TESTING ENGINEERS, INC.

Quality Assurance Services
Materials Consulting
Since 1954

August 8, 2018

Ms. Jackie Yamnitz
EARTHWORKS
19797 Eisenbeis Bottom Road
STE Genevieve, MO 63670

Lab. No.: K832

SUBJECT: Testing of "Pewter Mist-Light to Medium Range" Limestone Samples.

Dear Ms. Yamnitz;

At your request, we have completed tests 1 through 5 (listed below) on the above referenced stone samples submitted to our laboratory. The description and corresponding ASTM methods for the tests performed are as follows:

Test 1 - Absorption & Density- ASTM C97

Test 2 - Compressive Strength, Dry, Wet, Perpendicular & Parallel to Rift – ASTM C170

Test 3 - Flexural Strength, Dry, Wet, Perpendicular to Rift – ASTM C880

Test 4 – Modulus of Rupture, Dry, Wet, Perpendicular & Parallel to Rift - ASTM C99

Test 5 – Coefficient of Friction – ASTM C1028

Test 6 – Freeze/Thaw – ASTM C67 (in progress)

Test 7 – Freeze/Thaw & De-icing Salt Durability – ASTM C1645 (in progress)

PROCEDURES & RESULTS

The specimens for each test were prepared and tested in accordance with the above ASTM designations.

A 60 kip Tinius Olsen S/N 82421/3190 (calibration traceable to NIST) test machine was employed for tests 3 and 4. For test 2, a Tinius Olson 200 Kip Super L S/N 84568 was used.

The test results for tests 1 through 5 are presented in Tables I through V. Tests 6 and 7 are long term exposure tests and have not been completed at this point.

If you have any questions regarding this report, please contact the undersigned at 510 835 3142.

Respectfully Submitted,
TESTING ENGINEERS, INC.

Hossein Arbabi, Ph.D., P.E.
Senior Engineer

TABLE I
Absorption – ASTM C97
"Pewter Mist-Light to Medium Range" Limestone

Specimen No.	Absorption, %	Specific Gravity	Density, lbs/ft^3
1	3.1	2.4	149.8
2	3.2	2.4	149.8
3	3.2	2.4	149.8
4	3.2	2.4	149.8
5	3.2	2.4	149.8
Average	**3.2**	**2.4**	149.8

TABLE II
Compressive Strength, psi – ASTM C170
"Pewter Mist-Light to Medium Range" Limestone

Specimen No.	Compressive Strength, Dry, Perpendicular to Rift	Compressive Strength, Dry, Parallel to Rift	Compressive Strength, Wet, Perpendicular to Rift	Compressive Strength, Wet, Parallel to Rift
1	12,646	7,107	8,334	4,585
2	12,340	4,867	6,416	5,752
3	11,208	12,853	8,389	5,180
4	12,781	12,151	8,390	7,265
5	11,964	11,059	6,743	6,689
Average	**12,188**	**9,607**	**7,654**	**5,894**

TABLE III
Modulus of Rupture, psi – ASTM C99
"Pewter Mist-Light to Medium Range" Limestone

Specimen No.	Modulus of Rupture, Dry, Perpendicular to Rift	Modulus of Rupture, Dry, Parallel to Rift	Modulus of Rupture, Wet, Perpendicular to Rift	Modulus of Rupture, Wet, Parallel to Rift
1	1,506	1,120	2,070	1,011
2	1,410	1,181	1,692	1,082
3	1,274	1,132	1,703	822
4	1,099	1,199	1,740	784
5	1,155	1,226	1,555	1,171
Average	**1,289**	**1,172**	**1,752**	**974**

TABLE IV
Flexural Strength, psi - ASTM C880
"Pewter Mist-Light to Medium Range" Limestone

Specimen No.	Flexural Strength, Dry, Perpendicular to Rift	Flexural Strength, Dry, Parallel to Rift	Flexural Strength, Wet, Perpendicular to Rift	Flexural Strength, Wet, Parallel to Rift
1	894	916	956	690
2	676	1,139	716	530
3	1,400	617	781	426
4	800	572	961	651
5	744	971	760	456
Average	**903**	**843**	**835**	**551**
Stand. Dev.	**289**	**242**	**115**	**117**

