Attachment J
RJ Lee Group Response to Issues Raised by Erskine Environmental Consulting

RJ LEE GROUP
DELIVERING SCIENTIFIC RESOLUTION

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Prepared for Specialty Granules LLC

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At the request of Specialty Granules LLC (SGI), RJ Lee Group has reviewed the requests set forth in the Pennsylvania Department of Environmental Protection (PA DEP) letter dated September 30, 2019 seeking responses to certain issues relating to geologic characterization, sampling methodology, sample preparation, and laboratory analysis raised by Erskine Environmental Consulting in three different reports[1] concerning a different quarry in northeast Pennsylvania (item 10 of the PA DEP letter). Dr. Erskine opined in these reports about the appropriate actions that should occur when inspecting a quarry for natural occurrences of asbestos (NOA) including suggestions concerning geologic assessments, sample selection methods, and testing/analytic methodologies. Erskine claimed that appropriate methods had not been used at the quarry in northeast Pennsylvania and he recommended specific alternative protocols. RJ Lee Group has evaluated these issues from the perspective of their potential applicability to the SGI Charmian Quarry operations, and our responses are provided below.

1.0 Geological Assessment

Dr. Erskine suggested that a geologic investigation should be conducted at a quarry prior to any mining activities in order to identify possible lithological units that occur at the site. As a general proposition, such an investigation is prudent, and SGI has studied the lithology at Charmian, based on published geology studies, drill core evaluations, and examinations of mined benches as they are opened.

Dr. Erskine has further suggested that such investigation should include identification of all veins or other features (such as ductile or brittle shear zones) that contain or may contain asbestos. This type of subsurface investigation simply is not feasible at quarry like Charmian, where minerals containing potential asbestiform fiber do not occur in veins or other readily identifiable features. Rather, at Charmian, potential asbestos containing materials occur only rarely, in randomly spaced small pockets, which are not amenable to identification or mapping in advance of mining.

[1] The three reports cited in the PA DEP letter are as follows:

B. G. Erskine (2019). "Review of Qualitative Geologic Survey Sampling Plan", Erskine Environmental Consulting, June 6, 2019.

B. G. Erskine (2019). "Review of Asbestos Test Results, Final Revision REV3", Erskine Environmental Consulting, September 1, 2019.

B. G. Erskine (2019). "Comments: DEP Comment Regarding Heavy Equipment Loadout; Review of DEP Reanalysis of Asbestos Test Results by TEM Methodology", Erskine Environmental Consulting, September 23, 2019.

We've also considered a fourth report subsequently issued by Erskine as follows:

B. G. Erskine (2019). "Comments: Hanson/RJ Lee Letter Dated October 4, 2019", Erskine Environmental Consulting, October 13, 2019.

2.0 Sampling Methodology

Dr. Erskine suggested that specifically sampling rock or ore that is suspected to be asbestos or to be asbestos-containing is inappropriate because, he alleges, that it is not possible to identify fine asbestos fibers from simple visual observations. Dr. Erskine apparently believes that such sample selection is subjective and is based on non-consensus definitions of what is and is not asbestos.

SGI implements a Suspect Minerals Identification and Management Protocol that is overly-inclusive with respect to the identification of potential asbestos-containing materials. That Protocol does not seek to identify asbestos fibers, but rather to identify any minerals that have the potential to contain asbestos fibers (although many of those minerals will in fact be coarsely crystalline, rather than fibrous, in nature), SGI segregates and avoids any materials that might potentially contain asbestos. Features in rock that might contain asbestos are identifiable visually and are visually distinct from the metabasalt that is the object of the mining. SGI segregates and disposes of the materials that might contain asbestos and does not process them. This, in effect, removes from the system the materials that might conceivably contain asbestos.

In addition, samples of product are routinely collected and evaluated for any possible asbestos content. This product comprises the granules used to make the roof shingles. Each sample is then analyzed using the appropriate procedures.

