VTCA
Virginia Transportation Construction Alliance

Sustainable Use of Quarry Resources:
Product Balance

Northern Virginia District Dialogue
11.13.2023

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Education:
Civil Engineering, B.S., Virginia Military Institute
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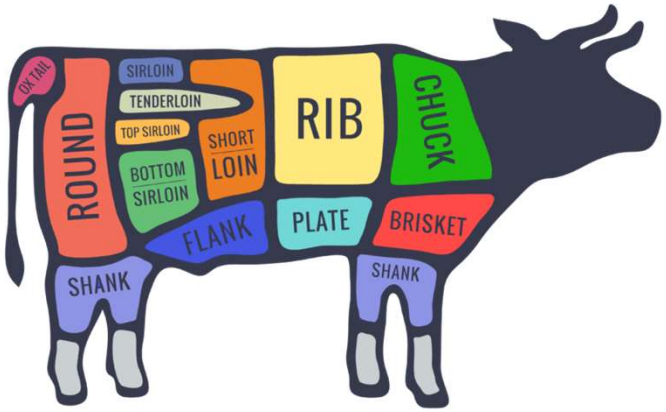
Experience:
Soils, aggregates, and materials testing
Project and people management
Research and development
Geotechnical engineering

Hobbies:
Building, fishing, home improvements, canoeing

Me:
Husband (12 years) and father of two boys (5 & 3)

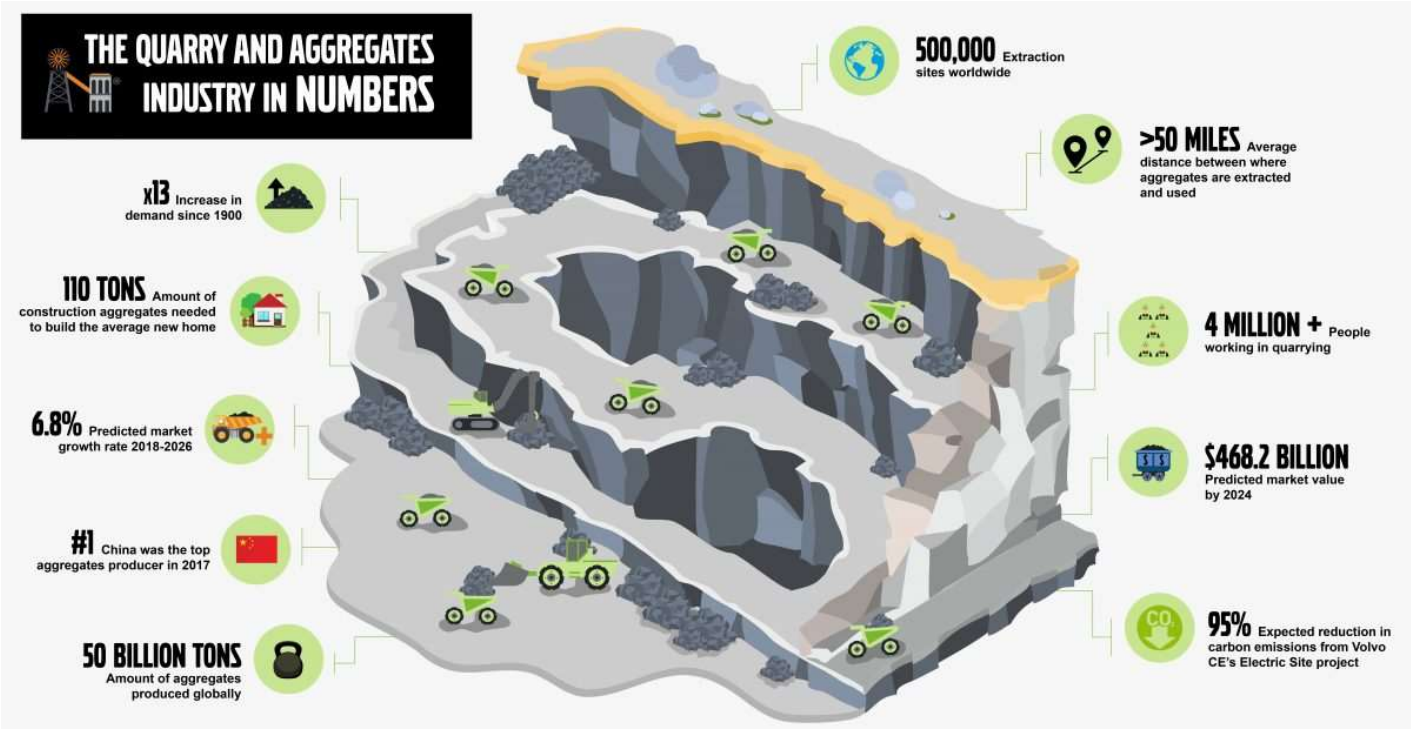
Agenda

- Industry Facts
- Quarry Operations
- Aggregate Products
- Product Balance
- Challenges
- Solutions
- Product Naming
- Key Takeaways



Aggregate Facts

- **#1 Product used by VDOT**
- 94% of Asphalt
- 70% of Concrete
- 50 Billion Tons Globally