Table V
Coefficient of Friction – ASTM C1028
"Pewter Mist-Light to Medium Range" Limestone

Frctional Force, lbf	
Dry	**Wet**
30.8	30.4
31.6	29.2
33.0	30.2
32.4	30.0
32.0	29.8
32.2	29.8
31.4	30.0
31.8	31.2
32.4	30.8
31.6	29.6
30.6	30.2
30.4	29.4
Average = 31.7	Average = 30.1
Average Coefficient of Friction = 1.17	**Average Coefficient of Friction = 0.60**

TESTING ENGINEERS, INC.

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October 17, 2018

Ms. Jackie Yamnitz
EARTHWORKS
19797 Eisenbeis Bottom Road
STE Genevieve, MO 63670

Lab. No.: K832B

SUBJECT: Freeze/Thaw Testing of "Pewter Mist" Limestone Stone Samples.

Dear Ms. Yamnitz;

At your request, we have completed the testing of the above referenced stone samples submitted to our laboratory. The test description and corresponding ASTM test method were as follows:

Test 1 – Freeze/Thaw – ASTM C67.

Test 2 – Freeze/Thaw & De-icing Salt Durability – ASTM C1645.

PROCEDURES & RESULTS

The specimens for each test were prepared and tested in accordance with the above ASTM designations.

Five specimens with 2"x2"x4" were subjected to 50 cycles of freezing and thawing in accordance with ASTM C67. There were no indications of, cracking, or breakage on any of the five specimens tested, and the average weight loss on completion of testing was 0.07%. The results are presented in Table I. The specimens meet the requirements of AC51/ ASTM C67 for freeze/thaw.

Five specimens with dimensions 3"x3"x6" were subjected to 28 cycles of freeze/thaw with specimens submerged in salt water. The tests were performed in accordance with ASTM C1645. The results for 7 day and 28 day cycles are presented in Table II. Based on the data, the weight loss on all specimens was below the maximum of 225 grams/m^2 specified in ASTM C936.

If you have any questions regarding this report, please contact the undersigned at 510 835 3142 X199.

Respectfully Submitted,
TESTING ENGINEERS, INC.

Hossein Arbabi, Ph.D., P.E.
Senior Engineer

TABLE I
Freeze/Thaw – ASTM C67
"Pewter Mist" Limestone

Specimen No.	Orginal weight, g	Weight after 50 freeze/thaw cycles, g	Weight loss, g	Percent weight loss
1	647.9	647.5	0.4	0.06
2	646.6	646.2	0.4	0.06
3	648.7	648.3	0.4	0.06
4	649.5	649.0	0.5	0.08
5	652.4	651.9	0.5	0.08
Average				**0.07**

TABLE II
Salt Water Exposure-freeze/thaw – ASTM C1645
"Pewter Mist" Limestone

Specimen No.	7 Day Weight Loss, g	7 Day Weight Loss per Unit Area, g/m^2	28 Day Weight Loss, g	28 day Weight Loss per Unit Area, g/m^2
1	0.020	0.22	0.033	0.36
2	0.014	0.15	0.048	0.52
3	0.038	0.41	0.050	0.54
Average	**0.024**	**0.32**	**0.044**	**0.47**

TESTING ENGINEERS, INC.

Quality Assurance Services
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September 28th, 2016

Laboratory No.: H917
Client No.: EWS000
P.O. NO. Verbal

Jacky Yamnitz
Earthworks
19797 Eisenbeis
STE Genevieve, MO 63670

Subject: Petrographic study on submitted limestone sample

Jacky Yamnitz:

As requested, testing was conducted on submitted limestone samples. Below is the summary of the attached pertrographic study:

The petrographic classification of Pewter Mist Light dimension stone, as represented by the examined sample, is packed biomicrite or fossiliferous limestone. The overall fabric is massive. The stone is dense, generally uniform, and free of constituents and features that are likely to affect the durability of the stone in service. No directional features such as layering, bedding, veins, or stylolites were observed. No fractures, large voids or cavities were observed. Potential stain-causing minerals and excessive amounts of clay were not observed. Absorption on fracture surfaces was moderately low.

