

August 13, 2007
Project No. 44862

Mr. Gary W. Johnson
Granite Construction, Inc.
38000 Monroe Street
Indio, California 92203

Subject: Potential Crystalline Silica Emissions and Exposure Associated with the Liberty Quarry and Other Activities in the Region

Dear Mr. Johnson:

This draft letter report presents the results of an analysis requested by Granite Construction Company (Granite) related to potential exposure of individuals to crystalline silica emissions from the proposed Liberty Quarry compared to exposure of individuals to regional sources of crystalline silica. The comparison is based on bulk samples of soil and rock at the proposed Liberty Quarry site and at the nearby Red Hawk development. We understand that a health risk assessment is going to be undertaken to further evaluate the potential health risk of such exposure.

SUMMARY

Two data sources were used to evaluate the potential exposure to crystalline silica from operations associated with the proposed Liberty Quarry and other regional activities. One was an estimate of particulate emissions associated with the proposed quarry, complete build out of the Red Hawk development, and the existing Interstate 15 (I-15) traffic through the City of Temecula. The other was an ambient air quality monitoring study of upwind and downwind locations at the boundary of two large operating quarries and aggregate plants.

Evaluation of these two data sources indicates the following:

1. Emission estimates of PM₄ and PM₄ crystalline silica from the proposed Liberty Quarry are less than PM₄ crystalline silica emissions from the Red Hawk development and existing I-15 traffic in the region.
2. Bulk crystalline silica content in the soil and rocks at the proposed Liberty Quarry site are the same or slightly less than in soils at the Red Hawk development.
3. Ambient monitoring at the boundary of active quarries does not show an increase in ambient PM₄ concentrations due to quarry activities.
4. Crystalline silica content of ambient PM₄ is much less than the crystalline silica content of bulk samples.
5. Ambient concentrations of PM₄ crystalline silica immediately adjacent to active quarries are much less than levels potentially associated with health effects (i.e.,

(on the order of 5 percent or less of the potential health effects standard published by OEHHA).

INTRODUCTION

Crystalline silica (quartz) is an ubiquitous substance found wherever there is sand and soils derived from granitic and similar rocks. In southern California, this can be geographically extensive, as the geology from the desert areas through the coastal mountain ranges to the beaches are primarily granitic rock mountains or outcroppings or alluvial and colluvial deposits from granitic sources. The proposed Liberty Quarry is located on the north side of the Riverside County and San Diego County Line adjacent to and west of Interstate 15. The Red Hawk development is located about 3 miles east-northeast of the proposed quarry site and separated from the proposed quarry by two ridgelines and I-15. The Liberty Quarry site is underlain by granitic rock (primarily granite and granodiorite) as reported by Kleinfelder in a separate study (Kleinfelder, 2006a). These rocks contain quartz, and thus some amount of crystalline silica is present. The rock underlying the proposed Liberty Quarry site is not unique to the proposed site, and the same type of rock and crystalline silica is found throughout the region.

Granite obtained and analyzed representative bulk samples of rock at the proposed Liberty Quarry and soil at the Red Hawk development. These samples showed a crystalline silica content of from 17 to 28 percent by weight at the proposed quarry and from 17 to 31 percent by weight at the Red Hawk development. Based on the geology, samples of rock or soil from other sites in the region would likely result in similar values of crystalline silica.

Crystalline silica exposure can occur anytime there are mechanical forces that grind rock/soil containing crystalline silica into very small (mean aerodynamic diameter less than 4 microns -- PM₄) particles, the very small particles become airborne, and persons inhale the particles. The California Office of Environmental Health Hazard Assessment (OEHHA) has established a reference exposure level of 3 ug/m³ PM₄ crystalline silica. If persons are exposed to concentrations of PM₄ crystalline silica greater than the REL over a lifetime, then there is the potential for health effects. (Throughout this document, "PM₄" refers to the total amount of PM₄ particles, "PM₄ crystalline silica" refers to the crystalline silica fraction of total PM₄, and "crystalline silica" refers to total amount of crystalline silica at any size.) Although the OEHHA published REL applies to all forms of exposure, the scientific studies upon which the REL is based were generally conducted for high level occupational exposure, not ambient exposures. The scientific assessment of potential crystalline silica health effects at typical ambient concentrations continues and refinements can be expected.

