Use of Quarry Fines to Make a Construction Aggregate

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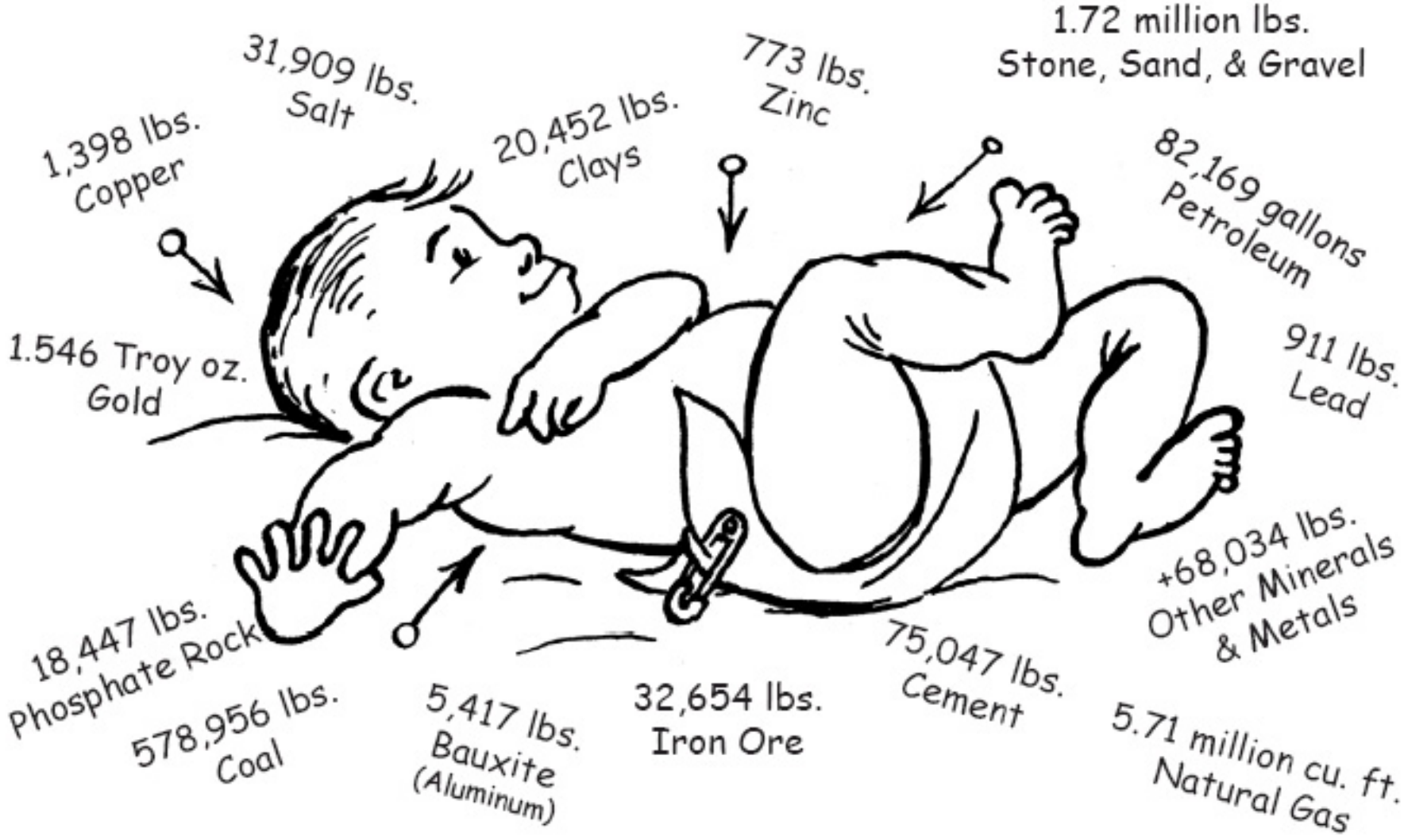
Every American Born Will Need . . .