Thus, the issues that Dr. Erskine has raised with respect to the other quarry are not relevant to the SGI operation. SGI has conducted the appropriate literature review, collected drill cores in advance of mining, and has examined the mined materials and analyzed the processed product for possible asbestos content.

3.0 Testing Methodologies

Dr. Erskine has expressed concerns regarding appropriate methodologies for testing of bulk (rock/ore), air, and/or water samples. Some of his concerns seem to revolve around how the analysis is conducted (what and how something is counted) while other concerns are related to definitions of asbestos and whether these definitions are appropriate for NOA.

3.1 Analytical Procedures

Samples of the rock, water, and airborne particulate have been collected at the SGI site and have been analyzed using the appropriate analytical procedures.

Bulk Samples

For the purposes of this memo, bulk samples include samples of aggregate piles, drill cuttings, and select veins or pods of suspect amphibole minerals.

Polarized light microscopy (PLM) has been utilized as the method of choice for the analysis of rocks, drill cores, and drill cuttings for possible asbestos content. As noted by Erskine, PLM is the method specified by California for the analysis of serpentine aggregate (using method CARB 435). The EPA recommends the use of CARB 435 for the analysis of soil samples for possible asbestos content.[2]

[2] US EPA (2016). Guidelines for Enhanced Management of Asbestos in Water at Ordered Demolitions, EPA-453/B-16-002a. "… currently OLEM is recommending CARB 435 as the method of choice for the direct detection of asbestos in soil media." (page 34)

PLM is certainly capable of observing asbestos fibers. Examples of PLM asbestos fibers are shown in Mr. Erskin's recent publication.[3] Examination of amphibole asbestos and non-asbestos amphibole particles show that these particles have the widths necessary to be visible in the PLM (generally 0.2 µm and larger).[4,5] What is necessary for the examination of these samples using PLM is size reduction (that is, reducing the size of sample particles to dimensions that can be viewed using PLM). For tests of SGI bulk samples, each sample is pulverized in a disc grinder in general accordance with CARB 435. Care is taken to avoid overgrinding the samples as this will destroy any asbestos and possibly lead to false negative findings.[6] (It should be noted that RJ Lee Group assisted CARB with the development of the CARB 435 Guidance document by providing research to CARB on grinding, point counting, and mineral identification.)

All analytical results of SGI's bulk samples are reported in terms of a percentage of asbestos which correlates with regulatory standards. The Erskine comments suggest that the data be reported in terms of "fibers per gram" rather than as a percentage. Federal regulations are written requiring the data from bulk analyses to be reported as a percentage.[7] Even Dr. Erskine's recommended procedure, CARB 435, requires the data to be reported as a percentage.

Erskine also suggests in one comment that the data be analyzed to an analytical sensitivity[8] of "0.005 – 0.0001 structures per gram" using TEM methodology. Given that typically a microgram of material is analyzed by TEM, such a level is technically not feasible. Also, such a level is far below the concentrations Dr. Erskine reports in a recent publication[3], where his reported concentrations are on the order of 100,000,000,000 fibers per gram.

Water Samples
In conducting samples of water discharged from the SGI facility and instream samples, SGI has utilized two US Environmental Protection Agency (EPA) approved analytical procedures: EPA 100.1 (*Analytical Method for Determination of Asbestos Fibers in Water*) and 100.2 (*Determination of Asbestos Structures Over 10 µm in Length in Drinking Water*).

