TEST & EVALUATION REPORT

Shingle Rejuvenator Benchmark Life-Cycle Study

September 1, 2023

Report For: Greener Shingles Rejuvenator
Saskatchewan, Canada

Email: info@greenershinglesrejuvenator.com

Sample Data/Information:

SAMPLE ID	GRADE/TYPE	DATE SAMPLED	DATE RECEIVED	SOURCE
Aged Asphalt Shingles	Architectural – Post Consumer	*Note 1	9/15/22	Roofing Contractor
Shingle Rejuvenator	Greener Shingles	9/2022		

***Shingles removed from a home in Crystal River, FL approximately 14 years after installation**

OBJECTIVES:

Conduct a Benchmark Life-Cycle Study of Greener Shingles Rejuvenator utilizing aged asphalt shingles that were removed from a home after approximately 14 years of exposure in Crystal River, Florida. Determine the estimated contribution to the shingles life-cycle made by the rejuvenator and quantify the differences to that of an untreated set of shingles.

The study used a miniature steep sloped roof, constructed at PRI made with commonly used stock material (2X4's, plywood, peel-n-stick underlayment, and stainless-steel roofing nails). Both slopes were roofed with the aged shingles, with one side being treated with Greener Shingles rejuvenator and the other side being an un-treated roof deck. The rejuvenator was applied according the manufacturer's recommendations. See appendix for photos and details of construction

The miniature roof was weathered according to ASTM D4798 – "Standard Practice for Accelerated Weathering Test Conditions and Procedures for Bituminous Materials" using a modified exposure cycle consisting of, 51 minutes of light only and 9 minutes of light with rain. Studies have shown that 3000 Hours of APWS aging can be correlated to 10 years of normal outdoor exposure.

CONCLUSIONS: Primary Property Assessment

- **Mass Loss**: Mass loss in asphalt shingles is due to both the oxidative aging of the binder and granular loss during the accelerated weathering process.
  - After 1,500 hours of exposure the mass loss of the un-treated shingles was 5.4% compared to 0.5% for the Greener Shingles' rejuvenator.
    - ***Greener Shingles Rejuvenator performs 10.8 times better than un-treated shingles***
  - After 3,000 hours of exposure the mass loss of the un-treated shingles was 9.1% compared to 1.0% for the Greener Shingles' rejuvenator.
    - ***Greener Shingles Rejuvenator performs 9.1 times better than un-treated shingles***

- **Wash off Material**: The exposure cycles consistently contained particulate material and shingle granules that were washed off by the accelerated weathering process.
  - After 1,500 hours of exposure the mass of the collected particulate from the un-treated shingles was 4.08g compared to 0.70g for the Greener Shingles' rejuvenator.
    - ***Greener Shingles Rejuvenator performs 5.8 times better than un-treated shingles***
  - After 3,000 hours of exposure the mass of the collected particulate from the un-treated shingles was 12.41g compared to 3.94g for the Greener Shingles' rejuvenator.
    - ***Greener Shingles Rejuvenator performs 3.1 times better than un-treated shingles***

- **Oxidative Aging** **(Measured by Carbonyl Indices)**: Oxidative aging in asphalt-based products can be quantified by a peak in a specific position on an FT-IR spectrum.
  - After 1,500 hours of exposure the un-treated shingles exhibited a 30.7% increase in carbonyl index, compared to Greener Shingle's 7.8% increase.
    - ***Greener Shingles Rejuvenator performs 3.9 times better than un-treated shingles***
  - After 3,000 hours of exposure the un-treated shingles exhibited a 77.9% increase in carbonyl index, compared to Greener Shingle's 9.6% increase.
    - ***Greener Shingles Rejuvenator performs 8.1 times better than un-treated shingles***

- **Shingle Flexibility**: After 1,500 and 3,000 hours of exposure, Greener Shingles Rejuvenator improved low temperature flexibility from -22°F to -31°F.

- **Shingle Color and Appearance:** After 1,500 and 3,000 hours of exposure, the shingles treated with Greener Shingles Rejuvenator exhibit a significantly different appearance than those left un-treated.
  - Un-treated shingles show a clear increase in the roofing granules lost. (Appendix A-4/5)

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APPENDIX

APPENDIX A-1 (Roof Deck Construction):

Ridge Cap Installation:

Completed Roof Deck Before Rejuvenator Application

DISCUSSION:

A type of common, commercially used ridge-cap shingles were then cut and applies to the cap of the roof deck. The cap was selected for the closest visual match to the shingles used.