3.7 **million pounds of minerals, metals, and fuels in their lifetime**

Mineral Extraction

- Locate Ore Body
- Mine
- Mill
- Separation

Tailings Properties & Disposal

Environmental Hazards

- Acid Mine Drainage
- Heavy Metal Contamination
- Processing Chemical Contamination
- Erosion & Sedimentation

Project Purpose

- Convert tailings waste to usable product
- Decrease the environmental hazards
- Decrease impoundment land use

Materials

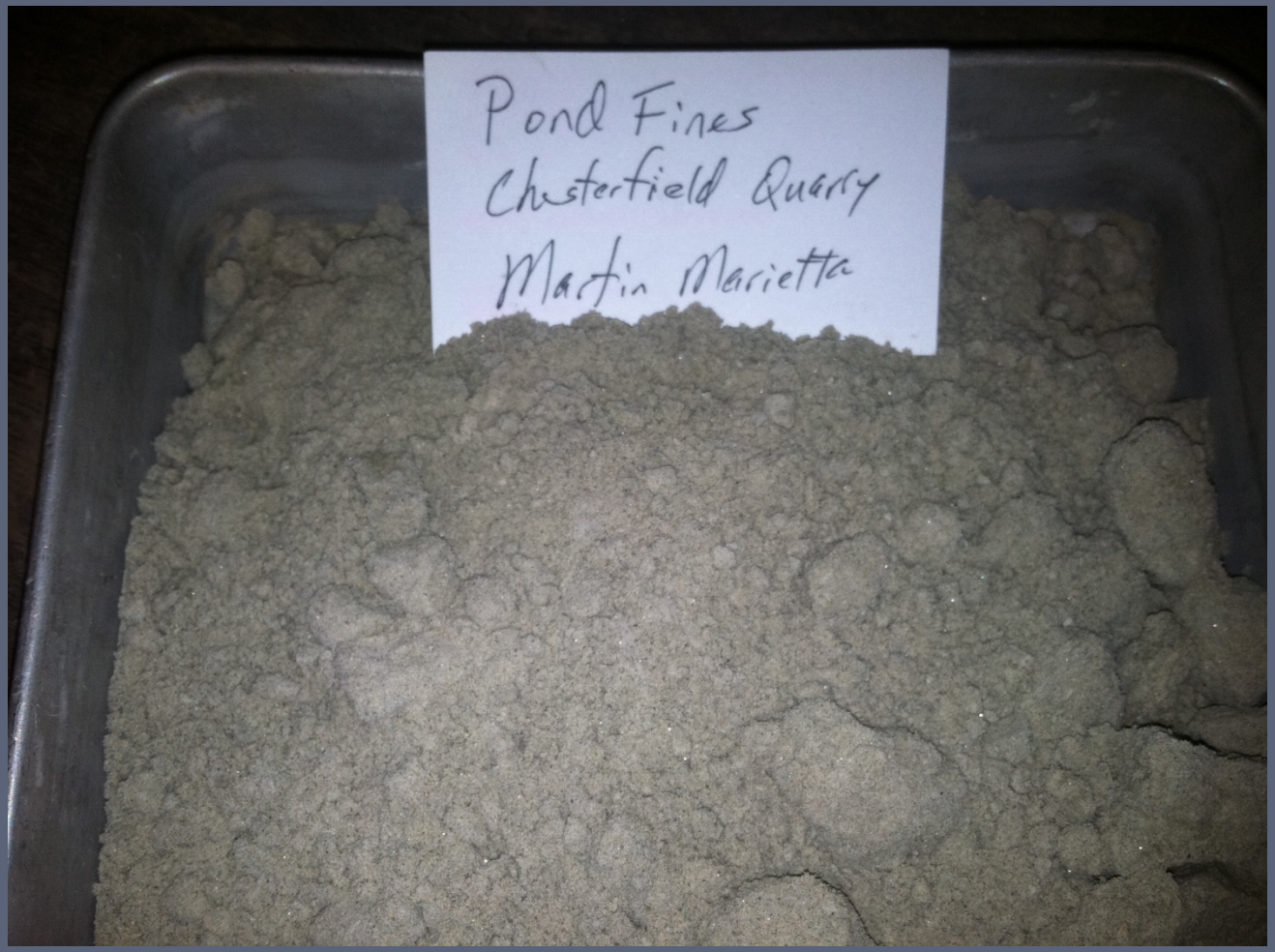
- Obtained mine tailings from Chesterfield Quarry – Jefferson, SC
- Used colloidal silica as binder

