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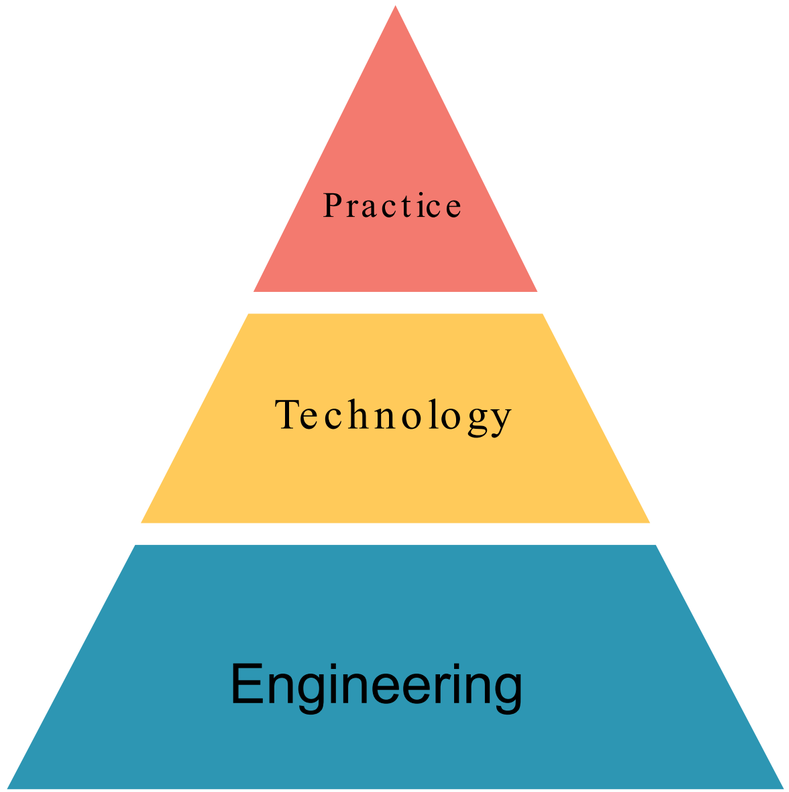
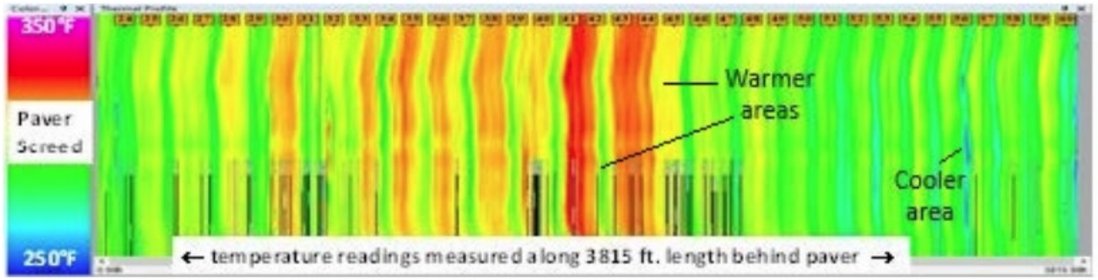
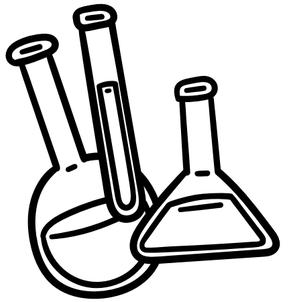
Warm Mix Asphalt and Workability:

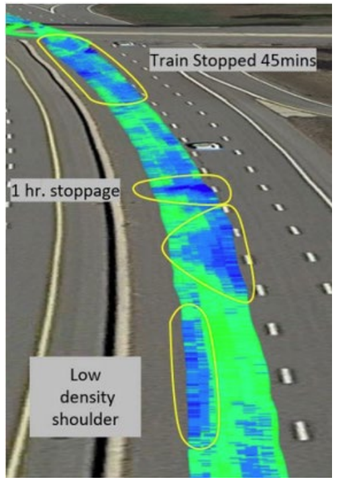
Practical Outcomes from an Incentive -Based Approach

Colorado Asphalt Pavement Association


Practice
Technology
Engineering


350°F
Paver
Screed
250°F
Warmer
areas
Cooler
area
← temperature readings measured along 3815 ft. length behind paver →




Train Stopped 45mins
1 hr. stoppage
Low
density
shoulder

Sustainability: The Full Picture

Sustainability isn’t a separate goal; it’s part of delivering quality.

