

# Mineral Wool Insulation is Not Green, Sustainable or Environmentally Friendly

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The proposed Rockwool factory located in Ranson West Virginia will manufacturer mineral wool insulation for use in the building industry. All insulation saves energy when installed in buildings. Because insulation saves energy it does not mean that all types of insulation are inherently sustainable. The raw material used, the manufacturing process, the emissions and by-products, the use of resources, the environmental and health impacts and the disposal method and reuse of the insulation after its life all have a bearing on the sustainability of the insulation.

Based on the following information and facts the mineral wool insulation to be manufactured by Rockwool in the Ranson factory is not green, sustainable or environmentally friendly.

## THE RANSON FACTORY MANUFACTURING PROCESS

Mineral wool is made from stone melted in furnaces. Stone is not a recycled or sustainable material. It is extremely energy-intensive to produce and has high embodied energy. The manufacturing process involves on-site fuel combustion using gas and coal in furnaces, boilers, and dryers. The stone must be melted at very high temperatures and the furnace run 24 hours a day, every day of the year. The Rockwool factory in Ranson will use the following technology and equipment to melt the stone and manufacture the mineral wool insulation:

- **Melt Furnace.** Coal Fired Melt Furnace with Bag House for emissions control.
- **Production Line** (Spinner, Curing, Cooler). Wet Electrostatic Precipitator (WESP) for emissions control.

The factory will process up to 650 tons of raw materials and use up to 93 tons of coal daily. The **stone and coal will be transported to the site in heavy duty trucks.** Based on 120 trucks transporting material to and from the factory, the service vehicles and the 150 employee vehicles which will enter and leave the factory every day, there will be on average 540 vehicles entering and leaving the factory each day, an average of 22.5 trucks or vehicles every hour, every day of the year. **One truck or vehicle will enter or leave the factory every 2.6 minutes, or 156 seconds, 24 hours a day, every day of the year.** The above estimates are only averages; there will be more traffic during peak periods such as shift changes. There will also be school buses and parents dropping off and picking up school children and traffic from local residents on the same road at the same time.

**The manufacturing process results in by-products that are hazardous.** They are stored on site in containers or lagoons susceptible to leaks and spills and then are transported by road or rail for offsite disposal.

The installation process requires workers to wear full body suits and face masks to protect them from breathing the mineral wool fibers and to protect their eyes and skin from irritation.

Mineral wool is **difficult to recycle** and has few reuse applications. It **does not decompose or breakdown** when disposed of in landfills.

## THE ENVIRONMENTAL IMPACT OF THE RANSON FACTORY

### Air Quality

The 21-story smokestacks are permitted to emit 470 tons of volatile organic compounds (VOC) and 239 tons of nitrogen oxides each year. **This will make the Rockwool factory in Jefferson County the second largest VOC**

**polluter and the tenth Hazardous Fine Particulate Matter (PM 2.5) in the state of West Virginia**, based on 2014 EPA NEI data. The dramatic increase of toxic emissions and particulate matter air pollution pose a threat to all residents, particularly the most vulnerable—the children, the elderly, and those with compromised respiratory systems.

The prevailing winds in Jefferson County are from the west, northwest. Ranson, Charles Town, Harpers Ferry and the surrounding areas will receive the greatest amount of pollution from the Rockwool smoke stacks. Shepherdstown will receive less pollution.

