Construction Considerations in Concrete Pavement Recycling

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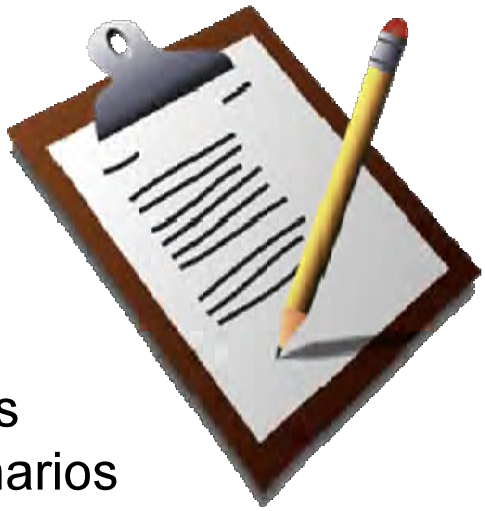
Construction Considerations in Concrete Pavement Recycling

- Webinar Outline
  - ✓RCA basics
  - ✓Equipment
  - ✓Materials
  - ✓Process
  - ✓Constraints
  - ✓Design considerations
  - ✓Example project scenarios



Recycling Basics

- Commercial recycle yard
- Mobilization of a crusher to a project
  - ✓Haul materials to a crusher site
  - ✓On-grade processing

Commercial Recycle Yard

- Mixture of source materials
  - ✓Concrete
  - ✓Masonry
  - ✓Asphalt
- RCA specifications (gradation and deleterious materials) impact the potential use of this type of material

On-Site Crusher

- Crushing, screening and stockpiling at a central location
  - ✓Interchange ramps within the R.O.W. or similar areas are ideal
- Broken concrete is hauled to the crusher site
- RCA is hauled back to the grade

Typical RCA Site

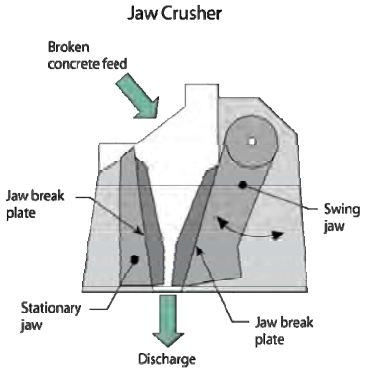
On-Grade Crusher

- Mobile crusher processes the broken concrete on the grade
- No haul-off or haul back of RCA

Typical On-Grade Crushing

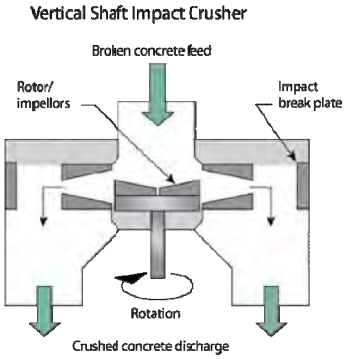
RCA Equipment

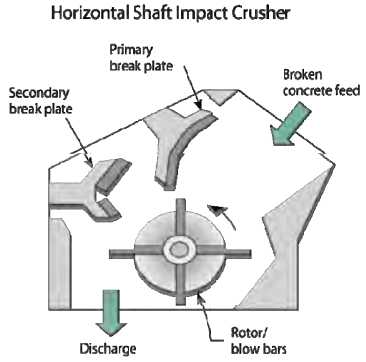
- Jaw crusher can be used as a primary crusher
  - ✓Allows feeding of larger sized pieces of broken concrete (24”)
  - ✓Helps to separate steel from the broken concrete



RCA Equipment

- Impact crusher is the most common for RCA applications
- Most steel (dowels, crcp and mesh) should be removed prior to crushing
- Smaller feed size (approx. 12” minus)





RCA Process

- In almost all cases, a screen is used to properly size the material
  - ✓Allows for increased production by returning oversized material to the crusher
  - ✓Can be used to split material on a mid-sized sieve (e.g. 3/8”) when specifications require

RCA Process

- Equipment used to produce RCA is identical to that used in a quarry producing virgin aggregates
  - ✓Similar QC results for gradation