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APPENDIX A-2 (Roof Deck Construction):

Application of Rejuvenators:

Roof Deck After Rejuvenator Application

REJUVENATOR APPLICATION DATA:

PROPERTY	TEST METHODS	RESULTS, SAMPLE ID Greener Shingles
Rejuvenator Application Data		
Dilution Rate, (%Water: %Product)	PRI Measurements	70:30
Volume Applied, mL		266
Weight Applied, g		257.1
Specific Gravity of Diluted Product	ASTM D70	0.9674
Calculated Application Rate, gal/ft^2	Calculation	0.0099

DISCUSSION:

The Greener Shingles Rejuvenator was prepared and applied according to manufacturer guidelines using common garden spray bottles and allowed to cure for 24 hours:

- Manufacturer recommendations – A mixture of 70% water and 30% Rejuvenator concentrate stirred by hand to homogeneity.
- The product was applied were to one side of the roof deck at a target rate of 1 gallon per 100ft^2 using simple spray bottles.
- The other side was left un-treated.

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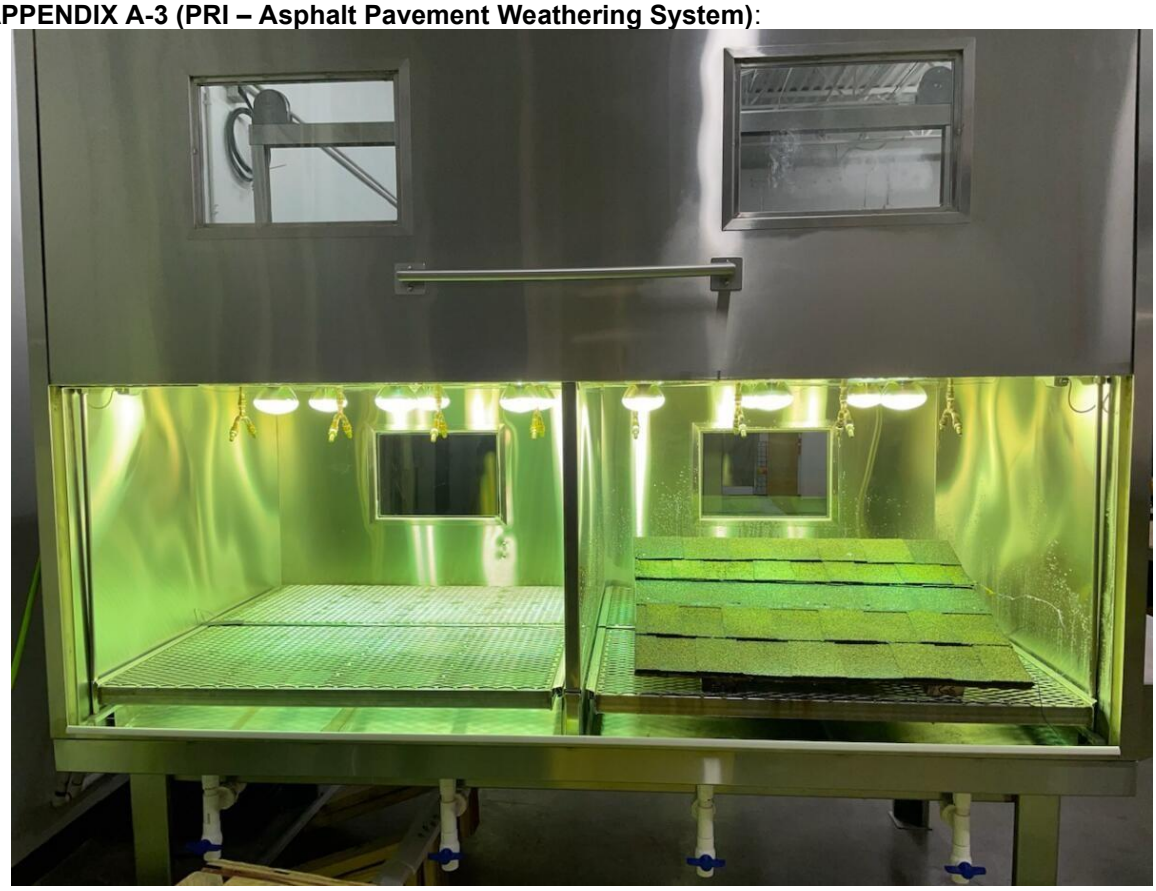
APPENDIX A-3 (PRI – Asphalt Pavement Weathering System):



DISCUSSION:

An open view of PRI's Asphalt Pavement Weathering System with the roof deck positioned in the front chamber (right).