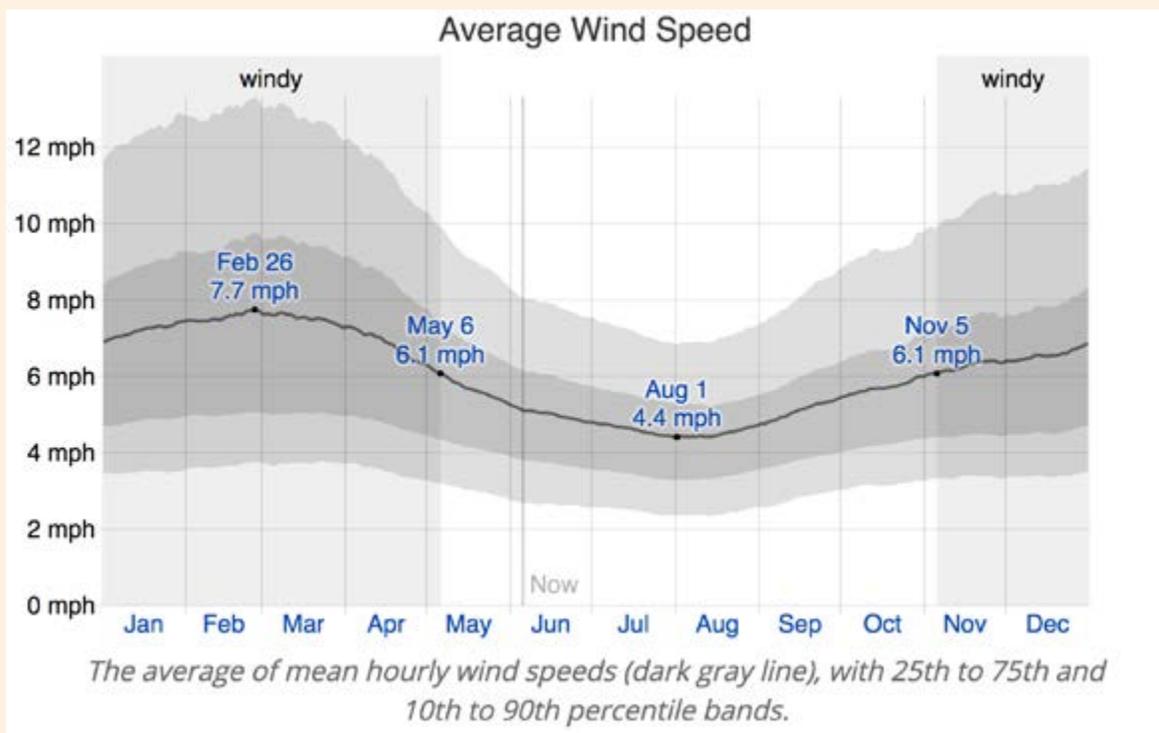
### Why Local Weather Matters

*David Michael Glenn PhD; the retired director of the USDA-ARS-Appalachian Fruit Research Station, Kearneysville, WV, with over 30 years experience in weather measurement and interpretation, provided the following weather information related to the Rockwool project:*

As stated in the Rockwool permit, they will be emitting 471 tons/year of volatile organic compounds (VOC's) and 239 tons/year of nitrogen dioxides (NOx's), the building blocks of ozone, in addition to 154 tons/year of particulate matter. The reason that

this project will construct 210 foot smoke stacks is to use wind currents to dilute and distribute the pollutants off-site.

It is my argument that wind characteristics in the Jefferson county area do not support this strategy and differ significantly from Milton, Ontario and the area near Byhalia, MS where Rockwool has existing and similar plants. The Rockwool plant's plan for mitigation of particulate and gaseous emissions with a 210 foot tall smoke stack is unacceptable to Jefferson county given the wind behavior and prevalence of calm winds for extended periods of time throughout the year.



(Source: <https://weatherspark.com/y/21067/Average-Weather-in-Charles-Town-West-Virginia-United-States-Year-Round>)

In Charles Town, WV, The windier part of the year lasts for 6 months, from November through April, with average wind speeds of approximately 7 miles per hour. The calmer time of year lasts for 6 months, from May through October with average wind speed of approximately 5 mph.

### The Effects of Calm Air Events on Particulate Pollution

From 2008 to 2017, 30% of the year had wind speeds less than 3 knots (3.45 mph) which the national Weather Service (NWS) classifies as ‘calm’ meaning there is no detectable wind motion by the instrumentation. The predominance of still air occurs at night but night or day, the still air provides ample time for particulates to settle to the ground in very close proximity to the site since this plant operates 24/7. Under these conditions, the nearby schools, businesses and homes will experience fallout of the particulate matter ranging from an average of 5 hours to an extreme of 15-20 hours throughout the year.

Ozone pollution is an additional concern. Ozone is a heavy gas and will settle to ground.

During the daylight hours from March to October when light and temperature conditions are adequate for ozone production (8 AM to 6 PM) due to the VOC and NOx emissions, calm air occurs an average of 1.5 hours of each day but calm periods can occur for 6-8 hours. These are conditions typical of the spring frosts, inversions, and hot sultry days that occur in Jefferson county. Calm wind conditions would allow ozone to be generated at the top of the 210 foot tall smoke stack and settle nearby potentially affecting

ozone sensitive groups, children and the elderly as well and further reducing soybean yield in nearby farms due to direct ozone damage.

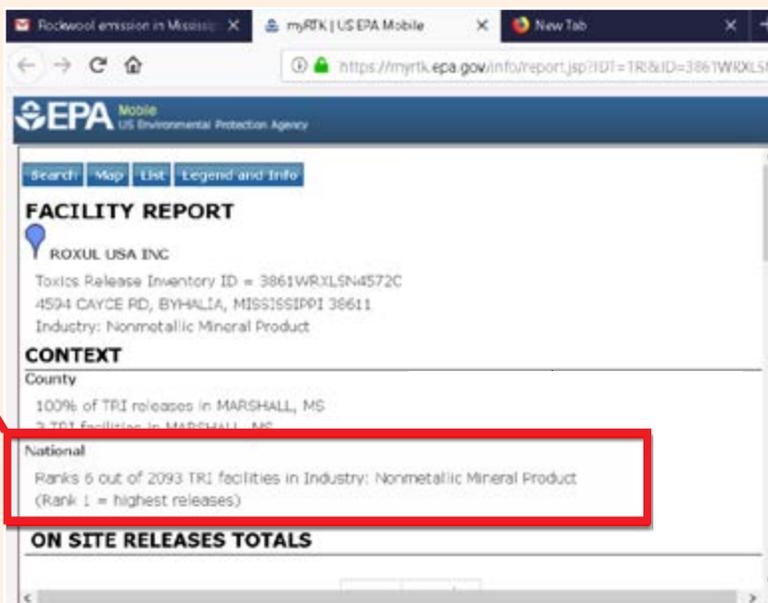
These data do not support the premise of Rockwool that a 210 foot smokestack will distribute and dilute its emissions with no effect on the populace and businesses of Jefferson County.