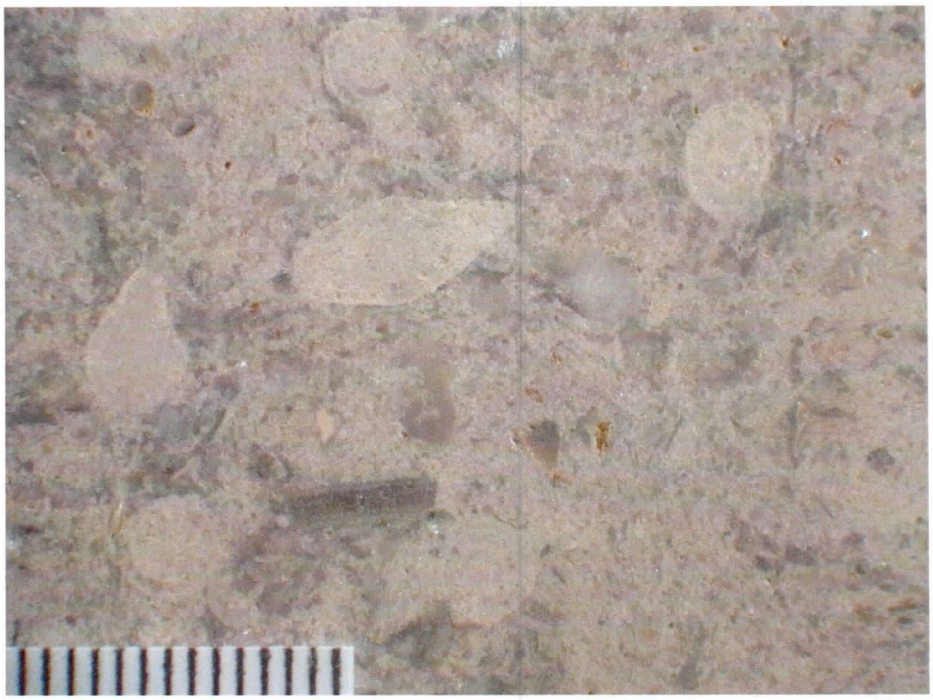
The stone appears to be generally suitable for use as dimension stone in applications where medium density limestone is specified, provided it meets the minimum physical requirements listed in ASTM C568, Standard Specification for Limestone Dimension Stone. Limited testing (five cubes removed from the block provided) indicates that the stone meets the absorption requirement listed in ASTM C568 for high-density limestone (3 percent maximum) and the density requirement for medium-density limestone (135 lbs/ft3 minimum), but does not meet the density requirement for high-density limestone (160 lbs/ft3 minimum). If the stone is to be used in an exterior freeze/thaw environment, we recommend that additional evaluation or testing be performed to evaluate its durability.

If you have any questions and/or if we may be of further service please contact the undersigned at 510-835-3142.

Sincerely,
TESTING ENGINEERS, INC.

John Anzaldo, Jr.
Staff Engineer

PEWTER MIST DIMENSION STONE
Petrographic Studies



Final Report
September 26, 2016
WJE No. 2016.5463

Prepared for:
Testing Engineers, Inc.
2811 Teagarden Street
San Leandro, CA 94577

Prepared by:
Wiss, Janney, Elstner Associates, Inc.
330 Pfingsten Road
Northbrook, Illinois 60062
847.272.7400 tel | 847.291.5189 fax

PEWTER MIST DIMENSION STONE
Petrographic Studies

Laura J. Powers
Associate Principal, Petrographer

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WJE ENGINEERS ARCHITECTS MATERIALS SCIENTISTS

PEWTER MIST DIMENSION STONE
Petrographic Studies

INTRODUCTION

Petrographic studies were conducted on a sample of stone submitted by Dr. Hossein Arbabi of Testing Engineers, Inc. The studies were requested to assess the composition and textural characteristics of the stone to determine its general suitability for use as dimension stone. The stone received for examination was identified as Pewter Mist Light limestone and consisted of a saw-cut block measuring approximately 11 inches by 11 inches by 3.1 inch thick (Figure 1). The name and location of the stone quarry were not provided.

