Erskine Environmental Consulting

Geologic Investigations Hazardous Materials Naturally Occurring Asbestos

Technical Memorandum

August 31, 2020

Subject: Comments on:
Additional Sample Analyses Rock Hill Quarry
Hanson Aggregates Pennsylvania LLC SMP # 7974SM1
East Rockhill Twp., Bucks Co., PA, dated August 14, 2020

EEC has reviewed Hanson's submittal regarding the analysis of additional samples, referenced above, and offers comments and opinions.

Comments are provided for two parts of the report:

1. The discussion section on pages 3 and 4 of the report, and
2. Petrographic analysis conducted by RJLG.

Although submitted under Hanson's cover, it is apparent that the analyses, interpretations and calculations in the discussion section were provided mostly, if not entirely, by RJLG. Therefore, the comments in this memorandum refer to RJLG rather than Hanson or the Hanson team.

Based on the review of the two documents, and considering the body of information provided in previous Hanson/EarthRes/RJLG submittals, EEC concludes the following:

1. RJLG acknowledges that Method ISO 22262 *"does not attempt to differentiate fibers of asbestiform from non-asbestiform morphologies"*. The method also does not provide any leeway to remove countable fibers from reporting using subjective criteria. It is required that all fibers that meet the definition of a fiber be reported as asbestos. Method EPA 600/R093/116 also does not include any provisions as well. Yet, RJLG continues to selectively remove the majority of countable fibers from the reporting of asbestos, and bases this practice on methodology that has not been disclosed. To DEP, not accepted by any regulatory agency, and not the standard to be followed as per the NVLAP accreditation.

   This deviation from the test methodologies significantly under reports the concentration of asbestos. The fibers classified as "asbestos" and "non-asbestos cleavage fragments" should be combined for reporting purposes, per test method counting rules. Also, examples of fibers in TEM photographs are virtually indistinguishable from those reported by OSHA, and meet the criteria for asbestos that is applied by essentially all asbestos testing laboratories.

2. When applying their subjective criteria, RJLG reports that 23 of 41 samples from drill core, quarry face, and selected boulders contain asbestos, representing 56% of the samples. When all countable fibers are included, asbestos was not reported

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in only four samples of the entire data set. This is far more than previously reported, and is contradictory to EarthRes' conclusion in the QGSR that the data *"indicates that detectable concentrations of asbestos are not present in the diabase rock".*

3. RJLG reports the average concentration of 1.39% and a high of 13% for the actinolite veins. Both EPA and OSHA define any material that has an asbestos concentration >1% as Asbestos Containing Material (ACM), and regulates ACM with an elevated standard. Since OSHA is particularly concerned about the exposure risk to workers when disturbing ACM, it follows that DEP should have a similar concern regarding the potential risk to those who work or live near the site, particularly children who are the most sensitive of receptors.

4. RJLG places into question the validity of TEM data, and appear to be invalidating their own test results, using language such as:

    a. *"The use of TEM for the quantification of the mass concentration of asbestos in a bulk material is challenging to interpret",*
    b. *"the ability to meaningfully extrapolate the mass observed by TEM up to the scale of a representative sample of the material of concern is lost",*
    c. *"Reliance on TEM alone as an assessment of the quantity of asbestos in natural bulk materials, such as rock, is of limited value".*

    EPA, OSHA, and the asbestos testing community at large would disagree. Both EPA and OSHA have produced approved peer-reviewed bulk testing methods by TEM, and TEM is the method of choice when quantitative mass determinations are needed and there is a desire to quantify all fibers that are not visible using PLM protocols. If RJLG feels that TEM produces a significant error, or RJLG is unable to produce meaningful test results, it should have been stated in the laboratory reports from the beginning, and the upper- and lower-confidence limits reported. If the RJLG comments are taken at face value and there is significant error, then it can be reasonably concluded that the concentrations of asbestos may be significantly higher than reported.

4. The petrographic analysis showed that actinolite veining is present across the diabase unit, and not restricted to the large macroscopic veins that were originally targeted. In addition, the analysis demonstrated that primary pyroxene crystals have been replaced, through hydrothermal alteration processes of metamorphism, to fibrous actinolite. Collectively, this shows that fibrous actinolite is pervasively distributed ("ubiquitous") across the diabase unit, and this has been documented by the presence of actinolite asbestos in most of the samples reported in the Hanson submittal.

    The original QGSSP biased the sampling based on the assumption that actinolite was restricted to the macroscopic veins, and the final QGSR concluded: *"The diabase at the Site has not undergone metamorphism upon which asbestos could materialize from the primary minerals of the igneous rock. Testing at the Site indicates that detectable concentrations of asbestos are not present in the diabase rock and rarely in the infrequent actinolite mineral veins".* A fundamental misunderstanding of geologic processes created a systemic bias and targeted sampling approach, and the report was not revised to include the new test data and revise the conclusion accordingly. This effectively invalidates the data set and

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conclusions in the "Final" QGSR, particularly when RJLG's concerns about their own TEM test data is considered.

5. EPA has stated, unequivocally, that the disturbance activity is more important to the concentration of asbestos, and that low asbestos concentrations in rock and soil may lead to high airborne concentrations. The disturbance activities during hard rock mining are extensive, with disturbance of a unit volume of rock occurring many times through the process: drilling, blasting, sizing and sorting, excavation, bulldozing, processing, and loading. In addition, traditional dust control methods are only partially effective because hard rock cannot be wetted. As a result, it can be concluded, unequivocally, that mining operations at the Rock Hill quarry has a significant potential for adverse exposure to Rockhill Township residents, particularly to sensitive receptors such as children who live or attend school near the site.

Please contact me if you have any questions.

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Comments on the Discussion Section, Pages 3-5 of the Hanson Cover Letter

The following are comments regarding the Discussion section of the Hanson submittal. Blue italic text represents the comments or text included in the submittal by the Hanson team, followed by EEC's responses in black.