### Deficiencies of the AERMOD Model of Air Pollution Used by EPA and WVDEP

If you wonder why the WVDEP did not consider these conditions, it is because the AERMOD model of EPA uses hourly data and pools data into average annual events to arrive at average annual emission levels. Details such as extended periods of calm air are masked by the pooling protocol required by the AERMOD model. The ‘devil is in the details’ and those details are a critical issue in the acceptance of the Rockwool plant into the community of Jefferson County. There is no ‘average’ person and no ‘average’ day, month or year. It is the unique characteristics of each day that will determine the effect of Rockwool’s emissions on the businesses and population of Jefferson County. The fact that the WVDEP is unable to model to such a fine level of detail does not dismiss the fact that extended calm periods will have an effect in Jefferson County.

**It is my argument that the Rockwool plant’s plan for mitigation of particulate and gaseous emissions with a 210 foot tall smoke stack is unacceptable to Jefferson County given the wind behavior and prevalence of calm winds for extended periods of time throughout the year.**

**Rockwool emissions rank 6th highest out of 2,093 in the industry**



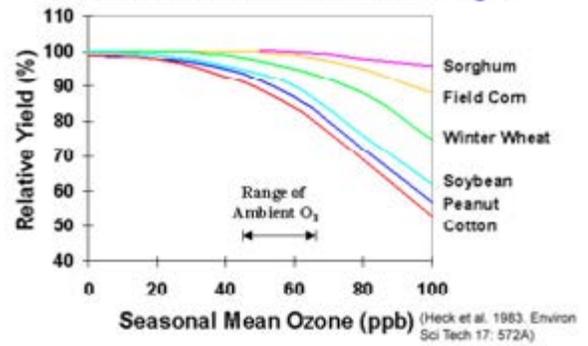
## Farming, Agriculture and Orchards

The increased pollution will impact the natural environment, including the land, agriculture and vegetation. Retired director of the USDA-ARS-Appalachian Fruit Research Station, Kearneysville, WV; David Michael Glenn PhD cites peer reviewed literature that **increased ozone levels from Rockwool could reduce crop yields for soybeans by up to 50%, winter wheat by 25% and corn by 10%.** Rockwool could harm livestock and cattle, particularly horses, which are 15 times more sensitive to particulate matter pollutants in the air than humans, according to a new study published in the journal of Veterinary Internal Medicine. Pollination by bees, which is critical to local orchards, will be impacted because of the environmental problems and loss of habitat resulting from the construction and operation of the factory.



Ozone damage on soybeans (<https://www.ars.usda.gov/southeast-area/raleigh-nc/plant-science-research/docs/climate-changeair-quality-laboratory/ozone-effects-on-plants/>)