PETROGRAPHIC STUDIES

The sample was examined in accordance with the methods described in ASTM C1721, *Standard Guide for Petrographic Examination of Dimension Stone*. Larger-scale textural characteristics of the stone were assessed by visual inspection of the surfaces of the as-received sample and a stereomicroscope examination of fracture surfaces and lapped (semi-polished) surfaces. A 5-inch block was cut from the larger sample. Mutually perpendicular surfaces were lapped to facilitate observations of directional features. Lapped surfaces are shown in Figures 2 and 3. Constituents of the stone and microstructural characteristics were determined by thin-section analyses. Thin sections were prepared from mutually perpendicular orientations to capture variations in composition and microstructure. The thin sections were examined using a petrographic (polarized-light) microscope. Petrographic observations are described in greater detail in the following sections.

Petrographic Description

Stone represented by the sample is predominantly beige-gray in color (close to Munsell 5YR 6/1). The color is variable on a scale of millimeters from cream to purple-gray. The stone contains abundant carbonate microfossils and shell fragments suspended in a predominantly fine-grained calcite (micrite) matrix (Figures 4 through 6). The petrographic classification is fossiliferous limestone or biomicrite, according to the Folk classification. Bio indicates biologically-derived material such as shells and micrite indicates fine-grained matrix. The overall fabric is massive. No directional features such as layering, bedding, veins, or stylolites were observed. No empty or filled fractures were observed. Potential stain-causing constituents such as sulfides were not observed. Excessive amounts of clay were not observed.

Thin-Section Analyses

Thin-section analysis allows for refinement in the classification of the stone. The stone contains greater than 50 percent fossils and is classified as packed biomicrite. The matrix consists of micrite and sparry calcite (larger crystals). Regions of sparry calcite probably represent local recrystallization of the fine-grained matrix. Fossils include fusilinids and other foraminifera, coral, bryozoans, crinoids, sponges, broken shells, green and brown glauconite pellets, and others. The largest fossils are shell fragments up to 10 mm long and fusilinids up to 5 mm long. Small to trace amounts of clay-like material, iron compounds (mixture of hematite and limonite), and an amorphous, possibly phosphatic allochem were also observed. The constituents and microstructure of the stone are shown in Figures 7, 8 and 9.

The stone is dense and the fabric is uniform. Fractures produced in the laboratory with a geology hammer do not reveal any preferred breaking direction. No cavities or large pores were observed. Small regions of micro-porosity were scattered throughout the stone. Water absorptivity on fracture surfaces was moderately low. Absorption and specific gravity were determined on five 2-inch cube specimens removed from the block in accordance with the procedures described in ASTM C97, *Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone*. Absorption was 2.65 percent, bulk specific gravity was 2.45, and density was 152.7 lbs/ft^3.

SUMMARY

The petrographic classification of Pewter Mist Light dimension stone, as represented by the examined sample, is packed biomicrite or fossiliferous limestone. The overall fabric is massive. The stone is dense, generally uniform, and free of constituents and features that are likely to affect the durability of the stone in service. No directional features such as layering, bedding, veins, or stylolites were observed. No fractures, large voids or cavities were observed. Potential stain-causing minerals and excessive amounts of clay were not observed. Absorption on fracture surfaces was moderately low.

The stone appears to be generally suitable for use as dimension stone in applications where medium density limestone is specified, provided it meets the minimum physical requirements listed in ASTM C568, *Standard Specification for Limestone Dimension Stone*. Limited testing (five cubes removed from the block provided) indicates that the stone meets the absorption requirement listed in ASTM C568 for high-density limestone (3 percent maximum) and the density requirement for medium-density limestone (135 lbs/ft^3 minimum), but does not meet the density requirement for high-density limestone (160 lbs/ft^3 minimum). If the stone is to be used in an exterior freeze/thaw environment, we recommend that additional evaluation or testing be performed to evaluate its durability.