Test Methods

- NCDOT test methods:
  - Sieve analysis
  - L.A. Abrasion
  - Absorption
  - Specific Gravity
  - Sodium Sulfate Soundness

Making a Synthetic Aggregate

Dried & Sieved Tailings Sample



Pelletizing

Pelletizing

Pelletizing

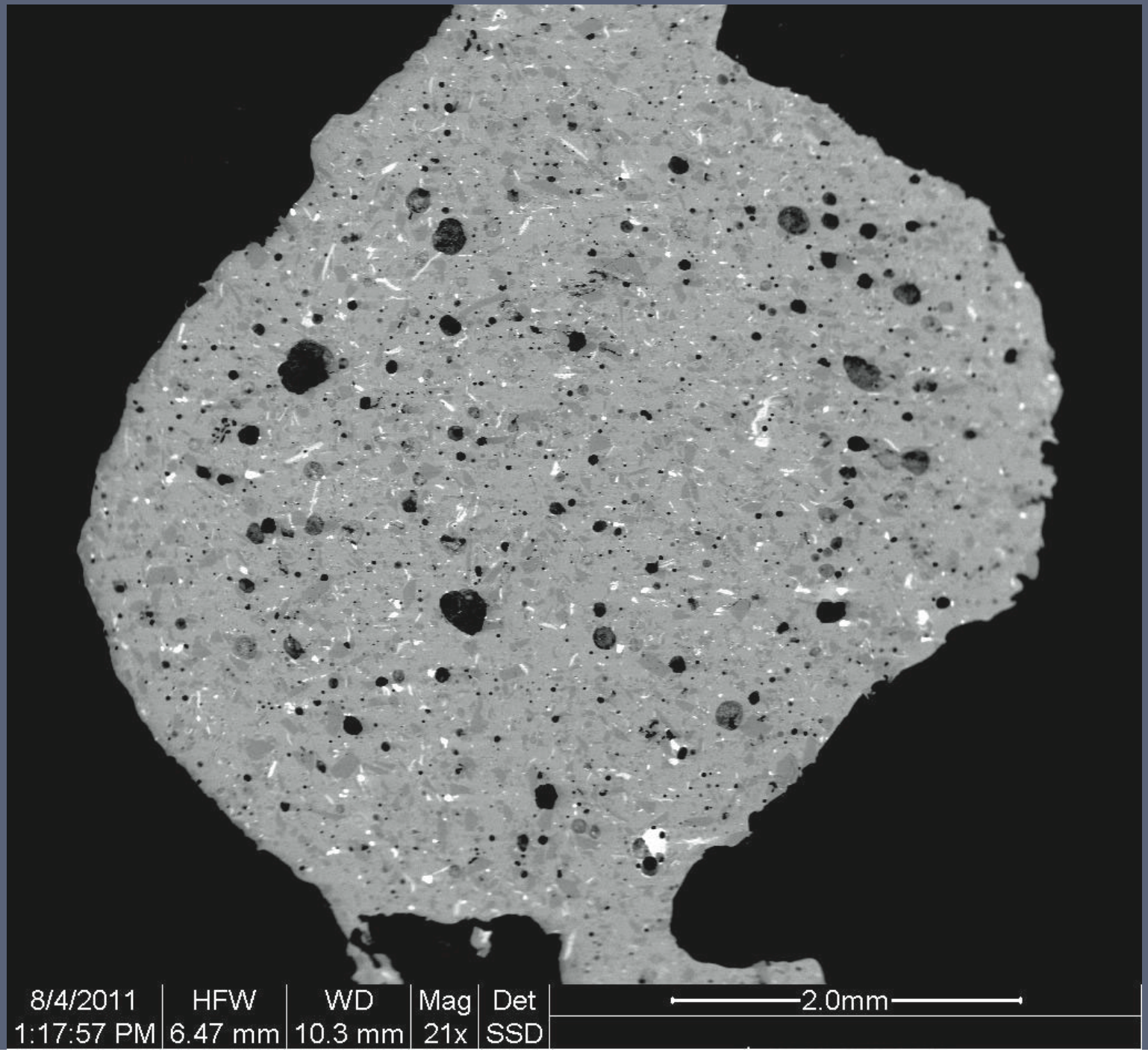
