

Headwaters Resources Performance Pozzolan

Headwaters Resources

Plant Miller, Quinton, AL Blending Facility



Blended Class C and Class F Fly Ash



P² is a homogeneous blend of Class C and F fly ash. Combining C & F classifications of fly ash provides consumers the positive attributes of both materials and reduces variations that are sometimes expected from power plants operating under today's more stringent environmental climate.

The two classifications of fly ash offers end users more benefits. P² can be used in any application where a Class F fly ash is specified.

Class C and Class F fly ashes are blended using the same technology used in concrete batch plants. Materials are weighed, recorded then evenly discharged into individual air slides that connect to a common air slide.

The common air slide mixes the materials and discharges into a bucket elevator (right) that empties into a loading silo.

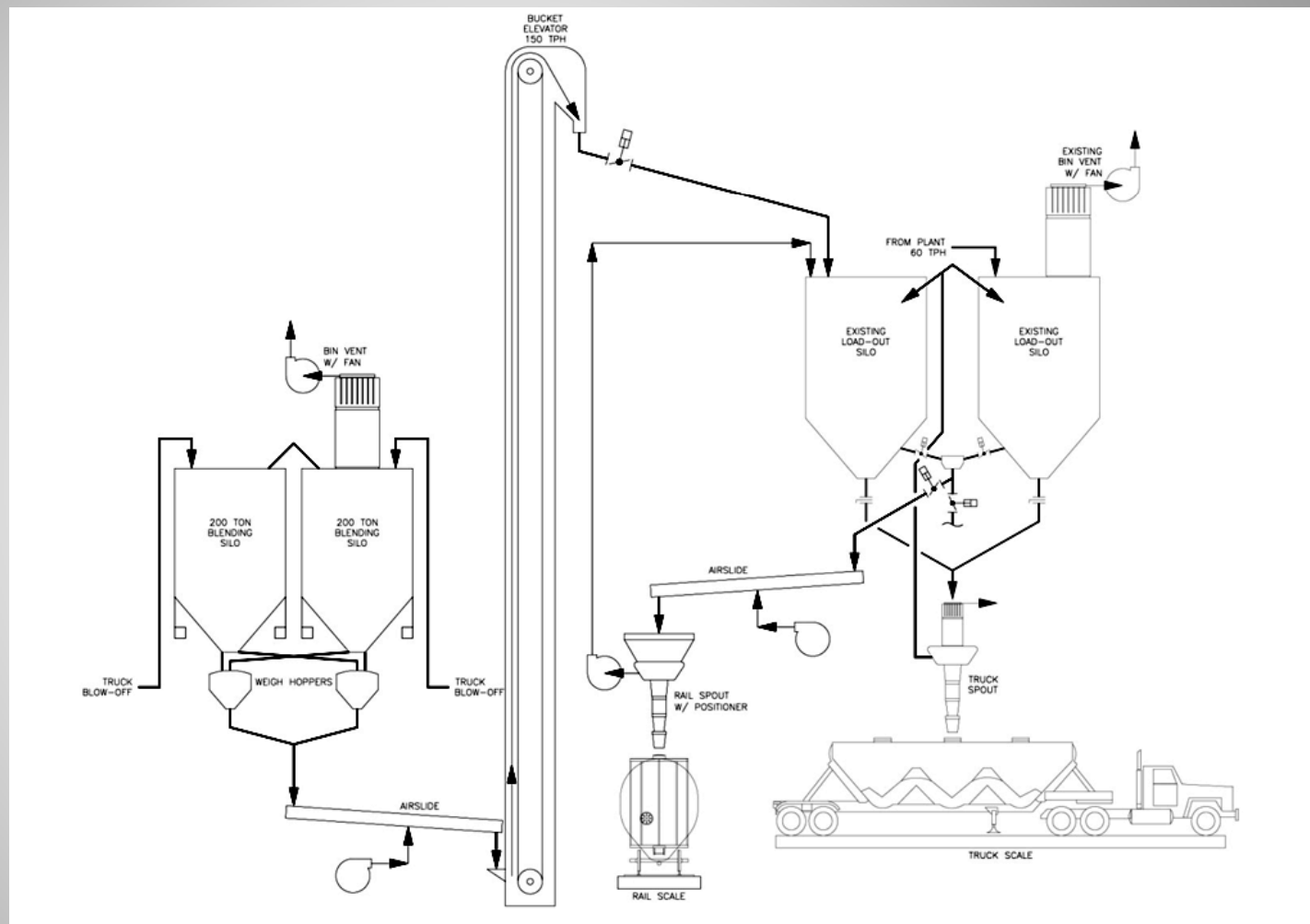


Class C and Class F fly ash mixing occurs in the air slides. (right)

High volume, low pressure air suspends and mixes fly ashes. Mixing is continuous throughout the delivery process to the storage silo.



Blending plant
and loading flow
chart



Performance Pozzolan Blending Objectives

- Individual materials are tested for chemical oxides, particle density and LOI.
- Objectives keep the sum of constituents between 70% and 76%.
- Material is blended to conform with ASTM D5370 uniformity $\pm 5.0\%$.
- LOI is kept below 2.0%.
- Available Alkalies are held at 1.2%.
- Lower the CaO found in Class C ash that exacerbates sulfate attack and ASR

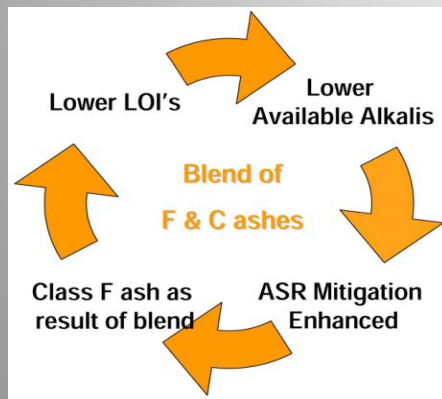
				ASTM C 618	ASSHTO
Chemical	Class F	Class C	Class F/Class C	Class F	M295 - 06
				Specifications	
Silicon Dioxide, SiO2	47.73%	39.32%	42.74%		
Aluminum Oxide, Al2O3	28.19%	19.24%	23.21%		
Iron Oxide, Fe2O3	11.92%	6.22%	9.28%		
Sum SiO ₂ , Al ₂ O ₃ & Fe ₂ O ₃	87.84%	64.78%	75.23%	70 Min	70 Min
Sulfur Trioxide, SO3	0.32%	1.52%	1.03%	5.0 Max	5.0 Max
Calcium Oxide, CaO	4.02%	23.25%	13.56%		
Sodium Oxide, Na2O	0.66%	1.70%	1.16%		
Magnesium Oxide, MgO	1.44%	5.55%	3.49%		
Potassium Oxide, K2O	2.65%	0.67%	1.64%		
Phosphorus Pentoxide, P2O5	0.68%	1.21%	0.95%		
Titanium Dioxide, TiO2	1.49%	1.33%	1.45%		
Moisture %	0.13	0.106	0.1	3.0 Max	3.0 Max
LOI %	2.13	0.31	1.09	6% Max	5% Max
Physical Analysis					
Fineness %	24.02	25.1	23.76	34% Max	34% Max
Water Requirement % Control	95%	99%	96%	105% Max	105% Max
Specific Gravity gm/cm ³	2.38	2.49	2.42		
Autoclave Expansion %				.8% Max	.8% Max
Strength Activity Index					
With Portland Cement 7 Day	78%	81%	93%	75% Min	75% Min
28 Day	89%	88%	97%	75% Min	75% Min

