STS
750 Corporate Woods Parkway, Vernon Hills, IL 60061
T 847.279.2500 F 847.279.2510 www.sts.aecom.com

August 20, 2008

Ms. Elaine McCluskey
Fermi National Accelerator Laboratory
P.O. Box 500
Batavia, Illinois 60510-5011

Re: Laboratory Testing Program For The Fermi National Accelerator Laboratory NuMI Tunnel And Enclosure – STS Project No. 200801095

Dear Ms. McCluskey,

We are pleased to submit two (2) copies of our second laboratory report that pertains to the testing of three (3) additional molded cement / aggregate specimens. The initial three specimen test data were reported in our report dated June 4, 2008. The testing was performed in reference to the Fermi National Accelerator Laboratory NuMI Tunnel And Enclosure project.

Scope of Services

The scope of services provided by STS was to provide laboratory testing services and necessary equipment to determine the hydraulic conductivity and porosity of three (3) molded aggregate / cement samples. The samples were prepared and tested in our Vernon Hills, IL testing facility.

Specimen Preparation

The initial stage of testing was to prepare the three molded test specimens. The cement / aggregate mix specimens consisted of 4 components, an aggregate (new), cement, an admixture and water. All components, except for the water, were supplied in bulk to STS by Fermilab. The mix components were combined together in proportions duplicating those outlined in Mix #536 which was supplied to STS by Fermilab and has been attached.

Once combined, the components were thoroughly mixed and placed into a 2.875 inch diameter mold in 2 layers. Each layer was rodded 25 times using a 3/8 inch diameter tamping rod following the procedure outlined in ASTM C 192. The specimens, once molded, were sealed in plastic and allowed to set for 24 hours. Following the 24 hour initial set period, the specimens were removed from the molds and stored in a moist cure room where the temperature is maintained between 70° and 77° F at 100% humidity. The specimens were cured under these conditions for a period of 28 days.

Specimen Testing

After reaching the 28 day moist cure period, each of the three specimens were removed from the cure room. Initial specimen dimensions and weights were determined and recorded. Each specimen was then encased in a flexible latex membrane and placed into a triaxial permeameter. The specimens were back pressure saturated at pressures of 42 pounds per square inch (psi) confining pressure and 40 psi back pressure. Each of the specimens was allowed to saturate under these conditions for forty eight hours prior to initiating permeant flow.

Following the 48 hour saturation period, permeant flow was initiated through the bottom of the specimens and allowed to exit through the top of the specimens. The permeant inflow and outflow were measured using calibrated burettes. The hydraulic conductivity of each of the specimens was determined. These procedures were in accordance with those outlined in ASTM D 5084.

Specimen Porosity

After meeting all the test termination criteria per the ASTM standard, each of the specimens were removed from the triaxial permeameter. Every effort was made to account for all water retained within the specimen voids upon specimen disassembly. The apparent porosity was determined by the volume of water retained in the specimen divided by the total specimen volume and reported as a percentage.

Test Results

The test results have been summarized below and on the attached test summaries:

Specimen No. Number	Dry Density (pcf)	Hydraulic Conductivity (cm/sec)	Porosity (%)
S-1A	132.0	7.56×10^{-06}	21.4
S-2A	130.2	3.26×10^{-06}	22.1
S-3A	130.8	6.26×10^{-06}	22.0

The test data included in this report only represent the samples tested and may not reflect actual site materials and/or conditions. The scope of services provided by STS did not include interpretation of the laboratory test data, and therefore, we are not liable for any interpretation performed by others. If you wish us to provide you with this service, we would be happy to discuss this matter with you at your convenience. Any reproduction of this report must be done in its entirety.

We are pleased to have the opportunity to provide you with our testing services. Should you have any questions, or require additional assistance, please feel free to contact us at any time.

