

Frac Sand Mining in Wisconsin: Risks to Respiratory Health

Northwestern Wisconsin is experiencing a large expansion of frac sand mining and processing operations. Frac Sand is used to help extract oil and gas from previously hard to reach shale deposits. It is exported from Wisconsin to places with gas and oil bearing shale where it is used in a combined process called **hydraulic fracturing and horizontal drilling**. Frac sand is mixed with high volumes of water and potentially toxic chemicals and forced into the shale, where it holds open fissures allowing the oil or gas to be extracted.

Hydraulic fracturing and horizontal drilling are causing well publicized concerns over public health and land use wherever it is done. Wisconsin communities have similar concerns: destruction of productive agricultural land, risks of water contamination and depletion, degraded property values, loss of traditional rural communities, noise and traffic increases, and threats to health and safety.

Each of the thousands of oil and gas wells can use as much as 3 million pounds of sand for completion. (See, <http://www.marcellus-shale.us/Canadian-SandProppant.htm>) Demand for frac sand will be as limitless as demand for oil and gas. It is expected that many thousands of acres of Wisconsin hills, farmland and woods will be converted to open pit mines, with the transport and processing of sand occurring across the region. Therefore, the public health risks of frac sand mining must be more fully understood.

Large scale mining operations will increase the amounts of both Particulate Matter (PM) and Respirable Crystalline Silica in the air. These pollutants at certain levels can cause respiratory illnesses, including silicosis, and do pose a public health threat.

Particulate Matter

Particles are dangerous for our health. The toxicity of particles depends on their chemical composition and their size: the finer the particle is, the deeper it penetrates into our lungs. Scientists classify particles into two different size ranges which are known as **PM10** and **PM2.5**.

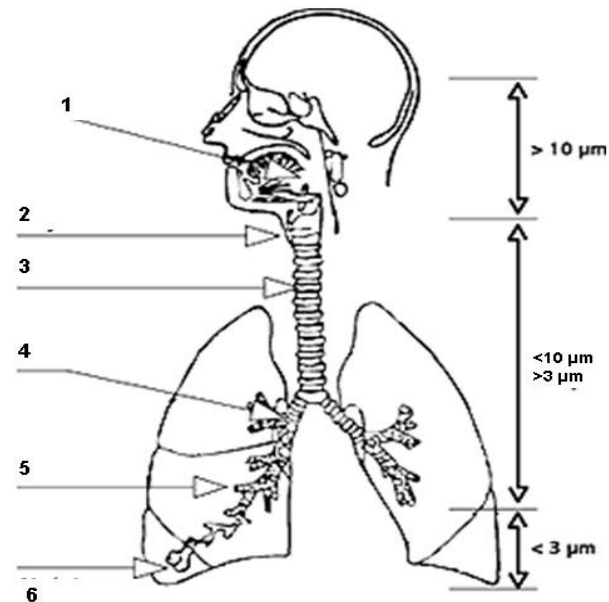
“**PM**” stands for **Particulate Matter** which is another name for particles. **PM10** refers to all particles which are **less than 10 microns (μm) in size**. **PM2.5** refers to all particles **less than 2.5 μm in size**. The size of airborne particles is significant as this determines where in the respiratory tract the particles are deposited when we breathe them in. It also governs how the particles are cleared from our system and how quickly.

The Respiratory System: Look at the diagram [that follows] of a respiratory tract; note the penetration of particles according to their size.

You can see that the coarsest particles (from 3 to 10 micrometers in diameter) tend to be deposited in the upper parts of the respiratory system. These particles can generally be expelled back into the throat.

PM2.5 are responsible for causing the greatest harm to human health because they are so small. These fine particles can be inhaled deep into the lungs, reaching the 600 million pulmonary alveoli. They can cause breathing and respiratory problems, irritation, inflammation and cancer.

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|------------|----------------------|
| 1: Pharynx | 4: Bronchus |
| 2: Larynx | 5: Bronchioles |
| 3: Trachea | 6: Pulmonary Alveoli |



The preceding material on Particulate Matter

Everybody Round the Earth, http://www.atmosphere.mpg.de/enid/2_Particles/-Particles_and_respiratory_tract_297.html

PARTICULATE MATTER (PM) can be defined as very fine solid or liquid airborne particles such as gas, dust, soot, and ash.