Storage: Thirty days after completion of our studies, the samples will be discarded unless the client submits a written request for their return. Shipping and handling fees will be assessed for any samples returned to the client. Any hazardous materials that may have been submitted for study will be returned to the client and shipping and handling fees will apply. The client may request that WJE retain samples in storage in our warehouse. In that case, a yearly storage fee will apply.

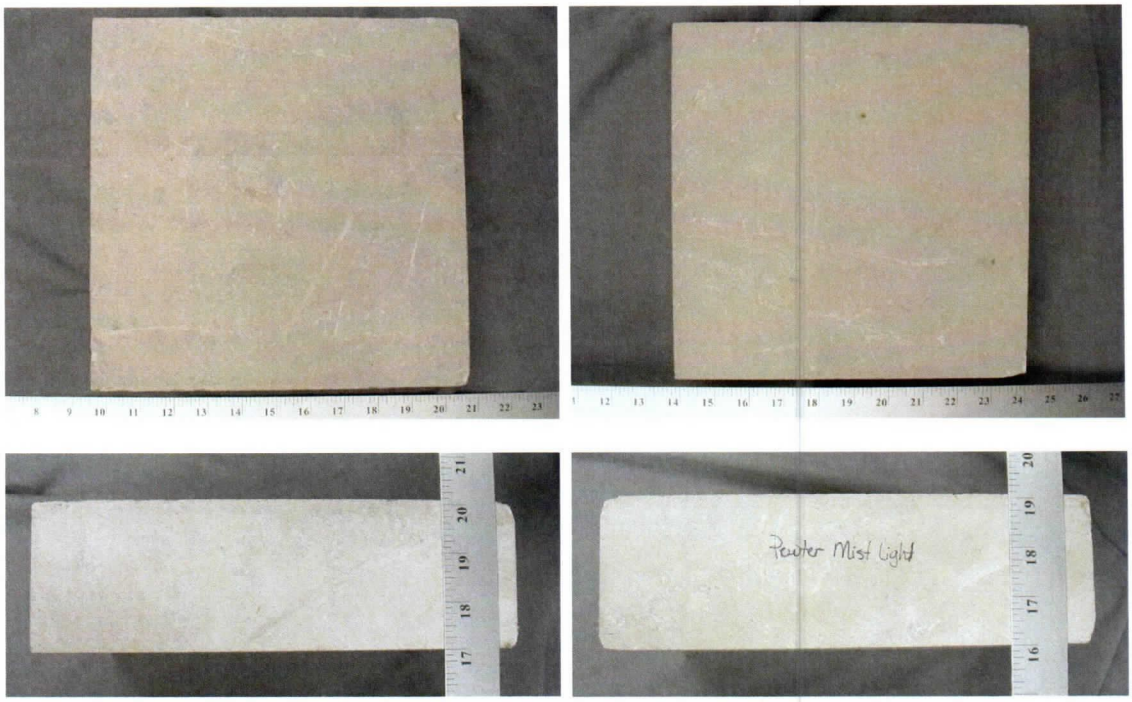

Figure 1. Top row shows top and bottom surfaces of saw-cut block. Bottom row shows unlabeled and labeled sides of the block.

Figure 2. Lapped section cut parallel to the top surface of the sample block.

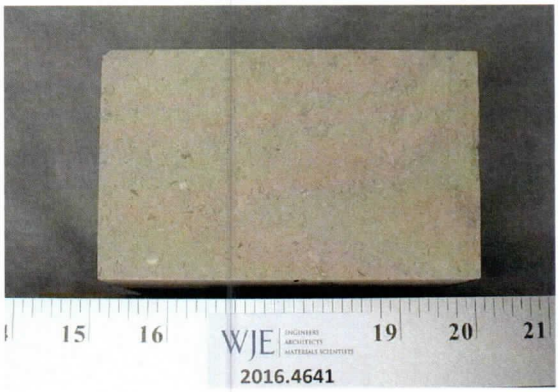

Figure 3. Lapped section cut through the thickness of the sample block.