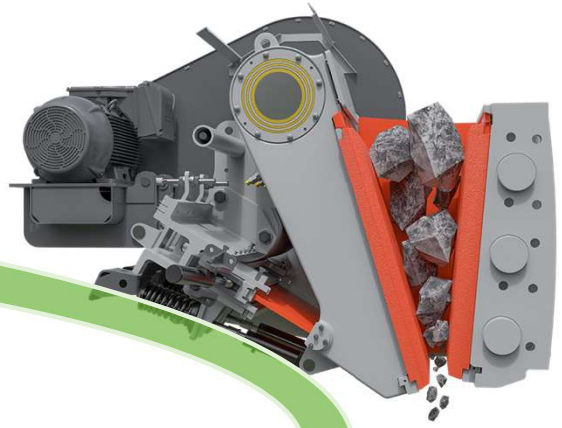


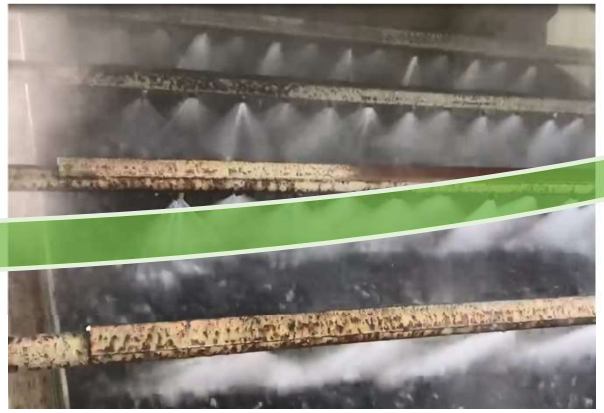
How It's Made: Aggregates

- Manufactured through **disassembly**
  - Multiple products produced simultaneously (fines and base)
  - Single sized = not possible

