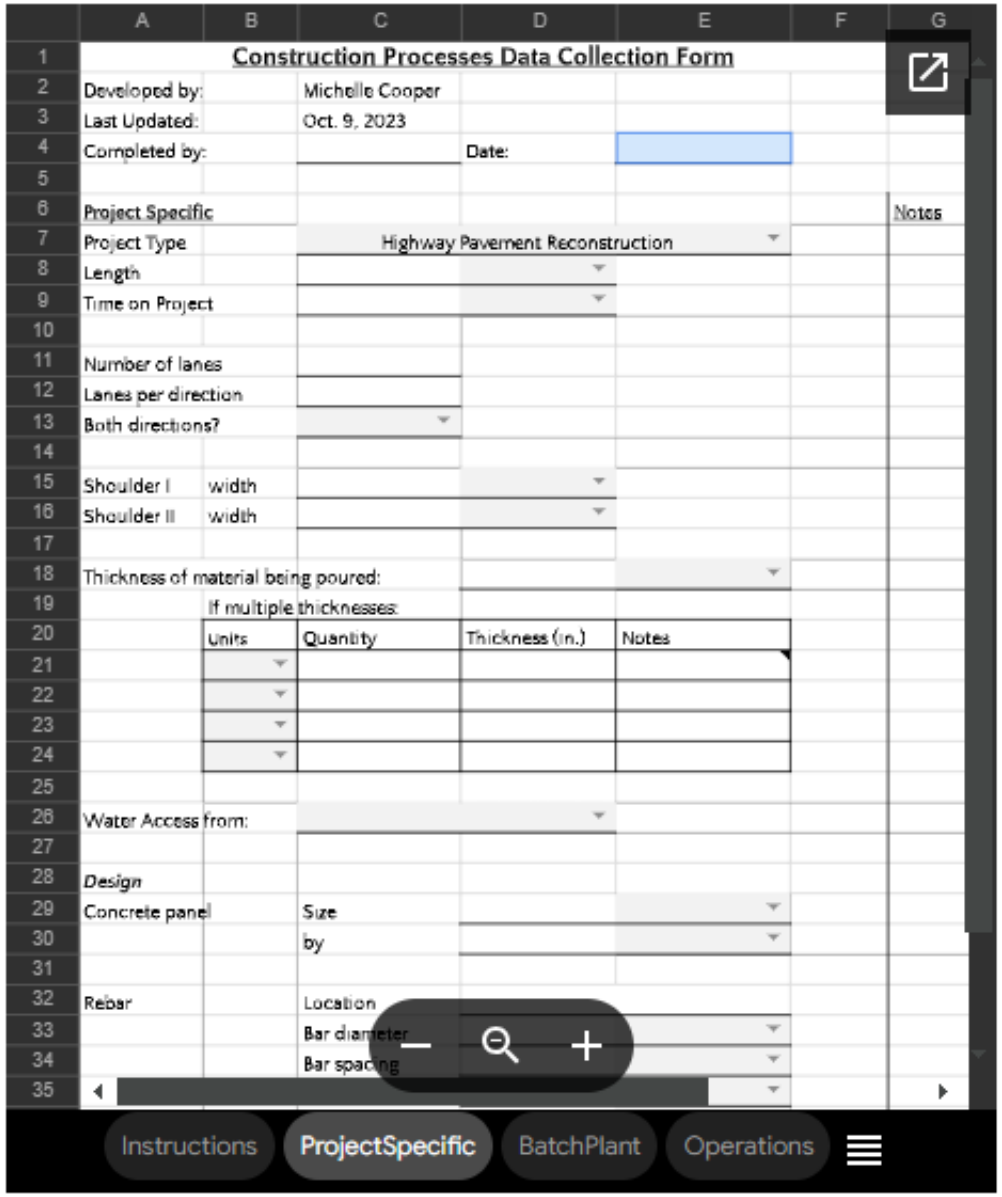


- New SB alignment
- 3 lanes and shoulder
- 11.5” thick concrete pavement over 6” granular base
- Concrete produced at portable plant just off site
- Paver/producer is CTI

Progress to Date

- A kickoff meeting on October 26 with the CP Tech Center research team, IA DOT and CTI personnel.
- Identified tentative dates for data collection during mainline paving. Preliminary data collection was initiated via spreadsheets.
- Research Team collected data on-site on November 14 and 15, documenting operations at the plant and on grade.
- Data analysis has been initiated and is ongoing by both EPD subcontractor (WAP Sustainability) and LCA subcontractor (MIT Concrete Sustainability Hub).
- A project TAC has also been identified for this effort.