Respectfully,

STS

William P. Quinn
Laboratory Manager

Chia K. Tan, PE
Principal Engineer

Attachment:

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 279-2500 Fax:(847) 279-2550

STS PROJECT NO.:	**200801095**	**8/13/2008**
PROJECT NAME:	**Fermilab NuMI Tunnel & Enclosure**	
CLIENT NAME:	**Fermi National Accelerator Laboratory**	

SUMMARY OF TEST RESULTS

SAMPLE NO.	S-1A
SAMPLE MIX	Mix Design #536
SPECIMEN DESCRIPTION	Cement, Aggregate, Admixture and Water Duplicating Proportions For Mix #536 Mixed and Molded to Target Specimen Size. Cured at 100% Humidity and 70-76° F for 28 Days

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	132.0	132.2
WATER CONTENT (%)	9.1	10.1
DIAMETER (cm)	7.105	7.101
LENGTH (cm)	9.556	9.550

HYDRAULIC GRADIENT (MAXIMUM)	2.51	
POROSITY (%) (Based upon WC)	21.4	(Porosity calculation is based on final specimen measurements and volume of water retained.)
HYDRAULIC CONDUCTIVITY k (cm/sec)	7.56E-06	

Deaired tap water was used as the liquid permeant.

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HYDRAULIC CONDUCTIVITY DETERMINATION
ASTM D 5084, METHOD C

Laboratory Services Group 750 Corporate Woods Parkway Vernon Hills, Illinois 60061 Phone:(847) 279-2500 Fax:(847) 279-2550

STS PROJECT NO.:	**200801095**	**8/13/2008**
PROJECT NAME:	**Fermilab NuMI Tunnel & Enclosure**	
CLIENT NAME:	**Fermi National Accelerator Laboratory**	

SUMMARY OF TEST RESULTS

SAMPLE NO.	S-2A		
SAMPLE MIX	Mix Design #536		
SPECIMEN DESCRIPTION	Cement, Aggregate, Admixture and Water Duplicating Proportions For Mix #536 Mixed and Molded to Target Specimen Size. Cured at 100% Humidity and 70-76° F for 28 Days		
		INITIAL	FINAL
DRY UNIT WEIGHT (pcf)		130.2	130.3
WATER CONTENT (%)		9.6	10.6
DIAMETER (cm)		7.106	7.105
LENGTH (cm)		11.157	11.150
HYDRAULIC GRADIENT (MAXIMUM)	2.15		
POROSITY (%) (Based upon WC)	22.1	(Porosity calculation is based on final specimen measurements and volume of water retained.)	
HYDRAULIC CONDUCTIVITY k (cm/sec)	3.26E-06		

Deaired tap water was used as the liquid permeant.

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STS PROJECT NO.:	**200801095**	**8/13/2008**
PROJECT NAME:	**Fermilab NuMI Tunnel & Enclosure**	
CLIENT NAME:	**Fermi National Accelerator Laboratory**	

SUMMARY OF TEST RESULTS

SAMPLE NO.	S-3A	
SAMPLE DEPTH	Mix Design #536	
CLASSIFICATION	Cement, Aggregate, Admixture and Water Duplicating Proportions For Mix #536 Mixed and Molded to Target Specimen Size. Cured at 100% Humidity and 70-76o F for 28 Days	

	INITIAL	FINAL
DRY UNIT WEIGHT (pcf)	130.8	131.4
WATER CONTENT (%)	9.4	10.5
DIAMETER (cm)	7.106	7.102
LENGTH (cm)	11.464	11.431

HYDRAULIC GRADIENT (MAXIMUM)	2.09	
POROSITY (%) (Based upon WC)	22.0	(Porosity calculation is based on final specimen measurements and volume of water retained.)
HYDRAULIC CONDUCTIVITY k (cm/sec)	6.27E-06	

Deaired tap water was used as the liquid permeant.

Mix Design 536

PROJECT: Fermilab NuMI Tunnel & Enclosure: adjusted May 9, 2002
PROJECT NO.: FESS130279ARF
CONTRACTOR: S. A. Healy Company

CUBIC YARD CALCULATOR

Material	Description/Source	Lbs.	Specific Gravity	Absolute Volume	Adjusted Mix Based on Abs. Volume
Cement Type III	Illinois Cement	241	3.15	1.226	245.95
FA-5(incl abs water)*	Conco Western	2981.2	2.63	18.165	3042.35
Ad Mixture - ML330	W.R. Grace	3	1.0687	0.045	3.06
Air Content (4.5%)		NA	NA	0.878	0.88
Water(incl free moisture)		383.3	1	6.143	391.19
Totals		3608.5		26.457	3683.42
PCF	136.391				~~136.42~~ pcf

