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ATTACHMENTS

ASTM C 97 Immersion Testing

Product Data literature for all products evaluated

Material Safety Data Sheets for all products evaluated

FOR: Bob Cason
Matt Miller
cc: Mike Dickey

SUBJECT: Sanco/Earthworks Quarry

DATE: May 3, 2001

PROJECT: 0103-05 PC

SAMPLES SUBMITTED: 3 different types of dolostone (3 samples each)

Sample	Color/Finish	Size
“Aux Vases” dolostone	Buff	5” x 3” x 1”
“Chocolate Marble” dolostone	Brown	5” x 3” x 1”
“Sea Blue” dolostone	Tan	5” x 3” x 1”

Submitted by: Bob Cason

PURPOSE OF TESTING:

Samples with 3 different styles of unknown stone were submitted to PROSOCO, Inc.'s Testing Laboratory with a request to determine the type of stone. The identified stone samples will be tested to see if application of the products evaluated will produce any surface alteration during new construction cleaning operations. Additionally, the effectiveness of water repellents and stain repellents, suitable for the specific stone masonry units, will be evaluated.

A. Stone Identification – A sample of the submitted stone was sent off for petrographic analysis and x-ray diffraction.

B. New Construction Cleaning – Enviro Klean® Mortar & Grout Remover was evaluated for removal of laboratory applied mortar.

To simulate new construction soiling, all masonry units are placed on a bench with finished surface facing upward. Hollow cylinders measuring 50 mm in diameter and 75 mm tall are positioned on top of each stone and filled with a wet mixture of Ash Grove® Type S cementitious mortar. The wet, mortar-filled cylinder is allowed to remain in contact with the surface of the stone for 10 minutes before removal.

Soiled masonry units are allowed to dry before test cleaning.

Heavy deposits of mortar are removed with dry scraping after 24 hours. Prepared cleaning solutions are then evaluated for their effectiveness in removing residual Ash Grove® Type S mortar staining after 3 days, 7 days, and 14 days of curing.

C. Surface Alteration Testing – Enviro Klean® Mortar & Grout Remover was tested to determine if a cleaning program implemented to remove excess mortar and related new construction soiling would otherwise alter the appearance of cleaned surfaces. Surface Alteration was evaluated visually based upon perceived discoloration or erosion/etching of the masonry unit.

Substrate Deterioration is the visual examination of the stone comparing the surface of the untreated control to surfaces cleaned with selected product(s) at given dilutions looking for any potential erosion/digestion of the brick.

Color Change is the visual examination comparing the color of the untreated control surface to color of surfaces cleaned with selected products at given dilutions.

Staining is the visual examination for changes that are the result of a chemical reaction that leaves a staining precipitate.

D. Water Repellent Evaluation –Sure Klean® Weather Seal Natural Stone Treatment and Sure Klean® Weather Seal H40 were evaluated on the submitted samples for their ability to provide water repellency.

E. Stain Repellency Evaluation – Stand Off® Stone, Tile & Masonry Protector, Stand Off® Limestone & Marble Protector, and Stand Off® Impregnator were evaluated on the submitted samples for their ability to resist staining from various food staining agents.

CLEANING PRODUCTS

Sample	Mortar & Grout Remover
All Submitted Stone Types	1 lb : 1 gallon

SURFACE ALTERATIONS PRODUCTS EVALUATED

Sample	Mortar & Grout Remover
All Submitted Stone Types	1 lb : 1 gallon

WATER REPELLENT PRODUCTS EVALUATED

Sample	Treatment
All Submitted Stone Types	Natural Stone Treatment
	H40

Dilution ratios refer to mixtures of concentrated product : fresh water.

STAIN REPELLENT PRODUCTS EVALUATED

Sample	Treatment
All Submitted Stone Types	Stone, Tile, & Masonry Protector
	Limestone & Marble Protector
	Impregnator

SECTION A - STONE IDENTIFICATION

Petrographic Examination

Identification of the mineralogical composition of the masonry sample is determined through optical microscopical evaluation and x-ray diffraction analysis. Accurate identification of the composition and physical characteristics of the masonry material is vital in determining the suitability of the substrate for chemical conservation treatment.

TEST RESULTS – Stone Identification

PETROGRAPHIC AND X-RAY DIFFRACTION ANALYSES FOR:

This sample is a small (8 x 11 x 20 mm) pyramidal chip of fresh, compact, fine-grained, banded brown and brownish-gray dolostone. Three of the faces are sawn surfaces; the fourth is a fracture surface. None of the surfaces show signs of weathering. A fetid, oily odor is produced upon pulverizing the sample.