Combining Class C and Class F fly ash has the following benefits:

Lower CaO

Lower LOI

Lower available Na₂O



ASTM C618-05 / AASHTO M 295-0 Testing of Performance Pozzolan Alabama Fly Ash

Sample Type: 3200-ton Report Date: 6/15/2009
 Sample Date: 4/1-4/15/09 MTRF ID 601P2A
 Sample ID:

Chemical Analysis	ASTM / AASHTO Limits		ASTM Test	
	Class F	Class C	Method	
Silicon Dioxide (SiO ₂)	44.11	%		
Aluminum Oxide (Al ₂ O ₃)	23.22	%		
Iron Oxide (Fe ₂ O ₃)	8.11	%		
Sum of Constituents	75.44	%	70.0% min	50.0% min D4326
Sulfur Trioxide (SO ₃)	1.14	%	5.0% max	5.0% max D4326
Calcium Oxide (CaO)	12.81	%		D4326
Moisture	0.08	%	3.0% max	3.0% max C311
Loss on Ignition (AASHTO M 295-00 req.)	1.50	%	6.0% max	6.0% max C311
Available Alkalies, as Na ₂ O (AASHTO M 295-00 req.)	1.15	%	5.0% max	5.0% max C311
Physical Analysis				
Fineness, % retained on #325	17.76	%	34% max	34% max C311, C430
Strength Activity Index - 7 or 28 day requirement				C311, C109
7 day, % of control	100	%	75% min	75% min
28 day, % of control	99	%	75% min	75% min
Water Requirement, % control	94	%	105% max	105% max
Autoclave Soundness	0.05	%	0.8% max	0.8% max C311, C151
True Particle Density	2.48			

Headwaters Resources certifies that, to the best of its knowledge, the test data listed herein was generated by applicable ASTM methods and meets the requirements of ASTM C618-05 for Class F fly ash.

Bobby Bergman
 Bobby Bergman
 MTRF Manager



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ASTM D5370

Pozzolan Blended Materials in Construction Applications

Appendix X1. Quality Assurance Program: Adequacy of the Blending Process at the Production Facility.

X1.1 A blend of two ingredients of different absolute densities should result in a known reproducible density for each proportion.

X1.3 The exact blending process must be in the QA report, including batch weights, blending times, blending procedure and other pertinent data.

X1.4 The check for the uniformity of the blend should be performed on a monthly basis or each time the blending process varies (equipment, blending time, weights, and so forth).

ASTM D5370



P²

ASTM D 5370 –06 Appendix X1.1-4 Blended Pozzolans (Worksheet)

**±0.05 Max
Variance
Actual vs
Theoretical**

Date	Sample ID	400 Ton	Weekly	Blended Density	Class C Density	Class F Density	Blend % C F		Theoretical Density	Actual Density	Actual vs Theoretical
							Class C	Class F			
10/15/09	1795MR-1797P2A	Y		2.45	2.66	2.28	49%	51%	2.47	2.45	-0.01
10/26/09	1850MR-1852P2A	Y		2.46	2.66	2.27	49%	51%	2.46	2.46	0.00
10/28/09	1903MR-1905P2A	Y		2.46	2.65	2.29	49%	51%	2.47	2.46	0.00
11/4/09	1906MR-1908P2A	Y		2.45	2.62	2.33	49%	51%	2.47	2.45	-0.01
11/16/09	1996MR-1998P2A	Y		2.47	2.65	2.31	49%	51%	2.48	2.47	0.00
11/24/09	2026MR-2028P2A	Y		2.47	2.68	2.41	49%	51%	2.54	2.47	-0.03
12/3/09	2110MR-2112P2A	Y		2.49	2.65	2.33	49%	51%	2.49	2.49	0.00
12/7/09	2113MR-2115P2A	Y		2.42	2.61	2.33	49%	51%	2.47	2.42	-0.02
12/21/09A	2169MR-2171P2A	Y		2.44	2.62	2.31	49%	51%	2.46	2.44	-0.01
12/21/09B	2172MR-2174P2A	Y		2.45	2.63	2.31	49%	51%	2.47	2.45	-0.01
12/22/09A	2175MR-2177P2A	Y		2.42	2.64	2.30	49%	51%	2.47	2.42	-0.02
12/22/09B	2178MR-2180P2A	Y		2.43	2.63	2.29	49%	51%	2.46	2.43	-0.01
12/23/09	2181MR-2183P2A	Y		2.42	2.67	2.29	49%	51%	2.48	2.42	-0.02

Blending is homogeneous,
the material does not
segregate and fly ash
chemical and physical
consistency is controlled
to meet specific targets.

Blending the fly ash
improves product
consistency, ensuring
reliable and predictable
concrete field results.