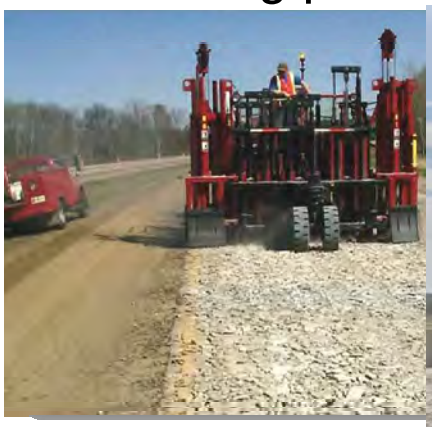
RCA Process

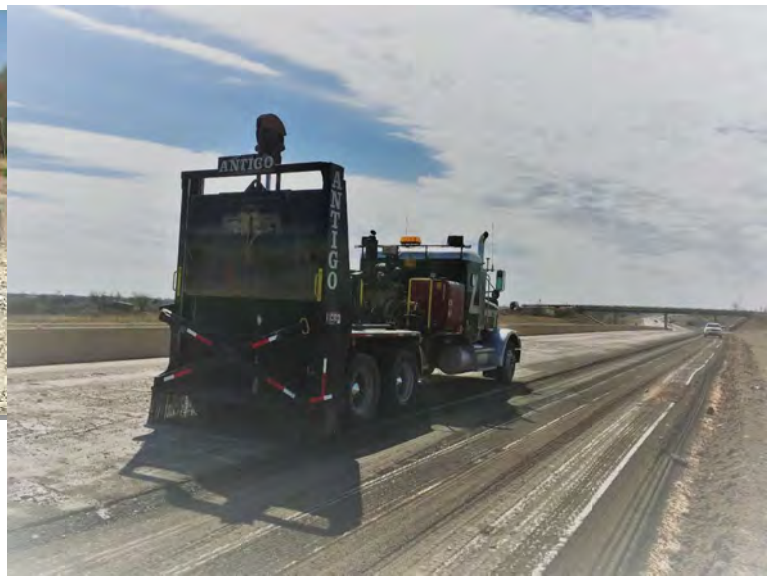
- What about existing sealant?
- What about existing bituminous patch materials?
  - ✓Unnecessary to remove prior to crushing
    - ➢Volume of these materials is negligible when compared to the volume of concrete being recycled

  - ✓… except when RCA is used as a coarse aggregate for the new concrete pavement

RCA Process

- Breaking pavement





RCA Process

- Removing Steel
  - ✓CRCP, dowels and mesh
  - ✓Tie-bars can be left in the broken concrete
  - ✓Steel is usually hauled to a salvage facility

RCA Process

- Loading and hauling

RCA Process

- Crushing and sizing

RCA Process

- Hydraulic hammer breaking over-size rubble

RCA Process

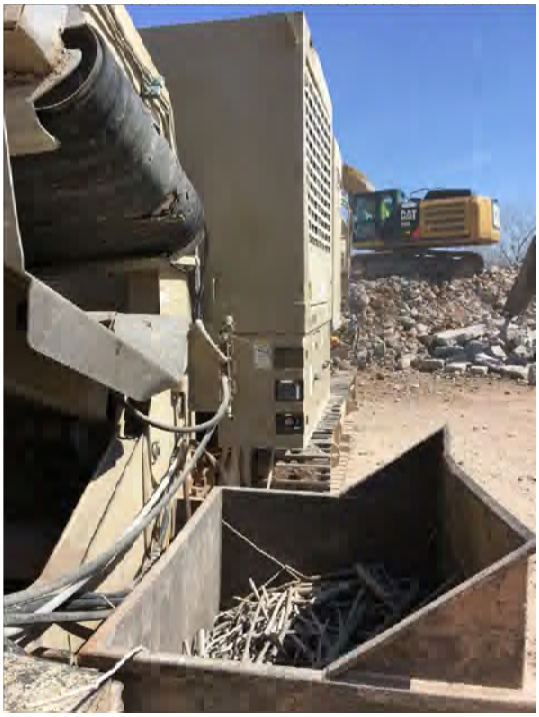
- Excavator feeding crusher

RCA Process

- Crusher

RCA Process

- Magnet



RCA Process

- Sizing screens
  - ✓Oversized returns to crusher
  - ✓Finished product transferred by conveyor

