

# Rejuvenated Cold Recycling





# Background

- Conglomeration of materials from many projects
- Surface treatments, legacy mixes, Superpave, etc.
- Often quality Superpave rock, sand, filler, binder
- **RAP as an asset that should be optimally monetized**
- Cutback rejuvenation in the northeast since early 80s
- Green rejuvenation options for cutback replacement
- High polymer emulsions for more robust designs.



# Background





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# Proven History

- 2012 VDOT on Track<sub>3</sub>, Lee Road 159<sub>1</sub>
- 2015 US-280<sub>4</sub>, cold HMA plant<sub>1</sub>
- 2019 70<sup>th</sup> Street near MnROAD<sub>6</sub>
- 2021 VDOT<sub>1</sub> (re-recycling), Track off-ramp<sub>5</sub>



# 2015 CR Base<sub>s8</sub> from Cold HMA Plant





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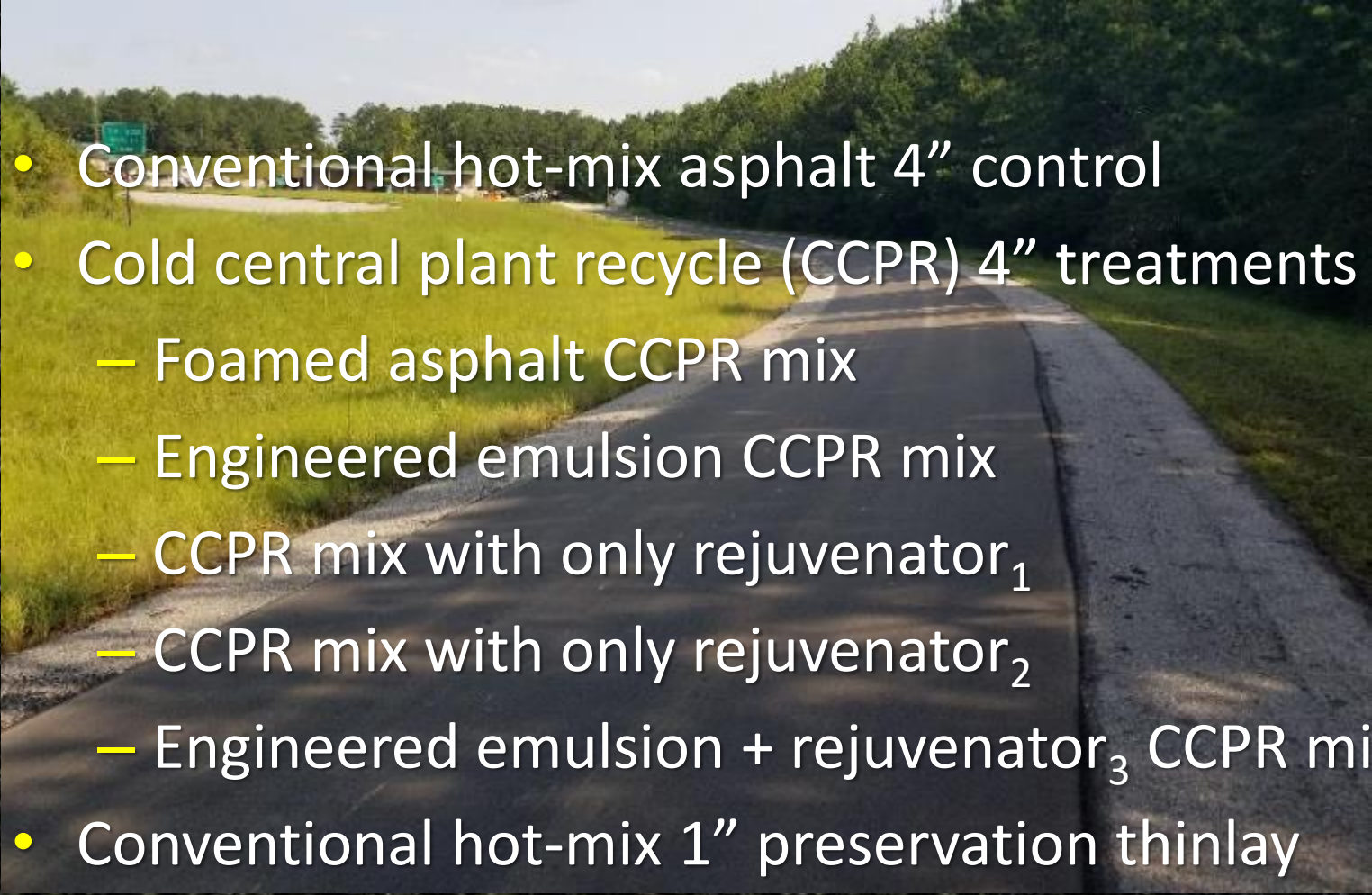