Miller C

P2

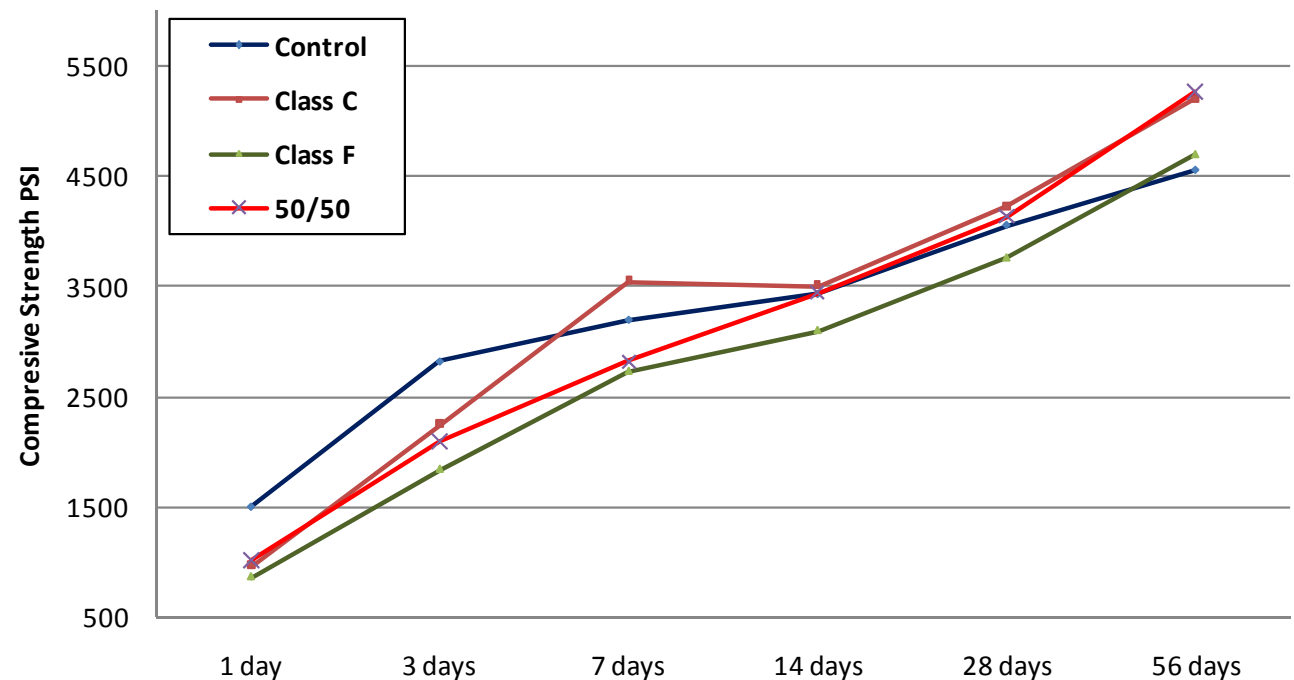
Gaston

(left to right)



The blending process reduces variability of Class F fly ash from the power plant. The blend in concrete at a 25 percent substitution rate performs better than the control mix and the Class F mix at 28 and 56 days.

Average Concrete Strengths ASTM C-39

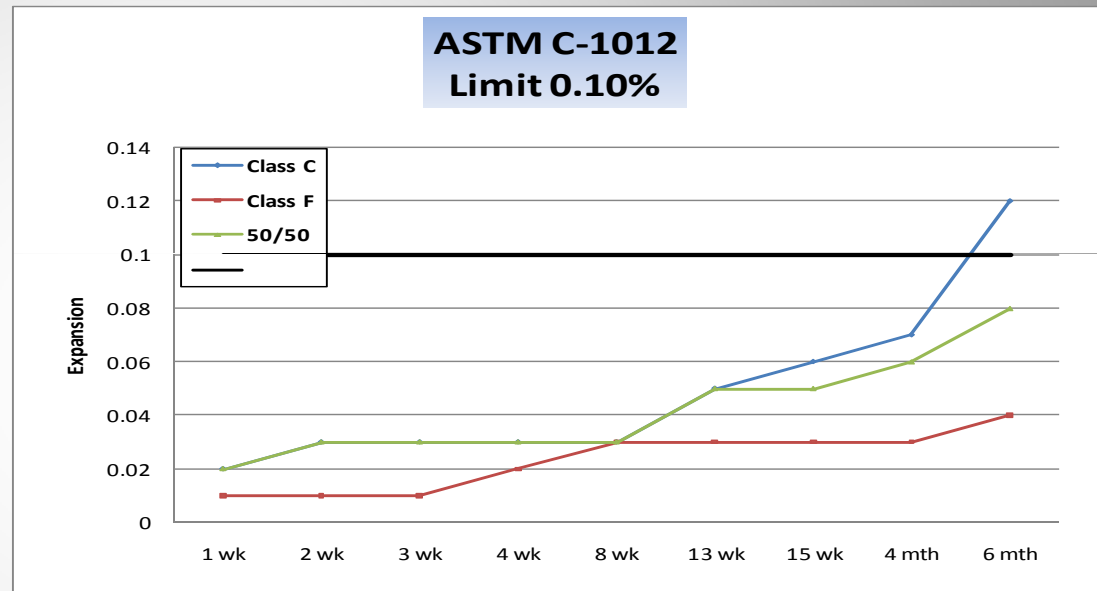




ASTM C-1012 sulfate expansion graph results, Class C fly ash is exceeding maximum expansion limits at six months. P² does not perform as well as a straight Class F ash; however, performs better than straight Class C fly ash.