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RCA Process

- Oversize return

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RCA Process

- Stockpiling – use proper techniques to minimize segregation

On-Grade Recycling

- Same equipment
- No hauling required
  - ✓Significant cost savings
  - ✓Reduced exposure to traffic

On-Grade Recycling

- Typically used as granular base
  - ✓Dense graded or semi-drainable
- Stockpile on the existing shoulder if subgrade manipulation is required

RCA Summary

- A controlled process
  - ✓Breaking
  - ✓Crushing
  - ✓Sizing
  - ✓Stockpiling
  - ✓Return to project as quality aggregate for subbase, base, concrete, etc.

RCA Design/Construction Considerations

- Material applications
  - ✓Unbound granular base
  - ✓Bound granular base (cement treated)(plant mixed)
  - ✓Granular shoulder/backfill
  - ✓Concrete aggregate
  - ✓Other

RCA Design/Construction Considerations

- Construction processes for RCA
  - ✓Shaping and compacting of unbound base is the same as for virgin material
  - ✓However, absorption is higher so even more water will be necessary to attain optimum

RCA Design/Construction Considerations

- Construction processes for RCA
  - ✓Plant mixed materials are batched just like virgin materials
    - ➢Stockpiles must be kept moist (above SSD) to avoid absorption during the batching process
    - ➢Specific gravity of RCA is lower than virgin materials, therefore it will take less mass per CY of batched materials as compared to virgin aggregates

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RCA Design/Construction Considerations

- Fines in RCA
  - ✓Approx. 1% to 2% passing the #200 from crushing clean concrete pavement
  - ✓Additional fines come from excavating underlying soils when loading the broken concrete
  - ✓Gradation specifications should consider:
    - ➢Underlying material – subgrade vs. treated base
    - ➢Modify specification as needed (reduce the low end of % passing the #200)

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RCA Design/Construction Considerations

- Fines content comes predominantly from the underlying materials

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RCA Design/Construction Considerations

- Residual mortar particles in RCA used as concrete aggregate
  - ✓#4 and larger particles composed of mortar
  - ✓Potential for higher absorption
    - ➢Some projects have shown more distress
    - ➢Further crushing can break these particles down, but leads to inefficiencies (production and by-product)

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RCA Design/Construction Considerations

- Should RCA be mandated/specified, or should the market determine the most efficient means of constructing the project?
- Where should RCA be used?
  - ✓What are the objectives?
    - ➢Cost
    - ➢Sustainability
    - ➢Quality
    - ➢Other
  - ✓It depends …

RCA Design/Construction Considerations - Constraints

- RCA use and applications is impacted by:
  - ✓Availability of space for recycling
  - ✓Environmental permitting restrictions
  - ✓Cost of virgin materials

RCA Design/Construction Considerations - Constraints

- RCA use and applications is impacted by:
  - ✓Volume of RCA available from the project
  - ✓Timing of that availability (phasing)
  - ✓Material specifications

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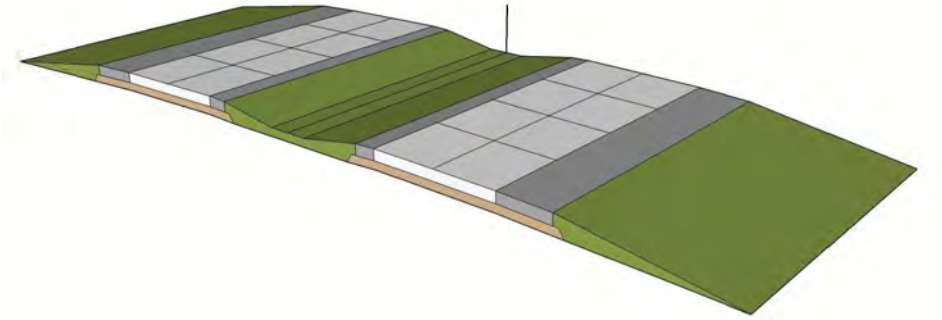
RCA Design/Construction Considerations