## Effect of Ozone on Yield of Crops

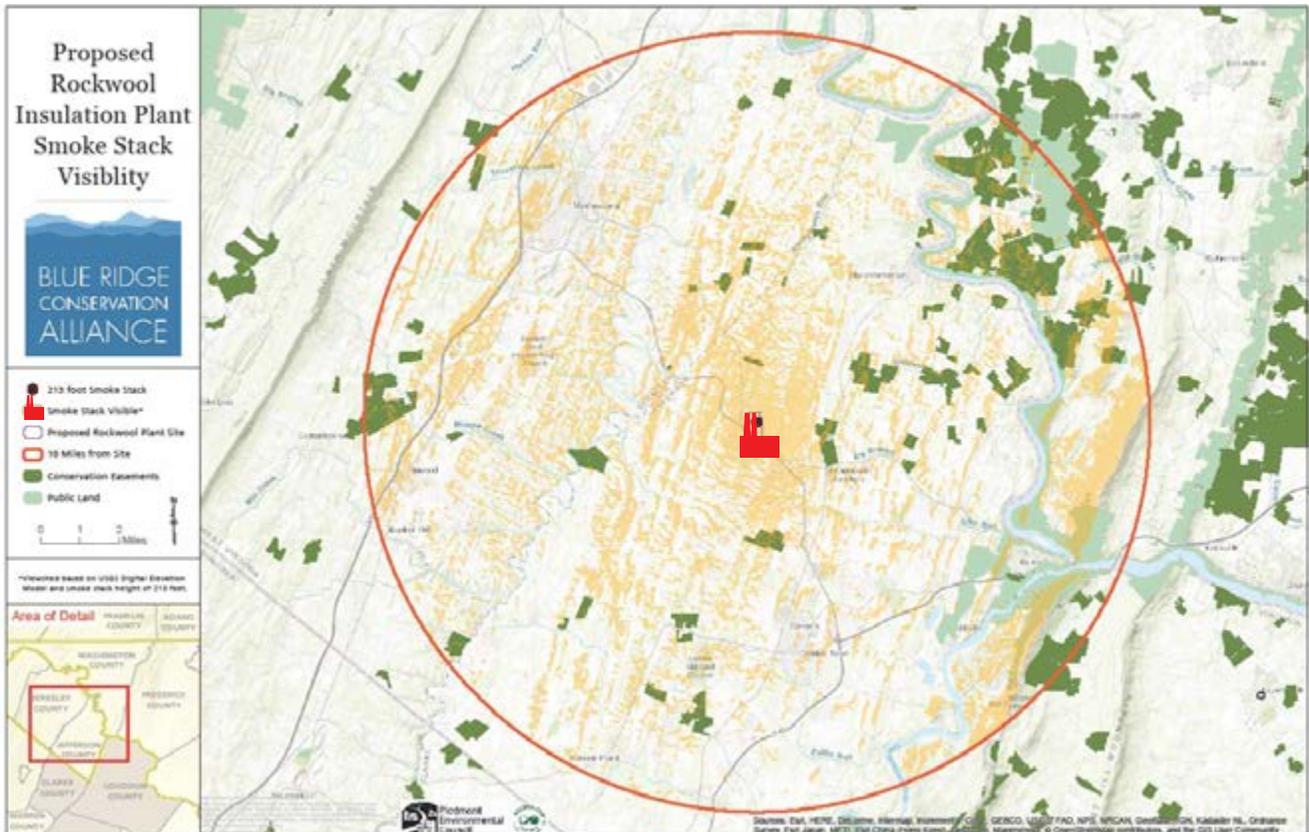


## Noise and Light Pollution

The factory will operate twenty four hours a day, every day of the year. **It will create increased noise and light pollution** for the residents, schools and businesses located within sight and hearing distance from the factory. The large number of heavy duty trucks, some carrying loads of coal, stone, and potentially natural gas, entering and leaving the factory twenty four hours a day, will also dramatically increase noise pollution for local residents.

## Visual Pollution

The Rockwool factory is located in close proximity to eleven structures listed or eligible for the National Register of Historic Place, according to the Jefferson County Historic Landmark Commission. The sight of the two 213 foot high smoke stacks, their lights and the emissions



coming from them will **negatively impact the views to and from local historic battlefields of Antietam and Shepherdstown, Harpers Ferry National Park, the Appalachian Trail as well as views of the first ridge of the Blue Ridge Mountains.**

The smoke stacks will be visible from every corner Jefferson County, including public lands and properties in conservation easement, many funded by the American Battlefield Protection Program

### Water Supply and River Pollution

The Rockwool factory is located in the Chesapeake Bay watershed and the Shenandoah River flows into the Potomac River which then flows into the Chesapeake Bay. **Storm water runoff, outside factory spills and overflows from the above ground lagoons from the Rockwool factory will flow into Rocky Marsh Run which flows into the Potomac River.** Communities, both locally and those down river from Rocky Marsh Run which depend on drinking water from the Potomac River could be impacted by the release of contaminants from the factory, potentially impacting the health of the river and the safety of the public water supply. Rocky Marsh Run is also in the Shepherdstown water supply watershed. The City of Shepherdstown pulls water from the Potomac River just after Rocky Marsh Run enters the river.

According to Rockwool’s application for a West Virginia national pollutant discharge elimination system water

pollution control permit modification, dated November 1, 2018, non-domestic wastewater from Rockwool at the Charles Town’s main wastewater treatment plant for ultimate treatment and discharge through Outlet 001, will feed into Evitt’s Run, a tributary Shenandoah River of the Potomac River.

**The Corporation of Harpers Ferry at its August 31, 2018 meeting was particularly concerned about what it has identified as a PSSC – “Potential Source for Significant Contamination” to the Harpers Ferry water supply.** Elks Run and its tributary the Elk Branch, are the main sources of drinking water for residents of Harpers Ferry, Bolivar, adjacent county customers, and the National Park Service. This watershed area is of critical concern and requires detailed scrutiny due to the proximity of the Rockwool plant to the Harpers Ferry surface water intake and the intake’s susceptibility to potential contaminants.

### Underground Water Supply, Wells, Springs, and Sink Holes

**Water for 80% of Jefferson County residents, businesses and farms is obtained from private wells.** The April 2, 2012 report, “County-Wide Groundwater Assessment Jefferson County, West Virginia” states that there are approximately 15,500+ wells in the county. The study also noted that there are areas of Jefferson County that are abundant with groundwater and also that demonstrate robust recharge. The report indicates that groundwater levels are affected by rainfall quantities, temperature and

**Any chemical introduced into the groundwater near the Rockwool Factory will contaminant the water of the northern part of the county**