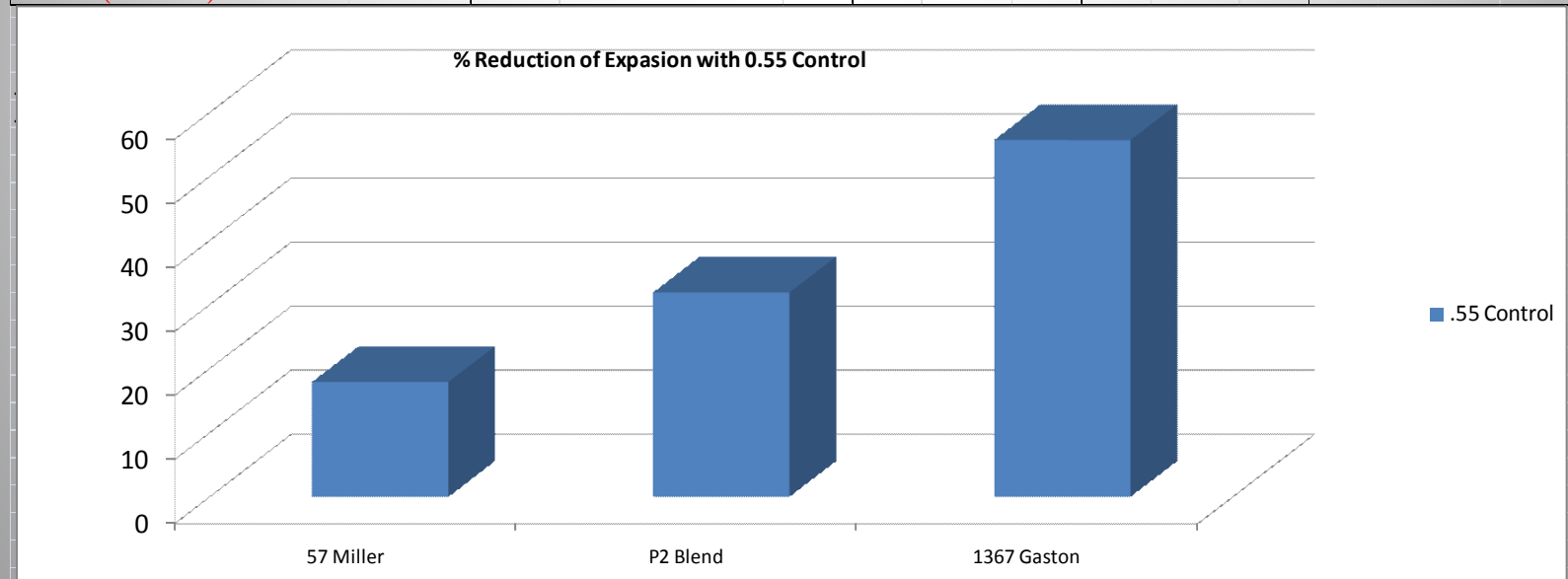
“Tilkasky and Carrasquillo (1993); and Dunstan (1976); showed that concrete containing some high-calcium fly ashes are susceptible to sulfate attack, and generally, higher volumes of high-calcium fly ash mixtures have a greater susceptibility to sulfate deterioration” (American Concrete Institute [ACI], 2008, p. 17).

Blending C with F fly ash mitigates problems caused by high CaO C ashes.



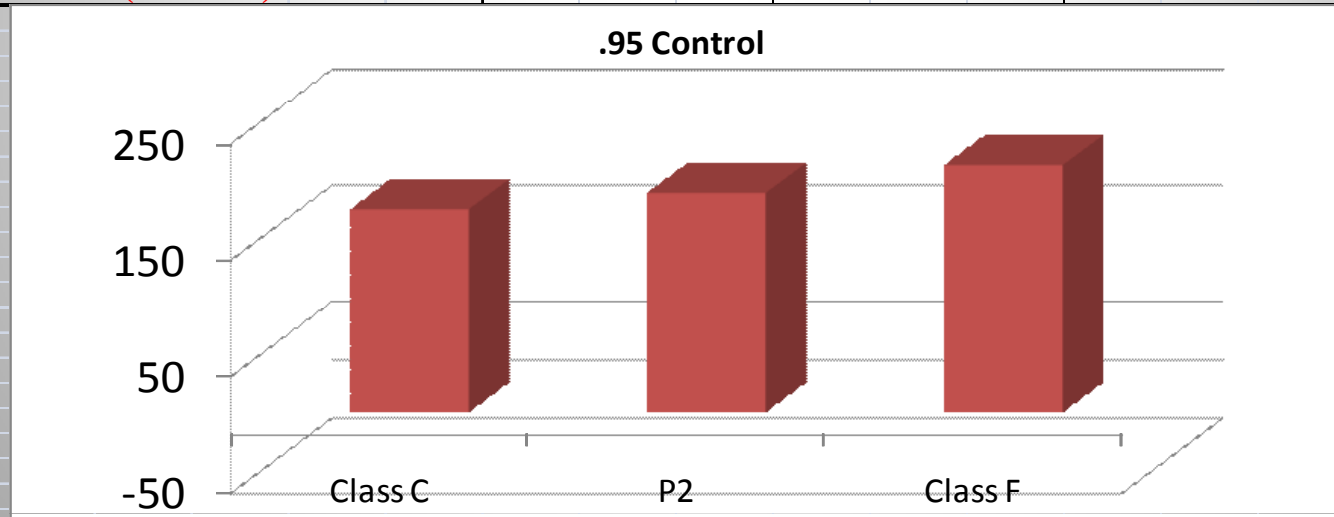
ASTM C441

		Control .55 Total Alkali			57 Miller			P2 Blend			1367 Gaston		
		Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3
Initial		0.1145	0.0663	0.1423	0.1199	0.1239	0.0936	0.0360	0.1472	0.1395	0.0965	0.0731	0.0706
14 day reading		0.1335	0.0822	0.1604	0.1408	0.1395	0.1006	0.0480	0.1595	0.1513	0.1056	0.0815	0.0766
	change	0.0190	0.0159	0.0181	0.0209	0.0156	0.0070	0.0120	0.0123	0.0118	0.0091	0.0084	0.0060
	Avg. Change		0.0177			0.0145			0.0120			0.0078	
% Reduction of Mortar Expansion						17.9			31.9			55.7	
14 day % change		0.1900	0.1590	0.1810									
in Control (0.25% min.)			0.1767										



ASTM C441

	Control .95 Total Alkali			Class C			P2			Class F		
	Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3	Bar 1	Bar 2	Bar 3
Initial	0.0318	0.1160	0.1194	0.1199	0.1239	0.0936	0.0360	0.1472	0.1395	0.0965	0.0731	0.0706
14 day reading	0.0778	0.1597	0.1658	0.1408	0.1395	0.1006	0.0480	0.1595	0.1513	0.1056	0.0815	0.0766
change	0.0460	0.0437	0.0464	0.0209	0.0156	0.0070	0.0120	0.0123	0.0118	0.0091	0.0084	0.0060
Avg. Change		0.0454			0.0145			0.0120			0.0078	
% Reduction of Mortar Expansion				174.7			188.7			212.5		
14 day % change in Control (0.25% min.)	0.4600	0.4370	0.4640									
		0.4537										



Headwaters Trial Batch Summary Results

Concrete Constituents

Cement	Type I/II Suwannee American		
Pozzolan	Headwaters P ² and Martin Lake		
Fine Aggregate	Vulcan Calera, AL		
Course aggregate	#57 Vulcan Calera, AL		
Water Reducer	WDRA 64 Grace		
Air Entrainment	Daravair AT60 Grace		

Mix ID	P2A	ML
Date	23-Apr-09	23-Apr-09
Time	9:55	11:00
Ambient Temp	65.4	68
Location	MTRF	MTRF

Mix Data

Weights	lbs	lbs
Water	269	269
Cement	526	526
Fly ash	132	132
% Fly ash	20%	20%
Design w/c	0.41	0.41
Design air %	4%	4%
Fine aggregate	1260	1263
Course aggregate	1837	1841