"The 57 bulk samples were analyzed by TEM to determine the mass concentration of asbestos. A total of 2439 structures were counted by EPA 600/R093/116 & ISO 22262, and 2425 by ISO 10312. The population of particles represents a mixed asbestiform/non-asbestiform population of particles. This supports observations of the samples reported previously. Figures 2-3 present representative electron micrographs of asbestiform fibers and non-asbestiform particles observed in the TEM analysis".

RJLG continues to apply undisclosed and non-conforming techniques to differentiate fibers that, are in their view, asbestos as opposed to non-asbestos. As discussed in several EEC memoranda, there are no test methods that allow or otherwise provide criteria for differentiation. RJLG has not provided to DEP their criteria, and stated that they have no SOP for analysts to follow and report precise, accurate, and reproducible results.

RJLG previously argued that regulatory descriptions of asbestos, and in particular, cite the OSHA Standard and test methodology where the term asbestiform is used. It is apparent that they use this term as a justification to differentiate fibers on the basis of morphology. OSHA, however, does not apply this term to categorize fibers, and use the definition of a fiber in its test methods to report asbestos.

To illustrate this point, Figure 1 is a comparison of fibers that RJLG rejected as asbestos to those from a recent study by OSHA related to the development of a new test method to report asbestos in talc deposits[1] (see Figures 2-3 of the Hanson report and Appendix A of the OSHA evaluation; the link is provided in the footer below). The OSHA and RJLG fibers are virtually indistinguishable: they exhibit parallel to subparallel and stepped sides, stepped tips, and parting along the fiber axes that produce thinner fibers or fibrils. All of the RJLG particles would be reported as asbestos by OSHA and experienced laboratories. The differentiation is not valid, and there is no justification for rejecting actinolite fibers as non-asbestos. The concentration reported for each sample should be the sum of the two concentrations reported by RJLG. There may be other actinolite fibers that were eliminated using other undisclosed criteria. Overall, the application of undisclosed criteria used to deviate from standard test methods invalidate the data.

[1] Report of Evaluation of Cosmetics and Cosmetic Talc for FDA, Daniel T Crane, 23 February 2019
https://www.fda.gov/media/122413/download

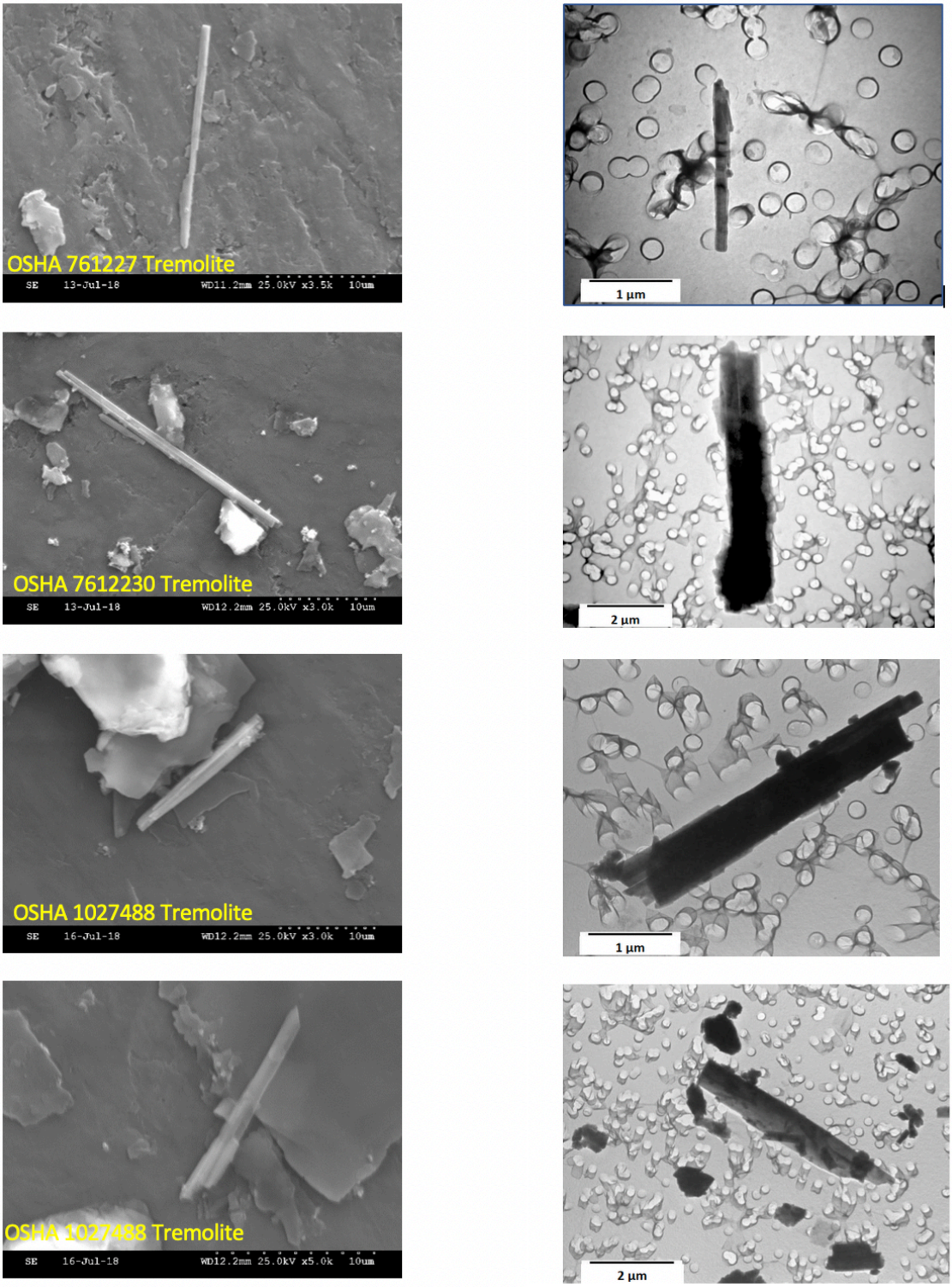

Figure 1: Comparison of fibers that OSHA has classified as asbestos (left) with RJLG photos of bundles classified as non-asbestos "cleavage fragments" (right). Note the fibers parting into thinner fibers in both sets. RJLG photos (left) from Figure 3 of the Hanson report: *"Electron micrographs of representative amphibole cleavage particles"*. OSHA photos (right) from Appendix A of the OSGA evaluation report.