When we talk about building roads for the future, we also have to focus on building the best roads we can today.

Thinking holistically about sustainability means considering the full picture: materials, performance, durability, and environmental impact.

Sustainability should never come at the cost of quality. In the asphalt industry, we’re constantly working to find that balance of delivering long lasting pavements with the resources available to us.

We may not control every factor, but what we can control, we’re improving through smarter specifications, better materials, and more efficient practices. That’s how we take responsibility for both sustainability and quality.

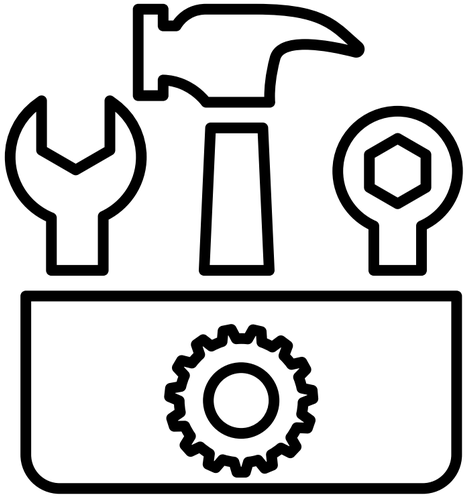
NAPA
NATIONAL ASPHALT
PAVEMENT ASSOCIATION

ROCKY MOUNTAIN
ASPHALT CONFERENCE & EQUIPMENT SHOW

The Road Forward

A Vision for Net Zero Carbon Emissions
for the Asphalt Pavement Industry

The Toolbox We Can Use Today



RAP + Mix Optimization

Push the boundaries of recycled asphalt in our mixes by using rejuvenators and oil types to blend.

Warm Mix

Use of WMA additives to improve workability and reduce temperatures.

Balanced Mix Design

Optimize mixes with cracking and rutting potential.

Definition: What is Warm Mix Asphalt

NAPA Definition: Warm mix asphalt is the generic term for various technologies that allow the producers of asphalt pavement material to lower the temperatures at which the material is mixed and placed on the road by at least 10 °F.

Warm mix asphalt represents a group of technologies that allow a reduction in the temperatures at which asphalt mixes are produced and placed. These technologies provide complete aggregate coating at lower temperatures and act as compaction aids. The mechanisms that allow larger temperature reductions, better coating, and compaction at low temperatures vary from one technology to another.