- Existing divided highway (5 mile project)
  - ✓8” JPCP
  - ✓HMA shoulders
  - ✓6” granular base



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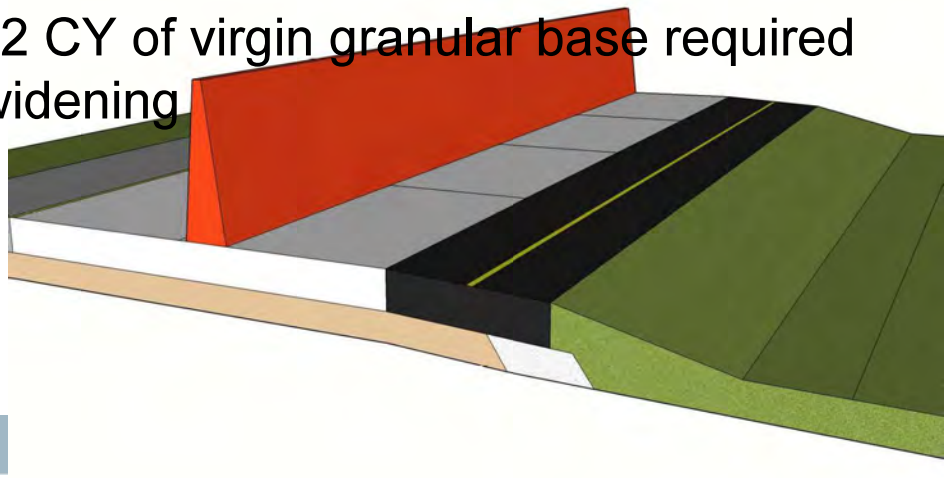
RCA Design/Construction Considerations

- Phase I
  - ✓Temporary HMA widening of NB
  - ✓Place traffic on widened NB
  - ✓0 CY of RCA available
  - ✓5,642 CY of virgin granular base required for widening