The presence of crystalline silica in a bulk sample is indicative, but not definitive, of potential crystalline silica exposure. This is due to the fact that it is difficult to mechanically grind any kind of rock/soil into particles as small as PM₄, and the harder

the substance being ground, the more difficult it is. Crystalline silica (quartz) is very hard, and thus a relatively smaller percentage of crystalline silica will be ground into PM₄ than other rock/soil that is not crystalline silica. A study was recently conducted to investigate this issue at aggregate quarries and processing plants, and it was found that the crystalline silica percentage of PM₄ particles is only 44% of the crystalline silica percentage in bulk samples of the same rock (Air Control Technologies, 2007).

In addition to obtaining and analyzing soil and rock samples in the proposed Liberty Quarry area and elsewhere, Granite has also conducted ambient air quality monitoring near two of its existing large operational quarries, the Tracy and Bradshaw quarries. This ambient monitoring program was designed to specifically monitor PM₄ crystalline silica in the ambient air at the boundary of the quarries. These data were reported in November 2004 (Air Control Techniques, 2004) and are also used in this assessment as discussed in the following paragraphs.

POTENTIAL EMISSIONS OF CRYSTALLINE SILICA

Kleinfelder has previously estimated (Kleinfelder, 2006b) potential emissions of particulate matter with a mean aerodynamic diameter of 10 microns or less (PM₁₀) for the Liberty Quarry, complete build out of the Red Hawk development, and for existing traffic on I-15 through the City of Temecula (Kleinfelder, 2006c). Table 1 on the following page shows the PM₁₀ emission estimates.

Total PM₁₀ emission estimates include both vehicle tailpipe and re-entrained dust emissions. Crystalline silica is associated only with the re-entrained dust. Therefore, Table 1 also provides an estimate of the non-tailpipe (i.e., re-entrained dust) PM₁₀ emissions. For the Liberty Quarry emission estimates, planned equipment and operating conditions were used to estimate the non-tailpipe emissions. Emission estimates for the Red Hawk development came from the URBEMIS model published by the California Air Resources Board (CARB). The URBEMIS model is used throughout the state of California to estimate emissions from various urban developments. It combines estimates of development activities (e.g., vehicular traffic, landscaping, space heating, etc.) with standard emission factors to estimate annual emissions of various pollutants, including PM₁₀. For the I-15 study, 91% of the emissions were from re-entrained dust. This is also consistent with the quarry emissions ratio. The 91% ratio was applied to the freeway and off-freeway traffic also.

The URBEMIS model that was used to estimate emissions from development of Red Hawk does not disaggregate tailpipe from non-tailpipe emissions. For the Red Hawk development, the URBEMIS emission estimates for total PM₁₀ include re-entrained dust and tailpipe emissions as well as emissions from other activities such as space heating and wood burning fireplaces that do not contribute crystalline silica emissions. These other sources contributed about 13.3 tons per year of the total PM₁₀ emissions. Therefore, the portion of the Red Hawk development total PM₁₀ emissions that could contain crystalline silica is 55.5 tons per year.

Table 1
PM₁₀ Emission Estimates

Notes	Source	Total PM ₁₀ Emissions (tons per year)	Portion of PM ₁₀ Emissions that could contain Crystalline Silica (tons per year)
1	Liberty Quarry On-Site Emissions	13.6	12.0
2	Total Freeway and Off-freeway Traffic Riverside and San Diego Counties as Additional Truck Traffic	8.6	7.8
3	Total Liberty Quarry Emissions Not Accounting for Stationary Source Offsets and Not Accounting for Reduction in Truck Miles Traveled in the County	24.6	19.8
4	Red Hawk Development at Full Build Out	68.8	55.5
5	I-15 traffic through the City of Temecula	126.5	115.1

Notes:

1. Liberty Quarry emission estimates are based on an initial plant design as of August 2007 for full scale operations of 5 million tons per year aggregate production in the year 2020. However, the plant design continues to be refined and may change, thus changing the emission estimates.
2. Total freeway and off-freeway traffic emissions are all emissions associated with all truck traffic involved in delivering Liberty Quarry product (aggregate, cement, asphaltic cement) to market as if all of the truck traffic was new truck traffic.
3. South Coast Air Quality Management District rules will require emission reduction credits to be obtained for some of the stationary source emissions at the Quarry. However, these offsets have not been accounted for in the net quarry emissions estimate.
4. Red Hawk total PM₁₀ development emission estimates are based on the URBEMIS 2002 model for full build out of the development (3,215 dwellings) in the year 2020, no wood stoves, and ten percent of fireplaces wood burning. The URBEMIS model uses the number of dwellings and similar development data to estimate emissions associated with that development, including vehicle traffic, re-entrained dust, operational emissions associated with the facility, landscaping, etc.
5. I-15 emission estimates are based on the California Air Resources Methodology for estimating re-entrained dust emission from vehicular traffic on freeways for Riverside county (CARB, 1997), the EMFAC2002 emissions model, and CalTrans vehicular traffic counts for 2004 through the City of Temecula, 134,300 vehicles per day (CalTrans, 2005).

A two-step process was used to estimate emissions of PM₄ crystalline silica. The first step was to determine the PM₄ fraction of the PM₁₀ emissions. This was accomplished by analyzing the size distribution of particulate emissions associated with aggregate handling and storage as reported by the USEPA (USEPA AP-42, Chapter 13, Section 2.4-3) and the size distribution of particulate emissions associated with paved roads (USEPA AP-42, Chapter 13, Section 2.1-4). The USEPA report for aggregate handling provides size fraction data for PM_{2.5}, PM₅, and PM₁₀ as a percentage of total suspended particulate (TSP). PM_{2.5} is 5.3% of TSP, PM₅ is 20%, and PM₁₀ is 35% of TSP. A linear interpolation between PM_{2.5} and PM₅ was used to estimate the PM₄ fraction of TSP as 14%. Since PM₁₀ is 35% of TSP, and PM₄ is 14% of TSP, then PM₄ is 40% of PM₁₀ (PM₄/PM₁₀ = 0.14/0.35). This PM₄ to PM₁₀ ratio was used for the proposed Liberty Quarry emission estimates. (Note that particulate matter size distributions are generally

not linear. However, since the interpolation between PM_{2.5} and PM₅ is over a very small size range, linear interpolation is sufficient.)

The USEPA report on paved road emissions provides emission factors for PM₁₀ and PM_{2.5}. The emission factors are a function of a size parameter, k, in terms of grams per vehicle mile traveled (g/VMT). The value of k for PM_{2.5} is 1.1 g/VMT and the value of k for PM₁₀ is 7.3 g/VMT. A linear interpolation was made between PM_{2.5} and PM₁₀ to estimate k for PM₄ of 2.34. Accordingly, PM₄ for paved roads is 32% of PM₁₀ ($2.34/7.3 = 0.32$). This PM₄ to PM₁₀ ratio was applied to all of the development activities and I-15 emissions.

The second step was to apply the bulk percentage of crystalline silica and the ratio of PM₄ crystalline silica to bulk crystalline silica to the PM₄ emission rates. Table 2 presents the bulk crystalline silica percentages found at the proposed quarry and at Red Hawk.

Table 2
Results of Bulk Sampling and Analysis for Crystalline Silica

Sample Location	Sample Date	Sample Number	Sample Type	Analytical Results (Percent)		
				Quartz	Cristobalite	Tridymite
Liberty Quarry	7/26/06	1	Bulk	28	ND	ND
Liberty Quarry	7/26/06	2	Bulk	17	ND	ND
Average				23		
Red Hawk	2/15/07	S-1	Bulk	24	<1.0	<1.0
Red Hawk	2/15/07	S-2	Bulk	17	<1.0	<1.0
Red Hawk	2/15/07	S-3	Bulk	31	<1.0	<1.0
Red Hawk	2/15/07	S-4	Bulk	24	<1.0	<1.0
Red Hawk	2/15/07	S-5	Bulk	27	<1.0	<1.0
Average				25		