X-ray diffraction analysis indicates that dolomite ($CaMg(CO_3)_2$) is by far, the dominant component of the stone. Minor calcite ($CaCO_3$) and a trace of quartz (SiO_2) were also detected.

Petrographic examination, confirms the XRD results, though quartz was not found (it is likely present as rare silt grains). The dolomite is present as euhedral to subhedral rhombohedral crystals 30-50µm across, with turbid cores and transparent rims. Calcite was distinguished by staining with Alizarin Red S, which showed the calcite to be present as scattered anhedral, sparry patches 20-40µm across, cementing the dolomite crystals. The dolomite is tinted with thin, reddish-brown films of petroleum on the crystal surfaces. The oil has a splotchy distribution, accounts for the odor produces when the stone is broken, and is the pigmenting agent of the stone.
No gypsum was detected by staining, nor was pyrite found during the petrographic examination.

Summary of Mineralogy:

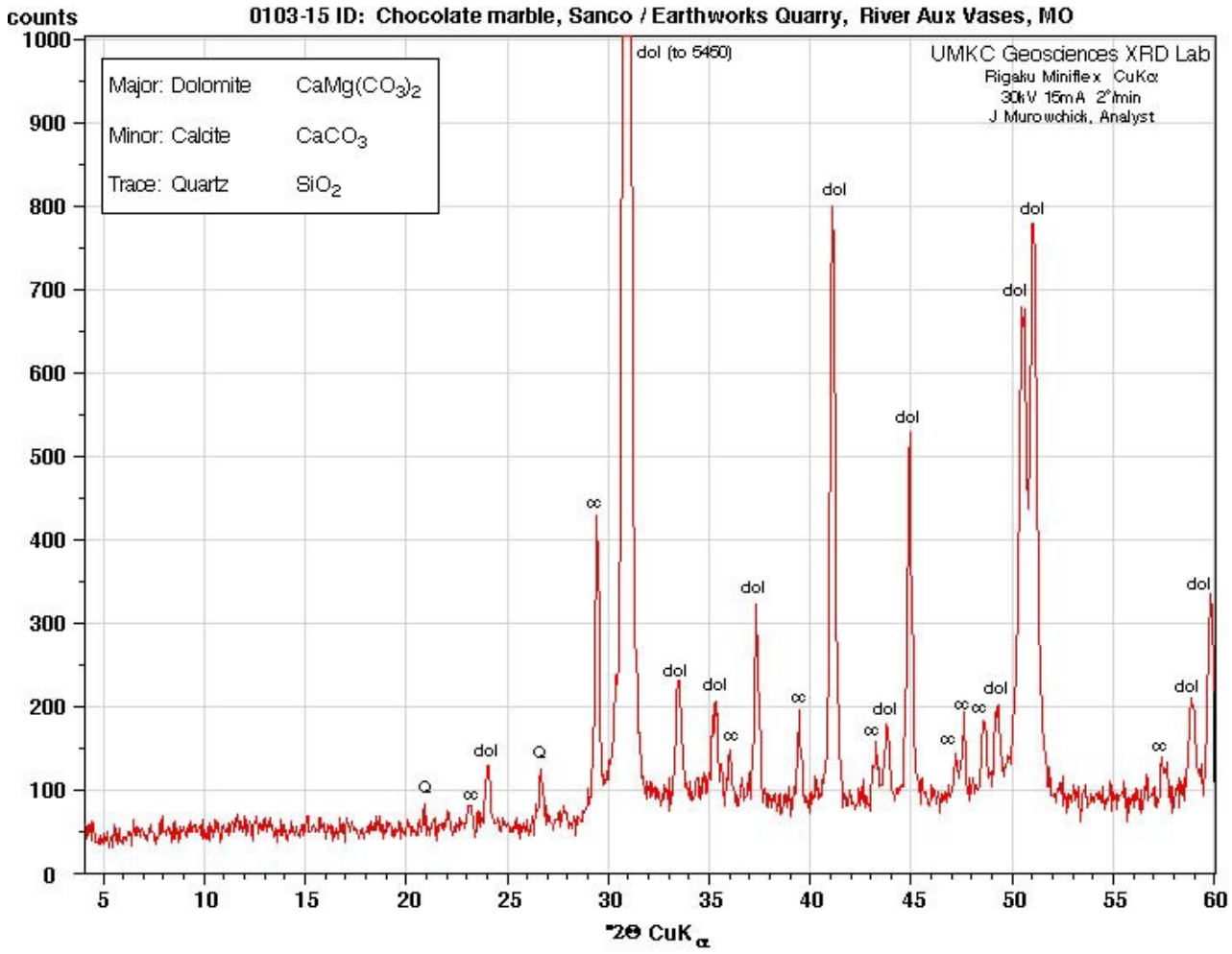
Major Components (>20%):	Dolomite ($CaMg(CO_3)_2$)
Minor Components (2-20%):	Calcite ($CaCO_3$)
Trace Components (<2%):	Petroleum, quartz (SiO_2)