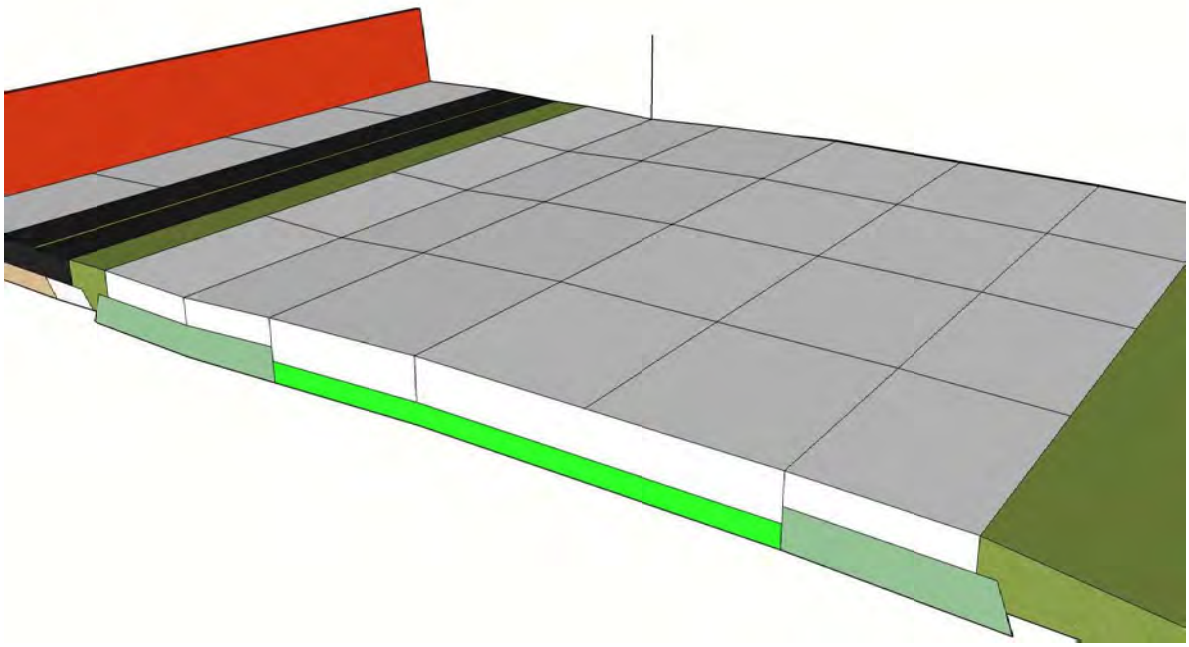


RCA Design/Construction Considerations

- Phase II
  - ✓Reconstruct SB
    - ➢12” JPCP on 6” RCA granular base
      - – RCA available = 46,933 CY
      - – RCA required = 52,800 CY
      - – Virgin required = 5,867 CY (≈ 11%)
    - ➢8” JPCP shoulders on salvaged granular base
      - – Salvaged available = 60,133 CY
      - – Salvaged required = 69,412 CY
      - – Virgin required = 9,279 CY (≈ 13%)

RCA Design/Construction Considerations

- Phase II



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RCA Design/Construction Considerations

- Phase III
  - ✓Reconstruct NB
    - ➢12” JPCP on 6” RCA granular base
      - – RCA available = 46,933 CY
      - – RCA required = 52,800 CY
      - – Virgin required = 5,867 CY (≈ 11%)
    - ➢8” JPCP shoulders on salvaged granular base
      - – Salvaged available = 69,207 CY
      - – Salvaged required = 28,101 CY
      - – Excess salvaged granular base = 41,106 CY

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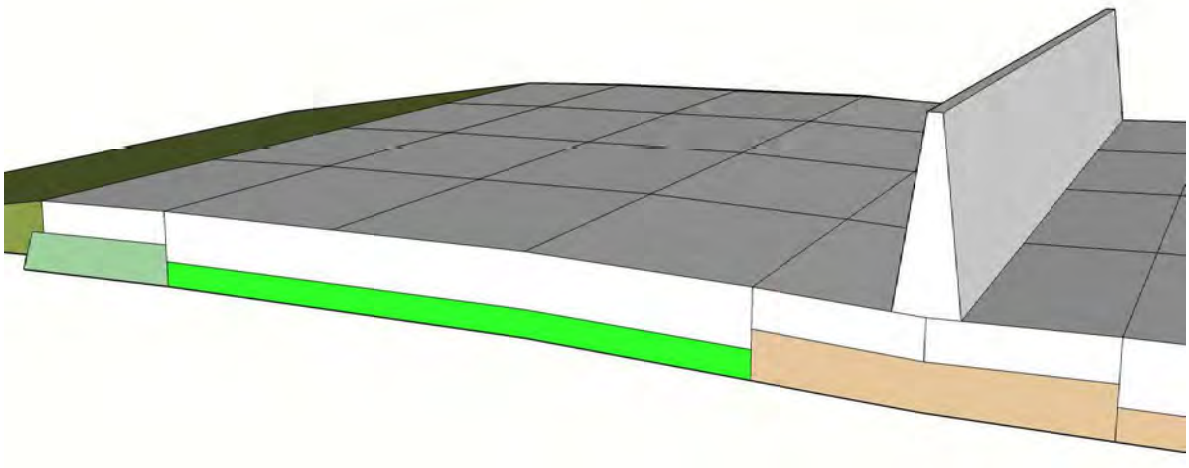
RCA Design/Construction Considerations

- Phase III



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RCA Design/Construction Considerations

- What about other RCA applications for the same hypothetical project?
  - ✓4” cement treated granular base
  - ✓4” cement treated drainable base
  - ✓Incorporated as coarse aggregate in the JPCP

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RCA Design/Construction Considerations

- Specified gradation impacts the amount of RCA recovered
  - ✓Drainable base specifications have fewer fines than a granular base
  - ✓Coarse aggregate for concrete has fewer fines than drainable bases

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RCA Design/Construction Considerations