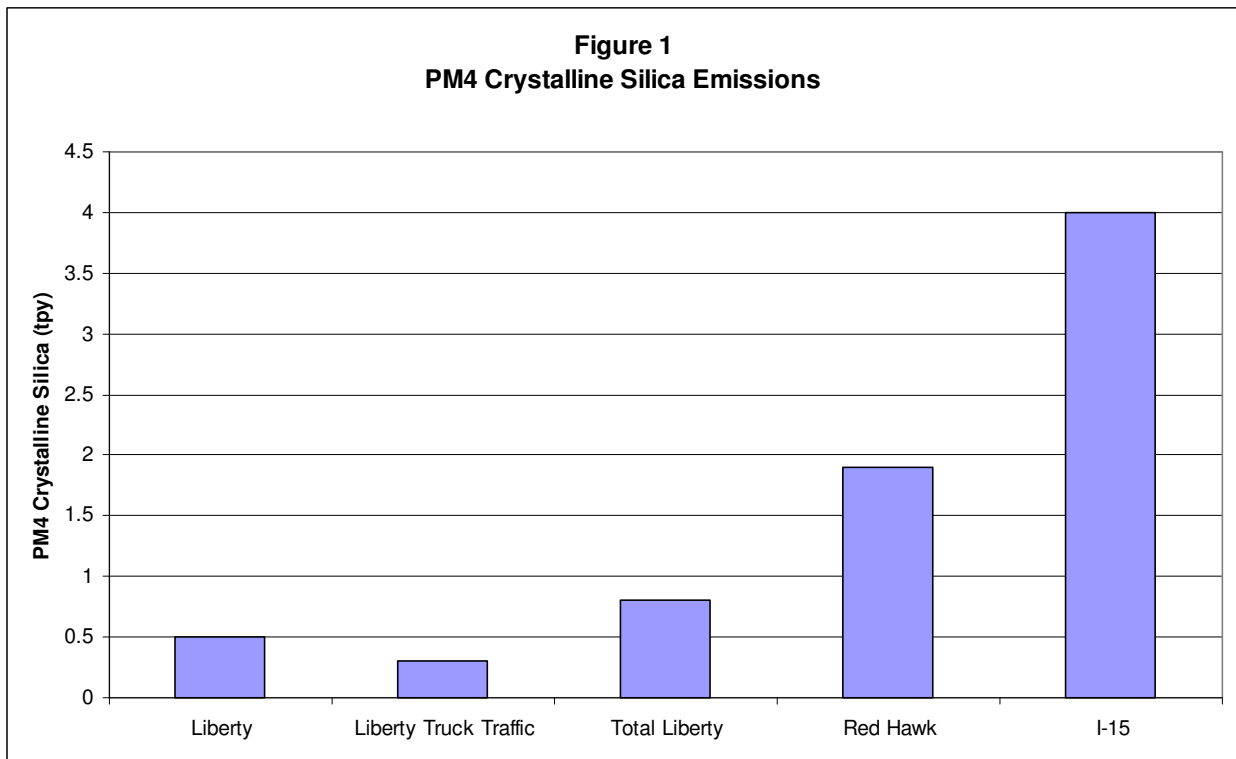
The data in Table 1 and 2 and the ratio of PM₄ crystalline silica percentage to bulk crystalline silica percentage (i.e., 0.44) can then be combined to yield the PM₄ crystalline silica emission estimates shown in Table 3. The PM₄ crystalline silica emissions from the Liberty Quarry are estimated at 4 percent of non-tailpipe PM₁₀ ($0.40 \times 0.23 \times 0.44 = 0.04$) and the PM₄ crystalline silica emissions from development activities and I-15 are estimated at 3.5 percent of PM₁₀ ($0.32 \times 0.25 \times 0.44 = 0.035$).

The same methodology was used to estimate emissions from all sources, the proposed quarry, freeway and off-freeway traffic, and development activities. In order for there to be PM₄-sized crystalline silica emitted, there must be mechanical grinding forces that crush the bulk crystalline silica into very small particles. Therefore, the type of PM₄ crystalline silica emissions is the same for all sources.

The data in Table 3 are graphed in Figure 1. These data show that the PM₄ crystalline silica emissions associated with the proposed Liberty Quarry are less than emissions associated with the Red Hawk development and much less than I-15 emissions.