Sincerely yours,
James B. Murowchick, Ph.D.

J. B. Murowchick

Consulting Mineralogist
April 23, 2001

X-RAY DIFFRACTION



CONCLUSION:

The stone samples submitted to PROSOCO, Inc., by Sanco/Earthworks Quarry are a dolomitic limestone (dolostone). The major component is dolomite ($CaMg(CO_3)_2$) and the minor components are calcite ($CaCO_3$) and quartz (SiO_2). Petroleum in various trace amounts accounts for the coloring of the stone.

SECTION B – NEW CONSTRUCTION CLEANING

DESCRIPTION OF PRODUCTS EVALUATED – New Construction Cleaning

These cleaning trials were conducted to determine the optimal cleaning/cure time combination to most efficiently remove Ash Grove® Type S mortar from the submitted stone samples.

Enviro Klean® Mortar & Grout Remover – A safe and effective way to remove excess mortar, grout and job dirt from masonry. Mixes with water at the job site to clean most brick, concrete, tile and stone surfaces. Also ideal for colored mortars and grouts, and since it's made from natural food products, it's safe for the environment.

TEST METHOD – New Construction Cleaning

Dilution ratios refer to mixtures of concentrated cleaner : fresh water. Chemical cleaners were evaluated using the following procedure:

1. Prewet the surface with water.
2. Apply the cleaner at the appropriate dilution.
   Mortar & Grout Remover.....1 lb : 1 gallon
3. Allow the appropriate dwell time, as specified.
   Mortar & Grout Remover..... 3-5 minutes
4. Pressure rinse thoroughly with plenty of fresh water.*

* Pressure rinsing was conducted at ~ 1300 psi using a warm water flow rate of 1.9 gallons per minute.

TEST RESULTS - New Construction Cleaning

% Removal

"Aux Vases"

	3 day	7 day	14 day
EK Mortar & Grout Remover (1 lb : 1 gal)	100%	100%	100%

"Chocolate Marble"

	3 day	7 day	14 day
EK Mortar & Grout Remover (1 lb : 1 gal)	100%	100%	100%

"Sea Blue"

	3 day	7 day	14 day
EK Mortar & Grout Remover (1 lb : 1 gal)	100%	100%	100%

CONCLUSIONS - Cleaning:

Based on the test results, Enviro Klean® Mortar & Grout Remover diluted 1 lb powder to 1 gallon of fresh water performed extremely well in removing excess mortar smears on the submitted dolostone samples from Sanco/Earthworks Quarry, River Aux Vases, MO. The cleaner performed well in removing the mortar soils even after allowing the mortar to remain on the surface of the stone for 14 days under ideal curing conditions. Enviro Klean® Mortar & Grout Remover was the only cleaner thoroughly tested due to the sensitive finish of the stone and its tendency to etch.

To facilitate easier removal of excess mortar and construction dirt while minimizing any potential adverse affect on the sensitive surface finish, clean within 7 days of construction.

RECOMMENDED PRODUCTS AND DILUTIONS - CLEANING:

Sample	Enviro Klean® Mortar & Grout Remover
"Aux Vases"	1 lb of powder / 1 gallon of fresh water
"Chocolate Marble"	
"Sea Blue"	

SECTION C – Surface Alterations:

DESCRIPTION OF PRODUCTS EVALUATED – Surface Alterations:

Enviro Klean® Mortar & Grout Remover – A safe and effective way to remove excess mortar, grout and job dirt from masonry. Mixes with water at the job site to clean most brick, concrete, tile and stone surfaces. Also ideal for colored mortars and grouts, and since it's made from natural food products, it's safe for the environment.