Pelletizing

Air Drying

Firing

Product: Synthetic Aggregate

Synthetic Aggregate Composition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HFW
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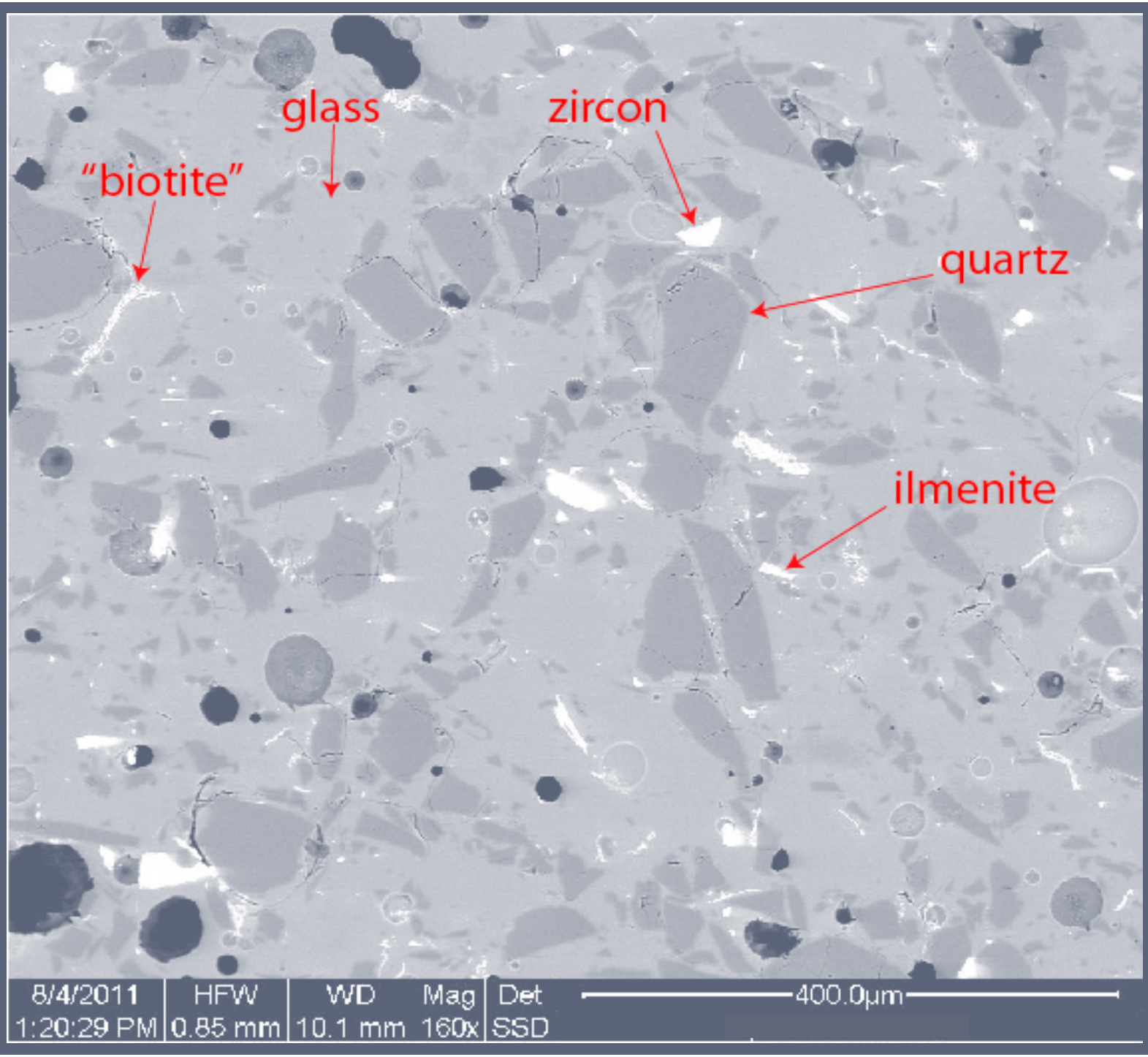
WD
10.3 mm
Mag
21x
Det
SSD
2.0mm