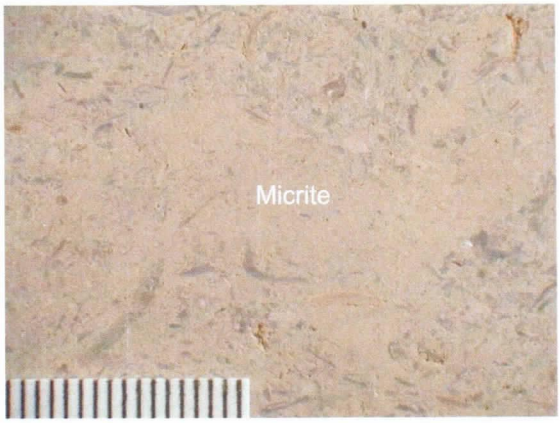

Figure 4. Smooth beige region is micrite (fine-grained calcite) matrix. Scale increments are 0.5 mm.

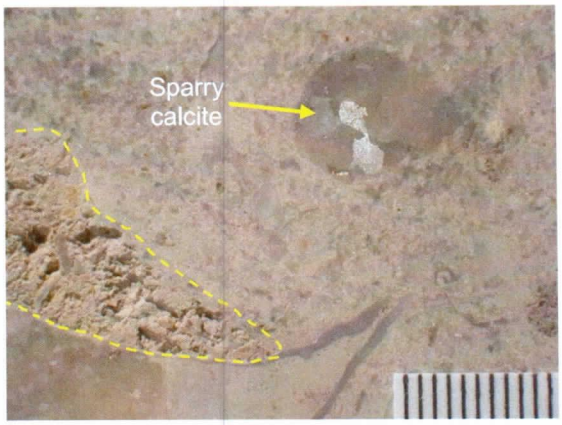

Figure 5. Regions of sparry (coarse-grained) calcite were uncommon. A porous, soft region is outlined. Scale increments are 0.5 mm.

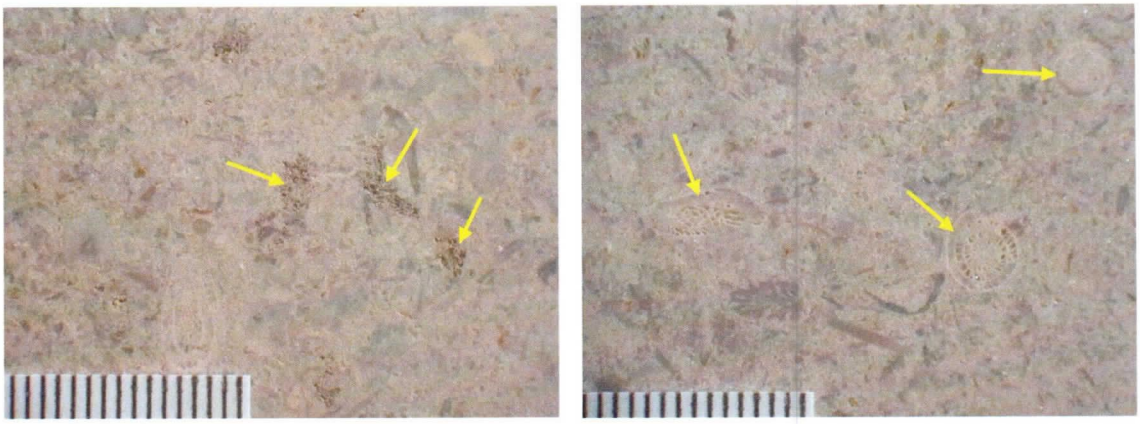

Figure 6. Arrows in micrograph on the left show examples of regions of micro-porosity associated with fossils. Micro-porosity in the micrograph on the right occurs in the chambers of the fusilinid fossils (arrows). Scale increments are 0.5 mm.