Todd Hanson, Chris Brakke, Elija Gansen, Greg Mulder, Lisa McDaniel



Construction Processes Data Collection Form

Developed by:		Michelle Cooper				
Last Updated:		Oct. 9, 2023				
Completed by:			Date:			
Project Specific						Notes
Project Type		Highway Pavement Reconstruction				
Length						
Time on Project						
Number of lanes						
Lanes per direction						
Both directions?						
Shoulder I	width					
Shoulder II	width					
Thickness of material being poured:						
	If multiple thicknesses:					
	Units	Quantity	Thickness (in.)	Notes		
Water Access from:						
Design						
Concrete panel		Size				
		by				
Rebar		Location				
		Bar diameter				
		Bar spacing				

Instructions | ProjectSpecific | BatchPlant | Operations

DATA COLLECTION

The crucial data for determining construction operations emissions includes:

- fuel consumption rates,
- production rates, and
- materials quantities.

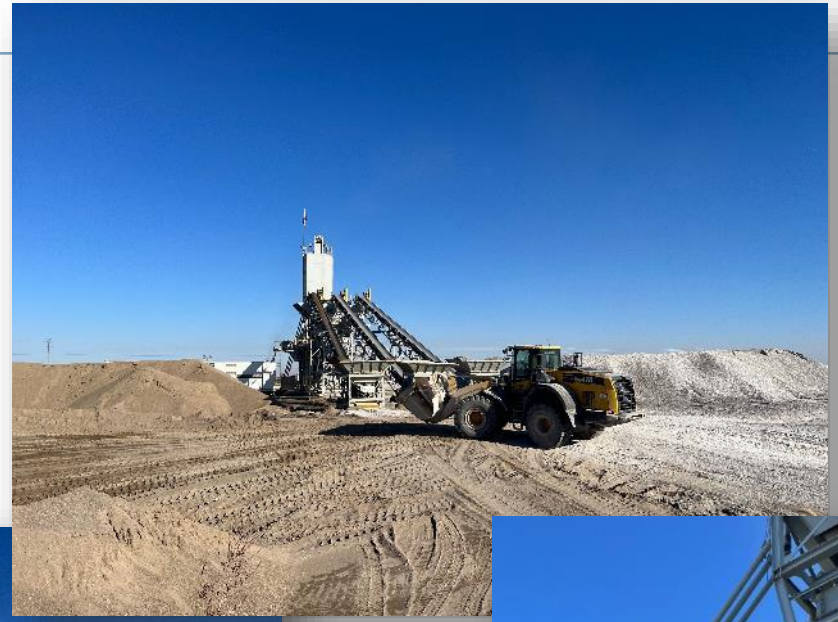
Data for construction operations emissions can be feasibly estimated without interrupting construction operations by reports from equipment operators, job site managers, and batch plant managers. In addition, certain production rates and materials quantities can be measured on-site.

Project Data

Construction Processes Data Collection Form

Developed by:	Michelle Cooper			
Last Updated:	Oct. 9, 2023			
Completed by:	Beau Sprouse	Date:	10/31/2023	
Project Specific				
Project Type	Highway Pavement Reconstruction			
Length	5	mi		
Time on Project	4	months		
Number of lanes	3			
Lanes per direction	3			
Both directions?	No			
Shoulder I width	12	ft		
Shoulder II width	6	ft		
Thickness of material being poure		11.5	inches	
If multiple thicknesses:				
Units	Quantity	Thickness (in.	Notes	
yd2	22464	10	Mainline Rural	
yd2	132990	11.5	Interstate Mainline	
Water Access from:	city water			
Design				
Concrete panel	Size	12	ft	
	by	20	ft	
Rebar	Location	Centerline		
	Bar diameter	8-May	inches	
	Bar spacing	15	inches	
	Grid area			
	Grid spacing			