Benefits over conventional asphalt

Improved fuel usage

Improved working conditions

Reduced plant emissions

Compaction aid

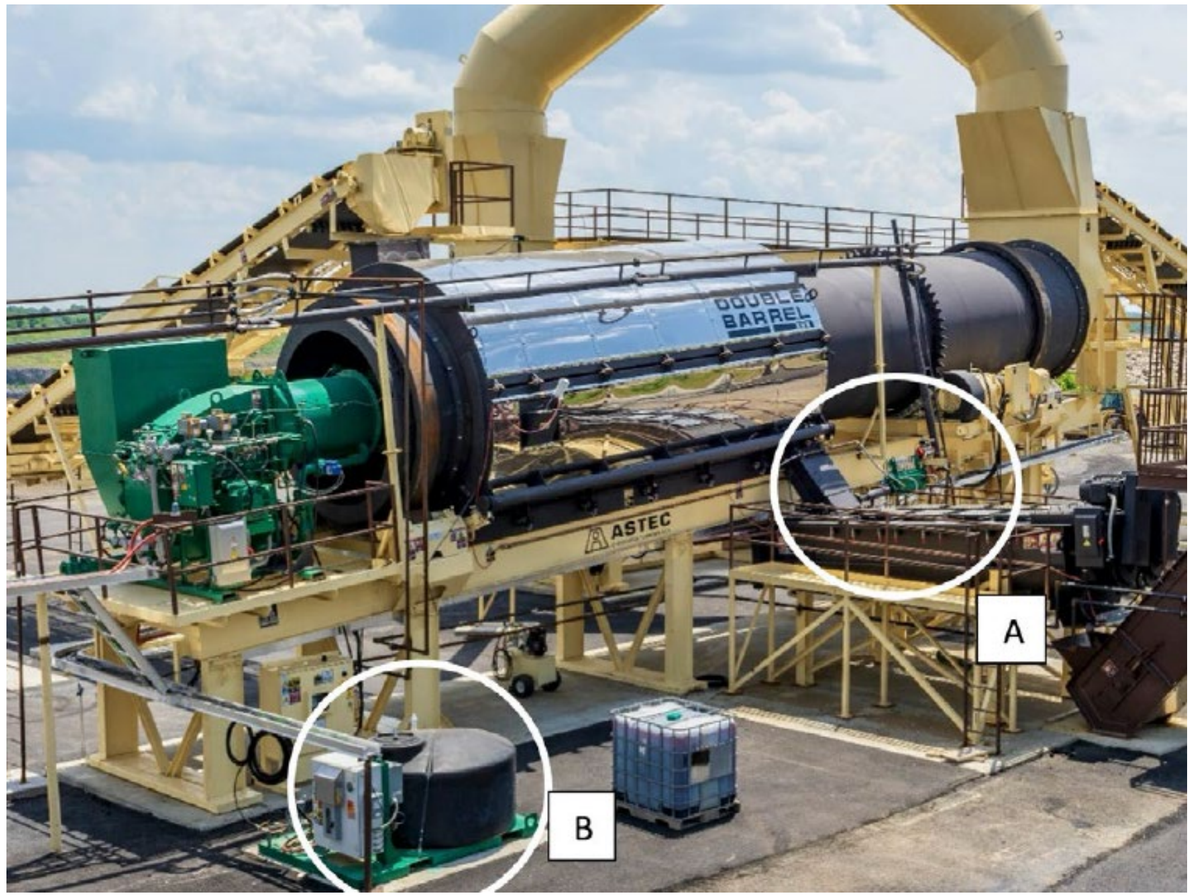
Ability to pave in cooler ambient temperatures

Increase haul distances

WMA Technologies Available

Foaming

Introduce small amounts of water into the asphalt binder and rely on the expansion of the water as it turns to steam. In turn, this causes microscopic steam bubbles to for which results as an increase in the binder volume and lower viscosity. This improves the coating of aggregate particles during mixing.



(A) Multi - nozzle Foaming Manifold
(B) Water Skid

Chemical Additives

Chemical additives are typically emulsions and surfactants that improve the ability of the binder to coat the aggregate by reducing the surface energy of the aggregate/binder interface, as opposed to reducing the binder viscosity. Chemical additives typically work on a microscopic level at the interface of the binder and aggregate to reduce the frictional forces at that interface, generally within a range of temperatures typically between 185 and 285°F. Reducing the frictional forces improves the lubrication between the binder and aggregate during mixing and compaction

(Caputo et al., 2020).

Organic / Wax -type additives

Organic additives are usually waxes (natural or synthetic) and fatty amides, which can reduce the viscosity of the binder above the melting point of the binder. Waxes suitable for WMA applications have melting points below conventional mixture production temperatures, and they become dispersible in the mix during the mix production process.

Approved Products List

COLORADO
Department of Transportation

CDOT Approved Products List

Technology Name	Technology Type	Supplier
Accu-Shear	Warm Mix Asphalt (Foam)	Stansteel
Anova 1501	Warm Mix Asphalt	Cargill
AquaBlack Solutions	Warm Mix Asphalt (Foam)	Maxam
Evotherm 3G (J, M, & P Series)	Warm Mix Asphalt	Ingevity
Evotherm DAT (F6 and H5)	Warm Mix Asphalt	Ingevity
Green System	Warm Mix Asphalt (Foam)	Astec, Inc
Rediset LQ	Warm Mix Asphalt	Nouryon (formally Akzo
Super Anti-Strip	Warm Mix Asphalt	StarChem USA
Ultrafoam GX2	Warm Mix Asphalt (Foam)	Gencor
WarmGrip ULTRA 1	Warm Mix Asphalt	Arkema-Road Science
WarmGrip ULTRA 37N	Warm Mix Asphalt	Arkema-Road Science
Zycotherm SP	Warm Mix Asphalt	Zydex