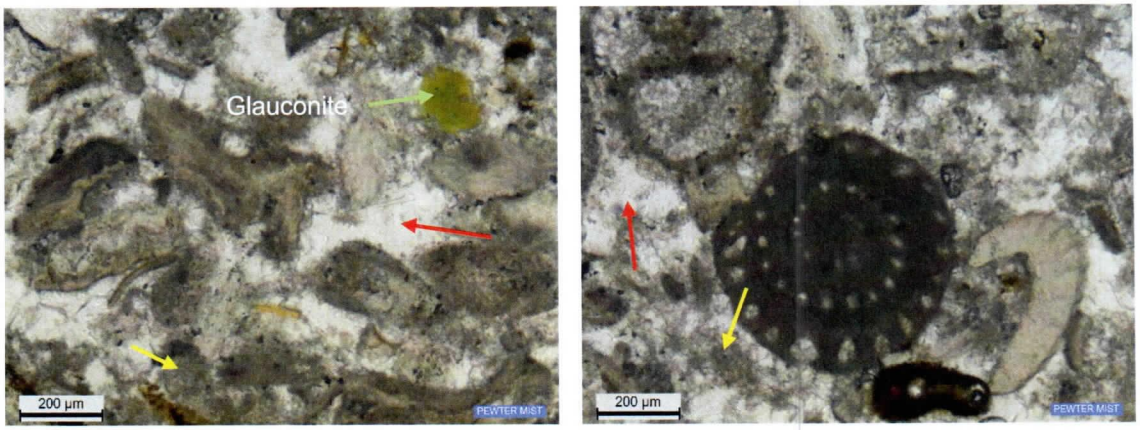

Figure 7. Thin-section micrographs showing abundant fossils in sparry calcite (red arrows, smooth white) and micrite (yellow arrows, dark beige) matrix. Plane-polarized light.

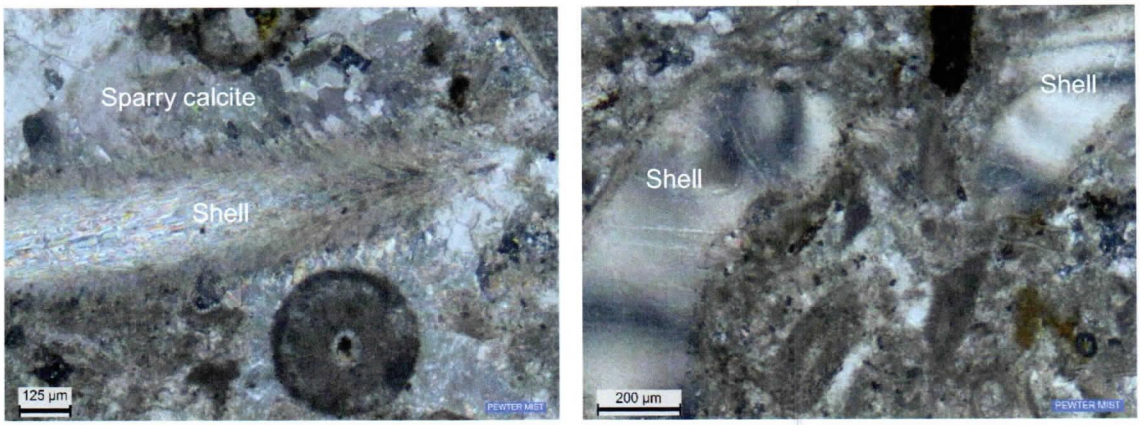

Figure 8. Thin-section micrographs showing shell fragments. Sparry calcite matrix on left and mostly micritic matrix on right. Cross-polarized light