Batch Plant Data



Construction Processes Data Collection Form

Developed by:	Michelle Cooper				
Last Updated:	Oct. 9, 2023				
Completed by:	Beau Sprouse	Date:	10/31/2023		
Batch Plant					
Concrete Trucks					
Number of concrete trucks:		typical	15		
		busy day	22		

Concrete Mixture Design

Cement	Type	1L			
	Content	444	lbs/yd3		
	Source		or Distance	80	miles
SCM	Type	Flyash			
	Content	20%	lbs/yd3		
	Source		or Distance	75	miles
Fine Aggregate	Type	Sand			
	Content	1360	lbs/yd3		
	Source		or Distance	25	miles
Intermediate	Type	Limestone Chips			
	Content	475	lbs/yd3		
	Source		or Distance	25	miles
Coarse Aggreg	Type	1 1/2" Limestone			
	Content	1475	lbs/yd3		
	Source		or Distance	25	miles
Water	Content	20		gallons	
	Source	City	or Distance	0.05	miles
Admixture I	Type	WR			
	Content	15	other	ounces	
	Source		or Distance	50	miles
Admixture II	Type	Air			
	Content	12	other	ounces	
	Source		or Distance	50	miles
Dowel Bar	Diameter	1.5	inches		
	Length	20	inches		
	Spacing	12	inches	c-c	
		OR		per panel	
	Source		or Distance	125	miles
Ties	Diameter	0.63	inches		
	Length	30	inches		