TEST METHOD – Surface Alteration Testing:

Dilution ratios refer to mixtures of concentrated cleaner : fresh water.

Enviro Klean® Mortar & Grout Remover was evaluated using a dilution of 1 lb : 1 gallon.

The following procedure was used:

1. Prewet the surface with water.
2. Apply each cleaner at the appropriate dilutions.
3. Allow a 3-5 minute exposure time.
4. Reapply the products and moderately agitate with a brush.
5. Pressure rinse thoroughly.*
6. Allow the surface to dry for at least 18 hours and visually examine.

* Pressure rinsing was conducted at approximately ~1300 psi with a warm water flow rate of 1.9 gallons per minute.

TEST RESULTS - Surface Alteration Results:

Substrate: "Aux Vases"				
Product	Dilution	Substrate Deterioration	Color Change	Staining
EK Mortar & Grout Remover	1 lb : 1 gal	0	0	0
Substrate: "Chocolate Marble"				
Product	Dilution	Substrate Deterioration	Color Change	Staining
EK Mortar & Grout Remover	1 lb : 1 gal	0	0	0
Substrate: "Sea Blue"				
Product	Dilution	Substrate Deterioration	Color Change	Staining
EK Mortar & Grout Remover	1 lb : 1 gal	0	0	0

0 – no change
1 – slight
2 – moderate

CONCLUSIONS – Surface Alterations

Test results indicate that Enviro Klean® Mortar & Grout Remover does not cause any alterations to the natural appearance of the three types of dolostone submitted by Sanco/Earthworks Quarry, River Aux Vases, MO.

RECOMMENDED PRODUCTS AND DILUTIONS - CLEANING:

Sample	**Enviro Klean® Mortar & Grout Remover**
"Aux Vases"	1 lb of powder / 1 gallon of fresh water
"Chocolate Marble"	
"Sea Blue"	

SECTION D - PROTECTIVE WATER REPELLENTS:

The testing described below evaluates the suitability of water repellent treatments.

The surface treatments evaluated were selected for their suitability for application based on the following selection criteria:

1. Weatherproofing properties
2. Color change
3. Ease of application

DESCRIPTIONS OF PRODUCTS EVALUATED - Protective Water Repellents:

Sure Klean® Weather Seal Natural Stone Treatment – A modified siloxane water repellent developed for limestone, marble, and most other traditional masonry surfaces. It penetrates deeply to provide long-lasting protection without altering the natural appearance of the substrate.

Sure Klean® Weather Seal H40 – A deep-penetrating water repellent and consolidation treatment for brick, most natural stone, terra cotta, historic concrete, stucco and cast stone surfaces. H40 protects against deterioration caused by water and waterborne contaminants while strengthening weathered surfaces and soft mortar joints.

SAMPLE PREPARATION - Protective Water Repellents:

The submitted stone were cut, oven dried and allowed to reabsorb atmospheric humidity for 24 hours prior to treatment. The treatment method consisted of two 10-second immersions with a 20-second absorption period between immersions to simulate a wet-on-wet application. All treatments were allowed to cure for at least 3 days prior to testing.

TEST METHODS - Protective Water Repellents:

Water Absorption: ASTM C 97, Immersion

Water absorption was determined by comparing the dry weight of the sample with its weight after immersion in water at 10-minute, 30-minute, 60-minute and 24-hour intervals. See ASTM C 97 for additional information.

Reduced water absorption values – reported as effectiveness – measure the effectiveness of selected treatments in protecting samples from water penetration and water related decay mechanisms. Generally a reduction of approximately 80% is required to provide resistance to water intrusion under normal exposure conditions.

TEST RESULTS - Protective Water Repellents:

Water Absorption: ASTM C 97, Immersion

"Aux Vases"	% Absorption	% Effectiveness
Untreated Control	2.89	---
Natural Stone Treatment	2.12	26.8
H40	1.19	58.8
"Chocolate Marble"	**% Absorption**	**% Effectiveness**
Untreated Control	0.78	---
Natural Stone Treatment	0.34	55.8
H40	0.18	80.0
"Sea Blue"	**% Absorption**	**% Effectiveness**
Untreated Control	55.8	---
Natural Stone Treatment	0.75	86.6
H40	0.74	86.7

CONCLUSIONS - Protective Water Repellents:

Based upon laboratory evaluations, Sure Klean® Weather Seal H40 was able to provide adequate water repellency on two of the submitted types of dolostone ("Chocolate Marble" and "Sea Blue"). None of the water repellents tested were able to achieved water repellency on "Aux Vases". Due to the limited amount of substrate submitted, no other water repellents were tested on this substrate.