Dr. Erskine seems to suggest that EPA method 100.1 is the standard procedure for water analyses. In fact, there is no "standard" method for analyzing water from streams, lakes, or sediment ponds. Both the EPA 100.1 and 100.2 methods are designed to analyze water that is drinking water or drinking water supplies. Because of there is no approved EPA method for water from streams, the drinking water methods are adapted for application to water with (comparatively) high suspended solids by changing the target analytical sensitivity (0.2 MFL). The methods chosen, EPA 100.1 and EPA 100.2, have been modified for

[3] B. Erskine and M. Bailey (2018). "Characterization of asbestiform glaucophane-winchite in the Franciscan Complex blueschist, northern Diablo Range, California", *Toxicology and Applied Pharmacology*, 361, p. 3–13.
[4] D. Van Orden, R. Lee, C. Hefferan, S. Schlaegle and M. Sanchez (2016). "Determination of the Size Distribution of Amphibole Asbestos and Amphibole Non-Asbestos Mineral Particles", *The Microscope*, 64, p 13 – 25.
[5] D. Van Orden, R. Lee, K. Allison, and J. Addison (2009). "Width Distributions of Asbestos and Non-Asbestos Amphibole Minerals", *Indoor and Built Environment*, 18, p. 531–540.
[6] D. Van Orden, J. Wilmoth, and M. Sanchez (2012). "Effect of Size Reduction Processes on the Apparent Fiber Content of Rock Samples", *The Microscope*, 60, p. 3-9.
[7] For example, see 40 CFR Part 763 Appendix E to Subpart E, and 40 CFR §61.141 ("*Friable asbestos material* means any material containing more than **1 percent asbestos** as determined using the method specified in appendix E, subpart E, 40 CFR part 763, section 1, Polarized Light Microscopy …")
[8] Analytical Sensitivity is defined as the equivalent concentration in a sample when one (1) asbestos fiber is counted.

purposes of the SGI water samples to count all fibers 5 µm and longer (instead of 10 um as provided in EPA 100.2 or 0.5 µm and longer in EPA 100.1) and all widths. These dimensions are used in estimating risk assuming any observed fibers become airborne and can be breathed. Fibers or particles shorter than 5 µm are considered to be non-carcinogenic to humans.[9]

The only promulgated standard for water is found in the EPA regulations (which have been adopted by the Pennsylvania Department of Environmental Protection, DEP) for drinking water (see 40 CFR §141.51 and 141.62). These regulations set a maximum contaminant level (MCL) of 7 MFL (million fibers per liter) for fibers 10 µm and longer. EPA has also specified two TEM analytical methods to document compliance with this standard: EPA 100.1 and 100.2 (see 40 CFR §141.23).[10] The primary difference between the two methods is the sizes of fibers to be counted: 100.2 is specifically designed to meet the regulatory control limit for fibers 10 µm and longer. It should be noted that the 10 µm requirement is a health-based criterion for the ingestion of asbestos fibers.

The EPA developed this MCL based on a review of various studies. As noted on the EPA website (https://www.epa.gov/sites/production/files/2015-06/documents/ny_hh_336_w_03121998.pdf):

> [T]he U.S. EPA (1985b, 1989, 1991) promulgated drinking-water standards to reduce the potential risk of cancer and other effects from asbestos in drinking water. The U.S. EPA (1985a, 1991) evaluated the dose-response data for ingested asbestos and calculated a cancer potency factor of 1.4×10^{-13} per fibers (longer than 10 µm) per liter (1.4×10^{-13} (fibers (longer than 10 µm)/L)$^{-1}$) using a one-hit model (extra risk) … The water concentration corresponding to the lower bound estimate on the dose associated with an excess lifetime human cancer risk of one-in-one million is 1×10^{7} fibers (longer than 10 µm)/L.

This same article notes that "that high concentrations of asbestos in water can increase airborne asbestos concentrations and increase the cancer risks from inhaled asbestos", where "high" is interpreted to be values exceeding the MCL.

Although Dr. Erskine acknowledges that the use of on-site water for dust suppression is an acceptable procedure,[11] he argues that the water, when used for dust suppression, could release potential asbestos fibers into the air. This is one reason the water sample analyses were modified to count fibers 5 µm and longer. Additionally, it should be noted that the air is directly sampled at the Charmian site which will provide direct evidence of any asbestos present in the air.