Table 3
PM₄ Crystalline Silica Emission Estimates

Source	Portion of PM ₁₀ Emissions that could contain Crystalline Silica from Table 1 (tons per year)	PM ₄ Crystalline Silica Percentage of PM ₁₀	PM ₄ Crystalline Silica Emissions (tons per year)
Liberty Quarry On-Site Emissions	12.0	4.0%	0.5
Total Freeway and Off-freeway Traffic Riverside and San Diego Counties as Additional Truck Traffic	7.8	3.5%	0.3
Total Liberty Quarry Emissions Not Accounting for Stationary Source Offsets	19.8	4.0%	0.8
Red Hawk Development at Full Build Out	55.5	3.5%	1.9
I-15 traffic through the City of Temecula	115.1	3.5%	4.0



AMBIENT MONITORING RESULTS FOR CRYSTALLINE SILICA

Granite performed upwind/downwind monitoring for ambient concentrations of $PM_{4.5}$ and $PM_{4.5}$ crystalline silica at two large active quarries, one near Tracy, California (the Tracy Quarry) and the other near Sacramento, California (the Bradshaw Quarry). The monitoring was conducted by Air Control Technologies (ACT) using a R&P FRM 2000 $PM_{2.5}$ sampler that was modified by adjusting the air flow rate to sample $PM_{4.5}$ instead of only $PM_{2.5}$. This method was presented to the CARB, and although CARB has a policy that they will not officially approve methods, CARB had no adverse comments regarding the method. Based on the sampler airflow, a minimum sample time of one to three hours, and the ability of detecting crystalline silica on the filters, ACT determined that the detection limit of the method is an ambient concentration of less than 0.3 ug/m^3 . The $PM_{4.5}$ sampler is specific for $PM_{4.5}$. When PM_{10} data are obtained at the same time as $PM_{4.5}$, a separate PM_{10} sampler is used. This helps ensure that representative $PM_{4.5}$ data are obtained without potential artifacts from PM_{10} .

Both the Tracy and Bradshaw Quarries have quarrying and crushing/aggregate handling operations similar to the proposed Liberty Quarry. Production rates during the monitoring were an annual rate of about 2 million tons per year at Tracy and 2.6 million tons per year at Bradshaw. This production rate is about one-half the maximum production rate anticipated at the proposed Liberty Quarry. However, it is important to note that the proposed Liberty Quarry will also not continuously operate at the maximum annual production rate. Crystalline silica content of materials handled at Tracy ranged from 19 to 26 percent and at Bradshaw from 12 to 35 percent (the 12 percent value was for baghouse fines, other material handled at Bradshaw had a crystalline silica content of from 22 to 35%). During the sampling, wind speeds averaged from 2.0 to 6.6 miles per hour, with maximum observed winds of from 10 to 20 miles per hour. The wind speeds at the proposed Liberty Quarry are in the same range as those observed at Tracy and Bradshaw. The average wind speed at the proposed Liberty Quarry is 4 to 5 miles per hour.

The ambient monitoring showed that at upwind locations the percentage of crystalline silica in $PM_{4.5}$ ranged from about 2.0 to 9.1 percent. The downwind percentage of crystalline silica ranged from 1.8 to 4.3 percent. The ambient concentrations of $PM_{4.5}$ at the upwind locations ranged from 10.1 to 14.4 ug/m^3 and the downwind locations ranged from 6.5 to 17.0 ug/m^3 . Only one sample had a positive difference between downwind and upwind, a sample taken at the Bradshaw facility, where the downwind concentration was 2.6 ug/m^3 greater than the upwind concentration of 14.4 ug/m^3 . In all the other cases, the downwind concentrations were essentially the same as the upwind concentrations (downwind minus upwind for all samples ranged from -6.4 ug/m^3 to $+2.6 \text{ ug/m}^3$).

The crystalline silica percentage of PM₄ in any sample (upwind or downwind) ranged from 1.8 to 9.1 percent. These results can be compared to the bulk samples (not counting baghouse fines) at the quarries of 19 to 35 percent.