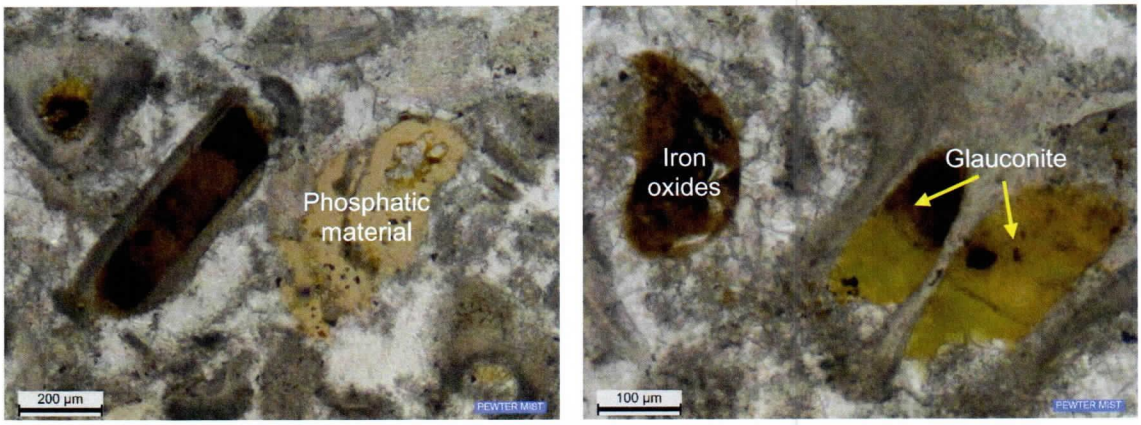

Figure 9. Thin-section micrographs showing dark reddish brown iron minerals, possible phosphatic material, and glauconite. The matrix includes both micritic and sparry calcite. Plane-polarized light.

TESTING ENGINEERS, INC.

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August 17, 2016

Ms. Jackie Yamnitz
EARTHWORKS
19797 Eisenbeis bottom road
STE Genevieve, MO 63670

Lab. No.: H792

SUBJECT: Solar Reflectance Tesing on four (4) sandblasted Stone Samples..

Dear Ms. Yamnitz;

At your request, four (4) stone samples submitted to our laboratory have been tested for determination of their Solar Reflectance in accordance with ASTM E1980. The stone samples were labeled as follows:

- *PEWTER MIST LIGHT*
- *PEWTER MIST DARK*
- *MERIDIAN RED*
- *EW GOLD L-5*

PROCEDURES & RESULTS

The 6"x6" sandblasted samples were tested on their finish side for their solar reflectance.

The test results are presented in Tables I through IV.

If you have any questions regarding this report, please contact the undersigned at 510 835 3142.

Respectfully Submitted,
TESTING ENGINEERS, INC.

Hossein Arbabi, Ph.D., P.E.
Senior Engineer

Table I
Solar Reflectance - ASTM E1980
"Pewter Mist-Light" Limestone

Sample ID	Solar Reflectance		Thermal Emittance		Solar Reflectance Index (SRI)		
	ASTM C1549		ASTM C1371		ASTM E1980		
	Average	Std. Dev.	Average	Std. Dev.	Low Wind	Medium Wind	High Wind
Limestone 6"x6"	**0.494**	**0.002**	**0.90**	**0.01**	**57**	**58**	**58**

Table II
Solar Reflectance - ASTM E1980
"Pewter Mist-Dark" Limestone

Sample ID	Solar Reflectance		Thermal Emittance		Solar Reflectance Index (SRI)		
	ASTM C1549		ASTM C1371		ASTM E1980		
	Average	Std. Dev.	Average	Std. Dev.	Low Wind	Medium Wind	High Wind
Limestone 6"x6"	**0.312**	**0.027**	**0.91**	**0.00**	**34**	**34**	**34**

Table III
Solar Reflectance - ASTM E1980
"Meridian Red" Limestone

Sample ID	Solar Reflectance		Thermal Emittance		Solar Reflectance Index (SRI)		
	ASTM C1549		ASTM C1371		ASTM E1980		
	Average	Std. Dev.	Average	Std. Dev.	Low Wind	Medium Wind	High Wind
Limestone 6"x6"	**0.386**	**0.008**	**0.91**	**0.00**	**44**	**44**	**44**

Table IV
Solar Reflectance - ASTM E1980
"EW Gold-L5" Limestone

Sample ID	Solar Reflectance		Thermal Emittance		Solar Reflectance Index (SRI)		
	ASTM C1549		ASTM C1371		ASTM E1980		
	Average	Std. Dev.	Average	Std. Dev.	Low Wind	Medium Wind	High Wind
Limestone 6"x6"	**0.411**	**0.009**	**0.91**	**0.00**	**47**	**47**	**47**