How It’s Made: Aggregates

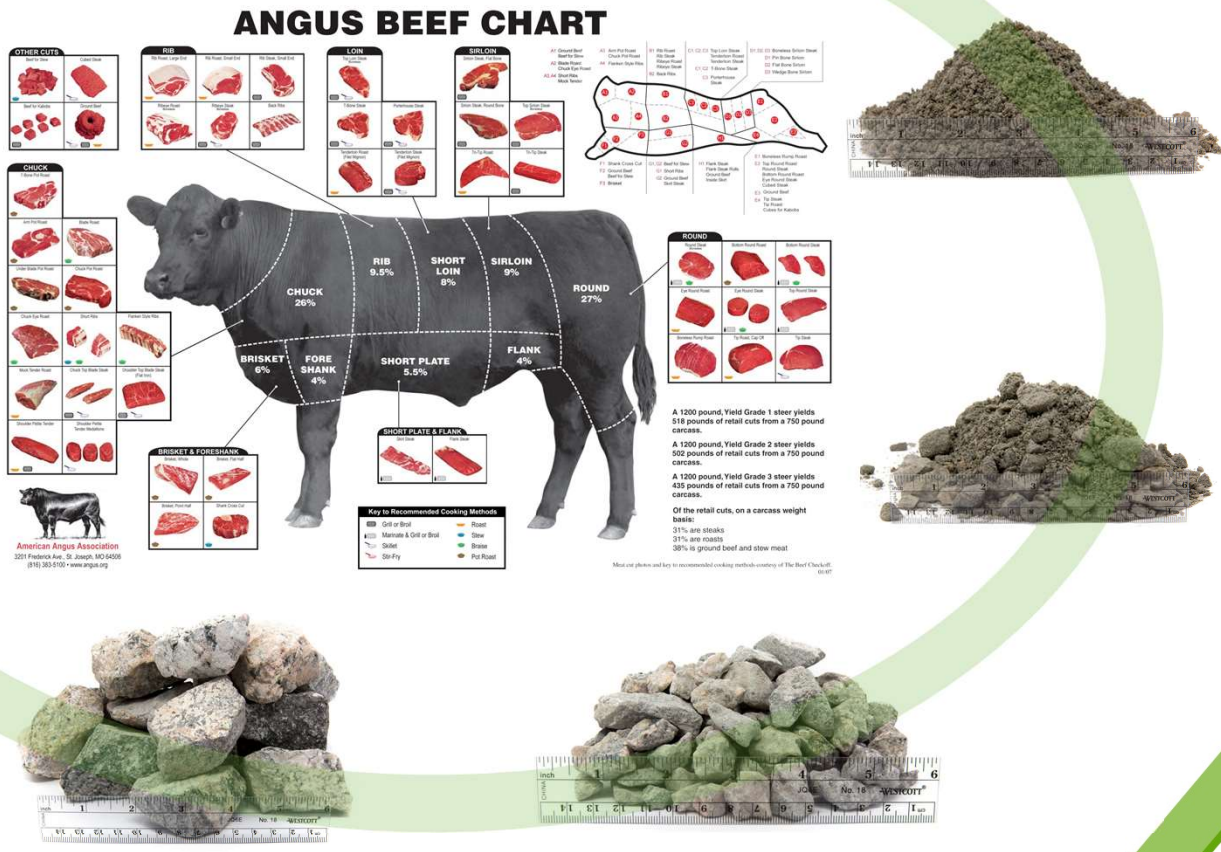
Aggregates 101





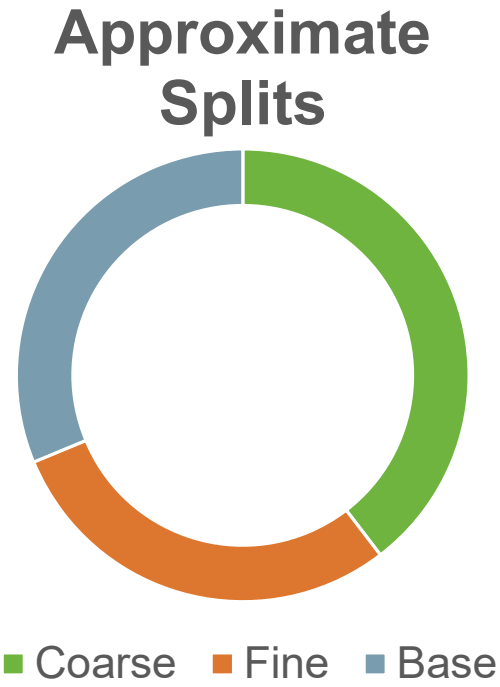
Aggregate Products

- **Armor stone**
- **Riprap**
  - Class I, II, III, etc.
- **Surge**
  - #1, #2, #3
- **Coarse**
  - #467
  - #57
  - #68
  - #8
- **Base**
  - GAB
  - 21A/21B/CBR30
  - P209
- **Fine**
  - Concrete Sand
  - Asphalt Sand
  - Mineral Filler

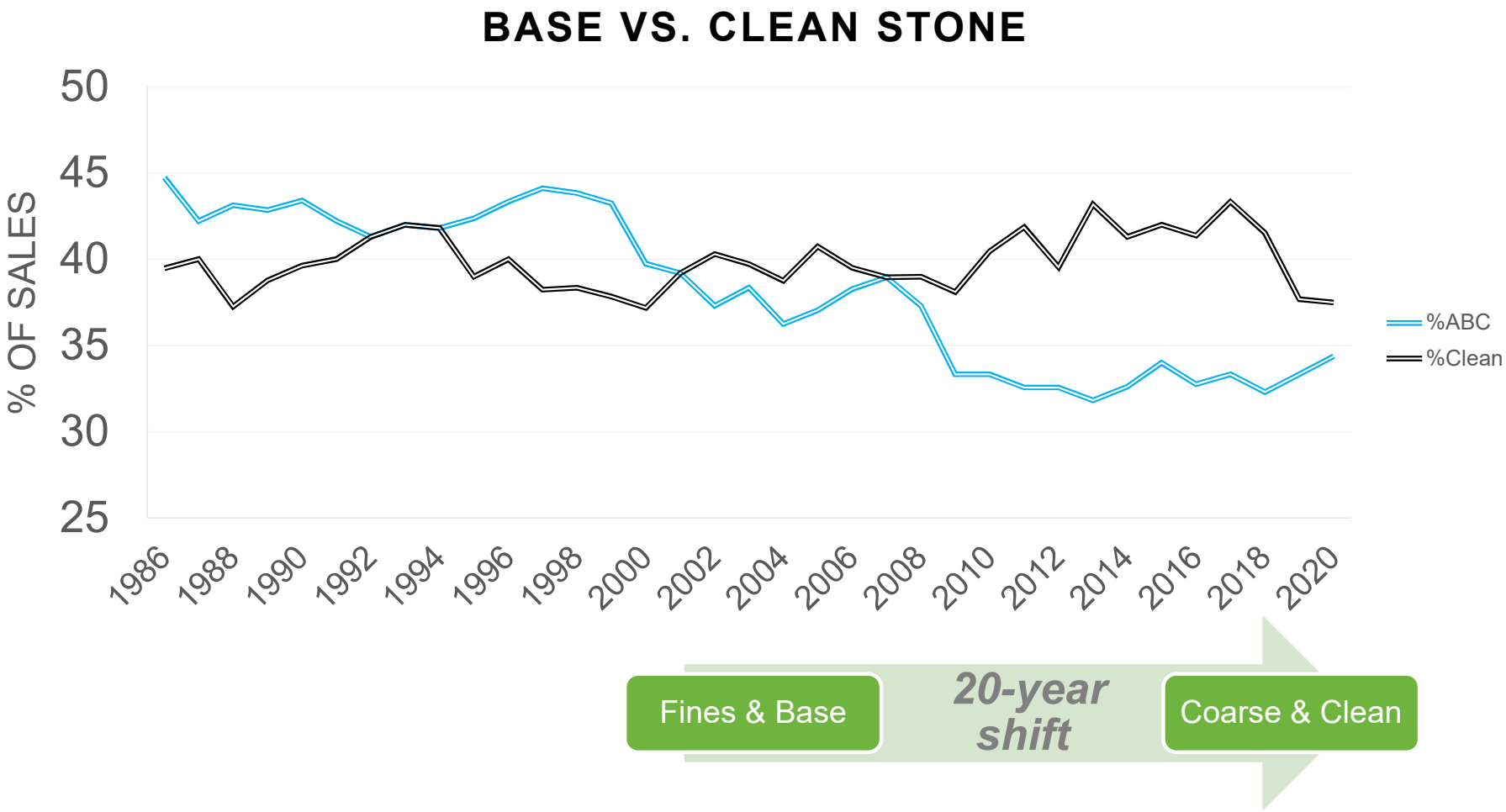


Typical Product Split

Aggregate Type	Ranges %
Coarse	30-45
Fine	20-35
Base	30-40



Sales Data


BASE VS. CLEAN STONE
% OF SALES
50
45
40
35
30
25
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
%ABC
%Clean
Fines & Base
20-year shift
Coarse & Clean