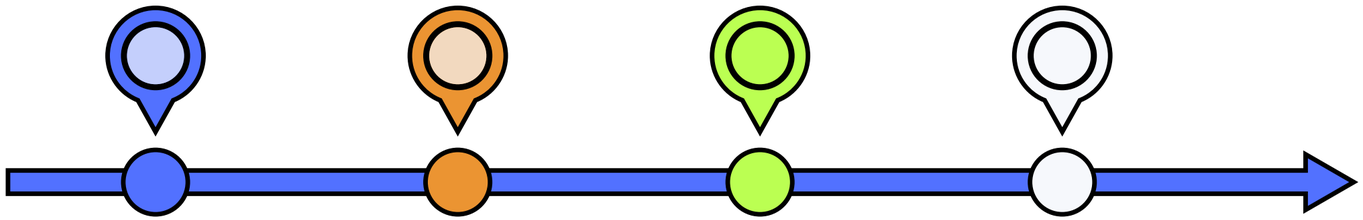
Minnesota Context: Why This Took Off

Minnesota EPD Mandate

Accelerated real conversations with industry & agency

Focus: What is achievable now

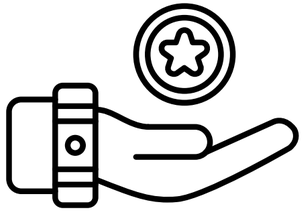
The toolbox



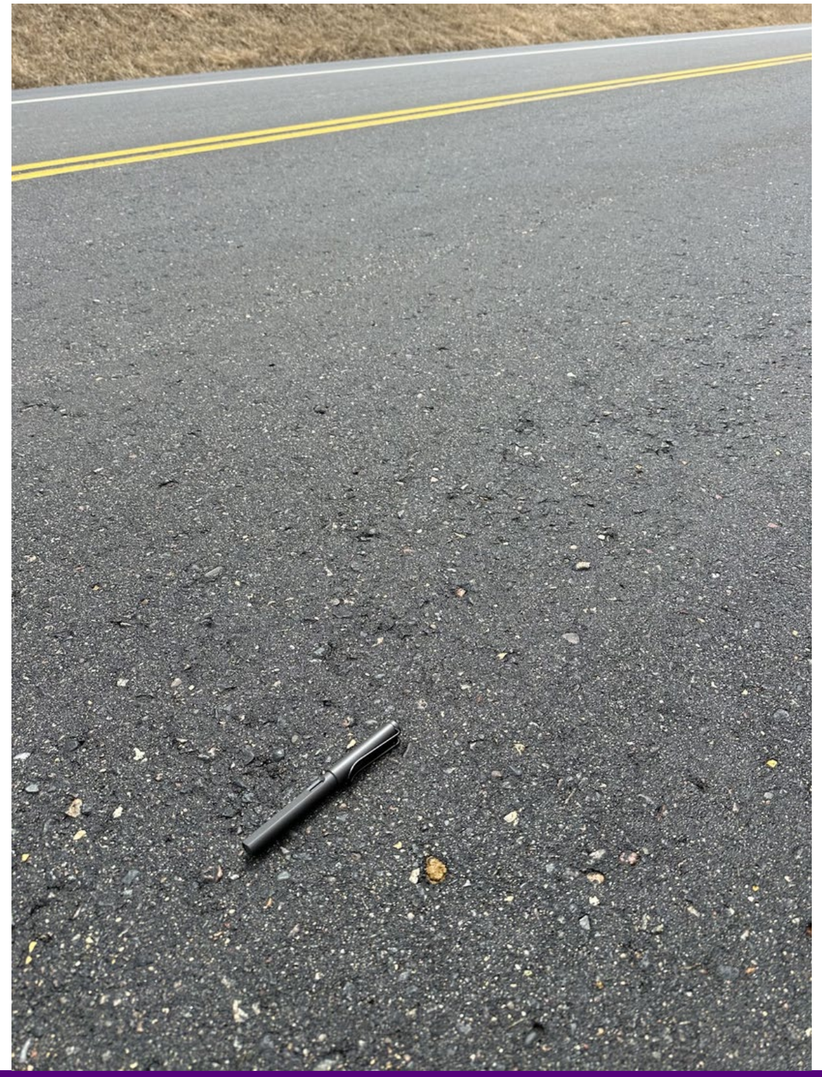
Specification Options: Mandate vs Incentive