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"The TEM analyses of the aggregate piles indicate that there is actinolite asbestos present in 9 of the samples. This asbestos was observed at concentrations below 0.23% (EPA 600/R-93/116). There is no significant difference in concentration of actinolite asbestos when comparing PLM and TEM results for the same samples. Where the PLM reported non-detect for asbestos, TEM either confirmed the non-detect, or determined the concentration to be much lower than the analytical sensitivity of the PLM technique, with only one exception. This indicates the utility of PLM as a screening test for crushed aggregate samples. This is further supported by the use of PLM for the testing of aggregate in methods required for use in California[7] and Nevada[8]. The TEM analysis determined asbestos was present in 9 of the 16 crushed aggregate samples, at concentrations ≤ 0.23% (average 0.049%)".

The test methods employed, EPA 600/R093/116, ISO 22262, and ISO 10312, do not provide criteria to exclude fibers from reporting on the basis of morphology. All fibers are counted that meet the definition of a fiber and are one of the five regulated minerals. RJLG used undisclosed criteria to under report asbestos in the veins and diabase, concluding that only nine of the aggregate samples contain asbestos. In fact, all of the samples collected from the aggregate piles contain reported asbestos (see Tables 5-6 in the Hanson report). The total asbestos is the sum of the asbestos column and cleavage fragment column, in accordance with the test method's reporting criteria. Only four samples in the entire data set did not contain asbestos (#4DB-4, RH-24, RH-25 and RH-28). This indicates that asbestos is not limited to the macroscopic veins as was previously reported, rather, it is distributed pervasively throughout the diabase. Additional evidence in support of this conclusion is provided in the review of the petrographic analyses following this section.

RJLG compares the test results by PLM with the results by TEM, and goes on to conclude that the results somehow validate PLM as a screening tool, a method that is known to be inferior to TEM because it cannot resolve the thin fibers of importance to NOA investigations. RJLG should know that the two methods measure two completely different and incomparable metrics. PLM provides a qualitative estimate of the projected area of large bundles relative to the total particle area, and is reported as percent by area. TEM provides a quantitative measure of mass as a percent of total sample mass, and is reported as a percent by weight. Using a false equivalency, RJLG trivializes the significance of the test data by comparing TEM data with the "analytical sensitivity" of the PLM method (it is assumed that "analytical sensitivity" refers to the CARB 435 PLM limit of quantitation of 0.25%).

RJLG seems to support their arguments by citing California regulatory requirements. To be clear: California regulations at school sites trigger protective remedial actions (such as capping) when asbestos concentrations determined by PLM are ≥0.25% AND asbestos concentrations are between 0.01%-0.001% weight percent determined by TEM. Both criteria must be met independently. A concentration of 0.23% asbestos is considered a significant concentration. For all earth moving projects, response actions (dust control, air monitoring, OSHA compliance) is triggered when asbestos is present in any amount. California subscribes to OSHA's determination that there is no known safe level of asbestos.

"The TEM analyses of samples collected from drill core, the quarry face, and selected boulders on the quarry site show a wider variation in results and show that 23 of the 41 samples in this group contain actinolite asbestos. Some of the samples contain higher concentrations (up to 13%) which is not unexpected given the targeted nature of the sampling strategy. Samples that contained macroscopic veins of amphibole were found to contain the highest concentrations of amphibole asbestos. In the 23 samples where asbestos was detected by TEM, the average concentration (EPA 600/R-93/116) is 1.39%. Sample 18 - RH #26 (3158840) was found to contain numerous non-asbestos or non-amphibole structures on the order of 200-300 per grid opening. These particles are consistent with clay weathering products of feldspar minerals and are easily distinguished from amphibole particles. These structures were not included in the counts for this sample".

Assuming that RJLG's argument that cleavage fragments, as reported using the RJLG methodology, should not be considered asbestos for the purposes of reporting, the conclusion that 23 of 41 samples contain asbestos show that at least 56% of the samples contain asbestos by RJLG's definition. This data indicates that the presence of asbestos is pervasive throughout the diabase, and this is supported by the RJLG petrographic analysis, discussed below.

The average concentration of 1.39% and a high of 13% for the actinolite veins is significant, particularly when RJLG reported microscopic veins that are present throughout the diabase (see comments on the petrographic analysis, following this section). Both EPA and OSHA define any material that has an asbestos concentration >1% as Asbestos Containing Material (ACM), and regulates ACM with a higher standard. OSHA defines work involving the disturbance of ACM as Class II Work, which triggers mandatory prescribed work practices, showers for workers, elevated training, signage, and several site-control measures. Daily, not periodic, personal monitoring is required. Because soil and rock cannot be removed "substantially intact", respirators must be worn at all times and daily personal monitoring cannot be reduced based on monitoring data. Neither OSHA nor EPA allow the compositing of different materials or averaging of test results from different units to diminish the asbestos content, as advocated by the Hanson team. Since OSHA is particularly concerned about the exposure risk to workers when disturbing ACM (>1%), it follows that DEP should have a similar concern regarding the potential risk to those who work or live near the site, particularly children who are the most sensitive of receptors.