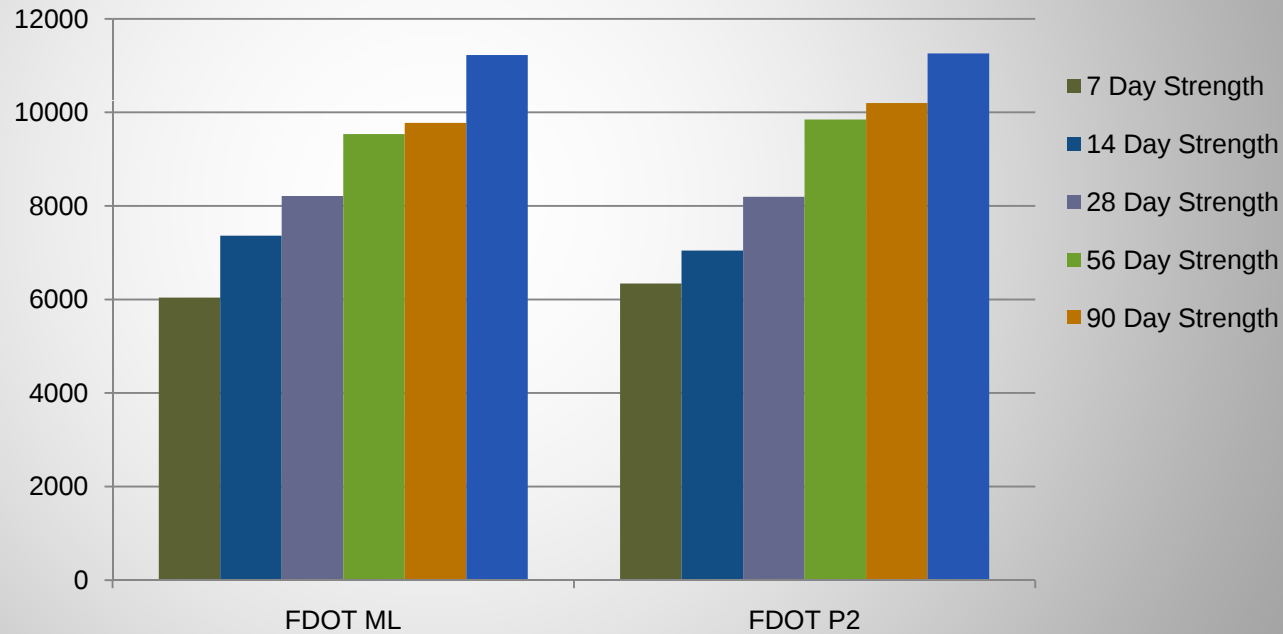
Admixtures

W/R	32oz	32oz
A/E	3.1oz	1.6oz

Plastic Properties

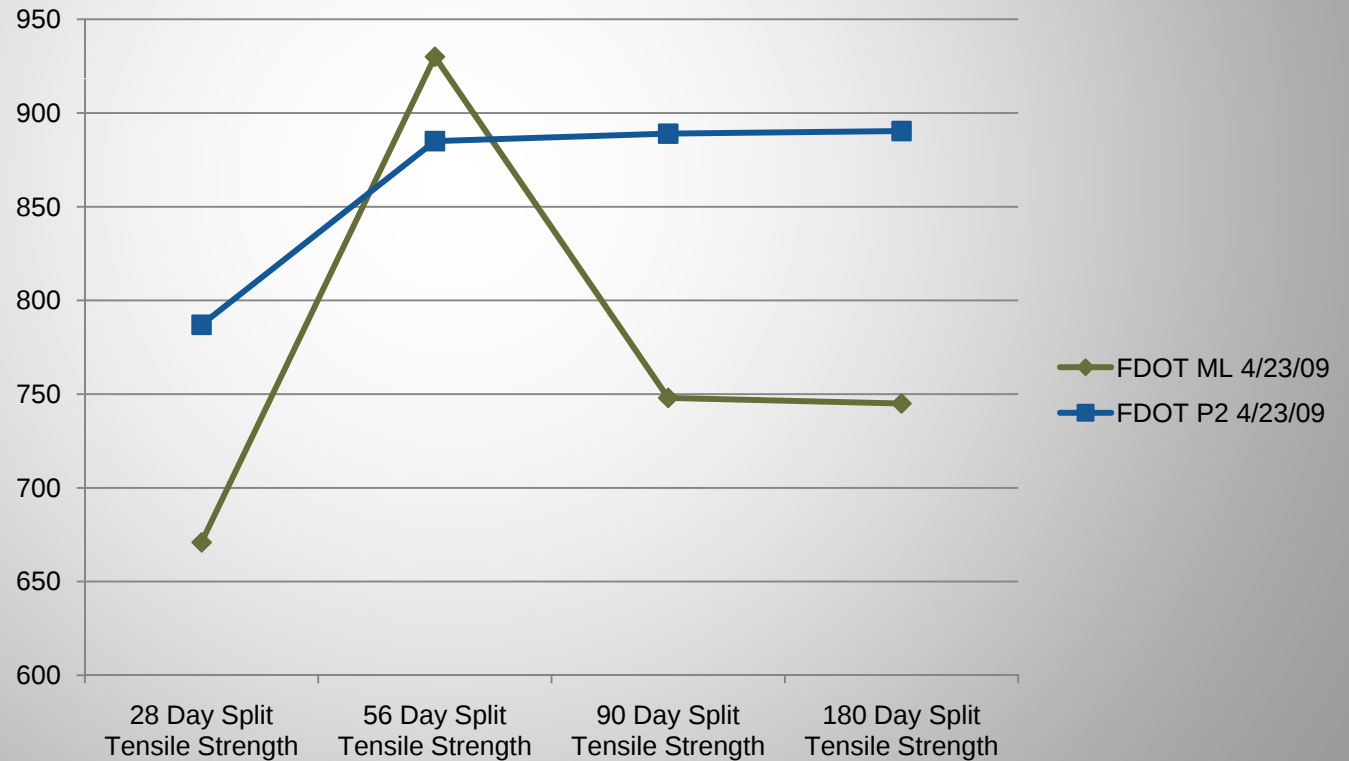
Slump	3	3
Unit Wt	148.20	150.60
Air	5%	5%
Actual yield	1.01	0.99
Conc temp	64.5	66
Actual w/c	0.41	0.41