**Proposed Rockwool Site**

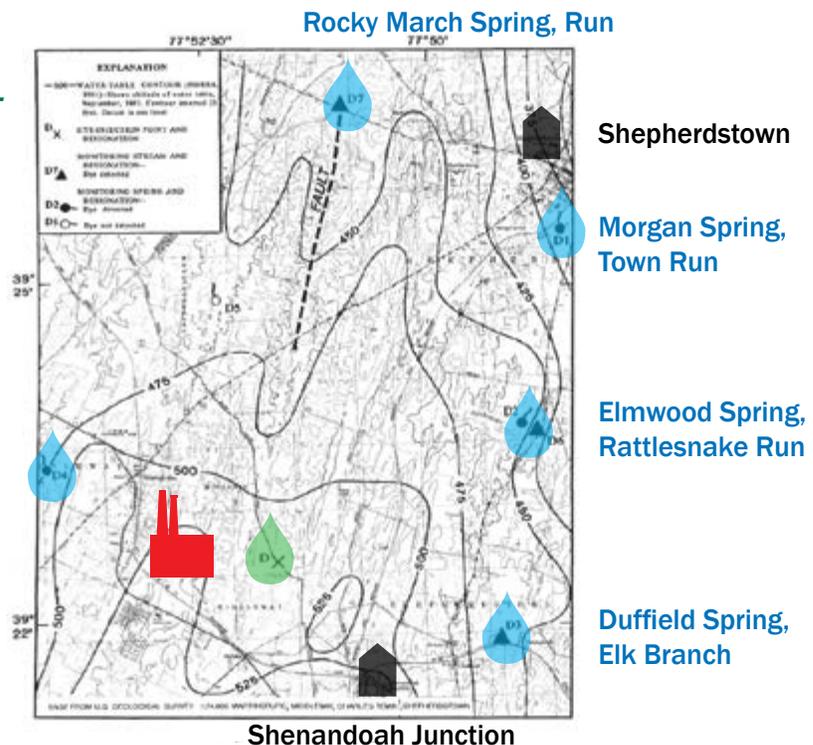


**Initial dye injection point**



**Dye detected weeks later**

**After the intial injection, dye was detected 2 weeks later at Rocky Marsh. It takes 25 weeks to clear from all locations.**



usage. According to Mary T. Sell of the Jefferson County Water Advisory Committee, the document is full of information about the availability of groundwater in the County to help inform decisions on how to best utilize and protect this critical natural resource in our County. The Assessment was prepared for the Jefferson County Commission.

Colin Stine, of Elmwood Farm has expressed concerns about the study's findings. He states that the models used to determine whether there is sufficient water is a generalized model which works 95% of the time. However he thinks that **it does not emphasize the importance of karst, and Jefferson County is primarily karst.** Therefore the models for water that were used are likely to be inaccurate. The most recent map of wells in the county was done in 2012 and includes less than 10% (~950) of the 15,000+ wells in the county. Ground water streams and wells need to be mapped before an accurate model can be produced. The assessment also does not report on the groundwater dye experiments done for USGS. The assessment does not do justice to our karst system. **Sinkholes in Jefferson County have direct connections to the groundwater and the groundwater flows rapidly in karst (limestone).**

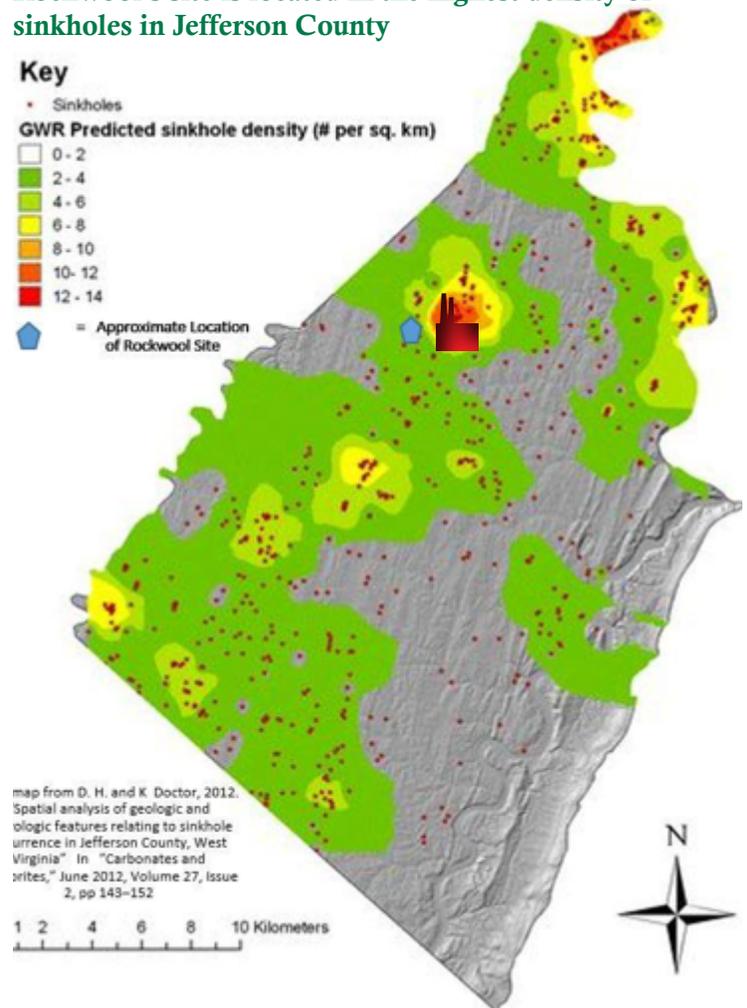
The location of the Rockwool factory, the sinkholes in Jefferson County and the local hydrology raises the possibility of pollutants entering the groundwater and contaminating wells and springs. A spill or leaking sewer line could result in health and safety issues as the contaminated material moves underground rapidly and is difficult to track and to clean up. According to maps by D.H. and K. Doctor in "Carbonates and Evaporates", June 2012, Vol 27, Issue 2, **the highest concentration of sinkholes in Jefferson County is located adjacent to the proposed Rockwool site.** The factory site is also located at the headwaters of a number of County streams.