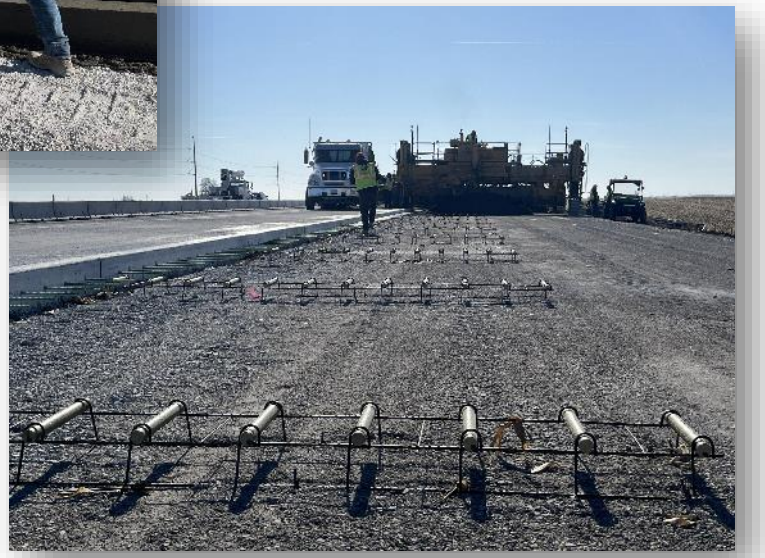
Paving Operations Data

Construction Processes Data Collection Form

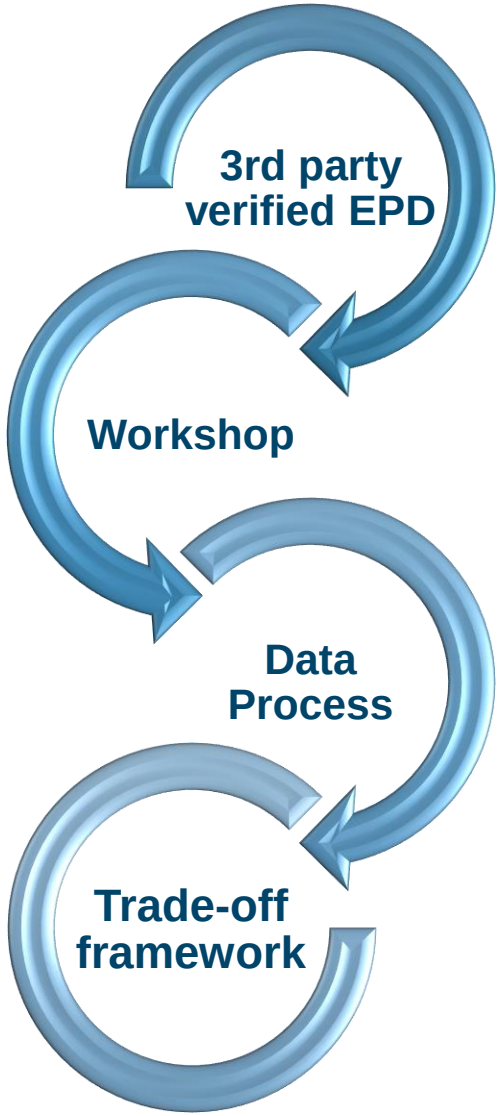
Developed by:	Michelle Cooper		
Last Updated:	Oct. 10, 2023		
Completed by:	Beau Sprou	Date:	10/31/2023

Operations	Production Rates					
Equipment	Mainline paving (typical	1000	linear ft	per		day(s)
Paver	minimum	500	linear ft	per		day(s)
Texturing mac	maximum	3500	linear ft	per		day(s)
Belt placer	Ramp paving (typical)	1000	linear ft	per		day(s)
Skid steer	minimum	400	linear ft	per		day(s)
Saw cutter	maximum	2000	linear ft	per		day(s)
Roller	Shoulder paving (typica	500	linear ft	per		day(s)
Fine grader	minimum	250	linear ft	per		day(s)
Dump truck	maximum	1000	linear ft	per		day(s)
Pickup truck	Grinding (typical)			per		
Water truck	minimum			per		
	maximum			per		
	Grading / Trimming (typ	2000	linear ft	per		day(s)
	minimum	1000	linear ft	per		day(s)
	maximum	5000	linear ft	per		day(s)
	Roller Compacting (typical)			per		
	minimum			per		
	maximum			per		
	Curing machine (typical	1000	linear ft	per		day(s)
	minimum	400	linear ft	per		day(s)
	maximum	3500	linear ft	per		day(s)
	Texturing machine (typi	1000	linear ft	per		day(s)
	minimum	400	linear ft	per		day(s)
	maximum	3500	linear ft	per		day(s)
	Saw cutting (typical)	2200	linear ft	per		day(s)
	minimum	880	linear ft	per		day(s)
	maximum	7700	linear ft	per		day(s)
	Hand Compacting (typical)			per		
	minimum			per		
	maximum			per		
	Hand-spray Curing (typical)			per		
	minimum			per		

Water Consur



Next Steps…



- Development of 3rd party verified EPD for mobile plant (‘theta’ license for up to 3 plants)
- A workshop, in collaboration with FHWA, to educate contractors and agency participants
- Data collection and organization process for concrete paving projects in Iowa, and associated benchmark/life cycle information model for concrete paving
- Trade-off framework for informing decision-making with both embodied and operational carbon considerations.

Outcomes…

- Better understand what is involved in developing EPDs
- State-of-the-art estimates of embodied and use phase emissions and costs.
- Establish strategies to reduce impacts of pavements

13th INTERNATIONAL CONFERENCE ON CONCRETE PAVEMENTS

INTERNATIONAL SOCIETY FOR CONCRETE PAVEMENTS

Minneapolis
Aug 25-29, 2024

- 100 Technical Paper Presentations
- 10 four-hour workshops and Student Competitions
- MnROAD and City Street Tours
- Social Events, Food, and Fun!
- National Concrete Consortium (NCC)
- **www.13thiccp.concretepavements.org**

NRRA National Road Research Alliance

MnROAD SAFER, SMARTER, SUSTAINABLE PAVEMENTS THROUGH INNOVATIVE RESEARCH

EUPAVE EUROPEAN CONCRETE PAVING ASSOCIATION

ASCP AUSTRALIAN SOCIETY FOR CONCRETE PAVEMENTS


THANK YOU!
IOWA STATE UNIVERSITY
Institute for Transportation
National Concrete Pavement Technology Center
Tech Center