glass
zircon
"biotite"
quartz
ilmenite
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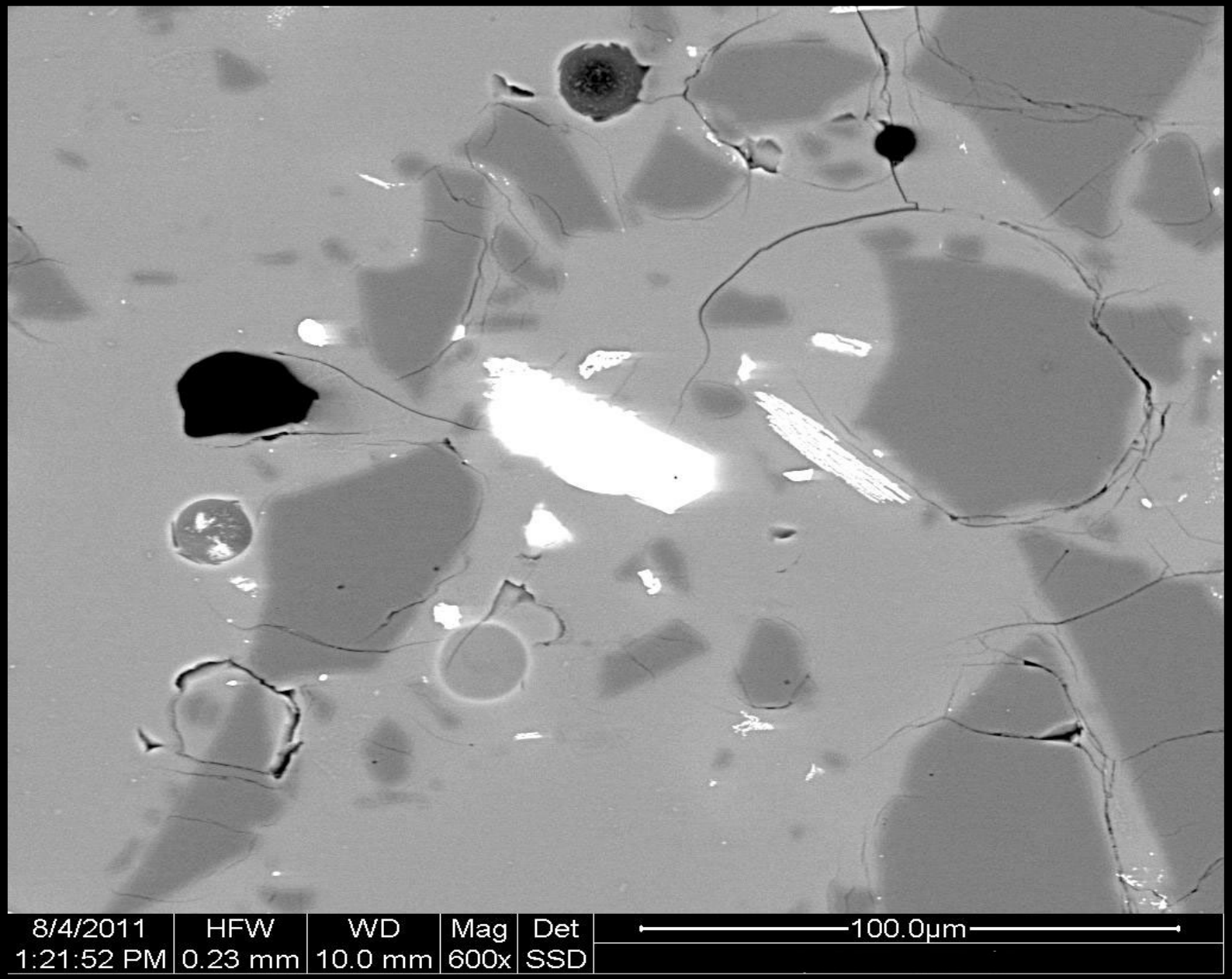
WD
10.1 mm
Mag
160x
Det
SSD
400.0µm