"TEM analysis excels at enumerating (counting) and identifying microscopic fibers that had been suspended in air and collected onto membrane filters from a known volume of air. This count of fibers is used to determine the numerical concentration of respirable fibers per volume of sampled air. TEM has been shown to be a very precise tool to accomplish this task. However, the method used in this study (ISO 10312) was developed to analyze airborne asbestos fibers and does not attempt to differentiate fibers of asbestiform from non-asbestiform morphologies".

RJLG acknowledges that the counting rules of the ISO 10312 test method does "*does not attempt to differentiate fibers of asbestiform from non-asbestiform morphologies".* This is also true for EPA 600/R-93/116. Fibers are reported when they meet the definition of a fiber. How a fiber came into being is not relevant and not considered in health risk analyses using the ISO 10312 data. A new test method for asbestos in talc

deposits and products under development by nine Federal agencies, including OSHA, EPA, USGS, NIOSH and NIST, does not make this distinction[2]. Why then, does RJLG continue to under report the asbestos concentrations, including their own ISO 10312 test data, when they acknowledge it to be contrary to the test methodologies and position taken by regulatory agencies and health risk professionals?

"The use of TEM for the quantification of the mass concentration of asbestos in a bulk material is challenging to interpret. As discussed above, because of the exceedingly small mass analyzed during a typical TEM analysis it is difficult to assume the mass analyzed is representative of the entire sample. Where an air sample collected from a dusty environment may contain a total of a few micrograms of material (1 microgram is 0.000001 g), locating and identifying fibers that may have a mass of only a few picograms (1 picogram is 0.000001 microgram) would still be reasonably representative on the scale of the total mass collected in the sample. However, when bulk materials are examined at the kilogram scale, the ability to meaningfully extrapolate the mass observed by TEM up to the scale of a representative sample of the material of concern is lost. If a fiber of 1 picogram is observed, this represents 1 x 10^{-15} kilogram (0.000000000000001 kg)".

RJLG appears to be challenging the precision, accuracy, and reproducibility of their own test data, and invalidating their results and conclusions by extension. They imply that the analyses that they have been providing for months is imprecise and not accurate. There was no mention of this when RJLG reported little or no asbestos previously, but now seems to cite its importance when many previous representations have been shown, by their own data, to have been incorrect.

EPA would disagree that their methods are imprecise: EPA 600/R-93/116 states: *"It (the method) has been subjected to the Agency peer and administrative review, and it has been approved for publication as an EPA document*." EPA methods are not published without extensive evaluation, peer review, and public participation. While RJLG's argument has some validity for interpreting a single sample with few fibers counted, error and variability is significantly reduced by collecting multiple samples, providing a much larger data set of fibers. For example, RJLG did not report data from a single fiber, rather, the data set included 2439 fibers from many samples. Experienced laboratories have learned to prepare and analyze bulk samples by TEM in the 27 years since the method was first developed, and RJLG should know how to prepare, analyze, and provide reliable data.

If RJLG believes that the TEM test methodologies as applied to bulk materials cannot produce accurate data, then this should be disclosed within the laboratory reports so that the data can be appropriately interpreted. The error should also be reported, providing the lower and upper confidence limit of each sample. RJLG is stating, essentially, the actual asbestos content could be much higher that reported.

[2] Executive Summary, Preliminary Recommendations n Testing Methods for Asbestos in Talc and Consumer Products Containing Talc, January 6, 2020. https://www.fda.gov/media/134005/download

"Reliance on TEM alone as an assessment of the quantity of asbestos in natural bulk materials, such as rock, is of limited value based on the extreme difference in the amount of material present on the site and the amount of material analyzed by TEM. As an example, one kilogram of sample is approximately half of the initial sample size required to be provided to the laboratory by CARB 435 to be analyzed by PLM. The sample is ground, and several grams of ground material are produced. From this ground sample, approximately 0.001 g is analyzed by PLM during the EPA 600/R-93/116 analysis performed by RJLG for this study. For the TEM analysis, approximately 0.0004 – 0.0005 g of ground sample is dispersed onto a 47 mm diameter polycarbonate membrane filter and of that, only approximately 0.00000009 g is actually examined during the TEM analysis. This is over 100,000 times less mass than is observed by PLM. Based on RJ Lee Groups extensive experience, it would take 77 years to examine by TEM the same mass analyzed using PLM in a single analysis which can be completed in less than 1 hour".

The potential error using a small mass of a sample is corrected by preparing and homogenizing the sample correctly to be representative of the material received. Once a representative sample has been prepared, the precision and accuracy of the reported concentration is established by analyzing sufficient grid opening area to achieve a desired Analytical Sensitivity. The Analytical Sensitivity achieved during the RJLG analyses is very low, ranging from approximately 10^{-5} to 10^{-6} (0.00001 to 0.000001) percent asbestos by weight. It seems illogical that RJLG feels that test results with reportable asbestos concentrations at the 0.2% level is of "limited value" when the analyses were conducted at an Analytical Sensitivity of 0.00001 to 0.000001, four to five orders of magnitude below the reported results. Again, RJLG appears to be questioning their ability to report reliable test data, placing all of the test results in question.

"Because of the large scaling factors involved, sampling error, such as nugget effects, can become very significant in TEM analysis. It is well understood by the analytical community that the significance of large structures observed during a TEM analysis have a large impact on the mass concentration calculations. The limited statistical significance of a single large structure observed during an analysis needs to be taken into account with interpreting mass concentration results produced from a TEM analysis of a bulk material. Several samples contained in this report contain large structures that appear to have a significant effect on the calculated asbestos concentrations".

Again, RJLG appears to be instilling doubt regarding the validity of their own test data.