RECOMMENDATIONS - Protective Water Repellents:

Based on test results, Sure Klean® Weather Seal H40 can be recommended on the submitted dolostone types “Chocolate Marble” and “Sea Blue”. Additional samples are requested for further water repellent testing on dolostone type “Aux Vases”.

It must be pointed out that in any installation, the stone are a single component of the masonry facade. The ability of a water repellent treatment to prevent the ingress of water is affected by a variety of other factors, therefore on-site testing should be carried out for all installations with the recommended systems to ensure job site workmanship yields equivalent results.

Apply all products in accordance with the manufacturer's recommendation provided on container labels and product data sheets. On-site testing should be conducted to determine the most appropriate water repellent product and procedures for a particular project. See product literature for additional application and product information.

SECTION E - PROTECTIVE STAIN REPELLENTS:

The testing described below evaluates the suitability of water repellent treatments.

The surface treatments evaluated were selected for their suitability for application based on the following selection criteria:

4. Stain resistance
5. Color change
6. Ease of application

DESCRIPTIONS OF PRODUCTS EVALUATED - Protective Stain Repellents:

Stand Off® Stone, Tile & Masonry Protector – A penetrating oil and stain repellent. This easy-to-use, low-VOC, low-odor protective treatment improves the stain resistance and simplifies maintenance cleaning or interior and exterior stone, quarry tile, concrete and masonry surfaces. Surfaces treated with STMP resist staining from oil, food and waterborne matter while retaining their natural color, texture, and breathability.

Stand Off® Limestone & Marble Protector – A clear penetrating water and oil repellent suitable for use on interior or exterior calcareous surfaces such as limestone, marble and travertine. It's also suitable for sandstone, granite and slate, and many other types of masonry surfaces. Stand Off® Limestone & Marble protector penetrates deeply to provide surface and subsurface protection without forming a glossy surface film. Treated surfaces retain their natural color, texture and appearance.

Stand Off® Impregnator – Combines water and oil repellency to prevent staining by waterborne or oily substances. This special system offers invisible protection and low volatility. The small molecular structure of Impregnator lets it penetrate and chemically bond deep within the substrate to provide long-lasting protection against water and oil related staining and deterioration.

FOOD AND OIL PRODUCTS EVALUATED:

	Temperature
Mustard	ambient (~70°F)
Balsamic Vinegar	ambient (~70°F)
Olive oil	200°F
Coffee	120°F

PRODUCT EVALUATED FOR STAIN REMOVAL:

Dilution ratios refer to parts concentrated cleaner : parts fresh water

	Dilution
Stand Off® All Surface Cleaner	1:10

SAMPLE PREPARATION - Protective Stain Repellents:

The submitted stone were cut, oven dried and allowed to reabsorb atmospheric humidity for 24 hours prior to treatment. The treatment method consisted of a wet-on-wet application. All treatments were allowed to cure for at least 72 hours prior to testing.

TEST METHODS - Protective Stain Repellents:

Surface Beading Evaluation

Drops of food and oil staining agents were placed on treated and untreated areas of the evaluated samples. Evaluation consisted of a visual examination of the tested areas to determine the beading properties on the treated surface. Readings were taken at 1 minute.

The results are reported as a rating based on the angle of contact between the base of the droplet and the substrate, and the change of wettability. A rating of "1" being the smallest angle of contact (<90°) and no wetting of the contact area (correlating to "above average" water repellency), up to a rating of "7". A rating of "7" indicating the droplet has completely absorbed and no visible moisture remains on the surface of the substrate (correlating to "below average/poor" water repellency).

Stain Resistance

The soiling agents were allowed to dwell on the treated and untreated substrate for times of 24 hours, 4 hours, 1 hour, and 10 minutes. The test areas were then cleaned with Stand Off® All Surface Cleaner diluted 1 part concentrate to 10 parts fresh water and scrubbed under a stream of running water from a faucet. Samples were allowed to dry for 24 hours. Evaluation consisted of a visual examination of the tested areas to determine the percentage of staining removal.