Label	FDOT ML	FDOT P2
Date Made	4/23/09	4/23/09
7 Day Strength	6039	6341
14 Day Strength	7365	7045
28 Day Strength	8211	8193.5
56 Day Strength	9535	9848
90 Day Strength	9776	10200
180 Day Strength	11226	11260

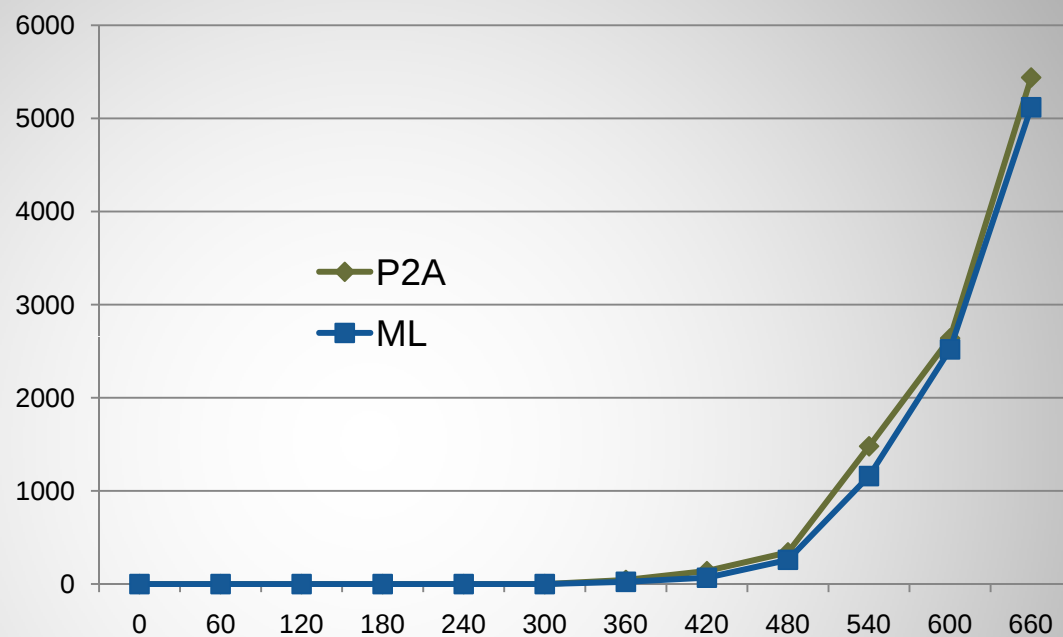


P² PERFORMANCE POZZOLAN

Label	FDOT ML	FDOT P2
Date Made	4/23/09	4/23/09
28 Day Split Tensile Strength	670.9	787
56 Day Split Tensile Strength	930	885
90 Day Split Tensile Strength	748	889
180 Day Split Tensile Strength	745	890.4
56 day P2 values sample 1 & 2	941.5	829

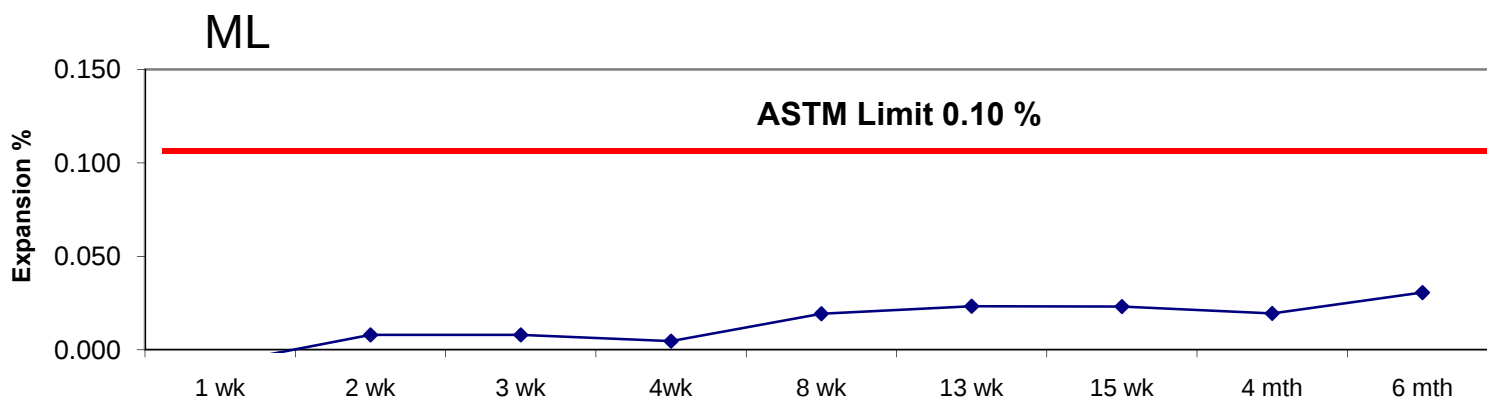


Minutes	P2A	ML
0	0	0
60	0	0
120	0	0
180	0	0
240	0	0
300	0	0
360	44	24
420	140	68
480	340	260
540	1480	1160
600	2640	2520
660	5440	5120