The "nugget effect" that RJLG cites is related to the fact that the volume of a fiber, and therefore the weight, increases exponentially with particle width. This effect, an upward bias of mass percent due to the presence of a large fiber or bundle, may subject the analysis to a large error at low Analytical Sensitivities due to low scan areas. The error is reduced by analyzing additional grid openings (larger scan area) and achieving a low Analytical Sensitivity. RJLG did just that by analyzing sufficient scan areas to achieve the low Analytical Sensitivities achieved in the analyses. As such, the "nugget effect" was sufficiently reduced or eliminated, and the relative mass contribution by the larger fibers was, in turn, properly represented.

It should be pointed out that the fiber dimensions assumed by the laboratory for their mass calculations significantly influences the final result, and RJLG's assumption depresses the concentration as compared to most laboratories. The width of the fiber in the plane of view is measured, but the width normal to the field of view must be assumed. Neither EPA 600/R-93/116 nor ISO 10312 provides criteria. Most laboratories assume that the width of asbestos fibers is equant, and use the equation: Fiber weight= (length)(width)(width)(density) to calculate the mass (in other words, a fiber has equal dimensions in cross section, much like a 4x4 board). RJLG assumes that the width of the fiber is one-half the width that is viewed in projection, and uses the equation: Fiber weight= (length)(width)(0.5 width)(density), much like a 2x4 board (see pages 24 and 25 of the Hanson report for RJLG's calculation of amphibole mass). RJLG's method reports a concentration that is half the concentration reported using the more standard approach.

RJLG's data provided in the petrographic analyses does not support the use of the equation applied by RJLG. Figure 2 is an SEM photo of a pyroxene that has been replaced by fibrous actinolite. The polishing of this rock sample produced parting of the fibrils that can be seen, even on this low-resolution photograph. The crystal appears to be separating into individual fibrils that do not have a bladed shape, and therefore, the equation using 0.5 width used by RJLG does not reflect asbestos in these samples. The equation where the two fiber widths are equant is more representative of the fibrous amphiboles, as indicated by the photograph. Therefore, the mass concentrations reported by RJLG are lower than the actual concentration, and may be under reported by a factor of two.

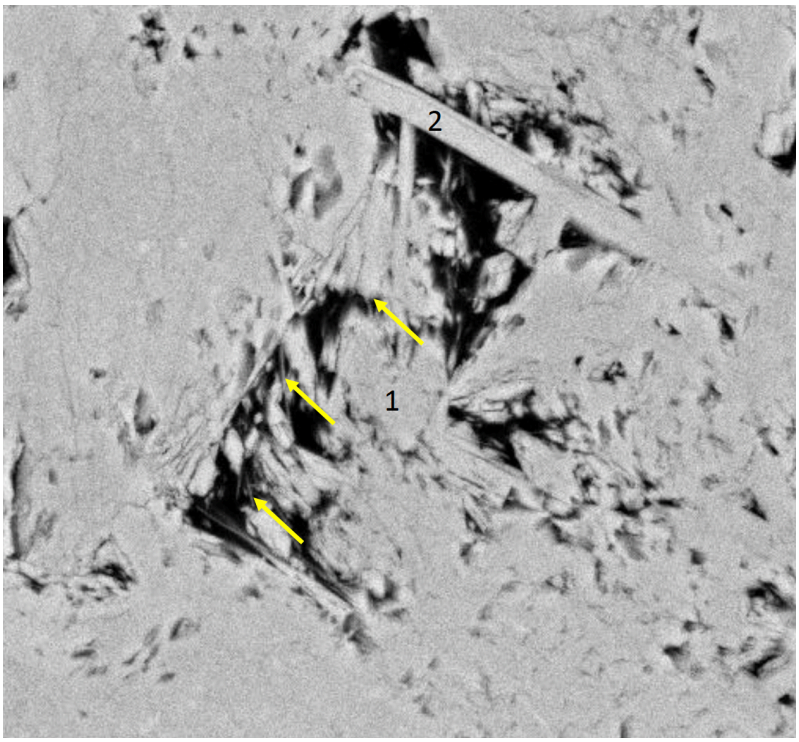

Figure 2: Pseudomorph of pyroxene that has been replaced by fibrous actinolite. Note the highly fibrous morphology (arrows), that when pulverized, will reduce the mass to fine fibers with widths that are approximately equidimensional. From Figure 19 of the RJLG report: *"DB-1 Duplicate (3161701). Backscattered electron micrograph and EDS spectra of fibrous calcic amphibole (1 & 2)".*

Comments on the RJLG Petrographic Analysis

The following are comments regarding the RJLG petrographic analysis of two samples (DB-1 and DB-5) collected from the Rock Hill quarry diabase. The analysis was conducted by a competent petrographer experienced in the petrogenesis of igneous and metamorphic rocks and processes related to the crystallization of fibrous minerals.

In summary, the petrographic analysis confirmed the following observations discussed in previous EEC memoranda:

1. Actinolite micro-veining is present, indicating that actinolite micro-veins are pervasive throughout the rock mass.

2. The diabase has been subjected to a metamorphic event where primary crystalline pyroxene in the diabase has been replaced by fibrous actinolite via hydrothermal alteration. Therefore, in addition to the actinolite micro-veining, fibrous actinolite from the replacement process is pervasive across the diabase unit.

3. The original QGSSP assumed that actinolite was present only in the macroscopic veins, and the QGSR concluded: *"The diabase at the Site has not undergone metamorphism upon which asbestos could materialize from the primary minerals of the igneous rock. Testing at the Site indicates that detectable concentrations of asbestos are not present in the diabase rock and rarely in the infrequent actinolite mineral veins".* These incorrect assumptions during the sampling phase biased the sampling effort, which led to erroneous conclusions in the geologic report.

The following are observations and conclusions that support the conclusions summarized above, based on the data provided within the petrographic report.