Glass Composition

	Na2O	MgO	Al2O3	SiO2	K2O	CaO	FeO	total
albite	11.2		20.4	67.4	3.3	1.1		100.0
glass	4.2	0.1	18.5	68.4	6.9	1.1	3.1	100.0
microcline			18.3	64.8	16.9			100.0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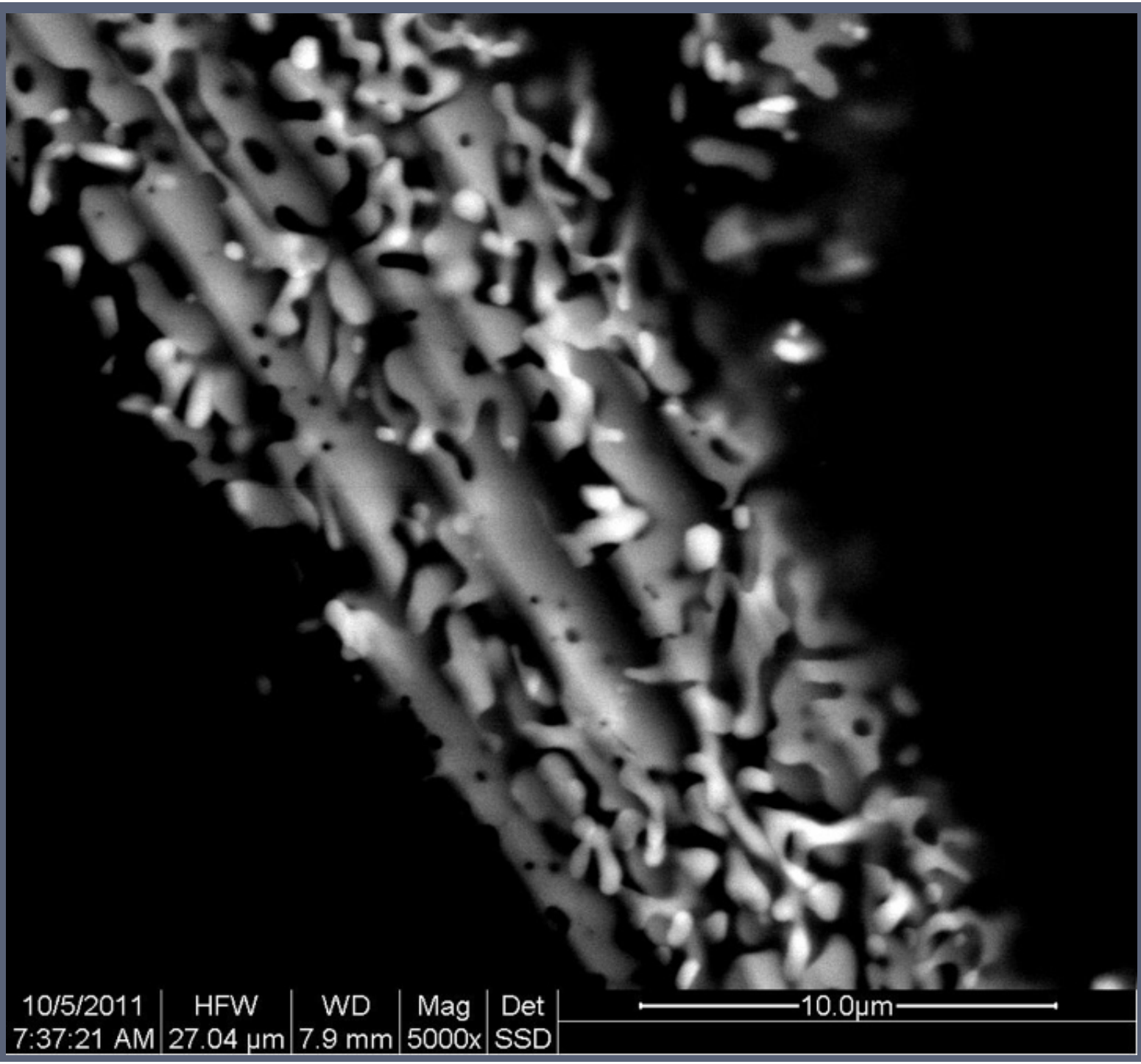
0.23 mm
WD
10.0 mm
Mag
600x
Det
SSD
100.0µm