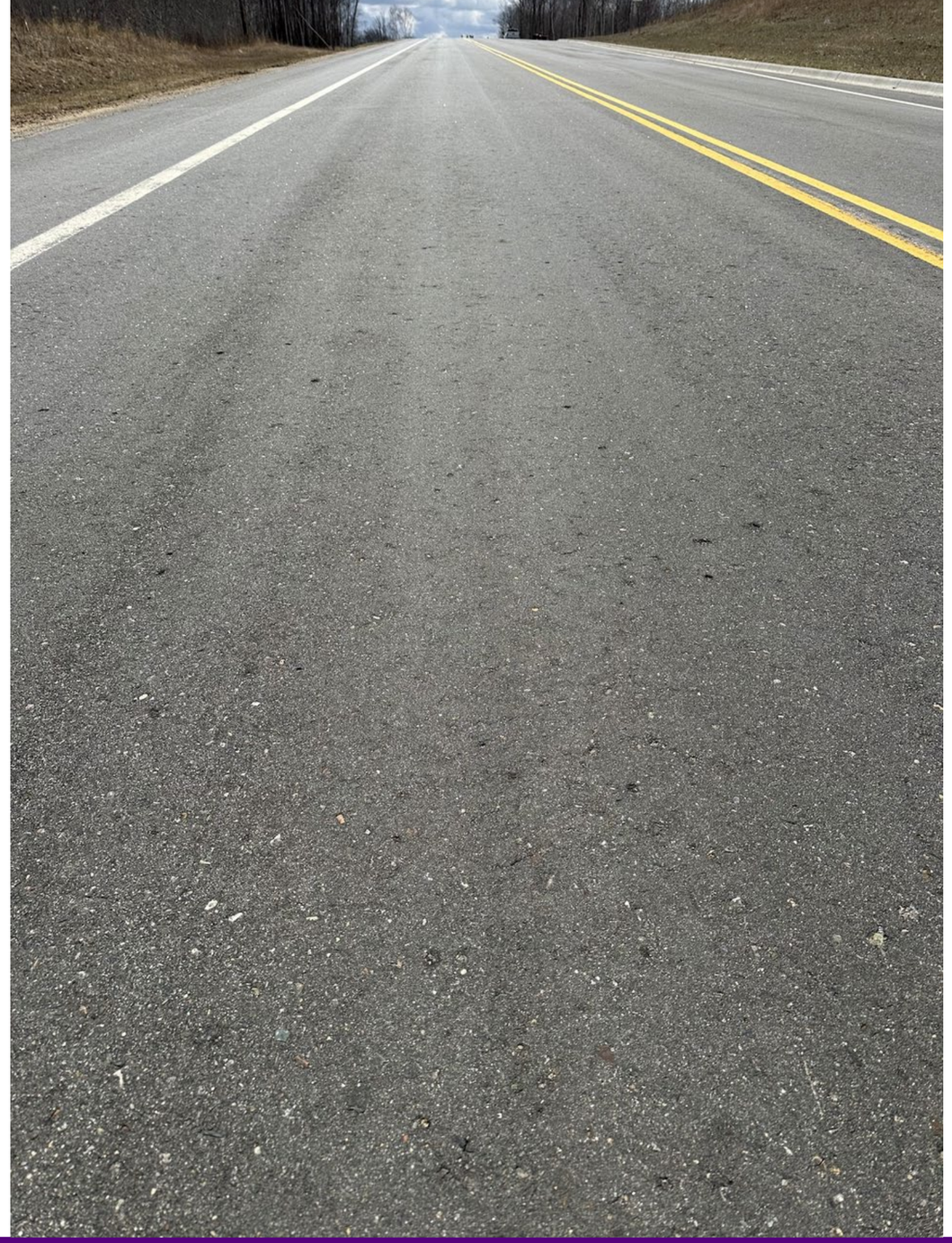
- Rigid mandate (with or without bid item)