<u>Actinolite Micro-Veining</u>

The potential presence of microscopic actinolite veining should have been anticipated by EarthRes' geologist, and the diabase should have been sampled accordingly. Post-emplacement veining during metamorphism occurs at all scales. It is not unusual that actinolite crystallizes in the fibrous form when metamorphism is accompanied by the presence of hydrothermal fluids.

Figure 3 shows two thin section micrographs of sample DB-1 showing the fine veins that are pervasive throughout this unit. The veins cross-cut and sometimes offsets primary crystals, indicating a secondary phase of metamorphism that occurred after the initial emplacement and crystallization of the diabase. The text of the RJLG report states: *"Several veins (in the thin section studied) are present throughout mostly infilled with prismatic to fibrous amphibole with some veins showing lateral displacement."*

The analysis of the macro-veins by RJLG reported asbestos concentrations exceeding 1%, and these concentrations are applicable to the finer veins as well. The actinolite veins are one source of actinolite asbestos that was reported in most of the samples by RJLG. Note that these photomicrographs also record actinolite replacement of primary pyroxene, discussed below.

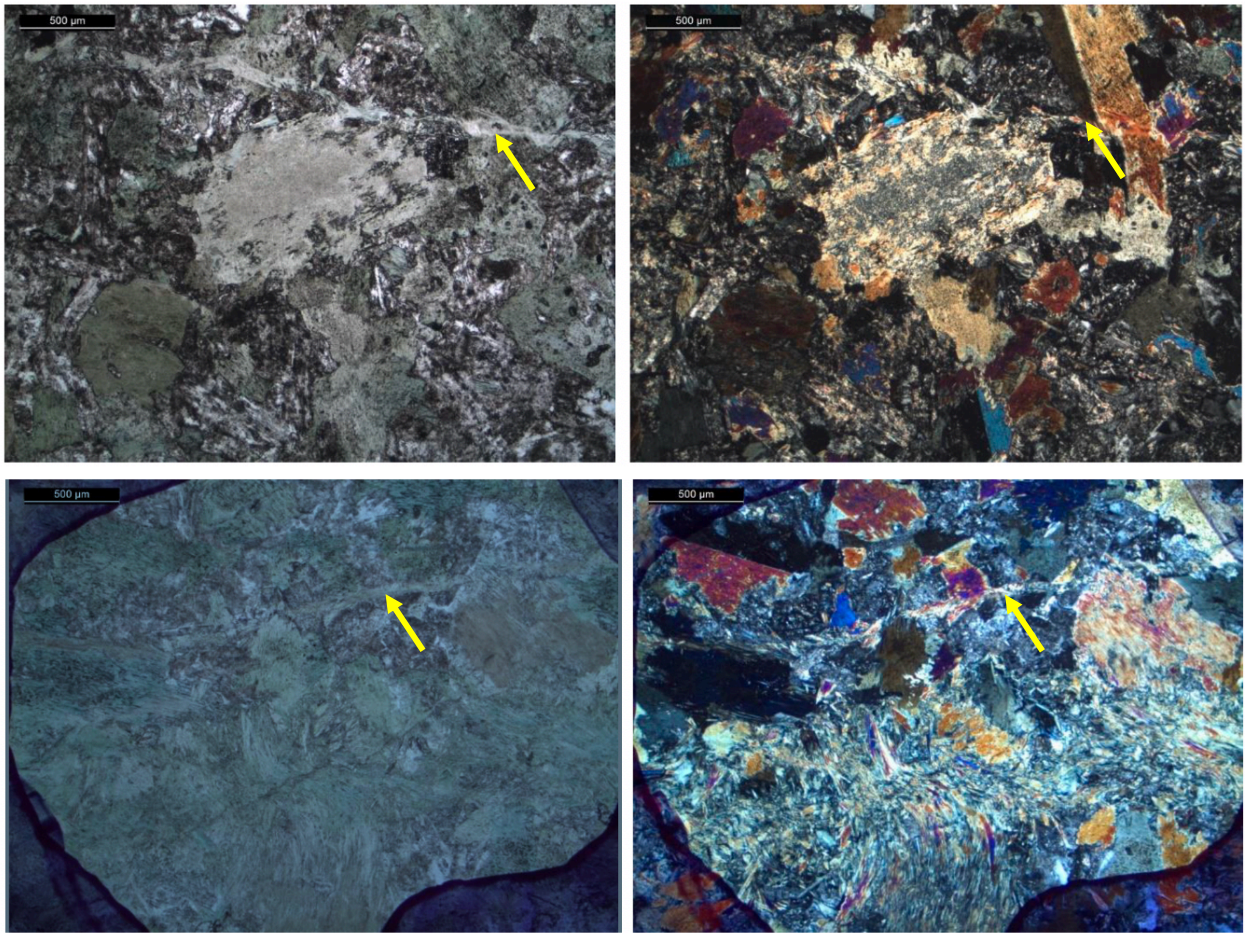

Figure 3: Location of actinolite veins (arrows) in sample DB-1, taken from Figure 10 of the RJLG petrographic analysis report. The caption of Figure 10 in the report states: *"Sample DB-1 (3158807). Plane (left) and cross (right) polarized light micrographs showing veins cross cutting sample from lower left to upper right of image. Vein mineralization comprised predominantly of calcic amphibole. Calcic amphibole pseudomorphs after pyroxene also present."*

Replacement of Primary Pyroxene to Fibrous Actinolite

Post-emplacement metamorphism of the diabase unit involving the introduction of hydrothermal fluids is documented by the replacement of crystalline single-chain pyroxene to fibrous double-chain actinolite. The replacement involved both a chemical and morphologic transformation.