Declining Usage of Fines & Base

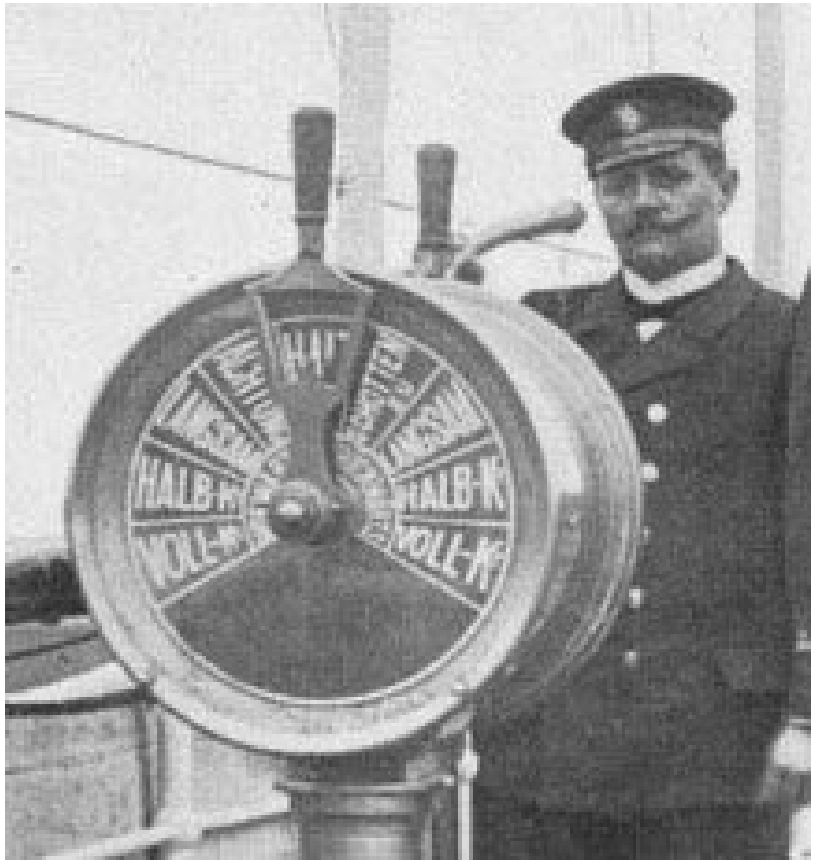
- **Fines Reduction**
  - Coarse asphalt mixes
    - Superpave, SMA, Ultrathin, OGFC
  - Lack of adoption of manufactured sand in concrete
  - Increased use of RAP in asphalt

- **Less Base or Coarser Base**
  - Less new pavement construction
  - Use of drainable pavements and bases
  - Increased use of in-place recycling

Changes & Costs

- **Product Split = Customer Demand**
  - Mass balance / plant efficiency studies
  - Crusher studies
  - Process improvement reviews
- **Market change = product demand change**
  - It's difficult to modify what we do
  - We can modify our product proportions
  - We can't stop making certain products

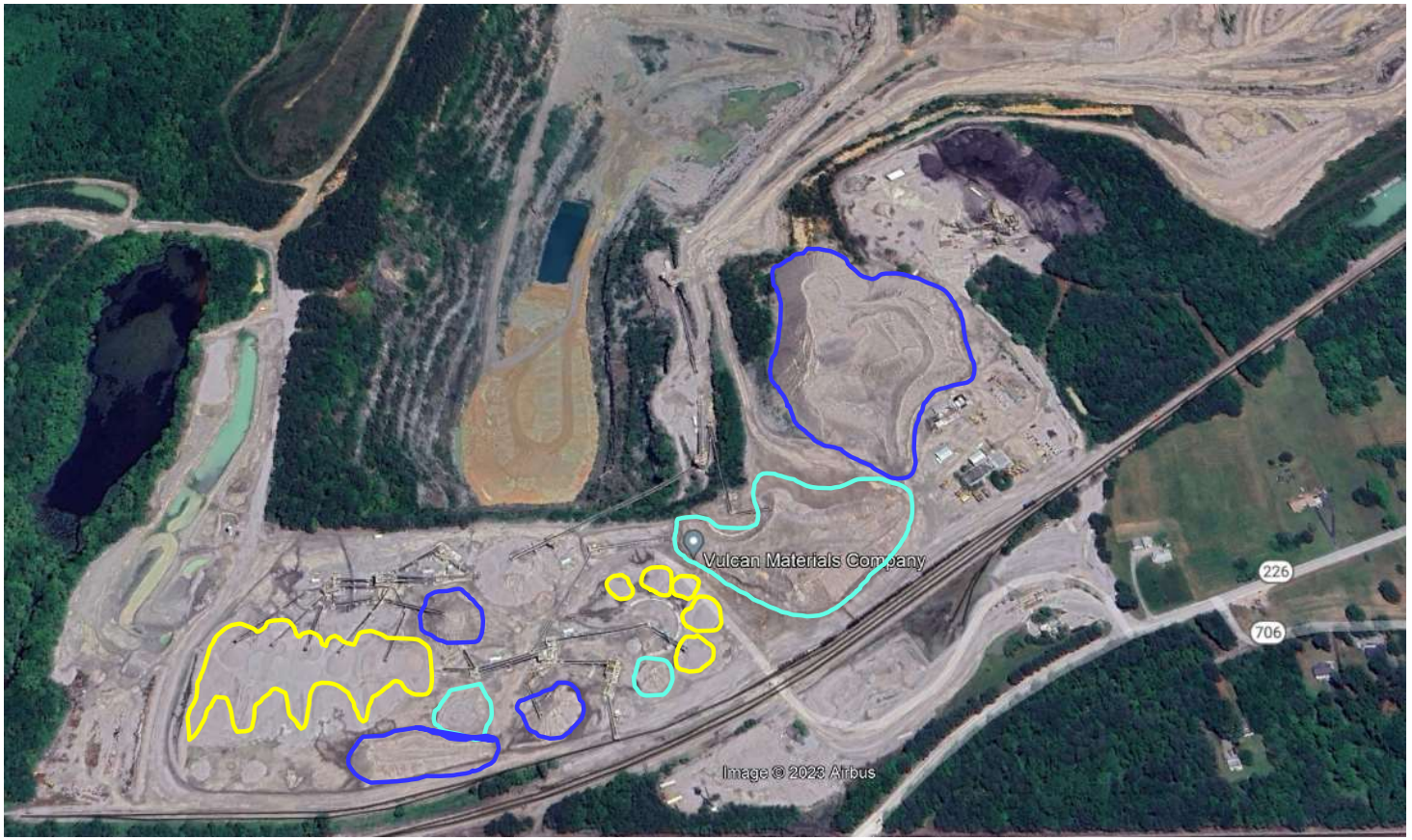
Product	Price
Crusher	$700K
Screen	$300K
Liner	$45K