# 2015 CR Base<sub>s8</sub> from Cold HMA Plant





# 2021 Cold Recycle Ramp Sections

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- Conventional hot-mix asphalt 4" control
  - Cold central plant recycle (CCPR) 4" treatments
    - Foamed asphalt CCPR mix
    - Engineered emulsion CCPR mix
    - CCPR mix with only rejuvenator<sub>1</sub>
    - CCPR mix with only rejuvenator<sub>2</sub>
    - Engineered emulsion + rejuvenator<sub>3</sub> CCPR mix
  - Conventional hot-mix 1" preservation thinlay



# Pugmill Systems Portable Pugmill





# Pavement Restorations, Inc.





# Wirtgen KMA





# “100%” RAP Cold Recycle (CR) Mixes

- Great in/adjacent to urban areas with RAP surplus
- Room for low, medium, and high-performance mixes
- Low performance with crushed RAP right from stockpile
- Medium performance w/ processed RAP, conventional design
- High performance w/ processed RAP, enhanced design
- Conventional layer coefficient  $\approx 0.375$ , enhanced maybe more
- Standalone pugmills and cold HMA plants with downtime.



# Low Performance CR Mix

- Great in/adjacent to urban areas with RAP surplus
- Option where there is not enough space to process, store
- Pull (crush) then immediately run through cold plant
- Utilize “typical” binder content with emulsion or foam
- E.g., 3 percent emulsion or 2 percent foam, 1 percent cement
- Add water to stockpile residual for desired workability
- Place, compact like HMA (peak density with a nuclear gauge).



# Medium Performance CR Mix Design

- Great in/adjacent to urban areas with RAP surplus
- Option where there is enough space to process, store
- Pull, crush/process, stockpile, sample, standard mix design
- Establish design binder content for emulsion or foam
- Design verification w/ Marshall, indirect tensile strength (IDT)
- Adjust moisture during production for desired workability
- Place, compact like HMA (max density with a nuclear gauge).