- **PM10** are invisible to the naked eye and small enough to be inhaled, which means they are respirable.
- **PM2.5** are small enough to be breathed into the deepest parts of lungs, and can pass through the lungs and into the bloodstream. They may also cause heart problems.
- Some airborne particles can latch on to bacteria and other toxics already in the air creating a health risk from two sources at once when these are inhaled.
- Regulatory agencies (EPA, DNR) have set standards for PM10 that must be met by industry.
 - Due to exemptions, the mining industry does not always have to “count” all the PM they produce. The dust they don't have to count is called “fugitive” dust.
 - Mining will increase the amount of particulate matter in the air via blasting, crushing, transporting and processing of the mined sand as well as from diesel truck emissions and other combustion sources.
- **Increasing the amount of PM10 in the air increases morbidity. Decreasing PM10 reduces morbidity. This is particularly true of PM2.5.ⁱ**

RESPIRABLE CRYSTALLINE SILICA

Wisconsin sandstone is mostly quartz sand, which is what the oil, gas, and mining companies need for use as frac sand. Sandstone was formed over many millenia by the compression of countless grains of sand that became cemented together to form the stone.

- **SILICA** is a compound made of oxygen and silicon (silicon dioxide).
- Silica is everywhere, because most sand, rock and mineral ores are made of silica.
- Silica exists in non-crystalline and **crystalline (sharp, jagged)** forms.
- **A grain of QUARTZ SAND is many crystalline silica particles** compressed into a single grain.
- Both sandstone and sand grains can be **fractured** into tiny particles of **crystalline silica dust**, through mining, blasting, abrasion, and crushing.
- The cementing material that holds all the grains of sand together in sandstone is mostly “free” crystalline silica particles, that are smaller than an individual sand grain. These **cement** particles of silica are safely trapped in the sandstone until they are released by mining and blasting.
- **This cement that holds all the sand grains together in a sandstone formation is expected to be a major source of dangerous silica dust in frac sand mining operations.**
- **Freshly fractured silica dust** is more harmful to lungs than aged, or weathered, silica dust such as the type that is stirred up by normal daily activities or by agricultural tilling.ⁱⁱ However, all silica dust that is small enough to be inhaled deeply carries health risks, whether it is aged or freshly fractured.
- Silica dust is a subset of Particulate Matter. **Silica dust particles larger than PM10.....**
 - can make the air visibly dustier, settle on streets, cars, vegetation and roofs
 - cannot be inhaled, but can be an irritant to skin, eyes, and noses
 - can cause upper respiratory irritation for infants because infants breathe through their mouths, bypassing the filtering function of noses
 - can clog the breathing apparatus of plants, and leaves, and increase the sedimentary load of lakes and streams where they settle
- **Silica dust particles smaller than PM10.....**
 - are invisible and respirable
 - can remain airborne for a long time and over long distances
 - **if smaller than PM4 = RESPIRABLE CRYSTALLINE SILICA**

In addition to the known health risks from breathing too much particulate matter, there are special concerns with breathing silica dust. **Because the silica particles do not dissolve, and because of their sharp, crystalline shape, the smallest sizes that are breathed most deeply into the lungs stay there permanently.**

The International Agency for Research on Cancer (IARC), and other health agencies, have determined that **Respirable Crystalline Silica is a carcinogen, or cancer causing substance. Prolonged or repeated exposure to fine airborne crystalline silica dust may cause severe scarring of the lungs, a disease called silicosis.** Silicosis can develop quickly or over many years, depending upon the amount of silica a person breathes and for how long. **Exposure to silica dust can lead to obstructive pulmonary disease. It can create breathing problems for people who have asthma, emphysema, and other obstructive lung diseases. Because the dust never leaves the lungs, its sharp edges can continue to cause irritation and inflammation for many years to come. Disease may not show up until years later, even if a person is no longer breathing silica dust. Children, the elderly, and people who already have health problems are more affected by silica dust, but anyone can be made ill by breathing this air pollutant.**

Special Concerns about AIR POLLUTION and Frac Sand Mining in Wisconsin

The demand for this sand could be as insatiable as the demand for oil, gas, and coal. The volume of sand that could be removed from Wisconsin would be exponentially greater than our traditional extraction of sand for local uses. Thousands of acres of hills, farmland, and forest will be removed with these large quarries as deep as 100 feet. To protect public health it is important to know how this will increase PM pollution.