What's the impact?

What's the impact?

What’s the impact?



Product Balance & Sustainability

- Where is the opportunity?

1. In the **product**
2. In the **specs**
3. In the **design/construction**

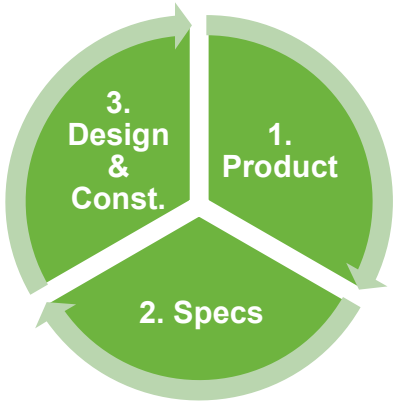


TABLE II-9
Design Range for Dense-Graded Aggregates

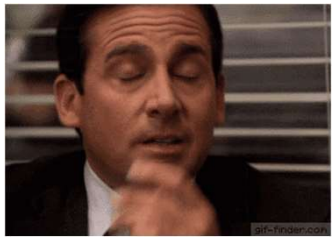
Size No.	Amounts Finer Than Each Laboratory Sieve (Square Openings[1]) (% by Weight) 2 in	1 in	3/8 in.	No. 10	No. 40	No. 200	ASTM D4791 Flat & Elongated 5:1
21A	100	94-100	63-72	32-41	14-24	6-12	30% max.
21B	100	85-95	50-69	20-36	9-19	4-7	30% max.
22	---	100	62-78	39-56	23-32	8-12	30% max.

[1]In inches, except where otherwise indicated. Numbered sieves are those of the U.S. Standard Sieve Series.

- Who can improve sustainability?

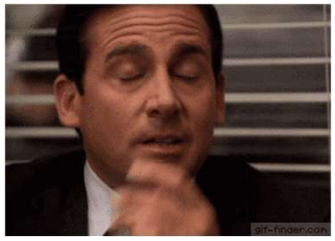
1. **Producers**
2. **Consultants/VDOT**
3. **Contractors**

Problematic Products



- **Overuse of 21B**
  - Uses very little fines
- **Drainable bases**
  - Increases fines production
- **SMA**
  - Flat and elongated requirement - *even more* fines than normal
  - SMA made with standard aggregate just as durable
- **Crushed concrete and RAP**
  - Due to excess inventories of these products
  - Replaces base and fines
  - The aggregate producers in Virginia have excess products far exceeding those of the RAP and crushed concrete

Problematic Specifications



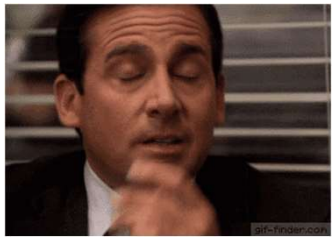
- **I-64 GAP Segment A Widening**

Minimum Pavement Section Alternates			
Asphalt Alternate		**Concrete Alternate**	
Travelway	**Median Shoulder**	**Travelway**	**Median Shoulder**
2" SMA 12.5 (64E-22)	2" SM-12.5D	11" JPCP*	2" SM-12.5D
3" SMA 19.0 (64E-22)	3" IM-19.0D	2" OGDL	3" IM-19.0D
4" BM-25.0D	4" BM-25.0D	10" Subbase**	6" BM-25.0D
2" OGDL	2" OGDL		2" OGDL
10" Subbase**	10" Subbase**		10" Subbase**

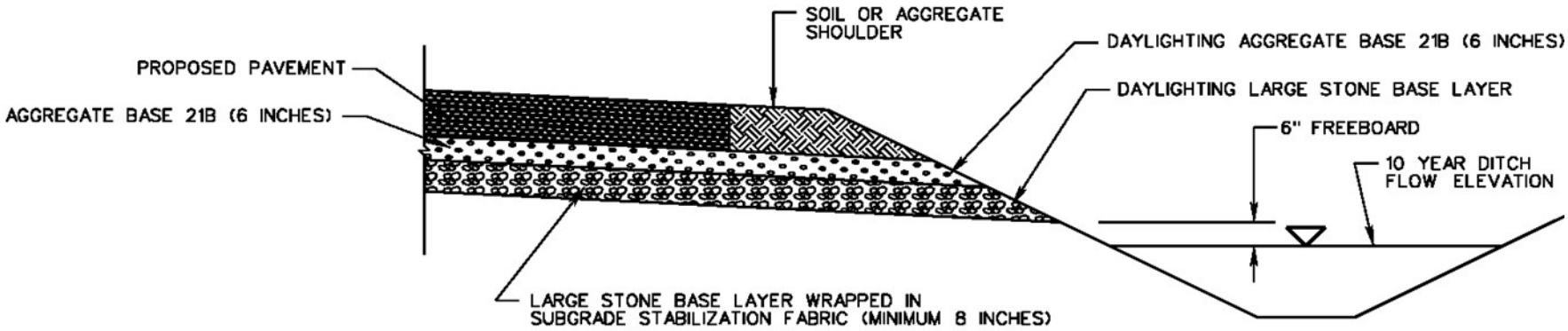
* Jointed Plain Concrete Pavement (JPCP) shall be designed to have 15-foot joint spacing, as a widened slab with 14-foot wide pavement, (12-feet in the travel lane and 2-feet incorporated into the median shoulder).