PRI's APWS was used for accelerated weathering of the roof deck after the application and curing of the rejuvenators. The weatherometer is monitored daily for even light distribution and water spray coverage, while temperature of the chamber, roof surface, water, ambient temperature and relative humidity are all tracked continuously.

ACCELERATED AGING PARAMETERS:

PARAMETER	SETTING
APWS Cycle and Climate Information	
Cycle Reference Method	ASTM D4798, Cycle A
Time of UV Light Exposure, mins	51
Time of UV Exposure with Rain Cycle, mins	9
Average Maximum Shingle Temperature, °F (Note 1)	149.5
Average "Rain Rate", gal/hr	12.6

Note 1 – Average Maximum Shingle Temperature is measured by taking the average of the temperature readings immediately before the beginning of the "rain cycle" when the temperature is at its highest level.

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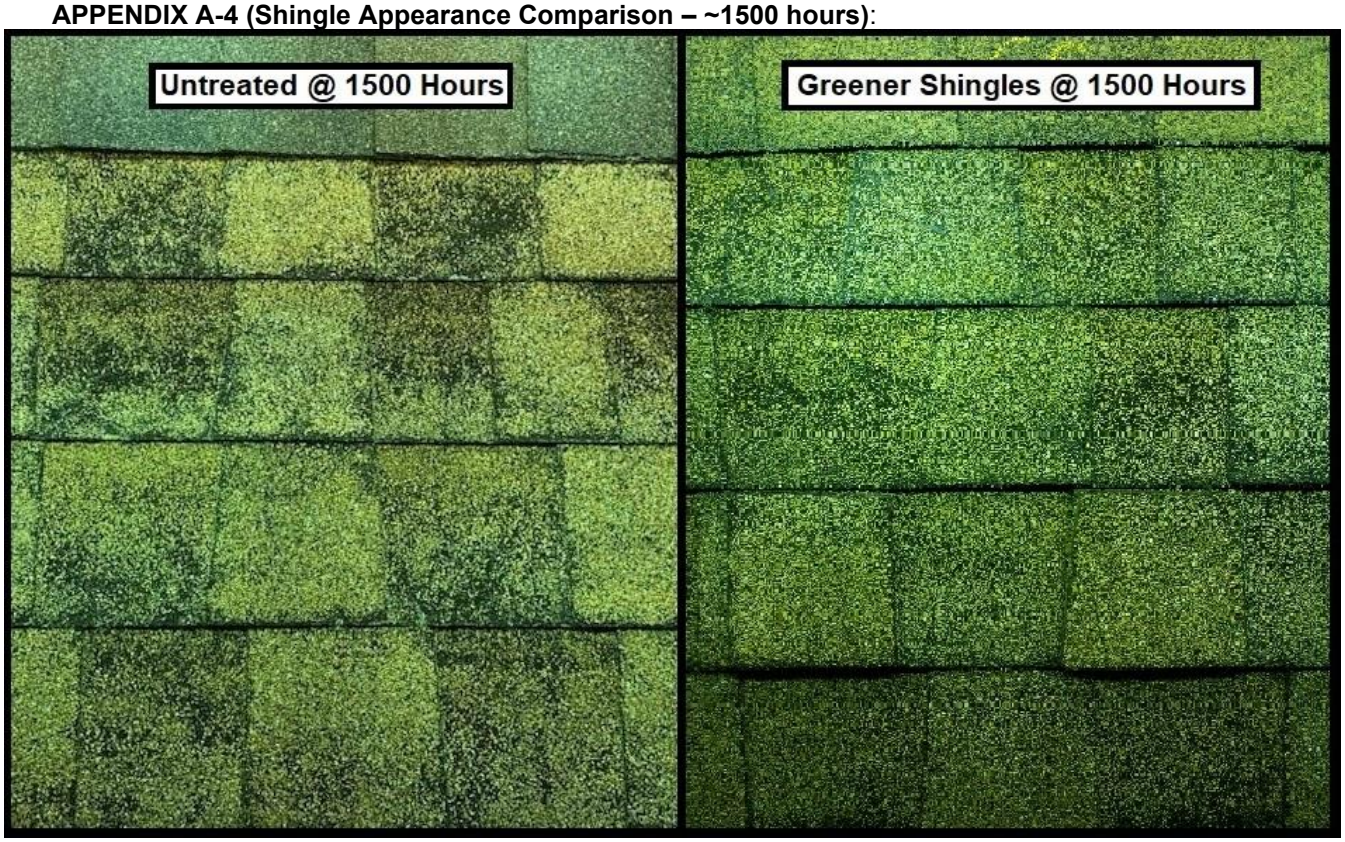
APPENDIX A-4 (Shingle Appearance Comparison – ~1500 hours):



DISCUSSION:

There is a notable difference in appearance between the untreated and treated shingles after 1500 Hours.