The choice of the minimum fiber length to be counted (5 µm) corresponds to the dimensions of fibers used for evaluating airborne risk (as described in the next section). These models, developed by both the

[9] Eastern Research Group (2003). "Report on the Expert Panel on Health Effects of Asbestos and Synthetic Vitreous Fibers: The Influence of Fiber Length", prepared for Agency for Toxic Substances and Disease Registry.
[10] Method 100.1, "Analytical Method for Determination of Asbestos Fibers in Water," EPA/600/4-83/043, EPA, September 1983. Available at NTIS, PB83-260471.
Method 100.2, "Determination of Asbestos Structure Over 10-µm In Length in Drinking Water," EPA/600/R-94/134, June 1994. Available at NTIS, PB94-201902.
[11] See B. Erskine and M. Bailey (2018). "Characterization of asbestiform glaucophane-winchite in the Franciscan Complex blueschist, northern Diablo Range, California", Toxicology and Applied Pharmacology, 361, at page 4.

US EPA and OSHA, use the concentration of fibers longer than 5 µm (with some additional restrictions) as the basis for evaluating risk.

Air Samples

Dr. Erskine suggests that the only appropriate analytical procedure for evaluating airborne particulate collected at the perimeter of a mining site is transmission electron microscopy (TEM) and counting of fibers of all dimensions (as short as 0.5 µm).

Analyses of air samples at SGI used two methods to determine the possible airborne asbestos concentration: NIOSH 7400 (*Asbestos and Other Fibers by PCM*) and NIOSH 7402 (*Asbestos by TEM*). Combined, these methods count and identify the fibers with the dimensions used in risk modelling (PCME, fibers 5 µm and longer with a minimum width of 0.25 µm and a minimum aspect ratio of 3:1). These risk models (see EPA IRIS[12]) utilize data derived from epidemiology studies that measured airborne asbestos concentrations using these size parameters. Recent developments in risk modeling[13] have updated both the IRIS and OSHA[14] risk models but continued to use the PCME fibers as the standard. The TEM method (NIOSH 7402) is equivalent to the method found at ISO 10312, Annex E (*Determination of the concentration of asbestos fibres and bundles longer than 5 µm, and PCM equivalent asbestos fibres*).

There is no reason to count short fibers. The pathogenicity of short fibers (shorter than 5 µm) was examined by the ATSDR in 2002 at a meeting held in New York City.[15] The panel concluded that: "Given findings from epidemiologic studies, laboratory animal studies, and in vitro genotoxicity studies, combined with the lung's ability to clear short fibers, the panelists agreed that there is a strong weight of evidence that asbestos and SVFs shorter than 5 µm are unlikely to cause cancer in humans." These findings were supported by a later study by Roggli[16] which concluded that there is no conclusive evidence that short fibers are carcinogenic.

Thus, the use of PCME fiber counting protocols are consistent with existing epidemiology and EPA and OSHA risk modelling. Dr. Erskine acknowledges this point when referencing EPA's comments made during the El Dorado investigation ("To present the 20:1 aspect ratio for commercial grade asbestos as a universal EPA policy, and to advocate its use as an appropriate standard for analyzing air samples of naturally occurring asbestos i**s inappropriate and contradictory to use of the PCME dimensional criteria as a tool for assessing exposure risk**.") [Emphasis added] In addition, the EPA, in the El Dorado report from which Dr. Erskine selectively quotes, states: "The PCME classification was used because human epidemiological studies, which form the basis of knowledge of asbestos health effects, measured asbestos fiber concentrations using phase contrast microscopy (PCM) analytical methods."

3.2 Definition and Reporting of "Asbestos"

Dr. Erskine suggests that calling a mineral particle as "asbestos" relies on inappropriate definitions, definitions that may not be applicable to NOA. Part of his argument relates to the morphological

[12] https://cfpub.epa.gov/ncea/iris2/chemicalLanding.cfm?substance_nmbr=371

[13] J. Hodgson and A. Darnton (2000). "The Quantitative Risks of Mesothelioma and Lung Cancer in Relation to Asbestos Exposure", *Annals of Occupational Hygiene*, 44, p 565-601.