In the 1990s, a county study injected dye into a well near Bardane in the Elk Run watershed and within less than two weeks the dye was also found in Rocky Marsh Spring, which feeds Rocky March Run, almost 8 miles away. The dye also found its way to the Morgan Spring, which feeds the Town Run, Elmwood Spring, which feeds Rattlesnake Run and the Duffield Spring- Elk Branch. The dye moved rapidly underground over a large landscape and took 25 weeks to clear from all locations. (Kozar, M. D., et al., 1990. Geohydrology, Water Availability, and Water Quality of Jefferson County, West Virginia, with Emphasis on the Carbonate Area. U.S. Geological Survey, Water-Resources Report 90-4118).

**According to Colin Stine, whose family has lived and farmed in Jefferson County since the 1940s, the water flow on his farm from the underground aquifer has significantly decreased in the past 30 years.** The farm

has five permanent springs, three seasonal springs and Rattlesnake run which flows through the center of the property. During the last ten years three of the permanent springs have gone dry in the fall, if the season is dry enough. In 1999 a portion of the Run which passes through the farm went dry for the first time. Since then a portion of the Run has gone dry during the fall in most years and in the past decade has gone dry every year, except in 2018. A portion of the Run goes dry because of an estevale in the stream in the middle of the farm. An estevale is a form of sinkhole with a dual function. It either discharges water as a spring or allows water to sink into the aquifer, depending on the groundwater conditions. The water problems of the Run on the farm have not yet affected the downstream water flow because there is one spring that has never gone dry and the Run is fed by other water sources. Another local farmer also reported that the Run through his property went dry because a sink hole opened up on the bank of the stream and all the water flowed into the sink hole. The water flow in the Run was restored once the bank was rebuilt. Also In 1999, "Elmwood Farm Spring" which is usually eight inches deep in the spring house, was down to about two inches deep. Thus the potential further lowering of the water table would cause that spring to go dry and affect the downstream water flow in the Run.

### Rockwool's site is located in the highest density of sinkholes in Jefferson County



## Streams, Wetlands, and Rare Marl Marshes

Rockwool proposes to withdraw 125 thousand gallons of water per day initially and then up to 500 thousand gallons of water per day. The internal underground drainage systems in karst areas are very sensitive to extraction. **Removing this quantity of water from the aquifers can have very serious and unpredictable adverse consequences.** Lowering of water tables can affect the hydrologic equilibrium of local streams as well as wetlands, including rare marl marshes, at substantial distances from the point of extraction. The potential impact is loss of critical wetland and riparian habitat for threatened and endangered species of plants and other forms of wildlife.

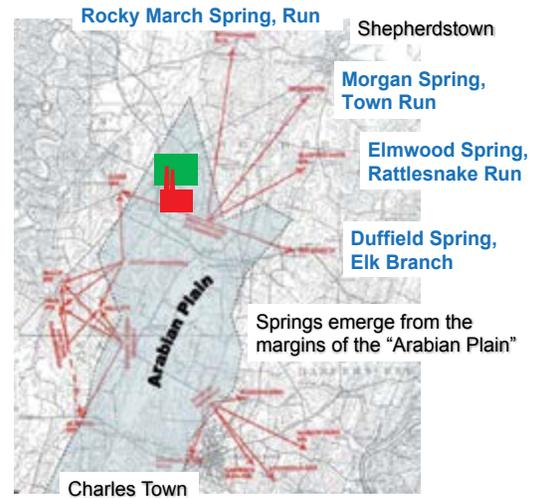


## Water Pollution in the Arabian Plain impacts most of the county

 Proposed Rockwool Site

 Highest density of sinkholes in the county

Small red arrows indicate rapid flow away from Arabian Plain to springs that feed our streams



## Endangered, Threatened, and Rare Species

In Jefferson County twenty-seven rare species live in the marl marshes. There is also one federally-listed Threatened Species: the Madison Cave Isopod, a small crustacean that lives in groundwater and has been documented in three locations, including two sites near the Rockwool factory. The WVDNR identifies several "High Quality and State Mussel Streams" including Evitts Run, Bullskin Run, Elks Run, and Long Marsh Run. The USFWS and the WVDNR also maintain lists of species of concern which includes the Baltimore Checker spot butterfly and Sedge Wren.