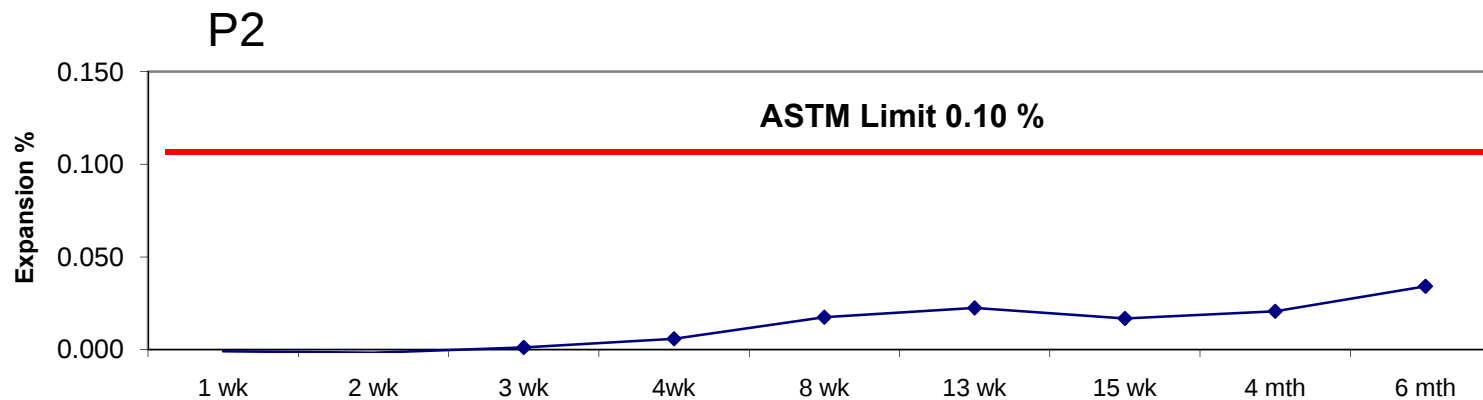


ASTM 1012

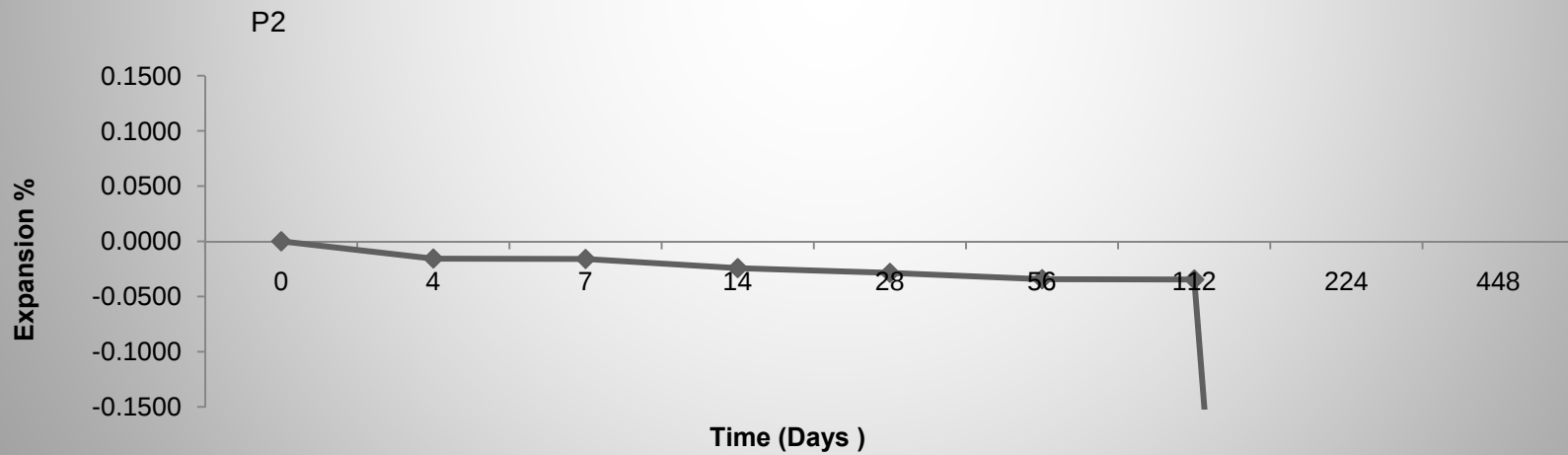
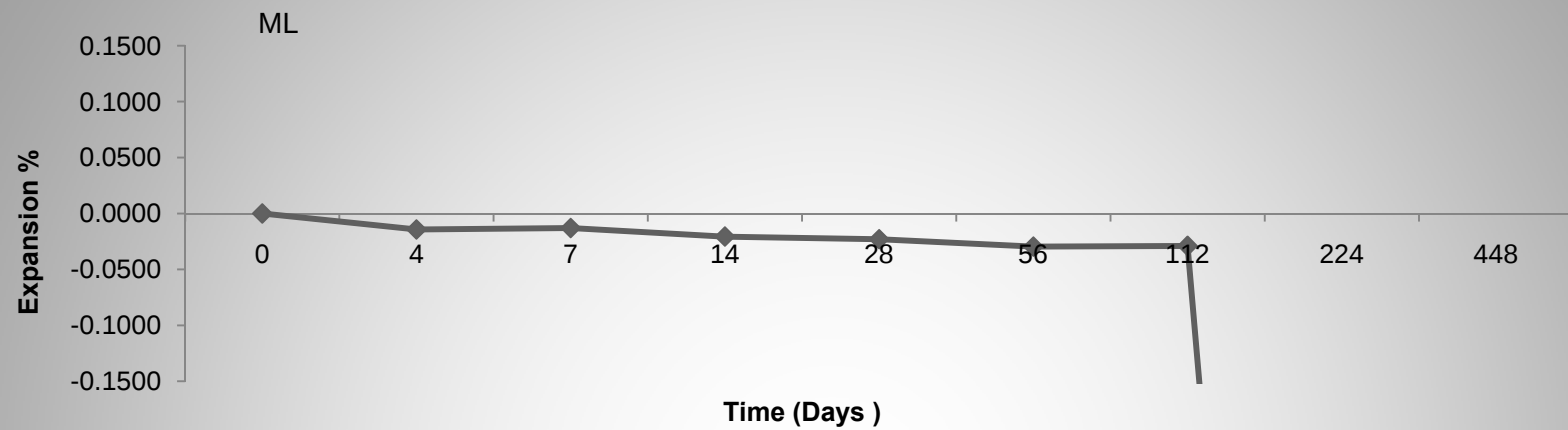
Age	1 wk	2 wk	3 wk	4wk	8 wk	13 wk	15 wk	4 mth	6 mth
% expansion	-0.007	0.008	0.008	0.005	0.019	0.023	0.023	0.020	0.031



Age	1 wk	2 wk	3 wk	4wk	8 wk	13 wk	15 wk	4 mth	6 mth
% expansion	-0.001	-0.002	0.001	0.006	0.018	0.023	0.017	0.021	0.034



ASTM C157



**Structural Materials Evaluation and
Research Laboratory Raw Data
Worksheet****Compressive Strength of Cylinders
(ASTM C 39-05ε1)**

Revised/Effective Date: 10/9/2008

By: C. Ishee

Page 1 of 1

Project Name: Headwaters

Cast Date: October 20, 2008

	Cylinder 1	Cylinder 2	Cylinder 3
Cylinder Number:	P2A-1	P2A-2	P2A-3
Age (days):	28	28	28
Length (in):	11.62	11.53	11.58
Diameter 1 (in):	5.97	5.97	5.95
Diameter 2 (in):	5.98	5.99	5.97
Avg. Diameter (in):	5.98	5.98	5.96
Area (in ²):	28.04	28.09	27.90
Maximum Load (lb):	92678	92678	92678
Comp Strength (psi):	3310	3300	3320
Fracture Type:			
MOE (psi):	5,850,000	5,850,000	5,850,000
Poisson's Ratio:	0.29	0.28	0.29
Ultrasonic Pulse :			