- Mining of sandstone will release freshly fractured silica dust and increase the volume of airborne aged silica dust as well. Mining and processing will continue indefinitely and year round. Thus, there will always be fresh supplies of crystalline silica dust in the air.
- DIESEL and other combustion emissions will also contribute particulate matter pollution.
- The purpose of Air Quality Permits, as issued by regulatory agencies, is to ensure the protection of natural resources and the public health.
 - Neither the Wisconsin Department of Natural Resources nor the EPA have set a standard for Respirable Crystalline Silica, despite it being a known carcinogen. The safe level of respirable crystalline silica is known, and other states have adopted this safe level as an air quality standard. Wisconsin has not.
 - Wisconsin DNR was suppose to have completed a Silica Study by 2006, but they failed to do so. At the prompting of citizens, WDNR has begun this study and issued their final report in August 2011. (<http://dnr.wi.gov/air/pdf/finalsilicareport.pdf>)
 - Because there is no national or state standard for Respirable Crystalline Silica this air toxic is not modeled for Air Permits. Therefore, the amount of Respirable Crystalline Silica, also called “silica dust,” that will be in the air is not predicted before permits are issued.ⁱⁱⁱ
 - Permitting laws in Wisconsin do not seem to be strong enough to protect natural resources and public health from the threats imposed by large scale mining of this type, much like other states are finding their laws inadequate to protect against oil and gas drilling.
 - The Department of Natural Resources and the Environmental Protection Agency do not always require mining companies to model the **escaped (*fugitive*) dust** when they calculate how much **PM10** will be produced by a particular mining operation. The fugitive dust produced does not count against the mining company in determining whether or not their operations are major source or minor source polluters.
 - In the past, mining and processing typically occurred at the mine site, allowing significant buffer zones of protection. Now, processing plants are sited in cities near residential areas. Sand is transported from multiple distant mines using multiple haul routes thus exposing exponentially more people to potential risks. Adequate buffer zones that might contain harmful dusts are nearly impossible with this model.

NON-HEALTH RELATED CONCERNS with FRAC SAND MINING

The sandstone formations of Wisconsin not only contain quartz sand, they contain the aquifers that supply water to our rural communities. The sandstone serves as a giant filter for this water supply. Mining operations threaten this water supply in both quality and quantity.

Despite state laws requiring the reclamation of mined land, reclaimed land does not have the same fertility or filtering capabilities as unmined land. It takes years to build soil, which is a living thing.

Returning mining waste to mine sites poses soil and water contamination risks. With the sandstone removed this waste is only a short distance above the aquifer.

Other risks are reduced property values, diminished wildlife habitat, noise pollution, increased road repair costs to local communities, traffic safety issues, the loss of rural quality of life, and a greatly changed landscape.

Finally, exporting a product to be used in hydraulic fracturing of oil and gas wells risks the health of those communities, and perpetuates our dependence on fossil fuels.

MISLEADING STATEMENTS MADE BY FRAC SAND MINING COMPANIES

“We only want whole grains of sand, so we won’t be fracturing the sand grains.”

Truth: The sand in sandstone formations is not present as 100% “whole grain”, pre-washed sand. There is a cement holding the grains together, and this is mostly composed of crystalline silica particles. There may also be non-silica and other particulate contaminants present in the sandstone. Blasting is needed to break up the cemented sandstone, and this will produce and release silica dust.