The maximum ambient concentration of PM₄ crystalline silica from any sample (upwind or downwind) was 0.11 ug/m³, with an average of 0.057 ug/m³. These values are 3.7 and 1.9 percent of the REL of 3 ug/m³ PM₄ crystalline silica.

The ambient monitoring study showed three things:

1. There is not a significant difference between upwind and downwind PM₄ ambient concentrations, thus quarry operations are not significant sources of PM₄.
2. The percentage of crystalline silica in PM₄ is much less than the percentage of crystalline silica in bulk samples (on the order of one-tenth as great).
3. Ambient concentrations of PM₄ crystalline silica are less than 5 percent of the REL, even immediately adjacent to active quarries that process rock with significant bulk percentages of crystalline silica. This also shows that quarry operations are not a significant source of ambient crystalline silica concentrations.

The ambient monitoring results from the Tracy and Bradshaw quarries are consistent with the emissions estimates presented in Table 3. Table 3 shows that emissions of crystalline silica at the proposed quarry are less than other regional activities and thus do not significantly contribute to ambient concentrations of crystalline silica. This is what was found in the ambient monitoring study.

CONCLUSION

Bulk samples of crystalline silica content in soils and rock at the Liberty Quarry site and at the Red Hawk development indicate that the amount of crystalline silica in both locations is similar, on the order of 17 to 31 percent. Previous analyses of particulate emissions associated with the proposed Liberty Quarry, complete build out of the Red Hawk development, and existing I-15 traffic through the City of Temecula indicate that the particulate emissions from the Liberty Quarry are less than these other regional activities. Therefore, emissions of crystalline silica and potential exposure to crystalline silica associated with the proposed quarry will also be less than that associated with other regional activities. The analysis shows that the total estimated crystalline silica PM₄ emissions from the proposed Liberty Quarry and truck traffic delivering product to market, not accounting for emission offsets, are:

- Less than 42% of the anticipated emissions from the Red Hawk development, and
- Less than 20% of the existing emissions from traffic on I-15 through the City of Temecula.

Ambient air quality monitoring conducted at the boundary of currently operating large quarries in California that contain approximately the same crystalline silica content as the Liberty Quarry region show that:

- Quarries are not significant sources of crystalline silica exposure; and
- The amount of crystalline silica in the small particles of concern with respect to health effects (i.e., PM₄) is much less than the amount of crystalline silica in bulk samples.

If you have any questions or would like for us to meet with you or others to go over the report in detail, please let us know.

Sincerely,
KLEINFELDER, INC.



Russell E. Erbes, CCM
Senior Principal

REE:mlm

- Attachments: References
- Appendix A: Crystalline and Amorphous Silica Concentrations in PM₄ Samples at Aggregate Handling Plants
 - Appendix B: CRRNOS PM₄ Crystalline Silica Emission Factor Data and Ambient Air Data
 - Appendix C: CARB Methodology, Paved Road Dust
 - Appendix D: 2004 Annual Average Daily Truck Traffic on the California State Highway System
 - Appendix E: Mineral Evaluation for Potential Asbestos Type Minerals
 - Appendix F: Air Emissions: Liberty Quarry vs. Other Area Land Uses
 - Appendix G: Air Emissions: Liberty Quarry vs. Interstate 15 Emissions
 - Appendix H: Paved Roads (c13s0201)
 - Appendix I: Unpaved Roads (c13s0202)

REFERENCES

- Air Control Technologies, 2004. *Crystalline and Amorphous Silica Concentrations in PM₄ Samples at Aggregate Handling Plants*, November 2004.
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- Kleinfelder, 2006a. *Mineral Evaluation for Potential Asbestos Type Minerals at the Proposed Liberty Quarry, Riverside County, California*, November 7, 2006.
- Kleinfelder, 2006b. Draft Letter Report Dated July 16, 2006, *Air Emissions: Liberty Quarry vs. Other Area Land Uses*.
- Kleinfelder 2006c. Draft Letter Report Dated August 5, 2006, *Air Emissions: Liberty Quarry vs. Interstate 15 Emissions*.
- USEPA, AP-42, Chapter 13, Section 2.1, Paved Roads, November, 2006.
- USEPA, AP-42, Chapter 13, Section 2.4, *Aggregate Handling and Storage Piles*, November, 2006.