* Absorption 1.5%

Absolute Volume/Theoretical of 27 = 1.021

PROJECT #:
200801095

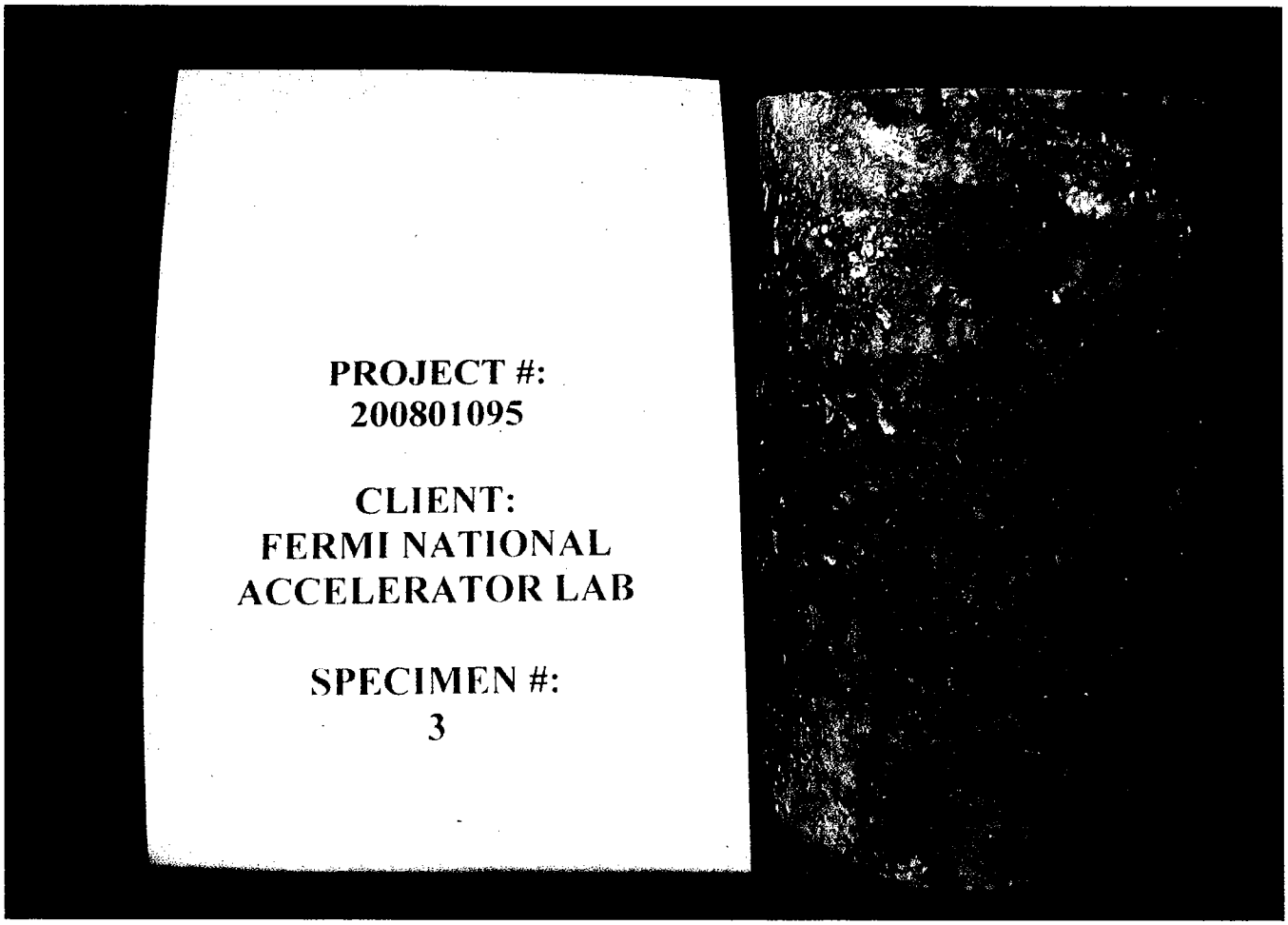
CLIENT:
FERMI NATIONAL
ACCELERATOR LAB

SPECIMEN #:
1

PROJECT #:
200801095

CLIENT:
FERMI NATIONAL
ACCELERATOR LAB

SPECIMEN #:
2


PROJECT #:
200801095
CLIENT:
FERMI NATIONAL
ACCELERATOR LAB
SPECIMEN #:
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