Dust can also be released during truck loading, transporting, stockpiling, crushing and conveying. While washing removes much of the silica dust, and other contaminants, if the sand is transported before it is washed, then silica dust will have more opportunities to escape during transport. Thus far, mining companies are not consistently covering their trucks during transport.

“The sand we want is just like sand at the beach, round and smooth.”

Truth: This is true. However, beach sand is ALWAYS wet and the finer particles are washed out of it. The sandstone to be mined will have some moisture, but this will be variable depending upon rainfall and drought levels. The breathable sizes will not be washed out of the mined material until much later in processing. Mining companies need to spray water over fugitive dust sources to “keep the dust down” but it is not certain that this misting of freshly mined sand will restrain the smallest particles of silica dust.

Sources Used in Preparation of this Document

Canadian Center for Occupational Health and Safety website:

http://www.ccohs.ca/oshanswers/chemicals/chem_profiles/quartz_silica/health_qua.html

OSHA fact sheet about quartz silica:

http://www.osha.gov/OshDoc/data_General_Facts/crystalline-factsheet.pdf

World Health Organization fact sheet:

<http://www.who.int/mediacentre/factsheets/fs238/en/>

National Toxicology Program, Department of Human Health and Services- Report on Carcinogens, 11th Edition: <http://ntp.niehs.nih.gov/ntp/roc/eleventh/profiles/s161sili.pdf>

OSHA Silica Advisor: <http://www.osha.gov/SLTC/etools/silica/silicosis/silicosis.html>

i American Journal of Respiratory and Critical Care Medicine:

We found an increased risk of total mortality associated with each $10\text{-}\mu\text{g}/\text{m}^3$ increase in average $\text{PM}_{2.5}$ over the entire follow-up period. *Conclusion:* Total, cardiovascular, and lung cancer mortality were each positively associated with ambient $\text{PM}_{2.5}$ concentrations. Reduced $\text{PM}_{2.5}$ concentrations were associated with reduced mortality risk. <http://ajrccm.atsjournals.org/cgi/content/full/173/6/667>

American Thoracic Society, 2006 International Conference: Abstract B16. Presented May 22, 2006

The study showed that each increase of $10\ \mu\text{g}/\text{m}^2$ of PM_{10} over 2 years increased the risk of death by 32% for patients with diabetes, by 28% for patients with COPD, by 27% for patients with congestive heart failure, and by 22% for people with inflammatory diseases such as rheumatoid arthritis or lupus. <http://www.medscape.com/viewarticle/533039>

ii Environmental Health Perspectives, *Supplements* Volume 108, Number S4, August 2000, "Agricultural Lung Diseases."

Very high concentrations of inorganic dusts are generated by field activities such as plowing, tilling, haying, and harvesting. The bulk of the inorganic dusts are silicates. These include crystalline silica (quartz) and noncrystalline amorphous silica (diatomite). Newer tractors with enclosed cabs containing air filtration can decrease respirable dust exposure from an average of $2\text{-}20\ \text{mg}/\text{m}^3$ to $0.1\text{-}1\ \text{mg}/\text{m}^3$.

Inorganic dusts, however, do not contribute to agricultural respiratory disease to the same extent as organic dusts. Furthermore, the weathering effects upon respirable quartz dusts generated by agriculture are considered to be less pathogenic than the freshly fractured quartz dust generated by industrial processes such as mining, quarrying, and sandblasting. Diatomaceous silicate inorganic dusts are also considered to have relatively nontoxic pulmonary properties (7).

7. American Thoracic Society. Respiratory health hazards in agriculture. *Am J Respir Crit Care Med* 158:S1-S76 (1998)

<http://www.ehponline.org/members/2000/suppl-4/705-712kirkhorn/kirkhorn-full.html>

iiiThe Air Quality Permit issued to Canadian Sand and Proppants, Inc. (transferred to EOG Resources in May 2010) is based on a wrong theory of science. It claims that a safe level of PM_{10} guarantees a safe level of Silica Dust. This is not necessarily true. One has to know the percent of PM_{10} that is silica dust in order to make this claim. The amount of respirable silica dust could change, depending on the area of the quarry being mined, how much blasting is done, and other factors.