- Specified gradation impacts the amount of RCA recovered

Sieve	RCA Granular Base Percent Passing	Drainable Base Percent Passing	Concrete Stone Percent Passing
1 ½"	100	100	100
1"	95-100	95-100	95-100
¾"	65-85	75-85	
½"		55-65	25-60
⅜"	40-60	40-50	
#4	25-45	15-25	0-10
#8		0-5	0-5
#10	15-30		
#40	5-15	0-5	
#200	0-10	0-3	0-2

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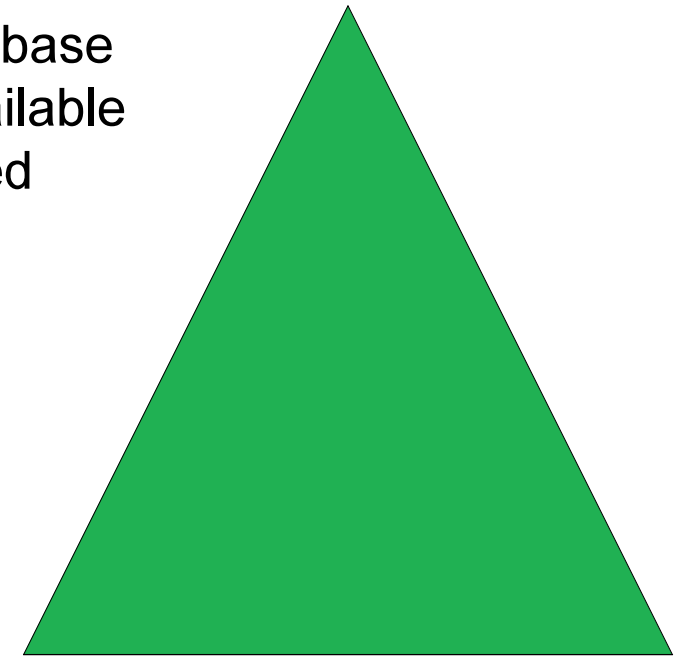
RCA Design/Construction Considerations

- RCA as granular base
  - ✓93,866 CY available
  - ✓93,866 CY used



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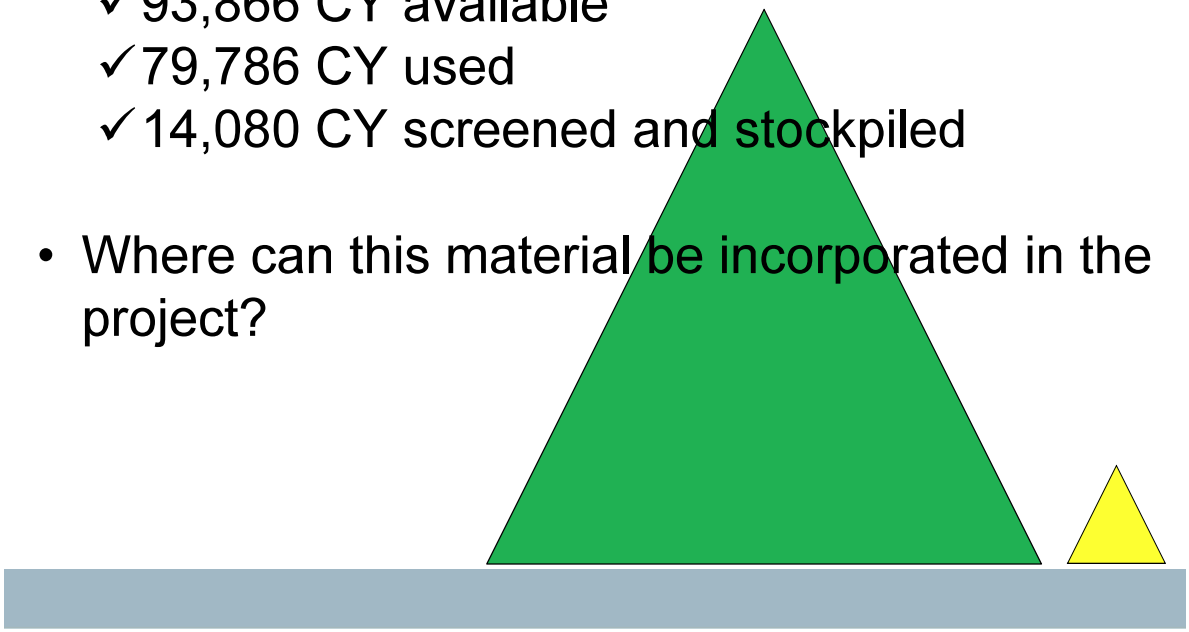
RCA Design/Construction Considerations