** Subbase shall be a Cement Treated Crushed Concrete or Cement Treated Recycled Asphalt Pavement (RAP) meeting the requirements of the Special Provision for FDR(SP315-DB0420-00).

Problematic Design/Construction

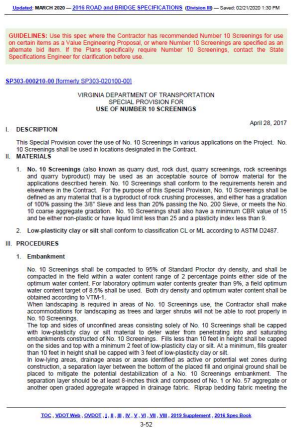


- **I-66 Re-design**
  - 21B replaced with VDOT #2 stone



Product & Specification Solutions

- VDOT #21A
- CTA with higher fines
- Cement treated screenings
- MSE Wall Backfill
- 4.75mm Pavements
- VDOT SP303-000210-00
  - Fill for embankments
  - Structural backfill
  - Pipe backfill
  - MSE Wall Backfill
  - Soft ground stabilization



Updated: MARCH 2020 — 2016 ROAD and BRIDGE SPECIFICATIONS (Revision 09) — Saved: 02/21/2020 1:30 PM

GUIDELINES: Use this spec where the Contractor has recommended Number 10 Screenings for use on certain items as a Value Engineering Proposal, or where Number 10 Screenings are specified as an alternate bid item. If the Plans specifically require Number 10 Screenings, contact the State Specifications Engineer for clarification before use.

SP303-000210-00 (formerly SP303-020100-00)

VIRGINIA DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION FOR
USE OF NUMBER 10 SCREENINGS

April 28, 2017

I. DESCRIPTION

This Special Provision cover the use of No. 10 Screenings in various applications on the Project. No. 10 Screenings shall be used in locations designated in the Contract.

II. MATERIALS

1. **No. 10 Screenings** (also known as quarry dust, rock dust, quarry screenings, rock screenings and quarry byproduct) may be used as an acceptable source of borrow material for the applications described herein. No. 10 Screenings shall conform to the requirements herein and elsewhere in the Contract. For the purpose of this Special Provision, No. 10 Screenings shall be defined as any material that is a byproduct of rock crushing processes, and either has a gradation of 100% passing the 3/8" Sieve and less than 20% passing the No. 200 Sieve, or meets the No. 10 coarse aggregate gradation. No. 10 Screenings shall also have a minimum CBR value of 15 and be either non-plastic or have liquid limit less than 25 and a plasticity index less than 9.

2. Low-plasticity clay or silt shall conform to classification CL or ML according to ASTM D2487.

III. PROCEDURES

1. Embankment

No. 10 Screenings shall be compacted to 95% of Standard Proctor dry density, and shall be compacted in the field within a water content range of 2 percentage points either side of the optimum water content. For laboratory optimum water contents greater than 9%, a field optimum water content target of 8.5% shall be used. Both dry density and optimum water content shall be obtained according to VTM-1.

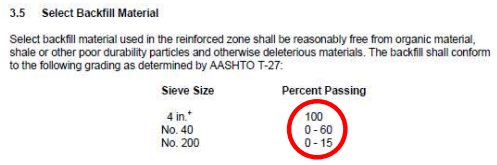
When landscaping is required in areas of No. 10 Screenings use, the Contractor shall make accommodations for landscaping as trees and larger shrubs will not be able to root properly in No. 10 Screenings.

The top and sides of unconfined areas consisting solely of No. 10 Screenings shall be capped with low-plasticity clay or silt material to deter water from penetrating into and saturating embankments constructed of No. 10 Screenings. Fills less than 10 feet in height shall be capped on the sides and top with a minimum 2 feet of low-plasticity clay or silt. At a minimum, fills greater than 10 feet in height shall be capped with 3 feet of low-plasticity clay or silt.

In low-lying areas, drainage areas or areas identified as active or potential wet zones during construction, a separation layer between the bottom of the placed fill and original ground shall be placed to mitigate the potential destabilization of a No. 10 Screenings embankment. The separation layer should be at least 6-inches thick and composed of No. 1 or No. 57 aggregate or another open graded aggregate wrapped in drainage fabric. Riprap bedding fabric meeting the

TOC , VDOT Web , OWSOT , I , II , III , IV , V , VI , VII , VIII , 2019 Supplement , 2016 Spec Book

3-52



3.5 Select Backfill Material

Select backfill material used in the reinforced zone shall be reasonably free from organic material, shale or other poor durability particles and otherwise deleterious materials. The backfill shall conform to the following grading as determined by AASHTO T-27:

Sieve Size	Percent Passing
4 in.+	100
No. 40	0 - 60
No. 200	0 - 15

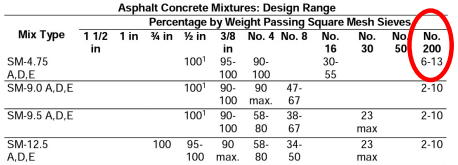
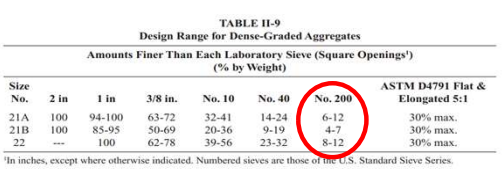


TABLE II-13
Asphalt Concrete Mixtures: Design Range

Mix Type	Percentage by Weight Passing Square Mesh Sieves										
	1 1/2 in	1 in	¾ in	½ in	3/8 in	No. 4	No. 8	No. 16	No. 30	No. 50	No. 200
SM-4.75 A,D,E				100[1]	95-100	90-100		30-55			6-13
SM-9.0 A,D,E				100[1]	90-100	90 max.	47-67				2-10
SM-9.5 A,D,E				100[1]	90-100	58-80	38-67		23 max		2-10
SM-12.5 A,D,E			100	95-100	90 max.	58-80	34-50		23 max		2-10



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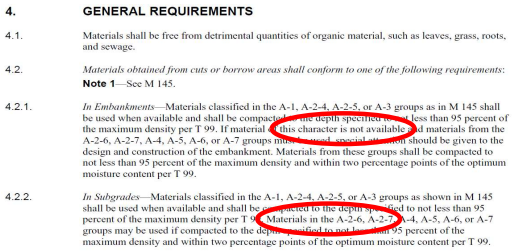


4. GENERAL REQUIREMENTS

4.1. Materials shall be free from detrimental quantities of organic material, such as leaves, grass, roots, and sewage.

4.2. *Materials obtained from cuts or borrow areas shall conform to one of the following requirements:*
Note 1—See M 145.

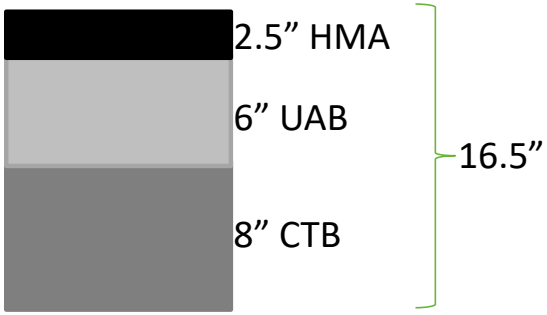
4.2.1. *In Embankments*—Materials classified in the A-1, A-2-4, A-2-5, or A-3 groups as in M 145 shall be used when available and shall be compacted to the depth specified to not less than 95 percent of the maximum density per T 99. If material of this character is not available, the materials from the A-2-6, A-2-7, A-4, A-5, A-6, or A-7 groups must be used, special attention should be given to the design and construction of the embankment. Materials from these groups shall be compacted to not less than 95 percent of the maximum density and within two percentage points of the optimum moisture content per T 99.

4.2.2. *In Subgrades*—Materials classified in the A-1, A-2-4, A-2-5, or A-3 groups as shown in M 145 shall be used when available and shall be compacted to the depth specified to not less than 95 percent of the maximum density per T 99. Materials in the A-2-6, A-2-7, A-4, A-5, A-6, or A-7 groups may be used if compacted to the depth specified to not less than 95 percent of the maximum density and within two percentage points of the optimum moisture content per T 99.

Design Solutions

- **Inverted Pavement**
  - 40+ years in South Africa
  - Proven track record under heavy axle loads and high traffic pavements
  - Utilizes thick layers of cement treated base, aggregate base
  - Thin layer of asphalt

Inverted

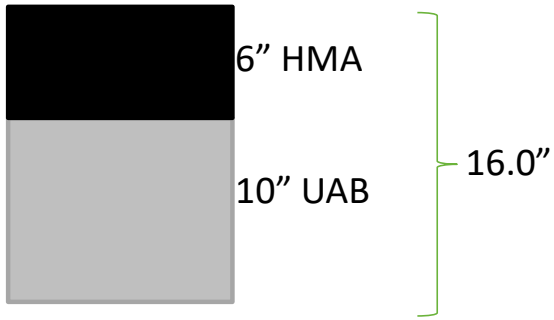


SN = 3.78

$35.92/SY

11.3% Less Expensive than Conventional

Conventional



SN = 4.04

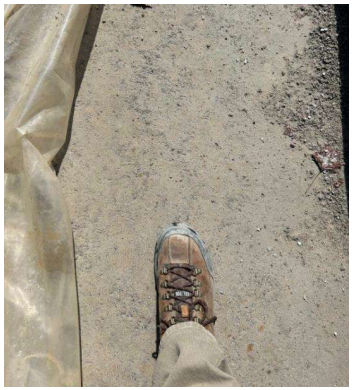
$40.51/SY

FHWA Research

- Inverted pavement test section at TFHRC
- Accelerated Loading Facility (ALF)
- 2 test lanes dedicated to inverted pavement