## Migratory Birds

Jefferson County is positioned on the Atlantic Flyway and immediately to the east of the Allegheny Front. Many migrating birds take advantage of the winds from the mountains and ridges of the Appalachian range to mitigate the challenges to their biennial long-distance flights. Migratory birds are protected under the Migratory Bird Treaty Act, which not only protects the birds themselves but also sets stipulations to protect habitats necessary for the birds' survival. According to Suzanne Offutt, Board President of the Potomac Valley Audubon



Society air emissions from the Rockwool factory, especially particulate matter, will create hazards to migrating birds using the Atlantic Flyway.

## **CELLULOUS INSULATION: A SUSTAINABLE ALTERNATIVE TO MINERAL WOOL**

Insulation is one of the most significant components of a building. In terms of volume it accounts for more than 50% of the building structure. It has the ability to significantly influence the performance of a building that goes beyond energy efficiency and heat loss.

Cellulose is a basic part of plants. Its fibers make up the pulp that is spread into sheets, pressed and dried to create paper. After the paper has been used, the plant fibers can be woven together to create a strong, durable material called cellulose insulation.

**Cellulose insulation has up to 85% recycled content and contains no formaldehyde or asbestos.** The remaining 15% is composed of natural fire retardants and anti-fungal agents such as boric acid and ammonium sulfate. Fiberglass has an average of up to 50% percent recycled content.

Cellulose insulation has a very low embodied energy and is manufactured using approximately **5 times less energy than is required for the manufacture of other insulation materials.** (1)

The cellulose manufacturing process involves fiberizing recycled paper to produce the insulation. It is a dry process driven by electric motors. The motors are powered by electricity from utility companies that supply the grid. The manufacturing process does not involve on-site fuel combustion in boilers, furnaces, or dryers or the on-site use of gas or coal. The cellulose production process also results in energy savings as it is shut down at the conclusion of a production day.

**Mineral wool is extremely energy-intensive to produce.** Stone must be melted at very high temperatures using gas and coal furnaces to turn the stone into the candy floss-like material. The furnaces run day and night, seven days a week.

**The mineral wool manufacturing process releases greenhouse gases and volatile organic compounds (VOCs) which includes six known or suspected cancer causing chemicals:** Acetaldehyde, Formaldehyde, Biphenyl, 1,3-Butadiene, Naphthalene and Benzene. Hazardous Fine Particulate Matter (PM 2.5) is also released during the manufacture of mineral wool insulation.

Cellulose insulation outperforms other types of insulation in R-Value, acoustical and fire properties, energy use, sustainability and the protection of human health and the environment. The advantages of cellulose insulation are:

### **The Best Thermal Insulation Values**

Cellulose insulation has an **R-Value of 3.7 per inch**; mineral wool which has an **R-Value of 3.0 to 3.3 per inch** and Fiberglass has an **R-Value of 2.2 to 2.7 per inch**, according to the US Department of Energy. **Cellulose insulation provides 17.5% more insulation than mineral wool**, based on an average R-Value of 3.15 form mineral wool

R-Value stands for “Resistance-Value,” and the number after the R tells how well a material keeps heat from flowing through it. The higher the R-Value, the greater the insulation power. Studies show cellulose insulation can save up to 22% in energy costs compared to other types of insulation. (2), (3).

Cellulose insulation is a densely packed insulation and is installed pneumatically resulting in no settling, voids or thermal bridges. It completely fills the gaps and voids around irregular objects such as wiring, plumbing and framing materials. Mineral wool or fiberglass insulation does not fill all the gaps or voids.

### **Water Usage and Disposal**

The cellulose insulation manufacturing process **does not use large quantities of water** and the waste fluids are not discharged into waste water or storm drains systems.

### **Optimum Sound Insulation**

Cellulose insulation provides up to **7 dB more sound insulation than conventional fiberglass** in partition walls. (4)

### **Maximum Resistance to Fire**

**Cellulose insulation has a Class 1 fire rating** and is up to 57% better at resisting fire than other types of insulation. Cellulose insulation is **treated to make it flame retardant**. Other forms of insulation do not contain active fire-resistant materials. In addition, its density is two to three times greater than fiberglass, and **qualifies as a fire-blocking material**. In a large-scale fire test it lasted 68 minutes – 60% longer than fiberglass batt insulation (5).

## Moisture Control

High-density cellulose helps prevent airborne moisture movement, improving building durability and longevity. Cellulose disperses moisture and helps to protect the surrounding building components.

It has the ability to store and release moisture without loss of its insulating properties.

## Does Not Promote Mold, Mildew or Fungal Growth

Cellulose insulation installed properly and maintained will be good for decades of excellent performance. It will not promote mold growth and meets the ASTM C-739, the industry standard for fungal resistance.

## Versatile Insulation and Availability

Cellulose insulation can be used in a variety of ways, e.g. the insulation of sloping roofs, top floor ceilings and walls or as insulation for buffer tanks, installation shafts, and vaulted ceilings and as visible spray-on acoustic insulation.