Figure 4 is a reproduction of Figure 5 from the petrographic report showing the presence of secondary actinolite that had replaced primary pyroxene. The metamorphic event that produced the transformation was regional in extent and not localized, and therefore, the replacement of pyroxene to actinolite would be expected throughout the diabase unit.

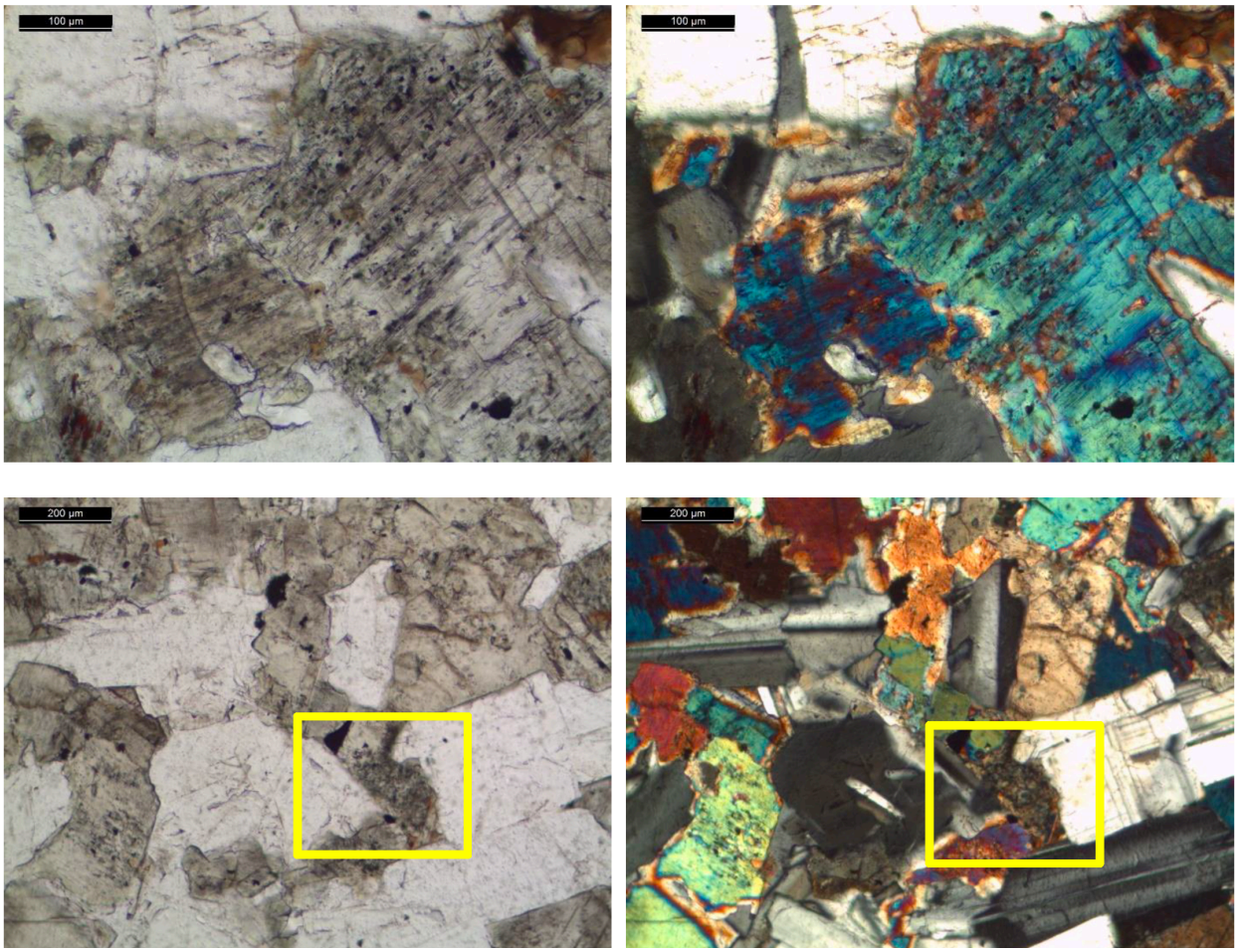

Figure 4: Photographs taken from Figure 5 of the petrographic analysis report showing replacement of pyroxene by actinolite. The caption of Figure 5 in the report states: *"Sample DB-5 (3164233). Plane and cross polarized light micrographs of representative clinopyroxene grains. Upper photos of unaltered pyroxene, lower photos show minor interstitial replacement of pyroxene to amphibole (box)."*

The caption of Figure 5 in the report describes the presence of actinolite as "minor". This use of language is common in petrographic analysis when describing the relative percentage of a mineral with respect to the minerals that dominant the rock, or that the presence of the mineral is inconsequential to the focus of the study. However, the presence of fibrous minerals is not inconsequential to a study involving asbestos: when considering the potential releasability of fibrous minerals, these relatively low amounts are significant because each amphibole crystal has the potential to release numerous fibers upon disturbance.

Consider the low-resolution SEM photograph of a tabular shaped pseudomorph of pyroxene (Figure 5) that illustrates the number of fibers that can be released upon disturbance. Note that the process of polishing the sample has plucked a large percentage of fibers from the pseudomorph, as indicated by the dark areas where fibers were removed. Another example is shown in Figure 6, illustrating the high fibrosity of the actinolite that replaced pyroxene. Both of the SEM photographs were imaged with low resolution, so the fine details are not obvious. This detail is shown in Figure 6 where the low-resolution photograph of the pyroxene pseudomorph is compared to a

high-resolution SEM photograph of fibrous actinolite that replaced crystalline hornblende amphibole in a granitic rock. The high fibrosity is apparent, as is the potential for release during disturbance. These photographs place into context EPA's determination that depending on the disturbance activity, and mining of diabase constitutes a high disturbance activity, the disturbance of relatively low concentrations of asbestos may generate high numbers of fibers leading to significant airborne concentrations of asbestos.