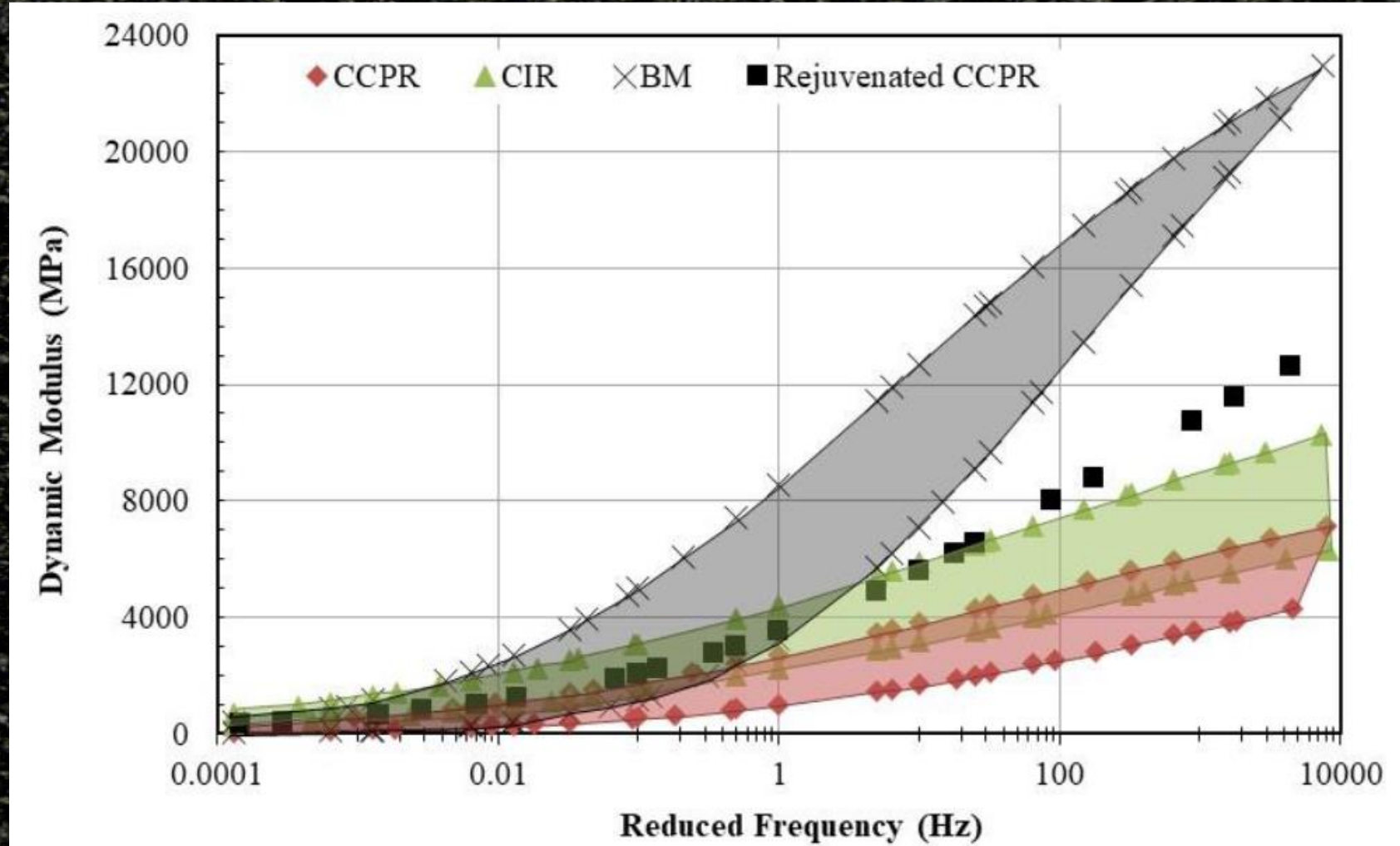


# High Performance CR Mix Design

- Great in/adjacent to urban areas with RAP surplus
- Option where there is enough space to process, store
- Pull, crush/process, stockpile, sample, enhanced mix design
- Design binder content with polymer emulsion + rejuvenator
- Adjust moisture during production for desired workability
- Production verification using Marshall, IDT, more...
- Place, compact like HMA (intelligent compaction for density).



# Rejuvenated Cold Recycle Mix





# Implementation Support

- Standardization of high-performance mix design criteria
- Vetting of RAP materials, selection of candidate project(s)
- Mix design completion, lab performance verification
- Initial mix production, quality verification of mix properties
- General technical support for mix production, construction
- Documentation for consideration of continued utilization.



# Cold Recycle Ramp Sections





# Takeaways

- Excellent performance of all cold recycle test sections
- Structural equivalence designs require thicker cold recycle
- Savings of about a third on both energy/carbon and cost
- Future with environmental product declarations (EPDs)
- Reduce/eliminate burner/haul for greatest EPD impact
- Potential for high performance from cold recycle mixes.





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