**Cellulose insulation is extremely safe to handle and install.** It contains no formaldehyde, glass fibers, asbestos, Chlorofluorocarbons (CFCs), Hydro fluorocarbons (HFC), or Hydro chlorofluorocarbons (HCFCs). There are no health risks such as cancer related warnings associated with its installation. It does not irritate skin or itch as does mineral wool and fiberglass insulation

Cellulose insulation can be purchased through a variety of retail channels - through big box retailers like Lowes and Home Depot, and also through companies like 84 Lumber, as well as through buy group co-ops and distributors like Do It Best, Cameron Ashley Building Products and True Value, among others.

## Sustainability

All types of insulation saves energy in operation but that does not mean they are all sustainable. The impact of insulation manufacture processes, use of resources and environment and health, to name a few, all have a bearing on sustainability. **Cellulose insulation has the capacity to be the most sustainable raw materials used in construction.** It absorbs carbon dioxide during growth and locks it up in the insulation material during service. It contains waste fibers or lower value fibers that would otherwise go to waste. As building standards require greater levels of thermal insulation, the environmental impact of the materials we use, in particular insulation, cannot be underestimated.

## Recyclable and Compostable

Cellulose insulation is a wood fiber product which naturally breaks down after its useful life and leaves non-toxic biodegradable materials, unlike mineral wool or fiberglass. The typical life span for cellulose insulation is 20 to 30 years.

### Sources and References

*The Alliance for Sustainable Building Products (ASBP), London, UK*

*US Green Fiber LLC, Charlotte NC, USA*

*Thermo Cell Industries, Ontario, Canada*

*Ms. Signe Sand, Architect, Denmark*

*Information Newspaper, Denmark*

*1 - Comparison is based on an R-30 value at one square foot coverage area. The comparison includes the production and energy used in the insulation manufacturing process and is based on Sustainability Impact Index prepared by Principal Partners.*

*2 - Based on a University of Colorado study (1990) comparing cellulose and fiberglass batt insulation in identical structures during the winter season.*

*3- According to Brookhaven National Laboratory Study comparing fiberglass batt to blow-in cellulose insulation and an Oak Ridge National Laboratory Study (1991), comparing fiberglass loose fill insulation to blow-in cellulose insulation.*

*4 - Based on STC ratings on complete assemblies using staggered drywall construction with Wall Spray Cellulose Insulation. Architectural Testing, Inc., Report No. A2954.01-113-11*

*5 - As demonstrated by The Large Scale Outdoor Fire Test Program comparing the fire performance of three structures: (1) an uninsulated structure; (2) a structure insulated with fiberglass batt (wall cavities) and blown-in, loose fill insulation (attic floor); and (3) a structure insulated with cellulose insulation using spray applied cellulose insulation (wall cavities) and blown-in, loose-fill cellulose insulation (attic floor) - Prepared by Steven Winter Associates Inc*

**FACT SHEET**

# The Disadvantages of Mineral Wool Insulation

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 JUNE 2019

The following information is from *INSULATION RECOMMENDATIONS - A Quick Guide to Cost, Health, and Environmental Considerations*, by BuildingGreen, Inc. The content for this report is excerpted from “Insulation Choices: What You Need to Know about Performance, Cost, Health and Environmental Considerations,” which is available through BuildingGreen.com. The full report contains detailed guidance on pros and cons of each insulation type, as well as essential background on using insulation in buildings.

### Do Not Use Mineral Wool! It has...

1. **Higher Embodied Energy** from Manufacturing than Cellulose or Fiberglass Insulation;
2. **Higher Toxic Emissions from Manufacturing** than Cellulose or Fiberglass Insulation;
3. **Higher Toxic Emissions during Application** than Cellulose or Fiberglass Insulation;
4. **Lower R-Value** than Cellulose or Fiberglass Insulation and
5. **Higher Costs** than Cellulose Insulation or Fiberglass Insulation.

Insulation	Type	R-Value	Installed Cost Per Foot for R-19 Low End	Installed Cost Per Foot for R-19 High End	Environmental Notes
<b>Cellulose</b>	Spray	3.8 - 3.9	\$0.73	\$1.59	High recycled content. Low embodied Energy. Low toxic emissions during application. Low Toxic emissions during manufacture.
	Loose fill	3.6 - 3.7	\$0.64	\$0.80	
<b>Fiberglass</b>	Batt	3.3	\$0.88	\$1.88	Low recycled content. High embodied Energy. Formaldehyde binders. Toxic emissions during manufacture.
	Blown-in	3.8	\$0.66	\$0.83	
	Spray	3.7 - 4.2	\$0.60	\$0.79	
<b>Mineral Wool</b>		3.3	\$1.20	\$1.44	Low recycled content. High embodied Energy. Toxic emissions during application. High toxic emissions during manufacture.

**R-Value** ranges reflect the variability of products, and for some spray-applied products, a range of installed densities.

**Installed Cost** estimates are provided by Vermeulens Cost Estimating and Davis Langdon, and are intended to be relevant throughout the U.S. Specific project conditions may affect costs, such as scale, scope, new vs. retrofit, or