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APPENDIX A-5 (Shingle Appearance Comparison – ~3000 hours):

DISCUSSION:

There is a notable difference in appearance between the untreated and treated shingles after 3000 Hours.

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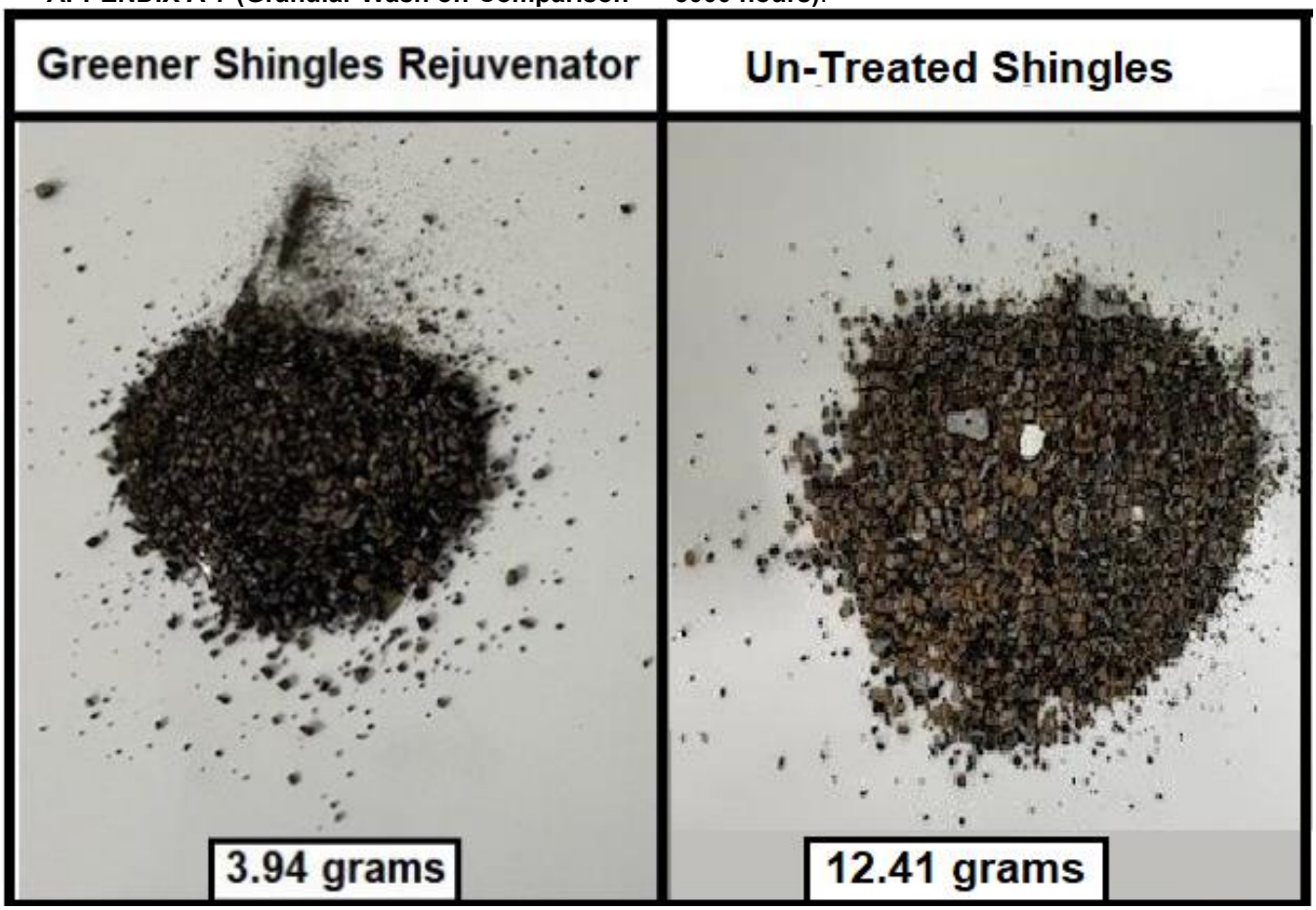
APPENDIX A-7 (Granular Wash off Comparison – ~3000 hours):



DISCUSSION:

Granules and particulate washed from the roof decks after 3000 hours of exposure. Particles have been filtered from the accompanying runoff water and dried for quantification.

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