- Incentive - based temperature targets



Case Study: MN County





MnDOT Insentive Based Specification

S-1 (2360) PLANT MIXED ASPHALT PAVEMENT (WARM MIX ASPHALT (WMA) OPTION WITH INCENTIVE PAYMENT)

S-1.1 Delete and replace MnDOT 2360.2C.4 with the following:

C.4 Warm Mix Asphalt (WMA) Option with Incentive Payment

WMA is an approved alternative to HMA. Any mix that is produced with a non-wax based warm mix chemical additive with a temperature less than or equal to 275°F as measured exiting the drum and recorded on the plant recordation system will be considered as WMA. Provide documentation the discharge temperature measuring device (sensor) has been calibrated for the current construction season. The Department will pay an incentive based on the HMA contract unit price for WMA produced in accordance with Table 2360.2-1A. An incentive will not be paid if the temperature sensor or the 20 minute recordation export is not functioning properly.

Plant mixing temperatures greater than 275°F will be allowed for the first 100 tons of daily production to allow for plant warm-up. That tonnage will be included in the incentive payment. Incentive payment for each mix type will be based on the day's average plant mixing temperature as determined from the 20 minute plant recordation. Excluding the first 100 tons of daily production, there will be no incentive payment for each mix type if more than 10 percent of the daily discharge mix temperature readings are above 275°F. Provide plant and laboratory mixing and compaction temperatures for temperature and dosage rates as determined by the manufacturer of the additive to the Engineer. The Department will not pay any WMA Incentive if greater than 25 percent of all density lots for the Project fail to meet the minimum density requirements in accordance with 2360, "Plant Mixed Asphalt Pavement." Use the composite pay factor for mainline density lots with longitudinal joint density.

Table 2360.2-1A

Warm Mix Asphalt Incentive Payment

Plant Mixing Temperature	Incentive Payment, percent
> 275°F	0
250°F - 275°F	2
< 250°F	4

MnDOT Insentive Based Specification

- Plant start up temperatures greater than 275F allowed for first 100 tons each day. That tonnage is included in incentive payment.
- Incentive payment is based on day's average plant mixing temperature printed on 20-minute plant recordation report.
- No incentive payment if more than 10 percent of daily discharge mix temps are above 275F.
- No incentive if greater than 25 percent of all density lots for the project fail to meet minimum density requirements.

				Avg. Density	
TH	**Percent of Max. Possible Incentive Earned**	**Mix Type**	**Avg. Daily Plant Temp. (ºF)**	**Mat Density**	**LJD**
73	52%	SPWEB340C	254	93.1	91.1
60	65%	SPNWB530B	262	92.7	91.9
		SPWEB540F		92.9	91.2
14	70%	SPWEB450E	255	93.4	90.2
22	90%	SPWEB340E	239	94.5	94.6

MnDOT Insentive Based Specification

- TH 14
  - Overall satisfied with project outcome
    - Would be interested in producing WMA again on future projects
  - Production at a permanent plant along with urban paving posed a challenge during construction
    - Producing WMA along with additional hot mixes introduced fluctuating plant temperatures during production
- TH 22
  - Plant ran well with average plant production temps around 240°F
    - Good densities were achieved
  - Areas requiring handwork were a challenge
  - No major struggles.

MnDOT Insentive Based Specification

- TH 73
  - Overall project went well
  - Were able to get better densities when producing mix < 250°F
  - Better on baghouse and lab equipment was cleaner
- TH 60
  - Good finished product
  - Higher traffic level mix with high amounts of quartzite made compaction a challenge
  - Production at plant went well

MnDOT 2026 WMA Projects

- District 1
  - SP 3809-09 TH169 (High RAM too!)
  - SP 6908-68, TH 2
- District 2
  - SP 0410-51, US 71
  - SP 6806-31, TH 89
- District 4
  - SP 8402-24, TH 9
- Metro
  - SP 1923-48, TH 50
- District 6
  - SP 8580-175, I90 EB&WB
  - SP 8580-178, I90 WB
  - SP 6603-30, TH 19
- District 8
  - SP 6502-17, TH 4 (TBD)

Questions?

4 practical takeaways

Incentives beat cliffs

Protect performance

Verify with field data

Keep it simple