[14] Occupational Safety and Health Administration, "Quantitative Risk Assessment for Asbestos-Related Cancers," OSHA Office of Carcinogen Standards, August, 1983

[15] Eastern Research Group (2003), footnote 9 above.

[16] V. Roggli (2015). "The So-called Short-Fiber Controversy, Literature Review and Critical Analysis", *Archives of Pathology & Laboratory Medicine*, 139, p. 1052-1057.

description of "asbestiform" while another part is concerned with what minerals are regulated as "asbestos".

Mineral identification

Dr. Erskine seems to be confounding mineralogy and particle morphology with these statements. When analyses are conducted, the analytical laboratory must properly identify the mineral, including amphibole minerals that are not part of the suite of regulated asbestos minerals.

Based on a review of the Erskine and Bailey article[17], it appears that Dr. Erskine is suggesting that other amphibole minerals that may occur in the asbestiform habit should also be reported as "asbestos". As noted above, the analytical laboratory should identify any such minerals, where appropriate. These other possible amphibole minerals (such as the glaucophane reported in the Erskine and Bailey article) are not found at the SGI site. If they are present, they should be reported. The amphibole minerals are easily observed using polarized light microscopy as evidenced by Figures 4, 5, and 13 of the Erskine and Bailey publication. The dimensions (especially the width) of amphibole fibers are large enough to make the amphibole minerals visible in the PLM.[18]

Asbestiform Morphology

EPA, OSHA, and MSHA all regulate the asbestiform varieties of six minerals.[19] OSHA specifically notes that they do not regulate the non-asbestos varieties of these minerals as if they were asbestos. (see the Preamble to the 1992 OSHA regulations, https://www.osha.gov/FedReg_osha_pdf/FED19920608.pdf) In addition, the PLM analytical methods require the differentiation of these mineral habits. As noted in EPA 600/R-93/116, "The qualitative preparation must allow the PLM analysis to classify the fibrous components of the sample as asbestos or nonasbestos." Also: "The major purpose of the quantitative preparation is to provide the analyst with a representative grain mount of the sample in which the asbestos can be observed and distinguished from the nonasbestos matrix."

Thus, laboratories are required by the analytical methods to classify the particles as asbestiform or non-asbestiform. In addition to morphological characteristics, one characteristic of non-asbestos amphibole minerals is that, when examined using polarized light microscopy, these particles will exhibit inclined extinction.[20] There have been several publications discussing this characteristic.[21,22] These papers examined various tremolite mineral samples and demonstrated that inclined extinction is associated with non-asbestiform mineral habits. Parallel extinction is an anomalous characteristic of asbestos fibers, but non-asbestos amphibole minerals (including actinolite) can also demonstrate parallel extinction if the crystal has a specific orientation in the PLM (lying on the (010) crystal plane). However, when using

[17] See footnote 3 above.

[18] See documents cited in footnotes 4 and 5.

[19] See 40 CFR §61.141. "*Asbestos* means the asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite."

[20] As defined in the American Geological Institute *Dictionary of Mining, Mineral, and Related Terms*, extinction is defined as: "In polarized-light microscopy with crossed polars and an anisotropic mineral in the light train, when two electric vectors (permitted light or vibration directions) of a randomly oriented crystal are parallel to those of the polars, no light is transmitted and the crystal is at extinction."

[21] J. Verkouteren and A. G. Wylie (2002). "Anomalous optical properties of fibrous tremolite, actinolite, and ferro-actinolite", *American Mineralogist*, 87, p. 1090-1095.

[22] M. Sanchez, R. Lee, and D. Van Orden (2008). "Extinction Characteristics of Six Tremolites with Differing Morphologies", *The Microscope*, 56, p. 13-27.

extinction characteristics in conjunction with morphology, the differences between asbestiform and non-asbestiform habit is discernable.