	Cylinder 4	Cylinder 5	Cylinder 6
Cylinder Number:	ML-1	ML-2	ML-3
Age (days):	28	28	28
Length (in):	11.67	11.58	11.71
Diameter 1 (in):	5.97	5.99	6.01
Diameter 2 (in):	5.98	5.99	6.00
Avg. Diameter (in):	5.98	5.99	6.01
Area (in ²):	28.04	28.18	28.32
Maximum Load (lb):	92876	92876	92876
Comp Strength (psi):	3310	3300	3280
Fracture Type:			
MOE (psi):	6,050,000	6,200,000	6,050,000
Poisson's Ratio:	0.29	0.30	0.29

**Structural Materials Evaluation and
Research Laboratory Raw Data
Worksheet**

**Compressive Strength of Cylinders
(ASTM C 39-05ε1)**

Revised/Effective Date: 10/9/2008

By: C. Ishee

Page 1 of 1

Project Name: Headwaters

Cast Date: October 20, 2008

	Cylinder 1	Cylinder 2
Cylinder Number:	P2A-4	P2A-5
Age (days):	56	56
Length (in):	11.69	11.67
Diameter 1 (in):	5.96	5.93
Diameter 2 (in):	5.94	5.97
Avg. Diameter (in):	5.95	5.95
Area (in ²):	27.81	27.81
Maximum Load (lb):	111378	111378
Comp Strength (psi):		
Fracture Type:		
MOE 1 (psi):	6,650,000	6,500,000
MOE 2 (psi):	6,650,000	6,450,000
Poisson's Ratio 1:	0.31	0.31
Poisson's Ratio 2:	0.31	0.31

	Cylinder 3	Cylinder 6
Cylinder Number:	ML-4	ML-5
Age (days):	56	56
Length (in):	11.73	11.59
Diameter 1 (in):	5.94	5.92
Diameter 2 (in):	5.96	5.98
Avg. Diameter (in):	5.95	5.95
Area (in ²):	27.81	27.81
Maximum Load (lb):	107838	107838
Comp Strength (psi):		
Fracture Type:		
MOE 1 (psi):	6,450,000	6,750,000
MOE 2 (psi):	6,450,000	6,750,000
Poisson's Ratio 1:	0.30	0.31
Poisson's Ratio 2:	0.30	0.30

*Thank you
for your time!*

Questions?

This concludes the presentation

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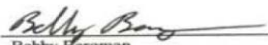
cwallace@headwaters.com

**ASTM C618-05 / AASHTO M 295-0 Testing of
Miller Plant Fly Ash**

Sample Type: 3200-ton **Report Date:** 7/24/2009
Sample Date: 6/12 - 6/16/09 **MTRF ID:** 861MR
Sample ID:

Chemical Analysis	ASTM / AASHTO Limits		ASTM Test	
	Class F	Class C	Method	
Silicon Dioxide (SiO ₂)	37.90	%		
Aluminum Oxide (Al ₂ O ₃)	18.71	%		
Iron Oxide (Fe ₂ O ₃)	6.25	%		
Sum of Constituents	62.86	%	70.0% min 50.0% min	D4326
Sulfur Trioxide (SO ₃)	1.77	%	5.0% max 5.0% max	D4326
Calcium Oxide (CaO)	23.24	%		D4326
Moisture	0.06	%	3.0% max 3.0% max	C311
Loss on Ignition (AASHTO M 295-00 req.)	0.55	%	6.0% max 5.0% max	C311
Available Alkalies, as Na ₂ O (AASHTO M 295-00 req.)	1.43	%	1.5% max 1.5% max	C311
Physical Analysis				
Fineness, % retained on #325	19.02	%	34% max 34% max	C311, C430
Strength Activity Index - 7 or 28 day requirement 7 day, % of control	99	%	75% min 75% min	C311, C109
28 day, % of control	105	%	75% min 75% min	
Water Requirement, % control	93	%	105% max 105% max	
Autoclave Soundness	0.07	%	0.8% max 0.8% max	C311, C151
True Particle Density	2.59			

Headwaters Resources certifies that, to the best of its knowledge, the test data listed herein was generated by applicable ASTM methods and meets the requirements of ASTM C618-05 for Class C fly ash.


 Bobby Bergman
 MTRF Manager



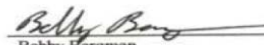
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**ASTM C618-05 / AASHTO M 295 Testing of
Gaston Fly Ash**

Sample Type: Monthly **Report Date:** 9/9/2009
Sample Date: 6/1 - 6/30/09 **MTRF ID:** 1108GT
Sample ID:

Chemical Analysis	ASTM / AASHTO Limits		ASTM Test	
	Class F	Class C	Method	
Silicon Dioxide (SiO ₂)	50.38	%		
Aluminum Oxide (Al ₂ O ₃)	27.20	%		
Iron Oxide (Fe ₂ O ₃)	9.14	%		
Sum of Constituents	86.72	%	70.0% min 50.0% min	D4326
Sulfur Trioxide (SO ₃)	0.30	%	5.0% max 5.0% max	D4326
Calcium Oxide (CaO)	2.49	%		D4326
Moisture	0.14	%	3.0% max 3.0% max	C311
Loss on Ignition (AASHTO M 295 req.)	2.95	%	6.0% max 5.0% max	C311
Available Alkalies, as Na ₂ O (AASHTO M 295 req.)	0.69	%	1.5% max 1.5% max	C311
Physical Analysis				
Fineness, % retained on #325	17.23	%	34% max 34% max	C311, C430
Strength Activity Index - 7 or 28 day requirement 7 day, % of control	79	%	75% min 75% min	C311, C109
28 day, % of control	81	%	75% min 75% min	
Water Requirement, % control	99	%	105% max 105% max	
Autoclave Soundness	0.02	%	0.8% max 0.8% max	C311, C151
True Particle Density	2.33			

Headwaters Resources certifies that pursuant to ASTM C618-05 protocol for testing, the test data listed herein was generated by applicable ASTM methods and meets the requirements of ASTM C618-05 for Class F fly ash.


 Bobby Bergman
 MTRF Manager



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