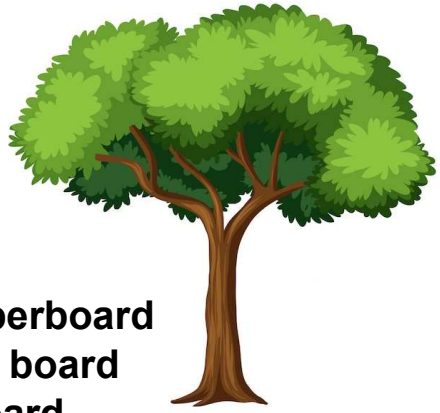
Lanes w/ Unbound Base

Lanes w/ Cement Treated Screenings

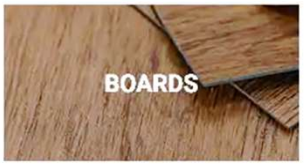


Logging

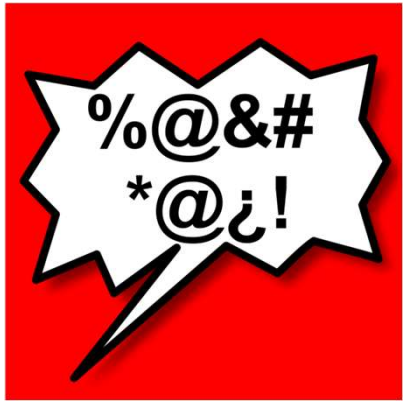
Product Naming



- Sold as:
  - **Timbers**
  - **Lumber**
  - **Boards**
  - **Plywood**
  - **Medium density fiberboard**
  - **Chipboard/particle board**
  - **Oriented strand board**
  - **Wood pellets**
  - **Mulch**
- Fines not sold/referred to as:
  - **“cuttings”**
  - **“waste dust”**
  - **“chippings”**
  - **“wood shavings”**
  - **“sawmill byproduct”**



"Four-Letter" Product Names



- **D***, F****, S********* (Dust, fines, screenings)

- **VDOT #10 Stone**
  - Fine aggregate
  - Dense graded
  - Sand
  - USCS-SM
- **Mineral Filler**
  - Super fines
  - Baghouse fines
  - Sand plant fines
  - Belt press fines
  - Pit fines
  - Pond fines
  - Pond dippings

Product Naming

- Project funded by GDOT and FHWA
- **Initial**:
  - Sustainable Application of **Quarry By-Products**
- **Edited**:
  - Sustainable Application of **Mineral Filler Sized Stone Products**
- Removed references to:
  - *"QB"*
  - *"waste“*
  - *"waste materials“*
  - *"quarry dust“*
  - *"quarry waste fines“*
  - *"by-product/byproduct“*
  - *"by-product mineral fine materials“*
  - *"quarry waste“*
  - *"by-product fines"*

Exhibit A. STATEMENT OF WORK

Research Revised Proposal for the
GEORGIA DEPARTMENT OF TRANSPORTATION

Sustainable Application of Mineral Filler Sized Stone Products in Georgia

Savannah State University
3219 College Street
Savannah, Georgia 31404

August 30, 2023

Submitted by:
Principal Investigator
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Co-Principal Investigator
Jayhyun Kwon
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Sustainable Application of Mineral Filler Sized Stone Products in Georgia

INTRODUCTION

The aggregate industry produces a wide range of stone products used by a variety of industries. These materials range from multi-ton armor stone to large riprap, to coarse aggregates, to sand and mineral filler. All the aggregate industry's products are useful in different ways. The issue can be an imbalance between a product's production rate and the rate of consumption. The range of stone products the aggregate industry produces is demonstrated in Figure 1.

Generic Aggregate Types

Figure 1. Image. Generic Aggregate Types Produced in Georgia

Three types of mineral filler sized stone products have been identified in Federal Highway Administration (FHWA) Report 97-148 (1). These include screenings, settling pond fines, and baghouse fines (1). Screenings is a general term used to label the finer fraction of crushed stone that accumulates after primary and secondary crushing and separation on a 4.75 mm (No. 4) sieve. Screenings contain freshly fractured faces with relatively uniform particle size distributions, and do not usually contain large quantities of plastic fines. Settling pond fines is referred to the fines obtained from the washing of a crushed stone aggregate and/or natural sand/gravel that are discharged to a series of sequential settling ponds or basins, where they settle by gravity or other flocculating agents. If the quarry operates as a dry plant, the use of dust collection systems including cyclones and baghouses will be required. The dust generated during the crushing operations and captured using the dust collection systems is called "baghouse fines".

Georgia Department of Transportation

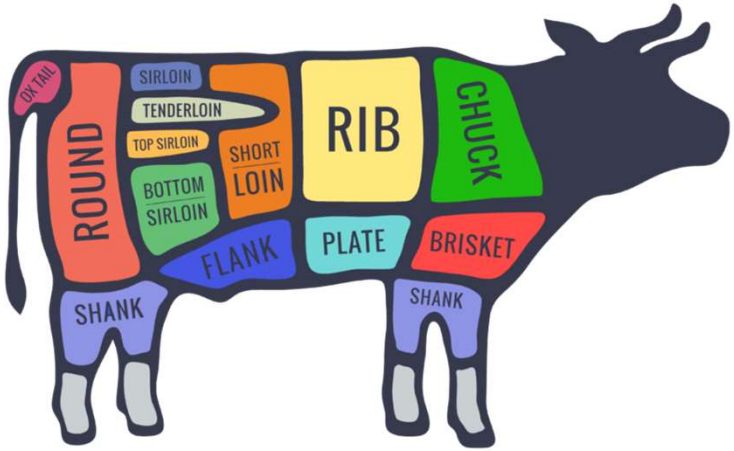
U.S. Department of Transportation
Federal Highway Administration

Key Takeaways

- Continued excess of base and fines
- Created by specifications and changes in product use
- Existing products and design options can help balance
- Product naming makes a difference

Who can improve sustainability?

- Producers - **product**
- Consultants/VDOT - **specs**
- Contractors - **construction**




Thank You
VTCA
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