Biotite Assimilation

	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO2	MnO	FeO	Fe2O3	H2O+	Total
Alt'd biotite	2.3	8.4	17.7	31.6	3.3	0.5	n/a	1.1	35.1	n/a	n/a	100.0
Biotite	0.2	4.2	14.6	37.2	8.3	0.2	3.1	0.1	26.9	3.8	1.4	99.7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HFW
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WD
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Mag
5000x
Det
SSD
10.0µm

Testing

Sieve Analysis

Retained on Sieve Size (inches)	Weight Retained on sieve (g)	% by Weight
1	0.0	0.0
3/4	61.1	0.5
1/2	8975.7	68.9
3/8	3034.5	23.3
#4*	951.4	7.3

* U.S. mesh size

L.A. Abrasion Test

- Abrasion resistance
- Maximum allowable loss for natural aggregate: 40-45%

L.A. Abrasion Test

	Loss
Synthetic Aggregate:	21%
Granite Aggregate:	27-49%
Limestone Aggregate:	19-30%

Water Absorption

- Proportion mixing

Pellets	Weight (g)	% Absorption by weight
Dry	218.0	
24 hour soak	219.3	0.596
2 hour boil	219.0	0.459

Specific Gravity

No.	Specific Gravity
1	2.05
2	2.00
3	2.03
4	1.98
5	1.95
6	1.91
7	1.96

Average 1.98± 0.05

Sodium Sulfate Soundness Test

- Resistance to disintegration by chemical saturation
- Average allowable loss for natural aggregate: 14%

Sodium Sulfate Soundness Test

- No adverse effects such as:
  - Splitting
  - Crumbling
  - Cracking

PASSED!

Production Cost Estimate

- $17 - $33 / ton
- based on:
  - $33/ton for aggregate from coal ash
    - Biernacki (2007)
  - $17/ton for aggregate from fly ash/biosolids
    - Minerals Research Lab (2005)

Conclusion

- Meets NCDOT natural aggregate requirements
- Decreases environmental impacts
- Converts waste to useful product

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