As noted above, the identification of the mineral growth habit (asbestiform or non-asbestiform) is required by the various analytical methods. The US EPA has issued as definition of asbestiform in its 1993 PLM method (EPA 600/R-93/116):

> "**Asbestiform (morphology)** - Said of a mineral that is like asbestos, i.e., crystallized with the habit of asbestos. Some asbestiform minerals may lack the properties which make asbestos commercially valuable, such as long fiber length and high tensile strength. With the light microscope, the asbestiform habit is generally recognized by the following characteristics:
>
> - Mean aspect ratios ranging from 20: 1 to 100: 1 or higher for fibers longer than 5µm. Aspect ratios should be determined for fibers. not bundles.
> - Very thin fibrils, usually less than 0.5 micrometers in width, and
> - Two or more of the following:
>   - Parallel fibers occurring in bundles,
>   - Fiber bundles displaying splayed ends,
>   - Matted masses of individual fibers, and/or
>   - Fibers showing curvature
>
> These characteristics refer to the population of fibers as observed in a bulk sample. It is not unusual to observe occasional particles having aspect ratios of 10:1 or less, but it is unlikely that the asbestos component should be dominated by particles (individual fibers) having aspect ratios of <20:1 for fibers longer than 5µm. If a sample contains a fibrous component of which most of the fibers have aspect ratios of <20:1 and that do not display the additional asbestiform characteristics, by definition the component should not be considered asbestos."

Asbestos fibers and non-asbestos cleavage fragments do not have the same dimensions. Very few cleavage fragments longer than 5 µm have dimensions of asbestos fibers and very few asbestos fibers have dimensions of cleavage fragments.[23,24] Below 5 µm the distinction is smaller but still significant.

It is our understanding that the "public health definition" of asbestos is based on the geological/mineralogical definition of asbestos and not the ≥3:1 aspect ratio adopted for convenience in counting particles,[25,26] which has no medical significance. The geological/mineralogical distinction between asbestos and non-asbestos amphiboles is well recognized. Asbestos analytical methods

[23] A.G. Wylie (1988). "Discriminating Amphibole Cleavage Fragments from Asbestos: Rationale and Methodology", *Proceedings VII Pneumoconiosis Conference, Part II*, p. 1065 – 1069.
[24] Virta, R. L., Shedd, K.B., Wylie, A.G., Snyder, J. G. (1983). "Size and Shape Characteristics of Amphibole Asbestos (Amosite) and Amphibole Cleavage Fragments (Actinolite, Cummingtonite) Collected on Occupational Air Monitoring Filters," Aerosols in the Mining and Industrial Work Environment, Vol. 2, Chapter 47, p. 633-643.
[25] W. Walton (1982). "The Nature, Hazards, and Assessment of Occupational Exposure to Airborne Asbestos Dust: A Review", *Annals of Occupational Hygiene*, 25, p. 115 – 247.
[26] E. Ilgren (2004). "The Biology of Cleavage Fragments: A Brief Synthesis and Analysis of Current Knowledge", *Indoor Build Environment*, 13, p. 343-356.

incorporate these distinctions in the physical characteristics of particles including the optical and electron optical properties of asbestos fibers and cleavage fragments.[27] The regulations regarding exposures to amphiboles and serpentines are based on the exposure to the asbestiform varieties of those minerals as defined geologically.[28]

Thus, the definition is clear and is not limited to "commercial" asbestos. It should be noted that OSHA also describes the asbestiform habit in their PLM analytical method (ID 191).

[27] A. Langer, R. Nolan, and J. Addison (1991). "Distinguishing Between Amphibole Asbestos Fibers and Elongate Cleavage Fragments of Their Non-Asbestos Analogues", *Mechanisms in Fibre Carcinogenisis*, p. 253-267.
[28] OSHA (1992). Preamble to Regulations, 57 FR 24310, June 8, 1992.