- RCA as cement treated drainable base
  - ✓93,866 CY available
  - ✓79,786 CY used
  - ✓14,080 CY screened and stockpiled
- Where can this material be incorporated in the project?



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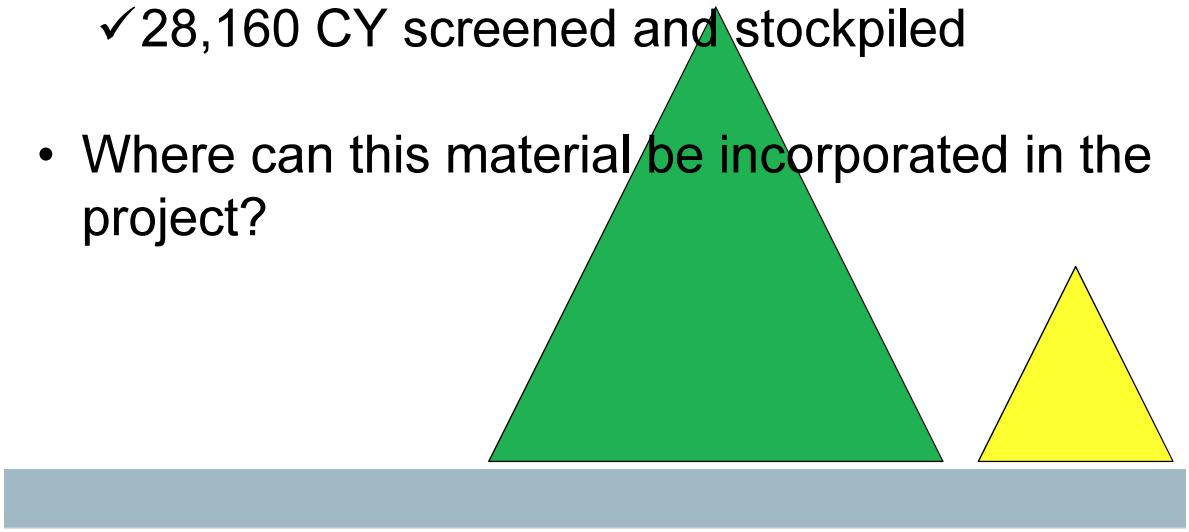
RCA Design/Construction Considerations

- RCA as coarse aggregate for concrete
  - ✓93,866 CY available
  - ✓65,706 CY used
  - ✓28,160 CY screened and stockpiled
- Where can this material be incorporated in the project?



RCA Design/Construction Considerations

- Back to the hypothetical project
  - ✓Phase III had approx. 41,000 CY of excess salvaged granular base
    - ➢Use as granular base under the 12" JPCP?
    - ➢This leaves ±35,000 CY of RCA that could be used for coarse aggregate in the JPCP
    - ➢Approx. 20,000 CY needed for the JPCP
    - ➢This leaves ±10,000 CY of excess fines and ± 5,000 CY of excess RCA

RCA Design/Construction Considerations

- Verify that the contractor is complying with:
  - ✓Environmental regulations (dust and runoff)
  - ✓Safety regulations

RCA Design/Construction Considerations (summary)

- There are many options for the use of RCA
  - ✓Specifications should allow RCA wherever possible
    - ➢Modify durability requirements (LA Abrasion, sodium sulfate, C 666, etc) to allow RCA
    - ➢Reduce the spec. for the low end of the material passing the #200
    - ➢Gradation QC should be performed at the same frequency as for virgin aggregates
- **Let the market determine how/where to incorporate RCA cost effectively**