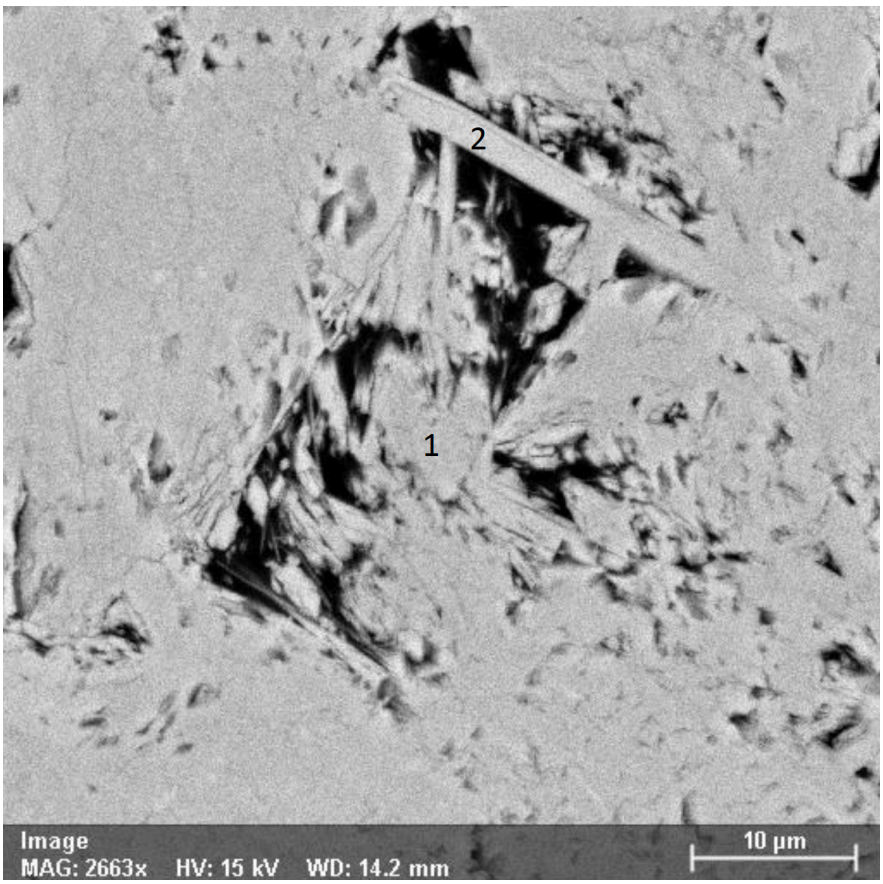

Figure 5: Photograph taken from Figure 19 of the petrographic report. The caption of Figure 19 states: *"Figure 19. DB-1 Duplicate (3161701). Backscattered electron micrograph and EDS spectra of fibrous calcic amphibole (1 & 2)."*

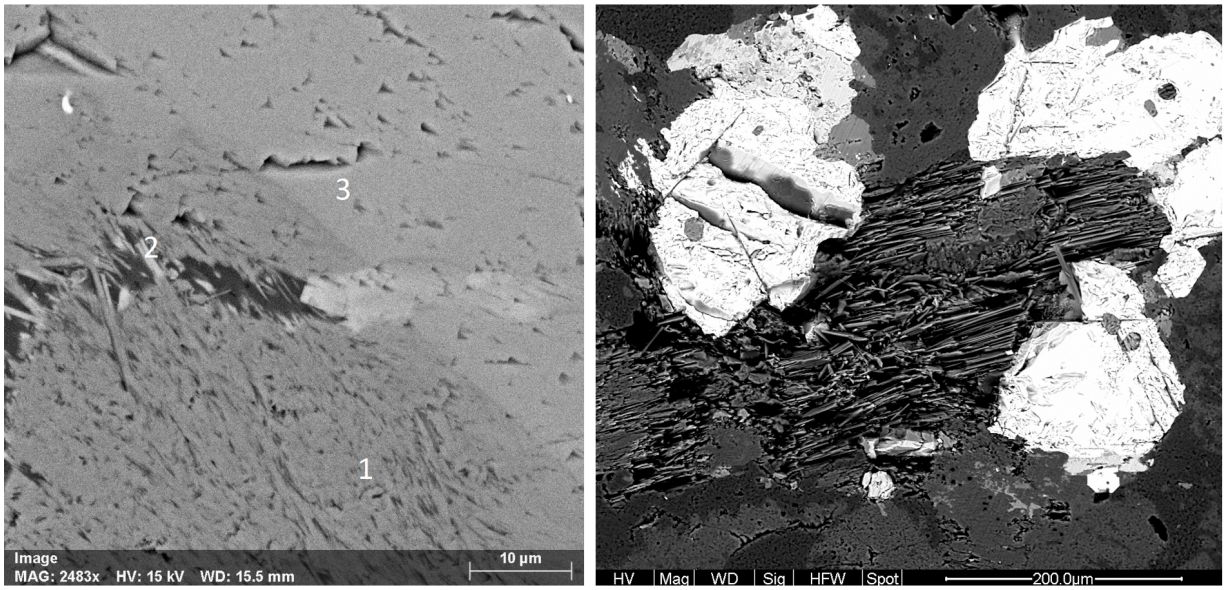

Figure 6: Comparison of fibrous actinolite replacing pyroxene within the Rock Hill diabase (left) to fibrous actinolite replacing hornblende at the Boulder City, Nevada, Bypass Project (right-photograph by Bradley Erskine). The caption of Figure 12 in the RJLG report (left photo) states: *"Sample DB-1: Backscatter electron micrograph showing variable fibrous (1 & 2) to prismatic (3) morphology and variable composition of calcic amphibole in vein (2) adjacent to calcic amphibole in altered pyroxene (1 & 3)".*

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