TEST RESULTS – Surface Beading Evaluation

	"Aux Vases" dolostone			
	Untreated Control	**LMP**	**STMP**	**Impregnator**
Mustard	N/A	N/A	N/A	N/A
Balsamic Vinegar	5	3	3	2
Olive Oil	5	3	2	2
Hot Coffee	5	3	3	3

	"Chocolate Marble" dolostone			
	Untreated Control	**LMP**	**STMP**	**Impregnator**
Mustard	N/A	N/A	N/A	N/A
Balsamic Vinegar	5	2	3	2
Olive Oil	5	3	3	3
Hot Coffee	5	3	4	3

	"Sea Blue" dolostone			
	Untreated Control	**LMP**	**STMP**	**Impregnator**
Mustard	N/A	N/A	N/A	N/A
Balsamic Vinegar	4	2	4	2
Olive Oil	5	3	3	3
Hot Coffee	4	3	4	3

N/A Staining agent is not a free flowing liquid.

TEST RESULTS - Stain Resistance

% Removal

"Aux Vases"

	Untreated Control			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	60%	90%	4%	100%
4 hour	80%	90%	<1%	100%
1 hour	100%	95%	<1%	100%
10 min.	100%	100%	<1%	100%

	Stone, Tile & Masonry Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	90%	60%	100%	100%
4 hour	98%	60%	100%	100%
1 hour	100%	100%	100%	100%
10 min.	100%	100%	100%	100%

	Limestone & Marble Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	95%	100%*	20%	100%
4 hour	98%	100%*	20%	100%
1 hour	100%	100%	20%	100%
10 min.	100%	100%	20%	100%

	Impregnator			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	50%*	100%*	20%	100%*
4 hour	60%*	100%*	20%	100%*
1 hour	100%*	100%*	20%	100%
10 min.	100%	100%	20%	100%

* Indicates etching of the surface finish due to acidic staining agents.

"Chocolate Marble"

	Untreated Control			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	90%*	100%*	<1%	100%
4 hour	100%*	100%*	50%	100%
1 hour	100%*	95%	80%	100%
10 min.	100%	100%	100%	100%

	Stone, Tile & Masonry Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	100%	100%	100%	100%
4 hour	100%	100%	100%	100%
1 hour	100%	100%	100%	100%
10 min.	100%	100%	100%	100%

	Limestone & Marble Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	90%*	100%	50%	100%*
4 hour	100%*	100%*	50%	100%*
1 hour	100%*	100%*	50%	100%
10 min.	100%	100%	50%	100%

	Impregnator			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	100%*	100%*	90%	100%
4 hour	100%*	100%*	100%	100%
1 hour	100%*	100%*	100%	100%
10 min.	100%	100%	100%	100%

* Indicates etching of the surface finish due to acidic staining agents.

"Sea Blue"

	Untreated Control			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	60*	60%	<1%	95%
4 hour	55%	60%	10%	100%
1 hour	100%	60%	90%	100%
10 min.	100%	100%	100%	100%

	Stone, Tile & Masonry Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	100%	100%	100%	100%
4 hour	100%	100%	100%	100%
1 hour	100%	100%	100%	100%
10 min.	100%	100%	100%	100%

	Limestone & Marble Protector			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	98%	100%*	99%	100%
4 hour	99%	100%*	100%	100%
1 hour	100%	100%	100%	100%
10 min.	100%	100%	100%	100%

	Impregnator			
	Mustard	**Balsamic Vinegar**	**Olive Oil**	**Hot Coffee**
24 hr	95%	80%	80%	100%
4 hour	98%	80%	100%	100%
1 hour	100%	90%	100%	100%
10 min.	100%	100%	100%	100%

* Indicates etching of the surface finish due to acidic staining agents.

CONCLUSIONS – Protective Stain Repellents

Test results indicate that Stand Off® Stone, Tile & Masonry Protector overall performed the best at repelling stains from the various staining agents.

RECOMMENDATIONS – Protective Stain Repellents

Based on the test results, Stand Off® Stone, Tile & Masonry Protector can be recommended as a stain repellent on all types of dolostone submitted by Sanco/Earthworks Quarry, River Aux Vases, MO.

Apply all products in accordance with the manufacturer's recommendation provided on container labels and product data sheets. On-site testing should be conducted to determine the most appropriate stain repellent product and procedures for a particular project. See product literature for additional application and product information.

Carmen M. Hupp
Project Testing Coordinator

CMH/csm

Laboratory Report

Pallet Card Evaluation

Sanco/Earthworks Quarry
River Aux Vases, MO

Project No. **0103-15 PC**

Prepared For:

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PROSOCO, Inc.
May 2001